Departament d'Enginyeria de Serveis
i Sistemes d'Informació
UNIVERSITAT POLITÈCNICA DE CATALUNYA

Development of the conceptual schema of the *osTicket* system by applying TDCM

Research Report

Albert Tort Pugibet
atort@essi.upc.edu

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Contents

1. Introduction

Conceptual schemas of information systems can be tested [6]. This essentially means that there is a testing language, in which the conceptual modeler writes programs that test the conceptual schema, and a testing environment in which test programs are executed.

TDCM is an iterative method aimed to drive the elicitation and the definition of the conceptual schema of an information system. TDCM uses test cases to drive the conceptual modeling activity. In TDCM, conceptual schemas are incrementally defined and continuously validated.

This document reports a case study application of Test-Driven Conceptual Modeling (TDCM) in the development of the conceptual schema of a well-known, open-source and widely-used online support system called *osTicket* [3]. In contrast with the case study application of TDCM in the development of the conceptual schema of a bowling game system [5], in this report TDCM is applied in order to perform reverse engineering of an existing system.

Chikofsky and Cross [1] defines reverse engineering as follows: *"Reverse engineering is the process of analyzing a subject system to identify the system's components and their interrelationships and create representations of the system in another form or at a higher level of abstraction". "The purpose of reverse engineering is to understand a software system in order to facilitate enhancement, correction, documentation and redesign".*

In this report we will use the testing language called CSTL (Conceptual Schema Testing Language) [4,6] in order to specify conceptual test cases. A CSTL processor prototype will be used to execute the test cases.

In the following, we briefly present the system used as a case study in this report (Section 1.1) and the expected properties and assumptions of the Conceptual Schema Under Development (CSUD) (Section 1.2).

1.1. The *osTicket* system

Ticket support systems allow customers to create and keep track of support requests as tickets and allow staff members to organize, manage and respond them. A ticket contains all the information related to a customer support request.

In particular, *osTicket* is an open source support ticket system which *"is designed to improve customer support efficiency by providing staff with tools they need to deliver fast, effective and measurable support"* [3].

The *osTicket* system allows users to create new tickets online or by email. It also allows the staff to create tickets in behalf of customers. The system provides automatic notices by email when a ticket is created, responded, etc. Moreover, the system allows the staff members to add internal notes to tickets. Configurable help topics, assignment of staff responsibility for each ticket, due dates, departments, priorities, etc. are also offered. Finally, customers may access the system to keep track of the status of their tickets and reply them.

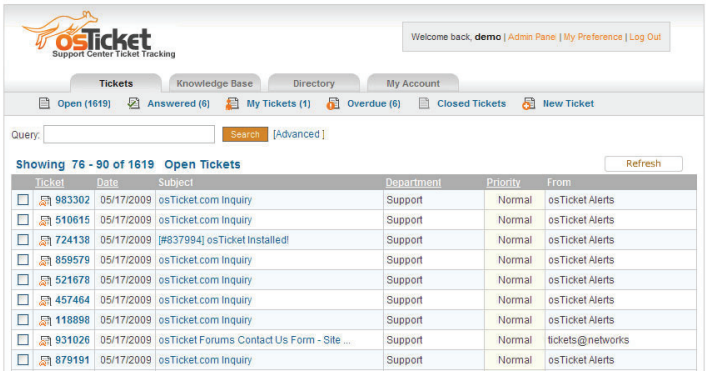


Fig. 1. *osTicket*'s staff panel screenshot

1.2. The Conceptual Schema Under Development

In this report, **we present an experimental application of Test-Driven Conceptual Modeling (TDCM) for the reverse engineering development of the UML/OCL conceptual schema of the *osTicket* system** (version 1.6.0).

You may review the main concepts and notation used to define the conceptual schema under development in [6].

In the following, we comment some assumptions about the desired properties of the Conceptual Schema Under Development (CSUD) in this case study. We defined these assumptions and properties for two different (but interrelated) areas of knowledge which constitute the *osTiket* system: 1) The basics and the configuration of the system and 2) The management and tracking of tickets.

Basics and configuration of the system

The *administrators* set the basics and the configuration of the system. Configuration includes knowledge about the system settings, the staff and administration users, the departments, etc.

The configuration knowledge is only updated according to changes in the customer support policy or due to changes in the organization of the company.

All configuration concepts and the relationships between them are assumed to be set by means of the occurrence of implicit structural events (entity insertion or update and relationship insertion or update) associated to each entity type or relationship type. We also assume that the occurrence of an implicit structural event is only valid if the resultant Information Base (IB) state is consistent according to the static constraints defined in the schema.

Therefore, **we only focus on the structural conceptual schema** for the system basics and configuration. No domain events are defined for the configuration because implicit structural events are assumed to exist.

Similarly, no predefined queries are specified because all base and derived configuration knowledge is assumed to be visible by the administrators.

Tickets management and tracking

Customers may create, comment and keep track of their tickets online by using the *osTicket* system. *Staff members* can also create tickets on behalf of *customers*. *Staff members* may manage tickets, assign them to other staff members or departments, post responses and internal notes, close them, reopen them, etc.

The knowledge about tickets management and tracking must be consistent with the structural conceptual schema of the system configuration part defined above.

The state of the domain may not change arbitrarily. Changes in the domain about tickets management are not as simple as implicit structural events for each schema element and not all changes are valid. Therefore, **for the purpose of defining the general knowledge about tickets management and tracking, the conceptual schema fragments of this area of knowledge is expected to include both the structural conceptual schema and the behavioral schema**.

The behavioral schema consists of the definition of the domain events (that define the valid changes of the information base) and significant predefined queries which specify commonly queried knowledge. The specification of the domain events ensures that all the changes in the Information Base are valid and they don't lead to inconsistent states. Moreover, all knowledge defined in the conceptual schema is assumed to be visible for staff members and customers (according to the defined visibility privileges).

2. Testing strategy

The application of TDCM should be supported by a previously defined testing strategy. Defining a strategy comprises the design of a representative set of test cases, which are the input of the TDCM application. The testing strategy should also include criteria to determine the source of the test cases and its order of processing when applying TDCM.

2.1. Strategy overview

Figure 2 summarizes the strategy overview for the development of the conceptual schema of the *osTicket* system. In the following, we explain the strategy for each area of knowledge of the CSUD. The strategy is aimed to determine 1) the source artifacts for defining the user stories which will be formally specified as test cases (which are the input for the TDCM application) and 2) the order of testing processing (aimed to minimize the dependencies that may lead to test cases rewriting).

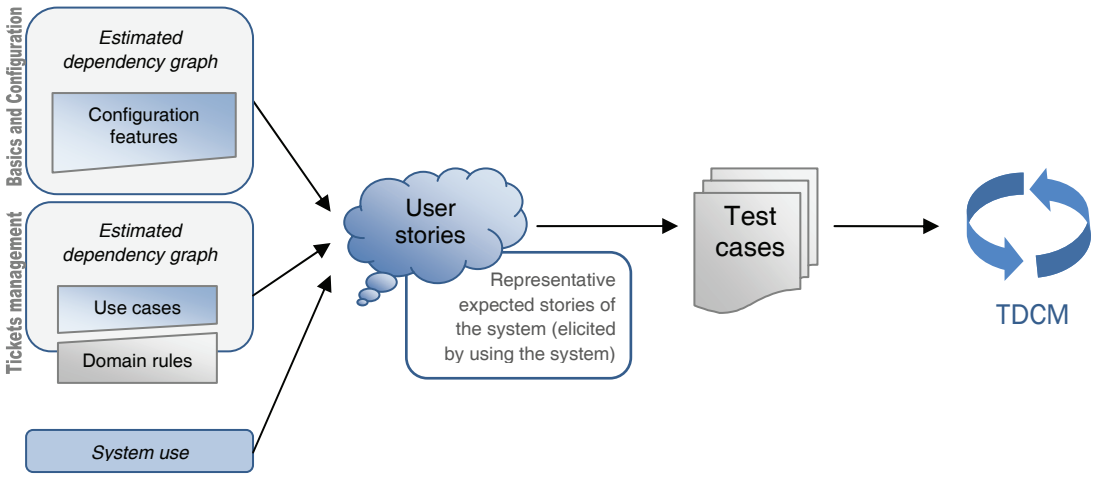


Fig. 2. Testing strategy

Basics and configuration of the system

The source artifacts are:

- An informal list (written in natural language) of requirements related to the basics and configuration of the system. These informal requirements are elicited from the public documentation of the *osTicket* system and by using it.
- An estimated dependency graph between the informal requirements.

Administration user stories will be written in order to cover representative configurations of the informal requirements. These stories will be formally specified as test cases.

The order of processing of test cases during the TDCM application will be determined by the following rules:

- In each TDCM iteration, the processed test case should have the minimum number of dependencies with non processed test cases. It allows minimizing the necessity of rewriting test cases and improves the efficiency of TDCM.

Tickets management and tracking

The source artifacts are:

- The specification of the use cases that informally describe the behavior of the system.
- The specification of the main domain rules of the system.
- An estimated dependency graph between the use cases and the domain rules.

Staff and customer user stories will be written in order to cover representative uses of the system (specified as use cases). User stories may be applied to different configurations of the system. These stories will be formally specified as test cases.

The processing order of test cases during the TDCM application will be determined by the following rules:

- In each TDCM iteration, the processed test case should have the minimum number of dependencies with non processed test cases. It allows minimizing the necessity of rewriting test cases and improves the efficiency of TDCM.

3. Source artifacts

In the following we describe the source artifacts for applying TDCM according to the testing strategy stated in Section 2.

3.1. Configuration and basics

Informal specification of features

(*) Mandatory properties

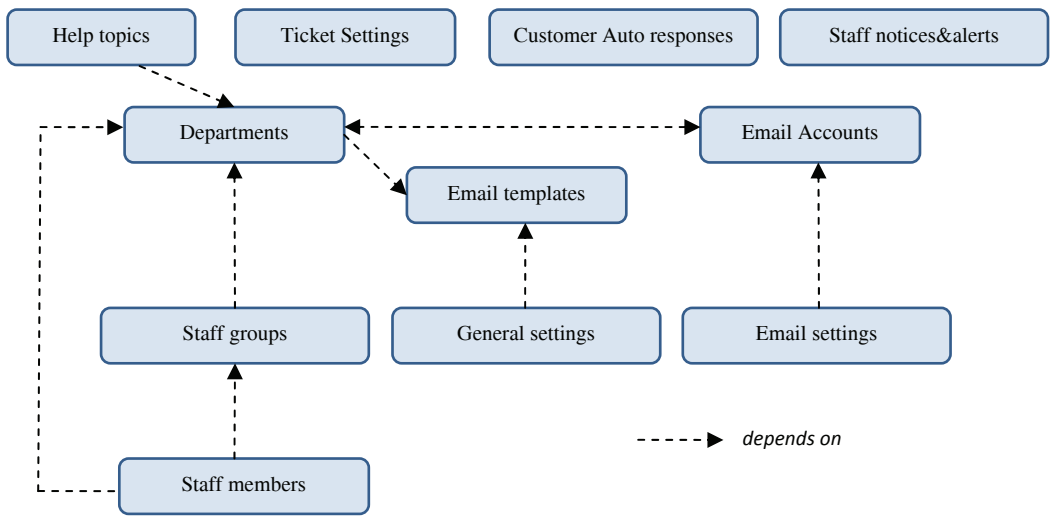
- **General settings:**
  - Helpdesk status: Online (customer functionalities active) / Offline (only staff functionalities are allowed) (*)
  - Helpdesk url: The root path for customers (*)
  - Helpdesk name: The name of the helpdesk (*)
  - Default email template: The default email template used when a mail is sent (*)
- **Ticket settings**
  - Ticket IDs mode: Sequential/Random (*)
  - Default priority: Low/Normal/High/Emergency (*)
  - Customers can change ticket priority: Yes/No (*)
  - Maximum open tickets per mail: Natural or unlimited (*)
  - Use email priority when available: Yes/No (*)
  - Ticket grace period: Hours before ticket is marked overdue (*)
  - Reopened tickets are assigned to the last respondent: Yes/No (*)
- **Email settings**
  - Default system email: The email address used by default for the system for sending customer notices (*)
  - Default staff alerts email: The email used by default for sending notices to staff. (*)
  - Administration email: The email for administration alerts. (*)
- **Auto responses by mail to the customer that owns a ticket**
  - Auto respond when a new ticket is created by a customer: Yes/No (*)
  - Auto respond when a new ticket is created by a staff member: Yes/No (*)
  - Auto respond when a new message has been appended to a ticket: Yes/no (*)
  - Auto respond when a customer violates the maximum of open tickets: Yes/no (*)

- **Alerts&notices by mail to the staff members**
  - When a new ticket is created is alerted by mail to the staff: Yes/No (*) (alerted staff may also be selected among the following options: Administration email, Department manager, department members.
  - When a new message is appended to a ticket, the message is alerted by mail to the staff: Yes/No (*) (alerted staff may also be selected among the following options: Last respondent, assigned staff, department manager.
  - When a new internal note is added to a ticket, the new note is alerted by mail to the staff: Yes/No (*) (alerted staff may also be selected among the following options: Last respondent, assigned staff, department manager
  - When a new ticket is overdue, this fact is alerted by mail to the staff: Yes/No (*) (alerted staff may also be selected among the following options: Assigned staff, department manager, department members.
- **Email accounts**
  - Email accounts can be created/edit or delete with the following properties:
    - Email address (*)
    - Email from name (*)
    - Default new ticket priority for tickets created via this email (*)
    - Default new ticket department (*)
    - Auto responses status: enabled/disabled (overwrites department setting) (*)
  - Email addresses can be added/removed from a banned list (no tickets are allowed for banned emails)
- **Email templates**
  - Email templates can be created/edit or delete with the following properties:
    - Name of the template (*)
    - Internal notes
  - Each email template has a subject and a message for each of the following email kinds:
    - New Ticket Autoresponse (*)
    - New Message Autoresponse (*)
    - New Ticket Notice (*)
    - Over Ticket limit Notice (*)
    - Ticket Response/Reply (*)
    - New Ticket Alert to Staff (*)
    - New Message Alert to Staff (*)
    - New Internal Note Alert to Staff (*)
    - Ticket Assigned Alert/Notice to Staff (*)
    - Overdue/Stale Ticket Alert/Notice to Staff (*)
- **Staff groups**
  - Staff groups may be created/edit/delete with the following properties:
    - Group name (*)
    - Group status: active/disabled (*)
    - Departments access: A set of departments which are additionally visible by the staff members of the group
    - Privileges (Yes/no) (*) *Restrictions are non-applicable to administration staff members*
      - Can create tickets on behalf of a customer
      - Can edit tickets *(restriction is non-applicable to department managers)*
      - Can transfer tickets
      - Can delete tickets
      - Can ban emails
- **Staff members**
  - Staff members may be created/edit/delete with the following properties:
    - Username (*)
    - Department (*)

- User group (*)
- First Name (*)
- Last Name (*)
- Email address (*)
- Office phone
- Phone extension
- Mobile phone
- Signature
- Password (*)
- Account status: active/locked (*)
- isAdministrator?: yes/no (*)
- Vacation mode (no tickets assigned and no alerts are received): yes/no (*)

- **Departments**
  - Departments may be created/edit/delete with the following properties:
    - Department name (*)
    - Department email (used for outgoing emails) (*)
    - Department manager (one of the staff members)
    - Department type: public/private (*) (when a ticket is in a private department, the name of the department is not shown to the ticket's customer)
    - Email template (Used for outgoing emails and notices to user and staff.) (*)
    - Auto-response when new ticket is created: yes/no (redefines general settings) (*)
    - Auto-response when new message is added: yes/no (redefines general settings) (*)
    - Auto-response email address (redefines general settings) (*)
- **Help topics**
  - Help topics may be created/edit/delete with the following properties:
    - Help topic name (*)
    - Topic status (active/disabled) (*)
    - Auto response (active/disabled). Overwrites department settings. (*)
    - New Ticket Priority (low, normal, high, emergency) (*)
    - New ticket Department (*)

Estimated dependency graph



3.2. Tickets management and tracking

Customer use cases

Use case: **Create a new online ticket**

Identifier: NTO.
Preconditions: Online mode is enabled.
Trigger: The customer wants to open a new request case as a ticket
Main Success Scenario:
1. The customer provides the details for creating a new ticket.
   [→NewTicketOnline]
2. The system validates that the data is correct
3. The system creates the new ticket.

Extensions:
2a. The ticket data is invalid.
   2a1. The system asks the customer to correct the data.
   2a2. The use case continues at step 1.

Use case: **Create a new ticket by email**

Identifier: NTE.
Preconditions: Online mode is enabled.
Trigger: The customer sends an email to a ticket support
Main Success Scenario:
1. The system creates the new ticket with the information of the email
   [→NewTicketByEmail]

Extensions:
1a. The addressee is not a valid incoming email account registered in the system.
   1a1. The use case ends.

Use case: **Check ticket status**

Identifier: CTS.
Preconditions: Online mode is enabled.
Trigger: The customer wants to see the details and the status of a ticket.
Main Success Scenario:
1. The customer provides his/her email and the ticket identifier to log in.
2. The system displays a list of all the tickets associated to the provided email.
   [→ DisplayTicketsAssociatedToEmail]
3. The customer selects a ticket.
4. The system displays the information of the ticket.

The customer repeats steps 3 and 4 as needed.

Extensions:
2a. The access data provided by the customer is not valid.
   2a1. The system informs the customer that the provided access data is invalid.
   2a2. The use case ends.
2b. There is only one ticket associated to the provided email
   2b1. The use case continues at step 4.
5a. The customer wants to respond the ticket

5a1. The customer writes his/her response
5a2. The system saves the response.
[→ ReplyTicketByCustomer]
5a3. The use case continues at step 4.
2c, 3a, 4a. The customer wants to log out
2c1, 3a1, 4a1. The use case ends.

Staff use cases

Use case: **Create a new offline ticket**

Identifier: NTOF.
Preconditions: The staff member is logged in and it is allowed to create new tickets.
Trigger: The staff member creates a ticket on behalf of a customer
Main Success Scenario:
1. The staff member provides the details for creating the new ticket.
[→NewTicketOffline]
2. The system validates that the data is correct
3. The system creates the new tiket
Extensions:
2a. The ticket data is invalid.
2a1. The system asks the staff member to correct the data.
2a2. The use case continues at step 1.

Use case: **Staff log in**

Identifier: SLI.
Preconditions: None.
Trigger: An Staff member wants to log in.
Main Success Scenario:
1. The staff member provides his/her log in data.
[→ StaffLogIn]
2. The system performs the log in.
Extensions:
2a. The log in data is not correct
2a1. The system informs the staff member that the log in data is invalid and asks him/her to enter valid data.
2a2. The use case continues at step 1.

Use case: **View tickets by status**

Identifier: VTS.
Preconditions: The staff member is logged in.
Trigger: The staff member wants to view the list of tickets which are in a particular state.
Main Success Scenario:
1. The staff member selects the filter status (open, assigned to the staff member, closed or overdue).
2. The system displays a list of all the tickets which are currently in the specified filter status.
The staff member repeats the following steps as necessary
3. The staff member selects a ticket
4. Manage ticket

Extensions:
3a. The staff member does not want to manage the ticket
3a1. The use case ends.

Use case: **Staff log out**

Identifier: SLO.
Preconditions: The staff member is logged in.
Trigger: An Staff member wants to log out.
Main Success Scenario:
1. The staff member confirms that he/she want to log out.
[→ StaffLogOut]
2. The system performs the log out.

Use case: **Manage ticket**

Identifier: MT.
Preconditions: The staff member is logged in. The ticket is visible by the staff member. The staff member is able to manage the ticket in each case.
Trigger: The staff member wants to manage a ticket.
Main Success Scenario:
1. The staff member selects an existing ticket.
2. The system displays all the information about the ticket.
The staff member may perform the following steps as necessary to manage the ticket, depending on the status of the ticket and the allowed actions of the staff member.
3. The staff member changes the priority of the ticket
[→ ChangeTicketPriority]
4. The staff member marks the ticket as overdue (if it is not overdue and the staff member is administrator).
[→ MarkTicketOverdue]
5. The staff member assigns the ticket to another staff member.
[→ AssignTicket]
6. The staff member releases (unassing) the ticket (if it is assigned).
[→ ReleaseTicket]
7. The staff member edits the general information of the ticket .
[→ EditTicket]
8. The staff member posts a reply.
[→ PostTicketReply]
9. The staff member posts an internal note.
[→PostTicketInternalNote]
10. The staff member transfers the responsibility of the ticket to another department.
[→ TransferDepartment]
11. The staff member closes the ticket (if it is open).
[→ CloseTicket]
[→ CloseTicketWithResponse]
12. The staff member reopens the ticket (if it is closed).
[→ ReopenTicket]
[→ ReopenTicketWithResponse]
13. The staff member bans the email and close the ticket (if it is open).
[→ BanEmailAndCloseTicket]
Extensions:
3a-13a. The staff member deletes the ticket.
3a1-13a1. The system deletes the ticket
[→ DeleteTicket]
3a2-13a2. The use case ends.

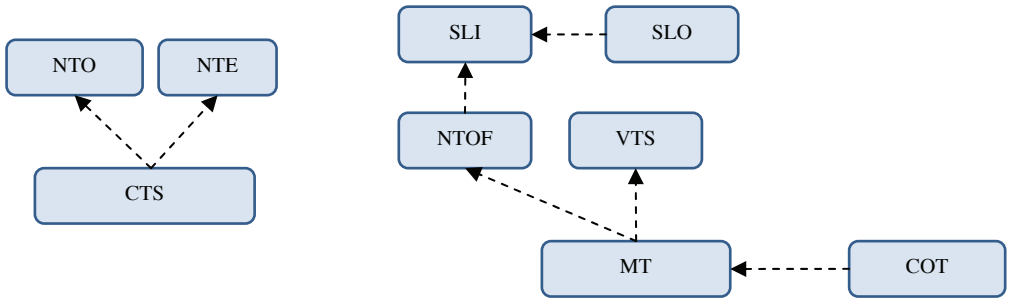
10a, 11a. The staff member wants to close the ticket on reply (if it is open) or to reopen it (if it is closed).
10a1, 11a1. The system changes the state of the ticket.
[→ CloseTicket]
[→ ReopenTicket]
10a2, 11a2. The use case continues.

System use cases

Use case: **CheckOverdueTickets**

Identifier: COT.
Preconditions: --
Trigger: The system checks if any ticket is overdue
Main Success Scenario:
1. The systems change the status of overdue tickets to "Overdue"
2. The system sends autorespones and alerts to staff according to the configuration
[→CheckOverdueTickets]

Estimated dependency graph



In order to minimize rewriting of test cases, we will process the user stories according to its associated use case and by taking into account the following order:

1. NTO
2. NTE
3. CTS
4. SLI
5. SLO
6. NTOF
7. VTS
8. MT

3.3. Domain rules

DR1. A ticket is always open or close.
DR2. An open ticket may be assigned to a staff member or may be unassigned.
DR3. An open ticket may be overdue.

4. User stories

In the following, we specify the user stories that will be processed when applying TDCM. User stories are written according to the testing strategy defined in Section 2.

4.1. Configuration and basics

We define several story fragments related to the basics of the system configured by the administrators. Each story fragment defines a representative configuration for each of the features groups defined in Section 3.1. Testable stories are combinations of some story fragments which are expected to be valid in the system. Dependent story fragments are combined in order to define testable stories to be processed by TDCM.

Story fragments

Story fragment #1: Email_template_default

- An administrator creates the email template *default*
  - Name: "Default"
  - Internal notes: "Email templates by default"
  - Subject "X" and message "YYY" for each email kind:
    - New Ticket Autoresponse
    - New Message Autoresponse
    - New Ticket Notice
    - Over Ticket limit Notice
    - Ticket Response/Reply
    - New Ticket Alert to Staff
    - New Message Alert to Staff
    - New Internal Note Alert to Staff
    - Ticket Assigned Alert/Notice to Staff
    - Overdue/Stale Ticket Alert/Notice to Staff

Story fragment #2a: General_settings_online

Dependency: Email_template_default

Helpdesk status: Online (customer functionalities active)
Helpdesk url: http://onlinesupport.com
Helpdesk name:Online customer support
Default email template: *default*

Story fragment #2b: General_settings_offline
Dependency: Email_template_default

Helpdesk status: Offline (customer functionalities active)
Helpdesk url: http://offlinesupport.com
Helpdesk name: ---
Default email template: *default*

Story fragment #3a: Ticket_settings_sequential
Ticket IDs mode: Sequential
Default priority: Normal
Customers can change ticket priority: No
Use email priority when available: Yes
Maximum open tickets per mail: 2
Ticket grace period: 0
Reopened tickets are assigned to the last respondent: Yes

Story fragment #3b: Ticket_settings_random
Ticket IDs mode: Random
Default priority: High
Customers can change ticket priority: Yes
Use email priority when available: No
Maximum open tickets per mail: Unlimited
Ticket grace period: 2
Reopened tickets are assigned to the last respondent: No

Story fragment #4a: Email_account_general
Dependency: Department_general

- An administrator creates the new email account *general@support.com*
  - Email address: questions@support.com
  - Email from name: General questions
  - Default new ticket priority for tickets created via this email: Low
  - Default new ticket department: *dptGeneral*
  - Auto responses status: enabled (overwrites department setting)

Story fragment #4b: Email_account_technical
Dependency: Department_technical

- An administrator creates the new email account *technical@support.com*
  - Email address: b@support.com
  - Email from name: B Support
  - Default new ticket priority for tickets created via this email: High
  - Default new ticket department: *dptTechnical*
  - Auto responses status: disabled (overwrites department setting)

Story fragment #5a: Department_general
Dependency: Email_template_default,Email_account_general

- An administrator creates the new public department *dptGeneral*
  - Department name: General support
  - Department email (used for outgoing emails): support@support.com
  - Department manager (one of the staff members, maybe empty): -

- Department type: public
- Email template (Used for outgoing emails and notices to user and staff): *default*
- Auto-response when new ticket is created: yes
- Auto-response when new message is added: yes
- Auto-response email: *general@support.com*

Story fragment #5b: Department_technical

Dependency: Email_template_default,Email_account_technical, Staff_member_generalAdministrator

- An administrator creates the new private department *dptTecnical*
  - Department name: Technical support
  - Department email (used for outgoing emails): technical@support.com
  - Department manager (one of the staff members, maybe empty): *generalAdministrator*
  - Department type: private
  - Email template (Used for outgoing emails and notices to user and staff): *default*
  - Auto-response when new ticket is created: yes
  - Auto-response when new message is added: yes
  - Auto-response email: *technical@support.com*

Story fragment #6a: Staff_group_minimum_privileges

- An administrator creates the new staff group *minimumPrivilegesGroup*
  - Group name: Minimum Privileges Group
  - Group status: active
  - Departments access: -
  - Privileges (Yes/no)
    - Can create tickets: No
    - Can edit tickets: No
    - Can close tickets: No
    - Can transfer tickets: No
    - Can delete tickets: No
    - Can ban emails: No

Story fragment #6b: Staff_group_maximum_privileges

Dependency: Department_general, Department_technical

- An administrator creates the new staff group *maximumPrivilegesGroup*
  - Group name: Maximum Privileges Group
  - Group status: active
  - Departments access: *dptGeneral*, *dptTechnical*
  - Privileges (Yes/no)
    - Can create tickets: Yes
    - Can edit tickets: Yes
    - Can close tickets: Yes
    - Can transfer tickets: Yes
    - Can delete tickets: Yes
    - Can ban emails: Yes

Story fragment #6c: Staff_group_inactive

- An administrator creates the new staff group *inactiveGroup*
  - Group name: Inactive Group
  - Group status: disabled
  - Departments access: --

- Privileges (Yes/no)
  - Can create tickets: Yes
  - Can edit tickets: No
  - Can close tickets: Yes
  - Can transfer tickets: No
  - Can delete tickets: Yes
  - Can ban emails: No

Story fragment #7a: Staff_member_general_administrator
Dependency: Department_general, Staff_group_maximum_privileges

- An administrator creates the new staff member *generalAdministrator*
  - Username: john
  - Department: *dptGeneral*
  - User group: *maximumPrivilegesGroup*
  - First Name: John
  - Last Name: Johny
  - Email address: john@support.com
  - Office phone: 11111
  - Phone extension: 11
  - Mobile phone: 11111
  - Signature: John Johny
  - Password: xxx
  - Account status: active
  - isAdministrator?: yes
  - Vacation mode (no tickets assigned and no alerts are received): no

Story fragment #7b: Staff_member_general_consultant
Dependency: Department_general, Staff_group_maximum_privileges

- An administrator creates the new staff member *generalConsultant*
  - Username: mary
  - Department: *dptGeneral*
  - User group: *maximumPrivilegesGroup*
  - First Name: Mary
  - Last Name: Mayer
  - Email address: mary@support.com
  - Office phone: 22222
  - Phone extension: 22
  - Mobile phone: 22222
  - Signature: Mary Mayer
  - Password: yyy
  - Account status: active
  - isAdministrator?: no
  - Vacation mode (no tickets assigned and no alerts are received): no

Story fragment #7c: Staff_member_general_consultant_vacation
Dependency: Department_general, Staff_group_maximum_privileges

- An administrator creates the new staff member *generalConsultantVacation*
  - Username: david
  - Department: *dptGeneral*
  - User group: *maximumPrivilegesGroup*
  - First Name: David
  - Last Name: Dassel

- Email address: david@support.com
- Office phone: 33333
- Phone extension: 33
- Mobile phone: 33333
- Signature: -
- Password: zzz
- Account status: active
- isAdministrator?: no
- Vacation mode (no tickets assigned and no alerts are received): yes

Story fragment #7d: Staff_member_technical_active

Dependency: Department_technical, Staff_group_minimum_privileges

- An administrator creates the new staff member *technicalActive*
  - Username: Martin
  - Department: *dptTechnical*
  - User group: *minimumPrivilegesGroup*
  - First Name: Martin
  - Last Name: Martech
  - Email address: martin@support.com
  - Office phone: ---
  - Phone extension: --
  - Mobile phone: ---
  - Signature: --
  - Password: ttt
  - Account status: active
  - isAdministrator?: no
  - Vacation mode (no tickets assigned and no alerts are received): no

Story fragment #7e: Staff_member_technical_inactive

Dependency: Department_technical

- An administrator creates the new staff member *technicalInactive*
  - Username: Patricia
  - Department: *dptTechnical*
  - User group: *minimumPrivilegesGroup*
  - First Name: Patricia
  - Last Name: Pauls
  - Email address: patricia@support.com
  - Office phone: ---
  - Phone extension: --
  - Mobile phone: ---
  - Signature: --
  - Password: uuu
  - Account status: locked
  - isAdministrator?: no
  - Vacation mode (no tickets assigned and no alerts are received): no

Story fragment #8a: Customer_auto_responses_active

Auto respond when a new ticket is created by a customer: Yes
Auto respond when a new ticket is created by a staff member: Yes
Auto respond when a new message has been appended to a ticket: Yes
Auto respond when a customer violates the maximum of open tickets: Yes

Story fragment #8b: Customer_auto_responses_inactive

Auto respond when a new ticket is created by a customer: No
Auto respond when a new ticket is created by a staff member: No
Auto respond when a new message has been appended to a ticket: No
Auto respond when a customer violates the maximum of open tickets: No

Story fragment #9a: Email settings

Default system email: *general@support.com*
Default staff alerts email: *general@support.com*
Administration email: system@support.com

Story fragment #10a: Staff_notices_alerts_active

When a new ticket is created is alerted by mail to the staff: Yes
(Administration email, Department manager, department members).
When a new message is appended to a ticket, the message is alerted by mail to the staff: Yes
(Last respondent, assigned staff, department manager).
When a new internal note is added to a ticket, the new note is alerted by mail to the staff: Yes *(Last respondent, assigned staff, department manager).*
When a new ticket is overdue, this fact is alerted by mail to the staff: Yes
(Assigned staff, department manager, department members).

Story fragment #10b: Staff_notices_alerts_inactive

When a new ticket is created is alerted by mail to the staff: No
When a new message is appended to a ticket, the message is alerted by mail to the staff: No
When a new internal note is added to a ticket, the new note is alerted by mail to the staff: No
When a new ticket is overdue, this fact is alerted by mail to the staff: No

Story fragment #11a: Help_topic_Installation
Dependency: Department_technical

- An administrator creates the new staff member *installationTopic*
  - Help topic name: Installation
  - Topic status: active
  - Auto response: disabled
  - New Ticket Priority: High
  - New ticket Department: *dtpTechnical*

Story fragment #11b: Help_topic_Use
Dependency: Department_general

- An administrator creates the new staff member *useTopic*
  - Help topic name: Use
  - Topic status: active
  - Auto response: active
  - New Ticket Priority: Normal
  - New ticket Department: *dtpGeneral*

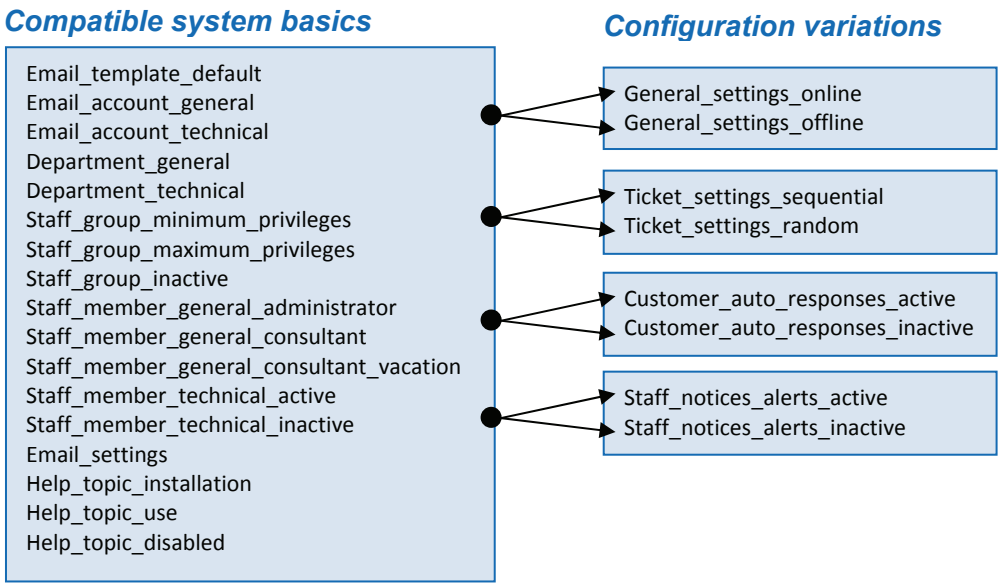
Story fragment #11c: Help_topic_disabled

Dependency: Department_general

- An administrator creates the new staff member *offersTopic*
  - Help topic name: Offers
  - Topic status: disabled
  - Auto response: disabled
  - New Ticket Priority: Low
  - New ticket Department: *dtpGeneral*

Testable stories

Testable stories are combinations of previously defined story fragments which represent configurations of the system which are expected to be valid. Testable stories are those that result from the combinations of the following schema:



Therefore, there are 16 valid testable stories about configuration and basics of the system that contains all compatible basics:

#1	Compatible basics	General_settings_online	Ticket_settings_sequential	Customer_auto_responses_active	Staff_notices_alerts_active
#2	Compatible basics	General_settings_online	Ticket_settings_sequential	Customer_auto_responses_active	Staff_notices_alerts_inactive
#3	Compatible basics	General_settings_online	Ticket_settings_sequential	Customer_auto_responses_inactive	Staff_notices_alerts_active
#4	Compatible basics	General_settings_online	Ticket_settings_sequential	Customer_auto_responses_inactive	Staff_notices_alerts_inactive

#5	Compatible basics	General_settings_online	Ticket_settings_random	Customer_auto_responses_active	Staff_notices_alerts_active
#6	Compatible basics	General_settings_online	Ticket_settings_random	Customer_auto_responses_active	Staff_notices_alerts_inactive
#7	Compatible basics	General_settings_online	Ticket_settings_random	Customer_auto_responses_inactive	Staff_notices_alerts_active
#8	Compatible basics	General_settings_online	Ticket_settings_random	Customer_auto_responses_inactive	Staff_notices_alerts_inactive
#9	Compatible basics	General_settings_offline	Ticket_settings_sequential	Customer_auto_responses_active	Staff_notices_alerts_active
#10	Compatible basics	General_settings_offline	Ticket_settings_sequential	Customer_auto_responses_active	Staff_notices_alerts_inactive
#11	Compatible basics	General_settings_offline	Ticket_settings_sequential	Customer_auto_responses_inactive	Staff_notices_alerts_active
#12	Compatible basics	General_settings_offline	Ticket_settings_sequential	Customer_auto_responses_inactive	Staff_notices_alerts_inactive
#13	Compatible basics	General_settings_offline	Ticket_settings_random	Customer_auto_responses_active	Staff_notices_alerts_active
#14	Compatible basics	General_settings_offline	Ticket_settings_random	Customer_auto_responses_active	Staff_notices_alerts_inactive
#15	Compatible basics	General_settings_offline	Ticket_settings_random	Customer_auto_responses_inactive	Staff_notices_alerts_active
#16	Compatible basics	General_settings_offline	Ticket_settings_random	Customer_auto_responses_inactive	Staff_notices_alerts_inactive

Other variations without some basics may be also used.

When evolving the schema to include the tickets management knowledge, all valid combinations can be used as the initial state of test cases.

4.2. Tickets management and tracking

We define several representative stories which are based on the use cases defined in Section 3.2. These stories are designed in order to cover the general scenarios (success scenario and extensions) of the defined use cases. Stories are ordered according to the strategy defined in Section 3.2.

Customer stories

S1: NewTicketOnline_SuccessScenario_SequentialTicketsNumber_StaffNotifications
Testing objectives: NTO

- Fixture: #1
- A customer wants to create a new ticket with the following data:
  - Full Name: "Mary Marnes"
  - Email: mary@marnes.mar
  - Telephone: xxxxxxxx
  - Ext: xxxxxxx
  - Help Topic: Installation
  - Subject: "Error operating system"
  - Message: "The installation process does not finish due to the following error: incompatible operating system"
- The creation event occurs
  - No auto-response is sent to the customer.
  - The ticket number is 1 (sequential)
  - The status of the ticket is open
  - The subject of the ticket is "Error operating system"
  - The priority of the ticket is High
  - No staff is assigned to the ticket
  - The source of the ticket is "Web"
  - The creation date is *SystemDateTime.now()*
  - The due date is empty
  - The last response date is empty
  - The last message date is *SystemDateTime.now()*
  - The ticket thread contains the customer message
  - An alert is sent to the administration email, the department manager and the department members (except for those which are in vacation mode or inactive).
  - The assigned department is *dptTechnical*
- TicketSettings::customersCanChangePriority becomes true
- A customer wants to create a new ticket with the following data:
  - Full Name: "James Jordan"
  - Email: james@jordan.jam
  - Telephone: xxxxxxxx
  - Ext: xxxxxxx
  - Help Topic: Use
  - Priority: Low (redefines the default priority of the help topic "Normal")
  - Subject: "Reopening ticket"
  - Message: "I don't know how to reopen one of my closed tickets"
- The creation event occurs
  - An auto-response is sent to the customer.
  - The ticket number is 2 (sequential)
  - The priority of the ticket is Normal (the default priority)
  - An alert is sent to the administration email, the department manager and the department members (except for those which are in vacation mode or inactive)
  - The assigned department is *dptGeneral*

S2: NewTicketOnline_maximumNumberOfTicketsViolated
Testing objectives: NTO

- Fixture: #1
- A customer wants to create a new ticket with the following data:
  - Full Name: "Mary Marnes"
  - Email: mary@marnes.mar
  - Telephone: xxxxxxxx
  - Ext: xxxxxxx
  - Help Topic: Installation
  - Subject: "Error operating system"
  - Message: "The installation process does not finish due to the following error: incompatible operating system"
- The creation event occurs
- A customer wants to create a new ticket with the following data:
  - Full Name: "Mary Marnes"
  - Email: mary@marnes.mar
  - Telephone: xxxxxxxx
  - Ext: xxxxxxx
  - Help Topic: Use
  - Subject: "Reopening ticket"
  - Message: "I don't know how to reopen one of my closed tickets"
- The creation event occurs
- A customer wants to create a new ticket with the following data:
  - Full Name: "Mary Marnes"
  - Email: mary@marnes.mar
  - Telephone: xxxxxxxx
  - Ext: xxxxxxx
  - Help Topic: Use
  - Subject: "Customize graphical interface"
  - Message: "May I change the background color?"
- The creation event cannot occur (the maximum number of tickets for this email is violated)

S3: NewTicketOnline_SuccessScenario_RandomTicketsNumber_StaffNotificationsDisabled
Testing objectives: NTO

- Fixture: #8
- A customer wants to create a new ticket with the following data:
  - Full Name: "Mary Marnes"
  - Email: mary@marnes.mar
  - Telephone: xxxxxxxx
  - Ext: xxxxxxx
  - Help Topic: Installation
  - Subject: "Error operating system"
  - Message: "The installation process does not finish due to the following error: incompatible operating system"
- The creation event occurs
  - No auto-response is sent to the customer.
  - An alert is not sent to the administration email, the department manager and the department members (except for those which are in vacation mode or inactive)
  - The assigned department is *dptTechnical*

S4: NewTicketOnline_SuccessScenario_SequentialTicketsNumber_AutoResponsesDisabled
Testing objectives: NTO

- Fixture: #3
- A customer creates a new ticket with the following data:
  - Full Name: "James Jordan"
  - Email: james@jordan.jam
  - Telephone: xxxxxxxx
  - Ext: xxxxxxx
  - Priority:Normal
  - Help Topic: Use
  - Subject: "Reopening ticket"
  - Message: "I don't know how to reopen one of my closed tickets"
- The creation event occurs
  - No auto-response is sent to the customer.
  - An alert is sent to the administration email, the department manager and the department members (except for those which are in vacation mode or inactive)
  - The assigned department is *dptGeneral*

S5: NewTicketOnline_SuccessScenario_NoTopic
Testing objectives: NTO

- Fixture: #4 (without help topics)
- A customer wants to create a new ticket with the following data:
  - Full Name: "James Jordan"
  - Email: james@jordan.jam
  - Subject: "Reopening ticket"
  - Message: "I don't know how to reopen one of my closed tickets"
- The creation event occurs
  - No auto-response is sent to the customer.
  - No alert is sent to the administration email, the department manager and the department members.
  - The help topic of the ticket is empty
  - The priority of the ticket is "Normal"
  - The assigned department is *dptGeneral* (which is the default department)

S6: NewTicketOnline_Extension2a
Testing objectives: NTO

- Fixture: #8
- A customer wants to create a new ticket with the following data:
  - Full Name: James Jordan
  - Email: james@jordan.jam
  - Priority: Low
  - Help Topic: Offers
  - Subject: "Reopening ticket"
  - Message: "I don't know how to reopen one of my closed tickets"
- The creation event cannot occur (the help topic is disabled)

S7: NewTicketOnline_PreconditionViolation
Testing objectives: NTO

- Fixture: #9
- A customer wants to create a new ticket with the following data:
  - Full Name: James Jordan

- Priority: Low
- Email: james@jordan.jam
- Subject: "Reopening ticket"
- Message: "I don't know how to reopen one of my closed tickets"

- The creation event cannot occur (online mode is disabled)

S8: NewTicketByEmail_successScenario_generalEmail
Testing objectives: NTE

- Fixture: #3
- A customer wants to create a new ticket by an email sent to general@support.com
  - From: james@jordan.jam
  - Subject: "Ticket priority"
  - Message: "How can I change the priority of one of my tickets?"
- The creation event occurs
  - An auto-response is sent to the customer.
  - The status of the ticket is open
  - The subject of the ticket is "Ticket Priority"
  - The priority of the ticket is Low
  - No staff is assigned to the ticket
  - The source of the ticket is "Email"
  - The creation date is *SystemDateTime.now()*
  - The due date is empty
  - The last response date is empty
  - The last message date is *SystemDateTime.now()*
  - The ticket thread contains the customer message
  - The assigned department is *dptGeneral*

S9: NewTicketByEmail_successScenario_technicalEmail
Testing objectives: NTE

- Fixture: #10
- A customer wants to create a new ticket by an email sent to technical@support.com
  - From: marta@johnes.mar
  - Subject: "See my tickets"
  - Message: "Can I see my tickets?"
- The creation event cannot occur (the online mode is disabled)
- The online mode is enabled
- The creation event occurs
  - No auto-response is sent to the customer.
  - The status of the ticket is open
  - The subject of the ticket is "See my tickets"
  - The priority of the ticket is High
  - No staff is assigned to the ticket
  - The source of the ticket is "Email"
  - The creation date is *SystemDateTime.now()*
  - The due date is empty
  - The last response date is empty
  - The last message date is *SystemDateTime.now()*
  - The ticket thread contains the customer message
  - The assigned department is *dptTechnical*

S10: NewTicketByEmail_extension_2a
Testing objectives: NTE

- Fixture: #8
- A customer wants to create a new ticket by an email sent to techdep@support.com
  - From: marta@johnes.mar
  - Subject: "See my tickets"
  - Message: "Can I see my tickets?"
- The creation event cannot occur (the addressee is not an incoming email)

S11: DisplayTicketsOfEmail_successScenario
Testing objectives: CTS

- Fixture: #1
- A customer creates a new ticket with the following data:
  - Full Name: James Jordan
  - Help Topic: Use
  - Email: james@jordan.jam
  - Subject: "Reopening ticket"
  - Message: "I don't know how to reopen one of my closed tickets"
- The creation event occurs
- A customer creates a new ticket with the following data:
  - Full Name: James Jordan
  - Email: james@jordan.jam
  - Help Topic: Installation
  - Subject: "Error operating system"
  - Message: "The installation process does not finish due to the following error: incompatible operating system"
- The creation event occurs
- The customer wants to keep track of his tickets by providing the email james@jordan.jam and the number of one of his/her tickets.
- The system displays the list of his/her tickets (number, create date, status, subject, department, email).

S12: DisplayTicketsOfEmail_extension_2a_nonExisting
Testing objectives: CTS

- Fixture: #1
- The customer wants to keep track of his tickets by providing the email james@jordan.jam and the ticket number 3.
- The query cannot occur because there are no tickets associated to james@jordan.jam

S13: DisplayTicketsOfEmail_extension_2a_invalidData
Testing objectives: CTS

- Fixture: #1
- A customer creates a new ticket with the following data:
  - Full Name: James Jordan
  - Priority: Low
  - Help Topic: Use
  - Email: james@jordan.jam
  - Subject: "Reopening ticket"
  - Message: "I don't know how to reopen one of my closed tickets"

- The creation event occurs
- The customer wants to keep track of his tickets by providing the email james@jordan.jam and the ticket number 2.
- The query cannot occur because the pair (james@jordan.jam, 2) is not valid

S14: RespondTicket_alertsActive
Testing objectives: CTS

- Fixture: #1
- A customer creates a new ticket with the following data:
  - Full Name: James Jordan
  - Help Topic: Installation (it enables autoresponses)
  - Email: james@jordan.jam
  - Subject: "Reopening ticket"
  - Message: "I don't know how to reopen one of my closed tickets"
- The creation event occurs
- The customer wants to respond the ticket
  - The customer provides the response
- The reply event occurs
  - The ticket thread contains the customer response
  - A notice is sent to the department manager
  - An autoresponse is sent to the customer
  - The last message date is updated with the ticket thread customer response datetime

S15: RespondTicket_alertsDisabled
Testing objectives: CTS

- Fixture: #2
- A customer creates a new ticket with the following data:
  - Full Name: James Jordan
  - Help Topic: Installation
  - Email: james@jordan.jam
  - Subject: "Reopening ticket"
  - Message: "I don't know how to reopen one of my closed tickets"
- The creation event occurs
- The customer wants to respond the ticket
  - The customer provides the response
- The reply event occurs
  - The ticket thread contains the customer response
  - No notice is sent.
  - The last message date is updated with the ticket thread customer response datetime

Staff stories

S16: StaffLogIn_successScenario
Testing objectives: NTOF

- Fixture: #1
- A staff member wants to login with the following data:
  - Username: mary
  - Password: yyy
- The login event occurs

- The staff member *generalConsultant* is logged in.

S17: StaffLogIn_PreconditionViolation
Testing objectives: NTOF

- Fixture: #1
- A staff member wants to login with the following data:
  - Username: mary
  - Password: yyy
- The creation event occurs
  - The staff member *generalConsultant* is logged in.
- A staff member wants to login with the following data:
  - Username: mary
  - Password: yyy
- The login event cannot occur (the staff member is already logged in)

S18: StaffLogIn_PreconditionViolation_InactiveStaffMember
Testing objectives: NTOF

- Fixture: #1
- A staff member wants to login with the following data:
  - Username: Patricia
  - Password: uuu
- The login event cannot occur (the staff member is locked)
- The group *maximumPrivilegesGroup* becomes *disabled*
- A staff member wants to login with the following data:
  - Username: mary
  - Password: yyy
- The login event cannot occur (the staff member is locked)

S19: StaffLogOut_successScenario
Testing objectives: NTOF

- Fixture: #1
- A staff member wants to login with the following data:
  - Username: mary
  - Password: yyy
- The login event occurs
  - The staff member *generalConsultant* is logged in.
- The user logs out
  - The staff member *generalConsultant* is not logged in.

S20: StaffLogIn_Extension2a
Testing objectives: NTOF

- Fixture: #1
- A staff member wants to login with the following data:
  - Username: mary
  - Password: zzz
- The login event cannot occur (the login data is not valid)

S21: NewTicketOffline_SuccessScenario_SequentialTicketsNumber_alertsAutoresponsesActive
Testing objectives: NTOF

- Fixture: #1 (*minimumPrivilegesGroup* allows creating tickets)
- The staff member *generalConsultant* logs in and wants to create a new ticket with the following data:
  - Full Name: "Mary Marnes"
  - Email: mary@marnes.mar
  - Telephone: xxxxxxxx
  - Ext: xxxxxxx
  - Ticket source: Phone
  - Department: Technical
  - Help Topic: Installation
  - Subject: "Error operating system"
  - Message: "The installation process does not finish due to the following error: incompatible operating system"
  - Internal note: "It seems that the correct installer is being used"
  - Due datetime: *SystemDateTime.now()* + 2 days
  - Priority: Normal
  - AssignedStaff: generalConsultant
- The creation event occurs
  - No auto-response is sent to the customer.
  - The ticket number is 1 (sequential)
  - The status of the ticket is open
  - The subject of the ticket is "Error operating system"
  - The priority of the ticket is Normal
  - Staff member *generalConsultant* is assigned to the ticket
  - The source of the ticket is "Phone"
  - The creation date is *SystemDateTime.now()*
  - The due date is *SystemDateTime.now()* + 2 days
  - The last response date is empty
  - The last message date is *SystemDateTime.now()*
  - The ticket thread contains the initial message
  - An alert is sent to the administration email, the department manager and the department members (except for those which are in vacation mode or inactive).
  - The assigned department is *dptTechnical*
- The staff member *generalConsultant* wants to create a new ticket with the following data:
  - Full Name: "James Jordan"
  - Email: james@jordan.jam
  - Help Topic: Use
  - Subject: "Reopening ticket"
  - Message: "I don't know how to reopen one of my closed tickets"
  - Ticket source: Other
  - Department: *dptGeneral*
  - Internal note: (empty)
  - Due datetime: (empty)
  - Priority: Low
  - AssignedStaff: (empty)
- The creation event occurs
  - An auto-response is sent to the customer.
  - The ticket number is 2 (sequential)
  - The ticket is unassigned
  - The priority of the ticket is Low (the default priority)
  - An alert is sent to the administration email, the department manager and the department members (except for those which are in vacation mode or inactive).
  - The assigned department is *dptGeneral*

S22: NewTicketOffline_SuccessScenario_ alertsAutoresponsesDisabled
Testing objectives: NTO

- Fixture: #2 (*minimumPrivilegesGroup* allows creating tickets)
- The staff member *generalConsultant* logs in and wants to create a new ticket with the following data:
  - Full Name: "Mary Marnes"
  - Email: mary@marnes.mar
  - Ticket source: Phone
  - Department: Technical
  - Help Topic: Installation
  - Subject: "Error operating system"
  - Message: "The installation process does not finish due to the following error: incompatible operating system"
  - Internal note: "It seems that the correct installer is being used"
  - Due datetime: *SystemDateTime.now()* + 2 days
  - Priority: Normal
  - AssignedStaff: generalConsultant
- The creation event occurs
  - No auto-response is sent to the customer.
  - An alert is not sent to the administration email, the department manager and the department members.
  - The assigned department is *dptTechnical*

S23: NewTicketOffline_SuccessScenario_NoTopic
Testing objectives: NTO

- Fixture: #4 (without help topics and *minimumPrivilegesGroup* allows creating tickets)
- The staff member *generalAdministrator* logs in and wants to create a new ticket with the following data:
  - Full Name: "James Jordan"
  - Email: james@jordan.jam
  - Subject: "Reopening ticket"
  - Message: "I don't know how to reopen one of my closed tickets"
  - Ticket source: Other
  - Department: *dptGeneral*
  - Internal note: (empty)
  - Due datetime: (empty)
  - Priority: Low
  - AssignedStaff: (empty)
- The creation event occurs
  - The help topic of the ticket is empty

S24: NewTicketOffline_PreconditionViolation_cannotCreateTickets
Testing objectives: NTO

- Fixture: #9
- The staff member *technicalActive* logs in and wants to create a new ticket with the following data:
  - Full Name: "Mary Marnes"
  - Email: mary@marnes.mar
  - Ticket source: Phone

- Department: Technical
- Help Topic: Installation
- Subject: "Error operating system"
- Message: "The installation process does not finish due to the following error: incompatible operating system"
- Internal note: (empty)
- Due datetime: (empty)
- Priority: Normal
- AssignedStaff: generalConsultant

- The creation event cannot occur (the staff member cannot create tickets).

S25: NewTicketOffline_PreconditionViolation_isNotLoggedIn
Testing objectives: NTO

- Fixture: #9
- The staff member *technicalActive* wants to create a new ticket with the following data:
  - Full Name: "Mary Marnes"
  - Email: mary@marnes.mar
  - Ticket source: Phone
  - Department: Technical
  - Help Topic: Installation
  - Subject: "Error operating system"
  - Message: "The installation process does not finish due to the following error: incompatible operating system"
  - Internal note: (empty)
  - Due datetime: (empty)
  - Priority: Normal
  - AssignedStaff: generalConsultant
- The creation event cannot occur (the staff is not logged in).

S26: ViewOpenTickets
Testing objectives: VTS

- Fixture: #11
- Fixture component: #created_tickets
  - The staff member *generalConsultant* logs in and wants to create a new ticket with the following data:
    - Full Name: "Mary Marnes"
    - Email: mary@marnes.mar
    - Telephone: xxxxxxxx
    - Ext: xxxxxxx
    - Ticket source: Phone
    - Department: *dptTechnical*
    - Help Topic: Installation
    - Subject: "Error operating system"
    - Message: "The installation process does not finish due to the following error: incompatible operating system"
    - Internal note: "It seems that the correct installer is being used"
    - Due datetime: *SystemDateTime.now()* + 2 days
    - Priority: Normal
    - AssignedStaff: *generalConsultant*
  - The creation event occurs
  - The staff member *generalConsultant* wants to create a new ticket with the following data:

        - Full Name: "John Johnes"
        - Email: john@johnes.nes
        - Ticket source: Other
        - Department: *dptGeneral*
        - Help Topic: Use
        - Subject: "Can I reply a ticket?"
        - Message: "I don't know how to reply a ticket"
        - Due datetime: (empty)
        - Priority: High
        - AssignedStaff: *generalConsultant*
    - The creation event occurs
    - The staff member *GeneralConsultant* logs out
    - The staff member *generalAdministrator* logs in and wants to create a new ticket with the following data:
        - Full Name: "Martin Pope"
        - Email: martin@pope.mar
        - Ticket source: Phone
        - Department: *dptTechnical*
        - Help Topic: Use
        - Subject: "Error while login"
        - Message: "I get an error when I try to login"
        - Due datetime: *SystemDateTime.now()* + 5 days
        - Priority: Low
        - AssignedStaff: *technicalActive*
    - The creation event occurs
    - *SystemDateTime.now() +1*
    - The staff member *generalAdministrator* logs out.
    - A customer creates a new ticket with the following data:
        - Full Name: "James Jordan"
        - Email: james@jordan.jam
        - Help Topic: Use
        - Subject: "Reopening ticket"
        - Message: "I don't know how to reopen one of my closed tickets"
    - The creation event occurs
    - A customer wants to create a new ticket by an email sent to technical@support.com
        - From: marta@johnes.mar
        - Subject: "See my tickets"
        - Message: "Can I see my tickets?"
    - The creation event occurs
- The staff member *generalAdministrator* logs in
- The staff member *generalAdministrator* wants to view the open tickets (this staff member can see the tickets of all departments)
- The result of the query is:

Ticket	Date	Subject	Department	Priority	From
1	now()-1	Error operating system	*dptTechnical*	Normal	Mary Marnes
2	now()-1	Can I reply a ticket?	*dptGeneral*	High	John Johnes
3	now()-1	Error while login	*dptTechnical*	Low	Martin Pope
4	now()	Reopening ticket	*dtpGeneral*	Normal	James Jordan
5	now()	See my tickets	*dptTechnical*	High	marta@johnes.mar

- The staff member *generalAdministrator* logs out
- The staff member *technicalActive* logs in

- The staff member *technicalActive* wants to view the open tickets (this staff member can only see the tickets of his/her department)
- The result of the query is:

Ticket	Date	Subject	Department	Priority	From
1	now()-1	Error operating system	*dptTechnical*	Normal	Mary Marnes
3	now()-1	Error while login	*dptTechnical*	Low	Martin Pope
5	now()	See my tickets	*dptTechnical*	High	marta@johnes.mar

S27: ViewOpenTickets_preconditionViolation_notLoggedIn
Testing objectives: VTS

- Fixture: #3
- The staff member wants to view the open tickets
- The query cannot occur because the staff member is not logged in

S28: ChangeTicketPriority
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalAdministrator* logs in.
- The staff member *generalAdministrator* wants to set the priority of the ticket #1 to *High*.
- The event for changing priority occurs
    - The ticket priority is *High*
    - The ticket thread includes the internal note with title “Ticket priority changed” and text “Ticket priority set to *High* by John Johny”

S29: ChangeTicketPriority_TicketNotVisible
Testing objectives: MT

- Fixture: #4
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.
- The staff member *technicalActive* wants to set the priority of the ticket #2 to *Normal*.
- The event for changing priority cannot occur (the ticket is not visible for the staff member)

S30: ChangeTicketPriority_NotLoggedIn
Testing objectives: MT

- Fixture: #4
- Fixture component: #created_tickets
- The staff member *generalAdministrator* logs in.
- The staff member *generalAdministrator* wants to set the priority of the ticket #2 to *Normal*.
- The event for changing priority cannot occur (the staff member is not logged in)

S31: MarkTicketOverdue
Testing objectives: MT

- Fixture: #3

- Fixture component: #created_tickets
- The staff member *generalAdministrator* logs in.
- The staff member *generalAdministrator* wants to mark the ticket #1 as overdue.
- The event occurs
    - The ticket is overdue
    - The ticket thread includes the internal note with title "Ticket MarkedOverdue" and text "Ticket flagged as overdue by John Johny"

S32: MarkTicketOverdue _staffIsNotAnAdministrator
Testing objectives: MT

- Fixture: #4
- Fixture component: #created_tickets
- The staff member *technicalInactive* logs in.
- The staff member *technicalInactive* wants to mark the ticket #1 as overdue.
- The event cannot occur (the staff member is not an administrator)

S33: MarkTicketOverdue _notLoggedIn
Testing objectives: MT

- Fixture: #4
- Fixture component: #created_tickets
- The staff member *generalAdministrator* wants to mark the ticket #1 as overdue.
- The event cannot occur (the staff member is not logged in)

S34: AssignTicket
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to assign ticket #1 to *generalAdministrator* with the comment "This is for you".
- The assignment event occurs
    - The ticket is assigned to *generalAdministrator*
    - The ticket thread includes the internal note posted by the *generalConsultant* with title "Ticket assigned to John Johny by Mary Mayer" and text "This is for you".
    - An alert is sent to the *generalAdministrator*

S35: AssignTicket _ticketIsNotVisible
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.
- The staff member *technicalActive* wants to assign ticket #2 to *generalAdministrator* with the comment "This is for you".
- The event cannot occur (the staff member cannot manage the ticket)

S36: AssignTicket_InVacationMode
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to assign ticket #1 to *generalConsultantVacation* with the comment "This is for you".
- The assignment event cannot occur (the staff member is on vacation mode).

S37: AssignTicket_NotLoggedIn
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* wants to assign ticket #1 to *generalAdministrator* with the comment "This is for you".
- The assignment event cannot occur (the staff member is not logged in).

S38: ReleaseTicket
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to release ticket #1
- The event occurs
    - The ticket is not assigned
    - The ticket thread includes the internal note with title "Ticked Unassigned" and text "Ticket released (unassigned) from Mary Mayer by Mary Mayer".

S39: ReleaseTicket_ticketIsNotVisible
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.
- The staff member *technicalActive* wants to release ticket #2.
- The event cannot occur (the staff member cannot manage the ticket)

S40: ReleaseTicket_NotAssigned
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to release ticket #4.
- The event cannot occur (the ticket is not assigned).

S41: ReleaseTicket_NotLoggedIn
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* wants to release ticket #2.
- The event cannot occur (the staff member is not logged in)

S42: EditTicket
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to edit ticket #1
  - EmailAddress: mary2@marnes.mar
  - Full Name:Mary Marnes2
  - Subject: "Error operating system2"
  - Telephone: "xxx2"
  - Ext: "xx2"
  - Due datetime: *SystemDateTime.now() + 3 days*
  - Priority: Low
  - Help topic: Use
  - Internal note (reasons for edit): "The customer asks for this changes"
- The event occurs
  - The ticket is updated
  - The ticket thread includes the internal note with title "Ticked updated" and text "The customer asks for this changes".

S43: EditTicket_ticketIsNotVisible
Testing objectives: MT

- Fixture: #3 (*technicalActive* becomes a member of the group *maximumPrivilegesGroup*)
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.
- The staff member *technicalActive* wants to edit ticket #2
  - EmailAddress: john2@johnes.nes
  - Full Name:John Johnes 22
  - Subject: "Can I reply a ticket? Yes or no?"
  - Telephone: "yyy2"
  - Ext: "yy2"
  - Due datetime: *SystemDateTime.now() + 2 days*
  - Priority: Normal
  - Help topic: Use
  - Internal note (reasons for edit): "The customer asks for this changes"
- The event cannot occur (the ticket is not visible)

S44: EditTicket_NotAllowed
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.

- The staff member *technicalActive* wants to edit ticket #1
  - EmailAddress: mary2@marnes.mar
  - Full Name:Mary Marnes2
  - Subject: “Error operating system2”
  - Telephone: “xxx2”
  - Ext: “xx2”
  - Due datetime: *SystemDateTime.now() + 3 days*
  - Priority: Low
  - Help topic: Use
  - Internal note (reasons for edit): “The customer asks for this changes”
- The event cannot occur (the staff member is not allowed to edit tickets)

S45: EditTicket_NotAllowedButAdministrator
Testing objectives: MT

- Fixture: #3(*technicalActive* becomes an administrator)
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.
- The staff member *technicalActive* wants to edit ticket #1
  - EmailAddress: mary2@marnes.mar
  - Full Name:Mary Marnes2
  - Subject: “Error operating system2”
  - Telephone: “xxx2”
  - Ext: “xx2”
  - Due datetime: *SystemDateTime.now() + 3 days*
  - Priority: Low
  - Help topic: Use
  - Internal note (reasons for edit): “The customer asks for this changes”
- The event occurs

S46: EditTicket_NotLoggedIn
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* wants to edit ticket #1
  - EmailAddress: mary2@marnes.mar
  - Full Name:Mary Marnes2
  - Subject: “Error operating system2”
  - Telephone: “xxx2”
  - Ext: “xx2”
  - Due datetime: *SystemDateTime.now() + 3 days*
  - Priority: Low
  - Help topic: Use
  - Internal note (reasons for edit): “The customer asks for this changes”
- The event cannot occur (the staff member is not logged in).

S47: PostTicketReply_alertsAndAutoresponsesActive
Testing objectives: MT

- Fixture: #1 (help topic installation has autoresponses enabled)
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.

- The staff member *generalConsultant* wants to reply ticket #1:
  - "You should choose the installation executable according to your operating system".
- The event occurs
  - The last response datetime is updated.
  - The ticket thread includes the response.
  - An alert of the response is sent to the last respondent, the assigned staff and the department manager (except for those which are in vacation mode or inactive).
  - An auto-response is sent to the customer.

