
GLOSSARY OF SYMBOLS

Transition systems

Symbol	Definition	Description	Page
$\langle S, \Sigma, T, s_0 \rangle$	2.1	Transition system (TS)	18
A	2.1	Transition system	18
S	2.1	Set of states	18
Σ	2.1	Alphabet of events	18
T	2.1	Transition relation	18
s	2.1	State	18
s_0	2.1	Initial state	18
e	2.1	Event	18
$s \xrightarrow{e} s'$	2.1	Transition	18
(s, e, s')	2.1	Transition	18
$\mathcal{E}(s)$	2.1	Events enabled at s	18
$FR(e)$	2.1	Firing region of e	18
ρ	2.2	Run	19
$s_1 \xrightarrow{e_1} s_2 \xrightarrow{e_2} \dots$	2.2	Run	19
$s_i \in \rho$	Notation	State of a run	19
$s_i \xrightarrow{e_i} s_{i+1} \in \rho$	Notation	Transition of a run	19
$FirstEnabled(\rho, s_i, e)$	2.4	Enabling interval of e in ρ	20
T^*	Notation	Reachability relation, transitive closure of T	20
$s \xrightarrow{\rho} s'$	Notation	s' is reachable by ρ from s	20
$s \xrightarrow{*} s'$	Notation	s' is reachable from s	20
$Reach(s', T)$	2.5	Reachable states from s	20
$\langle A^-, \delta^l, \delta^u \rangle$	2.6	Timed transition system (TTS)	22
A^-	2.6	Underlying transition system	22
$\delta(e)$	2.6	Delay of e	22
$\delta^l(e)$	2.6	Minimum delay bound of e	22
$\delta^u(e)$	2.6	Maximum delay bound of e	22
$[d, D]$	2.6	Min-max delay interval	22

Symbol	Definition	Description	Page
(s, τ)	2.7	Timed state	22
τ	2.7	Time stamp	22
$\langle S, \Sigma, T, s_0, \text{EnR} \rangle$	2.8	Lazy transition system (LzTS)	26
$\text{EnR}(e)$	2.8	Enabling region of e	26

Petri nets

Symbol	Definition	Description	Page
$\langle P, T, F, M_o \rangle$	2.10	Petri net (PN)	28
N	2.10	Petri net	28
P	2.10	Set of places	28
T	2.10	Set of transitions	28
F	2.10	Flow function	28
M	2.10	Marking	28
M_o	2.10	Initial marking	28
p	2.10	Place	28
t	2.10	Transition	28
(p, t)	Notation	Flow relation	28
(t, p)	Notation	Flow relation	28
$\bullet x$	Notation	Pre-set of a node	28
$x \bullet$	Notation	Post-set of a node	28
$M(p)$	2.11	Number of tokens in p at M	29
$M[t]$	2.11	t is enabled at M	29
$[t]$	2.11	Set of markings where t is enabled	29
$M[t]M'$	2.11	M' is reachable by firing t from M	29
σ	2.12	Firing sequence	30
$t_1 t_2 \dots$	2.12	Firing sequence	30
$M[\sigma]M'$	2.12	M' is reachable by σ from M	30
$[M_o]$	2.12	Set of markings reachable from M_o	30
$\langle [M_o], E \rangle$	2.12	Reachability graph (RG)	30
E	2.12	Set of arcs	30
(M, t, M')	2.12	Arc	30
$RG(N)$	Notation	Reachability graph of N	30
$\langle N, \Sigma, \Lambda \rangle$	2.13	Labeled Petri net	32
Σ	2.13	Alphabet of symbols	32
Λ	2.13	Labeling function	32
ϵ	2.13	“Silent” symbol	32
$\Sigma_I, \Sigma_O, \Sigma_H$	2.14	Alphabet of (input, output, internal) signals	32

Timed automata and clock regions

Symbol	Definition	Description	Page
X	Notation	Set of clocks	39
x	Notation	Clock	39
$\Phi(X)$	Notation	Set of clock constraints	39
φ	Notation	Clock constraints	39
$\langle \Sigma, S, S_o, X, I, T \rangle$	3.1	Timed automata	40
A	3.1	Timed automata	40
Σ	3.1	Alphabet	40
S	3.1	Set of locations	40
S_o	3.1	Set of initial locations	40
I	3.1	Location invariant	40
T	3.1	Set of transitions	40
s	3.1	Location	40
a	3.1	Symbol	40
λ	3.1	Set of clocks reset by a transition	40
$\langle s, a, \varphi, \lambda, s' \rangle$	3.1	Transition from s to s'	40
$\mathcal{T}(A)$	Notation	Transition system associated to A	41
$v(x)$	Notation	Valuation of a clock	41
(s, v)	Notation	Configuration	41
δ	Notation	Time increment	41
$(s, v) \xrightarrow{\delta} (s, v')$	Notation	Delay transition	41
$(s, v) \xrightarrow{a} (s, v')$	Notation	Action transition	41
c_x	Notation	Maximal constant a clock is compared to	46
$\lfloor v(x) \rfloor$	Notation	Integral part of a clock valuation	46
$fr(v(x))$	Notation	Fractional part of a clock valuation	46
\cong	Notation	Equivalence of clock valuations	46
$\mathcal{R}(A)$	Notation	Region automaton of A	48
α	Notation	Clock region	48
(s, α)	Notation	State	48
$\mathcal{Z}(A)$	Notation	Zone automaton of A	48
D	Notation	Difference-bound matrix	49
D_{ij}	Notation	Upper bound on the difference of two clocks	49
\mathbb{D}	Notation	Bounds domain	49

