Programación Paralela, Concurrente y de Tiempo Real

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Tiempo Real

1. Introducción al tiempo real
2. Tareas periódicas
3. ***Modelado de sistemas de tiempo real***
4. Sincronización
5. Soporte en el sistema operativo

3. Modelling Real-Time Systems

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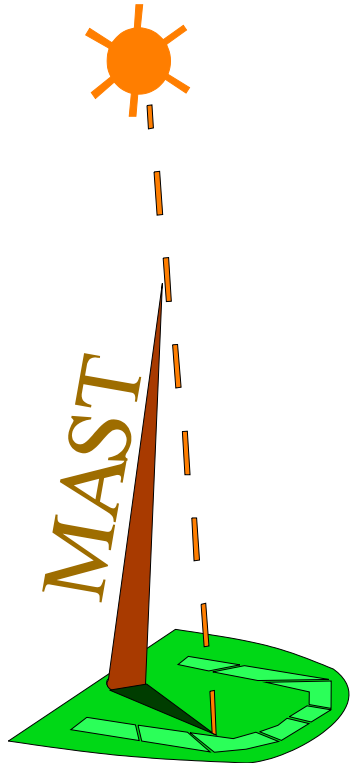
3.1 Overview of the real-time model

3.2 The platform model

3.3 Modelling the software modules

3.4 Modelling the activities

3.5 Analysis tools



3.1 Overview of the Real-Time Model

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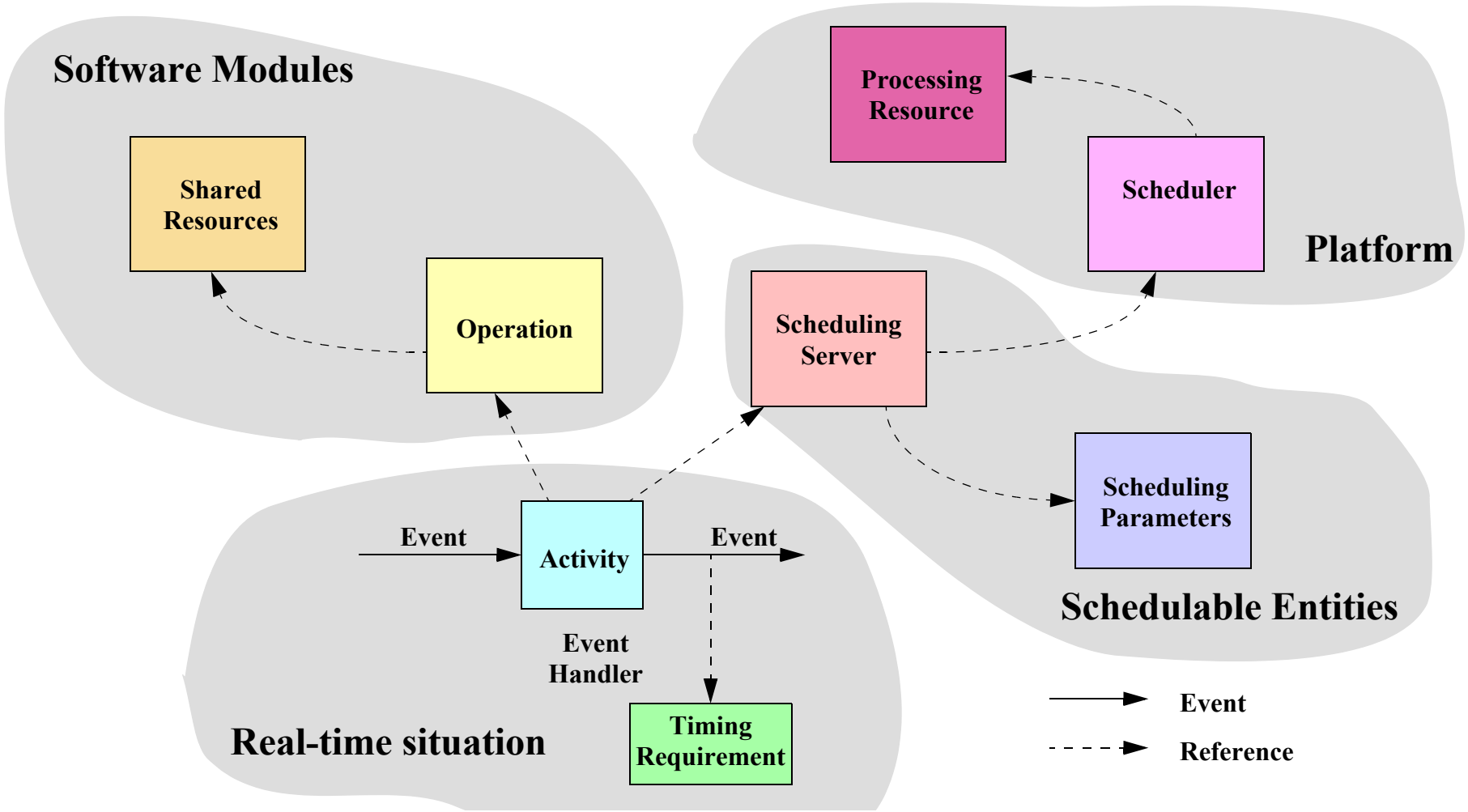
The real-time system model contains four independent parts:

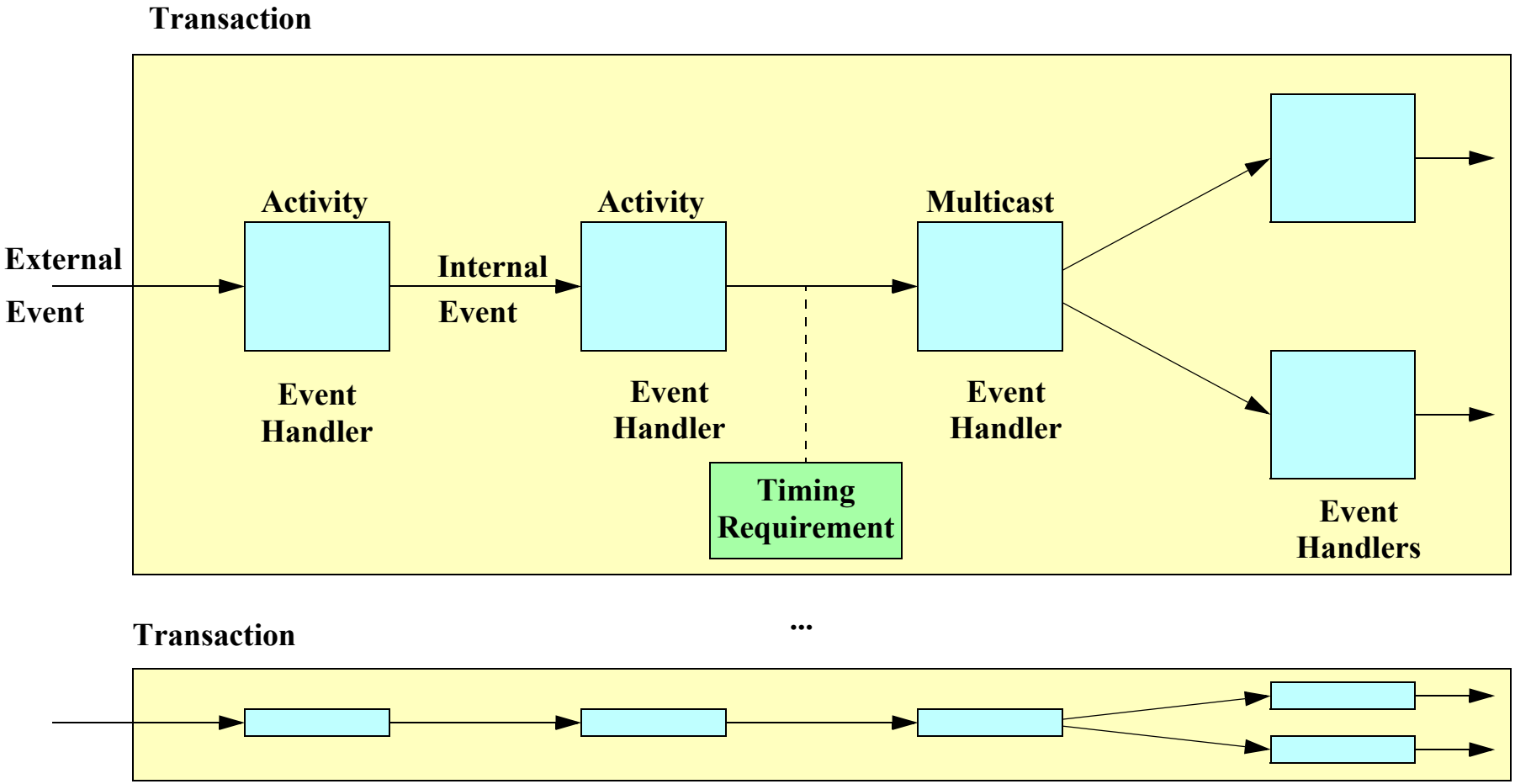
- Platform (processors, networks, schedulers,...)
- Schedulable entities (tasks, message streams)
- Software modules
  - operations
  - shared resources
- Real-time situation
  - representing a particular mode of operation of the system
  - composed of a set of *transactions*