S48: PostTicketReply_alertsAndAutoresponsesDisabled
Testing objectives: MT

- Fixture: #4 (help topic installation has autoresponses enabled)
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to reply ticket #1:
  - "You should choose the installation executable according to your operating system".
- The event occurs
  - The last response datetime is updated.
  - The ticket thread includes the response.
  - No alert of the response is sent to the last respondent, the assigned staff and the department manager (except for those which are in vacation mode or inactive).
  - No auto-response is sent to the customer.

S49: PostTicketReply_ticketIsNotVisible
Testing objectives: MT

- Fixture: #4
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.
- The staff member *technicalActive* wants to reply ticket #2:
  - "You may click on the "reply" option".
- The event cannot occur (the ticket is not visible)

S50: PostTicketReply_NotLoggedIn
Testing objectives: MT

- Fixture: #1
- Fixture component: #created_tickets
- The staff member *generalConsultant* wants to reply ticket #1:
  - "You should choose the installation executable according to your operating system".
- The event cannot occur (the staff member is not logged in).

S51: PostTicketInternalNote_staffAlertsEnabled
Testing objectives: MT

- Fixture: #1
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.
- The staff member *technicalActive* wants to add an internal note titled "No tickets?" to ticket #5
  - Note: "It seems that she does not have tickets"
- The event for changing priority occurs

- The ticket thread includes the internal note
- An alert of the internal note is sent to the last respondent, the assigned staff and the department manager (except for those which are in vacation mode or inactive).

S52: PostTicketInternalNote_staffAlertsDisabled
Testing objectives: MT

- Fixture: #4
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.
- The staff member *technicalActive* wants to add an internal note titled "No tickets?" to ticket #5
  - Note: "It seems that she does not have tickets"
- The event for changing priority occurs
  - The ticket thread includes the internal note
  - No alert of the internal note is sent to the last respondent, the assigned staff and the department manager (except for those which are in vacation mode or inactive).

S53: PostTicketInternalNote_TicketNotVisible
Testing objectives: MT

- Fixture: #4
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.
- The staff member *technicalActive* wants to add an internal note titled "Checked button" to ticket #4
  - Note: "Checked that the button appears"
- The event cannot occur (the ticket is not visible for the staff member)

S54: PostTicketInternalNote_NotLoggedIn
Testing objectives: MT

- Fixture: #4
- Fixture component: #created_tickets
- The staff member *technicalActive* wants to add an internal note titled "No tickets?" to ticket #5
  - Note: "It seems that she does not have tickets"
- The event cannot occur (the staff member is not logged in)

S55: TransferTicket_staffAlertsEnabled
Testing objectives: MT

- Fixture: #4
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to transfer ticket #2 to *dptTechnical* with the comment "This is a technical question to be resolved as soon as possible".
- The event occurs
  - The ticket is transferred to the department *dptTechnical*
  - The ticket thread includes the internal note posted by the *generalConsultant* with title "Dept. Transfer from General support to Technical Support" and text "This is a technical question to be resolved as soon as possible".

S56: TransferTicket_ticketIsNotVisible
Testing objectives: MT

- Fixture: #3 (*technicalActive* becomes a member of the group *maximumPrivilegesGroup* and his access to the ticket department is restricted)
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.
- The staff member *technicalActive* wants to transfer ticket #2 to *dptTechnical* with the comment "This is a technical question to be resolved as soon as possible".
- The event cannot occur (the ticket is not visible for the staff member).

S57: TransferTicket_SameDepartment
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to transfer ticket #2 to *dptGeneral* with the comment "This is a technical question to be resolved as soon as possible".
- The event cannot occur (the ticket is already assigned to this department).

S58: TransferTicket_NotAllowed ToTransfer
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.
- The staff member *technicalActive* wants to transfer ticket #1 to *dptGeneral* with the comment "This is a technical question to be resolved as soon as possible".
- The assignment event cannot occur (the staff member is not allowed to transfer tickets).

S59 TransferTicket_NotLoggedIn
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* wants to transfer ticket #1 to *dptGeneral* with the comment "This is a technical question to be resolved as soon as possible".
- The assignment event cannot occur (the staff member is not logged in).

S60: CloseTicket
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to close ticket #1
- The event occurs
  - The ticket is closed
  - The ticket thread includes the internal note with title "Ticket closed" and text "Ticket close without response by Mary Mayer".
- The staff member *generalConsultant* wants to close ticket #1
- The event cannot occur (the ticket is already closed)

S61: CloseTicket_ticketIsNotVisibleOrNotAllowed
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in (its staff group becomes not allowed to see tickets of *dptTechnical*)
- The staff member *generalConsultant* wants to close ticket #1
- The event cannot occur (the staff member cannot manage the ticket)
- The staff group of the staff member *generalConsultant* becomes allowed to see tickets of *dptTechnical*) but it loses the privilege to close tickets
- The staff member *generalConsultant* wants to close ticket #1
- The event cannot occur (the staff member cannot close tickets)

S62: CloseTicket_NotLoggedIn
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* wants to close ticket #1
- The event cannot occur (the staff member is not logged in)

S63: CloseTicketWithReply_alertsAndAutoresponsesEnabled
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to close ticket #1 with the reply "Ticket solved"
- The event occurs
    - The ticket is closed
    - The ticket thread includes the internal note with title "Ticket closed" and text "Ticket close without response by Mary Mayer".
    - The ticket thread includes the reply "Ticket solved"
    - An auto-response is sent to the customer
- The staff member *generalConsultant* wants to close ticket #1 with the reply "Ticket solved"
- The event cannot occur (the ticket is already closed)

S64: CloseTicketWithReply_alertsAndAutoresponsesDisabled
Testing objectives: MT

- Fixture: #4
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to close ticket #1 with the reply "Ticket solved"
- The event occurs
    - The ticket is closed
    - The ticket thread includes the internal note with title "Ticket closed" and text "Ticket close without response by Mary Mayer".
    - The ticket thread includes the reply "Ticket solved"
    - No auto-response is sent to the customer

S65: CloseTicketWithReply_ticketIsNotVisibleOrNotAllowed
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in (its staff group becomes not allowed to see tickets of *dptTechnical*)
- The staff member *generalConsultant* wants to close ticket #1 with reply "Ticket solved"
- The event cannot occur (the staff member cannot manage the ticket)
- The staff group of the staff member *generalConsultant* becomes allowed to see tickets of *dptTechnical*) but it loses the privilege to close tickets
- The staff member *generalConsultant* wants to close ticket #1 with reply "Ticket solved"
- The event cannot occur (the staff member cannot close tickets)

S66: CloseTicketWithReply_NotLoggedIn
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* wants to close ticket #1 with the reply "Ticket solved"
- The event cannot occur (the staff member is not logged in)

S67: ReopenTicket
Testing objectives: MT

- Fixture: #3 (ticket #1 is closed)
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to reopen ticket #1
- The event occurs
  - The ticket is open
  - The ticket thread includes the internal note with title "Ticket reopened" and text "Ticket reopened (without comments) by Mary Mayer".
- The staff member *generalConsultant* wants to reopen ticket #1
- The event cannot occur (the ticket is already open)

S68: ReopenTicket_ticketIsNotVisibleOrNotAllowed
Testing objectives: MT

- Fixture: #3 (ticket #2 is closed)
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.
- The staff member *technicalActive* wants to reopen ticket #2
- The event cannot occur (the staff member cannot manage the ticket)

S69: ReopenTicket_NotLoggedIn
Testing objectives: MT

- Fixture: #3 (ticket #1 is closed)
- Fixture component: #created_tickets
- The staff member *generalConsultant* wants to close ticket #1
- The event cannot occur (the staff member is not logged in)

S70: ReopenTicketWithReply_alertsAndAutoresponsesEnabled
Testing objectives: MT

- Fixture: #1 (ticket #1 is closed and *helpTopicInstallation* enables autoresponses)
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to reopen ticket #1 with the comment "The customer is not satisfied with the response"
- The event occurs
    - The ticket is open
    - The ticket thread includes the internal note with title "Ticket status changed to opened" and text "Mary Mayer reopened the ticket on reply".
    - The ticket thread includes the reply "Ticket solved"
    - An auto-response is sent to the customer
- The staff member *generalConsultant* wants to close ticket #1 with the reply "Ticket solved"
- The event cannot occur (the ticket is already closed)

S71: ReopenTicketWithReply_alertsAndAutoresponsesDisabled
Testing objectives: MT

- Fixture: #4 (ticket #1 is closed)
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to close ticket #1 with the comment "The customer is not satisfied with the response"
- The event occurs
    - The ticket is open
    - The ticket thread includes the internal note with title "Ticket status changed to opened" and text "Mary Mayer reopened the ticket on reply".
    - The ticket thread includes the reply "Ticket solved"
    - No auto-response is sent to the customer

S72: ReopenTicketWithReply_ticketIsNotVisible
Testing objectives: MT

- Fixture: #3 (ticket #1 is closed)
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.
- The staff member *technicalActive* wants to reopen ticket #2 with the comment "The customer is not satisfied with the response"
- The event cannot occur (the staff member cannot manage the ticket)

S73: ReopenTicketWithReply_NotLoggedIn
Testing objectives: MT

- Fixture: #3 (ticket #1 is closed)
- Fixture component: #created_tickets
- The staff member *generalConsultant* wants to reopen ticket #1 with the comment "The customer is not satisfied with the response"
- The event cannot occur (the staff member is not logged in)

S74: BanTicketCloseEmail
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to ban the email of ticket #1 and close the ticket
- The event occurs
  - The email of ticket #1 is banned and the the ticket is closed
  - The ticket thread includes the internal note with title "Ticket closed" and text "Email (mary@marnes.mar) added to banlist & ticket status set to closed".
- The staff member *generalConsultant* wants to ban the email & close again the ticket #1
- The event cannot occur (the ticket is already closed)

S75: BanTicketCloseEmail _ticketIsNotVisible
Testing objectives: MT

- Fixture: #3 (the *technicalActive* is allowed to ban emails)
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.
- The staff member *technicalActive* wants to ban the email of ticket #2 and close the ticket
- The event cannot occur (the staff member cannot manage the ticket)

S76: BanTicketCloseEmail _notAllowed
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The *generalConsultant* cannot ban emails
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to ban the email of ticket #2 and close the ticket
- The event cannot occur (the staff member cannot ban emails of tickets)

S77: BanTicketCloseEmail _NotLoggedIn
Testing objectives: MT

- Fixture: #11 (ticket #1 is closed)
- Fixture component: #created_tickets
- The staff member *generalConsultant* wants to ban the email of ticket #1 and close the ticket
- The event cannot occur (the staff member is not logged in)

S78: DeleteTicket
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalConsultant* logs in.
- The staff member *generalConsultant* wants to delete ticket #1
- The event occurs
  - The ticket is deleted

S79: DeleteTicket_ticketIsNotVisible
Testing objectives: MT

- Fixture: #3 (the *technicalActive* is not allowed to delete tickets)
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.
- The staff member *technicalActive* wants to delete ticket #2
- The event cannot occur (the staff member cannot manage the ticket)

S80: DeleteTicket_notAllowed
Testing objectives: MT

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *technicalActive* logs in.
- The staff member *technicalActive* wants delete ticket #2
- The event cannot occur (the staff member cannot ban emails of tickets)

S81: DeleteTicket_NotLoggedIn
Testing objectives: MT

- Fixture: #3 (ticket #1 is closed)
- Fixture component: #created_tickets
- The staff member *generalConsultant* wants delete ticket #1
- The event cannot occur (the staff member is not logged in)

S82: BannedEmailsCannotCreateTickets
Testing objectives: MT

- Fixture: #4
- Fixture component: #created_tickets
- Email 'hello_at_helloworld.hel' is in the banlist
- No ticket can be created online, offline or by email

S83: CheckOverdueTickets_staffAlertsDisabled
Testing objectives: MT

- Fixture: #4
- Fixture component: #created_tickets
- *SystemDateTime.now()* + 3 days
- The system checks the overdue tickets
    - No autoresponses to the customer are sent
    - No alerts are sent to the staff

S84: CheckOverdueTickets_staffAlertsEnabled
Testing objectives: MT

- Fixture: #1
- Fixture component: #created_tickets
- *SystemDateTime.now()* + 2 days
- The system checks the overdue tickets
    - No autoresponses to the customer are sent
    - No alerts are sent to the staff

S85: ViewTickets_open_myTickets_overdue_closed
Testing objectives: VTS

- Fixture: #3
- Fixture component: #created_tickets
- The staff member *generalAdministrator* logs in
- The staff member *generalAdministrator* wants to view the open tickets (this staff member can see the tickets of all departments)
    - The result of the query is:

Ticket	Date	Subject	Department	Priority	From
1	now()-1	Error operating system	*dptTechnical*	Normal	Mary Marnes
2	now()-1	Can I reply a ticket?	*dptGeneral*	High	John Johnes
3	now()-1	Error while login	*dptTechnical*	Low	Martin Pope
4	now()	Reopening ticket	*dtpGeneral*	Normal	James Jordan
5	now()	See my tickets	*dptTechnical*	High	marta@johnes.mar

- The staff member *generalAdministrator* wants to view his/her assigned tickets
    - The result of the query is empty
- The staff member *generalAdministrator* assigns ticket #4to the *generalAdministrator*.
- The staff member *generalAdministrator* wants to view his/her assigned tickets
    - The result of the query is:

Ticket	Date	Subject	Department	Priority	From
4	now()	Reopening ticket	*dtpGeneral*	Normal	James Jordan

- The staff member *generalAdministrator* wants to view the overdue tickets
    - The result of the query is empty
- *SystemDateTime.now()* +3 days
- The staff member *generalAdministrator* marks ticket #4 as overdue
- The staff member *generalAdministrator* wants to view the overdue tickets
    - The result of the query is:

Ticket	Date	Subject	Department	Priority	From
1	now()-1	Error operating system	*dptTechnical*	Normal	Mary Marnes
4	now()	Reopening ticket	*dtpGeneral*	Normal	James Jordan

- The staff member *generalAdministrator* wants to view the closed tickets
    - The result of the query is empty
- The staff member *generalAdministrator* closes ticket #4
- The staff member *generalAdministrator* wants to view the overdue tickets
    - The result of the query is:

Ticket	Date	Subject	Department	Priority	From
1	now()-1	Error operating system	*dptTechnical*	Normal	Mary Marnes

- The staff member *generalAdministrator* wants to view the closed tickets
    - The result of the query is:

Ticket	Date	Subject	Department	Priority	From
4	now()	Reopening ticket	*dtpGeneral*	Normal	James Jordan

5. TDCM application to the case study

In this section, we report the results of the TDCM application for the purpose of developing the conceptual schema of the *osTicket* system, according to the testing strategy defined in Section 2.

We report the following information for each iteration:

- **Iteration objective:** The objective of the current iteration.
- **Current test case:** This is the test case that initiates the TDCM iteration.
- **TDCM application. Summary of changes performed in the schema.** The execution of the current test case (and the previous test cases as regression tests) provides failure and error information that drives changes in the schema. These changes are summarized in order to explain the evolution of the schema by applying TDCM.
- **Time spent:** We register the minutes spent in order to specify the initial test case and the minutes to complete the iteration.
- **Errors and failures:** We categorize the types of errors and failures revealed during the iteration as a result of the application of TDCM.

We also present the resultant conceptual schema after the development of the *Configuration and basics* part, and after the development of the *Tickets management and tracking* part.

The USEx specification of the whole resultant conceptual schema may be found in appendix A (conceptual schema in UML/OCL) and appendix B (methods defined in CSTL).

The test cases after TDCM application are collected in appendix C.

Iteration 1

Iteration objective

Email templates

Current test case

```
testprogram ConfigurationAndBasics{

 fixturecomponent CompatibleConfigurationAndBasics{
   template_default:=new EmailTemplate(name:='Default');
   template_default.internalNotes:='Email templates by default';

   ek1:=new NewTicketAutoresponse(subject:='X',message:='Y');
   ek1.emailTemplate:=template_default;
   template_default.newTicketAutoresponse.subject:='X';
   template_default.newTicketAutoresponse.message:='Y';

   ek2:=new NewMessageAutoresponse(subject:='X',message:='Y');
   ek2.emailTemplate:=template_default;
   template_default.newMessageAutoresponse.subject:='X';
   template_default.newMessageAutoresponse.message:='Y';

   ek3:=new NewTicketNotice(subject:='X',message:='Y');
   ek3.emailTemplate:=template_default;
   template_default.newTicketNotice.subject:='X';
   template_default.newTicketNotice.message:='Y';

   ek4:=new OverTicketLimitNotice(subject:='X',message:='Y');
   ek4.emailTemplate:=template_default;
   template_default.overTicketLimitNotice.subject:='X';
   template_default.overTicketLimitNotice.message:='Y';

   ek5:=new TicketResponseNotice(subject:='X',message:='Y');
   ek5.emailTemplate:=template_default;
   template_default.ticketResponseNotice.subject:='X';
   template_default.ticketResponseNotice.message:='Y';

   ek6:=new NewTicketAlertToStaff(subject:='X',message:='Y');
   ek6.emailTemplate:=template_default;
   template_default.newTicketAlertToStaff.subject:='X';
   template_default.newTicketAlertToStaff.message:='Y';

   ek7:=new NewMessageAlertToStaff(subject:='X',message:='Y');
   ek7.emailTemplate:=template_default;
   template_default.newMessageAlertToStaff.subject:='X';
   template_default.newMessageAlertToStaff.message:='Y';

   ek8:=new NewInternalNoteAlertToStaff(subject:='X',message:='Y');
   ek8.emailTemplate:=template_default;
   template_default.newInternalNoteAlertToStaff.subject:='X';
   template_default.newInternalNoteAlertToStaff.message:='Y';

   ek9:=new TicketAssignedAlertToStaff(subject:='X',message:='Y');
   ek9.emailTemplate:=template_default;
   template_default.ticketAssignedAlertToStaff.subject:='X';
   template_default.ticketAssignedAlertToStaff.message:='Y';

   ek10:=new OverdueTicketAlertToStaff(subject:='X',message:='Y');
   ek10.emailTemplate:=template_default;
   template_default.overdueTicketAlertToStaff.subject:='X';
   template_default.overdueTicketAlertToStaff.message:='Y';
}
```

```
test testConfiguration1{
   load CompatibleConfigurationAndBasics;
   assert consistency;
}

}
```

TDCM application: Summary of changes performed in the schema

■ Added

```
class EmailTemplate
attributes
name:String[1]
internalNotes:String[1]
end

class EmailKind
attributes
subject:String
message:String
end

class NewTicketAutoresponse<EmailKind
end

association newTicketAutoresponse_emailTemplate between
   NewTicketAutoresponse[1]
   EmailTemplate[1]
end

class NewMessageAutoresponse<EmailKind
end

association newMessageAutoresponse_emailTemplate between
   NewMessageAutoresponse[1]
   EmailTemplate[1]
end

class NewTicketNotice<EmailKind
end

association newTicketNotice_emailTemplate between
   NewTicketNotice[1]
   EmailTemplate[1]
end

class OverTicketLimitNotice<EmailKind
end

association overTicketLimitNotice_emailTemplate between
   OverTicketLimitNotice[1]
   EmailTemplate[1]
end

class TicketResponseNotice<EmailKind
end

association ticketResponseNotice_emailTemplate between
   TicketResponseNotice[1]
   EmailTemplate[1]
end

class NewTicketAlertToStaff<EmailKind
end
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	7

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
17					
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed

Iteration 2

Iteration objective

Departments and Email Accounts (and their dependencies)

Current test case

```
testprogram ConfigurationAndBasics{

 fixturecomponent CompatibleConfigurationAndBasics{

   …

   dptGeneral := new Department(name:='General support');
   dptGeneral.type := #Public;
   dptGeneral.emailTemplate := template_default;
   dptGeneral.newTicketAutoresponseIsSent := true;
   dptGeneral.newAddedMessageIsNotified := true;

   dptTechnical := new Department(name:='Technical support');
   dptTechnical.type := #Private;
   dptTechnical.emailTemplate := template_default;
   dptTechnical.newTicketAutoresponseIsSent := true;
   dptTechnical.newAddedMessageIsNotified := true;

   generalSupportEmailAccount:=new EmailAccount(address:='general@support.com');
   generalSupportEmailAccount.fromName:='General questions';
   generalSupportEmailAccount.defaultNewPriority:=#Low;
   generalSupportEmailAccount.defaultNewTicketDepartment:=dptGeneral;
   generalSupportEmailAccount.autoresponsesStatus:=#Disabled;
```

```
    technicalSupportEmailAccount:=new EmailAccount(address:='technical@support.com');
    technicalSupportEmailAccount.fromName:='B Support';
    technicalSupportEmailAccount.defaultNewPriority:=#High;
    technicalSupportEmailAccount.defaultNewTicketDepartment:=dptTechnical;
    technicalSupportEmailAccount.autoresponsesStatus:=#Disabled;

    dptGeneral.outgoingEmail:=generalSupportEmailAccount;
    dptGeneral.autoresponseEmail:=generalSupportEmailAccount;

    dptTechnical.outgoingEmail:=technicalSupportEmailAccount;
    dptTechnical.autoresponseEmail:=technicalSupportEmailAccount;

    generalAdministrator:=new StaffMember(username:='john');
    generalAdministrator.department:=dptGeneral;
    generalAdministrator.firstName:='John';
    generalAdministrator.lastName:='Johny';
    generalAdministrator.emailAdress:='john@support.com';
    generalAdministrator.officePhone:='11111';
    generalAdministrator.phoneExtension:='11';
    generalAdministrator.mobilePhone:='11111';
    generalAdministrator.signature:='John Johny';
    generalAdministrator.password:='xxx';
    generalAdministrator.status:=#Enabled;
    generalAdministrator.isAdministrator:=true;
    generalAdministrator.isInVacationMode:=false;

    dptTechnical.departmentManager:=generalAdministrator;

     maximumPrivilegesGroup:=new StaffGroup(name:='Maximum Privileges Group');
     maximumPrivilegesGroup.status:=#Enabled;
     maximumPrivilegesGroup.departmentsAccess:=Set{dptGeneral,dptTechnical};
     maximumPrivilegesGroup.canCreateTickets:=true;
     maximumPrivilegesGroup.canEditTickets:=true;
     maximumPrivilegesGroup.canCloseTickets:=true;
     maximumPrivilegesGroup.canTransferTickets:=true;
     maximumPrivilegesGroup.canDeleteTickets:=true;
     maximumPrivilegesGroup.canBanEmails:=true;

     generalAdministrator.staffGroup:=maximumPrivilegesGroup;

 }


 test testConfiguration1{
    load CompatibleConfigurationAndBasics;
    assert consistency;
 }

}
```

TDCM application: Summary of changes performed in the schema

■ Added

```
enum DepartmentType{Public, Private}
enum Priority{Low,High}
enum Status{Enabled,Disabled}

...

class Department
attributes
name:String
type:DepartmentType
newTicketAutoresponseIsSent:Boolean
newAddedMessageIsNotified:Boolean
end

association department_emailTemplate between
   Department[*] role departmentOfEmailTemplate
```

```
    EmailTemplate[1]
end


association department_departmentManager between
    Department[*] role departmentOfManager
    StaffMember[0..1] role departmentManager
end

association department_autoresponseEmail between
    Department[*] role departmentOfAutoresponseEmail
    EmailAccount[1] role autoresponseEmail
end


association department_outgoingEmail between
    Department[*]
    EmailAccount[1] role outgoingEmail
end

class EmailAccount
attributes
address:String
fromName:String
defaultNewPriority:Priority
autoresponsesStatus:Status
end

association EmailAccount_defaultNewTicketDepartment between
    EmailAccount[*]
    Department[1] role defaultNewTicketDepartment
end

class StaffMember
attributes
username:String
firstName:String
lastName:String
emailAdress:String
officePhone:String
phoneExtension:String
mobilePhone:String
signature:String
password:String
status:Status
isAdministrator:Boolean
isInVacationMode:Boolean
end

association staffMember_department between
    StaffMember[*]
    Department[1]
end


association staffMember_staffGroup between
    StaffMember[*]
    StaffGroup[1]
end

class StaffGroup
attributes
name:String
status:Status
canCreateTickets:Boolean
canEditTickets:Boolean
canCloseTickets:Boolean
canTransferTickets:Boolean
canDeleteTickets:Boolean
canBanEmails:Boolean
end
```

```
association staffGroup_departmentsAccess between
   StaffGroup[*]
   Department[*] role departmentsAccess
end
```

The multiplicity of some association ends ant attributes has been changed thanks to the following failure information:

- The state is inconsistent: Multiplicity constraint violation in association `department_departmentManager': Object `oid12' of class `Department' is connected to 0 objects of class `StaffMember' but the multiplicity is specified as `1'.
- The state is inconsistent: Instances of Department violate the invariant minMultiplicityOfAttributeAutoresponseEmail

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	18
TIME TO COMPLETE THE ITERATION (IN MINUTES)	27

Errors and failures that drive the conceptual modeling

<table>
<tr><td colspan="2">A basic type involved in a test case does not exist in the CSUD</td><td colspan="2">A derived type involved in a test case does not exist in the CSUD</td><td colspan="2">An event type involved in a test case does not exist in the CSUD</td></tr>
<tr><td colspan="2">The basic type is relevant and it is added to the CSUD</td><td colspan="2">The derived type is relevant and it is added to the CSUD</td><td colspan="2">The event type is relevant and it is added to the CSUD</td></tr>
<tr><td colspan="2">43</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">Inconsistent state before the occurrence of an event</td><td colspan="2">Inconsistent state after the occurrence of an event</td><td colspan="2">The postcondition of an event is not satisfied.</td></tr>
<tr><td>Some static constraint is invalid and it is modified.</td><td>Some initial integrity constraint is invalid and it is modified.</td><td>The event postcondition/method is incorrect and it is modified.</td><td>Some constraint is invalid and it is modified.</td><td>The method is not correct and it is modified.</td><td>The postcondition is not correct and it is modified.</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">An assertion about the IB state fails or contains an error</td><td>Assert non-occurrence fails</td><td colspan="2">Semantic error in an expression</td></tr>
<tr><td colspan="2">The effect of an event type is not correct</td><td>A derivation rule is incorrect</td><td>A precondition is added/updated</td><td>The expression is corrected</td><td>The CSUD is changed</td></tr>
<tr><td colspan="2"></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Assert consistency fails</td><td colspan="4" rowspan="2"></td></tr>
<tr><td colspan="2">A static constraint needs to be changed</td></tr>
<tr><td colspan="2">2</td><td colspan="4"></td></tr>
</table>

Iteration 3

Iteration objective

Other staff members and staff groups

Current test case

```
testprogram ConfigurationAndBasics{

 fixturecomponent CompatibleConfigurationAndBasics{

  ...

    minimumPrivilegesGroup:=new StaffGroup(name:='Minimum Privileges Group');
    minimumPrivilegesGroup.status:=#Enabled;
    minimumPrivilegesGroup.departmentsAccess:=Set{};
    minimumPrivilegesGroup.canCreateTickets:=false;
    minimumPrivilegesGroup.canEditTickets:=false;
    minimumPrivilegesGroup.canCloseTickets:=false;
    minimumPrivilegesGroup.canTransferTickets:=false;
    minimumPrivilegesGroup.canDeleteTickets:=false;
    minimumPrivilegesGroup.canBanEmails:=false;

    inactiveGroup:=new StaffGroup(name:='Inactive Group');
    inactiveGroup.status:=#Disabled;
    inactiveGroup.departmentsAccess:=Set{};
    inactiveGroup.canCreateTickets:=true;
    inactiveGroup.canEditTickets:=false;
    inactiveGroup.canCloseTickets:=true;
    inactiveGroup.canTransferTickets:=false;
    inactiveGroup.canDeleteTickets:=true;
    inactiveGroup.canBanEmails:=false;


   generalConsultant:=new StaffMember(username:='mary');
   generalConsultant.department:=dptGeneral;
   generalConsultant.firstName:='Mary';
   generalConsultant.lastName:='Mayer';
   generalConsultant.emailAdress:='mary@support.com';
   generalConsultant.officePhone:='22222';
   generalConsultant.phoneExtension:='22';
   generalConsultant.mobilePhone:='22222';
   generalConsultant.signature:='Mary Mayer';
   generalConsultant.password:='yyy';
   generalConsultant.status:=#Enabled;
   generalConsultant.isAdministrator:=false;
   generalConsultant.isInVacationMode:=false;
   generalConsultant.staffGroup:=maximumPrivilegesGroup;

   generalConsultantVacation:=new StaffMember(username:='david');
   generalConsultantVacation.department:=dptGeneral;
   generalConsultantVacation.firstName:='David';
   generalConsultantVacation.lastName:='Dassel';
   generalConsultantVacation.emailAdress:='david@support.com';
   generalConsultantVacation.officePhone:='33333';
   generalConsultantVacation.phoneExtension:='33';
   generalConsultantVacation.mobilePhone:='33333';
   generalConsultantVacation.signature:='David Dassel';
   generalConsultantVacation.password:='zzz';
   generalConsultantVacation.status:=#Enabled;
   generalConsultantVacation.isAdministrator:=false;
   generalConsultantVacation.isInVacationMode:=true;
   generalConsultantVacation.staffGroup:=maximumPrivilegesGroup;

   technicalActive:=new StaffMember(username:='martin');
   technicalActive.department:=dptTechnical;
   technicalActive.firstName:='Martin';
   technicalActive.lastName:='Martech';
   technicalActive.emailAdress:='martin@support.com';
   technicalActive.password:='ttt';
   technicalActive.status:=#Enabled;
   technicalActive.isAdministrator:=false;
   technicalActive.isInVacationMode:=false;
   technicalActive.staffGroup:=minimumPrivilegesGroup;
```

```
    technicalInactive:=new StaffMember(username:='patricia');
    technicalInactive.department:=dptTechnical;
    technicalInactive.firstName:='Patricia';
    technicalInactive.lastName:='Pauls';
    technicalInactive.emailAdress:='patricia@support.com';
    technicalInactive.password:='ttt';
    technicalInactive.status:=#Disabled;
    technicalInactive.isAdministrator:=false;
    technicalInactive.isInVacationMode:=false;
    technicalInactive.staffGroup:=minimumPrivilegesGroup;

  }


  test testConfiguration1{
    load CompatibleConfigurationAndBasics;
    assert consistency;
  }

}
```

TDCM application: Summary of changes performed in the schema

■ Updated

```
class StaffMember
attributes
    username:String
    firstName:String
    lastName:String
    emailAdress:String
    officePhone:String[0..1]
    phoneExtension:String [0..1]
    mobilePhone:String[0..1]
    signature:String[0..1]
    password:String
    status:Status
    isAdministrator:Boolean
    isInVacationMode:Boolean
end
```

The multiplicity of the attributes StaffMember::mobilePhone, StaffMember::officePhone, StaffMember::phoneExtension, StaffMember::signature have been changed as a response to the following failure information:

- The state is inconsistent: Instances of StaffMember violate the invariant minMultiplicityOfAttributeMobilePhone
- The state is inconsistent: Instances of StaffMember violate the invariant minMultiplicityOfAttributeOfficePhone
- The state is inconsistent: Instances of StaffMember violate the invariant minMultiplicityOfAttributePhoneExtension
- The state is inconsistent: Instances of StaffMember violate the invariant minMultiplicityOfAttributeSignature

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	10
TIME TO COMPLETE THE ITERATION (IN MINUTES)	3

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed

Assert consistency fails
A static constraint needs to be changed
4

Iteration 4

Iteration objective

Email settings

Current test case

```
testprogram ConfigurationAndBasics{

 fixturecomponent CompatibleConfigurationAndBasics{

   ...
    emailSettings:=new EmailSettings;
    emailSettings.defaultSystemEmail:=generalSupportEmailAccount;
    emailSettings.defaultStaffAlertsEmail:=generalSupportEmailAccount;
    emailSettings.administrationEmail:='system@support.com';
 }

 test testConfiguration1{
    load CompatibleConfigurationAndBasics;
    assert consistency;
 }

}
```

TDCM application: Summary of changes performed in the schema

■ Added

```
class EmailSettings
attributes
   administrationEmail:String
end

association emailSettings_emailAccount between
```

```
    EmailSettings[*] role emailSettingsOfDefaultSystemEmail
    EmailAccount[1] role defaultSystemEmail
end

association emailSettings_defaultStaffAlertsEmail between
    EmailSettings[*] role emailSettingsOfDefaultStaffAlertsEmail
    EmailAccount[1] role defaultStaffAlertsEmail
end

context EmailSettings inv hasOnlyOneInstance:
    EmailSettings.allInstances()->size()=1
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	0,6
TIME TO COMPLETE THE ITERATION (IN MINUTES)	2

Errors and failures that drive the conceptual modeling

<table>
<tr><td colspan="2">A basic type involved in a test case does not exist in the CSUD</td><td colspan="2">A derived type involved in a test case does not exist in the CSUD</td><td colspan="2">An event type involved in a test case does not exist in the CSUD</td></tr>
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<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">An assertion about the IB state fails or contains an error</td><td>Assert non-occurrence fails</td><td colspan="2">Semantic error in an expression</td></tr>
<tr><td colspan="2">The effect of an event type is not correct</td><td>A derivation rule is incorrect</td><td>A precondition is added/updated</td><td>The expression is corrected</td><td>The CSUD is changed</td></tr>
<tr><td colspan="2"></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Assert consistency fails</td><td colspan="4" rowspan="2"></td></tr>
<tr><td colspan="2">A static constraint needs to be changed</td></tr>
<tr><td colspan="2"></td><td colspan="4"></td></tr>
</table>

Iteration 5

Iteration objective

Help topics

Current test case

```
testprogram ConfigurationAndBasics{

 fixturecomponent CompatibleConfigurationAndBasics{

    …

    helpTopicUse:=new HelpTopic(name:='Use');
    helpTopicUse.status:=#Enabled;
    helpTopicUse.autoresponse:=#Enabled;
    helpTopicUse.newTicketPriority:=#Normal;
    helpTopicUse.newTicketDepartment:=dptGeneral;

    helpTopicInstallation:=new HelpTopic(name:='Installation');
    helpTopicInstallation.status:=#Enabled;
    helpTopicInstallation.autoresponse:=#Disabled;
    helpTopicInstallation.newTicketPriority:=#High;
    helpTopicInstallation.newTicketDepartment:=dptTechnical;

    helpTopicDisabled:=new HelpTopic(name:='Offers');
    helpTopicDisabled.status:=#Disabled;
    helpTopicDisabled.autoresponse:=#Disabled;
    helpTopicDisabled.newTicketPriority:=#Low;
    helpTopicDisabled.newTicketDepartment:=dptGeneral;

 }

 test testConfiguration1{
    load CompatibleConfigurationAndBasics;
    assert consistency;
 }

}
```

TDCM application: Summary of changes performed in the schema

■ Added

```
enum Priority{Low,Normal,High}

class HelpTopic
attributes
name:String
status:Status
autoresponse:Status
newTicketPriority:Priority
end

association helpTopic_newTicketDepartment between
    HelpTopic[*]
    Department[1] role newTicketDepartment
End
```

The type of the attribute HelpTopic::autoresponse has been changed from Boolean to Status in order to solve the following error:

- [ConfigurationAndBasics.cstl] <line 199> Incompatible types: Enumeration value expression cannot be assigned to the property oid24.autoresponse

A new enumeration literal is defined for the enumeration Priority, because this user story reveals that it is relevant for the domain:

- [ConfigurationAndBasics.cstl] <Line 200>:1:1: Undefined enumeration literal `Normal'.

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	3,5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
7					
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect		A precondition is added/updated	The expression is corrected	The CSUD is changed
					1
Assert consistency fails					
A static constraint needs to be changed					

Iteration 6

Iteration objective

General settings online

Current test case

```
testprogram ConfigurationAndBasics{

...

 fixturecomponent GeneralSettingsOnline{
   generalSettings:=new GeneralSettings;
   generalSettings.status:=#Online;
   generalSettings.helpdeskURL:='http://onlinesupport.com';
   generalSettings.helpdeskName:='Online customer support';
   generalSettings.defaultEmailTemplate:=template_default;
 }

  test testConfiguration1{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   assert consistency;
 }


}
```

TDCM application: Summary of changes performed in the schema

■ Added

```
enum HelpDeskStatus{Online }

class GeneralSettings
attributes
status:HelpDeskStatus
helpdeskURL:String
helpdeskName:String
end

association generalSettings_defaultEmailTemplate between
   GeneralSettings[*]
   EmailTemplate[1] role defaultEmailTemplate
end

context GeneralSettings inv hasOnlyOneInstance:
   GeneralSettings.allInstances()->size()=1
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	3
TIME TO COMPLETE THE ITERATION (IN MINUTES)	5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
5					
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed

Assert consistency fails
A static constraint needs to be changed

Iteration 7

Iteration objective

General settings offline

Current test case

```
testprogram ConfigurationAndBasics{

...

  fixturecomponent GeneralSettingsOffline{
    generalSettings:=new GeneralSettings;
    generalSettings.status:=#Offline;
    generalSettings.defaultEmailTemplate:=template_default;
  }

  test testConfiguration1{
    load CompatibleConfigurationAndBasics;
    load GeneralSettingsOnline;
    assert consistency;
  }

  test testConfiguration9{
    load CompatibleConfigurationAndBasics;
    load GeneralSettingsOffline;
    assert consistency;
  }
}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

```
enum HelpDeskStatus{Online,Offline}

class GeneralSettings
attributes
status:HelpDeskStatus
helpdeskURL:String
helpdeskName:String[0..1]
end
```

The multiplicity of attributes GeneralSettings::helpdeskName and GeneralSettings::helpdeskURL is changed according the following failures:

- The state is inconsistent: Instances of GeneralSettings violate the invariant minMultiplicityOfAttributeHelpdeskName

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	1

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
1					
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect		A precondition is added/updated	The expression is corrected	The CSUD is changed
Assert consistency fails					
A static constraint needs to be changed					
1					

Iteration 8

Iteration objective

Ticket settings sequential (in combination with existing compatible configuration and basics)

Current test case

```
testprogram ConfigurationAndBasics{

…

 fixturecomponent TicketSettingsSequential{
   ticketSettings:=new TicketSettings;
   ticketSettings.mode:=#Sequential;
   ticketSettings.priority:=#Normal;
   ticketSettings.customersCanChangePriority:=false;
   ticketSettings.useEmailPriorityWhenAvailable:=true;
   ticketSettings.maximumOpenTicketsPerMail:=2;
   ticketSettings.ticketGracePeriod:=0;
   ticketSettings.reopenedTicketsAreAssignedToLastRespondent:=true;
}

 test testConfiguration1{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   assert consistency;
}

 test testConfiguration9{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOffline;
   load TicketSettingsSequential;
   assert consistency;
}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

```
enum TicketsMode{Sequential}

class TicketSettings
attributes
mode:TicketsMode
priority:Priority
customersCanChangePriority:Boolean
useEmailPriorityWhenAvailable:Boolean
maximumOpenTicketsPerMail:Integer
ticketGracePeriod:Integer
reopenedTicketsAreAssignedToLastRespondent:Boolean
end

context TicketSettings inv hasOnlyOneInstance:
   TicketSettings.allInstances()->size()=1
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	3,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
9					
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect		A precondition is added/updated	The expression is corrected	The CSUD is changed
Assert consistency fails					
A static constraint needs to be changed					

Iteration 9

Iteration objective

Ticket settings random (in combination with existing compatible configuration and basics)

Current test case

```
testprogram ConfigurationAndBasics{

…

  fixturecomponent TicketSettingsRandom{
   ticketSettings:=new TicketSettings;
   ticketSettings.mode:=#Random;
   ticketSettings.priority:=#High;
   ticketSettings.customersCanChangePriority:=true;
   ticketSettings.useEmailPriorityWhenAvailable:=false;
   //ticketSettings.maximumOpenTicketsPerMail:=#Unlimited;
   ticketSettings.openTicketsPerMailAreLimited:=false;
   ticketSettings.ticketGracePeriod:=2;
   ticketSettings.reopenedTicketsAreAssignedToLastRespondent:=false;
}

test testConfiguration1{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   assert consistency;
}

 test testConfiguration5{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsRandom;
   assert consistency;
}

  test testConfiguration9{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOffline;
   load TicketSettingsSequential;
   assert consistency;
}

 test testConfiguration13{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOffline;
   load TicketSettingsRandom;
   assert consistency;
}

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

We add the following enumeration value:

```
enum TicketsMode{Sequential,Random}
```

Initially, the current test case specifies the line:

```
ticketSettings.maximumOpenTicketsPerMail:=#Unlimited;
```

The test case execution reveals that this attribute was a number in the previous test cases. However, the test case expects to indicate that, in this case, there is no maximum of open tickets per mail. In order to deal with the two expectations, we modify the CSUD as follows:

```
class TicketSettings
attributes
```

```
mode:TicketsMode
priority:Priority
customersCanChangePriority:Boolean
useEmailPriorityWhenAvailable:Boolean
openTicketsPerMailAreLimited:Boolean
maximumOpenTicketsPerMail:Integer
ticketGracePeriod:Integer
reopenedTicketsAreAssignedToLastRespondent:Boolean
end

context TicketSettings inv hasOnlyOneInstance:
   TicketSettings.allInstances()->size()=1

context TicketSettings inv specifiesTheMaximumNumberOfOpenTickerPerMailIfNotUnlimited:
   self.openTicketsPerMailAreLimited implies self.maximumOpenTicketsPerMail.isDefined()
```

When we execute again, all test cases (the current one and the previous test cases) fail, with the following failure:

- The state is inconsistent: Instances of TicketSettings violate the invariant minMultiplicityOfAttributeOpenTicketsPerMailAreLimited

This failure reveals that there is an error in the CSUD: the multiplicity of the attribute *maximumOpenTicketsPerMail* should be 0..1

```
class TicketSettings
attributes
mode:TicketsMode
priority:Priority
customersCanChangePriority:Boolean
useEmailPriorityWhenAvailable:Boolean
openTicketsPerMailAreLimited:Boolean
maximumOpenTicketsPerMail:Integer[0..1]
ticketGracePeriod:Integer
reopenedTicketsAreAssignedToLastRespondent:Boolean
end
```

After this change, the test cases *testConfiguration1* and *testConfiguration9* (those that limit the number of tickets per mail) also fail (they are not consistent) because they do not specify a value for the attribute *openTicketsPerMailAreLimited*. We set the default value for the attribute *openTicketsPerMailAreLimited* to *false*.

```
class TicketSettings
attributes
mode:TicketsMode
priority:Priority
customersCanChangePriority:Boolean
useEmailPriorityWhenAvailable:Boolean
openTicketsPerMailAreLimited:Boolean=false
maximumOpenTicketsPerMail:Integer[0..1]
ticketGracePeriod:Integer
reopenedTicketsAreAssignedToLastRespondent:Boolean
end
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	7,5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
1					
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
				1

Assert consistency fails	
A static constraint needs to be changed	
1	***INCONSISTENCY BETWEEN REQUIREMENTS FIXED***

Iteration 10

Iteration objective

Customer auto responses active (in combination with existing compatible configuration and basics)

Current test case

```
testprogram ConfigurationAndBasics{

…

 fixturecomponent CustomerAutoresponsesActive{
    customerAutoresponsesSettings:=new CustomerAutoresponsesSettings;
    customerAutoresponsesSettings.autorespondWhenNewTicketCreatedByCustomer:=true;
    customerAutoresponsesSettings.autorespondWhenNewTicketCreatedByStaff:=true;
    customerAutoresponsesSettings.autorespondWhenNewMessageAppendedToTicket:=true;
    customerAutoresponsesSettings.autorespondWhenMaximumOpenTicketsOfCustomer:=true;
 }

 test testConfiguration1{
    load CompatibleConfigurationAndBasics;
    load GeneralSettingsOnline;
    load TicketSettingsSequential;
    load CustomerAutoresponsesActive;
    assert consistency;
 }

test testConfiguration5{
    load CompatibleConfigurationAndBasics;
    load GeneralSettingsOnline;
    load TicketSettingsRandom;
    load CustomerAutoresponsesActive;
```

```
   assert consistency;
}

 test testConfiguration9{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOffline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesActive;
   assert consistency;
}

 test testConfiguration13{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOffline;
   load TicketSettingsRandom;
   load CustomerAutoresponsesActive;
   assert consistency;
 }
}
```

TDCM application: Summary of changes performed in the schema

■ Added

```
class CustomerAutoresponsesSettings
attributes
autorespondWhenNewTicketCreatedByCustomer:Boolean
autorespondWhenNewTicketCreatedByStaff:Boolean
autorespondWhenNewMessageAppendedToTicket:Boolean
autorespondWhenMaximumOpenTicketsOfCustomer:Boolean
end

context CustomerAutoresponsesSettings inv hasOnlyOneInstance:
   CustomerAutoresponsesSettings.allInstances()->size()=1
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	3

Errors and failures that drive the conceptual modeling

<table>
<tr><td colspan="2">A basic type involved in a test case does not exist in the CSUD</td><td colspan="2">A derived type involved in a test case does not exist in the CSUD</td><td colspan="2">An event type involved in a test case does not exist in the CSUD</td></tr>
<tr><td colspan="2">The basic type is relevant and it is added to the CSUD</td><td colspan="2">The derived type is relevant and it is added to the CSUD</td><td colspan="2">The event type is relevant and it is added to the CSUD</td></tr>
<tr><td colspan="2">5</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">Inconsistent state before the occurrence of an event</td><td colspan="2">Inconsistent state after the occurrence of an event</td><td colspan="2">The postcondition of an event is not satisfied.</td></tr>
<tr><td>Some static constraint is invalid and it is modified.</td><td>Some initial integrity constraint is invalid and it is modified.</td><td>The event postcondition/method is incorrect and it is modified.</td><td>Some constraint is invalid and it is modified.</td><td>The method is not correct and it is modified.</td><td>The postcondition is not correct and it is modified.</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">An assertion about the IB state fails or contains an error</td><td>Assert non-occurrence fails</td><td colspan="2">Semantic error in an expression</td></tr>
<tr><td colspan="2">The effect of an event type is not correct</td><td>A derivation rule is incorrect</td><td>A precondition is added/updated</td><td>The expression is corrected</td><td>The CSUD is changed</td></tr>
<tr><td colspan="2"></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Assert consistency fails</td><td colspan="4" rowspan="2"></td></tr>
<tr><td colspan="2">A static constraint needs to be changed</td></tr>
<tr><td colspan="2"></td><td colspan="4"></td></tr>
</table>

Iteration 11

Iteration objective

Customer auto responses inactive (in combination with existing compatible configuration and basics)

Current test case

```
testprogram ConfigurationAndBasics{

…

 fixturecomponent CustomerAutoresponsesInactive{
   customerAutoresponsesSettings:=new CustomerAutoresponsesSettings;
   customerAutoresponsesSettings.autorespondWhenNewTicketCreatedByCustomer:=false;
   customerAutoresponsesSettings.autorespondWhenNewTicketCreatedByStaff:=false;
   customerAutoresponsesSettings.autorespondWhenNewMessageAppendedToTicket:=false;
   customerAutoresponsesSettings.autorespondWhenMaximumOpenTicketsOfCustomer:=false;
}

test testConfiguration1{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesActive;
   assert consistency;
}

 test testConfiguration3{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesInactive;
   assert consistency;
}

test testConfiguration5{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsRandom;
   load CustomerAutoresponsesActive;
   assert consistency;
}

 test testConfiguration9{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOffline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesActive;
   assert consistency;
}

test testConfiguration13{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOffline;
   load TicketSettingsRandom;
   load CustomerAutoresponsesActive;
   assert consistency;
}

}
```

TDCM application: Summary of changes performed in the schema

No changes in the CSUD.

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0

Iteration 12

Iteration objective

Staff notices alerts inactive (in combination with existing compatible configuration and basics)

Current test case

```
testprogram ConfigurationAndBasics{
   …

  fixturecomponent StaffNoticesAlertsInactive{
   staffNoticesAlertsSettings:=new staffNoticesAlertsSettings;
   staffNoticesAlertsSettings.alertWhenNewTicketCreated:=false;
   staffNoticesAlertsSettings.alertWhenNewMessage:=false;
   staffNoticesAlertsSettings.alertWhenInternalNote:=false;
   staffNoticesAlertsSettings.alertWhenTicketOverdue:=false;
}

test testConfiguration1{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesActive;
   assert consistency;
}

 test testConfiguration3{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesInactive;
   assert consistency;
}

test testConfiguration5{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsRandom;
   load CustomerAutoresponsesActive;
   assert consistency;
}

 test testConfiguration9{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOffline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesActive;
```

```
   assert consistency;
}

test testConfiguration13{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOffline;
   load TicketSettingsRandom;
   load CustomerAutoresponsesActive;
   assert consistency;
}
}
```

TDCM application: Summary of changes performed in the schema

■ Added

```
class StaffNoticesAlertsSettings
attributes
alertWhenNewTicketCreated:Boolean
alertWhenNewMessage:Boolean
alertWhenInternalNote:Boolean
alertWhenTicketOverdue:Boolean
end

context StaffNoticesAlertsSettings inv hasOnlyOneInstance:
   StaffNoticesAlertsSettings.allInstances()->size()=1
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	2,5

Errors and failures that drive the conceptual modeling

<table>
<tr><td colspan="2">A basic type involved in a test case does not exist in the CSUD</td><td colspan="2">A derived type involved in a test case does not exist in the CSUD</td><td colspan="2">An event type involved in a test case does not exist in the CSUD</td></tr>
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<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">An assertion about the IB state fails or contains an error</td><td>Assert non-occurrence fails</td><td colspan="2">Semantic error in an expression</td></tr>
<tr><td>The effect of an event type is not correct</td><td colspan="2">A derivation rule is incorrect</td><td>A precondition is added/updated</td><td>The expression is corrected</td><td>The CSUD is changed</td></tr>
<tr><td></td><td colspan="2"></td><td></td><td></td><td></td></tr>
<tr><td>Assert consistency fails</td><td colspan="5" rowspan="3"></td></tr>
<tr><td>A static constraint needs to be changed</td></tr>
<tr><td></td></tr>
</table>

Iteration 13

Iteration objective

Staff notices alerts active (in combination with existing compatible configuration and basics)

Current test case

```
testprogram ConfigurationAndBasics{

...
  fixturecomponent StaffNoticesAlertsActive{
   staffNoticesAlertsSettings:=new StaffNoticesAlertsSettings;
   staffNoticesAlertsSettings.alertWhenNewTicketCreated:=true;
   staffNoticesAlertsSettings.alertWhenNewTicketCreatedStaff:=Set{#Administrator,#DepartmentManager,#DepartmentMembers};;
   staffNoticesAlertsSettings.alertWhenNewMessage:=true;
   staffNoticesAlertsSettings.alertWhenNewMessageStaff:=Set{#LastRespondent,#AssignedStaff,#DepartmentManager};
   staffNoticesAlertsSettings.alertWhenInternalNote:=true;
   staffNoticesAlertsSettings.alertWhenInternalNoteStaff:=Set{#LastRespondent,#AssignedStaff,#DepartmentManager};
   staffNoticesAlertsSettings.alertWhenTicketOverdue:=true;
   staffNoticesAlertsSettings.alertWhenTicketOverdueStaff:=Set{#AssignedStaff,#DepartmentManager,#DepartmentMembers};;

}

test testConfiguration1{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesActive;
   load StaffNoticesAlertsActive;
   assert consistency;
}

 test testConfiguration2{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesActive;
   load StaffNoticesAlertsInactive;
   assert consistency;
}

 test testConfiguration3{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesInactive;
   load StaffNoticesAlertsActive;
   assert consistency;
}



test testConfiguration5{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsRandom;
   load CustomerAutoresponsesActive;
   load StaffNoticesAlertsActive;
   assert consistency;
}


 test testConfiguration9{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOffline;
```

```
    load TicketSettingsSequential;
    load CustomerAutoresponsesActive;
    load StaffNoticesAlertsActive;
    assert consistency;
  }

  test testConfiguration13{
    load CompatibleConfigurationAndBasics;
    load GeneralSettingsOffline;
    load TicketSettingsRandom;
    load CustomerAutoresponsesActive;
    load StaffNoticesAlertsActive;
    assert consistency;
  }

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

```
enum StaffRole{Administrator,DepartmentManager,DepartmentMembers,LastRespondent,AssignedStaff}

class StaffNoticesAlertsSettings
attributes
alertWhenNewTicketCreated:Boolean
alertWhenNewTicketCreatedStaff:Set(StaffRole)
alertWhenNewMessage:Boolean
alertWhenNewMessageStaff:Set(StaffRole)
alertWhenInternalNote:Boolean
alertWhenInternalNoteStaff:Set(StaffRole)
alertWhenTicketOverdue:Boolean
alertWhenTicketOverdueStaff:Set(StaffRole)
end
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	3,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	4

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
5					
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed

Assert consistency fails	
A static constraint needs to be changed	

Iteration 14

Iteration objective

All configuration and basics combinations

Current test case

```
testprogram ConfigurationAndBasics{
  …
 test testConfiguration1{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesActive;
   load StaffNoticesAlertsActive;
   assert consistency;
}

 test testConfiguration2{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesActive;
   load StaffNoticesAlertsInactive;
   assert consistency;
}

 test testConfiguration3{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesInactive;
   load StaffNoticesAlertsActive;
   assert consistency;
}

test testConfiguration4{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesInactive;
   load StaffNoticesAlertsInactive;
   assert consistency;
}
test testConfiguration5{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsRandom;
   load CustomerAutoresponsesActive;
   load StaffNoticesAlertsActive;
   assert consistency;
}

 test testConfiguration6{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsRandom;
```

```
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsInactive;
  assert consistency;
}

 test testConfiguration7{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsActive;
  assert consistency;
}

 test testConfiguration8{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsInactive;
  assert consistency;
}

test testConfiguration9{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsActive;
  assert consistency;
}

test testConfiguration10{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsInactive;
  assert consistency;
}

 test testConfiguration11{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsActive;
  assert consistency;
}

 test testConfiguration12{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsInactive;
  assert consistency;
}

test testConfiguration13{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsActive;
  assert consistency;
}

test testConfiguration14{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsRandom;
```

```
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsInactive;
  assert consistency;
}

 test testConfiguration15{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsActive;
  assert consistency;
}

 test testConfiguration16{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsInactive;
  assert consistency;
}


}
```

TDCM application: Summary of changes performed in the schema

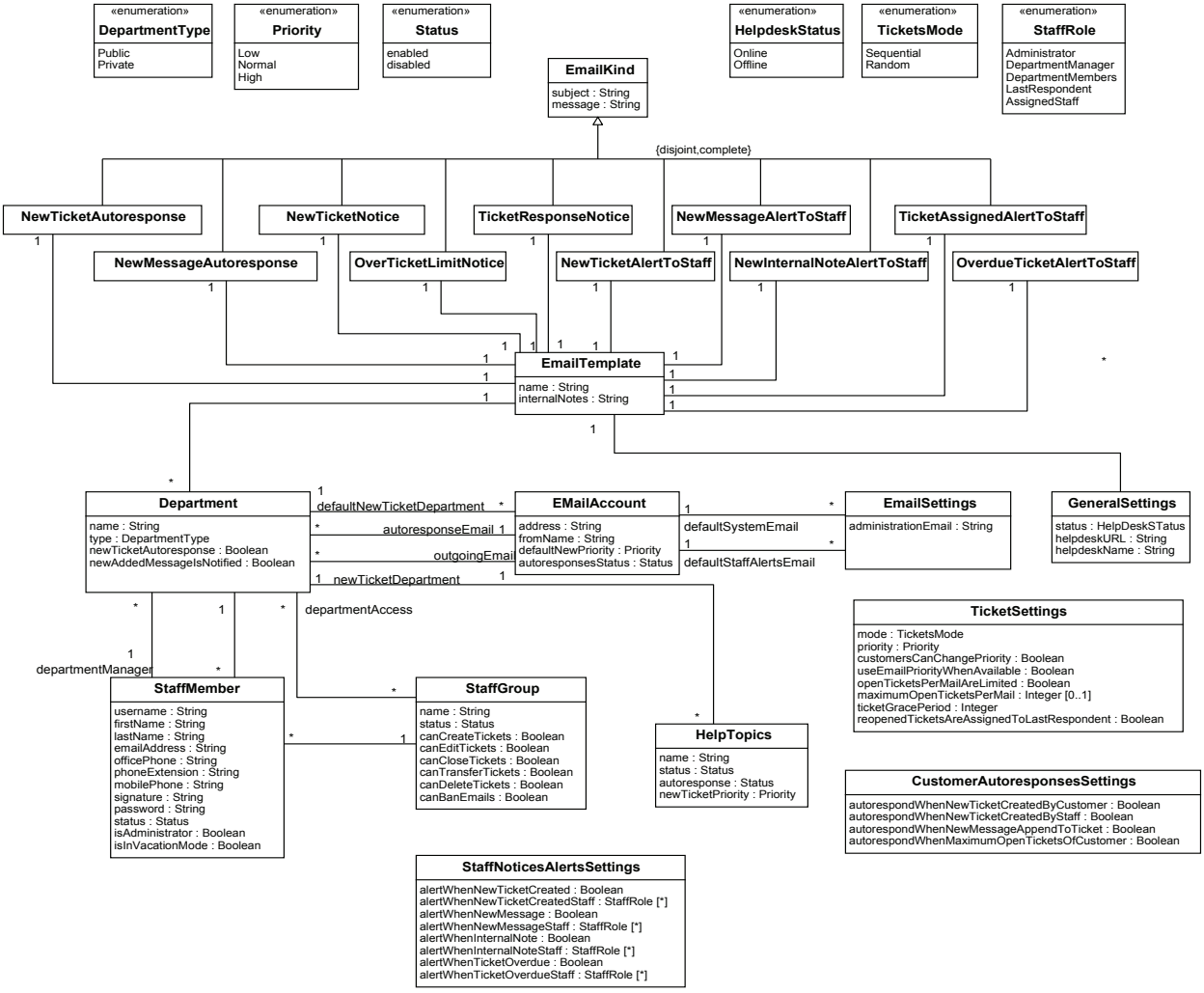
No changes in the CSUT

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0

Configuration & basics conceptual schema

We present the graphical form of the structural schema related to the configuration & basics of the *osTicket* system. This structural schema is the result of the incremental development performed by applying TDCM:




```
context EmailSettings inv hasOnlyOneInstance: EmailSettings.allInstances()->size()=1

context GeneralSettings inv hasOnlyOneInstance: GeneralSettings.allInstances()->size()=1

context TicketSettings inv hasOnlyOneInstance: TicketSettings.allInstances()->size()=1

context TicketSettings inv specifiesTheMaximumNumberOfOpenTickerPerMailIfNotUnlimited:
    self.openTicketsPerMailAreLimited implies self.maximumOpenTicketsPerMail.isDefined()

context CustomerAutoresponsesSettings inv hasOnlyOneInstance:
    CustomerAutoresponsesSettings.allInstances()->size()=1

context StaffNoticesAlertsSettings inv hasOnlyOneInstance:
    StaffNoticesAlertsSettings.allInstances()->size()=1
```

About the tickets management and tracking iterations

In the previous iterations, we developed the structural schema of the configuration options and the basics of the system.

The following iterations use the test cases that validate the configurations&basics schema as fixtures to test the tickets management and tracking stories.

These are the valid fixtures that will be used in the following iterations:

```
fixturecomponent testConfiguration1{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesActive;
   load StaffNoticesAlertsActive;
}

fixturecomponent testConfiguration2{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesActive;
   load StaffNoticesAlertsInactive;
}

fixturecomponent testConfiguration3{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesInactive;
   load StaffNoticesAlertsActive;
}

fixturecomponent testConfiguration4{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsSequential;
   load CustomerAutoresponsesInactive;
   load StaffNoticesAlertsInactive;
}

fixturecomponent testConfiguration5{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsRandom;
   load CustomerAutoresponsesActive;
   load StaffNoticesAlertsActive;
}

fixturecomponent testConfiguration6{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOnline;
   load TicketSettingsRandom;
   load CustomerAutoresponsesActive;
   load StaffNoticesAlertsInactive;
}
```

```
 fixturecomponent testConfiguration7{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsActive;
}

 fixturecomponent testConfiguration8{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsInactive;
}

fixturecomponent testConfiguration9{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsActive;
}

fixturecomponent testConfiguration10{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsInactive;
}

 fixturecomponent testConfiguration11{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsActive;
}

 fixturecomponent testConfiguration12{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsInactive;
}


fixturecomponent testConfiguration13{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsActive;
}

fixturecomponent testConfiguration14{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsInactive;
```

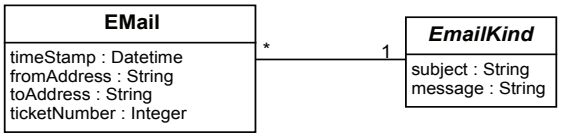
```
}

  fixturecomponent testConfiguration15{
    load CompatibleConfigurationAndBasics;
    load GeneralSettingsOffline;
    load TicketSettingsRandom;
    load CustomerAutoresponsesInactive;
    load StaffNoticesAlertsActive;
}

  fixturecomponent testConfiguration16{
    load CompatibleConfigurationAndBasics;
    load GeneralSettingsOffline;
    load TicketSettingsRandom;
    load CustomerAutoresponsesInactive;
    load StaffNoticesAlertsInactive;
}
```

Mock schema elements

Mock objects [2] are simulated objects that mimic the behavior of real objects for testing purposes. In conceptual schema testing, we can also define schema elements which simulate knowledge for testing purposes. In this case study, we assume the following conceptual schema fragment in order to keep track of the emails sent by the system:



We also assume that there is an instance of the entity type *System* and the following attributes:

- currentDateTime: Datetime. It is a value to specify the current date time as an Integer. For testing purposes, its value may be changed as desired to simulate the evolution of time.

- aleat: By this attribute we may specify an integer for testing aleatory values.

