Interactive and large format application for the presentation of Barcelona from a business vision

Author: Iván Sánchez Marcos
TFG Manager: Juan Manuel Miras López (Sitep S.L.)
TFG Speaker: Maria Jose Casañ Guerrero
Company: Sitep S.L.
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Grau en Enginyeria Informàtica
Especialitat en Enginyeria del Software
Facultat d’Informàtica de Barcelona (FIB) – Universitat Politècnica de Catalunya (UPC)
Resumen (Castellano)

Barcelona Activa, como gestora del edificio MEDITATIC, situado en la calle Rita Boronat 17 de Barcelona, pretende adecuar su hall para proporcionar una serie de servicios a empresas.

Este espacio se reservará en una sala multifuncional, denominada Sala Gran/Showroom, que estará presidida por un conjunto de monitores con estructura de Video Wall y que podrá ser visualizado en su conjunto o subdividido en dos mitades adaptadas a la multifuncionalidad de la sala. También podrá ser utilizado tanto para reuniones de empresas que la necesiten, como para atender delegaciones y realizar reuniones con las mismas. Por tanto, el sistema de pantallas tendrá que ser capaz de funcionar de 3 maneras diferentes:

1. Reposo/salvapantallas, con imágenes, videos o gráficas relevantes de Barcelona.
2. Como elemento de proyección para vídeos o presentaciones ad-hoc.
3. Mostrando información de Barcelona en clave económica y gestionable de manera táctil.

El entorno que Barcelona Activa pretende construir deberá ser capaz de ser usado de forma interactiva por cualquier usuario que quiera interactuar con las pantallas y visualizar los contenidos disponibles como si de un entorno museístico se tratase, o bien, ser usado por un presentador que dirija toda la interacción con los video walls para mostrar contenidos específicos a un público concreto.
Resum (Català)

Barcelona Activa, com a gestora de l'edifici MEDIATIC, situat al carrer Rita Boronat 17 de Barcelona, pretén adequar el seu hall per a proporcionar una sèrie de serveis a empreses.

Aquest espai es reservarà en una sala multifuncional, denominada Sala Gran/Showroom, que estarà presidida per un conjunt de monitors amb estructures de video wall, i que podrà ser visualitzat en el seu conjunt, o subdividit en dues meitats adaptades a la multi funcionalitat de la sala. També podrà ser utilitzat tant per a reunions d’empreses que la necessitin, com per atendre delegacions i realitzar reunions amb les mateixes. Per tant, el sistema de pantalles haurà de ser capaç de funcionar de 3 maneres diferents:

1. Repòs/salvapantalles, amb imatges, vídeos o gràfics rellevants de Barcelona.
2. Com a element de projecció per a vídeos o presentacions ad-hoc.
3. Mostrant informació de Barcelona en clau econòmica i gestionable de manera tàctil.

L'entorn que Barcelona Activa pretén construir haurà de ser capaç de ser usat de forma interactiva per qualsevol usuari que vulgui interactuar amb les pantalles i visualitzar els continguts disponibles com si d'un entorn museístics es tractés, o bé, ser usat per un presentador que dirigeixi tota la interacció amb els Video Walls per mostrar continguts específics a un públic concret.
Abstract (English)

Barcelona Activa, as manager of the building MEDIATIC located in Barcelona Rita Boronat 17, wants to adapt its hall to provide a range of services to companies.

This space will be reserved in a multipurpose room called Great Hall / Showroom, which will be headed by a set of monitors with video wall structure, which can be viewed as a whole or divided into two halves adapted to the multifunctional hall. It can also be used for company meetings and to support delegation meetings. Therefore, the system displays must be able to operate in 3 different ways:

1. Sleep/screensavers, with images, videos or graphics relevant from Barcelona.
2. As a projection for video presentations or ad-hoc presentations.
3. Displaying information of Barcelona in an economic way using touch gestures.

The environment that Barcelona Activa aims to build should be able to be used interactively by any user that wants to interact with screens and display content as if it were a museum environment, or otherwise be used by a presenter that directs all of the interaction with the Video Walls to display specific content to a specific audience.
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1. Introduction and motivation

The Business Support Office brings together a set of value-added services and resources under one roof to meet the needs of local and international companies. Here, you can find personalized information and advisory services, get legal paperwork and permit procedures done for businesses and the City Council, take part in business growth and training programs or attend organized networking activities.

Promoted by the City Council, via its development agency, Barcelona Activa, the Business Support Office was created to improve the competitiveness of businesses and the local economy in Barcelona, as well as to help smooth city landings for new companies.

This new city facility is located in the Barcelona Growth Centre. This space was designed as a meeting place for dialogue between the government and the private sector to revive the city’s economy.

Many of the key measures created by the so-called Barcelona Growth Committee, which was founded in 2011 by the City Council’s Department of Economy, Business and Employment, are being implemented here. [1]

The Business Support Office (OAE) is promoted by the City Council through Barcelona Activa, whose mission is to promote and facilitate economic activities in the city and promote the competitiveness of businesses. The OAE has an area suitable to meet and conduct business advisory services and business processes, and another area, Space & Showroom date Resource Center specifically designed to explain Barcelona in key economic available local businesses and international delegations. [2]

The OAE offers companies the Barcelona Showroom for corporate meetings and to showcase the city’s business potential.

The Barcelona Showroom is an innovative space with business-related resources, contents and data, available to local and foreign companies to meet with visitors and hold business meetings.

Located in the Barcelona Growth Centre, the Barcelona Showroom aims to boost and facilitate economic activity in the city, and to foster business competitiveness and networking. [3]
1.1. Content management

The three areas defined in the Hall of l’Edifici MediaTIC require one or more computer applications that help manage and display the necessary information through the different configurations of the monitors. These applications must have a content management system that facilitates the work load, maintenance and data access from any location, as well as a level of permissions or user keys to discriminate content and safety.

The information that is intended to show at the video wall and self-help zone is the following:

- Videos from Barcelona showing economic and history contents.
- Information about strategic city projects (Sagrera, 22@, etc.).
- Visual information about sector data and strategic thematic of Barcelona (Logistics Sector, Cultural Sector, Trade, etc.) with international evidence.
- Georeferenced information that serves to support the economic growth of Barcelona (location of premises available in the metropolitan area, population data, etc.).

With the Project Manager and in agreement with the managers of Barcelona Activa, the architecture must also define the most appropriate solution to fit in the most efficient and economical way to the ultimate goal of bringing modernity design and functionality to the Hall of l’Edifici MediaTIC.

1.2. Technical concepts

Below, we offer some more technical definitions of the concepts that are mentioned in this document.

- **Video wall**
  A video wall is a special multi-monitor setup that consists of multiple computer monitors, video projectors, or television sets tiled together contiguously or overlapped in order to form one large screen. Typical display technologies include LCD panels, LED arrays, DLP tiles, and rear projection screens. [4]
• **Unfolding maps**
Unfolding is a library to create interactive maps and geovisualizations in Processing and Java.

Unfolding enables you to quickly create interactive maps. Basic interactions such as Zoom & Pan are included. More advanced functionality such as Overview + Detail, or multitouch gestures can be easily added.  
http://unfoldingmaps.org

• **GIS**
A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data. The acronym GIS is sometimes used for geographical information science or geospatial information studies to refer to the academic discipline or career of working with geographic information systems and is a large domain within the broader academic discipline of Geoinformatics. What goes beyond a GIS is a spatial data infrastructure, a concept that has no such restrictive boundaries. [5]

• **TUIO**
TUIO is an open framework that defines a common protocol and API for tangible multitouch surfaces. The TUIO protocol allows the transmission of an abstract description of interactive surfaces, including touch events and tangible object states. This protocol encodes control data from a tracker application (e.g. based on computer vision) and sends it to any client application that is capable of decoding the protocol. There exists a growing number of TUIO enabled tracker applications and TUIO client libraries for various programming environments, as well as applications that support the protocol.  
http://www.tuio.org

1.3. Stakeholders
The main stakeholders of this project are listed below.

1.3.1. Project Sponsor
Barcelona Activa SAU SPM, as Enterprise Manager of l’Edifici MediaTIC acts as Project Sponsor and will also be the recipient of the product resulting from the installation of the multimedia content management system. Also, Barcelona Activa SAU SPM will act as contractor of the different outsourced companies and perform the final acceptance of the project.
1.3.2. Project Manager
Carries out management, planning and will ensure the coordination of the integration between products that various outsourced companies provide. Similarly, he will perform the analysis and technical design of the software solution required for managing the content that is displayed on the multimedia system, ensuring it satisfies the requirements of the project. The Project Manager will coordinate with internal and external content providers, obtaining the necessary data to feed the functionality of the solution, will train the key users and ensure the transfer of source codes of software products installed. He will coordinate follow-up meetings between the members of the project and conduct periodic reports to the Project Sponsor.

1.3.3. Outsourced hardware company
Provides the elements that make up the multimedia system. The outsourced company managing the hardware will make the installation of monitors and adjust light and contrast necessary to ensure the proper display of the light conditions at the MediaTIC Hall. It will also provide the right installation for the use of touch elements for the video wall.

1.3.4. Outsourced software company
Develops or adapts a software application that can contain information that must be displayed on the system monitors. The resulting application will have a room based Content Management solution that enables the selection of information shown in each area of the Hall, as well as integrate with the various interfaces required to provide information to various external content supplier. Furthermore, should also be integrated with the video wall touch system at the Great Hall through TUIO protocols and / or use the most appropriate hardware framework.

1.3.5. Content Providers
All contents shown in the various audiovisual systems will be managed by the Department of Communications of Barcelona Activa. The data will come from various sources (Barcelona City Hall, Ubicat, Cambres de Comerç, private companies of strategic sectors, etc.) and have a variability determined by their own kind. With these external content providers, it has to be fixed by contract the use of external data with the necessary guarantees for the protection of contents and define interfaces to update this contents when necessary.
1.3.6. End Users

Four types of users of the *Exhibition space and promotion of business* zone must be determined. The final solution and the use of each one of the different spaces aims these users:

- **Content Manager**
  Will be responsible for maintaining an updated back office CMS (Content Management System) and ensure the quality of the information provided by the system.