A transaction contains a set of *activities* that will be executed by the system in response to events

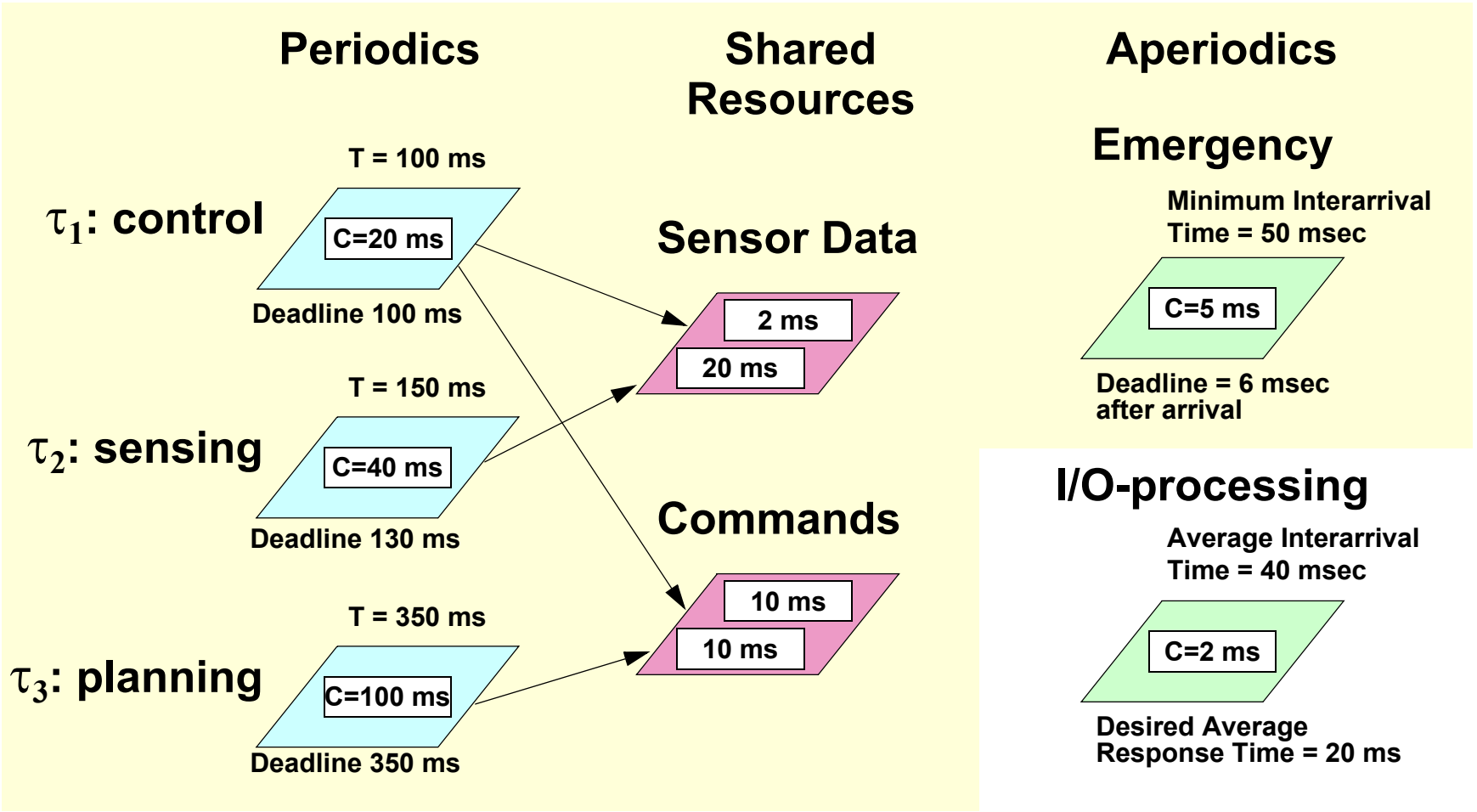
Real-Time Model: Overview



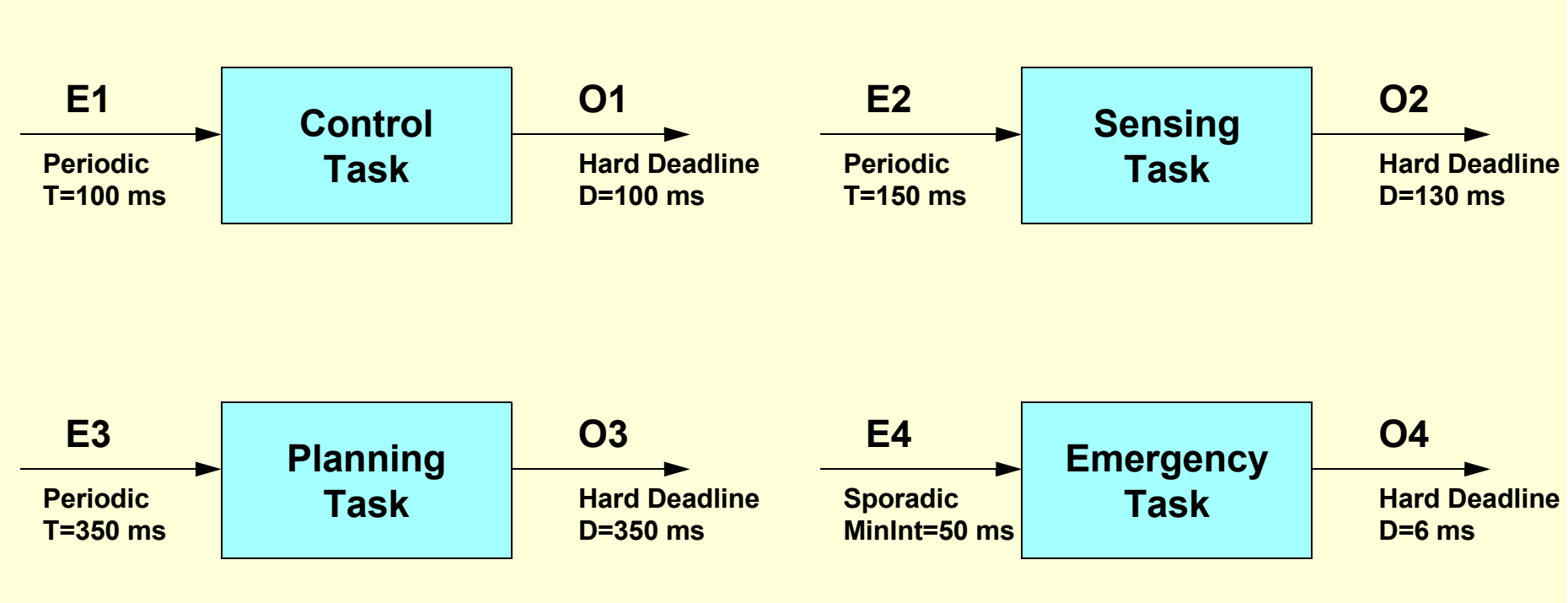
Real-Time Situation



An example


Periodics
Shared Resources
Aperiodics
T = 100 ms
τ1: control
C=20 ms
Deadline 100 ms
Sensor Data
2 ms
20 ms
Emergency
Minimum Interarrival Time = 50 msec
C=5 ms
Deadline = 6 msec after arrival
T = 150 ms
τ2: sensing
C=40 ms
Deadline 130 ms
Commands
10 ms
10 ms
I/O-processing
Average Interarrival Time = 40 msec
C=2 ms
Desired Average Response Time = 20 ms
T = 350 ms
τ3: planning
C=100 ms
Deadline 350 ms

Transactions in this example



Elements of the MAST Model

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Platform

1. Processing Resources
2. System Timers
3. Network Drivers
4. Schedulers (primary, secondary)
5. Scheduling policies (fixed priorities, EDF,...)

Schedulable entities

6. Scheduling Parameters (priorities, deadlines)
7. Synchronization parameters (preemption levels,...)
8. Scheduling servers (tasks, processes, threads, message streams...)