Iteration 15

Iteration objective

S1: NewTicketOnline_SuccessScenario_SequentialTicketsNumber_StaffNotifications (first ticket)

Current test case

```
testprogram TicketsManagementAndTracking{

 test S1{
   load testConfiguration1;

   nt:=new NewTicketOnline;
   nt.fullName:='Mary Marnes';
   nt.email:='mary_at_marnes.mar';
   nt.telephone:='xxxxxxxx';
   nt.ext:='xxxxxxxx';
   nt.helpTopic:=helpTopicInstallation;
   nt.subject:='Error operating system';
   nt.message:='The installation process does not finish....';
   assert occurrence nt;

   ticket1:=nt.createdTicket;

   assert equals ticket1.number 1;
   assert equals ticket1.ticketStatus #Open;
   assert equals ticket1.subject 'Error operating system';
   assert equals ticket1.priority #High;
   assert true ticket1.assignedStaff->isEmpty();
   assert equals ticket1.source #Web;
   assert equals ticket1.creationDatetime sys.currentDateTime;
   assert true ticket1.dueDatetime.isUndefined();
   assert true ticket1.lastResponseDatetime.isUndefined();
   assert equals ticket1.assignedDepartment dptTechnical;



   assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                m.text='The installation process does not finish....' and
                                m.author='Mary Marnes')];

   assert equals ticket1.lastMessageDatetime sys.currentDateTime;

   //no autoresponses
   assert true [not(EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAutoresponse)))];

   //notice to administrator
   assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='system_at_support.com' and
                                e.ticketNumber=1)];

   //notice to department manager
   assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='john_at_support.com' and
                                e.ticketNumber=1)];

  //notice to department members
   assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='martin_at_support.com' and
```

```
                                    e.ticketNumber=1)];
}

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

```
enum TicketsMode{Sequential,Random}
enum StaffRole{Administrator,DepartmentManager,DepartmentMembers,LastRespondent,AssignedStaff}
enum TicketStatus{Open,Closed}
enum TicketSource{Web}
…
-- TICKETS MANAGEMENT

class Ticket
attributes
/number:Integer=if TicketSettings.allInstances()->any(true).mode=#Sequential then
            Ticket.allInstances()->size()
        else System.allInstances()->any(true).aleat
        endif constant
ticketStatus:TicketStatus
fullName:String
email:String
telephone:String
ext:String
subject:String
message:String
priority:Priority
source:TicketSource
/creationDatetime:Datetime=System.allInstances()->any(true).currentDateTime constant
dueDatetime:Datetime[0..1]
lastResponseDatetime:Datetime[0..1]
lastMessageDatetime:Datetime[0..1]
end


association ticket_assignedStaff between
   Ticket[*]
   StaffMember[0..1] role assignedStaff
end

association ticket_ticketThreadMessage between
   Ticket[1]
   TicketThreadMessage[*]
end

class TicketThreadMessage
attributes
datetime:Datetime
text:String
author:String
end

association ticket_assignedDepartment between
   Ticket[*]
   Department[1] role assignedDepartment
end

event NewTicketOnline
attributes
fullName:String
email:String
telephone:String
ext:String
subject:String
message:String
createdTicket:Ticket[0..1]
operations
effect()
```

```
end

association newTicketOnline_helpTopic between
   NewTicketOnline[*]
   HelpTopic[1]
end

context NewTicketOnline::effect()
post:
let defaultPriority:Priority=
       if self.helpTopic->notEmpty() then
          self.helpTopic.newTicketPriority
       else
          TicketSettings.allInstances()->any(true).priority
       endif
in
let defaultDepartment:Department=
       if self.helpTopic->notEmpty() then
          self.helpTopic.newTicketDepartment
       else
          Department.allInstances()->any(dld.isDefault)
       endif
in
let sendNewTicketAlertToAdministrator:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#Administrator)
in
let sendNewTicketAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentManager)
in
let sendNewTicketAlertToDepartmentMembers:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentMembers)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let autoresponsesEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let sendAutoresponse:Boolean=
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewTicketCreatedByCustomer then
      if self.helpTopic->notEmpty then
         if self.helpTopic.autoresponse=#Enabled then true
         else false
         endif
      else
         defaultDepartment.newTicketAutoresponseIsSent
      endif
   else false
   endif
in
(Ticket.allInstances- Ticket.allInstances@pre)
  ->one(t | t.oclIsNew()
         and self.createdTicket=t
         and t.fullName=self.fullName
         and t.email=self.email
         and t.telephone=self.telephone
         and t.ext=self.ext
         and t.subject=self.subject
         and t.message=self.message
         and t.ticketStatus=#Open
         and t.priority=defaultPriority
         and t.source=#Web
         and t.assignedDepartment=defaultDepartment
         and (TicketThreadMessage.allInstances- TicketThreadMessage.allInstances@pre)
            ->one(tdm | tdm.oclIsNew()
            and tdm.datetime=System.allInstances()->any(true).currentDateTime
            and tdm.text=self.message
            and tdm.author=self.fullName
            and tdm.ticket=t
```

```
        and t.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)
    -- autoresponses
    and (sendAutoresponse implies
       EMail.allInstances()->exists(ele.fromAddress=t.email and
                                    e.toAddress=t.assignedDepartment.autoresponseEmail.address and
                                    e.ticketNumber=t.number))


    -- staff notices
    and (sendNewTicketAlertToAdministrator implies
       EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                    e.toAddress=EmailSettings.allInstances()->any(true).administrationEmail and
                                    e.ticketNumber=t.number))

    and  (sendNewTicketAlertToDepartmentManager
        and t.assignedDepartment.departmentManager->notEmpty()
        and t.assignedDepartment.departmentManager.status=#Enabled
        and not(t.assignedDepartment.departmentManager.isInVacationMode)
        implies
          EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                    e.toAddress=t.assignedDepartment.departmentManager.emailAddress and
                                    e.ticketNumber=t.number))

    and  (sendNewTicketAlertToDepartmentMembers
        implies
        t.assignedDepartment.staffMember->forAll(m|
          (m.status=#Enabled and not(m.isInVacationMode))
          implies
          EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                    e.toAddress= m.emailAddress and
                                    e.ticketNumber=t.number)))

)
```

The added knowledge is the result of evolving the schema in order to solve the errors and failures told by the CSTL Processor until the test case passes.

These are some of the obtained errors (some repetitive errors about undefined knowledge are not shown):

- [TicketsManagementAndTracking.cstl] <line 435> NewTicketOnline is not defined in the CSUT as a class or an association
- [TicketsManagementAndTracking.cstl] <line 443> The effect of NewTicketOnline is not defined as a method (specify/review first its postconditions)
- CSUT error: osTicketCSUT.use:362:1: Expected object type, found `Ticket'
- CSUT error: osTicketCSUT.use:374:21: Undefined operation named `createdTicket' in expression `NewTicketOnline.createdTicket()'
- [TicketsManagementAndTracking.cstl] <line 443> Inconsistent state before nt:NewTicketOnline event execution: Instances of NewTicketOnline violate the invariant minMultiplicityOfAttributeCreatedTicket
- [TicketsManagementAndTracking.cstl] <line 443> The effect of NewTicketOnline is not defined as a method (specify/review first its postconditions)
- [TicketsManagementAndTracking.cstl] <Line 447>:1:6: Undefined operation named `number' in expression `{Ticket}.number()'.
- CSUT error: osTicketCSUT.use:356:16: Branches of if expression have different type, found `Set(Ticket)' and `Integer'
- It detects an error in the derivation rule
- [TicketsManagementAndTracking.cstl] <Line 448>:1:6: Undefined operation named `status' in expression `{Ticket}.status()'

- [TicketsManagementAndTracking.cstl] <line 443> Inconsistent state after nt:NewTicketOnline event execution: Instances of Ticket violate the invariant minMultiplicityOfAttributeStatus
- The event needs to specify an status of the ticket
- CSUT error: osTicketCSUT.use:388:26: Undefined enumeration literal `Open'.
- CSUT error: osTicketCSUT.use:389:18: Undefined operation named `ticketStatus' in expression `Ticket.ticketStatus()'.
- [TicketsManagementAndTracking.cstl] postcondition 'post114' of NewTicketOnline is false
- The method has to be updated in order to specify the ticketStatus
- [TicketsManagementAndTracking.cstl] <Line 450>:1:6: Undefined operation named `priority' in expression `{Ticket}.priority()'.
- [TicketsManagementAndTracking.cstl] <line 443> Inconsistent state after nt:NewTicketOnline event execution: Instances of Ticket violate the invariant minMultiplicityOfAttributePriority
- [TicketsManagementAndTracking.cstl] postcondition 'post25' of NewTicketOnline is false (tickets priority is not included in the method)
- [TicketsManagementAndTracking.cstl] <line 443> Inconsistent state after nt:NewTicketOnline event execution: Multiplicity constraint violation in association `ticket_assignedStaff': Object `oid35' of class `Ticket' is connected to 0 objects of class `StaffMember' but the multiplicity is specified as `1'.
- We realize that there may be unasigned tickets (we change the CSUT)
- [TicketsManagementAndTracking.cstl] <Line 452>:1:6: Undefined operation named `source' in expression `{Ticket}.source()'
- [TicketsManagementAndTracking.cstl] postcondition 'post62' of NewTicketOnline is false
- TicketsManagementAndTracking.cstl] <Line 454>:1:6: Undefined operation named `creationDatetime' in expression `{Ticket}.dueDatetime()'.
- TicketsManagementAndTracking.cstl] <Line 454>:1:6: Undefined operation named `dueDatetime' in expression `{Ticket}.dueDatetime()'.
- [TicketsManagementAndTracking.cstl] <line 443> Inconsistent state after nt:NewTicketOnline event execution: Instances of Ticket violate the invariant minMultiplicityOfAttributeDueDatetime
- [TicketsManagementAndTracking.cstl] <Line 455>:1:6: Undefined operation named `lastResponseDatetime' in expression `{Ticket}.lastResponseDatetime()'.
- [TicketsManagementAndTracking.cstl] <Line 456>:1:6: Undefined operation named `assignedDepartment' in expression `{Ticket}.assignedDepartment()'.
- [TicketsManagementAndTracking.cstl] <line 443> Inconsistent state after nt:NewTicketOnline event execution: Multiplicity constraint violation in association `ticket_assignedDepartment': Object `oid35' of class `Ticket' is connected to 0 objects of class `Department' but the multiplicity is specified as `1'.
- During event effect specification we realize that the system needs a default department

```
class Department
attributes
name:String
type:DepartmentType
newTicketAutoresponseIsSent:Boolean
newAddedMessageIsNotified:Boolean
isDefault:Boolean=false
end

context Department inv hasAlwaysOneDefault:
   Department.allInstances()->select(dId.isDefault)->size()=1
```

- [TicketsManagementAndTracking.cstl] <line 443> Inconsistent state before nt:NewTicketOnline event execution: Instances of Department violate the invariant hasAlwaysOneDefault
- The fixture needs to be changed to ensure that there is always one default department
- [TicketsManagementAndTracking.cstl] <line 444> Inconsistent state after nt:NewTicketOnline event execution: Multiplicity constraint violation in association `ticket_assignedDepartment': Object `oid35' of class `Ticket' is connected to 0 objects of class `Department' but the multiplicity is specified as `1'.
- Tickets need to be assigned to departments
- [TicketsManagementAndTracking.cstl] postcondition 'post200' of NewTicketOnline is false
- TicketsManagementAndTracking.cstl] <Line 459>:1:6: Undefined operation named `lastMessageDatetime' in expression `{Ticket}.lastMessageDatetime()'.
- [TicketsManagementAndTracking.cstl] <line 444> Inconsistent state after nt:NewTicketOnline event execution: Instances of Ticket violate the invariant minMultiplicityOfAttributeLastMessageDatetime
- [TicketsManagementAndTracking.cstl] <Line 461>:1:6: Undefined operation named `message' in expression `{Ticket}.message()'.
- [TicketsManagementAndTracking.cstl] <Line 464>:1:27: Undefined operation `Set(TicketThreadMessage)->includes(Set(OclVoid))'
- There is no message assigned to the ticket
- [TicketsManagementAndTracking.cstl] postcondition 'post384' of NewTicketOnline is false
- CSUT error: osTicketCSUT.use:446:31: Undefined operation `Set(Ticket)->=(Ticket)'

```
association ticket_ticketThreadMessage between
   Ticket[1]
   TicketThreadMessage[*]
end
```

- The result is Undefined but it is expected to be an object (assert equals ticket1.lastMessageDatetime sys.currentDateTime)
- The lastMessageDatetime needs to be specified by the event NewTicketOnline
- [TicketsManagementAndTracking.cstl] postcondition 'post457' of NewTicketOnline is false

Assert expression is false and it is expected to be true:

```
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                          e.fromAddress='general_at_support.com' and
                                          e.toAddress='system_at_support.com' and
                                          e.ticketNumber=1)];
```

- The postcondition and the method of NewTicketOnline is changed to include autoresponses and alerts until the assertions are true

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	26
TIME TO COMPLETE THE ITERATION (IN MINUTES)	83

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
32		**2**		**1**	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
1		**8**	**1**	**6**	
An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect		A precondition is added/updated	The expression is corrected	The CSUD is changed
5					**4**
Assert consistency fails					
A static constraint needs to be changed					

Iteration 16

Iteration objective

S1: NewTicketOnline_SuccessScenario_SequentialTicketsNumber_StaffNotifications (complete)

Current test case

```
test S1{
   load testConfiguration1;

   nt:=new NewTicketOnline;
   nt.fullName:='Mary Marnes';
   nt.email:='mary_at_marnes.mar';
   nt.telephone:='xxxxxxxx';
   nt.ext:='xxxxxxxx';
   nt.helpTopic:=helpTopicInstallation;
   nt.subject:='Error operating system';
   nt.message:='The installation process does not finish....';
   assert occurrence nt;

   ticket1:=nt.createdTicket;

   assert equals ticket1.number 1;
   assert equals ticket1.ticketStatus #Open;
   assert equals ticket1.subject 'Error operating system';
   assert equals ticket1.priority #High;
   assert true ticket1.assignedStaff->isEmpty();
   assert equals ticket1.source #Web;
   assert equals ticket1.creationDatetime sys.currentDateTime;
   assert true ticket1.dueDatetime.isUndefined();
```

```
assert true ticket1.lastResponseDatetime.isUndefined();
assert equals ticket1.assignedDepartment dptTechnical;



assert true [ticket1.ticketThreadMessage->one(m|m.datetime=sys.currentDateTime and
                                m.text='The installation process does not finish....' and
                                m.author='Mary Marnes')];

assert equals ticket1.lastMessageDatetime sys.currentDateTime;

//no autoresponses
assert true [not(EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAutoresponse)))];

//notice to administrator
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='system_at_support.com' and
                                e.ticketNumber=1)];

//notice to department manager
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='john_at_support.com' and
                                e.ticketNumber=1)];

//notice to department members
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='martin_at_support.com' and
                                e.ticketNumber=1)];


//TICKET 2
ticketSettings.customersCanChangePriority:=true;

nt2:=new NewTicketOnline;
nt2.fullName:='James Jordan';
nt2.email:='james_at_jordan.jam';
nt2.telephone:='xxxxxxxx';
nt2.ext:='xxxxxxxx';
nt2.priority:=#Low;
nt2.helpTopic:=helpTopicUse;
nt2.subject:='Reopening ticket';
nt2.message:='I do not know how to reopen one of my closed tickets';
assert occurrence nt2;

ticket2:=nt2.createdTicket;

assert equals ticket2.number 2;
assert equals ticket2.priority #Low;
assert equals ticket2.assignedDepartment dptGeneral;

//autoresponses

assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAutoresponse) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='james_at_jordan.jam' and
                                e.ticketNumber=2)];

//notice to administrator
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='system_at_support.com' and
                                e.ticketNumber=2)];


//notice to department members
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='john_at_support.com' and
```

```
                                e.ticketNumber=2)];

assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='mary_at_support.com' and
                                e.ticketNumber=2)];

assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='david_at_support.com' and
                                e.ticketNumber=2)];

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 497> Binary property priority does not exist for this object
- We add the property *priority* to the event *NewTicketOnline*
- [TicketsManagementAndTracking.cstl] <line 444> Inconsistent state before nt:NewTicketOnline event execution: Instances of NewTicketOnline violate the invariant minMultiplicityOfAttributePriority
- A previous passing line causes this error. The reason is that the priority is only specified if the ticket settings allow it.

```
event NewTicketOnline
attributes
fullName:String
email:String
telephone:String
ext:String
subject:String
message:String
priority:Priority[0..1]
createdTicket:Ticket[0..1]
operations
effect()
end

context NewTicketOnline ini inv priorityMayBeSetWhenAllowed:
   if TicketSettings.allInstances->any(true).customersCanChangePriority then
      self.priority.isDefined()
   else
      self.priority.isUndefined()
   endif
```

- The result is #Normal but it is expected to be #Low (assert equals ticket2.priority #Low;)
- The priority, if specified by the user, replaces the default priority

```
context NewTicketOnline::effect()
post:
    let defaultPriority:Priority=
          if self.helpTopic->notEmpty() then
             self.helpTopic.newTicketPriority
          else
             TicketSettings.allInstances()->any(true).priority
          endif
    in
    let assignedPriority:Priority=
       if TicketSettings.allInstances()->any(true).customersCanChangePriority then
          self.priority
       else
          defaultPriority
```

```
        endif
    in
…
(Ticket.allInstances- Ticket.allInstances@pre)
  ->one(t | t.oclIsNew()
          and self.createdTicket=t
          and t.fullName=self.fullName
          and t.email=self.email
          and t.telephone=self.telephone
          and t.ext=self.ext
          and t.subject=self.subject
          and t.message=self.message
          and t.ticketStatus=#Open
          and t.priority=assignedPriority
…
```

- Assert expression is false and it is expected to be true (assert true [EMail.allInstances()->exists(e|e.emailKind.oclIsTypeOf(NewTicketAutoresponse) and e.fromAddress='technical_at_support.com' and e.toAddress='james_at_jordan.jam' and e.ticketNumber=2)];
- Autoresponses are not send correctly according to the expectations.
- We add a new assertions:

  assert equals EMail.allInstances->any(ticketNumber=2).fromAddress 'technical_at_support.com';

- We realize that toAddress and fromAddress are interchanged

```
context NewTicketOnline::effect()
post:
 (Ticket.allInstances- Ticket.allInstances@pre)
   ->one(t | t.oclIsNew()
          …

          -- autoresponses
          and (sendAutoresponse implies
          EMail.allInstances()->exists(e | e.fromAddress=t.assignedDepartment.autoresponseEmail.address and
                                           e.toAddress=t.email and
                                           e.ticketNumber=t.number))
          …

         )
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	8
TIME TO COMPLETE THE ITERATION (IN MINUTES)	15

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
1					
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

			1		
An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct		A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
2					
Assert consistency fails					
A static constraint needs to be changed					

Iteration 17

Iteration objective

S2: NewTIcketOnline_maximumNumberOfTicketsViolated

Current test case

```
test S2{

   load testConfiguration1;

   nt1:=new NewTicketOnline;
   nt1.fullName:='Mary Marnes';
   nt1.email:='mary_at_marnes.mar';
   nt1.telephone:='xxxxxxxx';
   nt1.ext:='xxxxxxxx';
   nt1.helpTopic:=helpTopicInstallation;
   nt1.subject:='Error operating system';
   nt1.message:='The installation process does not finish....';
   assert occurrence nt1;

   ticket1:=nt1.createdTicket;

   nt2:=new NewTicketOnline;
   nt2.fullName:='Mary Marnes';
   nt2.email:='mary_at_marnes.mar';
   nt2.telephone:='xxxxxxxx';
   nt2.ext:='xxxxxxxx';
   nt2.helpTopic:=helpTopicInstallation;
   nt2.subject:='Reopening ticket';
   nt2.message:='I do not know how to reopen one of my closed tickets';
   assert occurrence nt2;

   ticket2:=nt2.createdTicket;

   nt3:=new NewTicketOnline;
   nt3.fullName:='Mary Marnes';
   nt3.email:='mary_at_marnes.mar';
   nt3.telephone:='xxxxxxxx';
   nt3.ext:='xxxxxxxx';
   nt3.helpTopic:=helpTopicInstallation;
   nt3.subject:='Customize graphical interface';
   nt3.message:='May I change the background color?';
   assert non-occurrence nt3;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event nt3:NewTicketOnline are satisfied and consequently, the event can occur
- We need to add an initial integrity constraint

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	6

Errors and failures that drive the conceptual modeling

<table>
<tr><td colspan="2">A basic type involved in a test case does not exist in the CSUD</td><td colspan="2">A derived type involved in a test case does not exist in the CSUD</td><td colspan="2">An event type involved in a test case does not exist in the CSUD</td></tr>
<tr><td colspan="2">The basic type is relevant and it is added to the CSUD</td><td colspan="2">The derived type is relevant and it is added to the CSUD</td><td colspan="2">The event type is relevant and it is added to the CSUD</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">Inconsistent state before the occurrence of an event</td><td colspan="2">Inconsistent state after the occurrence of an event</td><td colspan="2">The postcondition of an event is not satisfied.</td></tr>
<tr><td>Some static constraint is invalid and it is modified.</td><td>Some initial integrity constraint is invalid and it is modified.</td><td>The event postcondition/method is incorrect and it is modified.</td><td>Some constraint is invalid and it is modified.</td><td>The method is not correct and it is modified.</td><td>The postcondition is not correct and it is modified.</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">An assertion about the IB state fails or contains an error</td><td>Assert non-occurrence fails</td><td colspan="2">Semantic error in an expression</td></tr>
<tr><td>The effect of an event type is not correct</td><td colspan="2">A derivation rule is incorrect</td><td>A precondition is added/updated</td><td>The expression is corrected</td><td>The CSUD is changed</td></tr>
<tr><td></td><td colspan="2"></td><td>1</td><td></td><td></td></tr>
<tr><td>Assert consistency fails</td><td colspan="5" rowspan="2"></td></tr>
<tr><td>A static constraint needs to be changed</td></tr>
<tr><td></td><td colspan="5"></td></tr>
</table>

Iteration 18

Iteration objective

S3: NewTicketOnline_successScenario_RandomTicketsNumber_StaffNotificationsDisabled

Current test case

```
test S3{
   load testConfiguration8;

   nt1:=new NewTicketOnline;
   nt1.fullName:='Mary Marnes';
```

```
nt1.email:='mary_at_marnes.mar';
nt1.telephone:='xxxxxxxx';
nt1.ext:='xxxxxxxx';
nt1.priority:=#Normal;
nt1.helpTopic:=helpTopicInstallation;
nt1.subject:='Error operating system';
nt1.message:='The installation process does not finish....';
assert occurrence nt1;

ticket1:=nt1.createdTicket;

assert equals ticket1.number 5;
//5 is the aleatory number specified for testing purposes

assert equals ticket1.assignedDepartment dptTechnical;

//no autoresponses
assert true [not(EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAutoresponse)))];

//notice to administrator
assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='system_at_support.com' and
                                    e.ticketNumber=5)];

//notice to department manager
assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=5)];

//notice to department members
assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='martin_at_support.com' and
                                    e.ticketNumber=5)];
}
```

TDCM application: Summary of changes performed in the schema

The CSUD has not been changed

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 19

Iteration objective

S4: NewTicketOnline_SuccessScenario_SequentialTicketsNumber_AutoresponsesDisabled

Current test case

```
test S4{
 load testConfiguration3;

 nt1:=new NewTicketOnline;
 nt1.fullName:='James Jordan';
 nt1.email:='james_at_jordan.jam';
 nt1.telephone:='xxxxxxxx';
 nt1.ext:='xxxxxxxx';
 nt1.helpTopic:=helpTopicUse;
 nt1.subject:='Reopening ticket';
 nt1.message:='I do not know how to reopen one of my closed tickets';
 assert occurrence nt1;

 ticket1:=nt1.createdTicket;


 assert equals ticket1.assignedDepartment dptGeneral;

 //no autoresponses
 assert true [not(EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAutoresponse)))];

 //notice to administrator
 assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='system_at_support.com' and
                                    e.ticketNumber=1)];


//notice to department members
 assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];

 assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=1)];

 assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='david_at_support.com' and
                                    e.ticketNumber=1)];
}
```

TDCM application: Summary of changes performed in the schema

The CSUD has not been changed

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 20

Iteration objective

S5:NewTicketOnline_SuccessScenario_NoTopic (assignment to the default department and with the default priority)

Current test case

```
test S5{
   load testConfiguration4;
   helpTopicUse.status:=#Disabled;
   helpTopicInstallation.status:=#Disabled;

   nt1:=new NewTicketOnline;
   nt1.fullName:='James Jordan';
   nt1.email:='james_at_jordan.jam';
   nt1.subject:='Reopening ticket';
   nt1.message:='I do not know how to reopen one of my closed tickets';
   assert occurrence nt1;

   ticket1:=nt1.createdTicket;


   assert equals ticket1.assignedDepartment dptGeneral;
   assert true ticket1.helpTopic->isEmpty();
   assert equals ticket1.priority #Normal;

   //no autoresponses
   assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAutoresponse))];

   //notice to administrator
   assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='system_at_support.com' and
                                    e.ticketNumber=1)];


  //notice to department members
   assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];

   assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=1)];

   assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='david_at_support.com' and
                                    e.ticketNumber=1)];
  }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 683> Inconsistent state before nt1:NewTicketOnline event execution: Multiplicity constraint violation in association `newTicketOnline_helpTopic':Object `oid202' of class `NewTicketOnline' is connected to 0 objects of class `HelpTopic'n but the multiplicity is specified as `1'.

- Help topics must be indicated only when there are available help topics

```
association newTicketOnline_helpTopic between
   NewTicketOnline[*]
   HelpTopic[0..1]
end

context NewTicketOnline ini inv helpTopicSpecifiedIfAvailable:
     if HelpTopic.allInstances()->select(hp|hp.status=#Enabled)->size()>0  then
        self.helpTopic->size()=1
     else
        self.helpTopic->size()=0
     endif
```

- [TicketsManagementAndTracking.cstl] <line 683> Inconsistent state before nt1:NewTicketOnline event execution: Instances of NewTicketOnline violate the invariant minMultiplicityOfAttributeExt

- We realize that the attribute Ext is optional

- The same happens for the attributes telephone

```
class Ticket
attributes
…
telephone:String [0..1]
ext:String[0..1]
…
end
```

- [TicketsManagementAndTracking.cstl] <Line 689>:1:7: Undefined operation named `helpTopic' in expression `{Ticket}.helpTopic()'.

- We realize that the help topic is not assigned to the ticket.

```
association ticket_helpTopic between
   Ticket[*]
   HelpTopic[0..1]
end

context NewTicketOnline::effect()
post:
…
(Ticket.allInstances- Ticket.allInstances@pre)
  ->one(t | t.oclIsNew()
          …
          and t.helpTopic=self.helpTopic
        …
```

- [TicketsManagementAndTracking.cstl] postcondition 'post337' of NewTicketOnline is false

- The method needs to be changed according to the new postcondition

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	3,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	8

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
2				1	

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
				1

Assert consistency fails
A static constraint needs to be changed

Iteration 21

Iteration objective

S6: NewTicketOnline extension (disabled topic)

Current test case

```
test S6{
   load testConfiguration5;
   nt1:=new NewTicketOnline;
   nt1.fullName:='James Jordan';
   nt1.email:='james_at_jordan.jam';
   nt1.subject:='Reopening ticket';
   nt1.message:='I do not know how to reopen one of my closed tickets';
   nt1.helpTopic:=helpTopicDisabled;
   nt1.priority:=#Low;
   assert non-occurrence nt1;
  }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event nt1:NewTicketOnline are satisfied and consequently, the event can occur

```
context NewTicketOnline ini inv helpTopicIsEnabled:
  self.helpTopic->notEmpty() implies self.helpTopic.status=#Enabled
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	4

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect		A precondition is added/updated	The expression is corrected	The CSUD is changed
			1		
Assert consistency fails					
A static constraint needs to be changed					

Iteration 22

Iteration objective

S7: NewTicketOnline_PreconditionViolation (online mode is disabled)

Current test case

```
test S7{
load testConfiguration9;
nt1:=new NewTicketOnline;
nt1.fullName:='James Jordan';
nt1.email:='james_at_jordan.jam';
nt1.subject:='Reopening ticket';
nt1.message:='I do not know how to reopen one of my closed tickets';
nt1.helpTopic:=helpTopicDisabled;
nt1.priority:=#Low;
assert non-occurrence nt1;
}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event nt1:NewTicketOnline are satisfied and consequently, the event can occur

```
context NewTicketOnline ini inv helpDeskStatusIsOnline:
  GeneralSettings.allInstances()->any(true).status=#Online
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	3

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 23

Iteration objective

S8: NewTicketByEmail_successScenario_generalEmail

Current test case

```
test S8{
   load testConfiguration3;
   nt1:=new NewTicketByEmail;
   nt1.toAddress:='general_at_support.com';
   nt1.fromName:='James Jordan';
   nt1.fromAddress:='james_at_jordan.jam';
   nt1.subject:='Ticket priority';
   nt1.message:='How can I change the priority of one of my tickets?';
```

```
assert occurrence nt1;

ticket1:=nt1.createdTicket;

assert equals ticket1.number 1;
assert equals ticket1.ticketStatus #Open;
assert equals ticket1.subject 'Ticket priority';
assert equals ticket1.priority #Low;
assert true ticket1.assignedStaff->isEmpty();
assert equals ticket1.source #EMail;
assert equals ticket1.creationDatetime sys.currentDateTime;
assert true ticket1.dueDatetime.isUndefined();
assert true ticket1.lastResponseDatetime.isUndefined();
assert equals ticket1.assignedDepartment dptGeneral;

assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                m.text='How can I change the priority of one of my tickets?' and
                                m.author='James Jordan')];
//autoresponses
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAutoresponse) and
                                  e.fromAddress='general_at_support.com' and
                                  e.toAddress='james_at_jordan.jam' and
                                  e.ticketNumber=1)];
//notice to department members
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                  e.fromAddress='general_at_support.com' and
                                  e.toAddress='john_at_support.com' and
                                  e.ticketNumber=1)];

assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                  e.fromAddress='general_at_support.com' and
                                  e.toAddress='mary_at_support.com' and
                                  e.ticketNumber=1)];

assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                  e.fromAddress='general_at_support.com' and
                                  e.toAddress='david_at_support.com' and
                                  e.ticketNumber=1)];

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 746> <line 746> NewTicketByEmail is not defined in the CSUT as a class or an association

```
event NewTicketByEmail
attributes
toAddress:String
fromName:String
fromAddress:String
subject:String
message:String
operations
effect()
end
```

- [TicketsManagementAndTracking.cstl] <line 752> The effect of NewTicketByEmail is not defined as a method (specify/review first its postconditions)event NewTicketByEmail

```
context NewTicketByEmail::effect()
post:
let incomingEmailAccount:EmailAccount=
  EmailAccount.allInstances()->any(ele.address=self.fromAddress)
in
```

```
let assignedPriority:Priority=
      if TicketSettings.allInstances()->any(true).useEmailPriorityWhenAvailable then
         incomingEmailAccount.defaultNewPriority
      else
            TicketSettings.allInstances()->any(true).priority
      endif
in
let defaultDepartment:Department=
      incomingEmailAccount.defaultNewTicketDepartment
in
let sendNewTicketAlertToAdministrator:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#Administrator)
in
let sendNewTicketAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentManager)
in
let sendNewTicketAlertToDepartmentMembers:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff-
>includes(#DepartmentMembers)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let autoresponsesEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let sendAutoresponse:Boolean=
      if (incomingEmailAccount.autoresponsesStatus=#Enabled) then true
      else false
      endif
in
(Ticket.allInstances- Ticket.allInstances@pre)
  ->one(t | t.oclIsNew()
         and self.createdTicket=t
         and t.fullName=self.fromName
         and t.email=self.fromAddress
         and t.subject=self.subject
         and t.message=self.message
         and t.ticketStatus=#Open
         and t.priority=assignedPriority
         and t.source=#EMail
         and t.assignedDepartment=incomingEmailAccount.defaultNewTicketDepartment
         and (TicketThreadMessage.allInstances- TicketThreadMessage.allInstances@pre)
            ->one(tdm | tdm.oclIsNew()
            and tdm.datetime=System.allInstances()->any(true).currentDateTime
            and tdm.text=self.message
            and tdm.author=self.fromName
            and tdm.ticket=t
            and t.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

         -- autoresponses
         and (sendAutoresponse implies
            EMail.allInstances()->exists(ele.fromAddress=t.assignedDepartment.autoresponseEmail.address and
                                 e.toAddress=t.email and
                                 e.ticketNumber=t.number))


         -- staff notices
         and (sendNewTicketAlertToAdministrator implies
            EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                 e.toAddress=EmailSettings.allInstances()->any(true).administrationEmail and
                                 e.ticketNumber=t.number))

         and  (sendNewTicketAlertToDepartmentManager
            and t.assignedDepartment.departmentManager->notEmpty()
            and t.assignedDepartment.departmentManager.status=#Enabled
            and not(t.assignedDepartment.departmentManager.isInVacationMode)
            implies
               EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
```

```
                                e.toAddress=t.assignedDepartment.departmentManager.emailAddress and
                                e.ticketNumber=t.number))

    and  (sendNewTicketAlertToDepartmentMembers
          implies
          t.assignedDepartment.staffMember->forAll(m|
            (m.status=#Enabled and not(m.isInVacationMode))
            implies
            EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                         e.toAddress=m.emailAddress and
                                         e.ticketNumber=t.number)))

    )

    context NewTicketByEmail ini inv maximumOpenTicketsLimitIsNotViolated:
        if TicketSettings.allInstances()->any(true).openTicketsPerMailAreLimited then
         Ticket.allInstances->select(tIt.email=self.fromAddress)->size()<TicketSettings.allInstances()
            ->any(true).maximumOpenTicketsPerMail
        else true
        endif
```

- osTicketCSUT.use:586:26: Undefined enumeration literal `EMail'.

```
enum TicketSource{Web,Email}
```

- [TicketsManagementAndTracking.cstl] <line 752> The effect of NewTicketByEmail is not defined as a method (specify/review first its postconditions)

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	7
TIME TO COMPLETE THE ITERATION (IN MINUTES)	26

Errors and failures that drive the conceptual modeling

<table>
<tr><td colspan="2">A basic type involved in a test case does not exist in the CSUD</td><td colspan="2">A derived type involved in a test case does not exist in the CSUD</td><td colspan="2">An event type involved in a test case does not exist in the CSUD</td></tr>
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<tr><td colspan="2">7</td><td colspan="2"></td><td colspan="2">1</td></tr>
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<tr><td colspan="2"></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Assert consistency fails</td><td colspan="4" rowspan="3"></td></tr>
<tr><td colspan="2">A static constraint needs to be changed</td></tr>
<tr><td colspan="2"></td></tr>
</table>

Iteration 24

Iteration objective

S9: NewTicketByEmail_successScenario_technicalEmail

Current test case

```
test S9{
  load testConfiguration10;
  nt1:=new NewTicketByEmail;
  nt1.toAddress:='technical_at_support.com';
  nt1.fromName:='Marta Johnes';
  nt1.fromAddress:='marta_at_johnes.mar';
  nt1.subject:='See my tickets';
  nt1.message:='Can I see my tickets?';
  assert non-occurrence nt1;

  generalSettings.status:=#Online;
  assert occurrence nt1;


  ticket1:=nt1.createdTicket;

  assert equals ticket1.number 1;
  assert equals ticket1.ticketStatus #Open;
  assert equals ticket1.assignedDepartment dptTechnical;
  assert equals ticket1.subject 'See my tickets';
  assert equals ticket1.priority #High;
  assert true ticket1.assignedStaff->isEmpty();
  assert equals ticket1.source #EMail;
  assert equals ticket1.creationDatetime sys.currentDateTime;
  assert true ticket1.dueDatetime.isUndefined();
  assert true ticket1.lastResponseDatetime.isUndefined();


  assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                  m.text='Can I see my tickets?' and
                                  m.author='Marta Johnes')];
  //autoresponses
  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAutoresponse) and
                                    e.fromAddress='technical_at_support.com' and
                                    e.toAddress='marta_at_johnes.mar' and
                                    e.ticketNumber=1)];
  //notice to department members
  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];

  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=1)];

  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='david_at_support.com' and
                                    e.ticketNumber=1)];

}
```

TDCM application: Summary of changes performed in the schema

■ Added

- Preconditions of the domain event nt1:NewTicketByEmail are satisfied and consequently, the event can occur

```
context NewTicketByEmail ini inv helpDeskStatusIsOnline:
    GeneralSettings.allInstances()->any(true).status=#Online
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	4,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	6

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails	
A static constraint needs to be changed	

Iteration 25

Iteration objective

S10: NewTicketByEmail_extension2a (invalid incoming email address)

Current test case

```
test S10{
  load testConfiguration8;
 nt1:=new NewTicketByEmail;
 nt1.toAddress:='techdep_at_support.com';
 nt1.fromName:='Marta Johnes';
 nt1.fromAddress:='marta_at_johnes.mar';
 nt1.subject:='See my tickets';
 nt1.message:='Can I see my tickets?';
 assert non-occurrence nt1;
}
```

TDCM application: Summary of changes performed in the schema

■ Added

- Preconditions of the domain event nt1:NewTicketByEmail are satisfied and consequently, the event can occur

```
context NewTicketByEmail ini inv theIncomingEmailIsValid:
        EmailAccount.allInstances()->one(address=self.toAddress)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	3
TIME TO COMPLETE THE ITERATION (IN MINUTES)	5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect		A precondition is added/updated	The expression is corrected	The CSUD is changed
			1		
Assert consistency fails					
A static constraint needs to be changed					

Iteration 26

Iteration objective

S11:DisplayTicketsOfEmail_successScenario

Current test case

```
test S11{
 load testConfiguration1;

nt1:=new NewTicketOnline;
nt1.fullName:='James Jordan';
nt1.email:='james_at_jordan.jam';
```

```
nt1.helpTopic:=helpTopicUse;
nt1.subject:='Reopening ticket';
nt1.message:='I do not know how to reopen one of my closed tickets';
assert occurrence nt1;

ticket1:=nt1.createdTicket;

nt2:=new NewTicketOnline;
nt2.fullName:='James Jordan';
nt2.email:='james_at_jordan.jam';
nt2.helpTopic:=helpTopicInstallation;
nt2.subject:='Error operating system';
nt2.message:='The installation process does not finish....';
assert occurrence nt2;

ticket2:=nt2.createdTicket;

cts:=new DisplayTicketsAssociatedToEmail(email:='james_at_jordan.jam', ticketNumber:=2);
assert occurrence cts;
assert equals cts.answer() [Set{Tuple{createDate=1,department='General
support',email='james_at_jordan.jam',number=1,status=#Open,subject='Reopening
ticket'},Tuple{createDate=1,department='Technical support',email='james_at_jordan.jam',number=2,status=#Open,subject='Error
operating system'}}];

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 872> <line 872> DisplayTicketsAssociatedToEmail is not defined in the CSUT as a class or an association

- We define the query event until the verdict is *Pass*

```
query DisplayTicketsAssociatedToEmail
attributes
email:String
ticketNumber:Integer
operations
answer():Set(Tuple(number:Integer,createDate:Integer,status:TicketStatus,subject:String,department:String,
email:String))=
    Ticket.allInstances
    -> sortedBy(number)
    -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
                status:t.ticketStatus,subject:t.subject,department:t.assignedDepartment.name, email:t.email})->asSet()
End
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	4,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	11

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD	A derived type involved in a test case does not exist in the CSUD	An event type involved in a test case does not exist in the CSUD
The basic type is relevant and it is added to the CSUD	The derived type is relevant and it is added to the CSUD	The event type is relevant and it is added to the CSUD
2		**1**

Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
4				

Assert consistency fails
A static constraint needs to be changed

Iteration 27

Iteration objective

S12: DisplayTicketsOfEmail extension_2a (non existing tickets)

Current test case

```
test S12{
  load testConfiguration1;

cts:=new DisplayTicketsAssociatedToEmail(email:='james_at_jordan.jam', ticketNumber:=2);
assert non-occurrence cts;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event cts:DisplayTicketsAssociatedToEmail are satisfied and consequently, the event can occur

```
context DisplayTicketsAssociatedToEmail ini inv thereAreTicketsAssociatedToTheEmail:
    Ticket.allInstances()->select(tlt.email=self.email)->size()>0
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	0,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	1,5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD	**A derived type involved in a test case does not exist in the CSUD**	**An event type involved in a test case does not exist in the CSUD**
The basic type is relevant and it is added to the CSUD	The derived type is relevant and it is added to the CSUD	The event type is relevant and it is added to the CSUD

Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 28

Iteration objective

S13: DisplayTicketsOfEmail extension_2a Invalid access data

Current test case

- Preconditions of the domain event cts:DisplayTicketsAssociatedToEmail are satisfied and consequently, the event can occur

```
context DisplayTicketsAssociatedToEmail ini inv thereAreTicketsAssociatedToTheEmail:
    Ticket.allInstances()->select(tIt.email=self.email)->size()>0
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

```
context DisplayTicketsAssociatedToEmail ini inv accessDataIsValid:
    Ticket.allInstances()->select(tIt.email=self.email).number->includes(self.ticketNumber)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1
TIME TO COMPLETE THE ITERATION (IN MINUTES)	2

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD	**A derived type involved in a test case does not exist in the CSUD**	**An event type involved in a test case does not exist in the CSUD**
The basic type is relevant and it is added to the CSUD	The derived type is relevant and it is added to the CSUD	The event type is relevant and it is added to the CSUD

Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 29

Iteration objective

S14: DisplayTicketInformationForCustomer

Current test case

```
test S14{
 load testConfiguration1;

 nt1:=new NewTicketOnline;
 nt1.fullName:='James Jordan';
 nt1.email:='james_at_jordan.jam';
 nt1.helpTopic:=helpTopicUse;
 nt1.subject:='Reopening ticket';
 nt1.message:='I do not know how to reopen one of my closed tickets';
 assert occurrence nt1;

 ticket1:=nt1.createdTicket;


 cr:=new ReplyTicketByCustomer(ticket:=ticket1,replyText:='Please help me');
 assert occurrence cr;

 assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewMessageAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];

 assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewMessageAutoresponse) and
                                    e.fromAddress='technical_at_support.com' and
                                    e.toAddress='james_at_jordan.jam' and
                                    e.ticketNumber=1)];

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 919> ReplyTicketByCustomer is not defined in the CSUT as a class or an association

```
event ReplyTicketByCustomer
attributes
replyText:String
operations
effect()
end

association replyTicketByCustomer_ticket between
   ReplyTicketByCustomer[*]
   Ticket[1]
end


context ReplyTicketByCustomer::effect()
post:
let sendNewMessageAlertToLastRespondent:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#LastRespondent)
in
let sendNewMessageAlertToAssignedStaff:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#AssignedStaff)
in
let sendNewMessageAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#DepartmentManager)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let sendAutoresponse:Boolean=
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewTicketCreatedByCustomer then
      if self.ticket.helpTopic->notEmpty then
         if self.ticket.helpTopic.autoresponse=#Enabled then true
         else false
         endif
      else
         self.ticket.assignedDepartment.newTicketAutoresponseIsSent
      endif
   else false
   endif
in
self.ticket.ticketThreadMessage->one(tdm | tdm.oclIsNew()
            and tdm.datetime=System.allInstances()->any(true).currentDateTime
            and tdm.text=self.replyText
            and tdm.author=self.ticket.fullName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)


         -- autoresponses
         and (sendAutoresponse implies
            EMail.allInstances()->exists(ele.fromAddress=self.ticket.assignedDepartment.autoresponseEmail.address and
                              e.toAddress=self.ticket.email and
                              e.ticketNumber=self.ticket.number))


         -- staff notices
         and (sendNewMessageAlertToLastRespondent and
            self.ticket.lastRespondent->notEmpty() and
            not(self.ticket.lastRespondent.isInVacationMode or self.ticket.lastRespondent.status=#Disabled)
            implies
            EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                              e.toAddress=self.ticket.lastRespondent and
```

```
                                    e.ticketNumber=self.ticket.number ))

            and  (sendNewMessageAlertToAssignedStaff
                and self.ticket.assignedStaff->notEmpty()
                and not(self.ticket.assignedStaff.isInVacationMode or self.ticket.assignedStaff.status=#Disabled)
                implies
                  EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                    e.toAddress=self.ticket.assignedStaff.emailAddress and
                                    e.ticketNumber=self.ticket.number))
```

- osTicketCSUT.use:676:71: Undefined operation named `lastRespondent' in expression `Ticket.lastRespondent()'.

```
association ticket_lastRespondent between
   Ticket[*] role ticketOfLastRespondent
   StaffMember[0..1] role lastRespondent
end
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	4
TIME TO COMPLETE THE ITERATION (IN MINUTES)	35

Errors and failures that drive the conceptual modeling

<table>
<tr><td colspan="2">A basic type involved in a test case does not exist in the CSUD</td><td colspan="2">A derived type involved in a test case does not exist in the CSUD</td><td colspan="2">An event type involved in a test case does not exist in the CSUD</td></tr>
<tr><td colspan="2">The basic type is relevant and it is added to the CSUD</td><td colspan="2">The derived type is relevant and it is added to the CSUD</td><td colspan="2">The event type is relevant and it is added to the CSUD</td></tr>
<tr><td colspan="2">2</td><td colspan="2"></td><td colspan="2">1</td></tr>
<tr><td colspan="2">Inconsistent state before the occurrence of an event</td><td colspan="2">Inconsistent state after the occurrence of an event</td><td colspan="2">The postcondition of an event is not satisfied.</td></tr>
<tr><td>Some static constraint is invalid and it is modified.</td><td>Some initial integrity constraint is invalid and it is modified.</td><td>The event postcondition/method is incorrect and it is modified.</td><td>Some constraint is invalid and it is modified.</td><td>The method is not correct and it is modified.</td><td>The postcondition is not correct and it is modified.</td></tr>
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<tr><td colspan="3">An assertion about the IB state fails or contains an error</td><td>Assert non-occurrence fails</td><td colspan="2">Semantic error in an expression</td></tr>
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<tr><td>3</td><td colspan="2"></td><td></td><td></td><td></td></tr>
<tr><td>Assert consistency fails</td><td colspan="5" rowspan="3"></td></tr>
<tr><td>A static constraint needs to be changed</td></tr>
<tr><td></td></tr>
</table>

Iteration 30

Iteration objective

S15: RespondTicket_alertsDisabled

Current test case

```
test S15{
 load testConfiguration2;

 nt1:=new NewTicketOnline;
 nt1.fullName:='James Jordan';
 nt1.email:='james_at_jordan.jam';
 nt1.helpTopic:=helpTopicInstallation;
 nt1.subject:='Reopening ticket';
 nt1.message:='I do not know how to reopen one of my closed tickets';
 assert occurrence nt1;

 ticket1:=nt1.createdTicket;


 cr:=new ReplyTicketByCustomer(ticket:=ticket1,replyText:='Please help me');
 assert occurrence cr;

 assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewMessageAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];

}
```

TDCM application: Summary of changes performed in the schema

The CSUD has not been changed

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 31

Iteration objective

S16: StaffLogIn_successScenario

Current test case

```
test S16{
  load testConfiguration1;

  assert false generalConsultant.isLoggedIn;
  li := new LogIn(username:='mary', password:='yyy');
  assert occurrence li;
  assert true generalConsultant.isLoggedIn;
 }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <Line 956>:1:7: Undefined operation named `isLoggedIn' in expression `{StaffMember}.isLoggedIn()'

```
class StaffMember
attributes
username:String
firstName:String
lastName:String
emailAddress:String
officePhone:String[0..1]
phoneExtension:String [0..1]
mobilePhone:String[0..1]
signature:String[0..1]
password:String
status:Status
isAdministrator:Boolean
isInVacationMode:Boolean
isLoggedIn:Boolean=false
end
```

- TicketsManagementAndTracking.cstl] <line 957> LogIn is not defined in the CSUT as a class or an association

```
event LogIn
attributes
username:String
password:String
operations
effect()
end

context LogIn::effect()
post:
StaffMember.allInstances()->any(sm|sm.username=self.username and sm.password=self.password).isLoggedIn=true

context StaffMember inv usernameIsUnique:
StaffMember.allInstances()->isUnique(username)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	7

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
3				**1**	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		Assert non-occurrence fails	Semantic error in an expression	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
Assert consistency fails				
A static constraint needs to be changed				

Iteration 32

Iteration objective

S17: StaffLogIn_PreconditionViolation

Current test case

```
test S17{
 load testConfiguration1;

 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;
 assert true generalConsultant.isLoggedIn;

 li := new LogIn(username:='mary', password:='yyy');
 assert non-occurrence li;


}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event li:LogIn are satisfied and consequently, the event can occur

```
context LogIn ini inv isNotLoggedIn:
StaffMember.allInstances()->select(sm|sm.username=self.username and sm.password=self.password)->size()>0
implies
    StaffMember.allInstances()->any(sm|sm.username=self.username and sm.password=self.password).isLoggedIn=false
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 33

Iteration objective

S18: StaffLogIn_PreconditionViolation_InactiveStaffMember

Current test case

```
test S18{
load testConfiguration1;

li := new LogIn(username:='patricia', password:='uuu');
assert non-occurrence li;

maximumPrivilegesGroup.status:=#Disabled;

li := new LogIn(username:='mary', password:='yyy');
assert non-occurrence li;
}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- First assert non-occurrence: Preconditions of the domain event li:LogIn are satisfied and consequently, the event can occur

```
context LogIn ini inv staffMemberIsEnabled:
StaffMember.allInstances()->select(sm|sm.username=self.username and sm.password=self.password)->size()>0
implies
    StaffMember.allInstances()->any(sm|sm.username=self.username and sm.password=self.password).status=#Enabled
    and StaffMember.allInstances()->any(sm|sm.username=self.username and
    sm.password=self.password).staffGroup.status=#Enabled
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	4

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect		A precondition is added/updated	The expression is corrected	The CSUD is changed
			1		
Assert consistency fails					
A static constraint needs to be changed					

Iteration 34

Iteration objective

S19: StaffLogOut_successScenario

Current test case

```
test S19{
 load testConfiguration1;

 assert false generalConsultant.isLoggedIn;

 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;
 assert true generalConsultant.isLoggedIn;

 lo := new LogOut(staffMember:=generalConsultant),
  assert occurrence lo;
 assert false generalConsultant.isLoggedIn;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 1000> LogOut is not defined in the CSUT as a class or an association

```
event LogOut
operations
effect()
end


association logOut_staffMember between
   LogOut[*]
   StaffMember[1]
end

context LogOut::effect()
post:
self.staffMember.isLoggedIn=false


context LogOut ini inv isNotLoggedIn:
self.staffMember.isLoggedIn=true
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	3
TIME TO COMPLETE THE ITERATION (IN MINUTES)	6,5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
1				**1**	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
				1	
An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect		A precondition is added/updated	The expression is corrected	The CSUD is changed
Assert consistency fails					
A static constraint needs to be changed					

Iteration 35

Iteration objective

S20: StaffLogIn extension_2a (invalid login data)

Current test case

```
test S20{
 load testConfiguration1;

 li := new LogIn(username:='mary', password:='zzz');
 assert non-occurrence li;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event li:LogIn are satisfied and consequently, the event can occur

```
context LogIn ini inv accessDataIsValid:
StaffMember.allInstances()->select(sm|sm.username=self.username and sm.password=self.password)->size()>0
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	0,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	1

Errors and failures that drive the conceptual modeling

<table>
<tr><td colspan="2">A basic type involved in a test case does not exist in the CSUD</td><td colspan="2">A derived type involved in a test case does not exist in the CSUD</td><td colspan="2">An event type involved in a test case does not exist in the CSUD</td></tr>
<tr><td colspan="2">The basic type is relevant and it is added to the CSUD</td><td colspan="2">The derived type is relevant and it is added to the CSUD</td><td colspan="2">The event type is relevant and it is added to the CSUD</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">Inconsistent state before the occurrence of an event</td><td colspan="2">Inconsistent state after the occurrence of an event</td><td colspan="2">The postcondition of an event is not satisfied.</td></tr>
<tr><td>Some static constraint is invalid and it is modified.</td><td>Some initial integrity constraint is invalid and it is modified.</td><td>The event postcondition/method is incorrect and it is modified.</td><td>Some constraint is invalid and it is modified.</td><td>The method is not correct and it is modified.</td><td>The postcondition is not correct and it is modified.</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">An assertion about the IB state fails or contains an error</td><td>Assert non-occurrence fails</td><td colspan="2">Semantic error in an expression</td></tr>
<tr><td colspan="2">The effect of an event type is not correct</td><td>A derivation rule is incorrect</td><td>A precondition is added/updated</td><td>The expression is corrected</td><td>The CSUD is changed</td></tr>
<tr><td colspan="2"></td><td></td><td>1</td><td></td><td></td></tr>
<tr><td colspan="2">Assert consistency fails</td><td colspan="4" rowspan="3"></td></tr>
<tr><td colspan="2">A static constraint needs to be changed</td></tr>
<tr><td colspan="2"></td></tr>
</table>

Iteration 36

Iteration objective

S21:
NewTicketOffline_successScenario_SequentialTicketsNumber_alertsAutoresponsesActive

Current test case

```
test S21{
 load testConfiguration1;
 minimumPrivilegesGroup.canCreateTickets:=true;

 nt:=new NewTicketOffline;
 nt.fullName:='Mary Marnes';
 nt.email:='mary_at_marnes.mar';
 nt.telephone:='xxxxxxxx';
 nt.ext:='xxxxxxxx';
 nt.source:=#Phone;
 nt.assignedDepartment:=dptTechnical;
 nt.helpTopic:=helpTopicInstallation;
 nt.subject:='Error operating system';
 nt.message:='The installation process does not finish....';
 nt.internalNote:='It seems that the correct installer is being used';

 dt2:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
 nt.dueDatetime:=dt2;
 nt.priority:=#Normal;
 nt.assignedStaff:=generalConsultant;
 assert occurrence nt;

 ticket1:=nt.createdTicket;

 assert equals ticket1.number 1;
 assert equals ticket1.ticketStatus #Open;
 assert equals ticket1.subject 'Error operating system';
 assert equals ticket1.priority #Normal;
 assert equals ticket1.assignedStaff generalConsultant;
 assert equals ticket1.source #Phone;
 assert equals ticket1.creationDatetime sys.currentDateTime;
 assert equals ticket1.lastMessageDatetime sys.currentDateTime;
 assert equals ticket1.dueDatetime.value 3;
 assert true ticket1.lastResponseDatetime.isUndefined();
 assert equals ticket1.assignedDepartment dptTechnical;



 assert true [ticket1.ticketThreadMessage->one(m|m.datetime=sys.currentDateTime and
                                  m.text='The installation process does not finish....' and
                                  m.author='Mary Marnes')];

 assert equals ticket1.lastMessageDatetime sys.currentDateTime;

 //no autoresponses
 assert true [not(EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketNotice)))];

 //notice to administrator
 assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                  e.fromAddress='general_at_support.com' and
                                  e.toAddress='system_at_support.com' and
                                  e.ticketNumber=1)];

 //notice to department manager
 assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
```

```
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];

  //notice to department members
   assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='martin_at_support.com' and
                                    e.ticketNumber=1)];


   //TICKET 2
   ticketSettings.customersCanChangePriority:=true;

   nt2:=new NewTicketOffline;
   nt2.fullName:='James Jordan';
   nt2.email:='james_at_jordan.jam';
   nt2.telephone:='xxxxxxxx';
   nt2.ext:='xxxxxxxx';
   nt2.source:=#Other;
   nt2.assignedDepartment:=dptGeneral;
   nt2.priority:=#Low;
   nt2.helpTopic:=helpTopicUse;
   nt2.subject:='Reopening ticket';
   nt2.message:='I do not know how to reopen one of my closed tickets';
   assert occurrence nt2;

   ticket2:=nt2.createdTicket;

   assert equals ticket2.number 2;
   assert equals ticket2.priority #Low;
   assert true ticket2.assignedStaff->isEmpty();

   //autoresponses

   assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketNotice) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='james_at_jordan.jam' and
                                    e.ticketNumber=2)];

   //notice to administrator
   assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='system_at_support.com' and
                                    e.ticketNumber=2)];


  //notice to department members
   assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=2)];

   assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=2)];

   assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='david_at_support.com' and
                                    e.ticketNumber=2)];


  }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 1012> NewTicketOffline is not defined in the CSUT as a class or an association

```
event NewTicketOffline
attributes
fullName:String
email:String
telephone:String[0..1]
ext:String[0..1]
source:TicketSource
subject:String
message:String
priority:Priority[0..1]
createdTicket:Ticket[0..1]
internalNote:String[0..1]
dueDatetime:Datetime[0..1]
operations
effect()
end


association newTicketOffline_department between
   NewTicketOffline[*]
   Department[1] role assignedDepartment
end

association newTicketOffline_helpTopic between
   NewTicketOffline[*]
   HelpTopic[0..1]
end

association newTicketOffline_assignedStaff between
   NewTicketOffline[*]
   StaffMember[0..1] role assignedStaff
end

context NewTicketOffline ini inv helpTopicSpecifiedIfAvailable:
   if HelpTopic.allInstances()->select(hp|hp.status=#Enabled)->size()>0  then
      self.helpTopic->size()=1
   else
      self.helpTopic->size()=0
   endif

context NewTicketOffline ini inv helpTopicIsEnabled:
  self.helpTopic->notEmpty() implies self.helpTopic.status=#Enabled


context NewTicketOffline ini inv maximumOpenTicketsLimitIsNotViolated:
   if TicketSettings.allInstances()->any(true).openTicketsPerMailAreLimited then
   Ticket.allInstances->select(tIt.email=self.email)->size()<TicketSettings.allInstances()-
>any(true).maximumOpenTicketsPerMail
   else true
   endif


context NewTicketOffline::effect()
post:
let sendNewTicketAlertToAdministrator:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#Administrator)
in
let sendNewTicketAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentManager)
in
```

```
let sendNewTicketAlertToDepartmentMembers:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff-
>includes(#DepartmentMembers)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let sendAutoresponse:Boolean=
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewTicketCreatedByCustomer then
      if self.helpTopic->notEmpty then
         if self.helpTopic.autoresponse=#Enabled then true
         else false
         endif
      else
         self.assignedDepartment.newTicketAutoresponseIsSent
      endif
   else false
   endif
in
(Ticket.allInstances- Ticket.allInstances@pre)
  ->one(t | t.oclIsNew()
         and self.createdTicket=t
         and t.fullName=self.fullName
         and t.email=self.email
         and t.telephone=self.telephone
         and t.ext=self.ext
         and t.subject=self.subject
         and t.message=self.message
         and t.ticketStatus=#Open
         and t.priority=self.priority
         and t.source=self.source
         and t.helpTopic=self.helpTopic
         and t.assignedDepartment=self.assignedDepartment
         and t.assignedStaff=self.assignedStaff
         and t.dueDatetime=self.dueDatetime
         and (TicketThreadMessage.allInstances- TicketThreadMessage.allInstances@pre)
             ->one(tdm | tdm.oclIsNew()
             and tdm.datetime=System.allInstances()->any(true).currentDateTime
             and tdm.text=self.message
             and tdm.author=self.fullName
             and tdm.ticket=t
             and t.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

         -- autoresponses
         and (sendAutoresponse implies
            EMail.allInstances()->exists(ele.fromAddress=t.assignedDepartment.autoresponseEmail.address and
                                  e.toAddress=t.email and
                                  e.ticketNumber=t.number))


         -- staff notices
         and (sendNewTicketAlertToAdministrator implies
            EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                  e.toAddress=EmailSettings.allInstances()->any(true).administrationEmail and
                                  e.ticketNumber=t.number))

         and  (sendNewTicketAlertToDepartmentManager
             and t.assignedDepartment.departmentManager->notEmpty()
             and t.assignedDepartment.departmentManager.status=#Enabled
             and not(t.assignedDepartment.departmentManager.isInVacationMode)
             implies
               EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                  e.toAddress=t.assignedDepartment.departmentManager.emailAddress and
                                  e.ticketNumber=t.number))

         and  (sendNewTicketAlertToDepartmentMembers
             implies
             t.assignedDepartment.staffMember->forAll(m|
               (m.status=#Enabled and not(m.isInVacationMode))
               implies
               EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
```

```
                                    e.toAddress=m.emailAddress and
                                    e.ticketNumber=t.number)))
                )
```

- [TicketsManagementAndTracking.cstl] <Line 1017>:1:1: Undefined enumeration literal `Phone' and 'Other'

```
enum TicketSource{Web,EMail,Phone,Other}
```

- Several method and postcondition errors and failures until the verdict becomes *Pass*

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	17
TIME TO COMPLETE THE ITERATION (IN MINUTES)	41

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
16				1	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
				2	
An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect		A precondition is added/updated	The expression is corrected	The CSUD is changed
Assert consistency fails					
A static constraint needs to be changed					

Iteration 37

Iteration objective

S22: NewTicketOffline_SuccessScenario_alertsAutoresponsesDisabled

Current test case

```
test S22{
 load testConfiguration2;
 minimumPrivilegesGroup.canCreateTickets:=true;
```

```
nt:=new NewTicketOffline;
nt.fullName:='Mary Marnes';
nt.email:='mary_at_marnes.mar';
nt.telephone:='xxxxxxxx';
nt.ext:='xxxxxxxx';
nt.source:=#Phone;
nt.assignedDepartment:=dptTechnical;
nt.helpTopic:=helpTopicInstallation;
nt.subject:='Error operating system';
nt.message:='The installation process does not finish....';
nt.internalNote:='It seems that the correct installer is being used';

dt2:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
nt.dueDatetime:=dt2;
nt.priority:=#Normal;
nt.assignedStaff:=generalConsultant;
assert occurrence nt;

ticket1:=nt.createdTicket;

assert equals ticket1.number 1;
assert equals ticket1.ticketStatus #Open;
assert equals ticket1.subject 'Error operating system';
assert equals ticket1.priority #Normal;
assert equals ticket1.assignedStaff generalConsultant;
assert equals ticket1.source #Phone;
assert equals ticket1.creationDatetime sys.currentDateTime;
assert equals ticket1.lastMessageDatetime sys.currentDateTime;
assert equals ticket1.dueDatetime.value 3;
assert true ticket1.lastResponseDatetime.isUndefined();
assert equals ticket1.assignedDepartment dptTechnical;


assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                m.text='The installation process does not finish....' and
                                m.author='Mary Marnes')];

assert equals ticket1.lastMessageDatetime sys.currentDateTime;

//no autoresponses
assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketNotice))];

//no notice to administrator
assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='system_at_support.com' and
                                e.ticketNumber=1)];

//no notice to department manager
assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='john_at_support.com' and
                                e.ticketNumber=1)];

//no notice to department members
assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='martin_at_support.com' and
                                e.ticketNumber=1)];

}
```

TDCM application: Summary of changes performed in the schema

The CSUD has not been changed

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 38

Iteration objective

S23: NewTicketOffline_SuccessScenario_NoTopic

Current test case

```
test S23{
  load testConfiguration4;
  minimumPrivilegesGroup.canCreateTickets:=true;
  helpTopicUse.status:=#Disabled;
  helpTopicInstallation.status:=#Disabled;

  nt:=new NewTicketOffline;
  nt.fullName:='Mary Marnes';
  nt.email:='mary_at_marnes.mar';
  nt.telephone:='xxxxxxxx';
  nt.ext:='xxxxxxxx';
  nt.source:=#Phone;
  nt.assignedDepartment:=dptTechnical;
  nt.subject:='Error operating system';
  nt.message:='The installation process does not finish....';

  nt.priority:=#Normal;
  assert occurrence nt;

  ticket1:=nt.createdTicket;

  assert true ticket1.helpTopic->isEmpty();

 }
```

TDCM application: Summary of changes performed in the schema

The CSUD has not been changed

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 39

Iteration objective

S24: NewTicketOffline_PreconditionViolation_cannotCreateTickets

Current test case

```
test S24{
load testConfiguration9;

li := new LogIn(username:='martin', password:='ttt');
assert occurrence li;


nt:=new NewTicketOffline;
nt.fullName:='Mary Marnes';
nt.email:='mary_at_marnes.mar';
nt.telephone:='xxxxxxxx';
nt.ext:='xxxxxxxx';
nt.source:=#Phone;
nt.helpTopic:=helpTopicInstallation;
nt.assignedDepartment:=dptTechnical;
nt.assignedStaff:=generalConsultant;
nt.subject:='Error operating system';
nt.message:='The installation process does not finish....';
nt.priority:=#Normal;
nt.creator:=technicalActive;
assert non-occurrence nt;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event nt:NewTicketOffline are satisfied and consequently, the event can occur

```
context NewTicketOffline ini inv creatorIsAllowedToCreateTickets:
  self.creator.staffGroup.canCreateTickets
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	3,5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD	A derived type involved in a test case does not exist in the CSUD	An event type involved in a test case does not exist in the CSUD
The basic type is relevant and it is added to the CSUD	The derived type is relevant and it is added to the CSUD	The event type is relevant and it is added to the CSUD

Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 40

Iteration objective

S25: NewTicketOffline_PreconditionViolation_isNotLoggedIn

Current test case

```
test S24{
 load testConfiguration9;

 nt:=new NewTicketOffline;
 nt.fullName:='Mary Marnes';
 nt.email:='mary_at_marnes.mar';
 nt.telephone:='xxxxxxxx';
 nt.ext:='xxxxxxxx';
 nt.source:=#Phone;
 nt.helpTopic:=helpTopicInstallation;
 nt.assignedDepartment:=dptTechnical;
 nt.subject:='Error operating system';
 nt.message:='The installation process does not finish....';
 nt.priority:=#Normal;
 assert non-occurrence nt;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event nt:NewTicketOffline are satisfied and consequently, the event can occur
- We realize that we do not check that we need to know the staff member that creates a ticket and checking if he/she is logged in.

```
association newTicketOffline_creator between
   NewTicketOffline[*] role newTicketOfflineOfCreator
   StaffMember[1] role creator
End

context NewTicketOffline ini inv creatorIsLoggedIn:
   self.creator.isLoggedIn
```

- The verdict of previous passing test cases that exercise the NewTicketOffline event is now error: [TicketsManagementAndTracking.cstl] <line 1036> Inconsistent state before nt:NewTicketOffline event execution: Multiplicity constraint violation in association `newTicketOffline_creator': Object `oid775' of class `NewTicketOffline' is connected to 0 objects of class `StaffMember' but the multiplicity is specified as `1'.

- We realize that in the current story and in previous stories, we did not consider that the staff member that creates a ticket offline needs to be known. We change the previous stories to include this expected knowledge.