- **Great Hall users**
  Since the Great Room is a space dedicated to company meetings, delegations and other meetings; the attendees will have sufficient autonomy to interact with the video wall in order to view the desired information inside the screen matrix.

- **Information search users**
  Any user or professional visitor, will be able to access the information available in one of the 5 self-help monitors. Since initially it is advised the use of devices such as mouse or keyboard, these users will simply have a closed and very usable interface that allows quick access to selected contents.

- **Companies using temporary or constantly some of the modules**
  The fourth type of user is companies that will occupy one of the 8 modules enabled to provide a forum for business and their clients. Professionals who will manage the monitors to show audiovisual information (that they consider necessary for their commercial interest) will be trained.
2. State of the art

The design of multitouch user interfaces has its own language, more specific yet if, in addition, is for large interactive surfaces (as is the case of video walls or large format tables), and for multiple simultaneous users.

The interaction about these types of interfaces, in fact, have been given a very new meaningful name to refer to it: the NUI (natural user interface). The natural interface is the one that interacts with a system, application, etc. without using commands or GUI input devices such as a mouse, alphanumeric keypad, stylus, joystick, touchpad, etc.

Instead, on the other hand, it uses gestural movements such as the hands. The body is the only control. In the case of capacitive multi-touch screens, operation or control is done by means of the tips of the fingers on one or several simultaneous points (multi-touch). It also includes the development of operating systems control by means of the human voice or close control on the screen but without touching it.

We all have in mind the classical effects of our smartphones and tablets to drag images and content windows with our fingers and let them go slip slightly as if they were on a real desktop (effects of inertia and friction). In the same way, gesturing with multiple fingers (even with both hands), allow us to rotate the objects again as if it were a sheet of paper.

This is the scope of the project in which we find ourselves.

2.1. Existing hardware solutions

First of all we have to take a look to the different hardware solutions we can find nowadays in the market. We are aiming to make a really big image display capable of receiving touch interactions and offering a high resolution and clean image.

2.1.1. Video projectors

The most common and best known are probably projectors generating a video image or helping a person to conduct a presentation. This type of display offers a limited resolution and a limited image quality.

A video projector, also known as a digital projector, may project onto a traditional reflective projection screen, or it may be built into a cabinet with a translucent rear-projection screen to form a single unified display device.

Common display resolutions for contemporary (as of 2012) portable projectors include SVGA (800×600 pixels), XGA (1024×768 pixels), 720p (1280×720 pixels), and 1080p (1920×1080 pixels).
The cost of a projector is determined by its resolution and its light output. A projector with a higher light output (measured in lumens, “lm”) is required for a larger screen or for a room with a larger amount of ambient light. For example, a light output of approximately 1500 to 2500 ANSI lumens is suitable for small screens viewed in rooms with low ambient light; approximately 2500 to 4000 lm is suitable for medium-sized screens with some ambient light; over 4000 lm is needed for very large screens or for use in rooms with no lighting control such as conference rooms. [6]

The main difference of this solution and what we want to achieve is that this kind of solution doesn’t offer touch interaction with the screens and therefore with the content. It’s just an image projection over a surface with no interaction from the users and a poor image quality in comparison to the matrix of several full-hd screens, so it’s far below from what we’re going to build.

2.1.2. Video boards

In most of the stadiums we can find really big screens or video boards where sport replays, announcements or publicity take place. These screens usually offered low resolutions and were mostly used for showing text and scoreboards, but nowadays they are used to show video footage and they are getting higher resolutions.

A good example of these boards is the Texas A&M Athletics video board. This enormous video board basically takes up one side of Darrell K Royal-Texas Memorial Stadium. The board stands 55 feet tall and is 134 feet long, measuring around 7,370 square feet. Texas' board has been the largest in college football since 2006 and has a beautiful pixel pitch (the distance between pixel clusters, is a measure of high definition) of 20mm and native resolution of 2064-by-848. [7]

These boards are a really great solution for users viewing its content from a large distance, but if the contents are made to be shown really close, this screen makes no sense in an environment like ours. As with the video wall, a touch device could be placed over the screen but having this resolution, the image near the screen would lack a lot more resolution to offer the quality and sensation we are aiming to achieve.
2.1.3. Video walls
A display made of several screens is the best choice to show a high resolution and high image quality. Adding a thin touch layer device in front of the video walls we can achieve TUIO compatibility and offer the possibility of touch interaction with the screens. We aim to build two sets of screens made each one of 12 screens, 3 high, 4 wide.

We can find a really good example of the display we want to achieve seeing what MultiTaction has achieved with one of its products, the MultiTaction iWall.

**MultiTaction iWall** is a massive 5-meter-wide turnkey interactive display wall. It simultaneously detects an unlimited number of fingers, hands, IR pens and real life objects. MultiTaction iWall’s computer vision touch tracking is ultrafast at 200 fps.

At 5 m (16') wide and 2.5 m (9') tall MultiTaction iWall creates a stunning impression with any audience in corporate spaces or in any other location. An entire ready-to-use 24 megapixel interactive wall, the iWall comprises of 12x 55” ultra-thin Bezel displays. Combined with a screen brightness of 500 nits, it provides astounding image quality that is guaranteed to draw attention. [8]

A really good example of a high quality video wall is the one we find in the Mall of the Emirates. **Mall of the Emirates**, Dubai, is one of the largest shopping centers in the Middle East. It has its fair share of attractions: an arts center, movie theater, indoor ski resort, and now an epic 54-monitor video wall powered by **Matrox Mura™ MPX Series** controller boards. Installed by ALMOE AV Systems and integrated by Mediasys, the wall displays dynamic digital signage content aimed at the 33-million-plus shoppers visiting the mall every year. [9]

2.2. Software possibilities
We need an application capable of showing all the client desired contents in a minimal and functional design of his choice. As the design will be made specifically for this client, we have to make our own application and develop the functionalities necessary to show all the media contents as the client specifies.

There are different approaches to achieve an application as explained before so for the selection of the development platform we need to compare different environments on the market and decide which one of them fits best our goals.
2.2.1. Processing

Processing is a programming language, development environment, and online community. Since 2001, Processing has promoted software literacy within the visual arts and visual literacy within technology. Initially created to serve as a software sketchbook and to teach computer programming fundamentals within a visual context, Processing evolved into a development tool for professionals. Today, there are tens of thousands of students, artists, designers, researchers, and hobbyists who use Processing for learning, prototyping, and production.

https://processing.org

Together with Unfolding maps, it also gives the possibility to use a GIS component allowing the viewing of different map contents inside the main application.

2.2.2. Adobe Flex

Flex is a highly productive, open source application framework for building and maintaining expressive web applications that deploy consistently on all major browsers, desktops, and devices. It provides a modern, standards-based language and programming model that supports common design patterns suitable for developers from many backgrounds.


2.2.3. OpenFrameworks

OpenFrameworks is an open source C++ toolkit designed to assist the creative process by providing a simple and intuitive framework for experimentation.

The code is written to be massively cross-compatible. Right now we support five operating systems (Windows, OSX, Linux, iOS, Android) and four IDEs (XCode, Code::Blocks, and Visual Studio and Eclipse). The API is designed to be minimal and easy to grasp.

http://openframeworks.cc/about/

2.2.4. CINDER

CINDER provides a powerful, intuitive toolbox for programming graphics, audio, video, networking, image processing and computational geometry. Cinder is cross-platform, and in general the exact same code works under Mac OS X, Windows and a growing list of other platforms — most recently the iPhone and iPad.

Cinder is designed to take advantage of platforms’ native capabilities whenever it’s possible, and relies on a minimum of 3rd party libraries. This makes for much lighter, faster applications, and means Cinder apps get free performance, security and capability upgrades whenever the operating system does.

http://libcinder.org/about
2.3. Usability and interactions

Recent developments in multi-touch screens and gesture based in-air devices provide scope for the design of UIs with multi-digit control. Software functionality choices that were traditionally controlled using buttons on pointing devices can now be selected by different gestures and/or combinations of touches. However, they require that the user memorizes complex gestures can create a barrier to them. [10]

Engineering interactive systems for use on emerging technologies such as touch-enabled devices and horizontal displays is not straightforward. Firstly, the migration process of a system from an old hardware platform to new multi-touch displays is challenging. Issues pertaining to scaling, orientation, new input mechanisms, novel interaction techniques and different SDKs need to be examined. Secondly, even after we manage to understand and resolve these issues, we need to find effective ways to migrate applications and maintain them. [11]

Knowing this, the main application gestures and user interactions will be carried out using nowadays most common gestures. We will make the user interact with the video walls the same way they do with their smartphones that means almost all users using the application will be familiar with the kind of interactions they can perform on it.

It doesn’t really make sense arguing if new interaction and touch methods should be studied. The way people interact with their smartphones has almost come to a standard and every touch device being created nowadays uses the same gestures and interaction methods.

2.4. Conclusions

2.4.1. Hardware

Having taking into account the different existing solutions in the market and all the possibilities they offer, for this project it’s been decided to build two self-made video walls. The reason of this choice is that Barcelona Activa is aiming to build a custom made application with no prebuilt environments or existing solutions. The client wants a new and fresh application having nothing similar in the market.

Two video walls with the possibility of joining them and making one big video wall is the best choice for the kind of display Barcelona Activa wants for its hall for the following reasons.

- A resolution of nearly 8k can be achieved with several full-hd screens.
- Having in mind the characteristics given from the screens, the overall image quality will be the best possible.
- A thin touch layer device can be placed in front of the screens to achieve touch controls.
2.4.2. Software

Analyzed the pros and cons of the different platforms we conclude that the best of possible alternatives is Processing.