Elements of the MAST Model (cont'd)

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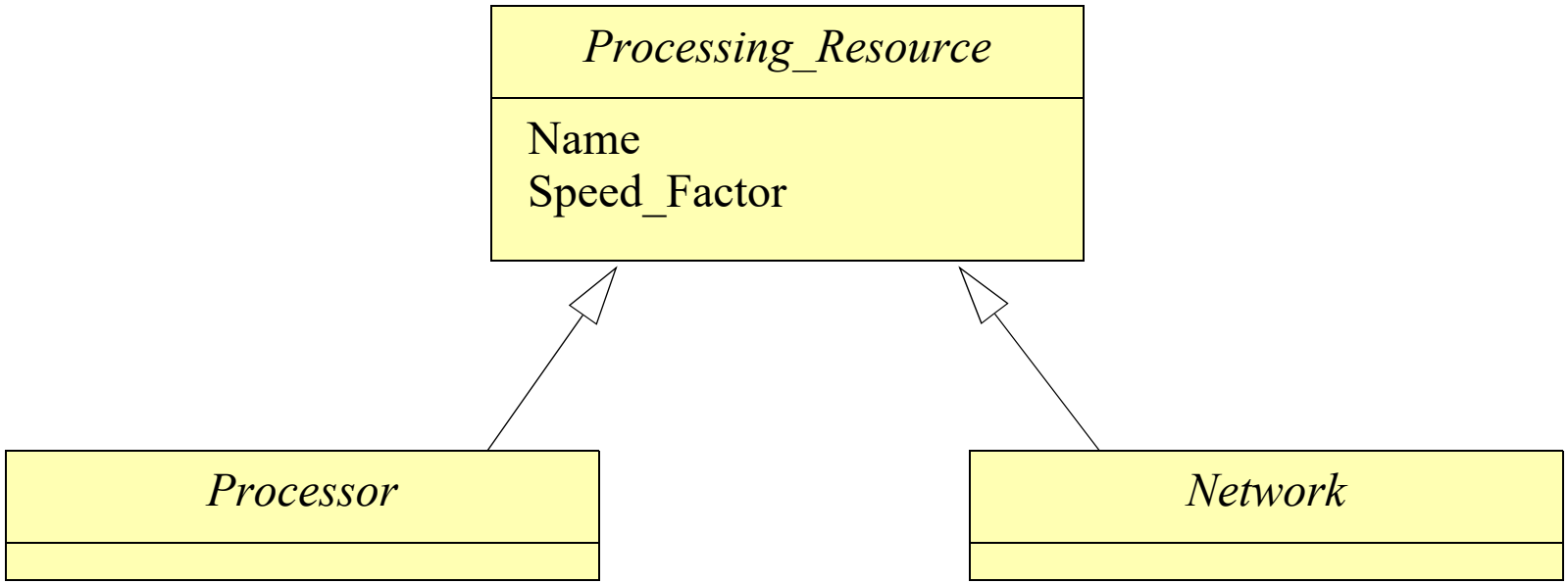
Software modules