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	0,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	14

Errors and failures that drive the conceptual modeling

<table>
<tr><th colspan="2">A basic type involved in a test case does not exist in the CSUD</th><th colspan="2">A derived type involved in a test case does not exist in the CSUD</th><th colspan="2">An event type involved in a test case does not exist in the CSUD</th></tr>
<tr><td colspan="2">The basic type is relevant and it is added to the CSUD</td><td colspan="2">The derived type is relevant and it is added to the CSUD</td><td colspan="2">The event type is relevant and it is added to the CSUD</td></tr>
<tr><td colspan="2">1</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><th colspan="2">Inconsistent state before the occurrence of an event</th><th colspan="2">Inconsistent state after the occurrence of an event</th><th colspan="2">The postcondition of an event is not satisfied.</th></tr>
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<tr><th colspan="3">An assertion about the IB state fails or contains an error</th><th>Assert non-occurrence fails</th><th colspan="2">Semantic error in an expression</th></tr>
<tr><td>The effect of an event type is not correct</td><td colspan="2">A derivation rule is incorrect</td><td>A precondition is added/updated</td><td>The expression is corrected</td><td>The CSUD is changed</td></tr>
<tr><td></td><td colspan="2"></td><td>1</td><td></td><td></td></tr>
<tr><th>Assert consistency fails</th><td colspan="5" rowspan="2"></td></tr>
<tr><td>A static constraint needs to be changed</td></tr>
<tr><td></td><td colspan="5">INCONSISTENCY BETWEEN REQUIREMENTS</td></tr>
</table>

Iteration 41

Iteration objective

S26: ViewOpenTickets

Current test case

```
fixturecomponent created_tickets{
     li := new LogIn(username:='mary', password:='yyy');
   assert occurrence li;

   nt1:=new NewTicketOffline;
   nt1.fullName:='Mary Marnes';
   nt1.email:='mary_at_marnes.mar';
   nt1.telephone:='xxxxxxxx';
   nt1.ext:='xxxxxxxx';
   nt1.source:=#Phone;
   nt1.assignedDepartment:=dptTechnical;
   nt1.helpTopic:=helpTopicInstallation;
   nt1.subject:='Error operating system';
   nt1.message:='The installation process does not finish....';
   nt1.internalNote:='It seems that the correct installer is being used';
   dt2:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
   nt1.dueDatetime:=dt2;
   nt1.priority:=#Normal;
   nt1.assignedStaff:=generalConsultant;
   nt1.creator:=generalConsultant;
   assert occurrence nt1;
   ticket1 := nt1.createdTicket;

   nt2:=new NewTicketOffline;
   nt2.fullName:='John Johnes';
   nt2.email:='mary_at_marnes.mar';
   nt2.source:=#Other;
   nt2.assignedDepartment:=dptGeneral;
   nt2.helpTopic:=helpTopicUse;
   nt2.subject:='Can I reply a ticket?';
   nt2.message:='I do not know how to reply a ticket';
   nt2.priority:=#High;
   nt2.assignedStaff:=generalConsultant;
   nt2.creator:=generalConsultant;
   assert occurrence nt2;
   ticket2 := nt2.createdTicket;

   lo := new LogOut(staffMember:=generalConsultant);
   assert occurrence lo;

   li := new LogIn(username:='john', password:='xxx');
   assert occurrence li;


   nt3:=new NewTicketOffline;
   nt3.fullName:='Martin Pope';
   nt3.email:='martin_at_pope.mar';
   nt3.source:=#Phone;
   nt3.assignedDepartment:=dptTechnical;
   nt3.helpTopic:=helpTopicUse;
   nt3.subject:='Error while login';
   nt3.message:='I get an error when I try to login';
   nt3.priority:=#Low;
   dt3:=new Datetime(value:=[(sys.currentDateTime.value+5)]);
   nt3.dueDatetime:=dt3;
   nt3.assignedStaff:=technicalActive;
   nt3.creator:=generalAdministrator;
   assert occurrence nt3;
   ticket3 := nt3.createdTicket;

   dt4:=new Datetime(value:=[(sys.currentDateTime.value+1)]);
   sys.currentDateTime:=dt4;

   lo := new LogOut(staffMember:=generalAdministrator);
   assert occurrence lo;

   nt4:=new NewTicketOnline;
   nt4.fullName:='James Jordan';
```

```
    nt4.email:='james_at_jordan.jam';
    nt4.helpTopic:=helpTopicUse;
    nt4.subject:='Reopening ticket';
    nt4.message:='I do not know how to reopen one of my closed tickets';
    assert occurrence nt4;
    ticket4 := nt4.createdTicket;

    nt5:=new NewTicketByEmail;
    nt5.toAddress:='technical_at_support.com';
    nt5.fromName:='Marta Johnes';
    nt5.fromAddress:='marta_at_johnes.mar';
    nt5.subject:='See my tickets';
    nt5.message:='Can I see my tickets?';
    assert occurrence nt5;
    ticket5 := nt5.createdTicket;
  }

test S26{
    load testConfiguration3;

    load created_tickets;

    li := new LogIn(username:='john', password:='xxx');
    assert occurrence li;

    dts:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#Open);
    assert occurrence dts;
    assert equals dts.answer() [Sequence{
            Tuple{createDate=1,department='Technical
            support',email='mary_at_marnes.mar',number=1,priority=#Normal,subject='Error operating system'},
            Tuple{createDate=1,department='General support',email='mary_at_marnes.mar',number=2,priority=#High,subject='Can
            I reply a ticket?'},
            Tuple{createDate=1,department='Technical
            support',email='martin_at_pope.mar',number=3,priority=#Low,subject='Error while login'},
            Tuple{createDate=2,department='General
            support',email='james_at_jordan.jam',number=4,priority=#Normal,subject='Reopening ticket'},
            Tuple{createDate=2,department='Technical
            support',email='marta_at_johnes.mar',number=5,priority=#High,subject='See my tickets'}}];

    lo := new LogOut(staffMember:=generalAdministrator);
    assert occurrence lo;

    li := new LogIn(username:='martin', password:='ttt');
    assert occurrence li;

    dts:=new DisplayTicketsByStatus(consultant:=technicalActive, status:=#Open);
    assert occurrence dts;
    assert equals dts.answer() [Sequence{
                    Tuple{createDate=1,department='Technical
                    support',email='mary_at_marnes.mar',number=1,priority=#Normal,subject='Error operating system'},
                    Tuple{createDate=1,department='Technical
                    support',email='martin_at_pope.mar',number=3,priority=#Low,subject='Error while login'},
                    Tuple{createDate=2,department='Technical
                    support',email='marta_at_johnes.mar',number=5,priority=#High,subject='See my tickets'}} ];];

  }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 1335> Initial IC 'helpDeskStatusIsOnline ' of nt4:NewTicketOnline event fails
- We detect that the story is incorrectly defined. We need that the help desk status is online in order to create tickets online.We change the fixture of the story from #11 to #3
- [TicketsManagementAndTracking.cstl] <line 1348> DisplayTicketsByStatus is not defined in the CSUT as a class or an association

```
event DisplayTicketsByStatus
attributes
status:TicketStatus
operations
answer():Sequence(Tuple(number:Integer,createDate:Integer,subject:String,department:String,
priority:Priority,email:String))=
      let visibleDepartments:Set(Department)=
          self.consultant.staffGroup.departmentsAccess->including(self.consultant.department)
      in
      Ticket.allInstances
      ->select(tIt.ticketStatus=self.status and visibleDepartments->includes(t.assignedDepartment))
      -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})->sortedBy(number)
effect()
end


association displayTicketsByStatus_consultant between
   DisplayTicketsByStatus[*] role newTicketOfflineOfConsultant
   StaffMember[1] role consultant
end
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	25
TIME TO COMPLETE THE ITERATION (IN MINUTES)	41

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
1					
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect		A precondition is added/updated	The expression is corrected	The CSUD is changed
4					
Assert consistency fails					
A static constraint needs to be changed					

Iteration 42

Iteration objective

S27: ViewOpenTickets_preconditionViolation_notLoggedIn

Current test case

```
test S27
   load testConfiguration11;

   dts:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#Open);
   assert non-occurrence dts;

  }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event dts:DisplayTicketsByStatus are satisfied and consequently, the event can occur

```
context DisplayTicketsByStatus ini inv consulantIsLoggedIn:
    self.consultant.isLoggedIn
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	3

Errors and failures that drive the conceptual modeling

<table>
<tr><td colspan="2">A basic type involved in a test case does not exist in the CSUD</td><td colspan="2">A derived type involved in a test case does not exist in the CSUD</td><td colspan="2">An event type involved in a test case does not exist in the CSUD</td></tr>
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<tr><td colspan="2"></td><td></td><td>1</td><td></td><td></td></tr>
<tr><td colspan="2">Assert consistency fails</td><td colspan="4" rowspan="2"></td></tr>
<tr><td colspan="2">A static constraint needs to be changed</td></tr>
<tr><td colspan="2"></td><td colspan="4"></td></tr>
</table>

Iteration 43

Iteration objective

S28: ChangeTicketPriority

Current test case

```
test S28{
 load testConfiguration3;

 load created_tickets;

 li := new LogIn(username:='john', password:='xxx');
 assert occurrence li;

 stp:=new ChangeTicketPriority(staffMember:=generalAdministrator, ticket:=ticket1, newPriority:=#High);
 assert occurrence stp;
 assert equals ticket1.priority #High;

 assert true [ticket1.internalNote->one(ili.datetime=sys.currentDateTime and
                                        i.text='The ticket priority has been changed' and
                                        i.subject='Ticket priority changed' and
                                        i.author='John')];

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 1419> ChangeTicketPriority is not defined in the CSUT as a class or an association

```
event ChangeTicketPriority
attributes
newPriority:Priority
operations
effect()
end

association changeTicketPriority_staffMember between
   ChangeTicketPriority[*]
   StaffMember[1]
end

association changeTicketPriority_ticket between
   ChangeTicketPriority[*]
   Ticket[1]
end


context ChangeTicketPriority::effect()
post:
self.ticket.priority=self.newPriority
```

- [TicketsManagementAndTracking.cstl] <Line 1423>:1:8: Undefined operation named `internalNote' in expression `{Ticket}.internalNote()'.

```
class InternalNote
attributes
datetime:Datetime
subject:String
text:String
author:String
end

association ticket_internalNote between
   Ticket[1]
   InternalNote[*]
 end
```

- Assert expression is false and it is expected to be true: assert true [ticket1.internalNote->one(i|i.datetime=sys.currentDateTime and i.text='Ticket priority changed' and i.subject='Ticket priority changed' andi.author='Martin')];

```
context ChangeTicketPriority::effect()
post:
self.ticket.priority=self.newPriority
and
(InternalNote.allInstances- InternalNote.allInstances@pre)
            ->one(i | i.oclIsNew()
            and i.datetime=System.allInstances()->any(true).currentDateTime
            and i.subject='Ticket priority changed'
            and i.text='The ticket priority has been changed'
            and i.author=self.staffMember.firstName
            and i.ticket=self.ticket)
  and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	6,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	25

Errors and failures that drive the conceptual modeling

<table>
<tr><td colspan="2">A basic type involved in a test case does not exist in the CSUD</td><td colspan="2">A derived type involved in a test case does not exist in the CSUD</td><td colspan="2">An event type involved in a test case does not exist in the CSUD</td></tr>
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<tr><td colspan="2">9</td><td colspan="2"></td><td colspan="2">1</td></tr>
<tr><td colspan="2">Inconsistent state before the occurrence of an event</td><td colspan="2">Inconsistent state after the occurrence of an event</td><td colspan="2">The postcondition of an event is not satisfied.</td></tr>
<tr><td>Some static constraint is invalid and it is modified.</td><td>Some initial integrity constraint is invalid and it is modified.</td><td>The event postcondition/method is incorrect and it is modified.</td><td>Some constraint is invalid and it is modified.</td><td>The method is not correct and it is modified.</td><td>The postcondition is not correct and it is modified.</td></tr>
<tr><td></td><td></td><td></td><td></td><td>4</td><td>1</td></tr>
<tr><td colspan="3">An assertion about the IB state fails or contains an error</td><td>Assert non-occurrence fails</td><td colspan="2">Semantic error in an expression</td></tr>
<tr><td>The effect of an event type is not correct</td><td colspan="2">A derivation rule is incorrect</td><td>A precondition is added/updated</td><td>The expression is corrected</td><td>The CSUD is changed</td></tr>
<tr><td>2</td><td colspan="2"></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Assert consistency fails</td><td colspan="4" rowspan="3"></td></tr>
<tr><td colspan="2">A static constraint needs to be changed</td></tr>
<tr><td colspan="2"></td></tr>
</table>

Iteration 44

Iteration objective

S29: ChangeTicketPriority_TicketNotVisible

Current test case

```
test S29{
 load testConfiguration3;

 load created_tickets;

 li := new LogIn(username:='martin', password:='ttt');
 assert occurrence li;

 stp:=new ChangeTicketPriority(staffMember:=technicalActive, ticket:=ticket2, newPriority:=#High);
 assert non-occurrence stp;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event stp:ChangeTicketPriority are satisfied and consequently, the event can occur

```
context ChangeTicketPriority ini inv theTicketIsVisible:
   self.staffMember.isAdministrator or
   (self.staffMember.staffGroup.departmentsAccess->including(self.staffMember.department))
         ->includes(self.ticket.assignedDepartment)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	7

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		Assert non-occurrence fails	Semantic error in an expression	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		
Assert consistency fails				
A static constraint needs to be changed				

Iteration 45

Iteration objective

S30: ChangeTicketPriority_NotLoggedIn

Current test case

```
test S30{
 load testConfiguration4;

 load created_tickets;


 stp:=new ChangeTicketPriority(staffMember:=generalAdministrator, ticket:=ticket1, newPriority:=#High);
 assert non-occurrence stp;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event stp:ChangeTicketPriority are satisfied and consequently, the event can occur

```
context ChangeTicketPriority ini inv theStaffMemberIsLoggedIn:
    self.staffMember.isLoggedIn
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	0,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	2

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD	A derived type involved in a test case does not exist in the CSUD	An event type involved in a test case does not exist in the CSUD
The basic type is relevant and it is added to the CSUD	The derived type is relevant and it is added to the CSUD	The event type is relevant and it is added to the CSUD

Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 46

Iteration objective

S31: MarkTicketOverdue

Current test case

```
 test S31{
load testConfiguration3;

load created_tickets;


li := new LogIn(username:='john', password:='xxx');
assert occurrence li;

mto:=new MarkTicketOverdue(staffMember:=generalAdministrator, ticket:=ticket1);
assert occurrence mto;

assert true ticket1.isOverdue;
assert true [ticket1.internalNote->one(ili.datetime=sys.currentDateTime and
                                       i.text='Ticket flagged as overdue' and
                                       i.subject='Ticket Marked Overdue' and
                                       i.author='John')];

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 1466> MarkTicketOverdue is not defined in the CSUT as a class or an association

```
event MarkTicketOverdue
operations
effect()
end
```

```
association markTicketOverdue_staffMember between
   MarkTicketOverdue[*]
   StaffMember[1]
end

association markTicketOverdue_ticket between
   MarkTicketOverdue[*]
   Ticket[1]
end

context MarkTicketOverdue::effect()
post:
self.ticket.isOverdue
and
(InternalNote.allInstances- InternalNote.allInstances@pre)
            ->one(i | i.oclIsNew()
            and i.datetime=System.allInstances()->any(true).currentDateTime
            and i.subject='Ticket Marked Overdue'
            and i.text='Ticket flagged as overdue'
            and i.author=self.staffMember.firstName
            and i.ticket=self.ticket)
  and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime
```

- osTicketCSUT.use:979:12: Undefined operation named `isOverdue' in expression `Ticket.isOverdue()'.

```
class Ticket
attributes
…
isOverdue:Boolean=false
end
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	4
TIME TO COMPLETE THE ITERATION (IN MINUTES)	7,5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
3				**1**	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
				1	
An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect		A precondition is added/updated	The expression is corrected	The CSUD is changed
1					
Assert consistency fails					
A static constraint needs to be changed					

Iteration 47

Iteration objective

S32: MarkTicketOverdue_staffIsNotAnAdministrator

Current test case

```
test S32{
   load testConfiguration3;

   load created_tickets;


   li := new LogIn(username:='martin', password:='ttt');
   assert occurrence li;

   mto:=new MarkTicketOverdue(staffMember:=technicalActive, ticket:=ticket1);
   assert non-occurrence mto;

  }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event mto:MarkTicketOverdue are satisfied and consequently, the event can occur

```
context MarkTicketOverdue ini inv staffMemberIsAnAdministrator:
   self.staffMember.isAdministrator
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	1

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		Assert non-occurrence fails	Semantic error in an expression	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		
Assert consistency fails				
A static constraint needs to be changed				

Iteration 48

Iteration objective

S33: MarkTicketOverdue_staffIsNotAnAdministrator

Current test case

```
test S33{
  load testConfiguration4;
  load created_tickets;

  mto:=new MarkTicketOverdue(staffMember:=generalAdministrator, ticket:=ticket1);
  assert non-occurrence mto;
 }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event mto:MarkTicketOverdue are satisfied and consequently, the event can occur

```
context MarkTicketOverdue ini inv staffMemberIsLoggedIn:
    self.staffMember.isLoggedIn
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	0,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	1,5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		A derived type involved in a test case does not exist in the CSUD		An event type involved in a test case does not exist in the CSUD	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		Assert non-occurrence fails	Semantic error in an expression	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		
Assert consistency fails				
A static constraint needs to be changed				

Iteration 49

Iteration objective

S34: AssignTicket

Current test case

```
test S34{
 load testConfiguration3;
 load created_tickets;

 at:=new AssignTicket(staffMember:=generalConsultant, ticket:=ticket1, assignee:=generalAdministrator, assignmentText:='This is
for you');
 assert occurrence at;

 assert equals ticket1.assignedStaff generalAdministrator;


 assert true [ticket1.internalNote->one(ili.datetime=sys.currentDateTime and
                                        i.text='This is for you' and
                                        i.subject='Ticket Reassigned' and
                                        i.author='Mary')];

 //notice sent to the assignee
 assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(TicketAssignedAlertToStaff) and
                                           e.fromAddress='general_at_support.com' and
                                           e.toAddress='john_at_support.com' and
                                           e.ticketNumber=1)];

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- TicketsManagementAndTracking.cstl] <line 1508> AssignTicket is not defined in the CSUT as a class or an association

```
event AssignTicket
attributes
assignmentText:String
operations
effect()
end

association assignTicket_staffMember between
   AssignTicket[*]
   StaffMember[1]
end
```

```
association assignTicket_assignee between
   AssignTicket[*] role assignTicketOfAssignee
   StaffMember[1] role assignee
end

association assignTicket_ticket between
   AssignTicket[*]
   Ticket[1]
end

context AssignTicket::effect()
post:
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
self.ticket.assignedStaff=self.assignee
and
(InternalNote.allInstances- InternalNote.allInstances@pre)
            ->one(i | i.oclIsNew()
            and i.datetime=System.allInstances()->any(true).currentDateTime
            and i.subject='Ticket Reassigned'
            and i.text=self.assignmentText
            and i.author=self.staffMember.firstName
            and i.ticket=self.ticket)
  and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime
   and (EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                              e.toAddress=self.assignee.emailAddress and
                              e.ticketNumber=self.ticket.number))
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	9
TIME TO COMPLETE THE ITERATION (IN MINUTES)	31

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
4				**1**	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
				2	
An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect		A precondition is added/updated	The expression is corrected	The CSUD is changed
1					
Assert consistency fails					
A static constraint needs to be changed					

Iteration 50

Iteration objective

S35: AssignTicket_ticketIsNotVisible

Current test case

```
test S35{
 load testConfiguration3;

 load created_tickets;

 li := new LogIn(username:='martin', password:='ttt');
 assert occurrence li;

 at:=new AssignTicket(staffMember:=technicalActive, ticket:=ticket2, assignee:=generalAdministrator,
                      assignmentText:='This is for you');
 assert non-occurrence at;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event at:AssignTicket are satisfied and consequently, the event can occur

```
context AssignTicket ini inv theTicketIsVisible:
    self.staffMember.isAdministrator or
    (self.staffMember.staffGroup.departmentsAccess->including(self.staffMember.department))
        ->includes(self.ticket.assignedDepartment)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	4

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		Assert non-occurrence fails	Semantic error in an expression	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		
Assert consistency fails				
A static constraint needs to be changed				

Iteration 51

Iteration objective

S36: AssignTicket_InVacationMode

Current test case

```
test S36{
  load testConfiguration3;

  load created_tickets;

   li := new LogIn(username:='mary', password:='yyy');
  assert occurrence li;

  at:=new AssignTicket(staffMember:=generalConsultant, ticket:=ticket1, assignee:=generalConsultantVacation,
                       assignmentText:='This is for you');
  assert non-occurrence at;

 }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event at:AssignTicket are satisfied and consequently, the event can occur

```
context AssignTicket ini inv assigneeIsNotInVacationMode:
    not(self.assignee.isInVacationMode)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	2

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD	A derived type involved in a test case does not exist in the CSUD	An event type involved in a test case does not exist in the CSUD
The basic type is relevant and it is added to the CSUD	The derived type is relevant and it is added to the CSUD	The event type is relevant and it is added to the CSUD

Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 52

Iteration objective

S37: AssignTicket_NotLoggedIn

Current test case

```
test S37{
 load testConfiguration3;

 load created_tickets;

 at:=new AssignTicket(staffMember:=generalConsultant, ticket:=ticket1, assignee:=generalAdministrator,
                      assignmentText:='This is for you');
 assert non-occurrence at;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event at:AssignTicket are satisfied and consequently, the event can occur

```
context AssignTicket ini inv staffMemberIsLoggedIn:
    self.staffMember.isLoggedIn
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	1

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 53

Iteration objective

S38: ReleaseTicket

Current test case

```
test S38{

  load testConfiguration3;

  load created_tickets;

   li := new LogIn(username:='mary', password:='yyy');
  assert occurrence li;

  rt:=new ReleaseTicket(staffMember:=generalConsultant, ticket:=ticket1);
  assert occurrence rt;

  assert true ticket1.assignedStaff.isUndefined();


  assert true [ticket1.internalNote->one(ili.datetime=sys.currentDateTime and
                                         i.text='Released ticket' and
                                         i.subject='Ticket unassigned' and
                                         i.author='Mary')];

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 1578> ReleaseTicket is not defined in the CSUT as a class or an association

```
event ReleaseTicket
operations
effect()
end

association releaseTicket_staffMember between
   ReleaseTicket[*]
   StaffMember[1]
end

association releaseTicket_ticket between
   ReleaseTicket[*]
   Ticket[1]
end

context ReleaseTicket::effect()
post:
self.ticket.assignedStaff->isEmpty()
and
(InternalNote.allInstances- InternalNote.allInstances@pre)
            ->one(i | i.oclIsNew()
            and i.datetime=System.allInstances()->any(true).currentDateTime
            and i.subject='Ticket unassigned'
            and i.text='Released ticket'
            and i.author=self.staffMember.firstName
            and i.ticket=self.ticket)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	4
TIME TO COMPLETE THE ITERATION (IN MINUTES)	13

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
2				**1**	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
1				

Assert consistency fails	
A static constraint needs to be changed	

Iteration 54

Iteration objective

S39: ReleaseTicket_ticketIsNotVisible

Current test case

```
test S39{

  load testConfiguration3;

  load created_tickets;

   li := new LogIn(username:='martin', password:='ttt');
  assert occurrence li;

  rt:=new ReleaseTicket(staffMember:=technicalActive, ticket:=ticket2);
  assert non-occurrence rt;

 }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event rt:ReleaseTicket are satisfied and consequently, the event can occur

```
context ReleaseTicket ini inv theTicketIsVisible:
    self.staffMember.isAdministrator or
    (self.staffMember.staffGroup.departmentsAccess->including(self.staffMember.department))
        ->includes(self.ticket.assignedDepartment)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	2

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		Assert non-occurrence fails	Semantic error in an expression	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		
Assert consistency fails				
A static constraint needs to be changed				

Iteration 55

Iteration objective

S40: ReleaseTicket_notAssigned

Current test case

```
test S40{

  load testConfiguration3;

  load created_tickets;

   li := new LogIn(username:='mary', password:='yyy');
  assert occurrence li;

  rt:=new ReleaseTicket(staffMember:=generalConsultant, ticket:=ticket4);
  assert non-occurrence rt;


 }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event rt:ReleaseTicket are satisfied and consequently, the event can occur

```
context ReleaseTicket ini inv theTicketIsAssigned:
    self.ticket.assignedStaff.isDefined()
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	4

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 56

Iteration objective

S41: ReleaseTicket_NotLoggedIn

Current test case

```
test S41{

 load testConfiguration3;

 load created_tickets;

 rt:=new ReleaseTicket(staffMember:=generalConsultant, ticket:=ticket2);
 assert non-occurrence rt;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event rt:ReleaseTicket are satisfied and consequently, the event can occur

```
context ReleaseTicket ini inv staffMemberIsLoggedIn:
   self.staffMember.isLoggedIn
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1
TIME TO COMPLETE THE ITERATION (IN MINUTES)	1,5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 57

Iteration objective

S42: EditTicket

Current test case

```
test S42{

   load testConfiguration3;
   load created_tickets;

    li := new LogIn(username:='mary', password:='yyy');
   assert occurrence li;
   dt3:=new Datetime(value:=[(sys.currentDateTime.value+3)]);
   et:=new EditTicket(staffMember:=generalConsultant, ticket:=ticket1,
                      emailAddress:='mary2@marnes.mar',
                      fullName:='Mary Marnes2',
                      subject:='Error operating system2',
                      telephone:='xxx2',
                      ext:='xx2',
                      dueDatetime:=dt3,
                      priority:=#Low,
                      helpTopic:=helpTopicUse,
                      editionInternalNote:='The customer asks for this changes');
   assert occurrence et;
   assert equals ticket1.email 'mary2@marnes.mar';
   assert equals ticket1.fullName 'Mary Marnes2';
   assert equals ticket1.subject 'Error operating system2';
   assert equals ticket1.telephone 'xxx2';
   assert equals ticket1.ext 'xx2';
   assert equals ticket1.priority #Low;
   assert equals ticket1.helpTopic helpTopicUse;

   assert true [ticket1.internalNote->one(ili.datetime=sys.currentDateTime and
                                          i.text='The customer asks for this changes' and
```

```
                    i.subject='Ticket updated' and
                    i.author='Mary')];
}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 1643> EditTicket is not defined in the CSUT as a class or an association

```
event EditTicket
attributes
emailAddress:String
fullName:String
subject:String
telephone:String [0..1]
ext:String[0..1]
priority:Priority
dueDatetime:Datetime
editionInternalNote:String
operations
effect()
end

association editTicket_staffMember between
   EditTicket[*]
   StaffMember[1]
end

association editTicket_ticket between
   EditTicket[*]
   Ticket[1]
end

association editTicket_helpTopic between
   EditTicket[*]
   HelpTopic[1]
end

context EditTicket::effect()
post:
self.ticket.email=self.emailAddress and
self.ticket.fullName=self.fullName and
self.ticket.subject=self.subject and
self.ticket.telephone=self.telephone and
self.ticket.ext=self.ext and
self.ticket.priority=self.priority and
self.ticket.helpTopic=self.helpTopic and
self.ticket.dueDatetime=self.dueDatetime
and
(InternalNote.allInstances- InternalNote.allInstances@pre)
            ->one(i | i.oclIsNew()
            and i.datetime=System.allInstances()->any(true).currentDateTime
            and i.subject='Ticket updated'
            and i.text=self.editionInternalNote
            and i.author=self.staffMember.firstName
            and i.ticket=self.ticket)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	6
TIME TO COMPLETE THE ITERATION (IN MINUTES)	32

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
11				**1**	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
				1	
An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect		A precondition is added/updated	The expression is corrected	The CSUD is changed
Assert consistency fails					
A static constraint needs to be changed					

Iteration 58

Iteration objective

S43: EditTicket_ticketIsNotVisible

Current test case

```
test S43{

  load testConfiguration3;

  load created_tickets;

  li := new LogIn(username:='martin', password:='ttt');
  assert occurrence li;
  dt3:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
  et:=new EditTicket(staffMember:=technicalActive, ticket:=ticket2,
                     emailAddress:='john2@johnes.nes',
                     fullName:='John Johnes2',
                     subject:='Can I reply a ticket? Yes or no?',
                     telephone:='yyy2',
                     ext:='yy2',
                     dueDatetime:=dt3,
                     priority:=#Normal,
                     helpTopic:=helpTopicUse,
                     editionInternalNote:='The customer asks for this changes');
  assert non-occurrence et;

 }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event et:EditTicket are satisfied and consequently, the event can occur

```
context EditTicket ini inv theTicketIsVisible:
    self.staffMember.isAdministrator or
    (self.staffMember.staffGroup.departmentsAccess->including(self.staffMember.department))
        ->includes(self.ticket.assignedDepartment)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	5,5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect		A precondition is added/updated	The expression is corrected	The CSUD is changed
			1		
Assert consistency fails					
A static constraint needs to be changed					

Iteration 59

Iteration objective

S44: EditTicket_NotAllowed

Current test case

```
test S44{

 load testConfiguration3;
```

```
load created_tickets;

li := new LogIn(username:='martin', password:='ttt');
assert occurrence li;
dt3:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
et:=new EditTicket(staffMember:=technicalActive, ticket:=ticket1,
                   emailAddress:='mary2@marnes.mar',
                   fullName:='John Johnes2',
                   subject:='Can I reply a ticket? Yes or no?',
                   telephone:='yyy2',
                   ext:='yy2',
                   dueDatetime:=dt3,
                   priority:=#Normal,
                   helpTopic:=helpTopicUse,
                   editionInternalNote:='The customer asks for this changes');
assert non-occurrence et;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event et:EditTicket are satisfied and consequently, the event can occur

```
context EditTicket ini inv staffMemberIsNotAllowedToEditTickets:
    self.staffMember.staffGroup.canEditTickets
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	4

Errors and failures that drive the conceptual modeling

<table>
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<tr><td colspan="3">An assertion about the IB state fails or contains an error</td><td>Assert non-occurrence fails</td><td colspan="2">Semantic error in an expression</td></tr>
<tr><td colspan="2">The effect of an event type is not correct</td><td>A derivation rule is incorrect</td><td>A precondition is added/updated</td><td>The expression is corrected</td><td>The CSUD is changed</td></tr>
<tr><td colspan="2"></td><td></td><td>1</td><td></td><td></td></tr>
<tr><td colspan="2">Assert consistency fails</td><td colspan="4" rowspan="3"></td></tr>
<tr><td colspan="2">A static constraint needs to be changed</td></tr>
<tr><td colspan="2"></td></tr>
</table>

Iteration 60

Iteration objective

S45: EditTicket_NotAllowedButAdministrator

Current test case

```
test S45{

load testConfiguration3;

load created_tickets;
technicalActive.isAdministrator:=true;

li := new LogIn(username:='martin', password:='ttt');
assert occurrence li;
dt3:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
et:=new EditTicket(staffMember:=technicalActive, ticket:=ticket1,
                   emailAddress:='mary2@marnes.mar',
                   fullName:='John Johnes2',
                   subject:='Can I reply a ticket? Yes or no?',
                   telephone:='yyy2',
                   ext:='yy2',
                   dueDatetime:=dt3,
                   priority:=#Normal,
                   helpTopic:=helpTopicUse,
                   editionInternalNote:='The customer asks for this changes');
assert occurrence et;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 1735> Initial IC 'staffMemberIsNotAllowedToEditTickets ' of et:EditTicket event fails

```
context EditTicket ini inv staffMemberIsNotAllowedToEditTickets:
    self.staffMember.staffGroup.canEditTickets or self.staffMember.isAdministrator
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	1

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD	A derived type involved in a test case does not exist in the CSUD	An event type involved in a test case does not exist in the CSUD
The basic type is relevant and it is added to the CSUD	The derived type is relevant and it is added to the CSUD	The event type is relevant and it is added to the CSUD

Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
	1				

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed

Assert consistency fails
A static constraint needs to be changed

Iteration 61

Iteration objective

S46: EditTicket_NotLoggedIn

Current test case

```
test S46{

  load testConfiguration3;

  load created_tickets;

  dt3:=new Datetime(value:=[(sys.currentDateTime.value+3)]);
  et:=new EditTicket(staffMember:=generalConsultant, ticket:=ticket1,
                     emailAddress:='mary2@marnes.mar',
                     fullName:='Mary Marnes2',
                     subject:='Error operating system2',
                     telephone:='xxx2',
                     ext:='xx2',
                     dueDatetime:=dt3,
                     priority:=#Low,
                     helpTopic:=helpTopicUse,
                     editionInternalNote:='The customer asks for this changes');
  assert non-occurrence et;

 }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event et:EditTicket are satisfied and consequently, the event can occur

```
context EditTicket ini inv staffMemberIsLoggedIn:
    self.staffMember.isLoggedIn
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	2

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 62

Iteration objective

S47: PostTicketReply_alertsAndAutoresponsesActive

Current test case

```
test S47{
   load testConfiguration1;
   helpTopicInstallation.autoresponse:=#Enabled;
   load created_tickets;

   li := new LogIn(username:='mary', password:='yyy');
   assert occurrence li;

   rt:=new PostTicketReply(staffMember:=generalConsultant, ticket:=ticket1,
                response:='You should choose the installation executable...');
   assert occurrence rt;

   assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                m.text='You should choose the installation executable...' and
                                m.author='Mary')];

   assert equals ticket1.lastMessageDatetime sys.currentDateTime;

   assert equals ticket1.lastRespondent generalConsultant;
```

```
  //autoresponse
  assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(TicketResponseNotice) and
                                    e.fromAddress='technical_at_support.com' and
                                    e.toAddress='mary_at_marnes.mar' and
                                    e.ticketNumber=1)];

  //notice to assigned staff
  assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewMessageAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=1)];

 //notice to department manager
  assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewMessageAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];

 }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 1768> PostTicketReply is not defined in the CSUT as a class or an association

```
event PostTicketReply
attributes
response:String
operations
effect()
end

association postTicketReply_ticket between
   PostTicketReply[*]
   Ticket[1]
end

association postTicketReply_staffMember between
   PostTicketReply[*]
   StaffMember[1]
end


context PostTicketReply::effect()
post:

let sendNewMessageAlertToLastRespondent:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#LastRespondent)
in
let sendNewMessageAlertToAssignedStaff:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#AssignedStaff)
in
let sendNewMessageAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#DepartmentManager)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let sendAutoresponse:Boolean=
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewMessageAppendedToTicket then
      if self.ticket.helpTopic->notEmpty then
         if self.ticket.helpTopic.autoresponse=#Enabled then true
         else false
```

```
        endif
      else
        self.ticket.assignedDepartment.newAddedMessageIsNotified
      endif
   else false
   endif
in
self.ticket.ticketThreadMessage->one(tdm | tdm.oclIsNew()
            and tdm.datetime=System.allInstances()->any(true).currentDateTime
            and tdm.text=self.response
            and tdm.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

        and self.ticket.lastRespondent=self.staffMember


        and (sendAutoresponse implies
          EMail.allInstances()->exists(ele.fromAddress=self.ticket.assignedDepartment.autoresponseEmail.address and
                                e.toAddress=self.ticket.email and
                                e.ticketNumber=self.ticket.number))

        -- staff notices
        and (sendNewMessageAlertToLastRespondent and
            self.ticket.lastRespondent@pre->notEmpty() and
            not(self.ticket.lastRespondent@pre.isInVacationMode or self.ticket.lastRespondent@pre.status=#Disabled)
            implies
            EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=self.ticket.lastRespondent@pre and
                                e.ticketNumber=self.ticket.number ))

       and  (sendNewMessageAlertToAssignedStaff
            and self.ticket.assignedStaff->notEmpty()
            and not(self.ticket.assignedStaff.isInVacationMode or self.ticket.assignedStaff.status=#Disabled)
            implies
              EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=self.ticket.assignedStaff.emailAddress and
                                e.ticketNumber=self.ticket.number))
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	9,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	27

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
3				1	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
				4	1
An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect		A precondition is added/updated	The expression is corrected	The CSUD is changed
3					
Assert consistency fails					
A static constraint needs to be changed					

Iteration 63

Iteration objective

S48: PostTicketReply_alertsAndAutoresponsesDisabled

Current test case

```
test S48{
 load testConfiguration4;
 helpTopicInstallation.autoresponse:=#Enabled;
 load created_tickets;

 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 rt:=new PostTicketReply(staffMember:=generalConsultant, ticket:=ticket1,
            response:='You should choose the installation executable...');
 assert occurrence rt;

 assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                m.text='You should choose the installation executable...' and
                                m.author='Mary')];

 assert equals ticket1.lastMessageDatetime sys.currentDateTime;

 assert equals ticket1.lastRespondent generalConsultant;


 //autoresponse
 assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(TicketResponseNotice) and
                                e.fromAddress='technical_at_support.com' and
                                e.toAddress='mary_at_marnes.mar' and
                                e.ticketNumber=1)];

 //notice to assigned staff
 assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewMessageAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='mary_at_support.com' and
                                e.ticketNumber=1)];

//notice to department manager
 assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewMessageAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='john_at_support.com' and
                                e.ticketNumber=1)];


}
```

TDCM application: Summary of changes performed in the schema

The CSUD has not been changed.

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 64

Iteration objective

S49: PostTicketReply_ticketIsNotVisible

Current test case

```
test S49{
   load testConfiguration4;
   load created_tickets;

   li := new LogIn(username:='martin', password:='ttt');
   assert occurrence li;

   rt:=new PostTicketReply(staffMember:=technicalActive, ticket:=ticket2,
                  response:='You should choose the installation executable...');
   assert non-occurrence rt;

  }
```

TDCM application: Summary of changes performed in the schema

■ Added

- Preconditions of the domain event rt:PostTicketReply are satisfied and consequently, the event can occur

```
context PostTicketReply ini inv theTicketIsVisible:
    self.staffMember.isAdministrator or
    (self.staffMember.staffGroup.departmentsAccess->including(self.staffMember.department))
        ->includes(self.ticket.assignedDepartment)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1
TIME TO COMPLETE THE ITERATION (IN MINUTES)	3

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		Assert non-occurrence fails	Semantic error in an expression	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		
Assert consistency fails				
A static constraint needs to be changed				

Iteration 65

Iteration objective

S50: PostTicketReply_NotLoggedIn

Current test case

```
test S50{
 load testConfiguration1;
 load created_tickets;

 rt:=new PostTicketReply(staffMember:=generalConsultant, ticket:=ticket1,
                response:='You should choose the installation executable...');
 assert non-occurrence rt;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event rt:PostTicketReply are satisfied and consequently, the event can occur

```
context PostTicketReply ini inv staffMemberIsLoggedIn:
    self.staffMember.isLoggedIn
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1
TIME TO COMPLETE THE ITERATION (IN MINUTES)	1,5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD	A derived type involved in a test case does not exist in the CSUD	An event type involved in a test case does not exist in the CSUD
The basic type is relevant and it is added to the CSUD	The derived type is relevant and it is added to the CSUD	The event type is relevant and it is added to the CSUD

Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 66

Iteration objective

S51: PostTicketInternalNote_staffAlertsEnabled

Current test case

```
test S51{
  load testConfiguration1;
  load created_tickets;

  li := new LogIn(username:='martin', password:='ttt');
  assert occurrence li;

  pin:=new PostTicketInternalNote(staffMember:=technicalActive, ticket:=ticket1,
                title:='No tickets?', note:='It seems that she does not have tickets');
  assert occurrence pin;

  assert true [ticket1.internalNote->one(m|m.datetime=sys.currentDateTime and
                                  m.subject='No tickets?'and
                                  m.text='It seems that she does not have tickets' and
                                  m.author='Martin')];

   //notice to assigned staff
  assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewInternalNoteAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=1)];

 //notice to department manager
  assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewInternalNoteAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];

 }
```

TDCM application: Summary of changes performed in the schema

■ Added

- [TicketsManagementAndTracking.cstl] <line 1875> PostTicketInternalNote is not defined in the CSUT as a class or an association

```
event PostTicketInternalNote
attributes
title:String
note:String
operations
effect()
end

association postTicketInternalNote_ticket between
   PostTicketInternalNote[*]
   Ticket[1]
end

association postTicketInternalNote_staffMember between
   PostTicketInternalNote[*]
   StaffMember[1]
end


context PostTicketInternalNote::effect()
post:

let sendNewMessageAlertToLastRespondent:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#LastRespondent)
in
let sendNewMessageAlertToAssignedStaff:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#AssignedStaff)
in
let sendNewMessageAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#DepartmentManager)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
            and int.subject=self.title
            and int.text=self.note
            and int.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)


        -- staff notices
        and (sendNewMessageAlertToLastRespondent and
            self.ticket.lastRespondent@pre->notEmpty() and
            not(self.ticket.lastRespondent@pre.isInVacationMode or self.ticket.lastRespondent@pre.status=#Disabled)
            implies
           EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=self.ticket.lastRespondent@pre and
                                e.ticketNumber=self.ticket.number ))

       and  (sendNewMessageAlertToAssignedStaff
            and self.ticket.assignedStaff->notEmpty()
            and not(self.ticket.assignedStaff.isInVacationMode or self.ticket.assignedStaff.status=#Disabled)
            implies
              EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=self.ticket.assignedStaff.emailAddress and
                                e.ticketNumber=self.ticket.number))
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	11
TIME TO COMPLETE THE ITERATION (IN MINUTES)	19

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
4				**1**	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
				1	

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed

Assert consistency fails
A static constraint needs to be changed

Iteration 67

Iteration objective

S52: PostTicketInternalNote_staffAlertsDisabled

Current test case

```
test S52{
 load testConfiguration4;
 load created_tickets;

 li := new LogIn(username:='martin', password:='ttt');
 assert occurrence li;

 pin:=new PostTicketInternalNote(staffMember:=technicalActive, ticket:=ticket5,
              title:='No tickets?', note:='It seems that she does not have tickets');
 assert occurrence pin;

 assert true [ticket5.internalNote->one(m|m.datetime=sys.currentDateTime and
                                  m.subject='No tickets?'and
                                  m.text='It seems that she does not have tickets' and
                                  m.author='Martin')];

  //notice to assigned staff
 assert false [EMail.allInstances()->exists(e|e.emailKind.oclIsTypeOf(NewInternalNoteAlertToStaff) and
                                  e.fromAddress='general_at_support.com' and
```

```
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=5)];

  //notice to department manager
   assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewInternalNoteAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=5)];

  }
```

TDCM application: Summary of changes performed in the schema

The conceptual schema has not been changed

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 68

Iteration objective

S53: PostTicketInternalNote_TicketNotVisible

Current test case

```
test S53{
  load testConfiguration4;
  load created_tickets;

  li := new LogIn(username:='martin', password:='ttt');
  assert occurrence li;

  pin:=new PostTicketInternalNote(staffMember:=technicalActive, ticket:=ticket4,
                  title:='Checked button', note:='Checked that the button appears');
  assert non-occurrence pin;
 }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event pin:PostTicketInternalNote are satisfied and consequently, the event can occur

```
context PostTicketInternalNote ini inv theTicketIsVisible:
    self.staffMember.isAdministrator or
    (self.staffMember.staffGroup.departmentsAccess->including(self.staffMember.department))
```

->includes(self.ticket.assignedDepartment)

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	6

Errors and failures that drive the conceptual modeling

<table>
<tr><td colspan="2">A basic type involved in a test case does not exist in the CSUD</td><td colspan="2">A derived type involved in a test case does not exist in the CSUD</td><td colspan="2">An event type involved in a test case does not exist in the CSUD</td></tr>
<tr><td colspan="2">The basic type is relevant and it is added to the CSUD</td><td colspan="2">The derived type is relevant and it is added to the CSUD</td><td colspan="2">The event type is relevant and it is added to the CSUD</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">Inconsistent state before the occurrence of an event</td><td colspan="2">Inconsistent state after the occurrence of an event</td><td colspan="2">The postcondition of an event is not satisfied.</td></tr>
<tr><td>Some static constraint is invalid and it is modified.</td><td>Some initial integrity constraint is invalid and it is modified.</td><td>The event postcondition/method is incorrect and it is modified.</td><td>Some constraint is invalid and it is modified.</td><td>The method is not correct and it is modified.</td><td>The postcondition is not correct and it is modified.</td></tr>
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<tr><td>Assert consistency fails</td><td colspan="5" rowspan="2"></td></tr>
<tr><td>A static constraint needs to be changed</td></tr>
<tr><td></td><td colspan="5"></td></tr>
</table>

Iteration 69

Iteration objective

S54: PostTicketInternalNote_NotLoggedIn

Current test case

```
test S54{
  load testConfiguration4;
  load created_tickets;


  pin:=new PostTicketInternalNote(staffMember:=technicalActive, ticket:=ticket1,
                  title:='No tickets?', note:='It seems that she does not have tickets');
  assert non-occurrence pin;

 }
```

TDCM application: Summary of changes performed in the schema

■ Added

- Preconditions of the domain event pin:PostTicketInternalNote are satisfied and consequently, the event can occur

```
context PostTicketInternalNote ini inv staffMemberIsLoggedIn:
    self.staffMember.isLoggedIn
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	0,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	1

Refactoring

We realize that we coud represent all the events that require logged in staff and a visible ticket as subclasses of an abstract class named *StaffTicketEvent*.

```
event StaffTicketEvent
end

association staffTicketEvent_ticket between
    StaffTicketEvent[*]
    Ticket[1]
end

association staffTicketEvent_staffMember between
    StaffTicketEvent[*]
    StaffMember[1]
end

context StaffTicketEvent ini inv theTicketIsVisible:
     self.staffMember.isAdministrator or
     (self.staffMember.staffGroup.departmentsAccess->including(self.staffMember.department))
->includes(self.ticket.assignedDepartment)

context StaffTicketEvent ini inv staffMemberIsLoggedIn:
     self.staffMember.isLoggedIn
```

The events *PostTicketInternalNote*, *PostTicketReply*, *ReleaseTicket, EditTicket, AssignTicket*, *MarkTicketOverdue, ChangeTicketPriority* are specified as a subclass of *StaffTicketEvent*. The associations with the ticket and the staff member, and the initial integrity constraints that check that the ticket is visible and the staff member is logged in are deleted from each particular event.

After running all test cases, we are sure that after refactoring, the verdict of all test cases remains *Pass.*

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 70

Iteration objective

S55: TransferTicket_staffAlertsEnabled

Current test case

```
test S55{
 load testConfiguration4;
 load created_tickets;


 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 tt:=new TransferDepartment(staffMember:=generalConsultant, ticket:=ticket1,
                department:=dptTechnical,
                note:='This is a technical question');
 assert occurrence tt;

 assert equals ticket1.assignedDepartment dptTechnical;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 1963> TransferDepartment is not defined in the CSUT as a class or an association

```
event TransferDepartment<StaffTicketEvent
attributes
note:String
operations
effect()
end

association transferDepartment_department between
   TransferDepartment[*]
   Department[1]
end


context TransferDepartment::effect()
post:
self.ticket.assignedDepartment=self.department and
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
            and int.subject='Department transfer'
            and int.text=self.note
            and int.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	4,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	6,5

Errors and failures that drive the conceptual modeling

<table>
<tr><td colspan="2">A basic type involved in a test case does not exist in the CSUD</td><td colspan="2">A derived type involved in a test case does not exist in the CSUD</td><td colspan="2">An event type involved in a test case does not exist in the CSUD</td></tr>
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<tr><td colspan="2">2</td><td colspan="2"></td><td colspan="2">1</td></tr>
<tr><td colspan="2">Inconsistent state before the occurrence of an event</td><td colspan="2">Inconsistent state after the occurrence of an event</td><td colspan="2">The postcondition of an event is not satisfied.</td></tr>
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<tr><td colspan="2"></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Assert consistency fails</td><td colspan="4" rowspan="2"></td></tr>
<tr><td colspan="2">A static constraint needs to be changed</td></tr>
<tr><td colspan="2"></td><td colspan="4"></td></tr>
</table>

Iteration 71

Iteration objective

S56: TransferTicket_ticketIsNotVisible

Current test case

```
test S56{
  load testConfiguration4;
  load created_tickets;
  technicalActive.staffGroup:=maximumPrivilegesGroup;
  maximumPrivilegesGroup.departmentsAccess:=Set{dptTechnical};

  li := new LogIn(username:='martin', password:='ttt');
  assert occurrence li;

  tt:=new TransferDepartment(staffMember:=technicalActive, ticket:=ticket2,
                department:=dptTechnical,
                note:='This is a technical question');
  assert non-occurrence tt;

 }
```

TDCM application: Summary of changes performed in the schema

The CSUT has not been changed.

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 72

Iteration objective

S57: TransferTicket_SameDepartment

Current test case

```
test S57{
  load testConfiguration4;

  load created_tickets;


  li := new LogIn(username:='mary', password:='yyy');
  assert occurrence li;
```

```
tt:=new TransferDepartment(staffMember:=generalConsultant, ticket:=ticket2,
                department:=dptGeneral,
                note:='This is a technical question');
assert non-occurrence tt;
}
```

TDCM application: Summary of changes performed in the schema

■ Added

- Preconditions of the domain event pin:PostTicketInternalNote are satisfied and consequently, the event can occur

```
context TransferDepartment ini inv departmentIsDifferent:
  self.department <> self.ticket.assignedDepartment
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1
TIME TO COMPLETE THE ITERATION (IN MINUTES)	3

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 73

Iteration objective

S58: TransferTicket_NotAllowedToTransfer

Current test case

```
test S58{
   load testConfiguration3;
   load created_tickets;


   li := new LogIn(username:='martin', password:='ttt');
   assert occurrence li;

   tt:=new TransferDepartment(staffMember:=generalConsultant, ticket:=ticket2,
                  department:=dptGeneral,
                  note:='This is a technical question');
   assert non-occurrence tt;


  }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event tt:TransferDepartment are satisfied and consequently, the event can occur

```
context TransferDepartment ini inv staffMemberIsAllowedToTransfer:
   self.staffMember.staffGroup.canTransferTickets
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	3

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
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An assertion about the IB state fails or contains an error			**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect		A precondition is added/updated	The expression is corrected	The CSUD is changed
			1		
Assert consistency fails					
A static constraint needs to be changed					

Iteration 74

Iteration objective

S59: TransferTicket_NotLoggedIn

Current test case

```
test S59{
  load testConfiguration3;
  load created_tickets;


  tt:=new TransferDepartment(staffMember:=generalConsultant, ticket:=ticket1,
                department:=dptGeneral,
                note:='This is a technical question');
  assert non-occurrence tt;

}
```

TDCM application: Summary of changes performed in the schema

The CSUD has not been changed

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 75

Iteration objective

S60: Close ticket

Current test case

```
test S60{
  load testConfiguration3;
  load created_tickets;

  li := new LogIn(username:='mary', password:='yyy');
  assert occurrence li;

  ct:=new CloseTicket(staffMember:=generalConsultant, ticket:=ticket1);
  assert occurrence ct;

  assert equals ticket1.ticketStatus #Closed;

  assert true [ticket1.internalNote->one(m|m.datetime=sys.currentDateTime and
                                m.subject='Ticket closed'and
                                m.text='Ticket closed without response' and
```

```
                                m.author='Mary')];

  ct:=new CloseTicket(staffMember:=generalConsultant, ticket:=ticket1);
  assert non-occurrence ct;

}
```

TDCM application: Summary of changes performed in the schema

■ Added

- [TicketsManagementAndTracking.cstl] <line 2044> CloseTicket is not defined in the CSUT as a class or an association

```
event CloseTicket<StaffTicketEvent
operations
effect()
end

context CloseTicket::effect()
post:
self.ticket.ticketStatus=#Closed and
self.ticket.internalNote->one(int | int.oclIsNew()
        and int.datetime=System.allInstances()->any(true).currentDateTime
        and int.subject='Ticket closed'
        and int.text='Ticket closed without response'
        and int.author=self.staffMember.firstName
        and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)
```

- Preconditions of the domain event ct:CloseTicket are satisfied and consequently, the event can occur

```
context CloseTicket ini inv ticketIsNotClosed:
  not (self.ticket.ticketStatus=#Closed)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	14

Errors and failures that drive the conceptual modeling

<table>
<tr><td colspan="2">A basic type involved in a test case does not exist in the CSUD</td><td colspan="2">A derived type involved in a test case does not exist in the CSUD</td><td colspan="2">An event type involved in a test case does not exist in the CSUD</td></tr>
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<tr><td></td><td colspan="2"></td><td>1</td><td></td><td></td></tr>
<tr><td>Assert consistency fails</td><td colspan="5"></td></tr>
<tr><td>A static constraint needs to be changed</td><td colspan="5"></td></tr>
<tr><td></td><td colspan="5"></td></tr>
</table>

Iteration 76

Iteration objective

S61: CloseTicket_ticketIsNotVisibleOrNotAllowed

Current test case

```
test S61{
 load testConfiguration3;
 load created_tickets;

 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 generalConsultant.staffGroup.departmentsAccess:=Set{dptGeneral};

 ct:=new CloseTicket(staffMember:=generalConsultant, ticket:=ticket3);
 assert non-occurrence ct;

 generalConsultant.staffGroup.departmentsAccess:=Set{dptGeneral,dptTechnical};
 generalConsultant.staffGroup.canCloseTickets:=false;

 ct:=new CloseTicket(staffMember:=generalConsultant, ticket:=ticket3);
 assert non-occurrence ct;

}
```

TDCM application: Summary of changes performed in the schema

■ Added

- Preconditions of the domain event ct:CloseTicket are satisfied and consequently, the event can occur

```
context CloseTicket ini inv staffMemberIsAllowedToClose:
  self.staffMember.staffGroup.canCloseTickets
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	8
TIME TO COMPLETE THE ITERATION (IN MINUTES)	5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		Assert non-occurrence fails	Semantic error in an expression	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		
Assert consistency fails				
A static constraint needs to be changed				

Iteration 77

Iteration objective

S62: CloseTicket_NotLoggedIn

Current test case

```
test S62{
  load testConfiguration3;
  load created_tickets;

  ct:=new CloseTicket(staffMember:=generalConsultant, ticket:=ticket3);
  assert non-occurrence ct;

 }
```

TDCM application: Summary of changes performed in the schema

The CSUD has not been changed

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 78

Iteration objective

S63: CloseTicketWithResponse_alertsAndAutoresponsesEnabled

Current test case

```
test S63{
 load testConfiguration1;
 load created_tickets;
 helpTopicInstallation.autoresponse:=#Enabled;

 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 ct:=new CloseTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket1,
            response:='Ticket solved');
 assert occurrence ct;

 assert equals ticket1.ticketStatus #Closed;

 assert true [ticket1.internalNote->one(mlm.datetime=sys.currentDateTime and
                                m.subject='Ticket closed'and
                                m.text='Ticket closed on reply' and
                                m.author='Mary')];


 assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(TicketResponseNotice) and
                                  e.fromAddress='technical_at_support.com' and
                                  e.toAddress='mary_at_marnes.mar' and
                                  e.ticketNumber=1)];

   assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                m.text='Ticket solved' and
                                m.author='Mary')];

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 2099> CloseTicketWithResponse is not defined in the CSUT as a class or an association

```
event CloseTicketWithResponse<StaffTicketEvent
attributes
response:String
operations
effect()
end

context CloseTicketWithResponse::effect()
post:
let sendAutoresponse:Boolean=
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewMessageAppendedToTicket then
      if self.ticket.helpTopic->notEmpty then
         if self.ticket.helpTopic.autoresponse=#Enabled then true
         else false
         endif
      else
         self.ticket.assignedDepartment.newAddedMessageIsNotified
      endif
   else false
   endif
in
self.ticket.ticketStatus=#Closed and
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
            and int.subject='Ticket closed'
```

```
                and int.text='Ticket closed on reply'
                and int.author=self.staffMember.firstName
                and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)
        and
        self.ticket.ticketThreadMessage->one(tdm | tdm.oclIsNew()
                and tdm.datetime=System.allInstances()->any(true).currentDateTime
                and tdm.text=self.response
                and tdm.author=self.staffMember.firstName
                and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

            and self.ticket.lastRespondent=self.staffMember


            and (sendAutoresponse implies
               EMail.allInstances()->exists(ele.fromAddress=self.ticket.assignedDepartment.autoresponseEmail.address and
                                e.toAddress=self.ticket.email and
                                e.ticketNumber=self.ticket.number))
```

- Preconditions of the domain event ct:CloseTicket are satisfied and consequently, the event can occur

```
context CloseTicketWithResponse ini inv ticketIsNotClosed:
   not (self.ticket.ticketStatus=#Closed)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	9
TIME TO COMPLETE THE ITERATION (IN MINUTES)	34

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
1				**1**	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
				2	

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
6		**1**		

Assert consistency fails
A static constraint needs to be changed

Iteration 79

Iteration objective

S64: CloseTicketWithResponse_alertsAndAutoresponsesDisabled

Current test case

```
test S64{
 load testConfiguration4;
 load created_tickets;


 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 ct:=new CloseTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket1,
              response:='Ticket solved');
 assert occurrence ct;

 assert equals ticket1.ticketStatus #Closed;

 assert true [ticket1.internalNote->one(mlm.datetime=sys.currentDateTime and
                                m.subject='Ticket closed'and
                                m.text='Ticket closed on reply' and
                                m.author='Mary')];


 assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(TicketResponseNotice) and
                                  e.fromAddress='technical_at_support.com' and
                                  e.toAddress='mary_at_marnes.mar' and
                                  e.ticketNumber=1)];

 assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                m.text='Ticket solved' and
                                m.author='Mary')];
}
```

TDCM application: Summary of changes performed in the schema

The CSUT has not been changed.

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 80

Iteration objective

S65: CloseTicketWithResponse_ticketIsNotVisibleOrNotAllowed

Current test case

```
test S65{
  load testConfiguration3;
  load created_tickets;

  li := new LogIn(username:='mary', password:='yyy');
  assert occurrence li;

  generalConsultant.staffGroup.departmentsAccess:=Set{dptGeneral};

  ct:=new CloseTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket3,
                                  response:='Ticket solved');
  assert non-occurrence ct;

  generalConsultant.staffGroup.departmentsAccess:=Set{dptGeneral,dptTechnical};
  generalConsultant.staffGroup.canCloseTickets:=false;

  ct:=new CloseTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket3,
                                  response:='Ticket solved');
  assert non-occurrence ct;

 }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event ct:CloseTicketWithResponse are satisfied and consequently, the event can occur

```
context CloseTicketWithResponse ini inv staffMemberIsAllowedToClose:
    self.staffMember.staffGroup.canCloseTickets
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	3

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD	A derived type involved in a test case does not exist in the CSUD	An event type involved in a test case does not exist in the CSUD
The basic type is relevant and it is added to the CSUD	The derived type is relevant and it is added to the CSUD	The event type is relevant and it is added to the CSUD

Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 81

Iteration objective

S66: CloseTicketWithReply_notLoggedIn

Current test case

```
test S66{
 load testConfiguration3;
 load created_tickets;


 ct:=new CloseTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket1,
                response:='Ticket solved');
 assert non-occurrence ct;

 }
```

TDCM application: Summary of changes performed in the schema

The CSUD has not been changed.

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	0,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 82

Iteration objective

S67: ReopenTicket

Current test case

```
test S67{
      load testConfiguration3;

      load created_tickets;
      ticket1.ticketStatus:=#Closed;

      li := new LogIn(username:='mary', password:='yyy');
      assert occurrence li;

      rot:=new ReopenTicket(staffMember:=generalConsultant, ticket:=ticket1);
      assert occurrence rot;

      assert equals ticket1.ticketStatus #Open;

      assert true [ticket1.internalNote->one(mIm.datetime=sys.currentDateTime and
                                    m.subject='Ticket reopened'and
                                    m.text='Ticket reopened without comments' and
                                    m.author='Mary')];

      rot:=new ReopenTicket(staffMember:=generalConsultant, ticket:=ticket1);
      assert non-occurrence rot;
   }
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 2201> ReopenTicket is not defined in the CSUT as a class or an association

```
event ReopenTicket<StaffTicketEvent
operations
effect()
end

context ReopenTicket::effect()
post:
self.ticket.ticketStatus=#Open and
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
            and int.subject='Ticket reopened'
            and int.text='Ticket reopened without comments'
            and int.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)
```

- Preconditions of the domain event rot:ReopenTicket are satisfied and consequently, the event can occur

```
context ReopenTicket ini inv ticketIsClosed:
 self.ticket.ticketStatus=#Closed
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	5,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	13

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
				1	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 83

Iteration objective

S68: ReopenTicket_ticketIsNotVisible

Current test case

```
test S68{
  load testConfiguration3;

  load created_tickets;
  ticket2.ticketStatus:=#Closed;

  li := new LogIn(username:='martin', password:='ttt');
  assert occurrence li;

  rot:=new ReopenTicket(staffMember:=technicalActive, ticket:=ticket2);
  assert non-occurrence rot;

}
```

TDCM application: Summary of changes performed in the schema

The conceptual schema has not been changed

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 84

Iteration objective

S69: ReopenTicket_NotLoggedIn

Current test case

```
test S69{
    load testConfiguration3;

    load created_tickets;
    ticket1.ticketStatus:=#Closed;

    rot:=new ReopenTicket(staffMember:=generalConsultant, ticket:=ticket1);
    assert non-occurrence rot;

 }
```

TDCM application: Summary of changes performed in the schema

The conceptual schema has not been changed

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	0,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 85

Iteration objective

S70: ReopenTicketWithReply_alertsAndAutoresponsesEnabled

Current test case

```
test S70{
  load testConfiguration1;
  helpTopicInstallation.autoresponse:=#Enabled;

  load created_tickets;
  ticket1.ticketStatus:=#Closed;

  li := new LogIn(username:='mary', password:='yyy');
  assert occurrence li;

  rot:=new ReopenTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket1,
                    response:='The customer is not satisfied');
  assert occurrence rot;

  assert equals ticket1.ticketStatus #Open;

  assert true [ticket1.internalNote->one(mlm.datetime=sys.currentDateTime and
                    m.subject='Ticket status changed to open'and
                    m.text='A staff member reopened the ticket on reply' and
                    m.author='Mary')];


  assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(TicketResponseNotice) and
                    e.fromAddress='technical_at_support.com' and
                    e.toAddress='mary_at_marnes.mar' and
                    e.ticketNumber=1)];

  assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                    m.text='The customer is not satisfied' and
                    m.author='Mary')];

  rot:=new ReopenTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket1,
                    response:='The customer is not satisfied');
  assert non-occurrence rot;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- [TicketsManagementAndTracking.cstl] <line 2249> ReopenTicketWithResponse is not defined in the CSUT as a class or an association

```
event ReopenTicketWithResponse<StaffTicketEvent
attributes
response:String
operations
effect()
end

context ReopenTicketWithResponse::effect()
post:
let sendAutoresponse:Boolean=
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewMessageAppendedToTicket then
      if self.ticket.helpTopic->notEmpty then
         if self.ticket.helpTopic.autoresponse=#Enabled then true
         else false
         endif
      else
         self.ticket.assignedDepartment.newAddedMessageIsNotified
      endif
   else false
   endif
in
self.ticket.ticketStatus=#Open and
```

```
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
            and int.subject='Ticket status changed to open'
            and int.text='A staff member reopened the ticket on reply'
            and int.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)
and
self.ticket.ticketThreadMessage->one(tdm | tdm.oclIsNew()
            and tdm.datetime=System.allInstances()->any(true).currentDateTime
            and tdm.text=self.response
            and tdm.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

        and self.ticket.lastRespondent=self.staffMember


        and (sendAutoresponse implies
          EMail.allInstances()->exists(ele.fromAddress=self.ticket.assignedDepartment.autoresponseEmail.address and
                                       e.toAddress=self.ticket.email and
                                       e.ticketNumber=self.ticket.number))

context ReopenTicketWithResponse ini inv ticketIsClosed:
 self.ticket.ticketStatus=#Closed
```

- Preconditions of the domain event rot:ReopenTicketWithResponse are satisfied and consequently, the event can occur

```
context ReopenTicketWithResponse ini inv ticketIsClosed:
 self.ticket.ticketStatus=#Closed
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	8,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	12

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
1				**1**	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
				1	

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
2				

Assert consistency fails	
A static constraint needs to be changed	

Iteration 86

Iteration objective

S71: ReopenTicketWithReply_alertsAndAutoresponsesDisabled

Current test case

```
test S71{
      load testConfiguration4;

      load created_tickets;
      ticket1.ticketStatus:=#Closed;

      li := new LogIn(username:='mary', password:='yyy');
      assert occurrence li;

      rot:=new ReopenTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket1,
                              response:='The customer is not satisfied');
      assert occurrence rot;

      assert equals ticket1.ticketStatus #Open;

      assert true [ticket1.internalNote->one(mlm.datetime=sys.currentDateTime and
                                    m.subject='Ticket status changed to open'and
                                    m.text='A staff member reopened the ticket on reply' and
                                    m.author='Mary')];


      assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(TicketResponseNotice) and
                                      e.fromAddress='technical_at_support.com' and
                                      e.toAddress='mary_at_marnes.mar' and
                                      e.ticketNumber=1)];

      assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                    m.text='The customer is not satisfied' and
                                    m.author='Mary')];


  }
```

TDCM application: Summary of changes performed in the schema

The CSUD has not been changed

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 87

Iteration objective

S72: ReopenTicketWithReply_ticketIsNotVisible

Current test case

```
test S72{
    load testConfiguration3;

    load created_tickets;
    ticket1.ticketStatus:=#Closed;

    li := new LogIn(username:='martin', password:='ttt');
    assert occurrence li;

    rot:=new ReopenTicketWithResponse(staffMember:=technicalActive, ticket:=ticket2,
                                response:='The customer is not satisfied');
    assert non-occurrence rot;

}
```

TDCM application: Summary of changes performed in the schema

The CSUD has not been changed

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 88

Iteration objective

S73: ReopenTicketWithReply_NotLoggedIn

Current test case

```
test S73{
    load testConfiguration1;
    helpTopicInstallation.autoresponse:=#Enabled;

    load created_tickets;
    ticket1.ticketStatus:=#Closed;

    rot:=new ReopenTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket1,
                                response:='The customer is not satisfied');
    assert non-occurrence rot;
}
```

TDCM application: Summary of changes performed in the schema

The CSUD has not been changed

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 89

Iteration objective

S74: BAnTicketCloseEmail

Current test case

```
test S74{
  load testConfiguration3;

  load created_tickets;

  li := new LogIn(username:='mary', password:='yyy');
  assert occurrence li;

  cbt:=new BanEmailAndCloseTicket(staffMember:=generalConsultant, ticket:=ticket1);
  assert occurrence cbt;

  assert equals ticket1.ticketStatus #Closed;
  assert true EmailSettings.allInstances->any(true).banList->includes(ticket1.email);

  cbt:=new BanEmailAndCloseTicket(staffMember:=generalConsultant, ticket:=ticket1);
  assert non-occurrence cbt;
}
```

TDCM application: Summary of changes performed in the schema

■ Added

- [TicketsManagementAndTracking.cstl] <line 2347> BanEmailAndCloseTicket is not defined in the CSUT as a class or an association

```
event BanEmailAndCloseTicket<StaffTicketEvent
operations
effect()
end

context BanEmailAndCloseTicket::effect()
post:
self.ticket.ticketStatus=#Closed and
EmailSettings.allInstances()->any(true).banList->includes(self.ticket.email) and
```

```
self.ticket.internalNote->one(int | int.oclIsNew()
        and int.datetime=System.allInstances()->any(true).currentDateTime
        and int.subject='Ticket closed'
        and int.text='Email added to banlist and ticket status set to closed'
        and int.author=self.staffMember.firstName
        and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)
```

- osTicketCSUT.use:1414:40: Undefined operation named `banList' in expression `EmailSettings.banList()'.