Processing is a programming language based on Java and open source integrated development environment (IDE) optimized for developing museum applications, electronic arts, new media and visual design communities.

The main reasons for selecting Processing as a development platform are:

- It is the only platform based on Java as a programming language. This allows greater flexibility in adapting the application to the self-help format. The application can be compiled as executable (video wall) and also as an applet (self-help web Java applet). Therefore, much of the application code of the video wall is common implementing the self-help module.
- It is one of the best-known platforms for multi-touch and multiuser interactive applications.
- It is the most multiplatform environment, both as Operating System (Windows, Linux, Mac OS X) as device (Android, iOS, Arduino, Raspberri Pi, others).
3. Scope

3.1. Problem explanation and main objective

BCNActiva wants to build a huge museum environment with two video walls for an interactive experience for the users. The main goal is to represent the city of Barcelona from a business vision using a set of two large video walls where users can interact with the screens.

This representation of Barcelona will be capable of showing high resolution images, maps, video and text. Users will be able to interact with this data being able to choose what they want to see or being shown specific content by a presenter. All the interactions will be gestural using nowadays-common gestures as we do on our smartphones.

3.2. Objectives

The main objectives of this project are the following:

- Build a custom made product given the necessities from BCN Activa, taking into account we cannot take advantage of existing environments and it’s not possible to adapt web oriented environments.

- Design the solution together with BCN Activa, both technically and in terms of interface and user experience.

- We will focus on enhancing the interaction between the user and the content, information must be accessible from a modern and visually appealing.

- It won’t be a closed platform. BCN Activa will be able to integrate geographic and alphanumeric data when they need it. In addition, there will be the possibility to manage multimedia content.

- Provide an interactive map with ability to display data from various sources, among others Ubica’t platform.

- Design a modern and minimalist application capable of showing all the clients desired contents.
3.3. Obstacles and risks

The most important obstacles and risk factors to be dealt with during the development have been grouped as follows:

- **Time restriction**
  The project delivered as *Treball final de Grau* has an end date. Any kind of problem or bug during the execution of the project shall be adequately managed not to delay it and if necessary a replanning will be made to avoid bigger impact.

- **Unknown technologies**
  Progress in the development of the solution will be closely linked to the degree of autonomous learning of the different and specific technologies used such as Processing API and Unfolding maps. Before beginning the development, I will study the different technologies in order to carry out a good development.

- **Limited development environment**
  The application requires an environment with high-end hardware and expensive components only available at the client final environment. Due to this the development environment will be limited regarding tests showing the real performance of the solution. Real test results will only be obtained when the solution is tested at the final environment.

- **Tests and trips to video wall environments**
  In order to obtain real results of the solution we will have to test it where the video walls are. There are actually two environments with video walls, one at Girona and one at the production environment (*BCNActiva*). Going to these places is for sure an inconvenience.

3.4. Methodology and rigor

3.4.1. Working methods and validation

The development of the solution follows a methodology that is based on prototyping.

An **Iterative and Incremental development** is used in which at each iteration, design modifications are made and new functional capabilities are added.

During the first iterations, documentation, study of new technologies and agreements with the client are carried out. Next, the main development iterations take place in which the solution grows up until it is ready for validation and showing the client.
Every requirement has a complete validation in a unique iteration, which includes testing and documentation enough to achieve all the goals to deliver to the client.

The validation of the solution is made according to the iterative and incremental method used. The client validates each iteration in which a technical design, a functional analysis and a prototype are made. For each iteration, documentation is made and it will be presented to the client. There is finally a validation meeting in which the client validates the iteration.

Once an iteration is validated, it starts over with new functionalities and finally in the final preparation phase the client validates and accepts the project.

3.4.2 Tracking tools
Tracking is based on two levels:
- Management tracking: Designed to follow the progress of the project every 15 days taking into account the risks and the actions to be taken.
- Project tracking: Designed to follow each week each and every one of the workflows running and coordinate them.

For each follow-up meeting a document is made that serves as guidance of:
- Current status of the modules and work with the data (% of execution and explanation).
- Work performed.
- Collection of open problems and corrective actions.
- New work to be started.

It also discusses the tracking of the project in order to have a complete vision of the progress and compliance schedules.
3.4.3 Development tools

Below is a list of technologies that make up each module and component, indicating what purpose they serve:

- **TUIO**: Open framework that defines a common API and protocol for multi-user and multi-touch surfaces. Used by the TUIO Tracker component to inform the application of the user actions. [http://www.tuio.org/](http://www.tuio.org/)

- **Processing**: Open framework to develop the frontend modules. [http://processing.org/](http://processing.org/)

- **GestureWorks Core**: NUI library (Natural User Interface) multi-user and multi-touch, for the management and interaction of user gestures. It will be a part of the user interaction module in the application. [http://gestureworks.com/core](http://gestureworks.com/core)

- **Massive Pixel Environment (MPE)**: Library for the multinode processing of a virtually unlimited number of screens and computers. [https://www.tacc.utexas.edu/taccsoftware/massive-pixel-environment](https://www.tacc.utexas.edu/taccsoftware/massive-pixel-environment)

- **Unfolding Maps**: Visualization API of cartographic data. [http://unfoldingmaps.org/](http://unfoldingmaps.org/)

- **AssetSystem**: Platform that allows the integration of data from multiple sources and formats, the representation of them on a map, the publication of data through Geoservices bus (graphic and alphanumeric) and the availability of an API to integrate maps, components and data in other systems. [https://www.assetsystem.net/es/](https://www.assetsystem.net/es/)

- **OpenStreetMap**: Provider of vectorial and image cartography with free license. It’s format is compatible with AssetSystem and Unfolding Maps. [http://www.openstreetmap.org/about](http://www.openstreetmap.org/about)

- **L’Institut Cartogràfic i Geològic de Catalunya**: Provider of vectorial data of the management limits and optionally the orthophotographic service. It’s format is compatible with AssetSystem and Unfolding Maps. [http://www.icgc.cat/](http://www.icgc.cat/)

- **Filezilla**: OpenSource FTP tool that supports FTPS and SFTP. [https://filezilla-project.org/](https://filezilla-project.org/)

- **Notepad++**: A free source code editor which supports several programming languages running under the MS Windows environment. [http://notepad-plus-plus.org/](http://notepad-plus-plus.org/)

4. Planning

4.1. Project duration
The estimated duration of the project was at first 5 months. The project started on 2 September 2014 and was planned for delivery to 24 February 2015. Due to a series of drawbacks explained in section 11. Problems and restrictions, the limited availability of the final environment and the back office installation delay, the project end date has been finally 20 May 2015.

4.2. Resources
The resources provided for the completion of this project are the following:

**Personal resources:** Three people, with a dedication to the project of an average of 60 hours a week. As the programmer, my weekly dedication to the project is 20 hours per week.

**Material resources:** Computers, Internet access, Apache Server, AssetSystem, Eclipse IDE and Processing and Unfolding Maps libraries.

4.3. Action plan and alternatives
As explained before, the project is developed in an iterative and incremental way. Knowing this, for every validation made, if there is something found that represents a stop or the impossibility to satisfy a requirement, the client can change the requirements and the objectives.

A replanning can and will most likely be made anytime the client changes the requirements or the project objectives. If this happens the project planning can be modified in order to satisfy his needs and the economic costs can be modified.

The project’s delivery date has been established with enough margin, taking into consideration possible deviation in task estimated times. Knowing this, if a delay in any of the project tasks occur, there’s enough margin time to overcome the obstacles and deliver the project in the estimated time.
4.4. Global considerations
Note that this project has been carried out by multiple people, and therefore, some tasks have been done in parallel. In addition, due to the nature of the project and the methodology used, the preparation of these tasks is necessarily parallel almost during the entire process so that different tasks can run at the same time if they don’t require the other to start.

As the project is done by multiple people, it is necessary to clarify that my role in the project is the Programmer’s role. I carried out part of the main application code development, the back office administration tool development and the installation of the same.

4.5. Task description

4.5.1. Technical design
During this phase all the different functionalities and components are considered in order to satisfy all the client requirements. The data catalog and a way to integrate such data is designed. Once every aspect of the technical design is taken into account, this design has to pass a technical validation.

4.5.2. Usability and graphical design
During this phase all the different application views are going to be designed in order to satisfy the client. Initial outlines are created in order to design a usable and modern application and a design proposal is selected to show to the client.

Once all the different components have a design proposal, a static and non-functional demo is made and shown to the client in order to get the client’s approval of the design.

4.5.3. Application development
This phase consists in the development of the application itself. It includes the elaboration of the contents such as images, buttons, animations, and the code to show all these contents as the graphical design dictates and later on the testing and bug fixing of the different functionalities.

At the end of this phase there is the installation of the application in the client environment, the formation to the final users of the different functionalities and the maintenance of the system.

Last but not least, a simple but functional web application back office is made to allow users to add new contents and manage the existing ones.
4.5.4. Viewer development
During this phase the map viewer is developed. This viewer has to be capable of showing different layers, points and polygons geopositioned in a consistent way. Each of these contents is eligible to be “touched” by the user so a functionality to achieve this and to show a popup information box is developed.

4.5.5. Map elaboration
The client wants specific Barcelona maps with specific and minimalist styles. This phase consists of the elaboration of such maps with such styles in order to satisfy the client requirements.

To make the viewer look fast and smooth, a map cache is generated to make the map data access faster.

4.5.6. Management
Mostly carried out by the Project manager, this task focuses on the meetings with the clients, the agreements reached out and the validations necessary for the project’s closure.

4.5.7. TFG specific
This task involves all the documentation and preparation done specifically for the Treball Final de Grau that I am carrying out as student.
4.6. Calendar

4.6.1. Time estimation

The list of tasks for the planning is described below. Detailed information about hour dedication and costs will be described in section 5.1.

