References


Index

A
abort, 34
actions, 67
algebraic semantics, 16
alphabetized parallel, 81
alphabetized predicate, 31
alphabetized relational calculus, 31
analytic function, 24
And diagram, 58
And state, 58
angelic choice, 35
architecture, 6
Ascending Chain Condition, 27
assignment, 32
Availability, 2

B
barrier certificate, 148
basis, 26
Gröbner basis, 27
Hilbert Basis Theorem, 26
behaviour, 85
block, 41
block method, 42
block diagram, 43
Buchberger’s Algorithm, 27

C
code generation, 7
combined scenario, 232
Communication, 2
communication event, 81
conditional operator, 32
congruently equivalent, 81
continuous block, 42, 151, 153
continuous dynamical system (CDS), 23
constrained CDS (CCDS), 24
elementary CCDS, 139
polynomial CCDS (PCCDS), 123
polynomial CDS (PCDS), 123
continuous sample time, 42
continuous solvers, 52
continuous state, 42
control signal, 43
CSP, 14
CTCS-3, 231
custom blocks, 44
MATLAB function blocks, 44
MATLAB system blocks, 44
S-function blocks, 44
subsystem blocks, 44
cyber-physical systems, 5

data, 63
data refinement, 34
deadlock, 86
default transition, 56
degree
monomial, 25
delay-redundancy-free, 85
demonic choice, 35
denotational semantics, 16
description predicate, 171
Dimensions and weight, 2
discrete block, 42, 151, 154
discrete sample time, 42
discrete solvers, 51
discrete state, 42
Duration Calculus (DC), 17, 91

E
early return logic, 59, 186
elementary function, 139
Embedded systems, 1
embedding
deep embedding, 107, 113
shallow embedding, 107, 109
event, 63
expressions, 200

F
feedback control, 25
first-order theory of reals, 27
real closed fields, 27
Fixed Point Theorem, 130
fixed-step solvers, 42, 51
flow, 82
flow chart, 57
formula
atomic formula, 28
quantified formula, 28
quantifier-free formula (QFF), 28
functionality, 6
functions, 64
graphical functions, 65
MATLAB functions, 66
Simulink functions, 66
truth table functions, 65
fundamental sample time, 42

G
gradient, 126
guidance, navigation and control (GNC), 237

H
HCSP, 14, 75
alphabets, 76
semantics, 80
syntax, 76
HCSP2Sim, 223
healthiness condition, 35, 36
HHL, 91
Hoare assertion, 93
proof system, 95
HHL prover, 107

history formula, 92
internal, 92
history junction, 57, 187
Hoare assertion
theorem, 100
validity, 94
Hoare logic, 15, 35
Hoare triple, 35
hybrid design, 36
Hybrid Hoare Logic (HHL), 14
Hybrid systems, 1

I
ideal membership, 27
implicit events, 63
inherited sample time, 42
inner (ingoing) transitions, 57
inner (outgoing) transitions, 57
invariant, 121
differential invariant (DI), 122
semi-algebraic DI, 123
invariant generator, 225
QE-Based, 226
SOS-Based, 227
inward set, 124
inverse inward set, 124
Isabelle oracle, 225
Isabelle/HOL, 107

J
join, 35
justification of translation, 176, 192, 210

L
Lie derivative, 126
higher order Lie derivative, 127
Life time, 2
link phase, 50
livelock, 86
local event broadcast, 67
directed local event broadcast, 67
undirected local event broadcast, 67
local Lipschitz condition, 24
Lyapunov function, 25
Lyapunov stability, 24

M
MARS, 15, 219
Mealy charts, 60
meet, 35
message, 64
miracle, 34
model compilation, 50
model referencing, 46
  Model block, 46
model transformation, 7
Model-based design, 6
model-based testing, 7
monitor process, 184
monomial, 25
Moore charts, 60
movement authority (MA), 232
multirate discrete system, 43

N
nondeterminism, 33
nontermination, 60, 187
normal form, 27

O
ODE solvers, 42
operational semantics, 16
Or diagram, 57
OR state, 57
ordering
  lexicographic (lex) order, 26
  monomial ordering, 26
ordinary differential equation (ODE), 23

P
parent model, 46
partial order, 34
physicality, 6
Plant-Controller (PLC), 79
polynomial, 25
  ideal, 26
  parametric polynomial, 135
  ring, 26
postcondition, 165
Power management, 2
precondition, 165
Processing, 2

Q
Quality of service (QoS), 2
quantifier, 27
  quantifier elimination (QE), 28

R
rank
  pointwise rank, 128
  Rank Theorem, 130
rapid prototyping, 7
reactive design, 35
Real-time systems, 1
Real-time systems
  soft real-time, 1
  hard real-time, 1
recursion, 34
referenced model, 46
refinement, 7, 34
relational calculus, 31
Reliability, 2
requirement management, 7

S
Safety, 2
safety-critical systems, 1
sample time, 42, 151
  block-based, 42
  inherited, 156
  port-based, 42
sample time hits, 43
Security, 2
semi-algebraic set (SAS), 28
semi-definite programming (SDP), 138
sequential composition, 32
Sim2HCSP, 220
simulation, 7, 140
  simulation map, 140
  simulation loop phase, 50
Simulink block library
  Continuous, 47
  Discontinuity, 47
  Discrete, 48
  Logic Operations, 48
  Math Operations, 48
  Ports and Subsystems, 48
  Signal Attributes, 49
  Signal Routing, 49
  Sinks, 49
  Sources, 49
  User-Defined Functions, 50
Simulink subsystems, 44, 160
  action subsystems, 45
    action subsystem initiator, 45
    atomic subsystems, 45
    enabled subsystems, 45, 162
Simulink subsystems (cont.)
  function-call subsystems, 45
  function-call initiator, 45
  normal subsystems, 45, 160
  triggered subsystems, 45, 161
state, 57, 82
  during action, 57
  entry action, 57
  exit action, 57
Stateflow, 55
Stateflow execution, 58
Storage, 2
Subsystem block, 44
sum-of-squares (SOS), 138
  SOS-relaxation, 138
super-dense computation, 80
synthesis, 7

T
Taylor model, 146
template
  semi-algebraic template, 135
temporal logic based actions, 68
  absolute-time based, 68
  event-based, 68
terminated, 86
testing, 4
time
  the design phase, 3
time
  the implementation phase, 4
time
  the integration phase, 4
time
  the requirement phase, 3
time
  the specification phase, 3
timeliness
  theory of designs, 31
Time-to-market and cost, 2
timed communication, 80
trajectory, 122
  inverse trajectory, 122
transition, 56
  condition, 56
  condition action, 56
  transition action, 56, 67
transition path, 56
transition relation, 82
TTN algorithm, 182

U
Unifying Theories of Programming (UTP), 14
UTP, 16, 20, 31
design, 16, 33

V
V-model, 3
validation, 4, 7
variable-step solvers, 42, 51
vector field, 23
  polynomial vector field (PVF), 26
verification, 4, 7
verification condition, 113

W
weakest precondition, 35

Y
Y-chart, 6

Z
Zeno phenomena, 80, 152, 224