```
class EmailSettings
attributes
   administrationEmail:String
   banList:Set{String}
end
```

- Preconditions of the domain event cbt:BanEmailAndCloseTicket are satisfied and consequently, the event can occur

```
context BanEmailAndCloseTicket ini inv ticketIsNotClosed:
not (self.ticket.ticketStatus=#Closed)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	5,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	9,5

Errors and failures that drive the conceptual modeling

<table>
<tr><td colspan="2">A basic type involved in a test case does not exist in the CSUD</td><td colspan="2">A derived type involved in a test case does not exist in the CSUD</td><td colspan="2">An event type involved in a test case does not exist in the CSUD</td></tr>
<tr><td colspan="2">The basic type is relevant and it is added to the CSUD</td><td colspan="2">The derived type is relevant and it is added to the CSUD</td><td colspan="2">The event type is relevant and it is added to the CSUD</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2">1</td></tr>
<tr><td colspan="2">Inconsistent state before the occurrence of an event</td><td colspan="2">Inconsistent state after the occurrence of an event</td><td colspan="2">The postcondition of an event is not satisfied.</td></tr>
<tr><td>Some static constraint is invalid and it is modified.</td><td>Some initial integrity constraint is invalid and it is modified.</td><td>The event postcondition/method is incorrect and it is modified.</td><td>Some constraint is invalid and it is modified.</td><td>The method is not correct and it is modified.</td><td>The postcondition is not correct and it is modified.</td></tr>
<tr><td></td><td></td><td></td><td></td><td>1</td><td></td></tr>
<tr><td colspan="3">An assertion about the IB state fails or contains an error</td><td>Assert non-occurrence fails</td><td colspan="2">Semantic error in an expression</td></tr>
<tr><td colspan="2">The effect of an event type is not correct</td><td>A derivation rule is incorrect</td><td>A precondition is added/updated</td><td>The expression is corrected</td><td>The CSUD is changed</td></tr>
<tr><td colspan="2">1</td><td></td><td>1</td><td></td><td></td></tr>
<tr><td colspan="2">Assert consistency fails</td><td colspan="4" rowspan="2"></td></tr>
<tr><td colspan="2">A static constraint needs to be changed</td></tr>
<tr><td colspan="2"></td><td colspan="4"></td></tr>
</table>

Iteration 90

Iteration objective

S75: BanTicketCloseEmail_ticketIsNotVisible

Current test case

```
test S75{
    load testConfiguration3;
    technicalActive.staffGroup.canBanEmails:=true;
    load created_tickets;

    li := new LogIn(username:='martin', password:='ttt');
    assert occurrence li;

    cbt:=new BanEmailAndCloseTicket(staffMember:=technicalActive, ticket:=ticket1);
    assert non-occurrence cbt;

}
```

TDCM application: Summary of changes performed in the schema

The CSUD has not been changed.

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 91

Iteration objective

S76: BanTicketCloseEmail_notAllowed

Current test case

```
test S76{
    load testConfiguration3;
    load created_tickets;
    generalConsultant.staffGroup.canBanEmails:=false;

    li := new LogIn(username:='mary', password:='yyy');
    assert occurrence li;

    cbt:=new BanEmailAndCloseTicket(staffMember:=generalConsultant, ticket:=ticket2);
    assert non-occurrence cbt;

}
```

TDCM application: Summary of changes performed in the schema

■ Added ■ Updated

- Preconditions of the domain event cbt:BanEmailAndCloseTicket are satisfied and consequently, the event can occur

```
context BanEmailAndCloseTicket ini inv staffMemberIsAllowedToBanEmails:
 self.staffMember.staffGroup.canBanEmails
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	2,5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails	
A static constraint needs to be changed	

Iteration 92

Iteration objective

S77: BanTicketCloseEmail_NotLoggedIn

Current test case

```
test S77{
   load testConfiguration3;
   load created_tickets;

   cbt:=new BanEmailAndCloseTicket(staffMember:=generalConsultant, ticket:=ticket2);
   assert non-occurrence cbt;
}
```

TDCM application: Summary of changes performed in the schema

The CSUD has not been changed.

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	2
TIME TO COMPLETE THE ITERATION (IN MINUTES)	2,5

Iteration 93

Iteration objective

S78: DeleteTicket

Current test case

```
test S78{
 load testConfiguration3;
 load created_tickets;

 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;


 dt:=new DeleteTicket(staffMember:=generalConsultant, ticket:=ticket1);
 assert occurrence dt;

 assert true [not(Ticket.allInstances()->exists(tIt.number=1))];

}
```

TDCM application: Summary of changes performed in the schema

■ Added

- [TicketsManagementAndTracking.cstl] <line 2401> DeleteTicket is not defined in the CSUT as a class or an association

```
event DeleteTicket
operations
effect()
end

association deleteTicket_ticket between
   DeleteTicket[*]
   Ticket[0..1]
end

association deleteTicket_staffMember between
   DeleteTicket[*]
   StaffMember[1]
end

context DeleteTicket::effect()
```

post:
Ticket.allInstances()->excludes(self.ticket@pre) and
self.ticket@pre.internalNote@pre->forAll(int|InternalNote.allInstances()->excludes(int))
and self.ticket@pre.ticketThreadMessage@pre->forAll(ttm|TicketThreadMessage.allInstances()->excludes(ttm))

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	4
TIME TO COMPLETE THE ITERATION (IN MINUTES)	22

Errors and failures that drive the conceptual modeling

<table>
<tr><th colspan="2">A basic type involved in a test case does not exist in the CSUD</th><th colspan="2">A derived type involved in a test case does not exist in the CSUD</th><th colspan="2">An event type involved in a test case does not exist in the CSUD</th></tr>
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<tr><th colspan="2">Inconsistent state before the occurrence of an event</th><th colspan="2">Inconsistent state after the occurrence of an event</th><th colspan="2">The postcondition of an event is not satisfied.</th></tr>
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<tr><td></td><td></td><td></td><td></td><td>8</td><td>3</td></tr>
<tr><th colspan="3">An assertion about the IB state fails or contains an error</th><th>Assert non-occurrence fails</th><th colspan="2">Semantic error in an expression</th></tr>
<tr><td colspan="2">The effect of an event type is not correct</td><td>A derivation rule is incorrect</td><td>A precondition is added/updated</td><td>The expression is corrected</td><td>The CSUD is changed</td></tr>
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<tr><th colspan="2">Assert consistency fails</th><td colspan="4" rowspan="2"></td></tr>
<tr><td colspan="2">A static constraint needs to be changed</td></tr>
<tr><td colspan="2"></td><td colspan="4"></td></tr>
</table>

Iteration 94

Iteration objective

S79: DeleteTicket_ticketIsNotVisible

Current test case

```
test S79{
 load testConfiguration3;
 load created_tickets;
 technicalActive.staffGroup.canDeleteTickets:=true;

 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 dt:=new DeleteTicket(staffMember:=technicalActive, ticket:=ticket2);
 assert non-occurrence dt;
}
```

TDCM application: Summary of changes performed in the schema

■ Added

- Preconditions of the domain event dt:DeleteTicket are satisfied and consequently, the event can occur

```
context DeleteTicket ini inv theTicketIsVisible:
    self.staffMember.isAdministrator or
    (self.staffMember.staffGroup.departmentsAccess->including(self.staffMember.department))
        ->includes(self.ticket.assignedDepartment)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	3

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails
A static constraint needs to be changed

Iteration 95

Iteration objective

S80: DeleteTicket_notAllowed

Current test case

```
test S80{
    load testConfiguration3;
    load created_tickets;
    technicalActive.staffGroup.canDeleteTickets:=false;

    li := new LogIn(username:='mary', password:='yyy');
```

```
    assert occurrence li;

    dt:=new DeleteTicket(staffMember:=technicalActive, ticket:=ticket1);
    assert non-occurrence dt;
}
```

TDCM application: Summary of changes performed in the schema

■ Added

- Preconditions of the domain event dt:DeleteTicket are satisfied and consequently, the event can occur

```
context DeleteTicket ini inv staffMemberIsAllowedToDeleteTickets:
    self.staffMember.isAdministrator or
    self.staffMember.staffGroup.canDeleteTickets
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1
TIME TO COMPLETE THE ITERATION (IN MINUTES)	1,5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
		1		

Assert consistency fails	
A static constraint needs to be changed	

Iteration 96

Iteration objective

S81: DeleteTicket_notLoggedIn

Current test case

```
test S81{

    load testConfiguration3;

    load created_tickets;

    dt:=new DeleteTicket(staffMember:=generalConsultant, ticket:=ticket1);
    assert non-occurrence dt;

}
```

TDCM application: Summary of changes performed in the schema

■ Added

- Preconditions of the domain event dt:DeleteTicket are satisfied and consequently, the event can occur

```
context DeleteTicket ini inv staffMemberIsLoggedIn:
  self.staffMember.isLoggedIn
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	1
TIME TO COMPLETE THE ITERATION (IN MINUTES)	1

Errors and failures that drive the conceptual modeling

<table>
<tr><td colspan="2">A basic type involved in a test case does not exist in the CSUD</td><td colspan="2">A derived type involved in a test case does not exist in the CSUD</td><td colspan="2">An event type involved in a test case does not exist in the CSUD</td></tr>
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<tr><td colspan="2"></td><td></td><td>1</td><td></td><td></td></tr>
<tr><td colspan="2">Assert consistency fails</td><td colspan="4" rowspan="3"></td></tr>
<tr><td colspan="2">A static constraint needs to be changed</td></tr>
<tr><td colspan="2"></td></tr>
</table>

Iteration 97

Iteration objective

S82: BannedEmailsCannotCreateTickets

Current test case

```
test S82{
    load testConfiguration4;
    EmailSettings.allInstances()->any(true).banList:=Set{'hello_at_helloworld.hel'};

    li := new LogIn(username:='mary', password:='yyy');
    assert occurrence li;
    nt1:=new NewTicketOffline;
    nt1.fullName:='Mary Marnes';
    nt1.email:='hello_at_helloworld.hel';
    nt1.telephone:='xxxxxxxx';
    nt1.ext:='xxxxxxxx';
    nt1.source:=#Phone;
    nt1.assignedDepartment:=dptTechnical;
    nt1.helpTopic:=helpTopicInstallation;
    nt1.subject:='Error operating system';
    nt1.message:='The installation process does not finish....';
    nt1.internalNote:='It seems that the correct installer is being used';
    dt2:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
    nt1.dueDatetime:=dt2;
    nt1.priority:=#Normal;
    nt1.assignedStaff:=generalConsultant;
    nt1.creator:=generalConsultant;
    assert non-occurrence nt1;

    nt4:=new NewTicketOnline;
    nt4.fullName:='James Jordan';
    nt4.email:='hello_at_helloworld.hel';
    nt4.helpTopic:=helpTopicUse;
    nt4.subject:='Reopening ticket';
    nt4.message:='I do not know how to reopen one of my closed tickets';
    assert non-occurrence nt4;

    nt5:=new NewTicketByEmail;
    nt5.toAddress:='technical_at_support.com';
    nt5.fromName:='Marta Johnes';
    nt5.fromAddress:='hello_at_helloworld.hel';
    nt5.subject:='See my tickets';
    nt5.message:='Can I see my tickets?';
    assert non-occurrence nt5;


}
```

TDCM application: Summary of changes performed in the schema

■ Added

- Preconditions of the domain event nt1:NewTicketOffline are satisfied and consequently, the event can occur

```
context NewTicketOffline ini inv emailIsNotInBanList:
   EmailSettings.allInstances()->any(true).banList->notEmpty() implies
   EmailSettings.allInstances()->any(true).banList->excludes(self.email)
```

- Preconditions of the domain event nt4:NewTicketOnline are satisfied and consequently, the event can occur

```
context NewTicketOnline ini inv emailIsNotInBanList:
  EmailSettings.allInstances()->any(true).banList->notEmpty() implies
  EmailSettings.allInstances()->any(true).banList->excludes(self.fromEmail)
```

- Preconditions of the domain event nt5:NewTicketByEmail are satisfied and consequently, the event can occur

```
context NewTicketEmail ini inv emailIsNotInBanList:
  EmailSettings.allInstances()->any(true).banList->notEmpty() implies
  EmailSettings.allInstances()->any(true).banList->excludes(self.email)
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	6
TIME TO COMPLETE THE ITERATION (IN MINUTES)	8,5

Errors and failures that drive the conceptual modeling

<table>
<tr><td colspan="2">A basic type involved in a test case does not exist in the CSUD</td><td colspan="2">A derived type involved in a test case does not exist in the CSUD</td><td colspan="2">An event type involved in a test case does not exist in the CSUD</td></tr>
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<tr><td></td><td colspan="2"></td><td>3</td><td></td><td></td></tr>
<tr><td>Assert consistency fails</td><td colspan="5" rowspan="3"></td></tr>
<tr><td>A static constraint needs to be changed</td></tr>
<tr><td></td></tr>
</table>

Iteration 98

Iteration objective

S83: CheckOverdueTickets_staffAlertsDisabled

Current test case

```
test S83{
  load testConfiguration3;
  load created_tickets;
```

```
    dt3:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
    sys.currentDateTime:=dt3;

    cot:=new CheckOverdueTickets;
    assert occurrence cot;


    assert equals ticket1.isOverdue true;

     //notice to assigned staff
    assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewInternalNoteAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=1)];

    //notice to department member
    assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewInternalNoteAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];
}
```

TDCM application: Summary of changes performed in the schema

■ Added

- [TicketsManagementAndTracking.cstl] <line 2499> CheckOverdueTickets is not defined in the CSUT as a class or an association

```
event CheckOverdueTickets
operations
effect()
end

context CheckOverdueTickets::effect()
post:
let sendOverdueTicketAlertToAdministrator:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdue and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdueStaff->includes(#Administrator)
in
let sendOverdueTicketAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdue and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdueStaff->includes(#DepartmentManager)
in
let sendOverdueTicketAlertToDepartmentMembers:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdue and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdueStaff->includes(#DepartmentMembers)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
Ticket.allInstances()->select(tl (System.allInstances()
                                  ->any(true).currentDateTime.value>(t.dueDatetime.value+TicketSettings.allInstances()
                                  ->any(true).ticketGracePeriod))
                            and not(t.isOverdue))
      -> forAll(tlt.isOverdue


      -- staff notices
      and (sendOverdueTicketAlertToAdministrator implies
         EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                  e.toAddress=EmailSettings.allInstances()->any(true).administrationEmail and
                                  e.ticketNumber=t.number))

      and  (sendOverdueTicketAlertToDepartmentManager
          and t.assignedDepartment.departmentManager->notEmpty()
          and t.assignedDepartment.departmentManager.status=#Enabled
          and not(t.assignedDepartment.departmentManager.isInVacationMode)
          implies
```

```
        EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                     e.toAddress=t.assignedDepartment.departmentManager.emailAddress and
                                     e.ticketNumber=t.number))

    and  (sendOverdueTicketAlertToDepartmentMembers
          implies
          t.assignedDepartment.staffMember->forAll(m|
            (m.status=#Enabled and not(m.isInVacationMode))
            implies
            EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                         e.toAddress=m.emailAddress and
                                         e.ticketNumber=t.number)))

        )
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	7,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	24

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
				1	
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.
				4	

An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
2				

Assert consistency fails
A static constraint needs to be changed

Iteration 99

Iteration objective

S84: CheckOverdueTickets_staffAlertsEnabled

Current test case

```
test S84{
      load testConfiguration1;
      load created_tickets;
```

```
    dt3:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
    sys.currentDateTime:=dt3;


    cot:=new CheckOverdueTickets;
    assert occurrence cot;


    assert equals ticket1.isOverdue true;

     //notice to assigned staff
    assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(OverdueTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=1)];

    //notice to department member
    assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(OverdueTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];
}
```

TDCM application: Summary of changes performed in the schema

The CSUD has not been changed

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	3,5
TIME TO COMPLETE THE ITERATION (IN MINUTES)	0,5

Iteration 100

Iteration objective

S85: ViewTickets_open_myTickets_overdue_closed

Current test case

```
test S85{
    load testConfiguration3;
    load created_tickets;

    li := new LogIn(username:='john', password:='xxx');
    assert occurrence li;

    dts:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#OpenTickets);
    assert occurrence dts;
    assert equals dts.answer() [Sequence{
        Tuple{createDate=1,department='Technical
support',email='mary_at_marnes.mar',number=1,priority=#Normal,subject='Error operating system'},
        Tuple{createDate=1,department='General support',email='mary_at_marnes.mar',number=2,priority=#High,subject='Can I
reply a ticket?'},
```

```
        Tuple{createDate=1,department='Technical support',email='martin_at_pope.mar',number=3,priority=#Low,subject='Error
while login'},
        Tuple{createDate=2,department='General
support',email='james_at_jordan.jam',number=4,priority=#Normal,subject='Reopening ticket'},
        Tuple{createDate=2,department='Technical support',email='marta_at_johnes.mar',number=5,priority=#High,subject='See
my tickets'}} ];

    dts2:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#AssignedToMe);
    assert occurrence dts2;
    assert equals dts2.answer() [Sequence{} ];

    at2:=new AssignTicket(staffMember:=generalAdministrator, ticket:=ticket4, assignee:=generalAdministrator,
assignmentText:='This is for me');
    assert occurrence at2;

    dts3:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#AssignedToMe);
    assert occurrence dts3;
    assert equals dts3.answer() [Sequence{Tuple{createDate=2,department='General
support',email='james_at_jordan.jam',number=4,priority=#Normal,subject='Reopening ticket'}}];

    dts4:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#OverdueTickets);
    assert occurrence dts4;
    assert equals dts4.answer() [Sequence{} ];

    dt3:=new Datetime(value:=[(sys.currentDateTime.value+3)]);
    sys.currentDateTime:=dt3;
    mto:=new MarkTicketOverdue(staffMember:=generalAdministrator, ticket:=ticket4);
    assert occurrence mto;
    cot:=new CheckOverdueTickets;
    assert occurrence cot;

    dts5:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#OverdueTickets);
    assert occurrence dts5;
    assert equals dts5.answer() [Sequence{
        Tuple{createDate=1,department='Technical
support',email='mary_at_marnes.mar',number=1,priority=#Normal,subject='Error operating system'},
        Tuple{createDate=2,department='General
support',email='james_at_jordan.jam',number=4,priority=#Normal,subject='Reopening ticket'}} ];

    dts6:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#ClosedTickets);
    assert occurrence dts6;
    assert equals dts6.answer() [Sequence{}];


    ct:=new CloseTicket(staffMember:=generalAdministrator, ticket:=ticket4);
    assert occurrence ct;

    dts7:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#OverdueTickets);
    assert occurrence dts7;
    assert equals dts7.answer() [Sequence{
        Tuple{createDate=1,department='Technical
        support',email='mary_at_marnes.mar',number=1,priority=#Normal,subject='Error operating system'}} ];

     dts8:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#ClosedTickets);
    assert occurrence dts8;
    assert equals dts8.answer() [Sequence{
        Tuple{createDate=2,department='General
        support',email='james_at_jordan.jam',number=4,priority=#Normal,subject='Reopening ticket'}} ];


}
```

TDCM application: Summary of changes performed in the schema

■ Added

- [TicketsManagementAndTracking.cstl] <Line 2557>:1:1: Undefined enumeration literal `Assigned'.

  enum StatusFilter{OpenTickets,ClosedTickets,AssignedToMe,OverdueTickets}

```
event DisplayTicketsByStatus
attributes
status:StatusFilter
operations
answer():Sequence(Tuple(number:Integer,createDate:Integer,subject:String,department:String,
priority:Priority,email:String))=
    let visibleDepartments:Set(Department)=
        self.consultant.staffGroup.departmentsAccess->including(self.consultant.department)
    in
    if self.status=#OpenTickets then
    Ticket.allInstances
    ->select(tIt.ticketStatus=#Open and visibleDepartments->includes(t.assignedDepartment))
    -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})->sortedBy(number)
    else
    if self.status=#AssignedToMe then
    Ticket.allInstances
    ->select(tIt.assignedStaff=self.consultant and t.ticketStatus<>#Closed and visibleDepartments-
>includes(t.assignedDepartment))
    -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})->sortedBy(number)
    else
    if self.status=#OverdueTickets then
    Ticket.allInstances
    ->select(tIt.isOverdue and visibleDepartments->includes(t.assignedDepartment))
    -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})->sortedBy(number)
    else
    Ticket.allInstances
    ->select(tIt.ticketStatus=#Closed and visibleDepartments->includes(t.assignedDepartment))
    -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})->sortedBy(number)
    endif
    endif
    endif
effect()
end
```

- The result is Sequence{Tuple{createDate=1,department='Technical support',email='mary_at_marnes.mar',number=1,priority=#Normal,subject='Error operating system'},Tuple{createDate=2,department='General support',email='james_at_jordan.jam',number=4,priority=#Normal,subject='Reopening ticket'}} but it is expected to be Sequence{Tuple{createDate=1,department='Technical support',email='mary_at_marnes.mar',number=1,priority=#Normal,subject='Error operating system'}}

  We realize that when asking for overdue, closed tickets are also shown

```
event DisplayTicketsByStatus
attributes
status:StatusFilter
operations
answer():Sequence(Tuple(number:Integer,createDate:Integer,subject:String,department:String,
priority:Priority,email:String))=
    let visibleDepartments:Set(Department)=
        self.consultant.staffGroup.departmentsAccess->including(self.consultant.department)
    in
    if self.status=#OpenTickets then
    Ticket.allInstances
    ->select(tIt.ticketStatus=#Open and visibleDepartments->includes(t.assignedDepartment))
    -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})-
>sortedBy(number)
    else
    if self.status=#AssignedToMe then
    Ticket.allInstances
    ->select(tIt.assignedStaff=self.consultant and t.ticketStatus<>#Closed and visibleDepartments-
>includes(t.assignedDepartment))
```

```
      -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})-
>sortedBy(number)
      else
      if self.status=#OverdueTickets then
      Ticket.allInstances
      ->select(tIt.isOverdue and t.ticketStatus<>#Closed and visibleDepartments-
>includes(t.assignedDepartment))
      -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})-
>sortedBy(number)
      else
      Ticket.allInstances
      ->select(tIt.ticketStatus=#Closed and visibleDepartments->includes(t.assignedDepartment))
      -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})-
>sortedBy(number)
      endif
      endif
      endif
effect()
end
```

Time spent

TIME TO WRITE TEST CASES (IN MINUTES)	13
TIME TO COMPLETE THE ITERATION (IN MINUTES)	14,5

Errors and failures that drive the conceptual modeling

A basic type involved in a test case does not exist in the CSUD		**A derived type involved in a test case does not exist in the CSUD**		**An event type involved in a test case does not exist in the CSUD**	
The basic type is relevant and it is added to the CSUD		The derived type is relevant and it is added to the CSUD		The event type is relevant and it is added to the CSUD	
1					
Inconsistent state before the occurrence of an event		**Inconsistent state after the occurrence of an event**		**The postcondition of an event is not satisfied.**	
Some static constraint is invalid and it is modified.	Some initial integrity constraint is invalid and it is modified.	The event postcondition/method is incorrect and it is modified.	Some constraint is invalid and it is modified.	The method is not correct and it is modified.	The postcondition is not correct and it is modified.

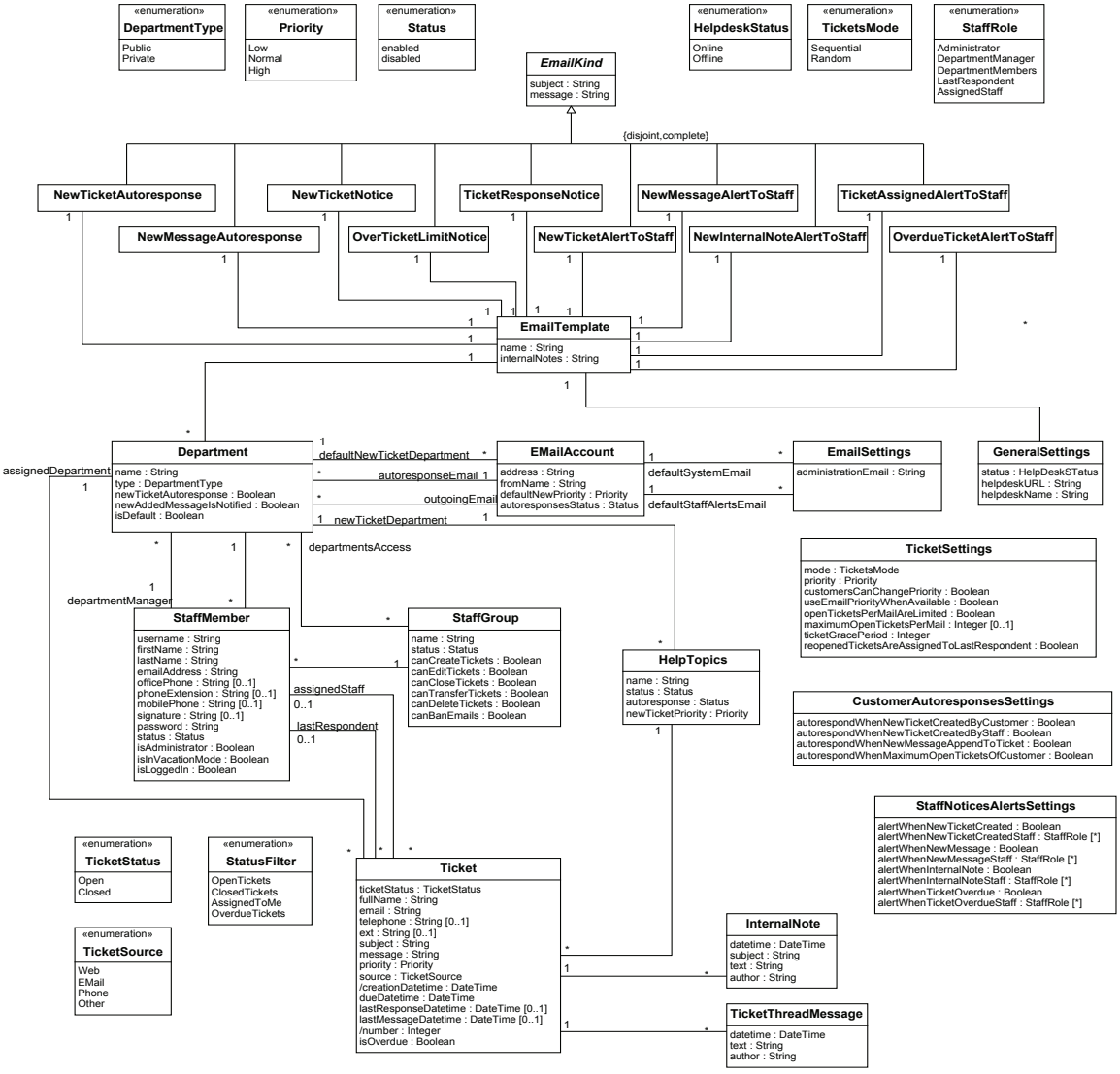
An assertion about the IB state fails or contains an error		**Assert non-occurrence fails**	**Semantic error in an expression**	
The effect of an event type is not correct	A derivation rule is incorrect	A precondition is added/updated	The expression is corrected	The CSUD is changed
1				

Assert consistency fails
A static constraint needs to be changed

Resultant conceptual schema

In the following, we present the graphical UML form of the resultant conceptual schema of the *osTicket* system, obtained by applying TDCM.

Structural schema



context Department inv hasAlwaysOneDefault:
Department.allInstances()->select(d|d.isDefault)->size()=1

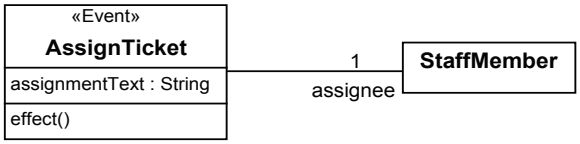
context EmailSettings inv hasOnlyOneInstance:
EmailSettings.allInstances()->size()=1

context GeneralSettings inv hasOnlyOneInstance:
GeneralSettings.allInstances()->size()=1

```
context TicketSettings inv hasOnlyOneInstance:
   TicketSettings.allInstances()->size()=1

context TicketSettings inv specifiesTheMaximumNumberOfOpenTickerPerMailIfNotUnlimited:
   self.openTicketsPerMailAreLimited implies self.maximumOpenTicketsPerMail.isDefined()

context CustomerAutoresponsesSettings inv hasOnlyOneInstance:
   CustomerAutoresponsesSettings.allInstances()->size()=1

context StaffNoticesAlertsSettings inv hasOnlyOneInstance:
   StaffNoticesAlertsSettings.allInstances()->size()=1
```

Behavioral schema

The resultant conceptual schema contains 24 event types. We present the UML graphical form of one of them (the assignment of tickets) and its event specification and initial integrity constraints (preconditions) in OCL:




```
context AssignTicket::effect()
post:
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
self.ticket.assignedStaff=self.assignee
and
(InternalNote.allInstances- InternalNote.allInstances@pre)
            ->one(i | i.oclIsNew()
            and i.datetime=System.allInstances()->any(true).currentDateTime
            and i.subject='Ticket Reassigned'
            and i.text=self.assignmentText
            and i.author=self.staffMember.firstName
            and i.ticket=self.ticket)
  and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime
   and (EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                              e.toAddress=self.assignee.emailAddress and
                              e.ticketNumber=self.ticket.number))
```

```
context AssignTicket ini inv assigneeIsNotInVacationMode:
    not(self.assignee.isInVacationMode)
```

We also reproduce the other event types in its USEx format:

```
event NewTicketOnline
attributes
fullName:String
email:String
telephone:String[0..1]
ext:String[0..1]
subject:String
message:String
priority:Priority[0..1]
createdTicket:Ticket[0..1]
operations
```

```
effect()
end

context NewTicketOnline ini inv priorityMayBeSetWhenAllowed:
   if TicketSettings.allInstances->any(true).customersCanChangePriority then
      self.priority.isDefined()
   else
      self.priority.isUndefined()
   endif


context NewTicketOnline ini inv emailIsNotInBanList:
 EmailSettings.allInstances()->any(true).banList->notEmpty() implies
   EmailSettings.allInstances()->any(true).banList->excludes(self.email)

association newTicketOnline_helpTopic between
   NewTicketOnline[*]
   HelpTopic[0..1]
end

context NewTicketOnline ini inv helpTopicSpecifiedIfAvailable:
   if HelpTopic.allInstances()->select(hp|hp.status=#Enabled)->size()>0  then
      self.helpTopic->size()=1
   else
      self.helpTopic->size()=0
   endif

context NewTicketOnline ini inv helpTopicIsEnabled:
  self.helpTopic->notEmpty() implies self.helpTopic.status=#Enabled

context NewTicketOnline ini inv helpDeskStatusIsOnline:
  GeneralSettings.allInstances()->any(true).status=#Online

context NewTicketOnline ini inv maximumOpenTicketsLimitIsNotViolated:
   if TicketSettings.allInstances()->any(true).openTicketsPerMailAreLimited then
   Ticket.allInstances->select(tIt.email=self.email)->size()<TicketSettings.allInstances()->any(true).maximumOpenTicketsPerMail
   else true
   endif


context NewTicketOnline::effect()
post:
let defaultPriority:Priority=
      if self.helpTopic->notEmpty() then
         self.helpTopic.newTicketPriority
      else
         TicketSettings.allInstances()->any(true).priority
      endif
in
let assignedPriority:Priority=
   if TicketSettings.allInstances()->any(true).customersCanChangePriority then
      self.priority
   else
      defaultPriority
   endif
in
let defaultDepartment:Department=
      if self.helpTopic->notEmpty() then
         self.helpTopic.newTicketDepartment
      else
         Department.allInstances()->any(dId.isDefault)
      endif
in
let sendNewTicketAlertToAdministrator:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#Administrator)
in
let sendNewTicketAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentManager)
in
let sendNewTicketAlertToDepartmentMembers:Boolean=
```

```
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentMembers)
in
let staffAlertsFromEMailAddress:String=
    EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let sendAutoresponse:Boolean=
    if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewTicketCreatedByCustomer then
        if self.helpTopic->notEmpty then
            if self.helpTopic.autoresponse=#Enabled then true
            else false
            endif
        else
            defaultDepartment.newTicketAutoresponseIsSent
        endif
    else false
    endif
in
(Ticket.allInstances- Ticket.allInstances@pre)
  ->one(t | t.oclIsNew()
          and self.createdTicket=t
          and t.fullName=self.fullName
          and t.email=self.email
          and t.telephone=self.telephone
          and t.ext=self.ext
          and t.subject=self.subject
          and t.message=self.message
          and t.ticketStatus=#Open
          and t.priority=assignedPriority
          and t.source=#Web
          and t.helpTopic=self.helpTopic
          and t.assignedDepartment=defaultDepartment
          and (TicketThreadMessage.allInstances- TicketThreadMessage.allInstances@pre)
              ->one(tdm | tdm.oclIsNew()
              and tdm.datetime=System.allInstances()->any(true).currentDateTime
              and tdm.text=self.message
              and tdm.author=self.fullName
              and tdm.ticket=t
              and t.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

          -- autoresponses
          and (sendAutoresponse implies
             EMail.allInstances()->exists(ele.fromAddress=t.assignedDepartment.autoresponseEmail.address and
                                  e.toAddress=t.email and
                                  e.ticketNumber=t.number))


          -- staff notices
          and (sendNewTicketAlertToAdministrator implies
             EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                  e.toAddress=EmailSettings.allInstances()->any(true).administrationEmail and
                                  e.ticketNumber=t.number))

          and  (sendNewTicketAlertToDepartmentManager
              and t.assignedDepartment.departmentManager->notEmpty()
              and t.assignedDepartment.departmentManager.status=#Enabled
              and not(t.assignedDepartment.departmentManager.isInVacationMode)
              implies
                EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                  e.toAddress=t.assignedDepartment.departmentManager.emailAddress and
                                  e.ticketNumber=t.number))

          and  (sendNewTicketAlertToDepartmentMembers
              implies
              t.assignedDepartment.staffMember->forAll(m|
                (m.status=#Enabled and not(m.isInVacationMode))
                implies
                EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                    e.toAddress=m.emailAddress and
                                    e.ticketNumber=t.number)))
        )
```

```
event NewTicketByEmail
attributes
toAddress:String
fromName:String
fromAddress:String
subject:String
message:String
createdTicket:Ticket[0..1]
operations
effect()
end


context NewTicketByEmail ini inv emailIsNotInBanList:
 EmailSettings.allInstances()->any(true).banList->notEmpty() implies
   EmailSettings.allInstances()->any(true).banList->excludes(self.fromAddress)

context NewTicketByEmail::effect()
post:
let incomingEmailAccount:EmailAccount=
  EmailAccount.allInstances()->any(ele.address=self.toAddress)
in
let assignedPriority:Priority=
      if TicketSettings.allInstances()->any(true).useEmailPriorityWhenAvailable then
         incomingEmailAccount.defaultNewPriority
      else
           TicketSettings.allInstances()->any(true).priority
      endif
in
let defaultDepartment:Department=
      incomingEmailAccount.defaultNewTicketDepartment
in
let sendNewTicketAlertToAdministrator:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#Administrator)
in
let sendNewTicketAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentManager)
in
let sendNewTicketAlertToDepartmentMembers:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentMembers)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let sendAutoresponse:Boolean=
      if (incomingEmailAccount.autoresponsesStatus=#Enabled) then true
      else false
      endif
in
(Ticket.allInstances- Ticket.allInstances@pre)
  ->one(t | t.oclIsNew()
         and self.createdTicket=t

         and t.assignedDepartment=incomingEmailAccount.defaultNewTicketDepartment
         and (TicketThreadMessage.allInstances- TicketThreadMessage.allInstances@pre)
             ->one(tdm | tdm.oclIsNew()
             and tdm.datetime=System.allInstances()->any(true).currentDateTime
             and tdm.text=self.message
             and tdm.author=self.fromName
             and tdm.ticket=t
             and t.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)


        )

        context NewTicketByEmail ini inv maximumOpenTicketsLimitIsNotViolated:
            if TicketSettings.allInstances()->any(true).openTicketsPerMailAreLimited then
```

```
            Ticket.allInstances->select(tIt.email=self.fromAddress)->size()<TicketSettings.allInstances()-
>any(true).maximumOpenTicketsPerMail
          else true
          endif

      context NewTicketByEmail ini inv theIncomingEmailIsValid:
        EmailAccount.allInstances()->one(address=self.toAddress)

      context NewTicketByEmail ini inv helpDeskStatusIsOnline:
         GeneralSettings.allInstances()->any(true).status=#Online

event DisplayTicketsAssociatedToEmail
attributes
email:String
ticketNumber:Integer
operations
answer():Set(Tuple(number:Integer,createDate:Integer,status:TicketStatus,subject:String,department:String, email:String))=
    Ticket.allInstances
    -> sortedBy(number)
    -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
status:t.ticketStatus,subject:t.subject,department:t.assignedDepartment.name, email:t.email})->asSet()
effect()
end

context DisplayTicketsAssociatedToEmail ini inv thereAreTicketsAssociatedToTheEmail:
  Ticket.allInstances()->select(tIt.email=self.email)->size()>0

context DisplayTicketsAssociatedToEmail ini inv accessDataIsValid:
  Ticket.allInstances()->select(tIt.email=self.email).number->includes(self.ticketNumber)


event ReplyTicketByCustomer
attributes
replyText:String
operations
effect()
end

association replyTicketByCustomer_ticket between
  ReplyTicketByCustomer[*]
  Ticket[1]
end


context ReplyTicketByCustomer::effect()
post:
let sendNewMessageAlertToLastRespondent:Boolean=
  StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
  StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#LastRespondent)
in
let sendNewMessageAlertToAssignedStaff:Boolean=
  StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
  StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#AssignedStaff)
in
let sendNewMessageAlertToDepartmentManager:Boolean=
  StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
  StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#DepartmentManager)
in
let staffAlertsFromEMailAddress:String=
  EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let sendAutoresponse:Boolean=
  if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewTicketCreatedByCustomer then
    if self.ticket.helpTopic->notEmpty then
      if self.ticket.helpTopic.autoresponse=#Enabled then true
      else false
      endif
    else
      self.ticket.assignedDepartment.newTicketAutoresponseIsSent
    endif
  else false
  endif
```

```
in
self.ticket.ticketThreadMessage->one(tdm | tdm.oclIsNew()
            and tdm.datetime=System.allInstances()->any(true).currentDateTime
            and tdm.text=self.replyText
            and tdm.author=self.ticket.fullName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)


        -- autoresponses
        and (sendAutoresponse implies
          EMail.allInstances()->exists(ele.fromAddress=self.ticket.assignedDepartment.autoresponseEmail.address and
                                e.toAddress=self.ticket.email and
                                e.ticketNumber=self.ticket.number))


        -- staff notices
        and (sendNewMessageAlertToLastRespondent and
            self.ticket.lastRespondent->notEmpty() and
            not(self.ticket.lastRespondent.isInVacationMode or self.ticket.lastRespondent.status=#Disabled)
            implies
          EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=self.ticket.lastRespondent and
                                e.ticketNumber=self.ticket.number ))

       and  (sendNewMessageAlertToAssignedStaff
            and self.ticket.assignedStaff->notEmpty()
            and not(self.ticket.assignedStaff.isInVacationMode or self.ticket.assignedStaff.status=#Disabled)
            implies
              EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=self.ticket.assignedStaff.emailAddress and
                                e.ticketNumber=self.ticket.number))


event LogIn
attributes
username:String
password:String
operations
effect()
end


context LogIn::effect()
post:
StaffMember.allInstances()->any(sm|sm.username=self.username and sm.password=self.password).isLoggedIn=true

context StaffMember inv usernameIsUnique:
StaffMember.allInstances()->isUnique(username)

context LogIn ini inv isNotLoggedIn:
StaffMember.allInstances()->select(sm|sm.username=self.username and sm.password=self.password)->size()>0
implies
    StaffMember.allInstances()->any(sm|sm.username=self.username and sm.password=self.password).isLoggedIn=false

context LogIn ini inv accessDataIsValid:
StaffMember.allInstances()->select(sm|sm.username=self.username and sm.password=self.password)->size()>0

context LogIn ini inv staffMemberIsEnabled:
StaffMember.allInstances()->select(sm|sm.username=self.username and sm.password=self.password)->size()>0
implies
    StaffMember.allInstances()->any(sm|sm.username=self.username and sm.password=self.password).status=#Enabled
    and StaffMember.allInstances()->any(sm|sm.username=self.username and
sm.password=self.password).staffGroup.status=#Enabled


event LogOut
operations
effect()
end
```

```
association logOut_staffMember between
   LogOut[*]
   StaffMember[1]
end

context LogOut::effect()
post:
self.staffMember.isLoggedIn=false


context LogOut ini inv isNotLoggedIn:
self.staffMember.isLoggedIn=true

event NewTicketOffline
attributes
fullName:String
email:String
telephone:String[0..1]
ext:String[0..1]
source:TicketSource
subject:String
message:String
priority:Priority[0..1]
createdTicket:Ticket[0..1]
internalNote:String[0..1]
dueDatetime:Datetime[0..1]
operations
effect()
end


context NewTicketOffline ini inv emailIsNotInBanList:
   EmailSettings.allInstances()->any(true).banList->notEmpty() implies
   EmailSettings.allInstances()->any(true).banList->excludes(self.email)

association newTicketOffline_department between
   NewTicketOffline[*]
   Department[1] role assignedDepartment
end

association newTicketOffline_helpTopic between
   NewTicketOffline[*]
   HelpTopic[0..1]
end

association newTicketOffline_assignedStaff between
   NewTicketOffline[*]
   StaffMember[0..1] role assignedStaff
end

association newTicketOffline_creator between
   NewTicketOffline[*] role newTicketOfflineOfCreator
   StaffMember[1] role creator
end

context NewTicketOffline ini inv creatorIsLoggedIn:
   self.creator.isLoggedIn

context NewTicketOffline ini inv creatorIsAllowedToCreateTickets:
   self.creator.staffGroup.canCreateTickets

context NewTicketOffline ini inv helpTopicSpecifiedIfAvailable:
   if HelpTopic.allInstances()->select(hp|hp.status=#Enabled)->size()>0  then
      self.helpTopic->size()=1
   else
      self.helpTopic->size()=0
   endif

context NewTicketOffline ini inv helpTopicIsEnabled:
  self.helpTopic->notEmpty() implies self.helpTopic.status=#Enabled
```

```
context NewTicketOffline ini inv maximumOpenTicketsLimitIsNotViolated:
   if TicketSettings.allInstances()->any(true).openTicketsPerMailAreLimited then
   Ticket.allInstances->select(tIt.email=self.email)->size()<TicketSettings.allInstances()->any(true).maximumOpenTicketsPerMail
   else true
   endif


context NewTicketOffline::effect()
post:
let sendNewTicketAlertToAdministrator:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#Administrator)
in
let sendNewTicketAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentManager)
in
let sendNewTicketAlertToDepartmentMembers:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentMembers)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let sendAutoresponse:Boolean=
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewTicketCreatedByCustomer then
      if self.helpTopic->notEmpty then
         if self.helpTopic.autoresponse=#Enabled then true
         else false
         endif
      else
         self.assignedDepartment.newTicketAutoresponseIsSent
      endif
   else false
   endif
in
(Ticket.allInstances- Ticket.allInstances@pre)
  ->one(t | t.oclIsNew()
         and self.createdTicket=t
         and t.fullName=self.fullName
         and t.email=self.email
         and t.telephone=self.telephone
         and t.ext=self.ext
         and t.subject=self.subject
         and t.message=self.message
         and t.ticketStatus=#Open
         and t.priority=self.priority
         and t.source=self.source
         and t.dueDatetime=self.dueDatetime
         and t.helpTopic=self.helpTopic
         and t.assignedDepartment=self.assignedDepartment
         and t.assignedStaff=self.assignedStaff
         and (TicketThreadMessage.allInstances- TicketThreadMessage.allInstances@pre)
             ->one(tdm | tdm.oclIsNew()
             and tdm.datetime=System.allInstances()->any(true).currentDateTime
             and tdm.text=self.message
             and tdm.author=self.fullName
             and tdm.ticket=t
             and t.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

         -- autoresponses
         and (sendAutoresponse implies
            EMail.allInstances()->exists(ele.fromAddress=t.assignedDepartment.autoresponseEmail.address and
                                         e.toAddress=t.email and
                                         e.ticketNumber=t.number))


         -- staff notices
         and (sendNewTicketAlertToAdministrator implies
            EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                         e.toAddress=EmailSettings.allInstances()->any(true).administrationEmail and
                                         e.ticketNumber=t.number))
```

```
        and  (sendNewTicketAlertToDepartmentManager
            and t.assignedDepartment.departmentManager->notEmpty()
            and t.assignedDepartment.departmentManager.status=#Enabled
            and not(t.assignedDepartment.departmentManager.isInVacationMode)
            implies
              EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                  e.toAddress=t.assignedDepartment.departmentManager.emailAddress and
                                  e.ticketNumber=t.number))

        and  (sendNewTicketAlertToDepartmentMembers
            implies
            t.assignedDepartment.staffMember->forAll(m|
              (m.status=#Enabled and not(m.isInVacationMode))
              implies
              EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                    e.toAddress=m.emailAddress and
                                    e.ticketNumber=t.number)))
      )


event DisplayTicketsByStatus
attributes
status:StatusFilter
operations
answer():Sequence(Tuple(number:Integer,createDate:Integer,subject:String,department:String, priority:Priority,email:String))=
      let visibleDepartments:Set(Department)=
          self.consultant.staffGroup.departmentsAccess->including(self.consultant.department)
      in
      if self.status=#OpenTickets then
      Ticket.allInstances
      ->select(tIt.ticketStatus=#Open and visibleDepartments->includes(t.assignedDepartment))
      -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})->sortedBy(number)
      else
      if self.status=#AssignedToMe then
      Ticket.allInstances
      ->select(tIt.assignedStaff=self.consultant and t.ticketStatus<>#Closed and visibleDepartments-
>includes(t.assignedDepartment))
      -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})->sortedBy(number)
      else
      if self.status=#OverdueTickets then
      Ticket.allInstances
      ->select(tIt.isOverdue and t.ticketStatus<>#Closed and visibleDepartments->includes(t.assignedDepartment))
      -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})->sortedBy(number)
      else
      Ticket.allInstances
      ->select(tIt.ticketStatus=#Closed and visibleDepartments->includes(t.assignedDepartment))
      -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})->sortedBy(number)
      endif
      endif
      endif
effect()
end



association displayTicketsByStatus_consultant between
   DisplayTicketsByStatus[*] role newTicketOfflineOfConsultant
   StaffMember[1] role consultant
end

context DisplayTicketsByStatus ini inv consulantIsLoggedIn:
    self.consultant.isLoggedIn

event ChangeTicketPriority<StaffTicketEvent
attributes
```

```
newPriority:Priority
operations
effect()
end


context ChangeTicketPriority::effect()
post:
self.ticket.priority=self.newPriority
and
(InternalNote.allInstances- InternalNote.allInstances@pre)
        ->one(i | i.oclIsNew()
        and i.datetime=System.allInstances()->any(true).currentDateTime
        and i.subject='Ticket priority changed'
        and i.text='The ticket priority has been changed'
        and i.author=self.staffMember.firstName
        and i.ticket=self.ticket)
  and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime


event MarkTicketOverdue<StaffTicketEvent
operations
effect()
end


context MarkTicketOverdue::effect()
post:
self.ticket.isOverdue
and
(InternalNote.allInstances- InternalNote.allInstances@pre)
        ->one(i | i.oclIsNew()
        and i.datetime=System.allInstances()->any(true).currentDateTime
        and i.subject='Ticket Marked Overdue'
        and i.text='Ticket flagged as overdue'
        and i.author=self.staffMember.firstName
        and i.ticket=self.ticket)
  and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime

context MarkTicketOverdue ini inv staffMemberIsAnAdministrator:
    self.staffMember.isAdministrator


event AssignTicket<StaffTicketEvent
attributes
assignmentText:String
operations
effect()
end


association assignTicket_assignee between
   AssignTicket[*] role assignTicketOfAssignee
   StaffMember[1] role assignee
end



context AssignTicket::effect()
post:
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
self.ticket.assignedStaff=self.assignee
and
(InternalNote.allInstances- InternalNote.allInstances@pre)
        ->one(i | i.oclIsNew()
        and i.datetime=System.allInstances()->any(true).currentDateTime
        and i.subject='Ticket Reassigned'
        and i.text=self.assignmentText
        and i.author=self.staffMember.firstName
        and i.ticket=self.ticket)
```

```
  and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime
   and (EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=self.assignee.emailAddress and
                                e.ticketNumber=self.ticket.number))


context AssignTicket ini inv assigneeIsNotInVacationMode:
    not(self.assignee.isInVacationMode)



event ReleaseTicket<StaffTicketEvent
operations
effect()
end



context ReleaseTicket::effect()
post:
self.ticket.assignedStaff->isEmpty()
and
(InternalNote.allInstances- InternalNote.allInstances@pre)
            ->one(i | i.oclIsNew()
            and i.datetime=System.allInstances()->any(true).currentDateTime
            and i.subject='Ticket unassigned'
            and i.text='Released ticket'
            and i.author=self.staffMember.firstName
            and i.ticket=self.ticket)



context ReleaseTicket ini inv theTicketIsAssigned:
    self.ticket.assignedStaff.isDefined()



event EditTicket<StaffTicketEvent
attributes
emailAddress:String
fullName:String
subject:String
telephone:String [0..1]
ext:String[0..1]
priority:Priority
dueDatetime:Datetime
editionInternalNote:String
operations
effect()
end


association editTicket_helpTopic between
   EditTicket[*]
   HelpTopic[1]
end

context EditTicket::effect()
post:
self.ticket.email=self.emailAddress and
self.ticket.fullName=self.fullName and
self.ticket.subject=self.subject and
self.ticket.telephone=self.telephone and
self.ticket.ext=self.ext and
self.ticket.priority=self.priority and
self.ticket.helpTopic=self.helpTopic and
self.ticket.dueDatetime=self.dueDatetime
and
(InternalNote.allInstances- InternalNote.allInstances@pre)
            ->one(i | i.oclIsNew()
            and i.datetime=System.allInstances()->any(true).currentDateTime
```

```
            and i.subject='Ticket updated'
            and i.text=self.editionInternalNote
            and i.author=self.staffMember.firstName
            and i.ticket=self.ticket)


context EditTicket ini inv staffMemberIsNotAllowedToEditTickets:
    self.staffMember.staffGroup.canEditTickets or self.staffMember.isAdministrator



event PostTicketReply<StaffTicketEvent
attributes
response:String
operations
effect()
end



context PostTicketReply::effect()
post:

let sendNewMessageAlertToLastRespondent:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#LastRespondent)
in
let sendNewMessageAlertToAssignedStaff:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#AssignedStaff)
in
let sendNewMessageAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#DepartmentManager)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let sendAutoresponse:Boolean=
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewMessageAppendedToTicket then
      if self.ticket.helpTopic->notEmpty then
         if self.ticket.helpTopic.autoresponse=#Enabled then true
         else false
         endif
      else
         self.ticket.assignedDepartment.newAddedMessageIsNotified
      endif
   else false
   endif
in
self.ticket.ticketThreadMessage->one(tdm | tdm.oclIsNew()
            and tdm.datetime=System.allInstances()->any(true).currentDateTime
            and tdm.text=self.response
            and tdm.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

         and self.ticket.lastRespondent=self.staffMember


         and (sendAutoresponse implies
            EMail.allInstances()->exists(ele.fromAddress=self.ticket.assignedDepartment.autoresponseEmail.address and
                                 e.toAddress=self.ticket.email and
                                 e.ticketNumber=self.ticket.number))

         -- staff notices
         and (sendNewMessageAlertToLastRespondent and
             self.ticket.lastRespondent@pre->notEmpty() and
             not(self.ticket.lastRespondent@pre.isInVacationMode or self.ticket.lastRespondent@pre.status=#Disabled)
             implies
            EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
```

```
                                e.toAddress=self.ticket.lastRespondent@pre and
                                e.ticketNumber=self.ticket.number ))

        and  (sendNewMessageAlertToAssignedStaff
             and self.ticket.assignedStaff->notEmpty()
             and not(self.ticket.assignedStaff.isInVacationMode or self.ticket.assignedStaff.status=#Disabled)
             implies
               EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=self.ticket.assignedStaff.emailAddress and
                                e.ticketNumber=self.ticket.number))



event PostTicketInternalNote<StaffTicketEvent
attributes
title:String
note:String
operations
effect()
end


context PostTicketInternalNote::effect()
post:

let sendNewMessageAlertToLastRespondent:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#LastRespondent)
in
let sendNewMessageAlertToAssignedStaff:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#AssignedStaff)
in
let sendNewMessageAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#DepartmentManager)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
self.ticket.internalNote->one(int | int.oclIsNew()
             and int.datetime=System.allInstances()->any(true).currentDateTime
             and int.subject=self.title
             and int.text=self.note
             and int.author=self.staffMember.firstName
             and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)


         -- staff notices
         and (sendNewMessageAlertToLastRespondent and
             self.ticket.lastRespondent@pre->notEmpty() and
             not(self.ticket.lastRespondent@pre.isInVacationMode or self.ticket.lastRespondent@pre.status=#Disabled)
             implies
            EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=self.ticket.lastRespondent@pre and
                                e.ticketNumber=self.ticket.number ))

        and  (sendNewMessageAlertToAssignedStaff
             and self.ticket.assignedStaff->notEmpty()
             and not(self.ticket.assignedStaff.isInVacationMode or self.ticket.assignedStaff.status=#Disabled)
             implies
               EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=self.ticket.assignedStaff.emailAddress and
                                e.ticketNumber=self.ticket.number))
```

```
abstract event StaffTicketEvent
end

association staffTicketEvent_ticket between
   StaffTicketEvent[*]
   Ticket[1]
end

association staffTicketEvent_staffMember between
   StaffTicketEvent[*]
   StaffMember[1]
end

context StaffTicketEvent ini inv theTicketIsVisible:
    self.staffMember.isAdministrator or
    (self.staffMember.staffGroup.departmentsAccess->including(self.staffMember.department))-
>includes(self.ticket.assignedDepartment)

context StaffTicketEvent ini inv staffMemberIsLoggedIn:
    self.staffMember.isLoggedIn


event TransferDepartment<StaffTicketEvent
attributes
note:String
operations
effect()
end

association transferDepartment_department between
   TransferDepartment[*]
   Department[1]
end


context TransferDepartment::effect()
post:
self.ticket.assignedDepartment=self.department and
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
            and int.subject='Department transfer'
            and int.text=self.note
            and int.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)


context TransferDepartment ini inv departmentIsDifferent:
    self.department <> self.ticket.assignedDepartment

context TransferDepartment ini inv staffMemberIsAllowedToTransfer:
    self.staffMember.staffGroup.canTransferTickets


event CloseTicket<StaffTicketEvent
operations
effect()
end


context CloseTicket::effect()
post:
self.ticket.ticketStatus=#Closed and
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
            and int.subject='Ticket closed'
            and int.text='Ticket closed without response'
            and int.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

 context CloseTicket ini inv staffMemberIsAllowedToClose:
    self.staffMember.staffGroup.canCloseTickets
```

```
 context CloseTicket ini inv ticketIsNotClosed:
   not (self.ticket.ticketStatus=#Closed)

event CloseTicketWithResponse<StaffTicketEvent
attributes
response:String
operations
effect()
end

context CloseTicketWithResponse::effect()
post:
let sendAutoresponse:Boolean=
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewMessageAppendedToTicket then
      if self.ticket.helpTopic->notEmpty then
         if self.ticket.helpTopic.autoresponse=#Enabled then true
         else false
         endif
      else
         self.ticket.assignedDepartment.newAddedMessageIsNotified
      endif
   else false
   endif
in
self.ticket.ticketStatus=#Closed and
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
            and int.subject='Ticket closed'
            and int.text='Ticket closed on reply'
            and int.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)
and
self.ticket.ticketThreadMessage->one(tdm | tdm.oclIsNew()
            and tdm.datetime=System.allInstances()->any(true).currentDateTime
            and tdm.text=self.response
            and tdm.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

         and self.ticket.lastRespondent=self.staffMember


         and (sendAutoresponse implies
            EMail.allInstances()->exists(ele.fromAddress=self.ticket.assignedDepartment.autoresponseEmail.address and
                                 e.toAddress=self.ticket.email and
                                 e.ticketNumber=self.ticket.number))

context CloseTicketWithResponse ini inv staffMemberIsAllowedToClose:
  self.staffMember.staffGroup.canCloseTickets

context CloseTicketWithResponse ini inv ticketIsNotClosed:
not (self.ticket.ticketStatus=#Closed)


event ReopenTicket<StaffTicketEvent
operations
effect()
end

context ReopenTicket::effect()
post:
self.ticket.ticketStatus=#Open and
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
            and int.subject='Ticket reopened'
            and int.text='Ticket reopened without comments'
            and int.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

context ReopenTicket ini inv ticketIsClosed:
 self.ticket.ticketStatus=#Closed
```

```
event ReopenTicketWithResponse<StaffTicketEvent
attributes
response:String
operations
effect()
end

context ReopenTicketWithResponse::effect()
post:
let sendAutoresponse:Boolean=
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewMessageAppendedToTicket then
      if self.ticket.helpTopic->notEmpty then
         if self.ticket.helpTopic.autoresponse=#Enabled then true
         else false
         endif
      else
         self.ticket.assignedDepartment.newAddedMessageIsNotified
      endif
   else false
   endif
in
self.ticket.ticketStatus=#Open and
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
            and int.subject='Ticket status changed to open'
            and int.text='A staff member reopened the ticket on reply'
            and int.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)
and
self.ticket.ticketThreadMessage->one(tdm | tdm.oclIsNew()
            and tdm.datetime=System.allInstances()->any(true).currentDateTime
            and tdm.text=self.response
            and tdm.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

         and self.ticket.lastRespondent=self.staffMember


         and (sendAutoresponse implies
            EMail.allInstances()->exists(ele.fromAddress=self.ticket.assignedDepartment.autoresponseEmail.address and
                                    e.toAddress=self.ticket.email and
                                    e.ticketNumber=self.ticket.number))

context ReopenTicketWithResponse ini inv ticketIsClosed:
 self.ticket.ticketStatus=#Closed


event BanEmailAndCloseTicket<StaffTicketEvent
operations
effect()
end


context BanEmailAndCloseTicket::effect()
post:
self.ticket.ticketStatus=#Closed and
EmailSettings.allInstances()->any(true).banList->includes(self.ticket.email) and
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
            and int.subject='Ticket closed'
            and int.text='Email added to banlist and ticket status set to closed'
            and int.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

context BanEmailAndCloseTicket ini inv ticketIsNotClosed:
not (self.ticket.ticketStatus=#Closed)

context BanEmailAndCloseTicket ini inv staffMemberIsAllowedToBanEmails:
 self.staffMember.staffGroup.canBanEmails
```

```
event DeleteTicket
operations
effect()
end

association deleteTicket_ticket between
   DeleteTicket[*]
   Ticket[0..1]
end

association deleteTicket_staffMember between
   DeleteTicket[*]
   StaffMember[1]
end


context DeleteTicket::effect()
post:
Ticket.allInstances()->excludes(self.ticket@pre) and
self.ticket@pre.internalNote@pre->forAll(int|InternalNote.allInstances()->excludes(int))
-- and self.ticket@pre.ticketThreadMessage@pre->forAll(ttm|TicketThreadMessage.allInstances()->excludes(ttm))


context DeleteTicket ini inv theTicketIsVisible:
    self.staffMember.isAdministrator or
    (self.staffMember.staffGroup.departmentsAccess->including(self.staffMember.department))-
>includes(self.ticket.assignedDepartment)

context DeleteTicket ini inv staffMemberIsLoggedIn:
   self.staffMember.isLoggedIn

context DeleteTicket ini inv staffMemberIsAllowedToDeleteTickets:
    self.staffMember.isAdministrator or
    self.staffMember.staffGroup.canDeleteTickets

event CheckOverdueTickets
operations
effect()
end

context CheckOverdueTickets::effect()
post:
let sendOverdueTicketAlertToAdministrator:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdue and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdueStaff->includes(#Administrator)
in
let sendOverdueTicketAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdue and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdueStaff->includes(#DepartmentManager)
in
let sendOverdueTicketAlertToDepartmentMembers:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdue and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdueStaff->includes(#DepartmentMembers)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
Ticket.allInstances()->select(t|(System.allInstances()-
>any(true).currentDateTime.value>(t.dueDatetime.value+TicketSettings.allInstances()->any(true).ticketGracePeriod))
                  and not(t.isOverdue))
          -> forAll(t|t.isOverdue


       -- staff notices
       and (sendOverdueTicketAlertToAdministrator implies
          EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=EmailSettings.allInstances()->any(true).administrationEmail and
                                e.ticketNumber=t.number))

       and  (sendOverdueTicketAlertToDepartmentManager
           and t.assignedDepartment.departmentManager->notEmpty()
           and t.assignedDepartment.departmentManager.status=#Enabled
```

```
    and not(t.assignedDepartment.departmentManager.isInVacationMode)
    implies
      EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                          e.toAddress=t.assignedDepartment.departmentManager.emailAddress and
                          e.ticketNumber=t.number))

and  (sendOverdueTicketAlertToDepartmentMembers
    implies
    t.assignedDepartment.staffMember->forAll(ml
      (m.status=#Enabled and not(m.isInVacationMode))
      implies
      EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                            e.toAddress=m.emailAddress and
                            e.ticketNumber=t.number)))

  )
```

6. Case study analysis

In this section, we analyze the experimentation reported in this document. We analyze the properties of the resultant conceptual schema, the testing effort, the kinds of errors and failures, and the characteristics of the TDCM iterations performed in order to develop the conceptual schema of the *osTicket* system.

6.1. The resultant conceptual schema

The resultant conceptual schema is the schema obtained in the last iteration as a result of the evolution of the schema by applying TDMC. You can download a zipped file with the CSTLProcessor and the case study files (the resultant conceptual schema in the USEx executable format, the methods file, and the CSTL test programs).