9. Shared resources (mutually exclusive)
10. Operations (procedures, functions, messages)

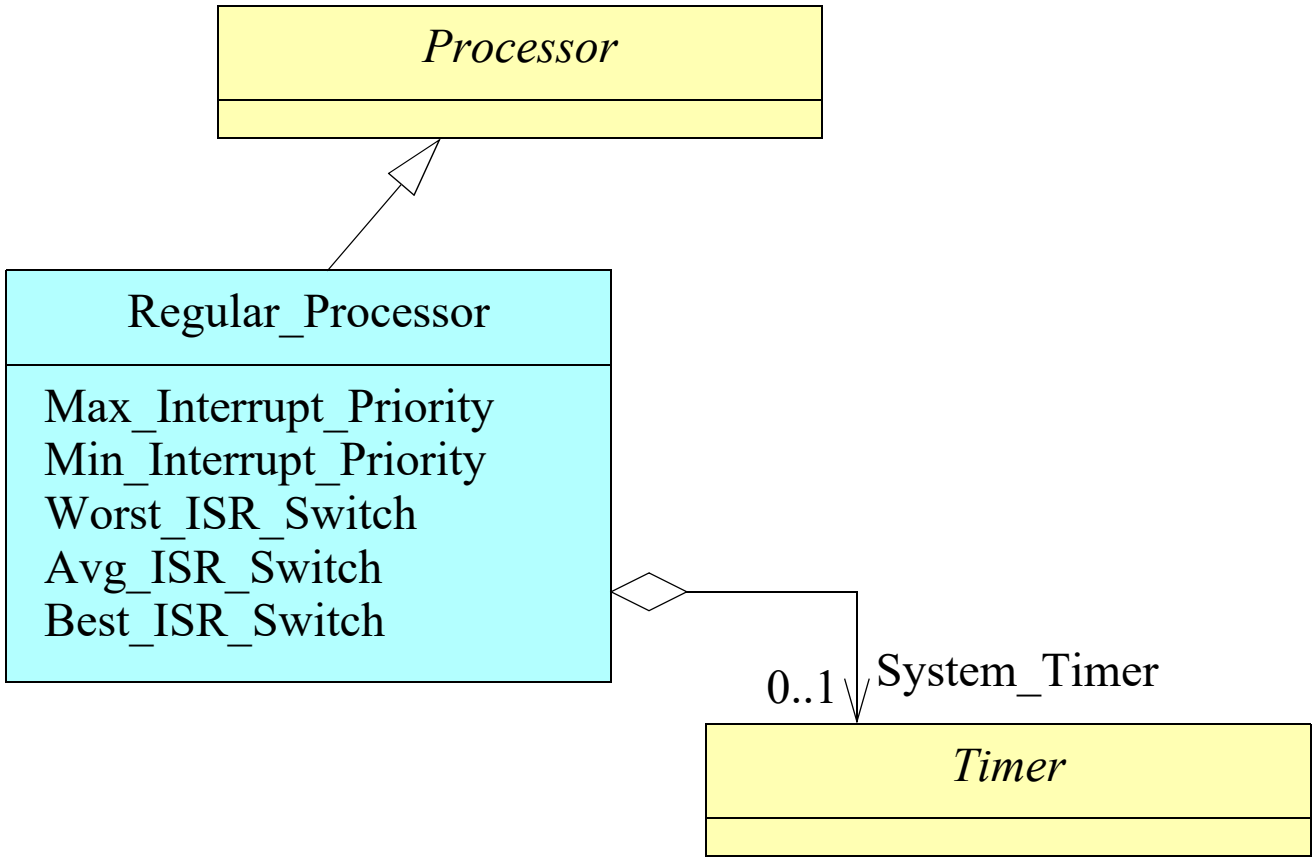
Real-time situation

11. Events
12. Timing Requirements
13. Event Handlers
14. Transactions
15. Overall system model

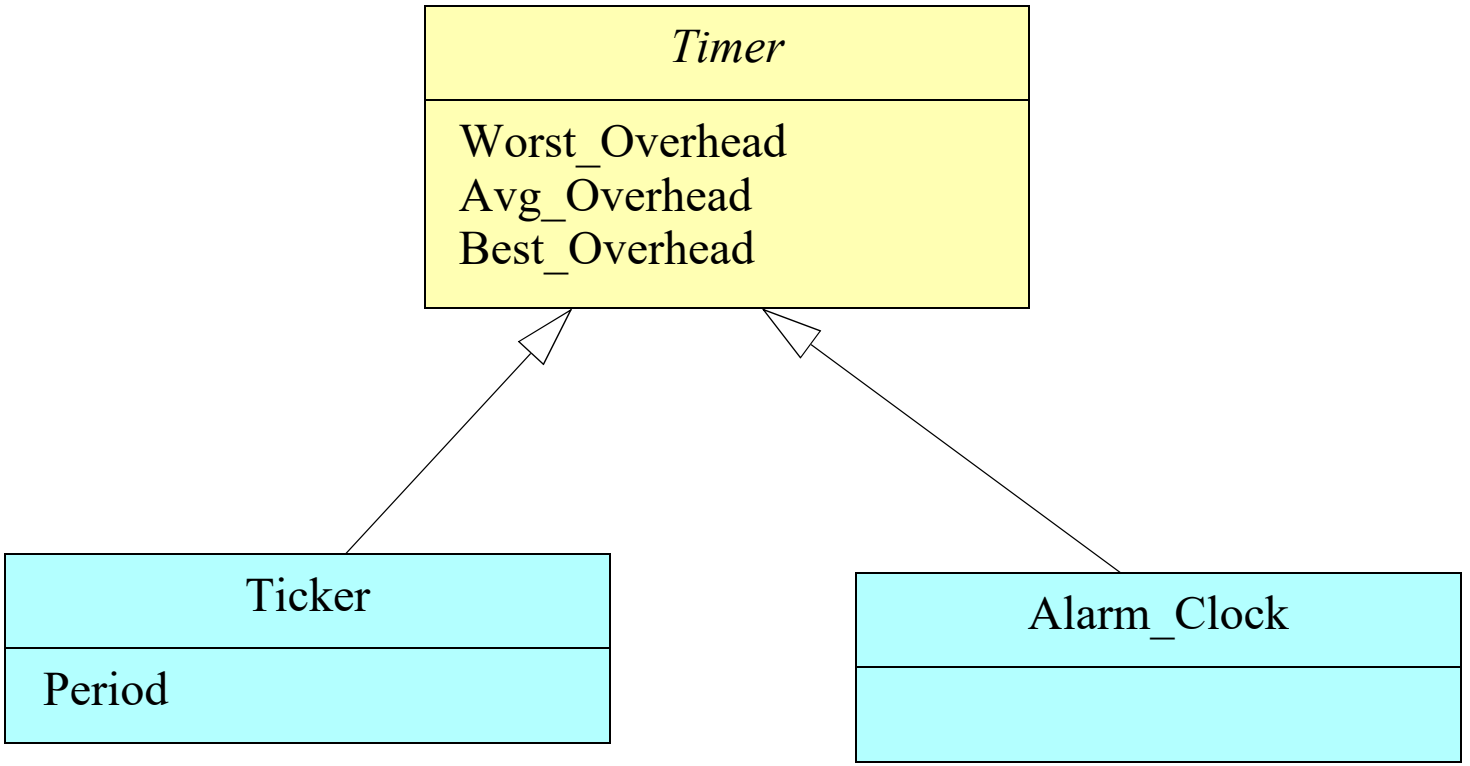
3.2 The Platform Model: Processing Resources