<table>
<thead>
<tr>
<th>ID</th>
<th>Task</th>
<th>Days</th>
<th>Human resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Technical design</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>Requirements</td>
<td>15</td>
<td>Project Manager</td>
</tr>
<tr>
<td>T3</td>
<td>Data catalog design</td>
<td>10</td>
<td>Project Manager</td>
</tr>
<tr>
<td>T4</td>
<td>Data integration process design</td>
<td>10</td>
<td>Project Manager</td>
</tr>
<tr>
<td>T5</td>
<td>Technical design validation</td>
<td>10</td>
<td>Project Manager</td>
</tr>
<tr>
<td>T6</td>
<td>Usability and graphical design</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>T7</td>
<td>Creativity</td>
<td>5</td>
<td>Programmer</td>
</tr>
<tr>
<td>T8</td>
<td>Initial outlines</td>
<td>5</td>
<td>Programmer</td>
</tr>
<tr>
<td>T9</td>
<td>Design proposal selection</td>
<td>1</td>
<td>Project Manager</td>
</tr>
<tr>
<td>T10</td>
<td>Non-functional demo</td>
<td>8</td>
<td>Project Manager</td>
</tr>
<tr>
<td>T11</td>
<td>Design approval</td>
<td>1</td>
<td>Project Manager</td>
</tr>
<tr>
<td>T12</td>
<td>Application development</td>
<td>239</td>
<td></td>
</tr>
<tr>
<td>T13</td>
<td>Development environment</td>
<td>80</td>
<td>Programmer</td>
</tr>
<tr>
<td>T14</td>
<td>Contents</td>
<td>45</td>
<td>Project Manager</td>
</tr>
<tr>
<td>T15</td>
<td>Programing</td>
<td>231</td>
<td>Programmer</td>
</tr>
<tr>
<td>T16</td>
<td>Testing and bug fixing</td>
<td>130</td>
<td>Programmer</td>
</tr>
<tr>
<td>T17</td>
<td>Installation and formation</td>
<td>70</td>
<td>Programmer</td>
</tr>
<tr>
<td>T18</td>
<td>Back office</td>
<td>14</td>
<td>Programmer</td>
</tr>
<tr>
<td>T19</td>
<td>Viewer development</td>
<td>183</td>
<td></td>
</tr>
<tr>
<td>T20</td>
<td>Layers</td>
<td>123</td>
<td>Programmer</td>
</tr>
<tr>
<td>T21</td>
<td>Touchable points</td>
<td>33</td>
<td>Programmer</td>
</tr>
<tr>
<td>T22</td>
<td>Touchable polygons</td>
<td>5</td>
<td>Programmer</td>
</tr>
<tr>
<td>T23</td>
<td>Popup information for all layers</td>
<td>5</td>
<td>Programmer</td>
</tr>
<tr>
<td>T24</td>
<td>Tag position and maps</td>
<td>5</td>
<td>Programmer</td>
</tr>
<tr>
<td></td>
<td>Task</td>
<td>Duration</td>
<td>Responsible</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------</td>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>T25</td>
<td>Map elaboration</td>
<td>55</td>
<td>Cartographer</td>
</tr>
<tr>
<td>T26</td>
<td>Content elaboration</td>
<td>21</td>
<td>Cartographer</td>
</tr>
<tr>
<td>T27</td>
<td>Layer symbolization</td>
<td>27</td>
<td>Cartographer</td>
</tr>
<tr>
<td>T28</td>
<td>Layer cache</td>
<td>27</td>
<td>Cartographer</td>
</tr>
<tr>
<td>T29</td>
<td>Management</td>
<td>235</td>
<td>Cartographer</td>
</tr>
<tr>
<td>T30</td>
<td>Project offer</td>
<td>10</td>
<td>Project Manager</td>
</tr>
<tr>
<td>T31</td>
<td>Meetings and validations</td>
<td>44</td>
<td>Project Manager</td>
</tr>
<tr>
<td>T32</td>
<td>TFG specific</td>
<td>54</td>
<td>Programmer</td>
</tr>
<tr>
<td>T33</td>
<td>GEP course</td>
<td>29</td>
<td>Programmer</td>
</tr>
<tr>
<td>T34</td>
<td>Documentation</td>
<td>22</td>
<td>Programmer</td>
</tr>
</tbody>
</table>

Some of this tasks depend on other previous tasks to start. The dependencies are described as the following:

- T2 < T3 < T4
- T4 < T5
- T20 < T22
- T20 < T23
- T20,T21 < T24
4.6.2. Gantt diagram

Here is the planning in detail using a Gantt diagram as planning tool. Take into consideration that each one of the people working on this project will dedicate 4 hours (average) per day to this project.
5. Financial management

The total project duration has been 192 days equivalent to a total of 1112 hours.

The costs are explained from a company’s point of view even though this project is presented as my TFG. My role in this project is the Programmer’s role. I develop part of the main application functionalities, the back office tool and decide the design of part of the frontend. My Project Manager is the one meeting the client and making important decisions and also building the server contents. Finally there’s a cartographer because of the map contents and because of the nature of my company (GIS).

In order not to overcome the budget that had been foreseen, the data have been updated after each task is completed. Therefore, the final budget contains the actual hours that have been worked and the final price. It has carried out a control with care, since it is necessary that the project is carried out within the established deadlines.

5.1. Human resources

The cost per hour of each role, following the pricing policy of the company is as follows:

<table>
<thead>
<tr>
<th>Task</th>
<th>Cost per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager</td>
<td>30,00 €</td>
</tr>
<tr>
<td>Programmer</td>
<td>24,00 €</td>
</tr>
<tr>
<td>Cartographer</td>
<td>26,00 €</td>
</tr>
</tbody>
</table>

Knowing the cost per hour, the following table describes the dedication and cost of each of the different people involved in this project and the tasks they have assigned.

It has been stipulated a dedication of 50% of their working time to this project, meaning 4 hours per day.

<table>
<thead>
<tr>
<th>Task</th>
<th>Hours</th>
<th>Resource</th>
<th>Cost (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Requirements</td>
<td>60</td>
<td>Project Manager</td>
<td>1.800</td>
</tr>
<tr>
<td>Data catalog design</td>
<td>40</td>
<td>Project Manager</td>
<td>1.200</td>
</tr>
<tr>
<td>Data integration process design</td>
<td>40</td>
<td>Project Manager</td>
<td>1.200</td>
</tr>
<tr>
<td>Technical design validation</td>
<td>40</td>
<td>Project Manager</td>
<td>1.200</td>
</tr>
<tr>
<td>Usability and graphical design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creativity</td>
<td>20</td>
<td>Programmer</td>
<td>480</td>
</tr>
<tr>
<td>Task</td>
<td>Hours</td>
<td>Role</td>
<td>Cost</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-------</td>
<td>---------------</td>
<td>-------</td>
</tr>
<tr>
<td>Initial outlines</td>
<td>20</td>
<td>Programmer</td>
<td>480</td>
</tr>
<tr>
<td>Design proposal selection</td>
<td>4</td>
<td>Project Manager</td>
<td>120</td>
</tr>
<tr>
<td>Non functional demo</td>
<td>32</td>
<td>Project Manager</td>
<td>960</td>
</tr>
<tr>
<td>Design approval</td>
<td>4</td>
<td>Project Manager</td>
<td>120</td>
</tr>
<tr>
<td><strong>Application development</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development environment</td>
<td>320</td>
<td>Programmer</td>
<td>7.680</td>
</tr>
<tr>
<td>Contents</td>
<td>180</td>
<td>Project Manager</td>
<td>5.400</td>
</tr>
<tr>
<td>Programming</td>
<td>924</td>
<td>Programmer</td>
<td>22.176</td>
</tr>
<tr>
<td>Testing and bug fixing</td>
<td>520</td>
<td>Programmer</td>
<td>12480</td>
</tr>
<tr>
<td>Installation, formation and maintenance</td>
<td>280</td>
<td>Programmer</td>
<td>6.720</td>
</tr>
<tr>
<td>Back office</td>
<td>56</td>
<td>Programmer</td>
<td>1.344</td>
</tr>
<tr>
<td><strong>Viewer development</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Layers</td>
<td>492</td>
<td>Programmer</td>
<td>11.808*</td>
</tr>
<tr>
<td>Touchable points</td>
<td>132</td>
<td>Programmer</td>
<td>3.168*</td>
</tr>
<tr>
<td>Touchable polygons</td>
<td>20</td>
<td>Programmer</td>
<td>480*</td>
</tr>
<tr>
<td>Popup information for all layers</td>
<td>20</td>
<td>Programmer</td>
<td>480*</td>
</tr>
<tr>
<td>Tag position and maps</td>
<td>20</td>
<td>Programmer</td>
<td>480*</td>
</tr>
<tr>
<td><strong>Map elaboration</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content elaboration</td>
<td>84</td>
<td>Cartographer</td>
<td>2.184</td>
</tr>
<tr>
<td>Layer symbolization</td>
<td>108</td>
<td>Cartographer</td>
<td>2.808</td>
</tr>
<tr>
<td>Layer cache</td>
<td>108</td>
<td>Cartographer</td>
<td>2808</td>
</tr>
<tr>
<td><strong>Management</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project offer</td>
<td>40</td>
<td>Project Manager</td>
<td>1200</td>
</tr>
<tr>
<td>Meetings and validations</td>
<td>176</td>
<td>Project Manager</td>
<td>5280</td>
</tr>
<tr>
<td><strong>TFG specific</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GEP course</td>
<td>116</td>
<td>Programmer</td>
<td>**</td>
</tr>
<tr>
<td>Documentation</td>
<td>88</td>
<td>Programmer</td>
<td>**</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>77.640</td>
</tr>
</tbody>
</table>
*Viewer development is considered a part of the task Programming so the hours dedicated to this task are not computed for the final cost.
**The specific work done for my TFG is not computed in the final cost.