Table 1 summarizes the number of schema elements that constitute the resultant conceptual schema obtained by applying TDCM in the *osTicket* case study:

osTicket Conceptual Schema	
Classes	28
Attributes	92
Associations	44
Event types	24
Integrity constraints	51

Table 1. Schema elements of the osTicket Conceptual schema

Quality properties of the resultant conceptual schema

The **resultant conceptual schema is correct according to the expectations formalized** in the processed test cases (the knowledge included in the conceptual schema fulfills the expectations formalized as test case assertions).

The resultant schema is also complete according to the test set, because the knowledge it contains makes possible the test set execution.

However, more user stories could be designed and, consequently, more test cases could be specified in order to increase our confidence about the correctness and the completeness, by testing the schema in more representative cases. This is a drawback inherent to all the testing processes, because the number of possible test cases is infinite. In this case study, we learned that it is very important to specify the test cases based on a representative set of user stories according to a planned testing strategy.

All knowledge defined in the **resultant conceptual schema is relevant**. The passing test set and its associated conceptual schema are not enough to assert the relevance of the schema (the defined knowledge is correct and necessary but the schema could contain irrelevant knowledge that does not alter the verdict of the test cases). However, the CSTL processor allows to automatically check whether the basic types, derived types, valid type configurations or domain event types are participants of any test case or not. If all the elements of the schema are needed in at least one correct test case, it is because the defined knowledge is relevant for the system.

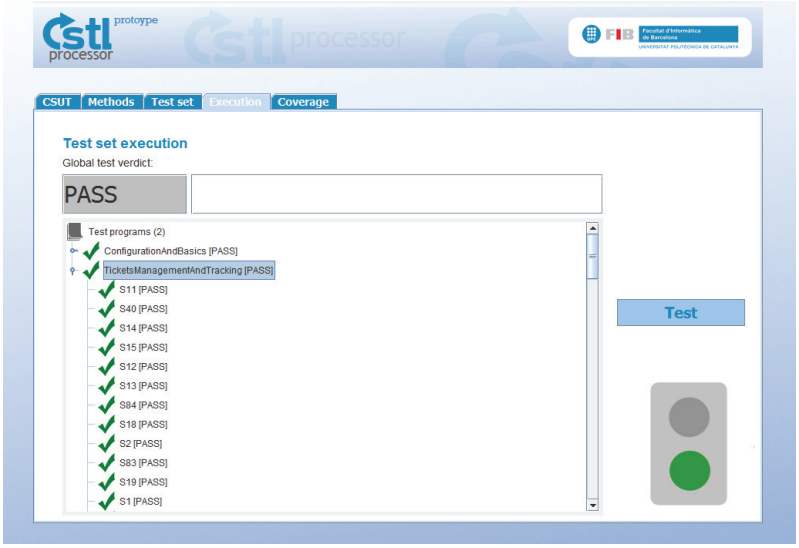


Fig. 3. Test case execution report provided by the CSTL processor

Figure 4 shows the coverage analysis report provided by the CSTL Processor at the end of the last iteration. It allows us to ensure the relevance of the knowledge defined in the resultant conceptual schema.

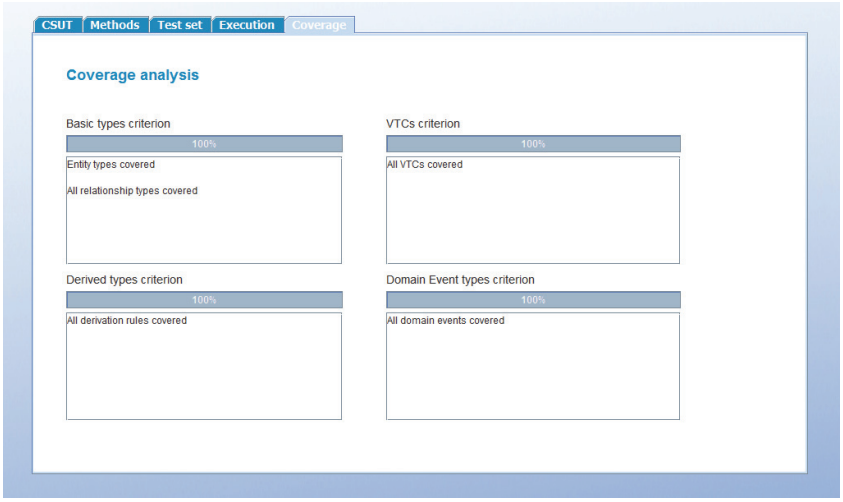


Fig. 4. Coverage report provided by the CSTL processor

6.2. The test set

The conceptual schema was obtained from an empty schema which was evolved in 100 iterations in which the stories defined in Section 2 were processed as test cases. Table 2 summarizes some data about the test set processed in this case study.

osTicket Test Set	
Number of test cases	101
Lines of test cases	2002
Fixture components	25

Table 2. Test set summary

We finished the TDCM application when two conditions hold: 1) we formalized as test cases all the representative stories according to our testing strategy, 2) the verdict of all the test cases became *Pass*.

6.3. TDCM iterations

The conceptual schema developed in this case study is the result of 100 TDCM iterations. This figure has no particular significance in this case study. There was not any intention for a particular number of iterations. In the following, we categorize the errors and failures fixed by applying TDCM and the changes they drove to evolve the schema.

Errors/failures categorization

In this case study we have categorized the errors and failures which may be obtained during the execution of test cases by applying TDCM. Neither syntactical errors nor incorrectly formalized expectations in test cases are considered in this table.

Figure 5 summarizes the categorization of errors/failures which has been used and refined. We also suggest the applicable changes to fix each error/failure type.

Code	*Description*	*Suggested changes to the schema to fix the error/failure*	
Rel_BT	An expected relevant base type (entity type or relationship type) is not specified in the conceptual schema	Specify the base type in the conceptual schema	*Add_Rel_BT*
Rel_DT	An expected relevant derived type is not specified in the conceptual schema	Specify the derived type (and its derivation rule) in the conceptual schema	*Add_Rel_DT*
Rel_ET	An expected relevant event type (domain event or query) is not specified in the conceptual schema	Specify the event type (and its effect or answer) in the conceptual schema	*Add_Rel_ET*
EvOc_bef	The IB state before an expected event occurrence is inconsistent (the event specification is invalid)	Some (too restrictive) static constraints or preconditions are updated	*Chg_constraint* *Chg_event_specification*
EvOc_after	The IB state after an expected occurrence of an event is inconsistent (the event specification is invalid)	The event postcondition, the event method or an static constraint are updated.	*Chg_event_specification*
EvOc_post	The postcondition is not satisfied after an expected event occurrence	Either the method or the postcondition are updated.	*Chg_event_specification*
Sem_exp	An OCL expression in a test case or in the conceptual schema are not valid or inconsistent (e.g. invalid operations for specific types)	Either the expression in the test case is corrected or an element of the schema needs to be changed according to the semantic error revealed.	*Chg_element_type* *Chg_exp*

Ib_ass	A test assertion about the IB state fails.	The effect of an event type or a derivation rule needs to be corrected.	*Chg_event_specification* *Chg_der_rule*
NonOc_ass	A test assertion about the non-occurrence of an event fails.	An event initial integrity constraint (postcondition) needs to be added/updated.	*Chg_event_specification*
AssConsis_fails	A test assertion about the consistency of an IB state fails.	A static constraint prevents the IB state to be consistent and it is updated.	*Chg_constraint*

Table 3. Errors and failures categorization

This categorization and their associated actions may be useful guidelines to help making progress in TDCM more efficiently. In TDCM, errors and failures to be fixed are the essence for progress. When errors/failures are revealed, then the modeler may use this table to find out applicable actions to change the schema in order to fix each error/failure.

In the case study, the errors/failures which drive the changes in each iteration are reported and classified using this categorization.

Errors and failures that drive conceptual modeling in the case study

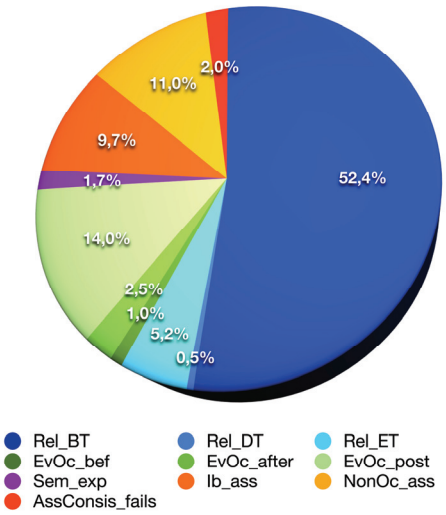


Chart 1. Errors and failures revealed (percentages)

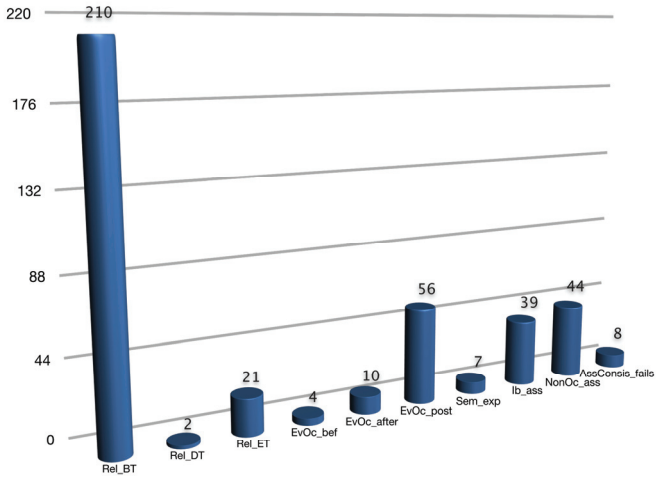


Chart 2. Number of errors and failures revealed

Code	*Description*	*Number of times revealed*	*Percentage (%)*
Rel_BT	An expected relevant base type (entity type or relationship type) is not specified in the conceptual schema	210	52,4
Rel_DT	An expected relevant derived type is not specified in the conceptual schema	2	0,5
Rel_ET	An expected relevant event type (domain event or query) is not specified in the conceptual schema	21	5,2
EvOc_bef	The IB state before an expected event occurrence is inconsistent (the event specification is invalid)	4	1,0
EvOc_after	The IB state after an expected occurrence of an event is inconsistent (the event specification is invalid)	10	2,5
EvOc_post	The postcondition is not satisfied after an expected event occurrence	56	14,0
Sem_exp	An OCL expression in a test case or in the conceptual schema are not valid or inconsistent (e.g. invalid operations for specific types)	7	1,7
Ib_ass	A test assertion about the IB state fails.	39	9,7
NonOc_ass	A test assertion about the non-occurrence of an event fails.	44	11,0
AssConsis_fails	A test assertion about the consistency of an IB state fails.	8	2,0

Table 4. Summary of errors and failures revealed

In charts 1 and 2, we analyze the errors and failures revealed by applying TDCM to the *osTicket* case study, according to the categorization described in the previous section. Table 4 summarizes the errors reported by the *CSTLProcessor* during the TDCM iterations.

We observe that TDCM drives the development of the conceptual schema by promoting to fix three main kinds of errors/failures:

- 58,1% of the errors/failures correspond to relevant types (basic types, derived types or event types) which have not been defined yet in the schema (Rel_BT+Rel_DT+Rel_ET). Rel_BT, Rel_DDT and Rel_ET are proportional to the relevant knowledge defined in the schema.

- 17,5% of the errors/failures correspond to erroneous definitions of domain event types (EvOc_bef+EvOc_after+EvOc_post), either because the state before the occurrence is inconsistent, or because the state after the occurrence is inconsistent, or because the postcondition is not satisfied.

- The rest of the errors correspond to unexpected results (assertions that fail). Most of them are assertions about the non-occurrence of events (11%), and about the IB state (9,7%). Others are assertions that check the consistency of an IB state (2%) –this assertions are only applied in the basics&configuration are of knowledge, where the implicit structural events are only considered-.

In this case study, some iterations have also been driven by other semantic errors in OCL expressions, such as incompatible types, invalid operations for some types, etc.

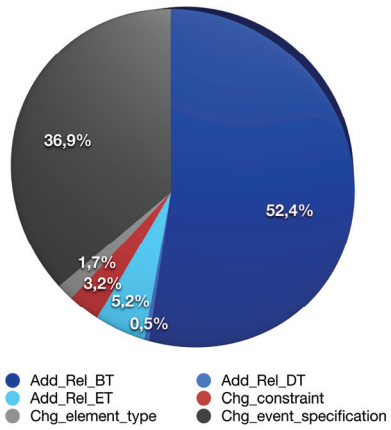


Chart 3. Changes to the conceptual schema while applying TDCM (percentatges)

The errors and failures which are reported by the CSTLProcessor in each iteration need to be fixed according to the TDCM cycle. Changing the schema to fix the errors/failures makes progress in the incremental development of the schema. By analyzing the kinds of actions applied to fix the previously analyzed errors/failures, we observe:

- Fixing the errors about missing relevant knowledge is almost trivial: they need to be added. Note that the percentage of the changes Add-Rel_BT (52,4%), Add_Rel_DT (0,5%) and Add_Rel_ET (5,2%) are exactly the same as the errors revealed due to missing relevant knowledge in the conceptual schema.

- 36,9% of changes correspond to the refinement of event specifications (precondition, postcondition, method) in order to be correctly defined according to the general definition of domain events.

- 3,2% of the changes correspond to the addition/refinement of static constraints of the schema. These changes are usually induced by invalid IB states when an event occurrence is asserted or when the assertion about the consistency of the IB state fails.

- Semantic errors in expressions reveal inconsistencies in the schema. They need to be corrected either by changing the expression or changing the type of an element of the schema in order to make possible the evaluation of the expression. In this case study, all of these errors have been corrected by changing the type of a schema element (1,7%).

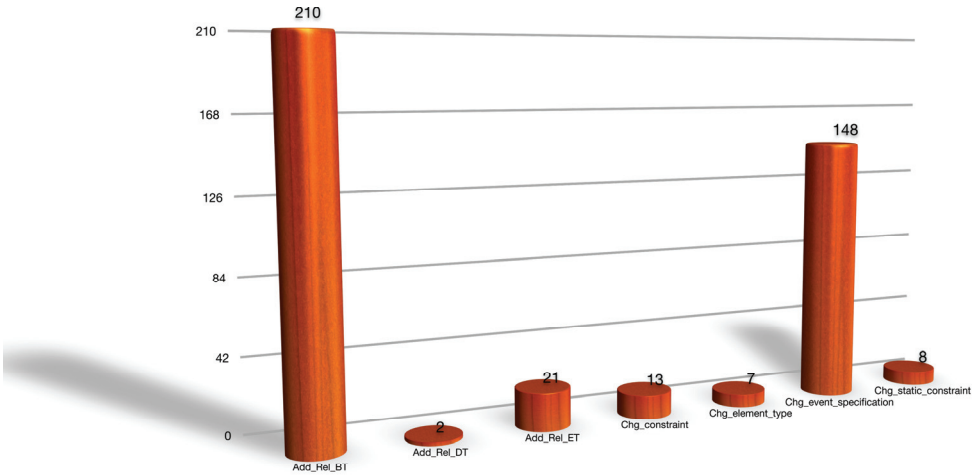


Chart 4. Number of changes to the conceptual schema while applying TDCM

It is important to note that these results point out a tendency about the most common errors/failures and their induced changes by analyzing the application of TDCM in a concrete case study. However the kind of errors/failures revealed and the changes driven by TDCM also depend on the knowledge of the universe of discourse of the system for which we develop the conceptual schema.

6.4. Iterations analysis

In this section, we analyze and compare the 100 iterations (we name them as It1, It2,…,It100) that have been performed by applying TDCM to this case study. A complete report about each iteration is described in Section 3.

Test cases specification

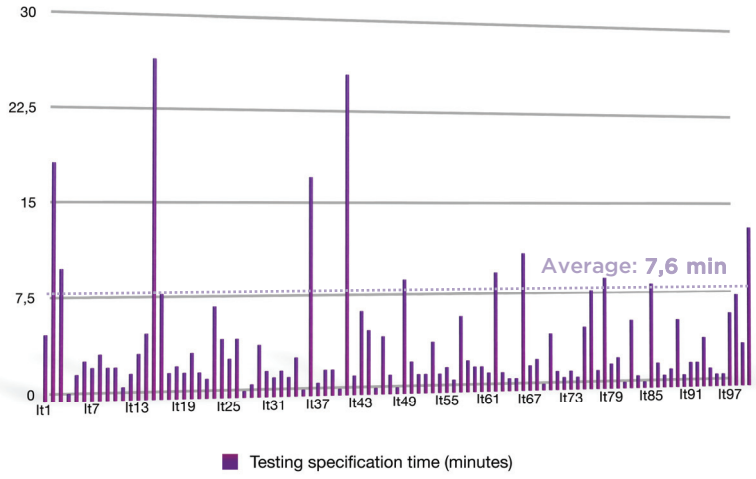


Chart 5. Time invest on testing specification in each iteration

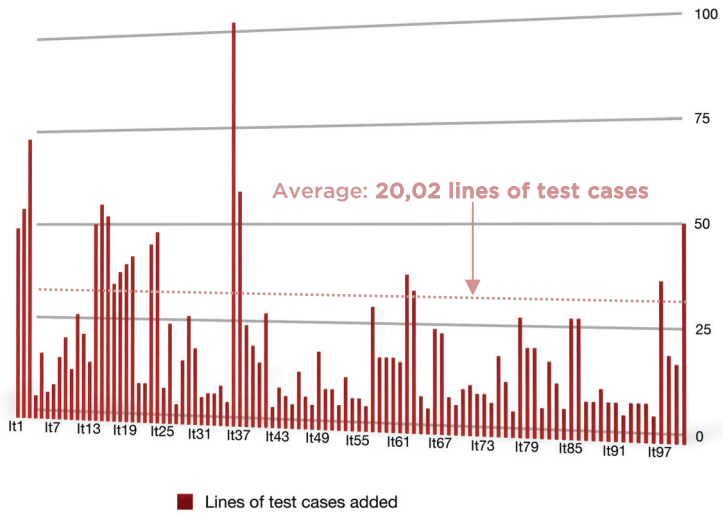


Chart 6. Lines of test cases added/updated in each iteration

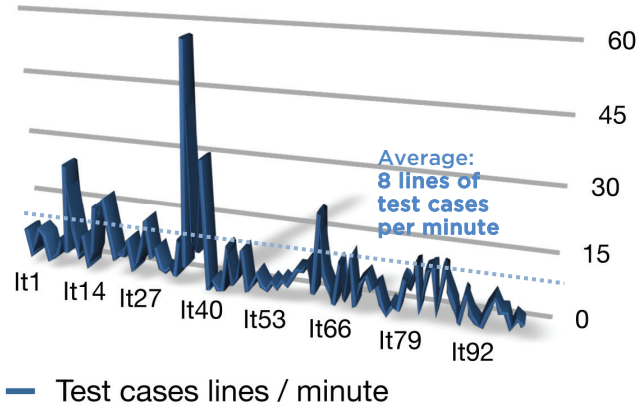


Chart 7. Testing specification productivity measured in test cases lines per minute

As we can observe in first bar chart 6, the numbers of lines of test cases added to the test set vary in each iteration depending on the processed story.

If we compare bar chart 6 (lines of test cases added) with the time spent by specifying the test cases in each iteration (bar chart 5), we can observe that the testing specification time is not directly proportional to the lines of test cases added in all cases.

Chart 7 represents the testing specification productivity (lines of test added/minute). We observe that, in general, the productivity tends to vary cyclically (the productivity increases periodically). If we analyze the iterations, we may observe that test cases may be grouped into similar stories (e.g. stories which are tested with variations or using different initial states or conditions). The first time we specify a story with very different testing objectives, the testing specification productivity decreases, but when we specify story variations as test cases, then the productivity increases.

We realize that there are peaks of productivity in the iterations when previously used testing structures are reused. In contrast, the testing specification consumes more time when we specify stories with new (and probably unknown) structures.

TDCM iterations productivity

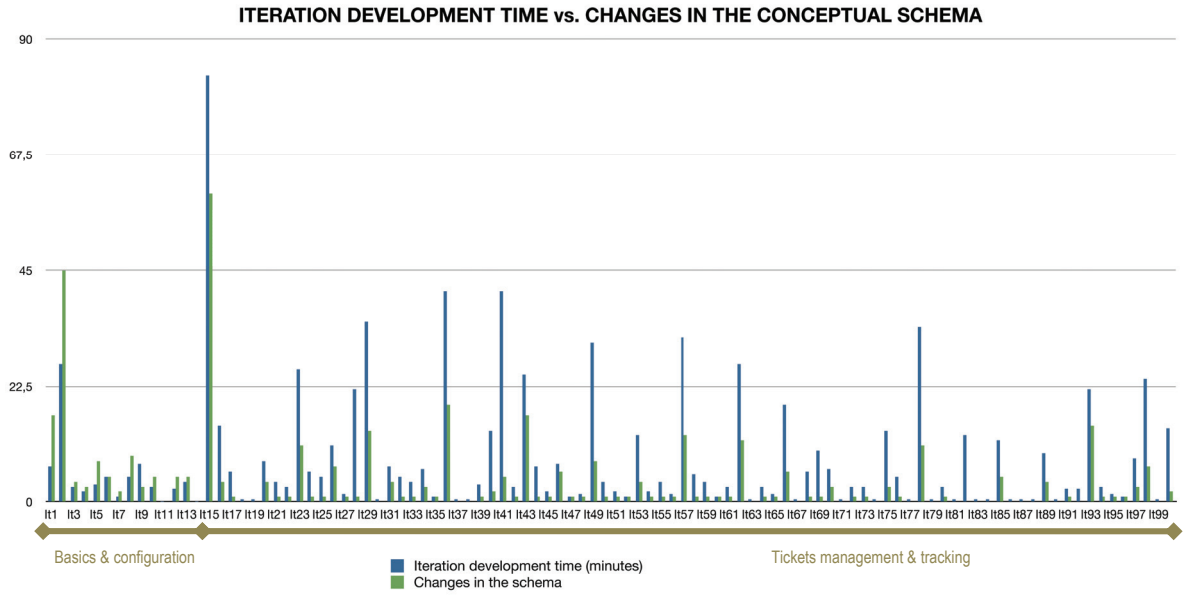


Chart 8. Iteration development time and changes in the schema

Bar chart 8 analyzes the development time used to complete each TDCM iteration and the changes applied to the schema due to the fixing actions induced by the revealed errors/failures.

We can observe that most of the iterations are productive because they drive changes in the schema. Morevoer, in many iterations, more development time implies more changes to the schema induced by errors and failures revealed by TDCM. This is also important to note, that some iterations have an insignificant development time and no changes are done to the schema. It means that the verdict of the test set is *Pass* from the first execution and, consequently, the iteration does not make progress in the TDCM cycle. Nevertheless, these iterations increase our confidence about the validity of the schema.

The time spent in a TDCM iteration is the time to fix the errors/failures (that is to evolve the schema). At the end of each iteration, we obtain an executable conceptual schema with a test set that validates its correctness and completeness.

We have also automatically analyzed, at the end of each iteration, the basic types, the derived types and the domain event types which have been tested in at least one of the passing test cases of the current test set. This analysis provides a measure of the basic coverage of the test set and allows us to identify elements in the schema that have not been tested.

When applying TDCM in this case study, we realized that, at the end of each iteration, the coverage was 100% (all the elements of the schema are participants of a valid and passing test case). The coverage report shown in Fig. 4 was obtained once each iteration was finished. Therefore, for all the elements of the schema, at the end of each iteration, its relevance was justified by the test set.

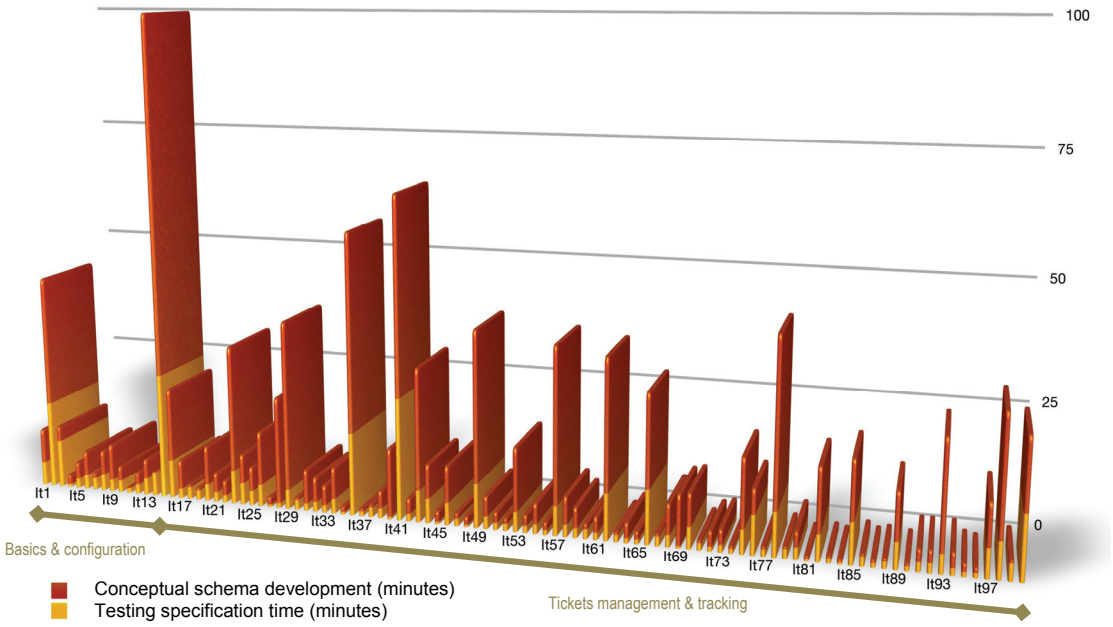


Chart 9. Total time per iteration

The previous accumulated bar chart represents the total time spent in each iteration. In most iterations, the time spent in the TDCM development (fixing errors and failures) is greater than the time spent in fixing errors/failures and changing the schema. It means that in most of the iterations, the testing specification time worth the while because the test case encourages and drives the evolution of the conceptual schema.

Again, the exceptions are those iterations which does not evolve the schema (although they increase confidence about the correctness of the schema). In these iterations, the TDCM iteration time is insignificant, because no changes are done in the schema (these are iterations that pass in the first execution). In these iterations, the time spent by designing and specifying the test case is higher in comparison with the TDCM iteration time spent.

Errors and failures evolution

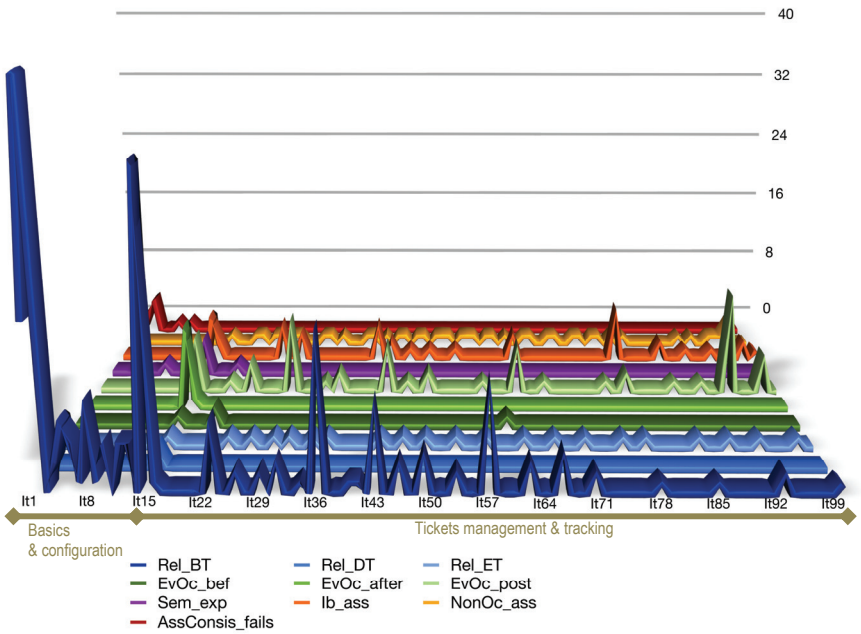


Chart 10. Errors/failures revealed during TDCM application

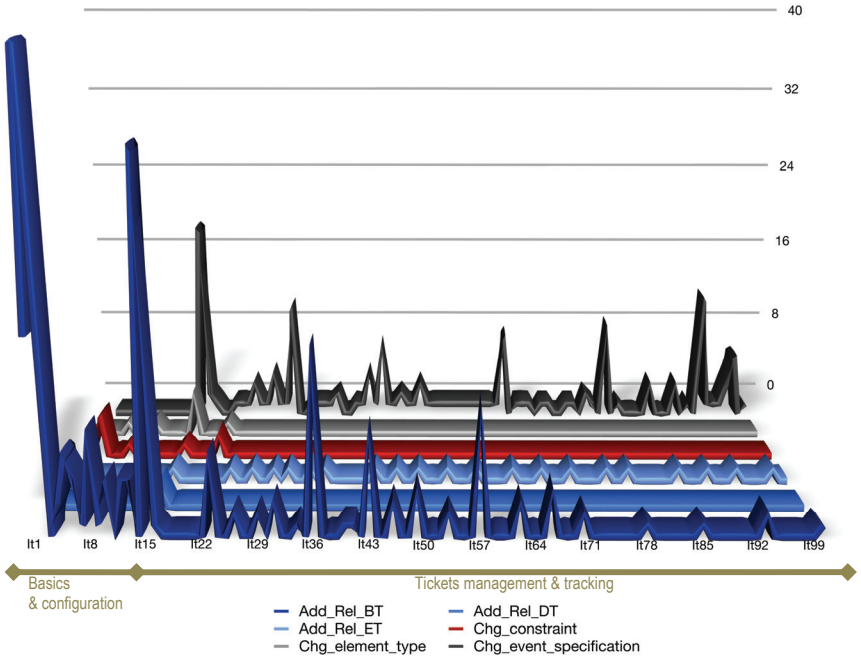


Chart 11. Changes to the conceptual schema during TDCM application

Finally, the two previous charts allows us to analyze the distribution of the errors/failures and the changes which have been performed to fix them while TDCM is applied.

We can observe that, in first iterations, the main errors found correspond to relevant types which are not in the schema. These iterations correspond to the processing of test cases about the basics and configuration of the system. The action to solve them is trivial for this kind of errors: It is required to add them to the conceptual schema. Once the main static schema elements are specified in the schema, the type of failures and errors that drive the schema evolution change significantly. As we add the first domain events, we detect inconsistent states that require refining static constraints and correctly specifying the effect of these events, but only some static knowledge is required to be added.

Charts 10 and 11 also support that not all kinds of knowledge require the same effort to be evolved or corrected according to the processed test cases. In the first iterations, the number of errors/failures is greater because we basically add relevant knowledge (although the time spent in fixing these errors is lower than the time invest on fixing the errors and failures of the next iterations). After the basic static knowledge is added (which is necessary to support the execution of the following test cases), we process stories which are sequences of event occurrences (like a common user story). When we specify the effect of the events and we make assertions about the IB states reached by the events, the required effort is greater because it is less evident how to change the schema in order to reach the verdict *Pass*.

Iterations summary

Table 5 summarizes some aggregated data related to the TDCM iterations applied in the development of the *osTicket* conceptual schema.

TDCM iterations	
Number of iterations	100 iterations
Total development time of the iterations	20 hours 11 minutes
Total time to specify test cases	6 hours 23 minutes
Total time to evolve the conceptual schema under development	13 hours 48 minutes
Average of lines per test case	20,02 lines
Average of testing specification time per iteration	7,6 minutes
Average of conceptual schema development time per iteration	16,4 minutes
Average of changes to the conceptual schema per iteration	4 changes

Table 5. Iterations summary

7. Conclusions

- **We have applied Test-Driven Conceptual Modeling** for the reverse engineering development of the conceptual schema of a widely-used and real-world ticket support system.

- After the application of TDCM in this case study, we obtained **an executable conceptual schema with a test set that checks the correctness and the completeness of the schema** according to the expectations formalized as tests. In other words, TDCM iterations drive the evolution of the conceptual schema and continuously perform its validation.

- The time spent to specify the test cases in each iteration varies depending on the formalized stories. However, we observe that **testing structures are reused and, therefore, the testing specification productivity tends to increase** as we make progress in TDCM.

- The time spent in the conceptual schema evolution (by fixing errors/failures) is greater than the time used to specify the test cases. Therefore, **most of the test cases are productive because they lead to make progress in the evolution of the schema**. The exception are those iterations that pass in the first execution (they increase our confidence about the validity of the schema, but they do not drive changes).

- At the end of each TDCM iteration, the basic coverage of the elements of the schema is 100%. It means that, **at the end of each iteration, for all the elements of the schema, its relevance its justified and, in at least one case, its correctness has been tested**.

- **The most common errors/failures** revealed correspond to missing relevant types, to invalid definitions of domain event types and to failing assertions (either due to incorrect domain event effects, invalid static constraints or incorrect derivation rules).

- In first iterations, the most common errors are about missing relevant types (which are necessary to build IB states). After that, the most common errors/failures are about the correct definition of domain event types and the correctness (according to the assertions) of the reached IB states.

- The time spent on fixing errors/failures is not proportional in all cases to the number of errors fixed in each iteration. It means that **not all errors/failures require the same effort to be fixed**. The analysis suggests that missing relevant types are trivial to be fixed (they need to be added). However, the changes to fix failing assertions about the state of the domain or incorrect domain event specifications may require different actions such as changing derivation rules, integrity constraints or the precondition and postcondition of the effect of the event.

- We have **identified and categorized the errors and failures that may be revealed and the associated changes in the schema that may be applied to fix them**. This categorization may help in the application of TDCM.

8. References

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2. Hamill, P. Unit test frameworks. O'Reilly (2004)
3. osTicket. osTicket website, http://http://www.osticket.com/
4. Tort, A. Testing the osCommerce Conceptual Schema by Using CSTL. Research Report LSI-09-28-R, UPC, http://hdl.handle.net/2117/6289 (2009)
5. Tort, A. Development of the conceptual schema of a bowling game system by applying TDCM. Research Report UPC, http://hdl.handle.net/2117/11196 (2011)
6. Tort, A., Olivé, A. An approach to testing conceptual schemas. Data & Knowledge Engineering 69(6), 598-618 (2010)

Appendix A. USE specification of the resultant schema

```
model osTicket

enum DepartmentType{Public, Private} --it2
enum Priority{Low,Normal,High}
enum Status{Enabled,Disabled}
enum HelpDeskStatus{Online,Offline} --it7
enum TicketsMode{Sequential,Random}
enum StaffRole{Administrator,DepartmentManager,DepartmentMembers,LastRespondent,AssignedStaff}
enum TicketStatus{Open,Closed}
enum TicketSource{Web,EMail,Phone,Other}
enum StatusFilter{OpenTickets,ClosedTickets,AssignedToMe,OverdueTickets}


class Datetime
attributes
   value:Integer
end

class System
attributes
currentDateTime:Datetime
aleat:Integer
end


class EMail
attributes
/timeStamp:Datetime=System.allInstances()->any(true).currentDateTime constant
fromAddress:String
toAddress:String
ticketNumber:Integer
end

association eMail_emailKind between
   EMail[*]
   EmailKind[1]
end


class EmailTemplate
attributes
name:String
internalNotes:String
```

```
end

class EmailKind
attributes
subject:String
message:String
end

class NewTicketAutoresponse<EmailKind
end

association newTicketAutoresponse_emailTemplate between
   NewTicketAutoresponse[1]
   EmailTemplate[1]
end

class NewMessageAutoresponse<EmailKind
end

association newMessageAutoresponse_emailTemplate between
   NewMessageAutoresponse[1]
   EmailTemplate[1]
end

class NewTicketNotice<EmailKind
end

association newTicketNotice_emailTemplate between
   NewTicketNotice[1]
   EmailTemplate[1]
end

class OverTicketLimitNotice<EmailKind
end

association overTicketLimitNotice_emailTemplate between
   OverTicketLimitNotice[1]
   EmailTemplate[1]
end

class TicketResponseNotice<EmailKind
end

association ticketResponseNotice_emailTemplate between
   TicketResponseNotice[1]
   EmailTemplate[1]
end

class NewTicketAlertToStaff<EmailKind
end

association newTicketAlertToStaff_emailTemplate between
   NewTicketAlertToStaff[1]
   EmailTemplate[1]
end

class NewMessageAlertToStaff<EmailKind
end

association newMessageAlertToStaff_emailTemplate between
   NewMessageAlertToStaff[1]
   EmailTemplate[1]
end


class NewInternalNoteAlertToStaff<EmailKind
end

association  newInternalNoteAlertToStaff_emailTemplate between
   NewInternalNoteAlertToStaff[1]
   EmailTemplate[1]
end
```

```
class TicketAssignedAlertToStaff<EmailKind
end

association  ticketAssignedAlertToStaff_emailTemplate between
   TicketAssignedAlertToStaff[1]
   EmailTemplate[1]
end


class OverdueTicketAlertToStaff<EmailKind
end

association  overdueTicketAlertToStaff_emailTemplate between
   OverdueTicketAlertToStaff[1]
   EmailTemplate[1]
end

---it2

class Department
attributes
name:String
type:DepartmentType
newTicketAutoresponseIsSent:Boolean
newAddedMessageIsNotified:Boolean
isDefault:Boolean=false
end

context Department inv hasAlwaysOneDefault:
   Department.allInstances()->select(dId.isDefault)->size()=1

association department_emailTemplate between
   Department[*] role departmentOfEmailTemplate
   EmailTemplate[1]
end


association department_departmentManager between
   Department[*] role departmentOfManager
   StaffMember[0..1] role departmentManager
end

association department_autoresponseEmail between
   Department[*] role departmentOfAutoresponseEmail
   EmailAccount[1] role autoresponseEmail
end

association department_outgoingEmail between
   Department[*]
   EmailAccount[1] role outgoingEmail
end

class EmailAccount
attributes
address:String
fromName:String
defaultNewPriority:Priority
autoresponsesStatus:Status
end

association EmailAccount_defaultNewTicketDepartment between
   EmailAccount[*]
   Department[1] role defaultNewTicketDepartment
end

class StaffMember
attributes
username:String
firstName:String
lastName:String
emailAddress:String
```

```
officePhone:String[0..1]
phoneExtension:String [0..1]
mobilePhone:String[0..1]
signature:String[0..1]
password:String
status:Status
isAdministrator:Boolean
isInVacationMode:Boolean
isLoggedIn:Boolean=false
end

association staffMember_department between
   StaffMember[*]
   Department[1]
end


association staffMember_staffGroup between
   StaffMember[*]
   StaffGroup[1]
end

class StaffGroup
attributes
name:String
status:Status
canCreateTickets:Boolean
canEditTickets:Boolean
canCloseTickets:Boolean
canTransferTickets:Boolean
canDeleteTickets:Boolean
canBanEmails:Boolean
end

association staffGroup_departmentsAccess between
   StaffGroup[*]
   Department[*] role departmentsAccess
end

--it4
class EmailSettings
attributes
   administrationEmail:String
   banList:String[*]
end

association emailSettings_emailAccount between
   EmailSettings[*] role emailSettingsOfDefaultSystemEmail
   EmailAccount[1] role defaultSystemEmail
end

association emailSettings_defaultStaffAlertsEmail between
   EmailSettings[*] role emailSettingsOfDefaultStaffAlertsEmail
   EmailAccount[1] role defaultStaffAlertsEmail
end


context EmailSettings inv hasOnlyOneInstance:
   EmailSettings.allInstances()->size()=1

--it5
class HelpTopic
attributes
name:String
status:Status
autoresponse:Status
newTicketPriority:Priority
end

association helpTopic_newTicketDepartment between
   HelpTopic[*]
   Department[1] role newTicketDepartment
```

```
end

class GeneralSettings
attributes
status:HelpDeskStatus
helpdeskURL:String
helpdeskName:String[0..1]
end

association generalSettings_defaultEmailTemplate between
   GeneralSettings[*]
   EmailTemplate[1] role defaultEmailTemplate
end

context GeneralSettings inv hasOnlyOneInstance:
   GeneralSettings.allInstances()->size()=1


class TicketSettings
attributes
mode:TicketsMode
priority:Priority
customersCanChangePriority:Boolean
useEmailPriorityWhenAvailable:Boolean
openTicketsPerMailAreLimited:Boolean=false
maximumOpenTicketsPerMail:Integer[0..1]
ticketGracePeriod:Integer
reopenedTicketsAreAssignedToLastRespondent:Boolean
end

context TicketSettings inv hasOnlyOneInstance:
   TicketSettings.allInstances()->size()=1

context TicketSettings inv specifiesTheMaximumNumberOfOpenTickerPerMailIfNotUnlimited:
   self.openTicketsPerMailAreLimited implies self.maximumOpenTicketsPerMail.isDefined()


class CustomerAutoresponsesSettings
attributes
autorespondWhenNewTicketCreatedByCustomer:Boolean
autorespondWhenNewTicketCreatedByStaff:Boolean
autorespondWhenNewMessageAppendedToTicket:Boolean
autorespondWhenMaximumOpenTicketsOfCustomer:Boolean
end

context CustomerAutoresponsesSettings inv hasOnlyOneInstance:
   CustomerAutoresponsesSettings.allInstances()->size()=1

class StaffNoticesAlertsSettings
attributes
alertWhenNewTicketCreated:Boolean
alertWhenNewTicketCreatedStaff:Set(StaffRole)
alertWhenNewMessage:Boolean
alertWhenNewMessageStaff:Set(StaffRole)
alertWhenInternalNote:Boolean
alertWhenInternalNoteStaff:Set(StaffRole)
alertWhenTicketOverdue:Boolean
alertWhenTicketOverdueStaff:Set(StaffRole)
end

context StaffNoticesAlertsSettings inv hasOnlyOneInstance:
   StaffNoticesAlertsSettings.allInstances()->size()=1


-- TICKETS MANAGEMENT

class Ticket
attributes
ticketStatus:TicketStatus
fullName:String
email:String
```

```
telephone:String [0..1]
ext:String[0..1]
subject:String
message:String
priority:Priority
source:TicketSource
/creationDatetime:Datetime=System.allInstances()->any(true).currentDateTime constant
dueDatetime:Datetime[0..1]
lastResponseDatetime:Datetime[0..1]
lastMessageDatetime:Datetime[0..1]
/number:Integer=(if TicketSettings.allInstances()->any(true).mode=#Sequential then
        Ticket.allInstances()->size()
    else System.allInstances()->any(true).aleat
    endif) constant
isOverdue:Boolean=false
operations
number()
end

association ticket_helpTopic between
  Ticket[*]
  HelpTopic[0..1]
end

association ticket_assignedStaff between
  Ticket[*]
  StaffMember[0..1] role assignedStaff
end


class TicketThreadMessage
attributes
datetime:Datetime
text:String
author:String
end

class InternalNote
attributes
datetime:Datetime
subject:String
text:String
author:String
end

association ticket_internalNote between
  Ticket[1]
  InternalNote[*]
 end


association ticket_ticketThreadMessage between
  Ticket[1]
  TicketThreadMessage[*]
end

association ticket_assignedDepartment between
  Ticket[*]
  Department[1] role assignedDepartment
end

association ticket_lastRespondent between
  Ticket[*] role ticketOfLastRespondent
  StaffMember[0..1] role lastRespondent
end


event NewTicketOnline
attributes
fullName:String
email:String
telephone:String[0..1]
```

```
ext:String[0..1]
subject:String
message:String
priority:Priority[0..1]
createdTicket:Ticket[0..1]
operations
effect()
end

context NewTicketOnline ini inv priorityMayBeSetWhenAllowed:
   if TicketSettings.allInstances->any(true).customersCanChangePriority then
      self.priority.isDefined()
   else
      self.priority.isUndefined()
   endif


context NewTicketOnline ini inv emailIsNotInBanList:
 EmailSettings.allInstances()->any(true).banList->notEmpty() implies
   EmailSettings.allInstances()->any(true).banList->excludes(self.email)

association newTicketOnline_helpTopic between
   NewTicketOnline[*]
   HelpTopic[0..1]
end

context NewTicketOnline ini inv helpTopicSpecifiedIfAvailable:
   if HelpTopic.allInstances()->select(hp|hp.status=#Enabled)->size()>0  then
      self.helpTopic->size()=1
   else
      self.helpTopic->size()=0
   endif

context NewTicketOnline ini inv helpTopicIsEnabled:
  self.helpTopic->notEmpty() implies self.helpTopic.status=#Enabled

context NewTicketOnline ini inv helpDeskStatusIsOnline:
  GeneralSettings.allInstances()->any(true).status=#Online

context NewTicketOnline ini inv maximumOpenTicketsLimitIsNotViolated:
   if TicketSettings.allInstances()->any(true).openTicketsPerMailAreLimited then
   Ticket.allInstances->select(tIt.email=self.email)->size()<TicketSettings.allInstances()->any(true).maximumOpenTicketsPerMail
   else true
   endif


context NewTicketOnline::effect()
post:
let defaultPriority:Priority=
      if self.helpTopic->notEmpty() then
         self.helpTopic.newTicketPriority
      else
         TicketSettings.allInstances()->any(true).priority
      endif
in
let assignedPriority:Priority=
   if TicketSettings.allInstances()->any(true).customersCanChangePriority then
      self.priority
   else
      defaultPriority
   endif
in
let defaultDepartment:Department=
      if self.helpTopic->notEmpty() then
         self.helpTopic.newTicketDepartment
      else
         Department.allInstances()->any(dId.isDefault)
      endif
in
let sendNewTicketAlertToAdministrator:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#Administrator)
```

```
in
let sendNewTicketAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentManager)
in
let sendNewTicketAlertToDepartmentMembers:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentMembers)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let sendAutoresponse:Boolean=
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewTicketCreatedByCustomer then
      if self.helpTopic->notEmpty then
         if self.helpTopic.autoresponse=#Enabled then true
         else false
         endif
      else
         defaultDepartment.newTicketAutoresponseIsSent
      endif
   else false
   endif
in
(Ticket.allInstances- Ticket.allInstances@pre)
  ->one(t | t.oclIsNew()
         and self.createdTicket=t
         and t.fullName=self.fullName
         and t.email=self.email
         and t.telephone=self.telephone
         and t.ext=self.ext
         and t.subject=self.subject
         and t.message=self.message
         and t.ticketStatus=#Open
         and t.priority=assignedPriority
         and t.source=#Web
         and t.helpTopic=self.helpTopic
         and t.assignedDepartment=defaultDepartment
         and (TicketThreadMessage.allInstances- TicketThreadMessage.allInstances@pre)
            ->one(tdm | tdm.oclIsNew()
            and tdm.datetime=System.allInstances()->any(true).currentDateTime
            and tdm.text=self.message
            and tdm.author=self.fullName
            and tdm.ticket=t
            and t.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

         -- autoresponses
         and (sendAutoresponse implies
            EMail.allInstances()->exists(ele.fromAddress=t.assignedDepartment.autoresponseEmail.address and
                                 e.toAddress=t.email and
                                 e.ticketNumber=t.number))


         -- staff notices
         and (sendNewTicketAlertToAdministrator implies
            EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                 e.toAddress=EmailSettings.allInstances()->any(true).administrationEmail and
                                 e.ticketNumber=t.number))

         and  (sendNewTicketAlertToDepartmentManager
            and t.assignedDepartment.departmentManager->notEmpty()
            and t.assignedDepartment.departmentManager.status=#Enabled
            and not(t.assignedDepartment.departmentManager.isInVacationMode)
            implies
              EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                 e.toAddress=t.assignedDepartment.departmentManager.emailAddress and
                                 e.ticketNumber=t.number))

         and  (sendNewTicketAlertToDepartmentMembers
            implies
            t.assignedDepartment.staffMember->forAll(m|
              (m.status=#Enabled and not(m.isInVacationMode))
```

```
            implies
            EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                    e.toAddress=m.emailAddress and
                                    e.ticketNumber=t.number)))
        )


event NewTicketByEmail
attributes
toAddress:String
fromName:String
fromAddress:String
subject:String
message:String
createdTicket:Ticket[0..1]
operations
effect()
end


context NewTicketByEmail ini inv emailIsNotInBanList:
 EmailSettings.allInstances()->any(true).banList->notEmpty() implies
   EmailSettings.allInstances()->any(true).banList->excludes(self.fromAddress)

context NewTicketByEmail::effect()
post:
let incomingEmailAccount:EmailAccount=
  EmailAccount.allInstances()->any(ele.address=self.toAddress)
in
let assignedPriority:Priority=
      if TicketSettings.allInstances()->any(true).useEmailPriorityWhenAvailable then
         incomingEmailAccount.defaultNewPriority
      else
           TicketSettings.allInstances()->any(true).priority
      endif
in
let defaultDepartment:Department=
      incomingEmailAccount.defaultNewTicketDepartment
in
let sendNewTicketAlertToAdministrator:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#Administrator)
in
let sendNewTicketAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentManager)
in
let sendNewTicketAlertToDepartmentMembers:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentMembers)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let sendAutoresponse:Boolean=
     if (incomingEmailAccount.autoresponsesStatus=#Enabled) then true
     else false
     endif
in
(Ticket.allInstances- Ticket.allInstances@pre)
  ->one(t | t.oclIsNew()
          and self.createdTicket=t

          and t.assignedDepartment=incomingEmailAccount.defaultNewTicketDepartment
          and (TicketThreadMessage.allInstances- TicketThreadMessage.allInstances@pre)
              ->one(tdm | tdm.oclIsNew()
              and tdm.datetime=System.allInstances()->any(true).currentDateTime
              and tdm.text=self.message
              and tdm.author=self.fromName
              and tdm.ticket=t
              and t.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)
```

```
        )

        context NewTicketByEmail ini inv maximumOpenTicketsLimitIsNotViolated:
            if TicketSettings.allInstances()->any(true).openTicketsPerMailAreLimited then
             Ticket.allInstances->select(tIt.email=self.fromAddress)->size()<TicketSettings.allInstances()-
>any(true).maximumOpenTicketsPerMail
            else true
            endif

        context NewTicketByEmail ini inv theIncomingEmailIsValid:
            EmailAccount.allInstances()->one(address=self.toAddress)

        context NewTicketByEmail ini inv helpDeskStatusIsOnline:
            GeneralSettings.allInstances()->any(true).status=#Online

event DisplayTicketsAssociatedToEmail
attributes
email:String
ticketNumber:Integer
operations
answer():Set(Tuple(number:Integer,createDate:Integer,status:TicketStatus,subject:String,department:String, email:String))=
      Ticket.allInstances
      -> sortedBy(number)
      -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
status:t.ticketStatus,subject:t.subject,department:t.assignedDepartment.name, email:t.email})->asSet()
effect()
end

context DisplayTicketsAssociatedToEmail ini inv thereAreTicketsAssociatedToTheEmail:
    Ticket.allInstances()->select(tIt.email=self.email)->size()>0

context DisplayTicketsAssociatedToEmail ini inv accessDataIsValid:
    Ticket.allInstances()->select(tIt.email=self.email).number->includes(self.ticketNumber)


event ReplyTicketByCustomer
attributes
replyText:String
operations
effect()
end

association replyTicketByCustomer_ticket between
   ReplyTicketByCustomer[*]
   Ticket[1]
end


context ReplyTicketByCustomer::effect()
post:
let sendNewMessageAlertToLastRespondent:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#LastRespondent)
in
let sendNewMessageAlertToAssignedStaff:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#AssignedStaff)
in
let sendNewMessageAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#DepartmentManager)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let sendAutoresponse:Boolean=
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewTicketCreatedByCustomer then
      if self.ticket.helpTopic->notEmpty then
         if self.ticket.helpTopic.autoresponse=#Enabled then true
         else false
         endif
```

```
      else
         self.ticket.assignedDepartment.newTicketAutoresponseIsSent
      endif
   else false
   endif
in
self.ticket.ticketThreadMessage->one(tdm | tdm.oclIsNew()
            and tdm.datetime=System.allInstances()->any(true).currentDateTime
            and tdm.text=self.replyText
            and tdm.author=self.ticket.fullName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)


         -- autoresponses
         and (sendAutoresponse implies
            EMail.allInstances()->exists(ele.fromAddress=self.ticket.assignedDepartment.autoresponseEmail.address and
                                 e.toAddress=self.ticket.email and
                                 e.ticketNumber=self.ticket.number))


         -- staff notices
         and (sendNewMessageAlertToLastRespondent and
            self.ticket.lastRespondent->notEmpty() and
            not(self.ticket.lastRespondent.isInVacationMode or self.ticket.lastRespondent.status=#Disabled)
            implies
            EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                 e.toAddress=self.ticket.lastRespondent and
                                 e.ticketNumber=self.ticket.number ))

        and  (sendNewMessageAlertToAssignedStaff
            and self.ticket.assignedStaff->notEmpty()
            and not(self.ticket.assignedStaff.isInVacationMode or self.ticket.assignedStaff.status=#Disabled)
            implies
              EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                 e.toAddress=self.ticket.assignedStaff.emailAddress and
                                 e.ticketNumber=self.ticket.number))


event LogIn
attributes
username:String
password:String
operations
effect()
end


context LogIn::effect()
post:
StaffMember.allInstances()->any(sm|sm.username=self.username and sm.password=self.password).isLoggedIn=true

context StaffMember inv usernameIsUnique:
StaffMember.allInstances()->isUnique(username)

context LogIn ini inv isNotLoggedIn:
StaffMember.allInstances()->select(sm|sm.username=self.username and sm.password=self.password)->size()>0
implies
   StaffMember.allInstances()->any(sm|sm.username=self.username and sm.password=self.password).isLoggedIn=false

context LogIn ini inv accessDataIsValid:
StaffMember.allInstances()->select(sm|sm.username=self.username and sm.password=self.password)->size()>0

context LogIn ini inv staffMemberIsEnabled:
StaffMember.allInstances()->select(sm|sm.username=self.username and sm.password=self.password)->size()>0
implies
   StaffMember.allInstances()->any(sm|sm.username=self.username and sm.password=self.password).status=#Enabled
   and StaffMember.allInstances()->any(sm|sm.username=self.username and
sm.password=self.password).staffGroup.status=#Enabled


event LogOut
operations
```

```
effect()
end


association logOut_staffMember between
   LogOut[*]
   StaffMember[1]
end

context LogOut::effect()
post:
self.staffMember.isLoggedIn=false


context LogOut ini inv isNotLoggedIn:
self.staffMember.isLoggedIn=true

event NewTicketOffline
attributes
fullName:String
email:String
telephone:String[0..1]
ext:String[0..1]
source:TicketSource
subject:String
message:String
priority:Priority[0..1]
createdTicket:Ticket[0..1]
internalNote:String[0..1]
dueDatetime:Datetime[0..1]
operations
effect()
end


context NewTicketOffline ini inv emailIsNotInBanList:
   EmailSettings.allInstances()->any(true).banList->notEmpty() implies
   EmailSettings.allInstances()->any(true).banList->excludes(self.email)

association newTicketOffline_department between
   NewTicketOffline[*]
   Department[1] role assignedDepartment
end

association newTicketOffline_helpTopic between
   NewTicketOffline[*]
   HelpTopic[0..1]
end

association newTicketOffline_assignedStaff between
   NewTicketOffline[*]
   StaffMember[0..1] role assignedStaff
end

association newTicketOffline_creator between
   NewTicketOffline[*] role newTicketOfflineOfCreator
   StaffMember[1] role creator
end

context NewTicketOffline ini inv creatorIsLoggedIn:
   self.creator.isLoggedIn

context NewTicketOffline ini inv creatorIsAllowedToCreateTickets:
   self.creator.staffGroup.canCreateTickets

context NewTicketOffline ini inv helpTopicSpecifiedIfAvailable:
   if HelpTopic.allInstances()->select(hp|hp.status=#Enabled)->size()>0  then
      self.helpTopic->size()=1
   else
      self.helpTopic->size()=0
   endif
```

```
context NewTicketOffline ini inv helpTopicIsEnabled:
  self.helpTopic->notEmpty() implies self.helpTopic.status=#Enabled


context NewTicketOffline ini inv maximumOpenTicketsLimitIsNotViolated:
   if TicketSettings.allInstances()->any(true).openTicketsPerMailAreLimited then
   Ticket.allInstances->select(tIt.email=self.email)->size()<TicketSettings.allInstances()->any(true).maximumOpenTicketsPerMail
   else true
   endif


context NewTicketOffline::effect()
post:
let sendNewTicketAlertToAdministrator:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#Administrator)
in
let sendNewTicketAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentManager)
in
let sendNewTicketAlertToDepartmentMembers:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentMembers)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let sendAutoresponse:Boolean=
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewTicketCreatedByCustomer then
      if self.helpTopic->notEmpty then
         if self.helpTopic.autoresponse=#Enabled then true
         else false
         endif
      else
         self.assignedDepartment.newTicketAutoresponseIsSent
      endif
   else false
   endif
in
(Ticket.allInstances- Ticket.allInstances@pre)
  ->one(t | t.oclIsNew()
         and self.createdTicket=t
         and t.fullName=self.fullName
         and t.email=self.email
         and t.telephone=self.telephone
         and t.ext=self.ext
         and t.subject=self.subject
         and t.message=self.message
         and t.ticketStatus=#Open
         and t.priority=self.priority
         and t.source=self.source
         and t.dueDatetime=self.dueDatetime
         and t.helpTopic=self.helpTopic
         and t.assignedDepartment=self.assignedDepartment
         and t.assignedStaff=self.assignedStaff
         and (TicketThreadMessage.allInstances- TicketThreadMessage.allInstances@pre)
            ->one(tdm | tdm.oclIsNew()
            and tdm.datetime=System.allInstances()->any(true).currentDateTime
            and tdm.text=self.message
            and tdm.author=self.fullName
            and tdm.ticket=t
            and t.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

         -- autoresponses
         and (sendAutoresponse implies
            EMail.allInstances()->exists(ele.fromAddress=t.assignedDepartment.autoresponseEmail.address and
                                 e.toAddress=t.email and
                                 e.ticketNumber=t.number))


         -- staff notices
```

```
        and (sendNewTicketAlertToAdministrator implies
           EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=EmailSettings.allInstances()->any(true).administrationEmail and
                                e.ticketNumber=t.number))

        and  (sendNewTicketAlertToDepartmentManager
            and t.assignedDepartment.departmentManager->notEmpty()
            and t.assignedDepartment.departmentManager.status=#Enabled
            and not(t.assignedDepartment.departmentManager.isInVacationMode)
            implies
              EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=t.assignedDepartment.departmentManager.emailAddress and
                                e.ticketNumber=t.number))

        and  (sendNewTicketAlertToDepartmentMembers
            implies
            t.assignedDepartment.staffMember->forAll(m|
              (m.status=#Enabled and not(m.isInVacationMode))
              implies
              EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                  e.toAddress=m.emailAddress and
                                  e.ticketNumber=t.number)))
      )


event DisplayTicketsByStatus
attributes
status:StatusFilter
operations
answer():Sequence(Tuple(number:Integer,createDate:Integer,subject:String,department:String, priority:Priority,email:String))=
      let visibleDepartments:Set(Department)=
          self.consultant.staffGroup.departmentsAccess->including(self.consultant.department)
      in
      if self.status=#OpenTickets then
      Ticket.allInstances
      ->select(tIt.ticketStatus=#Open and visibleDepartments->includes(t.assignedDepartment))
      -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})->sortedBy(number)
      else
      if self.status=#AssignedToMe then
      Ticket.allInstances
      ->select(tIt.assignedStaff=self.consultant and t.ticketStatus<>#Closed and visibleDepartments-
>includes(t.assignedDepartment))
      -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})->sortedBy(number)
      else
      if self.status=#OverdueTickets then
      Ticket.allInstances
      ->select(tIt.isOverdue and t.ticketStatus<>#Closed and visibleDepartments->includes(t.assignedDepartment))
      -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})->sortedBy(number)
      else
      Ticket.allInstances
      ->select(tIt.ticketStatus=#Closed and visibleDepartments->includes(t.assignedDepartment))
      -> collect (t | Tuple  {number : t.number, createDate:t.creationDatetime.value,
subject:t.subject,department:t.assignedDepartment.name, priority:t.priority, email:t.email})->sortedBy(number)
      endif
      endif
      endif
effect()
end


association displayTicketsByStatus_consultant between
   DisplayTicketsByStatus[*] role newTicketOfflineOfConsultant
   StaffMember[1] role consultant
end
```

```
context DisplayTicketsByStatus ini inv consulantIsLoggedIn:
    self.consultant.isLoggedIn

event ChangeTicketPriority<StaffTicketEvent
attributes
newPriority:Priority
operations
effect()
end



context ChangeTicketPriority::effect()
post:
self.ticket.priority=self.newPriority
and
(InternalNote.allInstances- InternalNote.allInstances@pre)
            ->one(i | i.oclIsNew()
            and i.datetime=System.allInstances()->any(true).currentDateTime
            and i.subject='Ticket priority changed'
            and i.text='The ticket priority has been changed'
            and i.author=self.staffMember.firstName
            and i.ticket=self.ticket)
  and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime



event MarkTicketOverdue<StaffTicketEvent
operations
effect()
end



context MarkTicketOverdue::effect()
post:
self.ticket.isOverdue
and
(InternalNote.allInstances- InternalNote.allInstances@pre)
            ->one(i | i.oclIsNew()
            and i.datetime=System.allInstances()->any(true).currentDateTime
            and i.subject='Ticket Marked Overdue'
            and i.text='Ticket flagged as overdue'
            and i.author=self.staffMember.firstName
            and i.ticket=self.ticket)
  and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime

context MarkTicketOverdue ini inv staffMemberIsAnAdministrator:
    self.staffMember.isAdministrator



event AssignTicket<StaffTicketEvent
attributes
assignmentText:String
operations
effect()
end



association assignTicket_assignee between
   AssignTicket[*] role assignTicketOfAssignee
   StaffMember[1] role assignee
end
```

```
context AssignTicket::effect()
post:
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
self.ticket.assignedStaff=self.assignee
and
(InternalNote.allInstances- InternalNote.allInstances@pre)
            ->one(i | i.oclIsNew()
            and i.datetime=System.allInstances()->any(true).currentDateTime
            and i.subject='Ticket Reassigned'
            and i.text=self.assignmentText
            and i.author=self.staffMember.firstName
            and i.ticket=self.ticket)
  and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime
   and (EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                              e.toAddress=self.assignee.emailAddress and
                              e.ticketNumber=self.ticket.number))


context AssignTicket ini inv assigneeIsNotInVacationMode:
    not(self.assignee.isInVacationMode)



event ReleaseTicket<StaffTicketEvent
operations
effect()
end



context ReleaseTicket::effect()
post:
self.ticket.assignedStaff->isEmpty()
and
(InternalNote.allInstances- InternalNote.allInstances@pre)
            ->one(i | i.oclIsNew()
            and i.datetime=System.allInstances()->any(true).currentDateTime
            and i.subject='Ticket unassigned'
            and i.text='Released ticket'
            and i.author=self.staffMember.firstName
            and i.ticket=self.ticket)


context ReleaseTicket ini inv theTicketIsAssigned:
    self.ticket.assignedStaff.isDefined()



event EditTicket<StaffTicketEvent
attributes
emailAddress:String
fullName:String
subject:String
telephone:String [0..1]
ext:String[0..1]
priority:Priority
dueDatetime:Datetime
editionInternalNote:String
operations
effect()
end


association editTicket_helpTopic between
   EditTicket[*]
   HelpTopic[1]
end
```

```
context EditTicket::effect()
post:
self.ticket.email=self.emailAddress and
self.ticket.fullName=self.fullName and
self.ticket.subject=self.subject and
self.ticket.telephone=self.telephone and
self.ticket.ext=self.ext and
self.ticket.priority=self.priority and
self.ticket.helpTopic=self.helpTopic and
self.ticket.dueDatetime=self.dueDatetime
and
(InternalNote.allInstances- InternalNote.allInstances@pre)
            ->one(i | i.oclIsNew()
            and i.datetime=System.allInstances()->any(true).currentDateTime
            and i.subject='Ticket updated'
            and i.text=self.editionInternalNote
            and i.author=self.staffMember.firstName
            and i.ticket=self.ticket)


context EditTicket ini inv staffMemberIsNotAllowedToEditTickets:
    self.staffMember.staffGroup.canEditTickets or self.staffMember.isAdministrator



event PostTicketReply<StaffTicketEvent
attributes
response:String
operations
effect()
end


context PostTicketReply::effect()
post:

let sendNewMessageAlertToLastRespondent:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#LastRespondent)
in
let sendNewMessageAlertToAssignedStaff:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#AssignedStaff)
in
let sendNewMessageAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#DepartmentManager)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
let sendAutoresponse:Boolean=
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewMessageAppendedToTicket then
      if self.ticket.helpTopic->notEmpty then
         if self.ticket.helpTopic.autoresponse=#Enabled then true
         else false
         endif
      else
         self.ticket.assignedDepartment.newAddedMessageIsNotified
      endif
   else false
   endif
in
self.ticket.ticketThreadMessage->one(tdm | tdm.oclIsNew()
            and tdm.datetime=System.allInstances()->any(true).currentDateTime
            and tdm.text=self.response
            and tdm.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)
```

```
        and self.ticket.lastRespondent=self.staffMember


        and (sendAutoresponse implies
           EMail.allInstances()->exists(ele.fromAddress=self.ticket.assignedDepartment.autoresponseEmail.address and
                                e.toAddress=self.ticket.email and
                                e.ticketNumber=self.ticket.number))

        -- staff notices
        and (sendNewMessageAlertToLastRespondent and
             self.ticket.lastRespondent@pre->notEmpty() and
             not(self.ticket.lastRespondent@pre.isInVacationMode or self.ticket.lastRespondent@pre.status=#Disabled)
             implies
           EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=self.ticket.lastRespondent@pre and
                                e.ticketNumber=self.ticket.number ))

       and  (sendNewMessageAlertToAssignedStaff
             and self.ticket.assignedStaff->notEmpty()
             and not(self.ticket.assignedStaff.isInVacationMode or self.ticket.assignedStaff.status=#Disabled)
             implies
               EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=self.ticket.assignedStaff.emailAddress and
                                e.ticketNumber=self.ticket.number))



event PostTicketInternalNote<StaffTicketEvent
attributes
title:String
note:String
operations
effect()
end



context PostTicketInternalNote::effect()
post:

let sendNewMessageAlertToLastRespondent:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#LastRespondent)
in
let sendNewMessageAlertToAssignedStaff:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#AssignedStaff)
in
let sendNewMessageAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#DepartmentManager)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
self.ticket.internalNote->one(int | int.oclIsNew()
             and int.datetime=System.allInstances()->any(true).currentDateTime
             and int.subject=self.title
             and int.text=self.note
             and int.author=self.staffMember.firstName
             and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)


        -- staff notices
        and (sendNewMessageAlertToLastRespondent and
             self.ticket.lastRespondent@pre->notEmpty() and
             not(self.ticket.lastRespondent@pre.isInVacationMode or self.ticket.lastRespondent@pre.status=#Disabled)
             implies
           EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=self.ticket.lastRespondent@pre and
```

```
                                e.ticketNumber=self.ticket.number ))

        and  (sendNewMessageAlertToAssignedStaff
             and self.ticket.assignedStaff->notEmpty()
             and not(self.ticket.assignedStaff.isInVacationMode or self.ticket.assignedStaff.status=#Disabled)
             implies
               EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                                e.toAddress=self.ticket.assignedStaff.emailAddress and
                                e.ticketNumber=self.ticket.number))



event StaffTicketEvent
end

association staffTicketEvent_ticket between
   StaffTicketEvent[*]
   Ticket[1]
end

association staffTicketEvent_staffMember between
   StaffTicketEvent[*]
   StaffMember[1]
end

context StaffTicketEvent ini inv theTicketIsVisible:
    self.staffMember.isAdministrator or
    (self.staffMember.staffGroup.departmentsAccess->including(self.staffMember.department))-
>includes(self.ticket.assignedDepartment)

context StaffTicketEvent ini inv staffMemberIsLoggedIn:
    self.staffMember.isLoggedIn


event TransferDepartment<StaffTicketEvent
attributes
note:String
operations
effect()
end

association transferDepartment_department between
   TransferDepartment[*]
   Department[1]
end


context TransferDepartment::effect()
post:
self.ticket.assignedDepartment=self.department and
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
            and int.subject='Department transfer'
            and int.text=self.note
            and int.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)


context TransferDepartment ini inv departmentIsDifferent:
    self.department <> self.ticket.assignedDepartment

context TransferDepartment ini inv staffMemberIsAllowedToTransfer:
    self.staffMember.staffGroup.canTransferTickets


event CloseTicket<StaffTicketEvent
operations
effect()
end
```

```
context CloseTicket::effect()
post:
self.ticket.ticketStatus=#Closed and
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
            and int.subject='Ticket closed'
            and int.text='Ticket closed without response'
            and int.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

 context CloseTicket ini inv staffMemberIsAllowedToClose:
    self.staffMember.staffGroup.canCloseTickets

  context CloseTicket ini inv ticketIsNotClosed:
    not (self.ticket.ticketStatus=#Closed)

event CloseTicketWithResponse<StaffTicketEvent
attributes
response:String
operations
effect()
end

context CloseTicketWithResponse::effect()
post:
let sendAutoresponse:Boolean=
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewMessageAppendedToTicket then
      if self.ticket.helpTopic->notEmpty then
         if self.ticket.helpTopic.autoresponse=#Enabled then true
         else false
         endif
      else
         self.ticket.assignedDepartment.newAddedMessageIsNotified
      endif
   else false
   endif
in
self.ticket.ticketStatus=#Closed and
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
            and int.subject='Ticket closed'
            and int.text='Ticket closed on reply'
            and int.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)
and
self.ticket.ticketThreadMessage->one(tdm | tdm.oclIsNew()
            and tdm.datetime=System.allInstances()->any(true).currentDateTime
            and tdm.text=self.response
            and tdm.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

         and self.ticket.lastRespondent=self.staffMember


         and (sendAutoresponse implies
            EMail.allInstances()->exists(ele.fromAddress=self.ticket.assignedDepartment.autoresponseEmail.address and
                                 e.toAddress=self.ticket.email and
                                 e.ticketNumber=self.ticket.number))

context CloseTicketWithResponse ini inv staffMemberIsAllowedToClose:
  self.staffMember.staffGroup.canCloseTickets

context CloseTicketWithResponse ini inv ticketIsNotClosed:
not (self.ticket.ticketStatus=#Closed)


event ReopenTicket<StaffTicketEvent
operations
effect()
end

context ReopenTicket::effect()
```

```
post:
self.ticket.ticketStatus=#Open and
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
            and int.subject='Ticket reopened'
            and int.text='Ticket reopened without comments'
            and int.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

context ReopenTicket ini inv ticketIsClosed:
 self.ticket.ticketStatus=#Closed


event ReopenTicketWithResponse<StaffTicketEvent
attributes
response:String
operations
effect()
end

context ReopenTicketWithResponse::effect()
post:
let sendAutoresponse:Boolean=
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewMessageAppendedToTicket then
      if self.ticket.helpTopic->notEmpty then
         if self.ticket.helpTopic.autoresponse=#Enabled then true
         else false
         endif
      else
         self.ticket.assignedDepartment.newAddedMessageIsNotified
      endif
   else false
   endif
in
self.ticket.ticketStatus=#Open and
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
            and int.subject='Ticket status changed to open'
            and int.text='A staff member reopened the ticket on reply'
            and int.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)
and
self.ticket.ticketThreadMessage->one(tdm | tdm.oclIsNew()
            and tdm.datetime=System.allInstances()->any(true).currentDateTime
            and tdm.text=self.response
            and tdm.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

         and self.ticket.lastRespondent=self.staffMember


         and (sendAutoresponse implies
            EMail.allInstances()->exists(ele.fromAddress=self.ticket.assignedDepartment.autoresponseEmail.address and
                                 e.toAddress=self.ticket.email and
                                 e.ticketNumber=self.ticket.number))

context ReopenTicketWithResponse ini inv ticketIsClosed:
 self.ticket.ticketStatus=#Closed


event BanEmailAndCloseTicket<StaffTicketEvent
operations
effect()
end


context BanEmailAndCloseTicket::effect()
post:
self.ticket.ticketStatus=#Closed and
EmailSettings.allInstances()->any(true).banList->includes(self.ticket.email) and
self.ticket.internalNote->one(int | int.oclIsNew()
            and int.datetime=System.allInstances()->any(true).currentDateTime
```

```
            and int.subject='Ticket closed'
            and int.text='Email added to banlist and ticket status set to closed'
            and int.author=self.staffMember.firstName
            and self.ticket.lastMessageDatetime=System.allInstances()->any(true).currentDateTime)

context BanEmailAndCloseTicket ini inv ticketIsNotClosed:
not (self.ticket.ticketStatus=#Closed)

context BanEmailAndCloseTicket ini inv staffMemberIsAllowedToBanEmails:
 self.staffMember.staffGroup.canBanEmails


event DeleteTicket
operations
effect()
end

association deleteTicket_ticket between
   DeleteTicket[*]
   Ticket[0..1]
end

association deleteTicket_staffMember between
   DeleteTicket[*]
   StaffMember[1]
end


context DeleteTicket::effect()
post:
Ticket.allInstances()->excludes(self.ticket@pre) and
self.ticket@pre.internalNote@pre->forAll(int|InternalNote.allInstances()->excludes(int))
-- and self.ticket@pre.ticketThreadMessage@pre->forAll(ttm|TicketThreadMessage.allInstances()->excludes(ttm))


context DeleteTicket ini inv theTicketIsVisible:
    self.staffMember.isAdministrator or
    (self.staffMember.staffGroup.departmentsAccess->including(self.staffMember.department))-
>includes(self.ticket.assignedDepartment)

context DeleteTicket ini inv staffMemberIsLoggedIn:
   self.staffMember.isLoggedIn

context DeleteTicket ini inv staffMemberIsAllowedToDeleteTickets:
    self.staffMember.isAdministrator or
    self.staffMember.staffGroup.canDeleteTickets

event CheckOverdueTickets
operations
effect()
end

context CheckOverdueTickets::effect()
post:
let sendOverdueTicketAlertToAdministrator:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdue and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdueStaff->includes(#Administrator)
in
let sendOverdueTicketAlertToDepartmentManager:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdue and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdueStaff->includes(#DepartmentManager)
in
let sendOverdueTicketAlertToDepartmentMembers:Boolean=
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdue and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdueStaff->includes(#DepartmentMembers)
in
let staffAlertsFromEMailAddress:String=
   EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address
in
Ticket.allInstances()->select(tl (System.allInstances()
                              ->any(true).currentDateTime.value>(t.dueDatetime.value+TicketSettings.allInstances()
                               ->any(true).ticketGracePeriod))
```

```
    and not(t.isOverdue))
   -> forAll(tIt.isOverdue


-- staff notices
and (sendOverdueTicketAlertToAdministrator implies
   EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                          e.toAddress=EmailSettings.allInstances()->any(true).administrationEmail and
                          e.ticketNumber=t.number))

and  (sendOverdueTicketAlertToDepartmentManager
    and t.assignedDepartment.departmentManager->notEmpty()
    and t.assignedDepartment.departmentManager.status=#Enabled
    and not(t.assignedDepartment.departmentManager.isInVacationMode)
    implies
      EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                          e.toAddress=t.assignedDepartment.departmentManager.emailAddress and
                          e.ticketNumber=t.number))

and  (sendOverdueTicketAlertToDepartmentMembers
    implies
    t.assignedDepartment.staffMember->forAll(ml
      (m.status=#Enabled and not(m.isInVacationMode))
      implies
      EMail.allInstances()->exists(ele.fromAddress=staffAlertsFromEMailAddress and
                            e.toAddress=m.emailAddress and
                            e.ticketNumber=t.number)))

  )
```