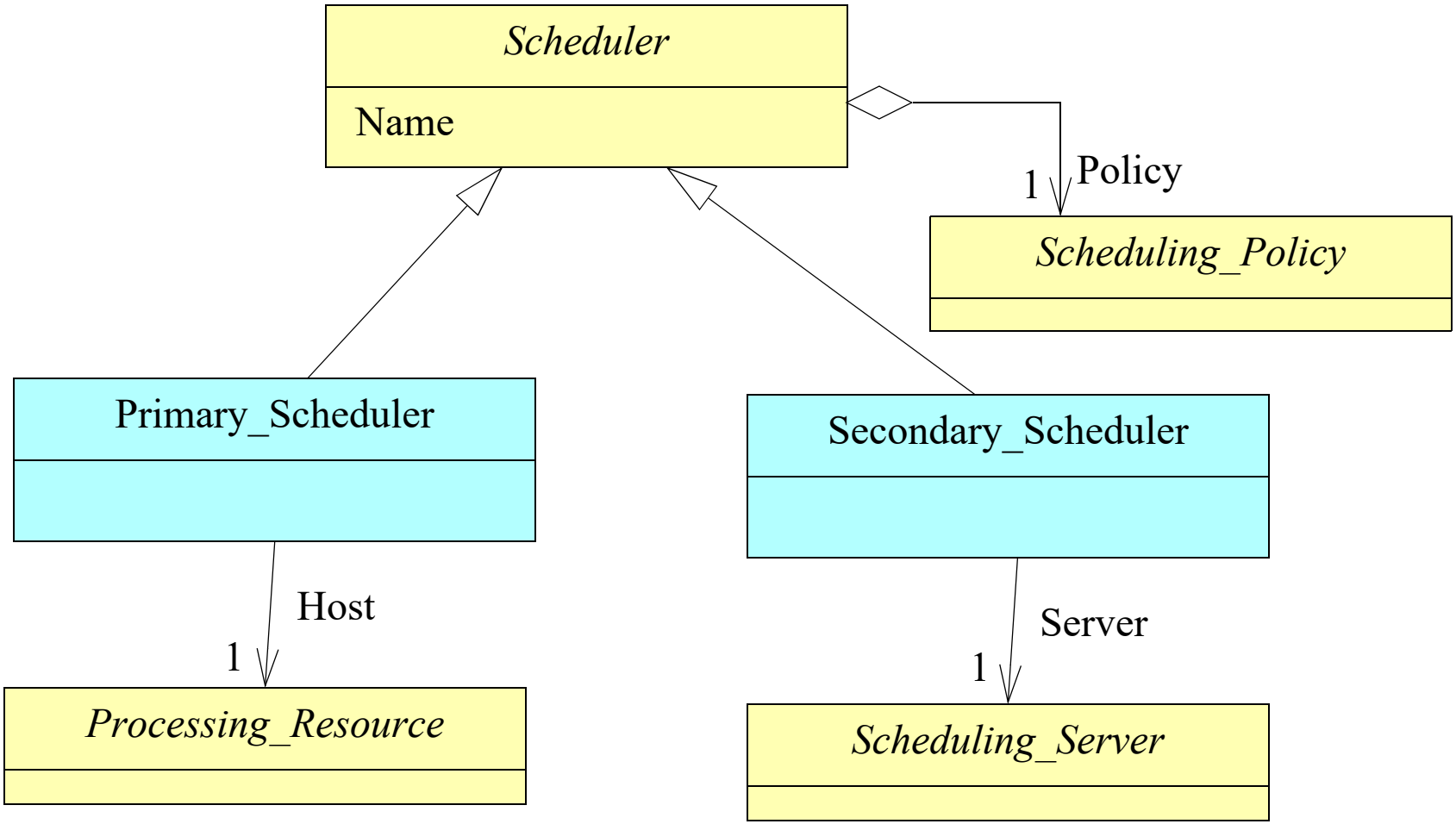
Processors


Processor
Regular_Processor
Max_Interrupt_Priority
Min_Interrupt_Priority
Worst_ISR_Switch
Avg_ISR_Switch
Best_ISR_Switch
0..1
System_Timer
Timer