5.2. Hardware resources

The main cost of this project, besides of human resources, is based on the high-end hardware components. Because of the nature of the project and the final environment size, some of the components used to test and validate the application are really expensive.

It's important to mention that the final environment components, which are 2 HP Z820 Workstations and 24 56” monitors are in charge of BCN Activa so they won’t suppose an increase in the budget.

Due to the high cost and high level of hardware acquired, the hardware has an estimated useful life of 4 years.

Deprecation cost = Price / (4 years * (239 days * 4 hours/day))

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Price (€)</th>
<th>Estimated hours</th>
<th>Deprecation cost (€/h)</th>
<th>Estimated cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 x Screen/Display 24” FullHD</td>
<td>24 x 271</td>
<td>24 x 100*</td>
<td>1,7</td>
<td>11.056,8</td>
</tr>
<tr>
<td>2 x 55” Multitouch frames</td>
<td>2 x 268</td>
<td>2 x 100</td>
<td>0,14</td>
<td>75</td>
</tr>
<tr>
<td>Workstation HP Z820</td>
<td>2.880</td>
<td>100*</td>
<td>0,753</td>
<td>2168,6</td>
</tr>
<tr>
<td>3 PCs</td>
<td>3 x 700</td>
<td>3824</td>
<td>0,549</td>
<td>1.152,9</td>
</tr>
<tr>
<td>Map/Content Server</td>
<td>400</td>
<td>3824</td>
<td>0,104</td>
<td>41,6</td>
</tr>
<tr>
<td>2 x AMD FirePRO W9100</td>
<td>2 x 3.905</td>
<td>100*</td>
<td>2,0423</td>
<td>15.950,36</td>
</tr>
<tr>
<td>Estimated total</td>
<td></td>
<td></td>
<td></td>
<td>30.445,26</td>
</tr>
</tbody>
</table>

*This components will only be used for validation and testing.
5.3. Software resources

As shown in the last table, the main costs of this project come from the hardware prices. Software resources barely involve any cost because the main development tools are free so doesn’t imply any increase in the budget.

<table>
<thead>
<tr>
<th>Software</th>
<th>Price (€)</th>
<th>Estimated hours</th>
<th>Deprecation cost (€/h)</th>
<th>Estimated cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eclipse IDE</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Processing API</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Unfolding Maps API</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Apache Tomcat</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Estimated total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>0</strong></td>
</tr>
</tbody>
</table>

5.4. General expenses

Once explained the main project costs there are some other points to look at. Due to the location of the environment with the multi-touch interface and the location of the client, moving from one place to another is something to take into account. Moreover, the cost of the office like internet access, energy, paper, etc. are specified in the table below.

<table>
<thead>
<tr>
<th>Description</th>
<th>Price (€)</th>
<th>Quantity</th>
<th>Estimated cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moving to Girona (2nd development environment)</td>
<td>50</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>Moving to BCNActiva</td>
<td>5</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>Internet 100mb/s</td>
<td>50/month</td>
<td>6 months</td>
<td>300</td>
</tr>
<tr>
<td>Energy</td>
<td>914/month</td>
<td>6 months</td>
<td>5,484</td>
</tr>
<tr>
<td>Paper</td>
<td>0,00576</td>
<td>2000</td>
<td>11,52</td>
</tr>
<tr>
<td><strong>Total cost</strong></td>
<td></td>
<td></td>
<td><strong>5,945,52</strong></td>
</tr>
</tbody>
</table>

*Energy cost is calculated with Iberdrola’s energy calculator.
5.5. Budget deviations

At the time to set the current budget, we have found 2 substantial modifications.

- The first one derived from the need of changing the application and cartography designs to a lighter colors has supposed an increase of the Programmer and Cartographer hours of 50 hour each which has supposed an increment of the total budget in 2500€.

- The second one comes from the extra validations and code migration because of the lack of performance detected in the early stages of the development. This has forced an increase in the budget of 720€ due to 30 extra hours for the migration of the application.

5.6. Total cost

The following table shows the total estimated cost of the project.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Estimated cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human resources</td>
<td>77.640,00</td>
</tr>
<tr>
<td>Hardware resources</td>
<td>30.445,26</td>
</tr>
<tr>
<td>Software resources</td>
<td>0,00</td>
</tr>
<tr>
<td>General expenses</td>
<td>5.945,52</td>
</tr>
<tr>
<td><strong>Total cost</strong></td>
<td><strong>117.030,78</strong></td>
</tr>
</tbody>
</table>
7. Requirements specification

A software requirements specification (SRS) is a description of a software system to be developed, laying out functional and non-functional requirements, it contains a detailed description of the different software requirements that must be fulfilled by the solution.

7.1. Functional requirements

This section presents the functional requirements that must be satisfied by the system. All requirements exposed here are essential, that is, would not be acceptable a system which does not satisfy any of the exposed requirements. The requirements were specified so that it is easy to check if the system offers them or not and if it offers them properly.

FR001. Accept multi-touch interaction with the screens.
FR002. Accept multi-user interaction with the videowalls.
FR003. Display a total resolution of 7680 x 3240 pixels.
FR004. Display 4K videos with sound.
FR005. Display interactive maps both from local sources and server sources.
FR006. Display three types of charts: composition, vertical and ranking charts.
FR007. Ability to detect users approaching the screens with the use of webcams.
FR008. Ability to change the contents of the application using a back office application.
FR009. Ability to change the settings of the application using a back office application.
FR010. Ability to retrieve contents from the local server. The application has to be able to call the local server map services and load server data.
7.2. Non-functional requirements

Non-functional requirements cover all the remaining requirements which are not covered by the functional requirements. They specify criteria that judge the operation of a system, rather than specific behaviors.

**R001. Performance**: The application has to maintain a stable image frequency of, at least, 30 frames per second.

**R002. Usability**: The application has to offer a natural user interface.

**R003. Security**: Only system administrators can modify the application settings and contents.

**R004. Modifiability**: All the contents and settings of the application have to be modifiable by the administrators.

**R005. Availability**: The application has to remain available all the time the MediaTIC building is open.

**R006. Accessibility**: Every user capable of performing touch interactions has to be able to use the application.
8. Architecture

In order to achieve all the objectives, the platform includes a series of modules that can be divided in two: the Front Office and the Back Office.
First of all, the high resolution front office is shown in two separate video walls made of 4x3 55” screens offering a multilanguage and multiuser interface. The set of screens will offer a total of 8 monitors long by 3 high.

The front office is composed of three parts:

- The user interaction module, which allows the selection of what is shown in an interactive and visual way.
- The static data presentation module, mainly multimedia productions (pictures, videos) and texts.
- The dynamic data module, mainly maps and graphic data.

In second place, the back office to administrate both platform and foreign content. This module provides two types of content:

- Multimedia content such as videos and static images. These contents are considered static since their creation involves specific production tasks. Due to their nature and complexity, the creation of this type of content will not be usual.
- Geographic and alphanumeric data. These contents are considered dynamic, since there are multiple institutions (areas of l’Ajuntament de Barcelona and from Diputació de Barcelona, Generalitat departments,...), platforms and enterprises (BCNOpenData, Ubica’t,...) that provide interesting data in order to show a business and economical view of Barcelona.

And as a value-added, we incorporated two new capabilities:

1. Detection of people who come to the interactive surface, in order to encourage the beginning of the interaction. This integrates a module for detecting presence and the installation of four webcams.

2. Remote control through an iPAD, in order to facilitate the tasks of a hypothetical presenter and their interaction with the public to a presentation.
During the development of the project we did some minor changes to the overall architecture. The most significant one is the elimination of the two *TUJO Tracker workstations* using instead the *app workstations* of each video wall. The other change in the scheme is the use of one webcam for each video wall instead of two.

The resulting overall architecture is represented in the following image.
8.1. Components

1. **TUIO Tracker**: This software is part of the module that interacts with users. It is connected to the multi-touch framework that receives the events of touch actions of multiple users at the same time and is responsible for processing and sending them to the APP. There are two entries, one for each module of the video wall.

2. **APP**: It is the application responsible for showing data of the city in various formats through the modules of presentation for alphanumeric, geographic and multimedia data. Reacts to the interactions it receives from users through TUIO Tracker, interpreting and presenting the information as appropriate in each case, which is the second component of the module of interaction with users. There are two instances, one for each module video wall. It communicates with a centralized server to perform the following tasks:
   - Consume or presenting the contents.
   - Propagate the actions that involve interaction with the other part of the video wall so that they are processed by another instance of the APP.

3. **Central server**: It is responsible for serving static and dynamic data and propagating the actions that involve interaction with a part of video wall from the other. The central server integrates the module for the administration of the front office, the management module of alphanumeric data and geographic and multimedia data management module. All the modules are technical in nature, aimed at use by an administrator who can drive out configuration and update content independently through procedures properly documented. The server itself can connect to a repository or other systems for consuming data.
8.2. Software Architecture

The following diagram summarizes at a high level the software architecture of this project, defining all the components involved and the interactions between them. Each component is explained below.

- **AssetSystem**: AssetSystem is a unique tool to manage all graphic, alphanumeric and multimedia information.
- **Front Office Video walls application**: The application shown on the Video walls.
- **GeoServer**: Open source server for sharing geospatial data
- **Modest Maps**: Small, extensible, and free library for designers and developers who want to use interactive maps in their own projects.
- **MapProxy**: Tool used for creating the local disk map tiles used for both showing maps and application backgrounds.
- **Back office administration tool**: Web application for managing the behavior of the front office application.
- **PostgreSQL Database**: Database storing geographic and different kinds of data.
- **Local TMS**: A local Tile Map Service for storing map tiles in a local disk.
- **Static repository**: Repository responsible for storing multimedia content such as videos.
- **Dynamic repository**: Repository responsible for storing mainly XML files.
8.2.1. Architecture model

The following schema represents the 3 layer architecture of this solution.