Appendix B. Methods specification

```
method SendMail{
m1:=new EMail;
m1.fromAddress:=self.fromAddress;
m1.toAddress:=self.toAddress;
m1.emailKind:=self.emailKind;
m1.ticketNumber:=self.ticketNumber;
m1.timeStamp:=System.allInstances()->any(true).currentDateTime;
self.createdEmail:=m1;
}

method NewTicketOnline{
   t1:=new Ticket;
   self.createdTicket:=t1;
   t1.fullName:=self.fullName;
   t1.email:=self.email;
   t1.telephone:=self.telephone;
   t1.ext:=self.ext;
   t1.subject:=self.subject;
   t1.message:=self.message;
   t1.ticketStatus:=#Open;
   t1.helpTopic:=self.helpTopic;


   dp1:=[if self.helpTopic->notEmpty() then
         self.helpTopic.newTicketPriority
      else
         TicketSettings.allInstances()->any(true).priority
      endif];

   ap1:=dp1;

   if TicketSettings.allInstances()->any(true).customersCanChangePriority then
      ap1:=self.priority;
   endif

   t1.priority:=ap1;
   t1.source:=#Web;

   ddpt1:=[if self.helpTopic->notEmpty() then
         self.helpTopic.newTicketDepartment
      else
         Department.allInstances()->any(dId.isDefault)
      endif];
   t1.assignedDepartment:=ddpt1;

   tdm1:=new TicketThreadMessage;
   tdm1.datetime:=System.allInstances()->any(true).currentDateTime;
   tdm1.text:=self.message;
   tdm1.author:=self.fullName;
   tdm1.ticket:=t1;
   t1.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;


   //Autoresponses
   sendAutoresponse:=false;
```

```
    if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewTicketCreatedByCustomer then
       if self.helpTopic->notEmpty then
          if self.helpTopic.autoresponse=#Enabled then sendAutoresponse:=true;
          endif
       else
           sendAutoresponse:=ddpt1.newTicketAutoresponseIsSent;
       endif
    endif

    if sendAutoresponse then
       m1:=new EMail(fromAddress:=t1.assignedDepartment.autoresponseEmail.address,
                  toAddress:=t1.email,
                  ticketNumber:=t1.number,emailKind:=NewTicketAutoresponse.allInstances()->any(true));
    endif

    //Staff alerts
    sendNewTicketAlertToAdministrator:=[
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#Administrator)];

    sendNewTicketAlertToDepartmentManager:=
    [StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentManager)];

    sendNewTicketAlertToDepartmentMembers:=
    [StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentMembers)];

    staffAlertsFromEMailAddress:=
    [EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address];

    if sendNewTicketAlertToAdministrator then
       m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                  toAddress:=[EmailSettings.allInstances()->any(true).administrationEmail],
                  ticketNumber:=t1.number,emailKind:=NewTicketAlertToStaff.allInstances()->any(true));
    endif

    if sendNewTicketAlertToDepartmentManager   then
       if  t1.assignedDepartment.departmentManager->notEmpty() then
          if  t1.assignedDepartment.departmentManager.status=#Enabled then
            if t1.assignedDepartment.departmentManager.isInVacationMode=false then
                m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                           toAddress:=[t1.assignedDepartment.departmentManager.emailAddress],
                           ticketNumber:=t1.number,emailKind:=NewTicketAlertToStaff.allInstances()->any(true));
           endif
          endif
       endif
    endif

    if sendNewTicketAlertToDepartmentMembers   then
       i:=1;
       staff:=t1.assignedDepartment.staffMember->asSequence();
       while i<t1.assignedDepartment.staffMember->size() do
          currentStaffMember:=staff->at(i);
          if currentStaffMember.isInVacationMode=false then
             if currentStaffMember.status=#Enabled then
                m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                        toAddress:=currentStaffMember.emailAddress,
                        ticketNumber:=t1.number, emailKind:=NewTicketAlertToStaff.allInstances()->any(true));
             endif
          endif
       i:=i+1;
       endwhile
    endif

}

method NewTicketByEmail{
    t1:=new Ticket;
    self.createdTicket:=t1;
    t1.fullName:=self.fromName;
    t1.email:=self.fromAddress;
```

```
t1.subject:=self.subject;
t1.message:=self.message;
t1.ticketStatus:=#Open;

incomingEmailAccount:=EmailAccount.allInstances()->any(ele.address=self.toAddress);

dp1:=TicketSettings.allInstances()->any(true).priority;

   if TicketSettings.allInstances()->any(true).useEmailPriorityWhenAvailable then
      dp1:=incomingEmailAccount.defaultNewPriority;
   endif

ap1:=dp1;


t1.priority:=ap1;
t1.source:=#EMail;

ddpt1:=incomingEmailAccount.defaultNewTicketDepartment;
t1.assignedDepartment:=ddpt1;

tdm1:=new TicketThreadMessage;
tdm1.datetime:=System.allInstances()->any(true).currentDateTime;
tdm1.text:=self.message;
tdm1.author:=self.fromName;
tdm1.ticket:=t1;
t1.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;

sendAutoresponse:=true;
//Autoresponses
if incomingEmailAccount.autoresponsesStatus=#Enabled then
   sendAutoresponse:=true;
else
   sendAutoresponse:=false;
endif


if sendAutoresponse then
   m1:=new EMail(fromAddress:=t1.assignedDepartment.autoresponseEmail.address,
            toAddress:=t1.email,
            ticketNumber:=t1.number,emailKind:=NewTicketAutoresponse.allInstances()->any(true));
endif

//Staff alerts
sendNewTicketAlertToAdministrator:=[
StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#Administrator)];

sendNewTicketAlertToDepartmentManager:=
[StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentManager)];

sendNewTicketAlertToDepartmentMembers:=
[StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentMembers)];

staffAlertsFromEMailAddress:=
[EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address];

if sendNewTicketAlertToAdministrator then
   m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
            toAddress:=[EmailSettings.allInstances()->any(true).administrationEmail],
            ticketNumber:=t1.number,emailKind:=NewTicketAlertToStaff.allInstances()->any(true));
endif

if sendNewTicketAlertToDepartmentManager   then
   if  t1.assignedDepartment.departmentManager->notEmpty() then
      if  t1.assignedDepartment.departmentManager.status=#Enabled then
        if t1.assignedDepartment.departmentManager.isInVacationMode=false then
           m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                    toAddress:=[t1.assignedDepartment.departmentManager.emailAddress],
                    ticketNumber:=t1.number,emailKind:=NewTicketAlertToStaff.allInstances()->any(true));
```

```
            endif
          endif
        endif
    endif

    if sendNewTicketAlertToDepartmentMembers   then
        i:=1;
        staff:=t1.assignedDepartment.staffMember->asSequence();
        while i<t1.assignedDepartment.staffMember->size() do
            currentStaffMember:=staff->at(i);
            if currentStaffMember.isInVacationMode=false then
                if currentStaffMember.status=#Enabled then
                    m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                            toAddress:=currentStaffMember.emailAddress,
                            ticketNumber:=t1.number, emailKind:=NewTicketAlertToStaff.allInstances()->any(true));
                endif
            endif
        i:=i+1;
        endwhile
    endif

}

method DisplayTicketsAssociatedToEmail{
}

method ReplyTicketByCustomer{
    //Staff alerts
    sendNewMessageAlertToLastRespondent:=[
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#LastRespondent)];

    sendNewMessageAlertToAssignedStaff:=[
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#AssignedStaff)];

    sendNewMessageAlertToDepartmentManager:=[
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#DepartmentManager)];

    staffAlertsFromEMailAddress:=
    [EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address];


   if sendNewMessageAlertToLastRespondent   then
        if  self.ticket.lastRespondent->notEmpty() then
            if  self.ticket.lastRespondent.status=#Enabled then
              if self.ticket.lastRespondent.isInVacationMode=false then
                  m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                            toAddress:=[self.ticket.lastRespondent.emailAddress],
                            ticketNumber:=self.ticket.number,emailKind:=NewMessageAlertToStaff.allInstances()->any(true));
              endif
            endif
        endif
    endif

      if sendNewMessageAlertToAssignedStaff   then
       if  self.ticket.assignedStaff->notEmpty() then
            if  self.ticket.assignedStaff.status=#Enabled then
              if self.ticket.assignedStaff.isInVacationMode=false then
                  m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                            toAddress:=[self.ticket.assignedStaff.emailAddress],
                            ticketNumber:=self.ticket.number,emailKind:=NewMessageAlertToStaff.allInstances()->any(true));
              endif
            endif
        endif
    endif

   if sendNewMessageAlertToDepartmentManager   then
        if  self.ticket.assignedDepartment.departmentManager->notEmpty() then
            if  self.ticket.assignedDepartment.departmentManager.status=#Enabled then
              if self.ticket.assignedDepartment.departmentManager.isInVacationMode=false then
```

```
            m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                    toAddress:=[self.ticket.assignedDepartment.departmentManager.emailAddress],
                    ticketNumber:=self.ticket.number,emailKind:=NewMessageAlertToStaff.allInstances()->any(true));
          endif
        endif
      endif
    endif

    tdm1:=new TicketThreadMessage;
    tdm1.datetime:=System.allInstances()->any(true).currentDateTime;
    tdm1.text:=self.replyText;
    tdm1.author:=self.ticket.fullName;
    tdm1.ticket:=self.ticket;
    self.ticket.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;


    sendAutoresponse:=false;
    if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewMessageAppendedToTicket then
      if self.ticket.helpTopic->notEmpty then
        if self.ticket.helpTopic.autoresponse=#Enabled then sendAutoresponse:=true;
        endif
      else
        sendAutoresponse:=self.ticket.assignedDepartment.newAddedMessageIsNotified;
      endif
    endif

    if sendAutoresponse then
      m1:=new EMail(fromAddress:=self.ticket.assignedDepartment.autoresponseEmail.address,
              toAddress:=self.ticket.email,
              ticketNumber:=self.ticket.number,emailKind:=NewMessageAutoresponse.allInstances()->any(true));
    endif


}

method LogIn{
    ls:=[StaffMember.allInstances()->any(sm|sm.username=self.username and sm.password=self.password)];
    ls.isLoggedIn:=true;
}

method LogOut{
    self.staffMember.isLoggedIn:=false;
}


method NewTicketOffline{
    t1:=new Ticket;
    self.createdTicket:=t1;
    t1.fullName:=self.fullName;
    t1.email:=self.email;
    t1.telephone:=self.telephone;
    t1.ext:=self.ext;
    t1.subject:=self.subject;
    t1.message:=self.message;
    t1.ticketStatus:=#Open;
    t1.helpTopic:=self.helpTopic;
    t1.priority:=self.priority;
    t1.source:=self.source;
    t1.assignedDepartment:=self.assignedDepartment;
    t1.assignedStaff:=self.assignedStaff;
    t1.dueDatetime:=self.dueDatetime;

    tdm1:=new TicketThreadMessage;
    tdm1.datetime:=System.allInstances()->any(true).currentDateTime;
    tdm1.text:=self.message;
    tdm1.author:=self.fullName;
    tdm1.ticket:=t1;
    t1.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;


    //Autoresponses
    sendAutoresponse:=false;
```

```
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewTicketCreatedByCustomer then
      if self.helpTopic->notEmpty then
         if self.helpTopic.autoresponse=#Enabled then sendAutoresponse:=true;
         endif
      else
          sendAutoresponse:=self.assignedDepartment.newTicketAutoresponseIsSent;
      endif
   endif

   if sendAutoresponse then
      m1:=new EMail(fromAddress:=t1.assignedDepartment.autoresponseEmail.address,
                toAddress:=t1.email,
                ticketNumber:=t1.number,emailKind:=NewTicketNotice.allInstances()->any(true));
   endif

   //Staff alerts
   sendNewTicketAlertToAdministrator:=[
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#Administrator)];

   sendNewTicketAlertToDepartmentManager:=
   [StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentManager)];

   sendNewTicketAlertToDepartmentMembers:=
   [StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreated and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewTicketCreatedStaff->includes(#DepartmentMembers)];

   staffAlertsFromEMailAddress:=
   [EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address];

   if sendNewTicketAlertToAdministrator then
      m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                toAddress:=[EmailSettings.allInstances()->any(true).administrationEmail],
                ticketNumber:=t1.number,emailKind:=NewTicketAlertToStaff.allInstances()->any(true));
   endif

   if sendNewTicketAlertToDepartmentManager   then
      if  t1.assignedDepartment.departmentManager->notEmpty() then
         if  t1.assignedDepartment.departmentManager.status=#Enabled then
           if t1.assignedDepartment.departmentManager.isInVacationMode=false then
               m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                         toAddress:=[t1.assignedDepartment.departmentManager.emailAddress],
                         ticketNumber:=t1.number,emailKind:=NewTicketAlertToStaff.allInstances()->any(true));
          endif
         endif
      endif
   endif

   if sendNewTicketAlertToDepartmentMembers   then
      i:=1;
      staff:=t1.assignedDepartment.staffMember->asSequence();
      while i<t1.assignedDepartment.staffMember->size() do
         currentStaffMember:=staff->at(i);
         if currentStaffMember.isInVacationMode=false then
            if currentStaffMember.status=#Enabled then
               m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                        toAddress:=currentStaffMember.emailAddress,
                        ticketNumber:=t1.number, emailKind:=NewTicketAlertToStaff.allInstances()->any(true));
            endif
         endif
      i:=i+1;
      endwhile
   endif

}

method DisplayTicketsByStatus{
}

method ChangeTicketPriority{
self.ticket.priority:=self.newPriority;
```

```
  i:=new InternalNote;
  i.datetime:=System.allInstances()->any(true).currentDateTime;
  i.subject:='Ticket priority changed';
  i.text:='The ticket priority has been changed';
  i.author:=self.staffMember.firstName;
  i.ticket:=self.ticket;
  self.ticket.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;
}

method MarkTicketOverdue{
   self.ticket.isOverdue:=true;

  i:=new InternalNote;
  i.datetime:=System.allInstances()->any(true).currentDateTime;
  i.subject:='Ticket Marked Overdue';
  i.text:='Ticket flagged as overdue';
  i.author:=self.staffMember.firstName;
  i.ticket:=self.ticket;
  self.ticket.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;
}


method AssignTicket{
   self.ticket.assignedStaff:=self.assignee;

   staffAlertsFromEMailAddress:=
   [EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address];

  i:=new InternalNote;
  i.datetime:=System.allInstances()->any(true).currentDateTime;
  i.subject:='Ticket Reassigned';
  i.text:=self.assignmentText;
  i.author:=self.staffMember.firstName;
  i.ticket:=self.ticket;
  self.ticket.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;

   m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                 toAddress:=self.assignee.emailAddress,
                 ticketNumber:=self.ticket.number,emailKind:=TicketAssignedAlertToStaff.allInstances()->any(true));
}

method ReleaseTicket{
  self.ticket.assignedStaff:=Set{};

  i:=new InternalNote;
  i.datetime:=System.allInstances()->any(true).currentDateTime;
  i.subject:='Ticket unassigned';
  i.text:='Released ticket';
  i.author:=self.staffMember.firstName;
  i.ticket:=self.ticket;
  self.ticket.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;

}


method EditTicket{
self.ticket.email:=self.emailAddress;
self.ticket.fullName:=self.fullName;
self.ticket.subject:=self.subject;
self.ticket.telephone:=self.telephone;
self.ticket.ext:=self.ext;
self.ticket.priority:=self.priority;
self.ticket.helpTopic:=self.helpTopic;
self.ticket.dueDatetime:=self.dueDatetime;

i:=new InternalNote;
  i.datetime:=System.allInstances()->any(true).currentDateTime;
  i.subject:='Ticket updated';
  i.text:=self.editionInternalNote;
  i.author:=self.staffMember.firstName;
  i.ticket:=self.ticket;
```

```
}

method PostTicketReply{
   //Staff alerts
   sendNewMessageAlertToLastRespondent:=[
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#LastRespondent)];

   sendNewMessageAlertToAssignedStaff:=[
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#AssignedStaff)];

   sendNewMessageAlertToDepartmentManager:=[
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
   StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#DepartmentManager)];

   staffAlertsFromEMailAddress:=
   [EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address];

   sendAutoresponse:=false;
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewMessageAppendedToTicket then
      if self.ticket.helpTopic->notEmpty then
         if self.ticket.helpTopic.autoresponse=#Enabled then sendAutoresponse:=true;
         endif
      else
          sendAutoresponse:=self.ticket.assignedDepartment.newAddedMessageIsNotified;
      endif
   endif

   if sendAutoresponse then
      m1:=new EMail(fromAddress:=self.ticket.assignedDepartment.autoresponseEmail.address,
                toAddress:=self.ticket.email,
                ticketNumber:=self.ticket.number,emailKind:=TicketResponseNotice.allInstances()->any(true));
   endif

  if sendNewMessageAlertToLastRespondent   then
      if  self.ticket.lastRespondent->notEmpty() then
         if  self.ticket.lastRespondent.status=#Enabled then
           if self.ticket.lastRespondent.isInVacationMode=false then
               m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                        toAddress:=[self.ticket.lastRespondent.emailAddress],
                        ticketNumber:=self.ticket.number,emailKind:=NewMessageAlertToStaff.allInstances()->any(true));
           endif
         endif
      endif
   endif

     if sendNewMessageAlertToAssignedStaff   then
      if  self.ticket.assignedStaff->notEmpty() then
         if  self.ticket.assignedStaff.status=#Enabled then
           if self.ticket.assignedStaff.isInVacationMode=false then
               m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                        toAddress:=[self.ticket.assignedStaff.emailAddress],
                        ticketNumber:=self.ticket.number,emailKind:=NewMessageAlertToStaff.allInstances()->any(true));
           endif
         endif
      endif
   endif

  if sendNewMessageAlertToDepartmentManager   then
      if  self.ticket.assignedDepartment.departmentManager->notEmpty() then
         if  self.ticket.assignedDepartment.departmentManager.status=#Enabled then
           if self.ticket.assignedDepartment.departmentManager.isInVacationMode=false then
               m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                        toAddress:=[self.ticket.assignedDepartment.departmentManager.emailAddress],
                        ticketNumber:=self.ticket.number,emailKind:=NewMessageAlertToStaff.allInstances()->any(true));
           endif
         endif
      endif
   endif
```

```
    self.ticket.lastRespondent:=self.staffMember;

    tdm1:=new TicketThreadMessage;
    tdm1.datetime:=System.allInstances()->any(true).currentDateTime;
    tdm1.text:=self.response;
    tdm1.author:=self.staffMember.firstName;
    tdm1.ticket:=self.ticket;
    self.ticket.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;


}


method PostTicketInternalNote{
    //Staff alerts
    sendNewMessageAlertToLastRespondent:=[
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#LastRespondent)];

    sendNewMessageAlertToAssignedStaff:=[
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#AssignedStaff)];

    sendNewMessageAlertToDepartmentManager:=[
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessage and
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenNewMessageStaff->includes(#DepartmentManager)];

    staffAlertsFromEMailAddress:=
    [EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address];


  if sendNewMessageAlertToLastRespondent   then
      if  self.ticket.lastRespondent->notEmpty() then
          if  self.ticket.lastRespondent.status=#Enabled then
            if self.ticket.lastRespondent.isInVacationMode=false then
                m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                        toAddress:=[self.ticket.lastRespondent.emailAddress],
                        ticketNumber:=self.ticket.number,emailKind:=NewInternalNoteAlertToStaff.allInstances()->any(true));
            endif
          endif
      endif
    endif

     if sendNewMessageAlertToAssignedStaff   then
      if  self.ticket.assignedStaff->notEmpty() then
          if  self.ticket.assignedStaff.status=#Enabled then
            if self.ticket.assignedStaff.isInVacationMode=false then
                m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                        toAddress:=[self.ticket.assignedStaff.emailAddress],
                        ticketNumber:=self.ticket.number,emailKind:=NewInternalNoteAlertToStaff.allInstances()->any(true));
            endif
          endif
      endif
    endif

  if sendNewMessageAlertToDepartmentManager   then
      if  self.ticket.assignedDepartment.departmentManager->notEmpty() then
          if  self.ticket.assignedDepartment.departmentManager.status=#Enabled then
            if self.ticket.assignedDepartment.departmentManager.isInVacationMode=false then
                m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                        toAddress:=[self.ticket.assignedDepartment.departmentManager.emailAddress],
                        ticketNumber:=self.ticket.number,emailKind:=NewInternalNoteAlertToStaff.allInstances()->any(true));
            endif
          endif
      endif
    endif


   i:=new InternalNote;
   i.datetime:=System.allInstances()->any(true).currentDateTime;
   i.subject:=self.title;
```

```
  i.text:=self.note;
  i.author:=self.staffMember.firstName;
  i.ticket:=self.ticket;
  self.ticket.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;


}

method TransferDepartment{

  self.ticket.assignedDepartment:=self.department;

  i:=new InternalNote;
  i.datetime:=System.allInstances()->any(true).currentDateTime;
  i.subject:='Department transfer';
  i.text:=self.note;
  i.author:=self.staffMember.firstName;
  i.ticket:=self.ticket;
  self.ticket.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;


}

method CloseTicket{

  self.ticket.ticketStatus:=#Closed;

  i:=new InternalNote;
  i.datetime:=System.allInstances()->any(true).currentDateTime;
  i.subject:='Ticket closed';
  i.text:='Ticket closed without response';
  i.author:=self.staffMember.firstName;
  i.ticket:=self.ticket;
  self.ticket.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;


}


method CloseTicketWithResponse{

  self.ticket.ticketStatus:=#Closed;

    tdm1:=new TicketThreadMessage;
   tdm1.datetime:=System.allInstances()->any(true).currentDateTime;
   tdm1.text:=self.response;
   tdm1.author:=self.staffMember.firstName;
   tdm1.ticket:=self.ticket;
   self.ticket.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;

   self.ticket.lastRespondent:=self.staffMember;

  i:=new InternalNote;
  i.datetime:=System.allInstances()->any(true).currentDateTime;
  i.subject:='Ticket closed';
  i.text:='Ticket closed on reply';
  i.author:=self.staffMember.firstName;
  i.ticket:=self.ticket;
  self.ticket.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;


   sendAutoresponse:=false;
   if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewMessageAppendedToTicket then
      if self.ticket.helpTopic->notEmpty then
         if self.ticket.helpTopic.autoresponse=#Enabled then sendAutoresponse:=true;
         endif
      else
          sendAutoresponse:=self.ticket.assignedDepartment.newAddedMessageIsNotified;
      endif
   endif

   if sendAutoresponse then
```

```
      m1:=new EMail(fromAddress:=self.ticket.assignedDepartment.autoresponseEmail.address,
                toAddress:=self.ticket.email,
                ticketNumber:=self.ticket.number,emailKind:=TicketResponseNotice.allInstances()->any(true));
   endif

}


method ReopenTicket{

  self.ticket.ticketStatus:=#Open;

  i:=new InternalNote;
  i.datetime:=System.allInstances()->any(true).currentDateTime;
  i.subject:='Ticket reopened';
  i.text:='Ticket reopened without comments';
  i.author:=self.staffMember.firstName;
  i.ticket:=self.ticket;
  self.ticket.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;

}

method ReopenTicketWithResponse{

 self.ticket.ticketStatus:=#Open;

    tdm1:=new TicketThreadMessage;
  tdm1.datetime:=System.allInstances()->any(true).currentDateTime;
  tdm1.text:=self.response;
  tdm1.author:=self.staffMember.firstName;
  tdm1.ticket:=self.ticket;
  self.ticket.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;

  self.ticket.lastRespondent:=self.staffMember;

  i:=new InternalNote;
  i.datetime:=System.allInstances()->any(true).currentDateTime;
  i.subject:='Ticket status changed to open';
  i.text:='A staff member reopened the ticket on reply';
  i.author:=self.staffMember.firstName;
  i.ticket:=self.ticket;
  self.ticket.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;


  sendAutoresponse:=false;
  if CustomerAutoresponsesSettings.allInstances()->any(true).autorespondWhenNewMessageAppendedToTicket then
     if self.ticket.helpTopic->notEmpty then
        if self.ticket.helpTopic.autoresponse=#Enabled then sendAutoresponse:=true;
        endif
     else
         sendAutoresponse:=self.ticket.assignedDepartment.newAddedMessageIsNotified;
     endif
  endif

  if sendAutoresponse then
     m1:=new EMail(fromAddress:=self.ticket.assignedDepartment.autoresponseEmail.address,
                toAddress:=self.ticket.email,
                ticketNumber:=self.ticket.number,emailKind:=TicketResponseNotice.allInstances()->any(true));
  endif

}

method BanEmailAndCloseTicket{
 self.ticket.ticketStatus:=#Closed;


  i:=new InternalNote;
  i.datetime:=System.allInstances()->any(true).currentDateTime;
  i.subject:='Ticket closed';
  i.text:='Email added to banlist and ticket status set to closed';
  i.author:=self.staffMember.firstName;
  i.ticket:=self.ticket;
```

```
   self.ticket.lastMessageDatetime:=System.allInstances()->any(true).currentDateTime;

   bl:=Set{self.ticket.email};
   if EmailSettings.allInstances()->any(true).banList->notEmpty then
    bl:=EmailSettings.allInstances()->any(true).banList->including(self.ticket.email);
   endif

    EmailSettings.allInstances()->any(true).banList:=bl;

}

method DeleteTicket{


   internalNotes:=self.ticket.internalNote;
   ticketThreadMessage:=self.ticket.ticketThreadMessage;
   self.ticket.internalNote:=Set{};
   delete self.ticket;

   while internalNotes->size()>0 do
       delete internalNote->any(true);
   endwhile

   while ticketThreadMessage->size()>0 do
          delete ticketThreadMessage->any(true);
   endwhile

}

method CheckOverdueTickets{

    //Staff alerts
    sendOverdueAlertToAssignedStaff:=[
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdue and
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdueStaff->includes(#AssignedStaff)];

    sendOverdueAlertToDepartmentManager:=
    [StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdue and
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdueStaff->includes(#DepartmentManager)];

    sendOverdueAlertToDepartmentMembers:=
    [StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdue and
    StaffNoticesAlertsSettings.allInstances()->any(true).alertWhenTicketOverdueStaff->includes(#DepartmentMembers)];

    staffAlertsFromEMailAddress:=
    [EmailSettings.allInstances()->any(true).defaultStaffAlertsEmail.address];

    newOverdueTickets:=[Ticket.allInstances()->select(tl(System.allInstances()-
>any(true).currentDateTime.value>(t.dueDatetime.value+TicketSettings.allInstances()->any(true).ticketGracePeriod)) and
not(t.isOverdue))->asSequence()];
    sizeOverdue:=newOverdueTickets->size();
    ii:=1;

    while ii<=sizeOverdue do
       overdueTicket:=newOverdueTickets->at(ii);
       overdueTicket.isOverdue:=true;


      if sendOverdueAlertToAssignedStaff   then
       if  overdueTicket.assignedStaff->notEmpty() then
          if  overdueTicket.assignedStaff.status=#Enabled then
            if overdueTicket.assignedStaff.isInVacationMode=false then
                m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                          toAddress:=[overdueTicket.assignedStaff.emailAddress],
                          ticketNumber:=overdueTicket.number,emailKind:=OverdueTicketAlertToStaff.allInstances()->any(true));
            endif
          endif
       endif
    endif

     if sendOverdueAlertToDepartmentManager   then
       if  overdueTicket.assignedDepartment.departmentManager->notEmpty() then
```

```
        if  overdueTicket.assignedDepartment.departmentManager.status=#Enabled then
          if overdueTicket.assignedDepartment.departmentManager.isInVacationMode=false then
              m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                        toAddress:=[overdueTicket.assignedDepartment.departmentManager.emailAddress],
                        ticketNumber:=overdueTicket.number,emailKind:=OverdueTicketAlertToStaff.allInstances()->any(true));
          endif
        endif
      endif
    endif


    if sendOverdueAlertToDepartmentMembers   then
      z:=1;
      staff:=overdueTicket.assignedDepartment.staffMember->asSequence();
      while z<staff->size() do
        currentStaffMember:=staff->at(z);
        if currentStaffMember.isInVacationMode=false then
          if currentStaffMember.status=#Enabled then
            m1:=new EMail(fromAddress:=staffAlertsFromEMailAddress,
                  toAddress:=currentStaffMember.emailAddress,
                  ticketNumber:=overdueTicket.number, emailKind:=OverdueTicketAlertToStaff.allInstances()->any(true));
          endif
        endif
      z:=z+1;
      endwhile
    endif


      ii:=ii+1;
    endwhile


}
```