Trace semantics

Symbol	Definition	Description	Page
θ	4.1	Trace	62
$E_1 \xrightarrow{e_1} E_2 \xrightarrow{e_2} \dots$	4.1	Trace	62
$E_i \xrightarrow{e_i} E_{i+1}$	4.1	Transition by firing e_i	62
E_i	4.1	Set of events enabled when e_i fires	62
D_i	4.4	Set of events disabled when e_i fires	66
d	4.4	Disabled event	66
$e_i \text{ dis } d$	4.4	d is disabled by the firing of e_i	66
$D(\theta)$	4.4	Set of events disabled along θ	66
θ_ρ	4.2	Trace defined by a run	62
$\mathcal{L}(A)$	4.3	Language of a transition system	63
θ_t	4.5	Fragment of a trace	68
map	4.5	Enabling-compatible mapping	68

Event structures

Symbol	Definition	Description	Page
$\langle \Sigma, \prec, \triangleright \rangle$	4.6	Causal event structure	71
CS	4.6	Causal event structure	71
Σ	4.6	Set of events	71
\prec	4.6	Causality relation	71
\triangleright	4.6	Conflict relation	71
\triangleright_μ	Notation	Disabling relation	71
X	Notation	Subset of events	72
$(\rightarrow X)_\prec$	Notation	Events <i>before</i> X	72
$(X^\rightarrow)_\prec$	Notation	Events <i>after</i> X	72
$(^\circ X)_\prec$	Notation	<i>Root</i> events of X	72
$(X^\circ)_\prec$	Notation	<i>Sink</i> events of X	72
$(\downarrow X)_\prec$	Notation	<i>Left-closure</i> of X	72
ω	4.7	Word	72
$e_1 \dots e_n$	4.7	Word	72
ω_i	4.7	i – <i>th</i> prefix of a word	72
ω_0	4.7	Empty prefix	72
$\mathcal{E}(\omega_i)$	4.8	Events enabled by a prefix	72
$\mathcal{D}(\omega_i)$	4.8	Events disabled by a prefix	72
$\mathcal{D}(\omega_i)$	Notation	Events disabled by a word	73
θ_ω	4.9	Trace generated by word ω	73
CS_θ	4.10	Causal event structure generated from trace θ	73

Symbol	Definition	Description	Page
$\langle \Sigma, \prec', \triangleright \rangle$	4.11	Lazy causal event structure	76
\prec'	4.11	Set of lazy relations	76
\mathcal{C}	4.12	Configuration	77
$\mathcal{E}(\mathcal{C})$	4.12	Set of events enabled in a configuration	77
\mathcal{C}	Notation	Set of reachable configurations	77
\top	Notation	Initial configuration	77
\perp	Notation	Final configuration	79
$\langle \Sigma, \prec, \triangleright \rangle$	4.13	Graph of reachable configurations	78
$\text{EnR}(\mathbf{e})$	Notation	Enabling region of \mathbf{e}	78
$\text{FR}(\mathbf{e})$	Notation	Firing region of \mathbf{e}	78
$\mathcal{C}_1 \xrightarrow{\mathbf{e}} \mathcal{C}_2$	Notation	Transition between configurations	78
$(\mathcal{C}_1, \mathbf{e}, \mathcal{C}_2)$	Notation	Transition between configurations	78

Timing analysis

Symbol	Definition	Description	Page
$\text{Sep}_{max}(\mathbf{e}_1, \mathbf{e}_2)$	Notation	Maximal separation time of two events	184
$ft(\mathbf{e}_1)$	Notation	Firing time of an event	184
Δ	Notation	Strongest bound for $\text{Sep}_{max}(\mathbf{e}_1, \mathbf{e}_2)$	186
$[d, D]$	Notation	Delay interval	186
$m(\mathbf{e}_k)$	Notation	m -value of \mathbf{e}_k	186
$M(\mathbf{e}_k)$	Notation	M -value of \mathbf{e}_k	187
h	Notation	Path	186
$d(h)$	Notation	Sum of minimum delay bounds along a path	186
$\mathbf{e}_k \xrightarrow{h} \mathbf{e}_j$	Notation	A path h exists between two events	186
$\mathbf{e}_k \not\xrightarrow{} \mathbf{e}_j$	Notation	No path exists between two events	186
$\mathbf{e}_l \xrightarrow{[d,D]} \mathbf{e}_k$	Notation	Edge between two events	187

Conventional symbols regarding sets, boolean functions, temporal logics, etc. is also used along the document. However, it is not included here since it corresponds to *well-known* notation.