- **Presentation layer**: It is the first layer of interaction with the user. Contains visual components and handles the user’s input (keyboard, mouse, etc.). This layer will be formed by the front office application showing the main project component and the back office web application.

- **Application layer**: It is the layer that provides the data to the presentation layer and manages user entries. Basically performs treatments of data (transformations, calculations, conversions, application logic, etc.). It also implements cache services. This layer will be made up of a GeoServer, the Modest Maps library and the MapProxy tool, managing geographic data following standards and the part of the back office managing the static and multimedia data to show in the web tool.

- **Data layer**: It is the layer that stores all the data of the business solution. This layer will contain mapping data, static contents such as XMLs and multimedia contents such as videos.
8.2.2. Architecture model with technologies

The following schema represents the 3 layer with the technologies used.

**Presentation layer**
- **AIR and ActionScript**: Adobe Integration Runtime together with ActionScript are used to show the contents and graphical user interface in the main application.
- **HTML, JavaScript and CSS**: Used to display a simple web application that lets the user see and edit XML files with a lot of facilities such as choosing available contents.

**Application layer**
- **TMS (Tile Map Service)**: The library Modest Maps facilitates the transformation of maps divided in tiles in a file system into fully navigable maps.
- **TMS, WMS and WMTS**: GeoServer, among other services, offers Tile Map Services, Web Map Services and Web Map Tile Services to provide the application with map layers.

**Data layer**
- **PostgreSQL**: Spatial database for GeoServer map data.
- **TMS**: Directory of tiles in the local disk organized as a Tile Map Service acting as a cache to let the front office access background tiles really fast.
9. Front office

In this section we will see the design and usability of the main front office application, the one being shown on the video walls.

It is necessary to make a brief introduction to both the specificities of technological means of this multimedia installation (a large multi-touch surface in the form of video wall), as well as the exceptions of the project and its context.

9.1. Introduction

In multimedia productions for video walls and large-format tables, the most common is that users interact for the access to the contents with a personal character, with or without the participation of other users who, like him, also interact with another area of the same device. This implies that in an interactive video wall, in terms of design, the contents are in a very close distance. Therefore, they must be sized to be seen optimally from a distance of between 60 cm and 1 m. This distance is determined to access the interface with the arm slightly extended (minimum distance), or, in addition, makes one or two steps to retire and see more comfortably the images, videos and texts (maximum distance).

Closely linked to this proximity of interaction and the problem of the sizes, distances and proportions we find ourselves with the fact that, by interacting with your fingers on a multi-touch surface, it is necessary to cover the variability of human fingers. In addition to this variability, it is a fact that the accuracy of the interaction with your fingers is inferior to the one we have with a good mouse (mouse); not only by the size of the finger, but also for the user's point of view.

All of these specifications are partially modified by the context and uses of the presentation mode. The main reason is that, in the multi-user interaction (where the ideas detailed above are fully applied), we have to take into account the specificities of the presenter mode when used.

This mode has the uniqueness that even though who interacts with the interface is next to the screen (the presenter), who should view the contents of the application properly and optimally are those attending the presentation. These "spectators" of the sessions (which are not users, in fact), see the texts, photos, videos and other content from a distance much greater than the presenter. The presenter is presupposed to have a purely driver function and, therefore, the contents are not designed for him but for the group.
In our scenario, even though the technological device is always the same — the walls of the video wall, the interface design and navigation model must provide answers to two very different users:

- The passive user that acts as public of the presentation in a group session watching the video wall from a certain distance.
- The active user that uses personally the application alone or in the presence of others like him.

The design that we have made and that is detailed in the following section, is unique for both stages, and depending on the usage mode (multi-user or presenter), can adapt itself in a visual (mainly) and in a functional level (in a lesser extent).

At a visual level, for example, the minimum and maximum sizes by default in the various graphic elements are bigger in presenter mode than in multi-user mode. The maximum and minimum size is the size to which you can expand or collapse, for example, a video window. The default size is the size of opening by default a piece of content, before the user expands or reduces in size.

In a functional level, variations are, for example, that in presenter mode you can enlarge the contents up to full screen. In multi-user mode, on the other hand, this functionality will not be available because it would invade open sessions for other users.

Next all the application interactions and designs are specified.
9.2. From the screensavers to the start of the interaction

The application shows by default the different screen savers randomly from among all the available ones. The set of screen savers is made up of a total of between 4 and 6 animations and images as well as for a last screen saver that is nothing more than an automatic mode of the presentation.

This automatic mode simulates the presence of a user of type presenter and chooses randomly one of the contents of the application.

The output of the screen saver can be direct in case that interaction takes place with the video wall or conditional in the event that the form of detection of new users through webcams has detected the presence of a user in the environs of the installation.

In the event that a user touches the video wall, it will not be closed automatically. It appears above in transparency on the screens in a visually attractive animation playback to invite this user to interact and, therefore, make it clear that this is not an ordinary video wall but an interactive and multi-touch one.

Interactive screen savers
9.3. The command control

Each new session (either the presenter or different users), has as its unique element, a control from which you can access to all the contents in a simple and intuitive way without interfering with the open windows.

The command control opens on touch wherever the touch has been realized and over any point of the video wall (equivalent to clicking in a conventional interface). The touch interaction to open this interface can be done over the screensavers or over the application's background.

This first touch on the screen normally and intuitively is realized with only one finger but the application will recognize up to five fingers simultaneously.

The shape of the control – circular –, demands that the effects of animation (both for the initial opening and for the selection of the content), have to be in the form of a beat: expansions and contractions with effect of bounce and return.
The visual zone of the command control allows its manipulation:

The command control can be *moved* all over the video walls dragging it with one or more fingers.

It can also be *rotated* with one or more fingers.

And using *pinches* and *spreads* with two or more fingers it can be *resized*.

Closing a user session is not a usual action. Users tend to leave the sessions open and, after a reasonable time not interacting with any of the elements associated with that session (no touch on the command and any of the opened content from that session), closes automatically.

However, thinking about this especially with the presenter mode, it is possible the *closure of the session* through a gesture of aggressive slide (very fast slide), with two or more fingers on the remote control.

The initial state of the command shows the buttons of the three languages (Catalan, Spanish and English), with the preselected default language (Catalan; but in any case, configurable from the back office). In this way we avoid an interaction for the majority of the users without handicapping the rest of them, who continue to require also the selection of the language without having to go back to navigation.

The different levels of content are shown in the form of rings or orbits segmented in color areas. In the example we can see how, beyond the selection of language, we have the next level of navigation and access to four large blocks of content:

1. Introducció (Introduction).
2. Infraestructures (Infrastructures).
3. Sectors estratègics. (Strategic sectors).
4. Projectes singulars (Singular projects).
With the selection of one of the four blocks of the second level of content we can access to the submenu of each block (see picture “Command control on the third level of navigation”). Visually, the ring that corresponds to the first and second level options orbit shrinks in size to uncover a new orbit with the second-level options.

The orbit of the previous level continues showing the selected option and allows going back by doing a tap on it. However, the language selector shrinks to make way for a central control that allows access to the level of previous navigation with a simple tap or well to the initial level (home) with a double-tap (again, this is not as intuitive, characteristically, is designed especially for the presenter).
A simple tap on the center of the command control returns to the previous level while a double-tap allows the direct access to the initial level (home).

In the following image (“Contents offered from the command control”) we can see how the user has chosen as an option of current level the block named “Ciències de la vida”, which offers final contents that could include videos, maps, charts, etc.

All the command control contents shown in the previous images are gathered from XML files representing each of the navigation paths. The first nodes of the XML content file represent the first level of the command control and their child nodes represent the blocks available when accessing the second level (and so on). Because of this, the only constant of the navigation of the command control is the way the user interacts with it.
9.4. Windows of contents

The content Windows inherit the same behaviors of the command control gestures: rotations, drags, zooms and closures by swiping.

All of these behaviors include effects and physical properties such as friction on the drag and inertia to let them go. The zooms, in addition, include the effects of gum (winding bounce).

The windows of the content, in full-screen mode, can be maximized by double-tap or aggressive swipes.

The windows have a visual ring that identifies the content to which it belongs and which appears only at the beginning (with its opening) and also during their handling for disappearing automatically in a few seconds.

All Windows connected to the same session are related to the command control visually with a line with the corporate color of the first class section. The dragging of these windows affects hierarchically the lines of connection.

Connection lines between command control and contents
This widget will display, beyond the example, any type of content, either text, video, maps, graphics, or profile data that is displayed in the form of floating window (see image "Video content").

The closing of the windows of contents can be done also with an aggressive swipe although we have incorporated a visual widget that allows the shutdown with a tap (a button with the icon of a cross to close, for example).

After a certain time of non-interaction with the window, it closes automatically (the user must be consulting and interacting with another window); a time always less than the time of no interaction with the command control (which would shut down the entire session and all related items).

As an exception to the closing behavior with a timeout, there is a specific duration for some contents: audiovisual and/or other animations and 3D images. In this case, the time to run the event of timeout will not start counting until you enter the content in pause or stop state.

The contents with selectors and other multimedia elements allow advanced interactions. The visual elements of these controls only appear when there is interaction with the window. Then, after a few seconds, are hidden automatically.

For example, in the case of the contents of audiovisual type (see image “Video content”), the user can navigate through the video (forward and back; scrub), show or hide the subtitle and turn up or down the sound.
The descriptions and other windows of content of great density that require an optimal reading have background colors completely solid (opaque). On the other hand, the windows with content that supports it, such as the statistical charts, have background colors with a transparency grade of 60%.

In the following sections we are going to see the main types of content the application is capable of showing.