Appendix C. Test set

```
testprogram ConfigurationAndBasics{

 fixturecomponent CompatibleConfigurationAndBasics{

    template_default:=new EmailTemplate(name:='Default');
    template_default.internalNotes:='Email templates by default';

    ek1:=new NewTicketAutoresponse(subject:='X',message:='Y');
    ek1.emailTemplate:=template_default;
    template_default.newTicketAutoresponse.subject:='X';
    template_default.newTicketAutoresponse.message:='Y';

    ek2:=new NewMessageAutoresponse(subject:='X',message:='Y');
    ek2.emailTemplate:=template_default;
    template_default.newMessageAutoresponse.subject:='X';
    template_default.newMessageAutoresponse.message:='Y';

    ek3:=new NewTicketNotice(subject:='X',message:='Y');
    ek3.emailTemplate:=template_default;
    template_default.newTicketNotice.subject:='X';
    template_default.newTicketNotice.message:='Y';

    ek4:=new OverTicketLimitNotice(subject:='X',message:='Y');
    ek4.emailTemplate:=template_default;
    template_default.overTicketLimitNotice.subject:='X';
    template_default.overTicketLimitNotice.message:='Y';

    ek5:=new TicketResponseNotice(subject:='X',message:='Y');
    ek5.emailTemplate:=template_default;
    template_default.ticketResponseNotice.subject:='X';
    template_default.ticketResponseNotice.message:='Y';

    ek6:=new NewTicketAlertToStaff(subject:='X',message:='Y');
    ek6.emailTemplate:=template_default;
    template_default.newTicketAlertToStaff.subject:='X';
    template_default.newTicketAlertToStaff.message:='Y';

    ek7:=new NewMessageAlertToStaff(subject:='X',message:='Y');
    ek7.emailTemplate:=template_default;
    template_default.newMessageAlertToStaff.subject:='X';
    template_default.newMessageAlertToStaff.message:='Y';

    ek8:=new NewInternalNoteAlertToStaff(subject:='X',message:='Y');
    ek8.emailTemplate:=template_default;
    template_default.newInternalNoteAlertToStaff.subject:='X';
    template_default.newInternalNoteAlertToStaff.message:='Y';

    ek9:=new TicketAssignedAlertToStaff(subject:='X',message:='Y');
    ek9.emailTemplate:=template_default;
    template_default.ticketAssignedAlertToStaff.subject:='X';
    template_default.ticketAssignedAlertToStaff.message:='Y';

    ek10:=new OverdueTicketAlertToStaff(subject:='X',message:='Y');
    ek10.emailTemplate:=template_default;
    template_default.overdueTicketAlertToStaff.subject:='X';
```

```
template_default.overdueTicketAlertToStaff.message:='Y';

dptGeneral := new Department(name:='General support');
dptGeneral.type := #Public;
dptGeneral.emailTemplate := template_default;
dptGeneral.newTicketAutoresponseIsSent := true;
dptGeneral.newAddedMessageIsNotified := true;
dptGeneral.isDefault:=true;

dptTechnical := new Department(name:='Technical support');
dptTechnical.type := #Private;
dptTechnical.emailTemplate := template_default;
dptTechnical.newTicketAutoresponseIsSent := true;
dptTechnical.newAddedMessageIsNotified := true;

generalSupportEmailAccount:=new EmailAccount(address:='general_at_support.com');
generalSupportEmailAccount.fromName:='General questions';
generalSupportEmailAccount.defaultNewPriority:=#Low;
generalSupportEmailAccount.defaultNewTicketDepartment:=dptGeneral;
generalSupportEmailAccount.autoresponsesStatus:=#Disabled;

technicalSupportEmailAccount:=new EmailAccount(address:='technical_at_support.com');
technicalSupportEmailAccount.fromName:='B Support';
technicalSupportEmailAccount.defaultNewPriority:=#High;
technicalSupportEmailAccount.defaultNewTicketDepartment:=dptTechnical;
technicalSupportEmailAccount.autoresponsesStatus:=#Disabled;

dptGeneral.outgoingEmail:=generalSupportEmailAccount;
dptGeneral.autoresponseEmail:=generalSupportEmailAccount;

dptTechnical.outgoingEmail:=technicalSupportEmailAccount;
dptTechnical.autoresponseEmail:=technicalSupportEmailAccount;

generalAdministrator:=new StaffMember(username:='john');
generalAdministrator.department:=dptGeneral;
generalAdministrator.firstName:='John';
generalAdministrator.lastName:='Johny';
generalAdministrator.emailAddress:='john_at_support.com';
generalAdministrator.officePhone:='11111';
generalAdministrator.phoneExtension:='11';
generalAdministrator.mobilePhone:='11111';
generalAdministrator.signature:='John Johny';
generalAdministrator.password:='xxx';
generalAdministrator.status:=#Enabled;
generalAdministrator.isAdministrator:=true;
generalAdministrator.isInVacationMode:=false;


dptTechnical.departmentManager:=generalAdministrator;


 maximumPrivilegesGroup:=new StaffGroup(name:='Maximum Privileges Group');
 maximumPrivilegesGroup.status:=#Enabled;
 maximumPrivilegesGroup.departmentsAccess:=Set{dptGeneral,dptTechnical};
 maximumPrivilegesGroup.canCreateTickets:=true;
 maximumPrivilegesGroup.canEditTickets:=true;
 maximumPrivilegesGroup.canCloseTickets:=true;
 maximumPrivilegesGroup.canTransferTickets:=true;
 maximumPrivilegesGroup.canDeleteTickets:=true;
 maximumPrivilegesGroup.canBanEmails:=true;

 generalAdministrator.staffGroup:=maximumPrivilegesGroup;


 //Iteration 3
 minimumPrivilegesGroup:=new StaffGroup(name:='Minimum Privileges Group');
 minimumPrivilegesGroup.status:=#Enabled;
 minimumPrivilegesGroup.departmentsAccess:=Set{};
 minimumPrivilegesGroup.canCreateTickets:=false;
 minimumPrivilegesGroup.canEditTickets:=false;
 minimumPrivilegesGroup.canCloseTickets:=false;
 minimumPrivilegesGroup.canTransferTickets:=false;
```

```
minimumPrivilegesGroup.canDeleteTickets:=false;
minimumPrivilegesGroup.canBanEmails:=false;

inactiveGroup:=new StaffGroup(name:='Inactive Group');
inactiveGroup.status:=#Disabled;
inactiveGroup.departmentsAccess:=Set{};
inactiveGroup.canCreateTickets:=true;
inactiveGroup.canEditTickets:=false;
inactiveGroup.canCloseTickets:=true;
inactiveGroup.canTransferTickets:=false;
inactiveGroup.canDeleteTickets:=true;
inactiveGroup.canBanEmails:=false;


generalConsultant:=new StaffMember(username:='mary');
generalConsultant.department:=dptGeneral;
generalConsultant.firstName:='Mary';
generalConsultant.lastName:='Mayer';
generalConsultant.emailAddress:='mary_at_support.com';
generalConsultant.officePhone:='22222';
generalConsultant.phoneExtension:='22';
generalConsultant.mobilePhone:='22222';
generalConsultant.signature:='Mary Mayer';
generalConsultant.password:='yyy';
generalConsultant.status:=#Enabled;
generalConsultant.isAdministrator:=false;
generalConsultant.isInVacationMode:=false;
generalConsultant.staffGroup:=maximumPrivilegesGroup;

generalConsultantVacation:=new StaffMember(username:='david');
generalConsultantVacation.department:=dptGeneral;
generalConsultantVacation.firstName:='David';
generalConsultantVacation.lastName:='Dassel';
generalConsultantVacation.emailAddress:='david_at_support.com';
generalConsultantVacation.officePhone:='33333';
generalConsultantVacation.phoneExtension:='33';
generalConsultantVacation.mobilePhone:='33333';
generalConsultantVacation.signature:='David Dassel';
generalConsultantVacation.password:='zzz';
generalConsultantVacation.status:=#Enabled;
generalConsultantVacation.isAdministrator:=false;
generalConsultantVacation.isInVacationMode:=true;
generalConsultantVacation.staffGroup:=maximumPrivilegesGroup;

technicalActive:=new StaffMember(username:='martin');
technicalActive.department:=dptTechnical;
technicalActive.firstName:='Martin';
technicalActive.lastName:='Martech';
technicalActive.emailAddress:='martin_at_support.com';
technicalActive.password:='ttt';
technicalActive.status:=#Enabled;
technicalActive.isAdministrator:=false;
technicalActive.isInVacationMode:=false;
technicalActive.staffGroup:=minimumPrivilegesGroup;

technicalInactive:=new StaffMember(username:='patricia');
technicalInactive.department:=dptTechnical;
technicalInactive.firstName:='Patricia';
technicalInactive.lastName:='Pauls';
technicalInactive.emailAddress:='patricia_at_support.com';
technicalInactive.password:='ttt';
technicalInactive.status:=#Disabled;
technicalInactive.isAdministrator:=false;
technicalInactive.isInVacationMode:=false;
technicalInactive.staffGroup:=minimumPrivilegesGroup;

emailSettings:=new EmailSettings;
emailSettings.defaultSystemEmail:=generalSupportEmailAccount;
emailSettings.defaultStaffAlertsEmail:=generalSupportEmailAccount;
emailSettings.administrationEmail:='system_at_support.com';

helpTopicUse:=new HelpTopic(name:='Use');
```

```
  helpTopicUse.status:=#Enabled;
  helpTopicUse.autoresponse:=#Enabled;
  helpTopicUse.newTicketPriority:=#Normal;
  helpTopicUse.newTicketDepartment:=dptGeneral;

  helpTopicInstallation:=new HelpTopic(name:='Installation');
  helpTopicInstallation.status:=#Enabled;
  helpTopicInstallation.autoresponse:=#Disabled;
  helpTopicInstallation.newTicketPriority:=#High;
  helpTopicInstallation.newTicketDepartment:=dptTechnical;

  helpTopicDisabled:=new HelpTopic(name:='Offers');
  helpTopicDisabled.status:=#Disabled;
  helpTopicDisabled.autoresponse:=#Disabled;
  helpTopicDisabled.newTicketPriority:=#Low;
  helpTopicDisabled.newTicketDepartment:=dptGeneral;


}

fixturecomponent GeneralSettingsOnline{
  generalSettings:=new GeneralSettings;
  generalSettings.status:=#Online;
  generalSettings.helpdeskURL:='http://onlinesupport.com';
  generalSettings.helpdeskName:='Online customer support';
  generalSettings.defaultEmailTemplate:=template_default;
}

 fixturecomponent GeneralSettingsOffline{
  generalSettings:=new GeneralSettings;
  generalSettings.helpdeskURL:='http://offlinesupport.com';
  generalSettings.status:=#Offline;
  generalSettings.defaultEmailTemplate:=template_default;
}

 fixturecomponent TicketSettingsSequential{
  ticketSettings:=new TicketSettings;
  ticketSettings.mode:=#Sequential;
  ticketSettings.priority:=#Normal;
  ticketSettings.customersCanChangePriority:=false;
  ticketSettings.useEmailPriorityWhenAvailable:=true;
  ticketSettings.openTicketsPerMailAreLimited:=true;
  ticketSettings.maximumOpenTicketsPerMail:=2;
  ticketSettings.ticketGracePeriod:=0;
  ticketSettings.reopenedTicketsAreAssignedToLastRespondent:=true;
}

  fixturecomponent TicketSettingsRandom{
  ticketSettings:=new TicketSettings;
  ticketSettings.mode:=#Random;
  ticketSettings.priority:=#High;
  ticketSettings.customersCanChangePriority:=true;
  ticketSettings.useEmailPriorityWhenAvailable:=false;
  ticketSettings.ticketGracePeriod:=2;
  ticketSettings.reopenedTicketsAreAssignedToLastRespondent:=false;
}

fixturecomponent CustomerAutoresponsesActive{
  customerAutoresponsesSettings:=new CustomerAutoresponsesSettings;
  customerAutoresponsesSettings.autorespondWhenNewTicketCreatedByCustomer:=true;
  customerAutoresponsesSettings.autorespondWhenNewTicketCreatedByStaff:=true;
  customerAutoresponsesSettings.autorespondWhenNewMessageAppendedToTicket:=true;
  customerAutoresponsesSettings.autorespondWhenMaximumOpenTicketsOfCustomer:=true;
}

 fixturecomponent CustomerAutoresponsesInactive{
  customerAutoresponsesSettings:=new CustomerAutoresponsesSettings;
  customerAutoresponsesSettings.autorespondWhenNewTicketCreatedByCustomer:=false;
  customerAutoresponsesSettings.autorespondWhenNewTicketCreatedByStaff:=false;
  customerAutoresponsesSettings.autorespondWhenNewMessageAppendedToTicket:=false;
  customerAutoresponsesSettings.autorespondWhenMaximumOpenTicketsOfCustomer:=false;
}
```

```
 fixturecomponent StaffNoticesAlertsInactive{
  staffNoticesAlertsSettings:=new StaffNoticesAlertsSettings;
  staffNoticesAlertsSettings.alertWhenNewTicketCreated:=false;
  staffNoticesAlertsSettings.alertWhenNewMessage:=false;
  staffNoticesAlertsSettings.alertWhenInternalNote:=false;
  staffNoticesAlertsSettings.alertWhenTicketOverdue:=false;
}


 fixturecomponent StaffNoticesAlertsActive{
  staffNoticesAlertsSettings:=new StaffNoticesAlertsSettings;
  staffNoticesAlertsSettings.alertWhenNewTicketCreated:=true;
  staffNoticesAlertsSettings.alertWhenNewTicketCreatedStaff:=Set{#Administrator,#DepartmentManager,#DepartmentMembers};
  staffNoticesAlertsSettings.alertWhenNewMessage:=true;
  staffNoticesAlertsSettings.alertWhenNewMessageStaff:=Set{#LastRespondent,#AssignedStaff,#DepartmentManager};
  staffNoticesAlertsSettings.alertWhenInternalNote:=true;
  staffNoticesAlertsSettings.alertWhenInternalNoteStaff:=Set{#LastRespondent,#AssignedStaff,#DepartmentManager};
  staffNoticesAlertsSettings.alertWhenTicketOverdue:=true;
  staffNoticesAlertsSettings.alertWhenTicketOverdueStaff:=Set{#AssignedStaff,#DepartmentManager,#DepartmentMembers};

}

test testConfiguration1{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsActive;
  assert consistency;
}

 test testConfiguration2{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsInactive;
  assert consistency;
}

 test testConfiguration3{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsActive;
  assert consistency;
}

test testConfiguration4{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsInactive;
  assert consistency;
}

test testConfiguration5{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsActive;
  assert consistency;
}

 test testConfiguration6{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
```

```
  load TicketSettingsRandom;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsInactive;
  assert consistency;
}

 test testConfiguration7{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsActive;
  assert consistency;
}

 test testConfiguration8{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsInactive;
  assert consistency;
}

test testConfiguration9{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsActive;
  assert consistency;
}

test testConfiguration10{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsInactive;
  assert consistency;
}

 test testConfiguration11{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsActive;
  assert consistency;
}

 test testConfiguration12{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsInactive;
  assert consistency;
}


test testConfiguration13{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsActive;
  assert consistency;
}

test testConfiguration14{
  load CompatibleConfigurationAndBasics;
```

```
    load GeneralSettingsOffline;
    load TicketSettingsRandom;
    load CustomerAutoresponsesActive;
    load StaffNoticesAlertsInactive;
    assert consistency;
  }

   test testConfiguration15{
    load CompatibleConfigurationAndBasics;
    load GeneralSettingsOffline;
    load TicketSettingsRandom;
    load CustomerAutoresponsesInactive;
    load StaffNoticesAlertsActive;
    assert consistency;
  }

   test testConfiguration16{
    load CompatibleConfigurationAndBasics;
    load GeneralSettingsOffline;
    load TicketSettingsRandom;
    load CustomerAutoresponsesInactive;
    load StaffNoticesAlertsInactive;
    assert consistency;
  }
 }

testprogram TicketsManagementAndTracking{

    now := new Datetime(value:=1);
    after:=new Datetime(value:=2);
    sys := new System(currentDateTime:=now);
    sys.aleat:=5;



    fixturecomponent CompatibleConfigurationAndBasics{

    template_default:=new EmailTemplate(name:='Default');
    template_default.internalNotes:='Email templates by default';

    ek1:=new NewTicketAutoresponse(subject:='X',message:='Y');
    ek1.emailTemplate:=template_default;
    template_default.newTicketAutoresponse.subject:='X';
    template_default.newTicketAutoresponse.message:='Y';

    ek2:=new NewMessageAutoresponse(subject:='X',message:='Y');
    ek2.emailTemplate:=template_default;
    template_default.newMessageAutoresponse.subject:='X';
    template_default.newMessageAutoresponse.message:='Y';

    ek3:=new NewTicketNotice(subject:='X',message:='Y');
    ek3.emailTemplate:=template_default;
    template_default.newTicketNotice.subject:='X';
    template_default.newTicketNotice.message:='Y';

    ek4:=new OverTicketLimitNotice(subject:='X',message:='Y');
    ek4.emailTemplate:=template_default;
    template_default.overTicketLimitNotice.subject:='X';
    template_default.overTicketLimitNotice.message:='Y';

    ek5:=new TicketResponseNotice(subject:='X',message:='Y');
    ek5.emailTemplate:=template_default;
    template_default.ticketResponseNotice.subject:='X';
    template_default.ticketResponseNotice.message:='Y';

    ek6:=new NewTicketAlertToStaff(subject:='X',message:='Y');
    ek6.emailTemplate:=template_default;
    template_default.newTicketAlertToStaff.subject:='X';
    template_default.newTicketAlertToStaff.message:='Y';

    ek7:=new NewMessageAlertToStaff(subject:='X',message:='Y');
    ek7.emailTemplate:=template_default;
```

```
template_default.newMessageAlertToStaff.subject:='X';
template_default.newMessageAlertToStaff.message:='Y';

ek8:=new NewInternalNoteAlertToStaff(subject:='X',message:='Y');
ek8.emailTemplate:=template_default;
template_default.newInternalNoteAlertToStaff.subject:='X';
template_default.newInternalNoteAlertToStaff.message:='Y';

ek9:=new TicketAssignedAlertToStaff(subject:='X',message:='Y');
ek9.emailTemplate:=template_default;
template_default.ticketAssignedAlertToStaff.subject:='X';
template_default.ticketAssignedAlertToStaff.message:='Y';

ek10:=new OverdueTicketAlertToStaff(subject:='X',message:='Y');
ek10.emailTemplate:=template_default;
template_default.overdueTicketAlertToStaff.subject:='X';
template_default.overdueTicketAlertToStaff.message:='Y';

dptGeneral := new Department(name:='General support');
dptGeneral.type := #Public;
dptGeneral.emailTemplate := template_default;
dptGeneral.newTicketAutoresponseIsSent := true;
dptGeneral.newAddedMessageIsNotified := true;
dptGeneral.isDefault:=true;

dptTechnical := new Department(name:='Technical support');
dptTechnical.type := #Private;
dptTechnical.emailTemplate := template_default;
dptTechnical.newTicketAutoresponseIsSent := true;
dptTechnical.newAddedMessageIsNotified := true;

generalSupportEmailAccount:=new EmailAccount(address:='general_at_support.com');
generalSupportEmailAccount.fromName:='General questions';
generalSupportEmailAccount.defaultNewPriority:=#Low;
generalSupportEmailAccount.defaultNewTicketDepartment:=dptGeneral;
generalSupportEmailAccount.autoresponsesStatus:=#Enabled;

technicalSupportEmailAccount:=new EmailAccount(address:='technical_at_support.com');
technicalSupportEmailAccount.fromName:='B Support';
technicalSupportEmailAccount.defaultNewPriority:=#High;
technicalSupportEmailAccount.defaultNewTicketDepartment:=dptTechnical;
technicalSupportEmailAccount.autoresponsesStatus:=#Disabled;

dptGeneral.outgoingEmail:=generalSupportEmailAccount;
dptGeneral.autoresponseEmail:=generalSupportEmailAccount;

dptTechnical.outgoingEmail:=technicalSupportEmailAccount;
dptTechnical.autoresponseEmail:=technicalSupportEmailAccount;

generalAdministrator:=new StaffMember(username:='john');
generalAdministrator.department:=dptGeneral;
generalAdministrator.firstName:='John';
generalAdministrator.lastName:='Johny';
generalAdministrator.emailAddress:='john_at_support.com';
generalAdministrator.officePhone:='11111';
generalAdministrator.phoneExtension:='11';
generalAdministrator.mobilePhone:='11111';
generalAdministrator.signature:='John Johny';
generalAdministrator.password:='xxx';
generalAdministrator.status:=#Enabled;
generalAdministrator.isAdministrator:=true;
generalAdministrator.isInVacationMode:=false;


dptTechnical.departmentManager:=generalAdministrator;


 maximumPrivilegesGroup:=new StaffGroup(name:='Maximum Privileges Group');
 maximumPrivilegesGroup.status:=#Enabled;
 maximumPrivilegesGroup.departmentsAccess:=Set{dptGeneral,dptTechnical};
 maximumPrivilegesGroup.canCreateTickets:=true;
 maximumPrivilegesGroup.canEditTickets:=true;
```

```
maximumPrivilegesGroup.canCloseTickets:=true;
maximumPrivilegesGroup.canTransferTickets:=true;
maximumPrivilegesGroup.canDeleteTickets:=true;
maximumPrivilegesGroup.canBanEmails:=true;

generalAdministrator.staffGroup:=maximumPrivilegesGroup;


//Iteration 3
minimumPrivilegesGroup:=new StaffGroup(name:='Minimum Privileges Group');
minimumPrivilegesGroup.status:=#Enabled;
minimumPrivilegesGroup.departmentsAccess:=Set{};
minimumPrivilegesGroup.canCreateTickets:=false;
minimumPrivilegesGroup.canEditTickets:=false;
minimumPrivilegesGroup.canCloseTickets:=false;
minimumPrivilegesGroup.canTransferTickets:=false;
minimumPrivilegesGroup.canDeleteTickets:=false;
minimumPrivilegesGroup.canBanEmails:=false;

inactiveGroup:=new StaffGroup(name:='Inactive Group');
inactiveGroup.status:=#Disabled;
inactiveGroup.departmentsAccess:=Set{};
inactiveGroup.canCreateTickets:=true;
inactiveGroup.canEditTickets:=false;
inactiveGroup.canCloseTickets:=true;
inactiveGroup.canTransferTickets:=false;
inactiveGroup.canDeleteTickets:=true;
inactiveGroup.canBanEmails:=false;


generalConsultant:=new StaffMember(username:='mary');
generalConsultant.department:=dptGeneral;
generalConsultant.firstName:='Mary';
generalConsultant.lastName:='Mayer';
generalConsultant.emailAddress:='mary_at_support.com';
generalConsultant.officePhone:='22222';
generalConsultant.phoneExtension:='22';
generalConsultant.mobilePhone:='22222';
generalConsultant.signature:='Mary Mayer';
generalConsultant.password:='yyy';
generalConsultant.status:=#Enabled;
generalConsultant.isAdministrator:=false;
generalConsultant.isInVacationMode:=false;
generalConsultant.staffGroup:=maximumPrivilegesGroup;

generalConsultantVacation:=new StaffMember(username:='david');
generalConsultantVacation.department:=dptGeneral;
generalConsultantVacation.firstName:='David';
generalConsultantVacation.lastName:='Dassel';
generalConsultantVacation.emailAddress:='david_at_support.com';
generalConsultantVacation.officePhone:='33333';
generalConsultantVacation.phoneExtension:='33';
generalConsultantVacation.mobilePhone:='33333';
generalConsultantVacation.signature:='David Dassel';
generalConsultantVacation.password:='zzz';
generalConsultantVacation.status:=#Enabled;
generalConsultantVacation.isAdministrator:=false;
generalConsultantVacation.isInVacationMode:=true;
generalConsultantVacation.staffGroup:=maximumPrivilegesGroup;

technicalActive:=new StaffMember(username:='martin');
technicalActive.department:=dptTechnical;
technicalActive.firstName:='Martin';
technicalActive.lastName:='Martech';
technicalActive.emailAddress:='martin_at_support.com';
technicalActive.password:='ttt';
technicalActive.status:=#Enabled;
technicalActive.isAdministrator:=false;
technicalActive.isInVacationMode:=false;
technicalActive.staffGroup:=minimumPrivilegesGroup;

technicalInactive:=new StaffMember(username:='patricia');
```

```
  technicalInactive.department:=dptTechnical;
  technicalInactive.firstName:='Patricia';
  technicalInactive.lastName:='Pauls';
  technicalInactive.emailAddress:='patricia_at_support.com';
  technicalInactive.password:='uuu';
  technicalInactive.status:=#Disabled;
  technicalInactive.isAdministrator:=false;
  technicalInactive.isInVacationMode:=false;
  technicalInactive.staffGroup:=minimumPrivilegesGroup;

  emailSettings:=new EmailSettings;
  emailSettings.defaultSystemEmail:=generalSupportEmailAccount;
  emailSettings.defaultStaffAlertsEmail:=generalSupportEmailAccount;
  emailSettings.administrationEmail:='system_at_support.com';

  helpTopicUse:=new HelpTopic(name:='Use');
  helpTopicUse.status:=#Enabled;
  helpTopicUse.autoresponse:=#Enabled;
  helpTopicUse.newTicketPriority:=#Normal;
  helpTopicUse.newTicketDepartment:=dptGeneral;

  helpTopicInstallation:=new HelpTopic(name:='Installation');
  helpTopicInstallation.status:=#Enabled;
  helpTopicInstallation.autoresponse:=#Disabled;
  helpTopicInstallation.newTicketPriority:=#High;
  helpTopicInstallation.newTicketDepartment:=dptTechnical;

  helpTopicDisabled:=new HelpTopic(name:='Offers');
  helpTopicDisabled.status:=#Disabled;
  helpTopicDisabled.autoresponse:=#Disabled;
  helpTopicDisabled.newTicketPriority:=#Low;
  helpTopicDisabled.newTicketDepartment:=dptGeneral;

}

fixturecomponent GeneralSettingsOnline{
  generalSettings:=new GeneralSettings;
  generalSettings.status:=#Online;
  generalSettings.helpdeskURL:='http://onlinesupport.com';
  generalSettings.helpdeskName:='Online customer support';
  generalSettings.defaultEmailTemplate:=template_default;
}

 fixturecomponent GeneralSettingsOffline{
  generalSettings:=new GeneralSettings;
  generalSettings.helpdeskURL:='http://offlinesupport.com';
  generalSettings.status:=#Offline;
  generalSettings.defaultEmailTemplate:=template_default;
}

 fixturecomponent TicketSettingsSequential{
  ticketSettings:=new TicketSettings;
  ticketSettings.mode:=#Sequential;
  ticketSettings.priority:=#Normal;
  ticketSettings.customersCanChangePriority:=false;
  ticketSettings.useEmailPriorityWhenAvailable:=true;
  ticketSettings.openTicketsPerMailAreLimited:=true;
  ticketSettings.maximumOpenTicketsPerMail:=2;
  ticketSettings.ticketGracePeriod:=0;
  ticketSettings.reopenedTicketsAreAssignedToLastRespondent:=true;
}

  fixturecomponent TicketSettingsRandom{
  ticketSettings:=new TicketSettings;
  ticketSettings.mode:=#Random;
  ticketSettings.priority:=#High;
  ticketSettings.customersCanChangePriority:=true;
  ticketSettings.useEmailPriorityWhenAvailable:=false;
  //ticketSettings.maximumOpenTicketsPerMail:=#Unlimited;
  ticketSettings.ticketGracePeriod:=2;
  ticketSettings.reopenedTicketsAreAssignedToLastRespondent:=false;
}
```

```
fixturecomponent CustomerAutoresponsesActive{
  customerAutoresponsesSettings:=new CustomerAutoresponsesSettings;
  customerAutoresponsesSettings.autorespondWhenNewTicketCreatedByCustomer:=true;
  customerAutoresponsesSettings.autorespondWhenNewTicketCreatedByStaff:=true;
  customerAutoresponsesSettings.autorespondWhenNewMessageAppendedToTicket:=true;
  customerAutoresponsesSettings.autorespondWhenMaximumOpenTicketsOfCustomer:=true;
}

 fixturecomponent CustomerAutoresponsesInactive{
  customerAutoresponsesSettings:=new CustomerAutoresponsesSettings;
  customerAutoresponsesSettings.autorespondWhenNewTicketCreatedByCustomer:=false;
  customerAutoresponsesSettings.autorespondWhenNewTicketCreatedByStaff:=false;
  customerAutoresponsesSettings.autorespondWhenNewMessageAppendedToTicket:=false;
  customerAutoresponsesSettings.autorespondWhenMaximumOpenTicketsOfCustomer:=false;
}

  fixturecomponent StaffNoticesAlertsInactive{
   staffNoticesAlertsSettings:=new StaffNoticesAlertsSettings;
   staffNoticesAlertsSettings.alertWhenNewTicketCreated:=false;
   staffNoticesAlertsSettings.alertWhenNewMessage:=false;
   staffNoticesAlertsSettings.alertWhenInternalNote:=false;
   staffNoticesAlertsSettings.alertWhenTicketOverdue:=false;
}



  fixturecomponent StaffNoticesAlertsActive{
   staffNoticesAlertsSettings:=new StaffNoticesAlertsSettings;
   staffNoticesAlertsSettings.alertWhenNewTicketCreated:=true;
   staffNoticesAlertsSettings.alertWhenNewTicketCreatedStaff:=Set{#Administrator,#DepartmentManager,#DepartmentMembers};
   staffNoticesAlertsSettings.alertWhenNewMessage:=true;
   staffNoticesAlertsSettings.alertWhenNewMessageStaff:=Set{#LastRespondent,#AssignedStaff,#DepartmentManager};
   staffNoticesAlertsSettings.alertWhenInternalNote:=true;
   staffNoticesAlertsSettings.alertWhenInternalNoteStaff:=Set{#LastRespondent,#AssignedStaff,#DepartmentManager};
   staffNoticesAlertsSettings.alertWhenTicketOverdue:=true;
   staffNoticesAlertsSettings.alertWhenTicketOverdueStaff:=Set{#AssignedStaff,#DepartmentManager,#DepartmentMembers};

}

fixturecomponent testConfiguration1{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsActive;
}

fixturecomponent testConfiguration2{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsInactive;
}

fixturecomponent testConfiguration3{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsActive;
}

fixturecomponent testConfiguration4{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsInactive;
}
```

```
fixturecomponent testConfiguration5{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsActive;
}

 fixturecomponent testConfiguration6{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsInactive;
}

  fixturecomponent testConfiguration7{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsActive;
}

  fixturecomponent testConfiguration8{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOnline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsInactive;
}

 fixturecomponent testConfiguration9{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsActive;
}

 fixturecomponent testConfiguration10{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsInactive;
}

  fixturecomponent testConfiguration11{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsActive;
}

  fixturecomponent testConfiguration12{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsSequential;
  load CustomerAutoresponsesInactive;
  load StaffNoticesAlertsInactive;
}


fixturecomponent testConfiguration13{
  load CompatibleConfigurationAndBasics;
  load GeneralSettingsOffline;
  load TicketSettingsRandom;
  load CustomerAutoresponsesActive;
  load StaffNoticesAlertsActive;
}
```

```
 fixturecomponent testConfiguration14{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOffline;
   load TicketSettingsRandom;
   load CustomerAutoresponsesActive;
   load StaffNoticesAlertsInactive;
}

  fixturecomponent testConfiguration15{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOffline;
   load TicketSettingsRandom;
   load CustomerAutoresponsesInactive;
   load StaffNoticesAlertsActive;
}

  fixturecomponent testConfiguration16{
   load CompatibleConfigurationAndBasics;
   load GeneralSettingsOffline;
   load TicketSettingsRandom;
   load CustomerAutoresponsesInactive;
   load StaffNoticesAlertsInactive;
}

fixturecomponent created_tickets{
     li := new LogIn(username:='mary', password:='yyy');
   assert occurrence li;

   nt1:=new NewTicketOffline;
   nt1.fullName:='Mary Marnes';
   nt1.email:='mary_at_marnes.mar';
   nt1.telephone:='xxxxxxxx';
   nt1.ext:='xxxxxxxx';
   nt1.source:=#Phone;
   nt1.assignedDepartment:=dptTechnical;
   nt1.helpTopic:=helpTopicInstallation;
   nt1.subject:='Error operating system';
   nt1.message:='The installation process does not finish....';
   nt1.internalNote:='It seems that the correct installer is being used';
   dt2:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
   nt1.dueDatetime:=dt2;
   nt1.priority:=#Normal;
   nt1.assignedStaff:=generalConsultant;
   nt1.creator:=generalConsultant;
   assert occurrence nt1;
   ticket1 := nt1.createdTicket;

   nt2:=new NewTicketOffline;
   nt2.fullName:='John Johnes';
   nt2.email:='mary_at_marnes.mar';
   nt2.source:=#Other;
   nt2.assignedDepartment:=dptGeneral;
   nt2.helpTopic:=helpTopicUse;
   nt2.subject:='Can I reply a ticket?';
   nt2.message:='I do not know how to reply a ticket';
   nt2.priority:=#High;
   nt2.assignedStaff:=generalConsultant;
   nt2.creator:=generalConsultant;
   assert occurrence nt2;
   ticket2 := nt2.createdTicket;

   lo := new LogOut(staffMember:=generalConsultant);
   assert occurrence lo;

   li := new LogIn(username:='john', password:='xxx');
   assert occurrence li;


   nt3:=new NewTicketOffline;
   nt3.fullName:='Martin Pope';
   nt3.email:='martin_at_pope.mar';
```

```
  nt3.source:=#Phone;
  nt3.assignedDepartment:=dptTechnical;
  nt3.helpTopic:=helpTopicUse;
  nt3.subject:='Error while login';
  nt3.message:='I get an error when I try to login';
  nt3.priority:=#Low;
  dt3:=new Datetime(value:=[(sys.currentDateTime.value+5)]);
  nt3.dueDatetime:=dt3;
  nt3.assignedStaff:=technicalActive;
  nt3.creator:=generalAdministrator;
  assert occurrence nt3;
  ticket3 := nt3.createdTicket;

  dt4:=new Datetime(value:=[(sys.currentDateTime.value+1)]);
  sys.currentDateTime:=dt4;

  lo := new LogOut(staffMember:=generalAdministrator);
  assert occurrence lo;

  nt4:=new NewTicketOnline;
  nt4.fullName:='James Jordan';
  nt4.email:='james_at_jordan.jam';
  nt4.helpTopic:=helpTopicUse;
  nt4.subject:='Reopening ticket';
  nt4.message:='I do not know how to reopen one of my closed tickets';
  assert occurrence nt4;
  ticket4 := nt4.createdTicket;

  nt5:=new NewTicketByEmail;
  nt5.toAddress:='technical_at_support.com';
  nt5.fromName:='Marta Johnes';
  nt5.fromAddress:='marta_at_johnes.mar';
  nt5.subject:='See my tickets';
  nt5.message:='Can I see my tickets?';
  assert occurrence nt5;
  ticket5 := nt5.createdTicket;
}

test S1{
  load testConfiguration1;

  nt:=new NewTicketOnline;
  nt.fullName:='Mary Marnes';
  nt.email:='mary_at_marnes.mar';
  nt.telephone:='xxxxxxxx';
  nt.ext:='xxxxxxxx';
  nt.helpTopic:=helpTopicInstallation;
  nt.subject:='Error operating system';
  nt.message:='The installation process does not finish....';
  assert occurrence nt;

  ticket1:=nt.createdTicket;

  assert equals ticket1.number 1;
  assert equals ticket1.ticketStatus #Open;
  assert equals ticket1.subject 'Error operating system';
  assert equals ticket1.priority #High;
  assert true ticket1.assignedStaff->isEmpty();
  assert equals ticket1.source #Web;
  assert equals ticket1.creationDatetime sys.currentDateTime;
  assert true ticket1.dueDatetime.isUndefined();
  assert true ticket1.lastResponseDatetime.isUndefined();
  assert equals ticket1.assignedDepartment dptTechnical;



  assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                  m.text='The installation process does not finish....' and
                                  m.author='Mary Marnes')];

  assert equals ticket1.lastMessageDatetime sys.currentDateTime;
```

```
//no autoresponses
assert true [not(EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAutoresponse)))];

//notice to administrator
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='system_at_support.com' and
                                    e.ticketNumber=1)];

//notice to department manager
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];

//notice to department members
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='martin_at_support.com' and
                                    e.ticketNumber=1)];


//TICKET 2
ticketSettings.customersCanChangePriority:=true;

nt2:=new NewTicketOnline;
nt2.fullName:='James Jordan';
nt2.email:='james_at_jordan.jam';
nt2.telephone:='xxxxxxxx';
nt2.ext:='xxxxxxxx';
nt2.priority:=#Low;
nt2.helpTopic:=helpTopicUse;
nt2.subject:='Reopening ticket';
nt2.message:='I do not know how to reopen one of my closed tickets';
assert occurrence nt2;

ticket2:=nt2.createdTicket;

assert equals ticket2.number 2;
assert equals ticket2.priority #Low;
assert equals ticket2.assignedDepartment dptGeneral;

//autoresponses

assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAutoresponse) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='james_at_jordan.jam' and
                                    e.ticketNumber=2)];

//notice to administrator
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='system_at_support.com' and
                                    e.ticketNumber=2)];


//notice to department members
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=2)];

assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=2)];

assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='david_at_support.com' and
                                    e.ticketNumber=2)];
```

```
}

 test S2{
  load testConfiguration1;

  nt1:=new NewTicketOnline;
  nt1.fullName:='Mary Marnes';
  nt1.email:='mary_at_marnes.mar';
  nt1.telephone:='xxxxxxxx';
  nt1.ext:='xxxxxxxx';
  nt1.helpTopic:=helpTopicInstallation;
  nt1.subject:='Error operating system';
  nt1.message:='The installation process does not finish....';
  assert occurrence nt1;

  ticket1:=nt1.createdTicket;

  nt2:=new NewTicketOnline;
  nt2.fullName:='Mary Marnes';
  nt2.email:='mary_at_marnes.mar';
  nt2.telephone:='xxxxxxxx';
  nt2.ext:='xxxxxxxx';
  nt2.helpTopic:=helpTopicInstallation;
  nt2.subject:='Reopening ticket';
  nt2.message:='I do not know how to reopen one of my closed tickets';
  assert occurrence nt2;

  ticket2:=nt2.createdTicket;

  nt3:=new NewTicketOnline;
  nt3.fullName:='Mary Marnes';
  nt3.email:='mary_at_marnes.mar';
  nt3.telephone:='xxxxxxxx';
  nt3.ext:='xxxxxxxx';
  nt3.helpTopic:=helpTopicInstallation;
  nt3.subject:='Customize graphical interface';
  nt3.message:='May I change the background color?';
  assert non-occurrence nt3;


 }

 test S3{
  load testConfiguration8;

  nt1:=new NewTicketOnline;
  nt1.fullName:='Mary Marnes';
  nt1.email:='mary_at_marnes.mar';
  nt1.telephone:='xxxxxxxx';
  nt1.ext:='xxxxxxxx';
  nt1.priority:=#Normal;
  nt1.helpTopic:=helpTopicInstallation;
  nt1.subject:='Error operating system';
  nt1.message:='The installation process does not finish....';
  assert occurrence nt1;

  ticket1:=nt1.createdTicket;

  assert equals ticket1.number 5;
  //5 is the aleatory number specified for testing purposes

  assert equals ticket1.assignedDepartment dptTechnical;

  //no autoresponses
  assert true [not(EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAutoresponse)))];

  //notice to administrator
  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
```

```
                                    e.toAddress='system_at_support.com' and
                                    e.ticketNumber=5)];

  //notice to department manager
  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=5)];

 //notice to department members
  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='martin_at_support.com' and
                                    e.ticketNumber=5)];
 }


 test S4{
  load testConfiguration3;

  nt1:=new NewTicketOnline;
  nt1.fullName:='James Jordan';
  nt1.email:='james_at_jordan.jam';
  nt1.telephone:='xxxxxxxx';
  nt1.ext:='xxxxxxxx';
  nt1.helpTopic:=helpTopicUse;
  nt1.subject:='Reopening ticket';
  nt1.message:='I do not know how to reopen one of my closed tickets';
  assert occurrence nt1;

  ticket1:=nt1.createdTicket;


  assert equals ticket1.assignedDepartment dptGeneral;

  //no autoresponses
  assert true [not(EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAutoresponse)))];

  //notice to administrator
  assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='system_at_support.com' and
                                    e.ticketNumber=1)];


 //notice to department members
  assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];

  assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=1)];

  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='david_at_support.com' and
                                    e.ticketNumber=1)];
 }


test S5{
  load testConfiguration4;
  helpTopicUse.status:=#Disabled;
  helpTopicInstallation.status:=#Disabled;

  nt1:=new NewTicketOnline;
  nt1.fullName:='James Jordan';
  nt1.email:='james_at_jordan.jam';
  nt1.subject:='Reopening ticket';
```

```
 nt1.message:='I do not know how to reopen one of my closed tickets';
 assert occurrence nt1;

 ticket1:=nt1.createdTicket;


 assert equals ticket1.assignedDepartment dptGeneral;
 assert true ticket1.helpTopic->isEmpty();
 assert equals ticket1.priority #Normal;

 //no autoresponses
 assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAutoresponse))];

 //notice to administrator
 assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='system_at_support.com' and
                                    e.ticketNumber=1)];


//notice to department members
 assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];

 assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=1)];

 assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='david_at_support.com' and
                                    e.ticketNumber=1)];
}


test S6{
 load testConfiguration5;
 nt1:=new NewTicketOnline;
 nt1.fullName:='James Jordan';
 nt1.email:='james_at_jordan.jam';
 nt1.subject:='Reopening ticket';
 nt1.message:='I do not know how to reopen one of my closed tickets';
 nt1.helpTopic:=helpTopicDisabled;
 nt1.priority:=#Low;
 assert non-occurrence nt1;
}

 test S7{
 load testConfiguration9;
 nt1:=new NewTicketOnline;
 nt1.fullName:='James Jordan';
 nt1.email:='james_at_jordan.jam';
 nt1.subject:='Reopening ticket';
 nt1.message:='I do not know how to reopen one of my closed tickets';
 nt1.helpTopic:=helpTopicUse;
 nt1.priority:=#Low;
 assert non-occurrence nt1;
}

test S8{
 load testConfiguration3;
 nt1:=new NewTicketByEmail;
 nt1.toAddress:='general_at_support.com';
 nt1.fromName:='James Jordan';
 nt1.fromAddress:='james_at_jordan.jam';
 nt1.subject:='Ticket priority';
 nt1.message:='How can I change the priority of one of my tickets?';
 assert occurrence nt1;
```

```
ticket1:=nt1.createdTicket;

assert equals ticket1.number 1;
assert equals ticket1.ticketStatus #Open;
assert equals ticket1.subject 'Ticket priority';
assert equals ticket1.priority #Low;
assert true ticket1.assignedStaff->isEmpty();
assert equals ticket1.source #EMail;
assert equals ticket1.creationDatetime sys.currentDateTime;
assert true ticket1.dueDatetime.isUndefined();
assert true ticket1.lastResponseDatetime.isUndefined();
assert equals ticket1.assignedDepartment dptGeneral;

assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                m.text='How can I change the priority of one of my tickets?' and
                                m.author='James Jordan')];
//autoresponses
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAutoresponse) and
                                  e.fromAddress='general_at_support.com' and
                                  e.toAddress='james_at_jordan.jam' and
                                  e.ticketNumber=1)];
//notice to department members
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                  e.fromAddress='general_at_support.com' and
                                  e.toAddress='john_at_support.com' and
                                  e.ticketNumber=1)];

assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                  e.fromAddress='general_at_support.com' and
                                  e.toAddress='mary_at_support.com' and
                                  e.ticketNumber=1)];

assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                  e.fromAddress='general_at_support.com' and
                                  e.toAddress='david_at_support.com' and
                                  e.ticketNumber=1)];

}

test S9{
 load testConfiguration10;
 nt1:=new NewTicketByEmail;
 nt1.toAddress:='technical_at_support.com';
 nt1.fromName:='Marta Johnes';
 nt1.fromAddress:='marta_at_johnes.mar';
 nt1.subject:='See my tickets';
 nt1.message:='Can I see my tickets?';
 assert non-occurrence nt1;

 generalSettings.status:=#Online;
 assert occurrence nt1;


 ticket1:=nt1.createdTicket;

 assert equals ticket1.number 1;
 assert equals ticket1.ticketStatus #Open;
 assert equals ticket1.assignedDepartment dptTechnical;
 assert equals ticket1.subject 'See my tickets';
 assert equals ticket1.priority #High;
 assert true ticket1.assignedStaff->isEmpty();
 assert equals ticket1.source #EMail;
 assert equals ticket1.creationDatetime sys.currentDateTime;
 assert true ticket1.dueDatetime.isUndefined();
 assert true ticket1.lastResponseDatetime.isUndefined();


 assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                m.text='Can I see my tickets?' and
                                m.author='Marta Johnes')];
 //autoresponses
 assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAutoresponse) and
```

```
                                    e.fromAddress='technical_at_support.com' and
                                    e.toAddress='marta_at_johnes.mar' and
                                    e.ticketNumber=1)];
  //notice to department members
  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];

  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=1)];

  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='david_at_support.com' and
                                    e.ticketNumber=1)];

 }


 test S11{
   load testConfiguration1;

  nt1:=new NewTicketOnline;
  nt1.fullName:='James Jordan';
  nt1.email:='james_at_jordan.jam';
  nt1.helpTopic:=helpTopicUse;
  nt1.subject:='Reopening ticket';
  nt1.message:='I do not know how to reopen one of my closed tickets';
  assert occurrence nt1;

  ticket1:=nt1.createdTicket;

  nt2:=new NewTicketOnline;
  nt2.fullName:='James Jordan';
  nt2.email:='james_at_jordan.jam';
  nt2.helpTopic:=helpTopicInstallation;
  nt2.subject:='Error operating system';
  nt2.message:='The installation process does not finish....';
  assert occurrence nt2;

  ticket2:=nt2.createdTicket;

  cts:=new DisplayTicketsAssociatedToEmail(email:='james_at_jordan.jam', ticketNumber:=2);
  assert occurrence cts;
  assert equals cts.answer() [Set{Tuple{createDate=1,department='General
support',email='james_at_jordan.jam',number=1,status=#Open,subject='Reopening
ticket'},Tuple{createDate=1,department='Technical support',email='james_at_jordan.jam',number=2,status=#Open,subject='Error
operating system'}}];

 }

  test S12{
    load testConfiguration1;

  cts:=new DisplayTicketsAssociatedToEmail(email:='james_at_jordan.jam', ticketNumber:=2);
  assert non-occurrence cts;

 }

  test S13{
  load testConfiguration1;

  nt1:=new NewTicketOnline;
  nt1.fullName:='James Jordan';
  nt1.email:='james_at_jordan.jam';
  nt1.helpTopic:=helpTopicUse;
  nt1.subject:='Reopening ticket';
  nt1.message:='I do not know how to reopen one of my closed tickets';
```

```
 assert occurrence nt1;

 ticket1:=nt1.createdTicket;


 cts:=new DisplayTicketsAssociatedToEmail(email:='james_at_jordan.jam', ticketNumber:=2);
 assert non-occurrence cts;

}

test S14{
 load testConfiguration1;

 nt1:=new NewTicketOnline;
 nt1.fullName:='James Jordan';
 nt1.email:='james_at_jordan.jam';
 nt1.helpTopic:=helpTopicInstallation;
 helpTopicInstallation.autoresponse:=#Enabled;
 nt1.subject:='Reopening ticket';
 nt1.message:='I do not know how to reopen one of my closed tickets';
 assert occurrence nt1;

 ticket1:=nt1.createdTicket;


 cr:=new ReplyTicketByCustomer(ticket:=ticket1,replyText:='Please help me');
 assert occurrence cr;

 assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewMessageAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];

 assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewMessageAutoresponse) and
                                    e.fromAddress='technical_at_support.com' and
                                    e.toAddress='james_at_jordan.jam' and
                                    e.ticketNumber=1)];

}

test S15{
 load testConfiguration2;

 nt1:=new NewTicketOnline;
 nt1.fullName:='James Jordan';
 nt1.email:='james_at_jordan.jam';
 nt1.helpTopic:=helpTopicInstallation;
 nt1.subject:='Reopening ticket';
 nt1.message:='I do not know how to reopen one of my closed tickets';
 assert occurrence nt1;

 ticket1:=nt1.createdTicket;


 cr:=new ReplyTicketByCustomer(ticket:=ticket1,replyText:='Please help me');
 assert occurrence cr;

 assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewMessageAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];

}

test S16{
 load testConfiguration1;

 assert false generalConsultant.isLoggedIn;
 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;
 assert true generalConsultant.isLoggedIn;
```

```
}

test S17{
 load testConfiguration1;

 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;
 assert true generalConsultant.isLoggedIn;

 li := new LogIn(username:='mary', password:='yyy');
 assert non-occurrence li;


}

 test S18{
 load testConfiguration1;

 li := new LogIn(username:='patricia', password:='uuu');
 assert non-occurrence li;

 maximumPrivilegesGroup.status:=#Disabled;

 li := new LogIn(username:='mary', password:='yyy');
 assert non-occurrence li;


}

test S19{
 load testConfiguration1;

 assert false generalConsultant.isLoggedIn;

 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;
 assert true generalConsultant.isLoggedIn;

 lo := new LogOut(staffMember:=generalConsultant);
  assert occurrence lo;
 assert false generalConsultant.isLoggedIn;


}

   test S20{
 load testConfiguration1;

 li := new LogIn(username:='mary', password:='zzz');
 assert non-occurrence li;

}


test S21{
 load testConfiguration1;
 minimumPrivilegesGroup.canCreateTickets:=true;

   li := new LogIn(username:='martin', password:='ttt');
 assert occurrence li;

 nt:=new NewTicketOffline;
 nt.fullName:='Mary Marnes';
 nt.email:='mary_at_marnes.mar';
 nt.telephone:='xxxxxxxx';
 nt.ext:='xxxxxxxx';
 nt.source:=#Phone;
 nt.assignedDepartment:=dptTechnical;
 nt.helpTopic:=helpTopicInstallation;
 nt.subject:='Error operating system';
 nt.message:='The installation process does not finish....';
```

```
nt.internalNote:='It seems that the correct installer is being used';

dt2:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
nt.dueDatetime:=dt2;
nt.priority:=#Normal;
nt.assignedStaff:=generalConsultant;
nt.creator:=technicalActive;
assert occurrence nt;

ticket1:=nt.createdTicket;

assert equals ticket1.number 1;
assert equals ticket1.ticketStatus #Open;
assert equals ticket1.subject 'Error operating system';
assert equals ticket1.priority #Normal;
assert equals ticket1.assignedStaff generalConsultant;
assert equals ticket1.source #Phone;
assert equals ticket1.creationDatetime sys.currentDateTime;
assert equals ticket1.lastMessageDatetime sys.currentDateTime;
assert equals ticket1.dueDatetime.value 3;
assert true ticket1.lastResponseDatetime.isUndefined();
assert equals ticket1.assignedDepartment dptTechnical;



assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                m.text='The installation process does not finish....' and
                                m.author='Mary Marnes')];

assert equals ticket1.lastMessageDatetime sys.currentDateTime;

//no autoresponses
assert true [not(EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketNotice)))];

//notice to administrator
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='system_at_support.com' and
                                e.ticketNumber=1)];

//notice to department manager
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='john_at_support.com' and
                                e.ticketNumber=1)];

//notice to department members
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                e.fromAddress='general_at_support.com' and
                                e.toAddress='martin_at_support.com' and
                                e.ticketNumber=1)];


//TICKET 2
ticketSettings.customersCanChangePriority:=true;

nt2:=new NewTicketOffline;
nt2.fullName:='James Jordan';
nt2.email:='james_at_jordan.jam';
nt2.telephone:='xxxxxxxx';
nt2.ext:='xxxxxxxx';
nt2.source:=#Other;
nt2.assignedDepartment:=dptGeneral;
nt2.priority:=#Low;
nt2.helpTopic:=helpTopicUse;
nt2.subject:='Reopening ticket';
nt2.creator:=technicalActive;
nt2.message:='I do not know how to reopen one of my closed tickets';
assert occurrence nt2;

ticket2:=nt2.createdTicket;
```

```
assert equals ticket2.number 2;
assert equals ticket2.priority #Low;
assert true ticket2.assignedStaff->isEmpty();

//autoresponses

assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketNotice) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='james_at_jordan.jam' and
                                    e.ticketNumber=2)];

//notice to administrator
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='system_at_support.com' and
                                    e.ticketNumber=2)];


//notice to department members
assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=2)];

assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=2)];

assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='david_at_support.com' and
                                    e.ticketNumber=2)];


}


test S22{
load testConfiguration2;
minimumPrivilegesGroup.canCreateTickets:=true;

li := new LogIn(username:='martin', password:='ttt');
assert occurrence li;


nt:=new NewTicketOffline;
nt.fullName:='Mary Marnes';
nt.email:='mary_at_marnes.mar';
nt.telephone:='xxxxxxxx';
nt.ext:='xxxxxxxx';
nt.source:=#Phone;
nt.assignedDepartment:=dptTechnical;
nt.helpTopic:=helpTopicInstallation;
nt.subject:='Error operating system';
nt.message:='The installation process does not finish....';
nt.internalNote:='It seems that the correct installer is being used';

dt2:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
nt.dueDatetime:=dt2;
nt.priority:=#Normal;
nt.assignedStaff:=generalConsultant;
nt.creator:=technicalActive;
assert occurrence nt;

ticket1:=nt.createdTicket;

assert equals ticket1.number 1;
assert equals ticket1.ticketStatus #Open;
assert equals ticket1.subject 'Error operating system';
assert equals ticket1.priority #Normal;
```

```
  assert equals ticket1.assignedStaff generalConsultant;
  assert equals ticket1.source #Phone;
  assert equals ticket1.creationDatetime sys.currentDateTime;
  assert equals ticket1.lastMessageDatetime sys.currentDateTime;
  assert equals ticket1.dueDatetime.value 3;
  assert true ticket1.lastResponseDatetime.isUndefined();
  assert equals ticket1.assignedDepartment dptTechnical;



  assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                  m.text='The installation process does not finish....' and
                                  m.author='Mary Marnes')];

  assert equals ticket1.lastMessageDatetime sys.currentDateTime;

  //no autoresponses
  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketNotice))];

  //no notice to administrator
  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                  e.fromAddress='general_at_support.com' and
                                  e.toAddress='system_at_support.com' and
                                  e.ticketNumber=1)];

  //no notice to department manager
  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                  e.fromAddress='general_at_support.com' and
                                  e.toAddress='john_at_support.com' and
                                  e.ticketNumber=1)];

 //no notice to department members
  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewTicketAlertToStaff) and
                                  e.fromAddress='general_at_support.com' and
                                  e.toAddress='martin_at_support.com' and
                                  e.ticketNumber=1)];


 }


test S23{
  load testConfiguration4;
  minimumPrivilegesGroup.canCreateTickets:=true;
  helpTopicUse.status:=#Disabled;
  helpTopicInstallation.status:=#Disabled;

  li := new LogIn(username:='martin', password:='ttt');
  assert occurrence li;

  nt:=new NewTicketOffline;
  nt.fullName:='Mary Marnes';
  nt.email:='mary_at_marnes.mar';
  nt.telephone:='xxxxxxxx';
  nt.ext:='xxxxxxxx';
  nt.source:=#Phone;
  nt.assignedDepartment:=dptTechnical;
  nt.subject:='Error operating system';
  nt.message:='The installation process does not finish....';
  nt.creator:=technicalActive;
  nt.priority:=#Normal;
  assert occurrence nt;

  ticket1:=nt.createdTicket;

  assert true ticket1.helpTopic->isEmpty();

 }

  test S24{
  load testConfiguration9;
```

```
  li := new LogIn(username:='martin', password:='ttt');
  assert occurrence li;


  nt:=new NewTicketOffline;
  nt.fullName:='Mary Marnes';
  nt.email:='mary_at_marnes.mar';
  nt.telephone:='xxxxxxxx';
  nt.ext:='xxxxxxxx';
  nt.source:=#Phone;
  nt.helpTopic:=helpTopicInstallation;
  nt.assignedDepartment:=dptTechnical;
  nt.assignedStaff:=generalConsultant;
  nt.subject:='Error operating system';
  nt.message:='The installation process does not finish....';
  nt.priority:=#Normal;
  nt.creator:=technicalActive;
  assert non-occurrence nt;


 }

 test S25{
  load testConfiguration9;

  nt:=new NewTicketOffline;
  nt.fullName:='Mary Marnes';
  nt.email:='mary_at_marnes.mar';
  nt.telephone:='xxxxxxxx';
  nt.ext:='xxxxxxxx';
  nt.source:=#Phone;
  nt.helpTopic:=helpTopicInstallation;
  nt.assignedDepartment:=dptTechnical;
  nt.subject:='Error operating system';
  nt.message:='The installation process does not finish....';
  nt.priority:=#Normal;
  nt.creator:=technicalActive;
  assert non-occurrence nt;


 }



  test S26{
  load testConfiguration3;

  load created_tickets;

  li := new LogIn(username:='john', password:='xxx');
  assert occurrence li;

  dts:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#OpenTickets);
  assert occurrence dts;
  assert equals dts.answer() [Sequence{
      Tuple{createDate=1,department='Technical support',email='mary_at_marnes.mar',number=1,priority=#Normal,subject='Error
operating system'},
      Tuple{createDate=1,department='General support',email='mary_at_marnes.mar',number=2,priority=#High,subject='Can I
reply a ticket?'},
      Tuple{createDate=1,department='Technical support',email='martin_at_pope.mar',number=3,priority=#Low,subject='Error
while login'},
      Tuple{createDate=2,department='General
support',email='james_at_jordan.jam',number=4,priority=#Normal,subject='Reopening ticket'},
      Tuple{createDate=2,department='Technical support',email='marta_at_johnes.mar',number=5,priority=#High,subject='See my
tickets'}}
      ];

  lo := new LogOut(staffMember:=generalAdministrator);
  assert occurrence lo;

  li := new LogIn(username:='martin', password:='ttt');
```

```
    assert occurrence li;

    dts:=new DisplayTicketsByStatus(consultant:=technicalActive, status:=#OpenTickets);
    assert occurrence dts;
    assert equals dts.answer() [Sequence{
                        Tuple{createDate=1,department='Technical
support',email='mary_at_marnes.mar',number=1,priority=#Normal,subject='Error operating system'},
                        Tuple{createDate=1,department='Technical
support',email='martin_at_pope.mar',number=3,priority=#Low,subject='Error while login'},
                        Tuple{createDate=2,department='Technical
support',email='marta_at_johnes.mar',number=5,priority=#High,subject='See my tickets'}} ];

   }

   test S27{
    load testConfiguration11;

    dts:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#OpenTickets);
    assert non-occurrence dts;

   }

   test S28{
    load testConfiguration3;

    load created_tickets;

    li := new LogIn(username:='john', password:='xxx');
    assert occurrence li;

    stp:=new ChangeTicketPriority(staffMember:=generalAdministrator, ticket:=ticket1, newPriority:=#High);
    assert occurrence stp;
    assert equals ticket1.priority #High;

    assert true [ticket1.internalNote->one(ili.datetime=sys.currentDateTime and
                                    i.text='The ticket priority has been changed' and
                                    i.subject='Ticket priority changed' and
                                    i.author='John')];


   }

   test S29{
    load testConfiguration4;

    load created_tickets;

    li := new LogIn(username:='martin', password:='ttt');
    assert occurrence li;

    stp:=new ChangeTicketPriority(staffMember:=technicalActive, ticket:=ticket2, newPriority:=#High);
    assert non-occurrence stp;


   }


   test S30{
    load testConfiguration4;

    load created_tickets;


    stp:=new ChangeTicketPriority(staffMember:=generalAdministrator, ticket:=ticket1, newPriority:=#High);
    assert non-occurrence stp;

   }

   test S31{
    load testConfiguration1;

    load created_tickets;
```

```
helpTopicInstallation.autoresponse:=#Enabled;

li := new LogIn(username:='john', password:='xxx');
assert occurrence li;

mto:=new MarkTicketOverdue(staffMember:=generalAdministrator, ticket:=ticket1);
assert occurrence mto;

assert true ticket1.isOverdue;
assert true [ticket1.internalNote->one(ili.datetime=sys.currentDateTime and
                                       i.text='Ticket flagged as overdue' and
                                       i.subject='Ticket Marked Overdue' and
                                       i.author='John')];


}

test S32{
 load testConfiguration3;

 load created_tickets;


 li := new LogIn(username:='martin', password:='ttt');
 assert occurrence li;

 mto:=new MarkTicketOverdue(staffMember:=technicalActive, ticket:=ticket1);
 assert non-occurrence mto;

}


test S33{
 load testConfiguration4;

 load created_tickets;

 mto:=new MarkTicketOverdue(staffMember:=generalAdministrator, ticket:=ticket1);
 assert non-occurrence mto;

}


test S34{

 load testConfiguration3;

 load created_tickets;

  li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 at:=new AssignTicket(staffMember:=generalConsultant, ticket:=ticket1, assignee:=generalAdministrator, assignmentText:='This is
for you');
 assert occurrence at;

 assert equals ticket1.assignedStaff generalAdministrator;


 assert true [ticket1.internalNote->one(ili.datetime=sys.currentDateTime and
                                       i.text='This is for you' and
                                       i.subject='Ticket Reassigned' and
                                       i.author='Mary')];

 //notice sent to the assignee
 assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(TicketAssignedAlertToStaff) and
                                     e.fromAddress='general_at_support.com' and
                                     e.toAddress='john_at_support.com' and
                                     e.ticketNumber=1)];

}
```

```
  test S35{
   load testConfiguration3;

   load created_tickets;

   li := new LogIn(username:='martin', password:='ttt');
   assert occurrence li;

   at:=new AssignTicket(staffMember:=technicalActive, ticket:=ticket2, assignee:=generalAdministrator, assignmentText:='This is for
you');
   assert non-occurrence at;

  }

 test S36{
   load testConfiguration3;

   load created_tickets;

    li := new LogIn(username:='mary', password:='yyy');
   assert occurrence li;

   at:=new AssignTicket(staffMember:=generalConsultant, ticket:=ticket1, assignee:=generalConsultantVacation,
assignmentText:='This is for you');
   assert non-occurrence at;

  }

  test S37{
   load testConfiguration3;

   load created_tickets;

   at:=new AssignTicket(staffMember:=generalConsultant, ticket:=ticket1, assignee:=generalAdministrator, assignmentText:='This is
for you');
   assert non-occurrence at;

  }

  test S38{

   load testConfiguration3;

   load created_tickets;

    li := new LogIn(username:='mary', password:='yyy');
   assert occurrence li;

   rt:=new ReleaseTicket(staffMember:=generalConsultant, ticket:=ticket1);
   assert occurrence rt;

   assert true ticket1.assignedStaff.isUndefined();


   assert true [ticket1.internalNote->one(ili.datetime=sys.currentDateTime and
                                          i.text='Released ticket' and
                                          i.subject='Ticket unassigned' and
                                          i.author='Mary')];

  }


   test S39{

   load testConfiguration3;

   load created_tickets;

    li := new LogIn(username:='martin', password:='ttt');
   assert occurrence li;
```

```
 rt:=new ReleaseTicket(staffMember:=technicalActive, ticket:=ticket2);
 assert non-occurrence rt;


}

 test S40{

 load testConfiguration3;

 load created_tickets;

  li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 rt:=new ReleaseTicket(staffMember:=generalConsultant, ticket:=ticket4);
 assert non-occurrence rt;


}

test S41{

 load testConfiguration3;

 load created_tickets;

 rt:=new ReleaseTicket(staffMember:=generalConsultant, ticket:=ticket2);
 assert non-occurrence rt;


}

test S42{

 load testConfiguration3;

 load created_tickets;

  li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;
 dt3:=new Datetime(value:=[(sys.currentDateTime.value+3)]);
 et:=new EditTicket(staffMember:=generalConsultant, ticket:=ticket1,
                    emailAddress:='mary2@marnes.mar',
                    fullName:='Mary Marnes2',
                    subject:='Error operating system2',
                    telephone:='xxx2',
                    ext:='xx2',
                    dueDatetime:=dt3,
                    priority:=#Low,
                    helpTopic:=helpTopicUse,
                    editionInternalNote:='The customer asks for this changes');
 assert occurrence et;
 assert equals ticket1.email 'mary2@marnes.mar';
 assert equals ticket1.fullName 'Mary Marnes2';
 assert equals ticket1.subject 'Error operating system2';
 assert equals ticket1.telephone 'xxx2';
 assert equals ticket1.ext 'xx2';
 assert equals ticket1.priority #Low;
 assert equals ticket1.helpTopic helpTopicUse;

 assert true [ticket1.internalNote->one(ili.datetime=sys.currentDateTime and
                                        i.text='The customer asks for this changes' and
                                        i.subject='Ticket updated' and
                                        i.author='Mary')];

}

test S43{

 load testConfiguration3;
```

```
load created_tickets;

li := new LogIn(username:='martin', password:='ttt');
assert occurrence li;
dt3:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
 et:=new EditTicket(staffMember:=technicalActive, ticket:=ticket1,
                    emailAddress:='mary2@marnes.mar',
                    fullName:='Mary Marnes2',
                    subject:='Error operating system2',
                    telephone:='xxx2',
                    ext:='xx2',
                    dueDatetime:=dt3,
                    priority:=#Low,
                    helpTopic:=helpTopicUse,
                    editionInternalNote:='The customer asks for this changes');
assert non-occurrence et;

}

test S44{

load testConfiguration3;

load created_tickets;

li := new LogIn(username:='martin', password:='ttt');
assert occurrence li;
dt3:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
et:=new EditTicket(staffMember:=technicalActive, ticket:=ticket1,
                    emailAddress:='mary2@marnes.mar',
                    fullName:='John Johnes2',
                    subject:='Can I reply a ticket? Yes or no?',
                    telephone:='yyy2',
                    ext:='yy2',
                    dueDatetime:=dt3,
                    priority:=#Normal,
                    helpTopic:=helpTopicUse,
                    editionInternalNote:='The customer asks for this changes');
assert non-occurrence et;

}

test S45{

load testConfiguration3;

load created_tickets;
technicalActive.isAdministrator:=true;

li := new LogIn(username:='martin', password:='ttt');
assert occurrence li;
dt3:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
et:=new EditTicket(staffMember:=technicalActive, ticket:=ticket1,
                    emailAddress:='mary2@marnes.mar',
                    fullName:='John Johnes2',
                    subject:='Can I reply a ticket? Yes or no?',
                    telephone:='yyy2',
                    ext:='yy2',
                    dueDatetime:=dt3,
                    priority:=#Normal,
                    helpTopic:=helpTopicUse,
                    editionInternalNote:='The customer asks for this changes');
assert occurrence et;

}

test S46{

load testConfiguration3;

load created_tickets;
```

```
 dt3:=new Datetime(value:=[(sys.currentDateTime.value+3)]);
 et:=new EditTicket(staffMember:=generalConsultant, ticket:=ticket1,
                emailAddress:='mary2@marnes.mar',
                fullName:='Mary Marnes2',
                subject:='Error operating system2',
                telephone:='xxx2',
                ext:='xx2',
                dueDatetime:=dt3,
                priority:=#Low,
                helpTopic:=helpTopicUse,
                editionInternalNote:='The customer asks for this changes');
 assert non-occurrence et;

}


test S47{
 load testConfiguration1;
 helpTopicInstallation.autoresponse:=#Enabled;
 load created_tickets;

 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 rt:=new PostTicketReply(staffMember:=generalConsultant, ticket:=ticket1,
                response:='You should choose the installation executable...');
 assert occurrence rt;

 assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                    m.text='You should choose the installation executable...' and
                                    m.author='Mary')];

 assert equals ticket1.lastMessageDatetime sys.currentDateTime;

 assert equals ticket1.lastRespondent generalConsultant;


 //autoresponse
 assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(TicketResponseNotice) and
                                    e.fromAddress='technical_at_support.com' and
                                    e.toAddress='mary_at_marnes.mar' and
                                    e.ticketNumber=1)];

 //notice to assigned staff
 assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewMessageAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=1)];

//notice to department manager
 assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewMessageAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];



}

test S48{
 load testConfiguration4;
 helpTopicInstallation.autoresponse:=#Enabled;
 load created_tickets;

 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 rt:=new PostTicketReply(staffMember:=generalConsultant, ticket:=ticket1,
                response:='You should choose the installation executable...');
 assert occurrence rt;
```

```
  assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                  m.text='You should choose the installation executable...' and
                                  m.author='Mary')];

  assert equals ticket1.lastMessageDatetime sys.currentDateTime;

  assert equals ticket1.lastRespondent generalConsultant;


  //autoresponse
  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(TicketResponseNotice) and
                                  e.fromAddress='technical_at_support.com' and
                                  e.toAddress='mary_at_marnes.mar' and
                                  e.ticketNumber=1)];

  //notice to assigned staff
  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewMessageAlertToStaff) and
                                  e.fromAddress='general_at_support.com' and
                                  e.toAddress='mary_at_support.com' and
                                  e.ticketNumber=1)];

 //notice to department manager
  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewMessageAlertToStaff) and
                                  e.fromAddress='general_at_support.com' and
                                  e.toAddress='john_at_support.com' and
                                  e.ticketNumber=1)];

 }

 test S49{
  load testConfiguration4;
  load created_tickets;

  li := new LogIn(username:='martin', password:='ttt');
  assert occurrence li;

  rt:=new PostTicketReply(staffMember:=technicalActive, ticket:=ticket2,
                response:='You should choose the installation executable...');
  assert non-occurrence rt;

 }

test S50{
  load testConfiguration1;
  load created_tickets;

  rt:=new PostTicketReply(staffMember:=generalConsultant, ticket:=ticket1,
                response:='You should choose the installation executable...');
  assert non-occurrence rt;

 }

test S51{
  load testConfiguration1;
  load created_tickets;

  li := new LogIn(username:='martin', password:='ttt');
  assert occurrence li;

  pin:=new PostTicketInternalNote(staffMember:=technicalActive, ticket:=ticket1,
                title:='No tickets?', note:='It seems that she does not have tickets');
  assert occurrence pin;

  assert true [ticket1.internalNote->one(mlm.datetime=sys.currentDateTime and
                                  m.subject='No tickets?'and
                                  m.text='It seems that she does not have tickets' and
                                  m.author='Martin')];

   //notice to assigned staff
  assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewInternalNoteAlertToStaff) and
                                  e.fromAddress='general_at_support.com' and
                                  e.toAddress='mary_at_support.com' and
```

```
                                    e.ticketNumber=1)];

 //notice to department manager
  assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewInternalNoteAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];

 }


 test S52{
  load testConfiguration4;
  load created_tickets;

  li := new LogIn(username:='martin', password:='ttt');
  assert occurrence li;

  pin:=new PostTicketInternalNote(staffMember:=technicalActive, ticket:=ticket5,
                title:='No tickets?', note:='It seems that she does not have tickets');
  assert occurrence pin;

  assert true [ticket5.internalNote->one(mlm.datetime=sys.currentDateTime and
                                    m.subject='No tickets?'and
                                    m.text='It seems that she does not have tickets' and
                                    m.author='Martin')];

   //notice to assigned staff
  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewInternalNoteAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=5)];

 //notice to department manager
  assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewInternalNoteAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=5)];

 }

test S53{
  load testConfiguration4;
  load created_tickets;

  li := new LogIn(username:='martin', password:='ttt');
  assert occurrence li;

  pin:=new PostTicketInternalNote(staffMember:=technicalActive, ticket:=ticket4,
                title:='Checked button', note:='Checked that the button appears');
  assert non-occurrence pin;



 }

test S54{
  load testConfiguration4;
  load created_tickets;


  pin:=new PostTicketInternalNote(staffMember:=technicalActive, ticket:=ticket1,
                title:='No tickets?', note:='It seems that she does not have tickets');
  assert non-occurrence pin;

 }

 test S55{
  load testConfiguration4;
  load created_tickets;
```

```
 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 tt:=new TransferDepartment(staffMember:=generalConsultant, ticket:=ticket2,
                department:=dptTechnical,
                note:='This is a technical question');
 assert occurrence tt;

 assert equals ticket1.assignedDepartment dptTechnical;

}

test S56{
 load testConfiguration3;
 technicalActive.staffGroup:=maximumPrivilegesGroup;
 maximumPrivilegesGroup.departmentsAccess:=Set{dptTechnical};
 load created_tickets;


 li := new LogIn(username:='martin', password:='ttt');
 assert occurrence li;

 tt:=new TransferDepartment(staffMember:=technicalActive, ticket:=ticket2,
                department:=dptTechnical,
                note:='This is a technical question');
 assert non-occurrence tt;



}

test S57{
 load testConfiguration3;
 load created_tickets;


 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 tt:=new TransferDepartment(staffMember:=generalConsultant, ticket:=ticket2,
                department:=dptGeneral,
                note:='This is a technical question');
 assert non-occurrence tt;


}


test S58{
 load testConfiguration3;
 load created_tickets;


 li := new LogIn(username:='martin', password:='ttt');
 assert occurrence li;

 tt:=new TransferDepartment(staffMember:=generalConsultant, ticket:=ticket1,
                department:=dptGeneral,
                note:='This is a technical question');
 assert non-occurrence tt;


}

test S59{
 load testConfiguration3;
 load created_tickets;


 tt:=new TransferDepartment(staffMember:=generalConsultant, ticket:=ticket1,
                department:=dptGeneral,
                note:='This is a technical question');
```

```
 assert non-occurrence tt;


}

test S60{
 load testConfiguration3;
 load created_tickets;

 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 ct:=new CloseTicket(staffMember:=generalConsultant, ticket:=ticket1);
 assert occurrence ct;

 assert equals ticket1.ticketStatus #Closed;

 assert true [ticket1.internalNote->one(m|m.datetime=sys.currentDateTime and
                                        m.subject='Ticket closed'and
                                        m.text='Ticket closed without response' and
                                        m.author='Mary')];

 ct:=new CloseTicket(staffMember:=generalConsultant, ticket:=ticket1);
 assert non-occurrence ct;

}

test S61{
 load testConfiguration3;
 load created_tickets;

 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 generalConsultant.staffGroup.departmentsAccess:=Set{dptGeneral};

 ct:=new CloseTicket(staffMember:=generalConsultant, ticket:=ticket3);
 assert non-occurrence ct;

 generalConsultant.staffGroup.departmentsAccess:=Set{dptGeneral,dptTechnical};
 generalConsultant.staffGroup.canCloseTickets:=false;

 ct:=new CloseTicket(staffMember:=generalConsultant, ticket:=ticket3);
 assert non-occurrence ct;

}


test S62{
 load testConfiguration3;
 load created_tickets;

 ct:=new CloseTicket(staffMember:=generalConsultant, ticket:=ticket3);
 assert non-occurrence ct;

}

test S63{
 load testConfiguration1;
 load created_tickets;
 helpTopicInstallation.autoresponse:=#Enabled;

 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 ct:=new CloseTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket1,
                response:='Ticket solved');
 assert occurrence ct;

 assert equals ticket1.ticketStatus #Closed;

 assert true [ticket1.internalNote->one(m|m.datetime=sys.currentDateTime and
```

```
                                m.subject='Ticket closed'and
                                m.text='Ticket closed on reply' and
                                m.author='Mary')];


 assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(TicketResponseNotice) and
                                  e.fromAddress='technical_at_support.com' and
                                  e.toAddress='mary_at_marnes.mar' and
                                  e.ticketNumber=1)];

   assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                m.text='Ticket solved' and
                                m.author='Mary')];

 ct:=new CloseTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket1,
              response:='Ticket solved');
 assert non-occurrence ct;

}

test S64{
 load testConfiguration4;
 load created_tickets;


 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 ct:=new CloseTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket1,
              response:='Ticket solved');
 assert occurrence ct;

 assert equals ticket1.ticketStatus #Closed;

 assert true [ticket1.internalNote->one(mlm.datetime=sys.currentDateTime and
                                m.subject='Ticket closed'and
                                m.text='Ticket closed on reply' and
                                m.author='Mary')];


 assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(TicketResponseNotice) and
                                  e.fromAddress='technical_at_support.com' and
                                  e.toAddress='mary_at_marnes.mar' and
                                  e.ticketNumber=1)];

 assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                m.text='Ticket solved' and
                                m.author='Mary')];


}

 test S65{
 load testConfiguration3;
 load created_tickets;

 li := new LogIn(username:='mary', password:='yyy');
 assert occurrence li;

 generalConsultant.staffGroup.departmentsAccess:=Set{dptGeneral};

 ct:=new CloseTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket3,
                response:='Ticket solved');
 assert non-occurrence ct;

 generalConsultant.staffGroup.departmentsAccess:=Set{dptGeneral,dptTechnical};
 generalConsultant.staffGroup.canCloseTickets:=false;

 ct:=new CloseTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket3,
                response:='Ticket solved');
```

```
 assert non-occurrence ct;

}

test S66{
 load testConfiguration3;
 load created_tickets;


 ct:=new CloseTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket1,
                response:='Ticket solved');
 assert non-occurrence ct;

}

 test S67{
    load testConfiguration3;

    load created_tickets;
    ticket1.ticketStatus:=#Closed;

    li := new LogIn(username:='mary', password:='yyy');
    assert occurrence li;

    rot:=new ReopenTicket(staffMember:=generalConsultant, ticket:=ticket1);
    assert occurrence rot;

    assert equals ticket1.ticketStatus #Open;

    assert true [ticket1.internalNote->one(mlm.datetime=sys.currentDateTime and
                                m.subject='Ticket reopened'and
                                m.text='Ticket reopened without comments' and
                                m.author='Mary')];

    rot:=new ReopenTicket(staffMember:=generalConsultant, ticket:=ticket1);
    assert non-occurrence rot;
}

 test S68{
    load testConfiguration3;

    load created_tickets;
    ticket2.ticketStatus:=#Closed;

    li := new LogIn(username:='martin', password:='ttt');
    assert occurrence li;

    rot:=new ReopenTicket(staffMember:=technicalActive, ticket:=ticket2);
    assert non-occurrence rot;

}

test S69{
    load testConfiguration3;

    load created_tickets;
    ticket1.ticketStatus:=#Closed;

    rot:=new ReopenTicket(staffMember:=generalConsultant, ticket:=ticket1);
    assert non-occurrence rot;

}

 test S70{
    load testConfiguration1;
    helpTopicInstallation.autoresponse:=#Enabled;

    load created_tickets;
    ticket1.ticketStatus:=#Closed;

    li := new LogIn(username:='mary', password:='yyy');
```

```
    assert occurrence li;

    rot:=new ReopenTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket1,
                                response:='The customer is not satisfied');
    assert occurrence rot;

    assert equals ticket1.ticketStatus #Open;

    assert true [ticket1.internalNote->one(mlm.datetime=sys.currentDateTime and
                                m.subject='Ticket status changed to open'and
                                m.text='A staff member reopened the ticket on reply' and
                                m.author='Mary')];


    assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(TicketResponseNotice) and
                                  e.fromAddress='technical_at_support.com' and
                                  e.toAddress='mary_at_marnes.mar' and
                                  e.ticketNumber=1)];

    assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                m.text='The customer is not satisfied' and
                                m.author='Mary')];

    rot:=new ReopenTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket1,
                                response:='The customer is not satisfied');
    assert non-occurrence rot;

}

test S71{
    load testConfiguration4;

    load created_tickets;
    ticket1.ticketStatus:=#Closed;

    li := new LogIn(username:='mary', password:='yyy');
    assert occurrence li;

    rot:=new ReopenTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket1,
                                response:='The customer is not satisfied');
    assert occurrence rot;

    assert equals ticket1.ticketStatus #Open;

    assert true [ticket1.internalNote->one(mlm.datetime=sys.currentDateTime and
                                m.subject='Ticket status changed to open'and
                                m.text='A staff member reopened the ticket on reply' and
                                m.author='Mary')];


    assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(TicketResponseNotice) and
                                  e.fromAddress='technical_at_support.com' and
                                  e.toAddress='mary_at_marnes.mar' and
                                  e.ticketNumber=1)];

    assert true [ticket1.ticketThreadMessage->one(mlm.datetime=sys.currentDateTime and
                                m.text='The customer is not satisfied' and
                                m.author='Mary')];


}

test S72{
    load testConfiguration3;

    load created_tickets;
    ticket1.ticketStatus:=#Closed;

    li := new LogIn(username:='martin', password:='ttt');
    assert occurrence li;
```

```
    rot:=new ReopenTicketWithResponse(staffMember:=technicalActive, ticket:=ticket2,
                                response:='The customer is not satisfied');
    assert non-occurrence rot;

}

test S73{
    load testConfiguration1;
    helpTopicInstallation.autoresponse:=#Enabled;

    load created_tickets;
    ticket1.ticketStatus:=#Closed;

    rot:=new ReopenTicketWithResponse(staffMember:=generalConsultant, ticket:=ticket1,
                                response:='The customer is not satisfied');
    assert non-occurrence rot;
}

test S74{
    load testConfiguration3;

    load created_tickets;

    li := new LogIn(username:='mary', password:='yyy');
    assert occurrence li;

    cbt:=new BanEmailAndCloseTicket(staffMember:=generalConsultant, ticket:=ticket1);
    assert occurrence cbt;

    assert equals ticket1.ticketStatus #Closed;
    assert true EmailSettings.allInstances->any(true).banList->includes(ticket1.email);

    cbt:=new BanEmailAndCloseTicket(staffMember:=generalConsultant, ticket:=ticket1);
    assert non-occurrence cbt;
}

 test S75{
    load testConfiguration3;
    technicalActive.staffGroup.canBanEmails:=true;
    load created_tickets;

    li := new LogIn(username:='mary', password:='yyy');
    assert occurrence li;

    cbt:=new BanEmailAndCloseTicket(staffMember:=technicalActive, ticket:=ticket1);
    assert non-occurrence cbt;

}

 test S76{
    load testConfiguration3;
    load created_tickets;
    generalConsultant.staffGroup.canBanEmails:=false;

    li := new LogIn(username:='mary', password:='yyy');
    assert occurrence li;

    cbt:=new BanEmailAndCloseTicket(staffMember:=generalConsultant, ticket:=ticket2);
    assert non-occurrence cbt;

}

 test S77{
    load testConfiguration3;
    load created_tickets;


    cbt:=new BanEmailAndCloseTicket(staffMember:=generalConsultant, ticket:=ticket2);
    assert non-occurrence cbt;

}
```

```
test S78{
    load testConfiguration3;
    load created_tickets;

    li := new LogIn(username:='mary', password:='yyy');
    assert occurrence li;


    dt:=new DeleteTicket(staffMember:=generalConsultant, ticket:=ticket1);
    assert occurrence dt;

    assert true [not(Ticket.allInstances()->exists(tIt.number=1))];

}

test S79{
    load testConfiguration3;
    load created_tickets;
    technicalActive.staffGroup.canDeleteTickets:=true;

    li := new LogIn(username:='mary', password:='yyy');
    assert occurrence li;


    dt:=new DeleteTicket(staffMember:=technicalActive, ticket:=ticket2);
    assert non-occurrence dt;
}

test S80{
    load testConfiguration3;
    load created_tickets;
    technicalActive.staffGroup.canDeleteTickets:=false;

    li := new LogIn(username:='mary', password:='yyy');
    assert occurrence li;


    dt:=new DeleteTicket(staffMember:=technicalActive, ticket:=ticket1);
    assert non-occurrence dt;
}


  test S81{
    load testConfiguration3;
    load created_tickets;

    dt:=new DeleteTicket(staffMember:=generalConsultant, ticket:=ticket1);
    assert non-occurrence dt;
}

 test S82{
    load testConfiguration4;
    EmailSettings.allInstances()->any(true).banList:=Set{'hello_at_helloworld.hel'};

    li := new LogIn(username:='mary', password:='yyy');
    assert occurrence li;
    nt1:=new NewTicketOffline;
    nt1.fullName:='Mary Marnes';
    nt1.email:='hello_at_helloworld.hel';
    nt1.telephone:='xxxxxxxx';
    nt1.ext:='xxxxxxxx';
    nt1.source:=#Phone;
    nt1.assignedDepartment:=dptTechnical;
    nt1.helpTopic:=helpTopicInstallation;
    nt1.subject:='Error operating system';
    nt1.message:='The installation process does not finish....';
    nt1.internalNote:='It seems that the correct installer is being used';
    dt2:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
    nt1.dueDatetime:=dt2;
    nt1.priority:=#Normal;
    nt1.assignedStaff:=generalConsultant;
```

```
    nt1.creator:=generalConsultant;
    assert non-occurrence nt1;

    nt4:=new NewTicketOnline;
    nt4.fullName:='James Jordan';
    nt4.email:='hello_at_helloworld.hel';
    nt4.helpTopic:=helpTopicUse;
    nt4.subject:='Reopening ticket';
    nt4.message:='I do not know how to reopen one of my closed tickets';
    assert non-occurrence nt4;

    nt5:=new NewTicketByEmail;
    nt5.toAddress:='technical_at_support.com';
    nt5.fromName:='Marta Johnes';
    nt5.fromAddress:='hello_at_helloworld.hel';
    nt5.subject:='See my tickets';
    nt5.message:='Can I see my tickets?';
    assert non-occurrence nt5;


}

  test S83{
    load testConfiguration3;
    load created_tickets;

    dt3:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
    sys.currentDateTime:=dt3;

    cot:=new CheckOverdueTickets;
    assert occurrence cot;


    assert equals ticket1.isOverdue true;

     //notice to assigned staff
    assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewInternalNoteAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=1)];

    //notice to department member
    assert false [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(NewInternalNoteAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
                                    e.ticketNumber=1)];
}

 test S84{
    load testConfiguration1;
    load created_tickets;

    dt3:=new Datetime(value:=[(sys.currentDateTime.value+2)]);
    sys.currentDateTime:=dt3;


    cot:=new CheckOverdueTickets;
    assert occurrence cot;


    assert equals ticket1.isOverdue true;

     //notice to assigned staff
    assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(OverdueTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='mary_at_support.com' and
                                    e.ticketNumber=1)];

    //notice to department member
    assert true [EMail.allInstances()->exists(ele.emailKind.oclIsTypeOf(OverdueTicketAlertToStaff) and
                                    e.fromAddress='general_at_support.com' and
                                    e.toAddress='john_at_support.com' and
```

```
                                    e.ticketNumber=1)];
}

test S85{
    load testConfiguration3;
    load created_tickets;

    li := new LogIn(username:='john', password:='xxx');
    assert occurrence li;

    dts:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#OpenTickets);
    assert occurrence dts;
    assert equals dts.answer() [Sequence{
        Tuple{createDate=1,department='Technical
support',email='mary_at_marnes.mar',number=1,priority=#Normal,subject='Error operating system'},
        Tuple{createDate=1,department='General support',email='mary_at_marnes.mar',number=2,priority=#High,subject='Can I
reply a ticket?'},
        Tuple{createDate=1,department='Technical support',email='martin_at_pope.mar',number=3,priority=#Low,subject='Error
while login'},
        Tuple{createDate=2,department='General
support',email='james_at_jordan.jam',number=4,priority=#Normal,subject='Reopening ticket'},
        Tuple{createDate=2,department='Technical support',email='marta_at_johnes.mar',number=5,priority=#High,subject='See
my tickets'}} ];

    dts2:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#AssignedToMe);
    assert occurrence dts2;
    assert equals dts2.answer() [Sequence{} ];

    at2:=new AssignTicket(staffMember:=generalAdministrator, ticket:=ticket4, assignee:=generalAdministrator,
assignmentText:='This is for me');
    assert occurrence at2;

    dts3:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#AssignedToMe);
    assert occurrence dts3;
    assert equals dts3.answer() [Sequence{Tuple{createDate=2,department='General
support',email='james_at_jordan.jam',number=4,priority=#Normal,subject='Reopening ticket'}}];

    dts4:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#OverdueTickets);
    assert occurrence dts4;
    assert equals dts4.answer() [Sequence{} ];

    dt3:=new Datetime(value:=[(sys.currentDateTime.value+3)]);
    sys.currentDateTime:=dt3;
    mto:=new MarkTicketOverdue(staffMember:=generalAdministrator, ticket:=ticket4);
    assert occurrence mto;
    cot:=new CheckOverdueTickets;
    assert occurrence cot;

    dts5:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#OverdueTickets);
    assert occurrence dts5;
    assert equals dts5.answer() [Sequence{
        Tuple{createDate=1,department='Technical
support',email='mary_at_marnes.mar',number=1,priority=#Normal,subject='Error operating system'},
        Tuple{createDate=2,department='General
support',email='james_at_jordan.jam',number=4,priority=#Normal,subject='Reopening ticket'}} ];

    dts6:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#ClosedTickets);
    assert occurrence dts6;
    assert equals dts6.answer() [Sequence{}];


    ct:=new CloseTicket(staffMember:=generalAdministrator, ticket:=ticket4);
    assert occurrence ct;

    dts7:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#OverdueTickets);
    assert occurrence dts7;
    assert equals dts7.answer() [Sequence{
      Tuple{createDate=1,department='Technical
support',email='mary_at_marnes.mar',number=1,priority=#Normal,subject='Error operating system'}} ];

     dts8:=new DisplayTicketsByStatus(consultant:=generalAdministrator, status:=#ClosedTickets);
    assert occurrence dts8;
```

```
        assert equals dts8.answer() [Sequence{
            Tuple{createDate=2,department='General
support',email='james_at_jordan.jam',number=4,priority=#Normal,subject='Reopening ticket'}} ];


    }

}
```