9.4.1. Video

The application can show videos to the users as shown in the previous image (“Video content”). These types of windows offer the public different interactions to manipulate the video reproduction such as closing or maximizing the window, and some others unique for videos:

A drag on the time slider allows you to move forward or back on the video. A drag and hold allows you to do the same but with greater accuracy.

A simple tap on the subtitle button allows you to toggle between showing or not. With this same interaction the user can move to the next or previous video.

A drag on the volume slider allows you to turn it up or down. A drag and hold allows you to do the same but with greater accuracy.

A double-tap on the volume button allows you to switch between mutate the sound or not (turn it up or down entirely).

All the video files shown in the front office have a resolution of 4K. The reproduction of this kind of content is one of the key points when looking into the applications performance.
9.4.2. Charts
Charts are a really good way of showing the users different statistics related to Barcelona and its business.

![Chart content](image)

The application is capable of showing different kinds of charts like composition charts, vertical bar charts with one or two dimensions and ranking charts. These charts are stored within the same XML that represents this specific content and all the different data shown by the charts can be modified with the web back office installed in the local server.

9.4.3. Maps
Sitep is specialized in the development of cartographic and map applications and because of this, the map contents have been one of the key components of this application.

As happens with videos and charts, maps can be opened as any other content and a new window will appear containing a map inside it. This video will show the generic buttons of maximize and close and the map. There won’t be any more buttons as all navigation the map offers is done with touch events, as a mobile application.
The map will show on the left bottom corner a button for each of the layers it has available. As seen in the previous image, the map is showing a heat layer ("Mapa de calor"), which represents any kind of density among data on the map. The different types of layers that can be added to the map are the following:

- Heat layers.
- Point or coordinate layers.
- Polygon layers (e.g. neighborhoods in different colors).
- Text layers (added to other type layers to specify contents).

The different interactions the user can do to navigate through the map are the following:

The user is allowed to **pan** the map (with fixed limits) by using one or more fingers and dragging them around the map.

It can also be **rotated** with one or more fingers.

The user can **zoom** in or out with two fingers by doing **pinches and spreads**.
All these layers are provided by our platform AssetSystem installed on the local server while the background map of the map content is stored in the local disk of the video walls as a local TMS (Tile Map Service) for a faster access from the application.

9.5. Mode preview

Below is a video wall running in presenter mode and another in multi-user mode. Both modes can be viewed in one video wall or in two, doubling the surface area of the user interface. The video wall in multi-user mode shows how two users interact simultaneously.

The following image corresponds to images made during the design phase and shows the previous UI design with dark colors.

![The two video walls, one in multi-user mode and the other one in presenter mode.](image-url)
10. Back office

As we have been describing throughout the previous chapters, the contents of the proposal can be divided into two types:

1. **Multimedia**: this category includes videos and images. We consider these static content, since their creation involves specific production tasks that, due to their nature and complexity, we anticipate will not be usual.

2. **Data**: in this category include alphanumeric and geographical data. We consider these dynamic contents, since there are multiple institutions (areas of l’Ajuntament de Barcelona and from the Diputació de Barcelona, departments from Generalitat, ..), companies and platforms (BCNOpenData, ...) that provide information of interest to expose the economic vision and business in Barcelona.

### 10.1. Multimedia

For multimedia content, we use free software for file management via standard protocols such as SFTP. For the management of XML files that define the behavior of the front office for the multimedia content available in the back office, we use the web application we made for this task, described in **10.3. Back office administration tool**. In short, leaving a few files in a specific directory and editing a XML through the administration tool should be enough to manage the media from the point of view of the back office.

### 10.2. Data

For the data, we use the commercial\(^1\) platform **AssetSystem**, which is a SaaS platform that can be installed on a private cloud in customer’s servers (always with administration by Sitep) and that allows to integrate data from various sources. Functionally, AssetSystem allows the following:

- Define data sources to integrate the platform and set their update frequency, without having to access the BD.

- Define and manually load data, through a graphical tool, which allows you to upload Excel files, CSV, KML and Shapefile.

\(^1\) Will license the right to use for 2 years, counting from the installation to the infrastructure of BCN. As a commercial product, BCN Activa will own exclusively configuration files that will be administered by their technical systems, in no case will have intellectual property rights on AssetSystem or any of its modules.
• Develop a cartographic viewer to integrate the front office through calls to the API.
• Publish data via OGC and REST services.
• Use graphic components in web or phone applications.

10.3. Back office administration tool
As stated before, all the configurations and contents shown on the video walls are referenced using XML files, which are consumed by the front office in order to let it know what to show depending on the user interactions.

In order to let the application administrators modify the front office behavior, we have developed a light web application based in simple PHP, HTML and JavaScript which lets them do the following:

- Add or delete new contents or items such as maps, movies, etc.
- Modify existing contents in order to change the command control navigations.
- Modify the application settings such as languages, sound volumes, system IPs, etc.
The look and feel follows the front office lead showing the web layout with white and blue colors.

![Edition of Català contents](image)

The main goal of this application is to facilitate the edition of the XML files storing all the system configurations and contents.

### 10.3.1. Usage

With the left menu (Image “Edition of Català contents”) the user can pick up any of the XML files he wants to edit and the application will show him this same XML formatted in a **onion ring way**.

For each node of the XML, a new html div is created with a darker color from the div containing it. Each of the attributes or text nodes of this node will be shown as a label and an input for the user to edit them.

In some nodes, a button appears to let the user inject an existing XML item file into the contents.
Inject a movie into the contents

As seen in the previous image (Image “Edition of Català contents”), the user has clicked the “Add movie” button and a pop up shows up letting him select one of the existing movies for adding it to the contents. The movie is no editable in this view as it is only for selection and injection.

The user can create **new contents** by clicking the add symbol button (+) in any of the left menu item or contents to create a new XML file from scratch. The web application will recognize which type of content the user wants to add and will open a new content from a XML skeleton with the necessary fields of that particular content.

In the case of the charts, the user will be prompt with a dialog letting him decide which kind of charts he wants to create because depending of the type of chart, the xml representing it will be different.
Finally, the representation of the XML lets the user pick up the multimedia files like videos 4K, subtitles and such, from selectors filled with the available resources in the local system repository.

10.3.2. XML transformation algorithm

We have seen how this web application is capable of consuming all kinds of XML files and show them in a structured way letting the user modify, inject nodes, select files as attributes, delete nodes and save the XML file back. Now we are going to see how all this transformation is carried out by the code.

The changing content of the web page, the one that represents the XMLs, is 100% created with JavaScript each time the user wants to see a file. The algorithm navigates through the nodes in a recursive way and transforms everything it finds into the corresponding piece of HTML code.

The algorithm works in two different ways, one for transforming XML files into a HTML web layout and one for transforming it back to XML. There’s a fixed representation between the two different in order to be able to save the file back.
The three elements of the XML content files taken into account by the code are the following:

- Nodes
- Attributes
- Text Nodes

Each one of these elements has a defined representation in the web layout explained as follows:

**Nodes**

An XML node is represented by a `<div>` tag with the class name “xmlContainer” in the HTML. The xmlContainer has a grey background and whenever an xmlContainer is inserted in another one, it gets its parent color a bit more dark as background.

So, following this, a simple XML node will look like this:

```html
<movie/>
```

while the XML nodes contained inside parents will look like this (dropdown buttons are for node removal):

```html
<movie>
  <movie>
    <movie/>
  </movie>
</movie>
```

**Text nodes**

At first all the contents were going to be distributed among nodes and attributes but with the development of the application some XML contents ended up having text nodes so we made a specific representation for them. A text node is represented by an xmlContainer `<div>` and a text input inside.
Attributes
The attributes store almost all the data necessary for running the application. Each XML attribute is basically a key-value pair in a specific node. Knowing this, the most appropriate representation for this elements is a label and a text input.

So, each node with attributes will be represented as an xmlContainer <div> with a <form> containing all the attributes in the form of label and text input.

```xml
<movie
    id="example"
    type="5"
/>
```

Real xml example
The following example shows the result with a real application XML file.

```xml
<services>
    <interfaceSettings>
        <wall_showcase>
            <screenSaver timeOut="60"/>
            <webCam active="true" detectionDelay="10">
                <webCam mode="left" id="1" active="true" deviceName='Logitech HD Webcam C615' sensitivity='60'/>
                <webCam mode="right" id="2" active="true" deviceName='Logitech HD Webcam C615' sensitivity='60'/>
            </webCam>
            <controls minSize='480' maxSize='940' defaultSize='620' controlsTimeOut='120'/>
        </wall_showcase>
    </interfaceSettings>
    <movies minSize='960,540' maxSize='3840,2160' defaultSize='1920,1080' windowTimeOut='-1' controlsTimeOut='120'/>
    <maps minSize='960,540' maxSize='3840,2160' defaultSize='1920,1080' windowTimeOut='-1' controlsTimeOut='120'/>
    <charts minSize='960,540' maxSize='3840,2160' defaultSize='1920,1080' windowTimeOut='-1' controlsTimeOut='120'/>
</services>
```

Piece of XML file to be shown as HTML
interfaceSettings

wall_showroom

screenSaver

timeOut: 60

webCams

active: true

detectionDelay: 10

webCam

node: left

id: _l

active: true

deviceName: Logitech HD WebCam C615

sensitivity: 60

webCam

node: right

id: _r

active: true

deviceName: Logitech HD WebCam C615

sensitivity: 60

Piece of the web layout produced by the previous XML
10.3.3. Specific functionalities

In order to facilitate the modification of this formatted XML files, we have expanded what has been explained in the previous chapter by letting the user inject existing XML files to the web representation or choose contents from disk (videos, subtitles, images, etc.) and show them in selectors.

To do this we have created XML skeleton files for each of the different types of items the users of this application want to add or edit.

A XML skeleton looks like this:

```xml
<ZNess addContent="true">
  <movie
    id=""
    short_title=""
    title=""
    thumbnail_showRoom="thumbnail"
    thumbnail_others="thumbnail"
    background=""
    poster_fullHD="poster"
    poster_4k="poster"
    posterFullScreenWall="poster"
    movie_fullHD='movie'
    movie_4k='movie'
    movieSubtitles="subtitles"
    forceSubtitles=""
    movieMediaContents="mediaContent"
  
  /
</ZNess>
```

This skeleton lets the application what attributes and nodes a certain element has. With this skeleton, if the user wants to, for example, add a new movie, the application will transform this XML file and let the user fill the attributes as he wishes.

The attributes that come with some value in the skeletons, are treated by the application as attributes with selectable content. For example, when displaying `poster_fullHD` attribute, the application will use a selectable instead of a text input letting the user select one of the posters available for the front office application.
Finally, there are specific nodes that can carry a list of children of the same type. In that case, the parent node receives the `addContent="true"` so when the code parses this node, it will add a button at the bottom to let the user add more items as children of this node.

There are special types of nodes where the add functionality will open up a dialog to let the user inject an existing XML item into the page. The user will be able to save this file as usual with the injected content inside. An example of this can be seen in a previous image (“Inject a movie into the contents”).
11. Problems and restrictions

During the development of this project we have found some problems or stoppers we didn’t imagine we would found. The two main problems found were the color distribution of the front office making the video walls really reflective and the impossibility of developing the project with the Processing API due to a lack of performance.

11.1. UI Design

At the beginning of the project it was decided that the main application shown in the video walls had to wear dark colors and show a minimalist GUI. The final environment couldn’t be tested until the application was almost done, so it was not until the end that we realized how reflective the video walls could be.

It was detected a mirror effect on the screens of the video wall, caused by the large amount of light from both the outside and the lighting elements of the environment (information cubes, ceiling lighting point, ...) combined with the use of a methacrylate that is not enough antireflective.

A series of tests were carried out and this effect gets really attenuated with white as a base color, rather than the black that was anticipated and with which all the designs and developments were carried out.

We proceeded to adapt the design of the front office, jumping from a palette of black and dark colors to a palette of white and bright colors, which affected the design of almost everything shown in the application.
11.1.1. Redesign of the application

A redesign of the application with lighter colors was made in order to avoid the mirror effect and the programming derived from it. The following two images show the differences in the color theme before and after the redesign.

![Image of the command control with the initial design.](image)

![Image of the command control with the new design.](image)

The charts also suffered a big change because of the new color theme, the image below shows the change between the first designed charts and the resultant ones.

![First theme color charts](image)

![Final theme color charts](image)
All the cartographic data that was custom made for the application with its theme colors had to be made again. The initial maps showed the earth in a scale of black and grey colors producing a really modern and minimal appearance while the new maps, done for the redesign, show the sea in a light blue color and the inland in white.

The images below show the differences between the initial map designs and the final.

Different maps with the initial design.

Different maps with the new design.
11.2. Bad performance

Following the calendar, the week of January 26, 2015 was to proceed to the deployment of the solution and the first tests, were there was found a lack of performance (approximately 10 frames per second) that made it impractical, and we understand that completely unacceptable as a solution.

After reviewing the consumption of resources of the application and analyzing the management of RAM and GPU, it was determined that the combination of elements of the platform (runtime, libraries, graphic drivers, etc.) worked as expected with screen resolutions of less than 4K. Until this resolution, the performance decreases linearly to, suddenly (from 4096 pixels), drop drastically, motivated by a disabling hardware acceleration of the graphics card drivers.

11.2.1. Tests conducted in the phase of construction

In the development space were made mainly two tests:

1. Reproduction tests of the most critical type of content (4K videos), with which the workstation space gave a performance between 2.5 and 3.5 times higher than the development workstation.
2. Performance tests of the two workstations (final and development workstations). In this case, the performance was identical to use two workstations for development because the operation in sync means precisely to run at the speed of the slower node.

11.2.2. Conclusions and possible actions

Neither in the phase of definition of the solution (beginning of the project) nor during the construction phase we have detected the problem. In case we had detected it, we could have anticipated that there was a problem, but the solution would have been the same that the one we describe below.

The actions that might could have solved this problem are the following:

- Raise the problem to the manufacturer of the graphics cards.
- In the event that the manufacturer of the graphics cards do not provide us with a solution to the problem, we should adapt the development, with one of the following alternatives:
  1. Expansion of the infrastructure and the adaptation of the current solution.
  2. Conservation of the infrastructure and migrate the solution to another technology.
It was finally decided to go for a migration of the solution to another technology, as the other possible actions required a higher investment in machinery.

The main change of the migration was the change from the Processing API, which we had determined was the best candidate for this project, to AIR Runtime / Windows.

Since the beginning of the project there were made different demos in different technologies such as Processing and Adobe, the main difficulty was to adapt the map content windows to Air Runtime since we had to move from Unfolding maps API working with Processing, to Modest Maps working with AIR Runtime.
12. Sustainability and social commitment

The amount of contamination and technological garbage increases everyday due to the increasing use of new technologies in everyday tasks and the technological evolution. Because of this, it’s important when starting a new project to have in mind the project impact to the environment and to try to do our best to achieve sustainable projects.

Because of the high hardware requirements, this project may seem not the best candidate for an environmental sustainability but as a public application and free to visit, some of its contents that relate to environmental issues may encourage people to take into account this matter.

The application can be filled with new contents easily thanks to the back office web application so it can be updated whenever the client wants without having to develop new updates or changes wasting time and material resources.

As a museum application for BCNActiva this project represents a big impact in society. It will provide people visiting the Media-TIC building a vision of Barcelona from an interactive view. It will allow people to play with the contents and show them in a huge resolution display. This project will make for sure presentations and museum’s shows a lot more interesting.

12.1. Sustainability table

<table>
<thead>
<tr>
<th>Sustainability</th>
<th>Economical</th>
<th>Social</th>
<th>Environmental</th>
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<td>Planning</td>
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<tr>
<td>Results</td>
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<td>Risks</td>
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</tr>
<tr>
<td>Overall evaluation</td>
<td>31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
13. Conclusions

During the course of the project and the TFG, we have succeeded in designing and implementing a unique museum environment for the representation of business and the main corporate activities of Barcelona. We have achieved the initial goals for which the client had chosen our proposal over other competitors like Telefónica.

At the beginning of the project it seemed difficult to develop a functional and attractive solution for the users given the characteristics of the environment. This project has been, from the beginning, very demanding due to its innovative nature and the fact that the result of this project will be available to the public in an open space with free access. There were expectations in performance and usability that in any other environment would have been easy to reach, but not in one of these dimensions.

Because of this, throughout the development of the project we have found obstacles that have forced us to seek alternatives and solutions without them affecting the expected outcome. The first of these, the reflections on the video wall screens due to the incoming light from the outside, was not expected at all and got solved by sacrificing the initial designs and adapting the design to the needs of the environment.

This same environment, in which performance is a key piece, makes the developer to confront challenges that in common applications would not be found as, for example, the variability of the user interface or the efficiency of the reproduction of contents that demand high resources such as videos with 4K resolution or interactive maps. Therefore, a challenge of this type made me, as a developer, learn how to manage the resources available in the best possible way.

On the other hand, as personal conclusions, I believe that thanks to my participation in this project, I have learned a lot from technologies and systems that I could not have learned otherwise. Outside the professional field, it is impossible to carry out a project of this category due to the high costs involved and the space required to install the solution.

I think that this is a perfect project to finish the studies due to the fact that, after years studying technologies and methods widely known in the industry, I have been able to participate in a project that presents really uncommon characteristics and which offered, from the beginning, a huge difficulty for the little information or support that could be found of museum environments with high resolution and touch interactions.
14. Laws and regulations

This project is related with three laws or regulations:

The first one is the European Regional Development Fund (ERDF) is a financial instrument of the European Commission whose purpose is to help the economic development of depressed regions of the European Union. These funds are repayable grants, to be managed directly by the public (central, regional and local) authorities having each assigned a quota of a priori funds for projects in the area. The aim of the ERDF is to develop the economic principles on which the OCA is based so that all regions of the European Union converge to the same level of development, and will strengthen the currency and the economic position of Europe.

As explained before, the client of this project is Barcelona Activa which is the local development agency of Barcelona’s town hall. BCNActiva takes advantage of the FEDER funds to develop this project which aims to attract companies into investing in Barcelona.

Next is the Spanish law LOPD (Ley orgánica de protección de datos). This is a Spanish Organic Law which aims to guarantee and protect, with regard to the processing of personal data, public freedoms and fundamental rights of individuals, and especially their honor, privacy and personal and family privacy. It was approved in the Spanish Parliament on 13 December 1999. This law is developed basing on article 18 of Spanish la constitución 1978 on the right to personal and family privacy and secrecy of communications.

This law affects our project in the way that we are showing different media content and maps, which are produced from data obtained by different private companies, and so their data has to remain private. The application does not show direct data or private contents, just uses them to show or represent certain statistics or media images.

The third and last one is the distribution of contents from the different providers. A content provider is any business that provides media content for distribution over the Internet. Content providers can create content or purchase content for reuse. A content provider is the one who can authorize access to, or distribute or share the content they provide.

All the contents shown in the application are free to use and the application itself shows the viewers a little icon informing which provider is offering the contents being shown. An example of this is the map content provider ICC (Institut Cartogràfic i Geològic de Catalunya).
15. Annex

The annex includes a series of pictures showing the project results in *l’Espai Barcelona* inside Barcelona growth center.

**Barcelona growth center / Edifici MediaTIC**

**Espai Barcelona** during the exposition opening.
Picture taken during the exposition opening. (© Inezdelprado)
Videowalls.

Left video wall with videos open.
Video wall application being used.

Picture of the two video walls in l’Espai Barcelona.
References