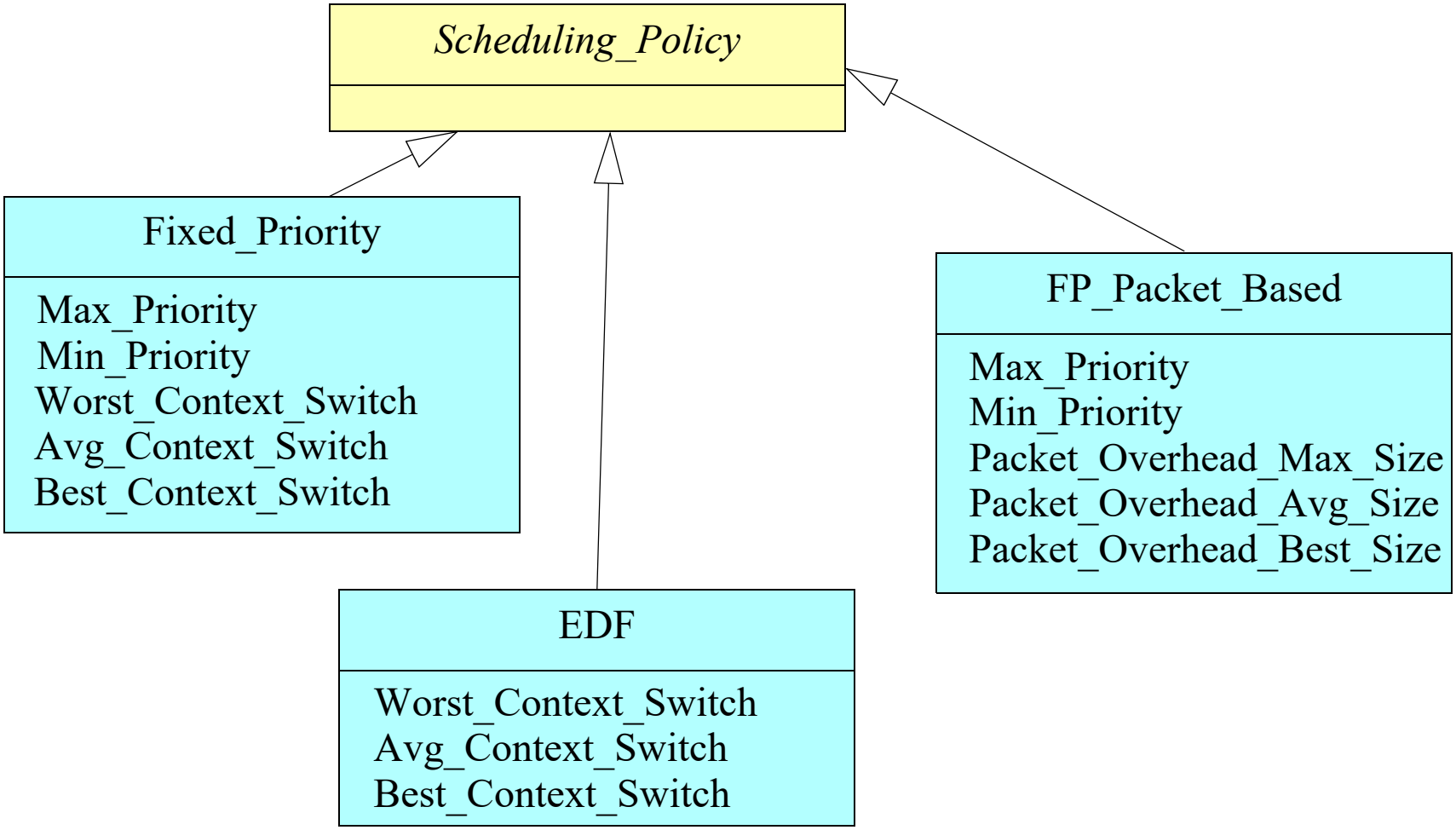
System Timers



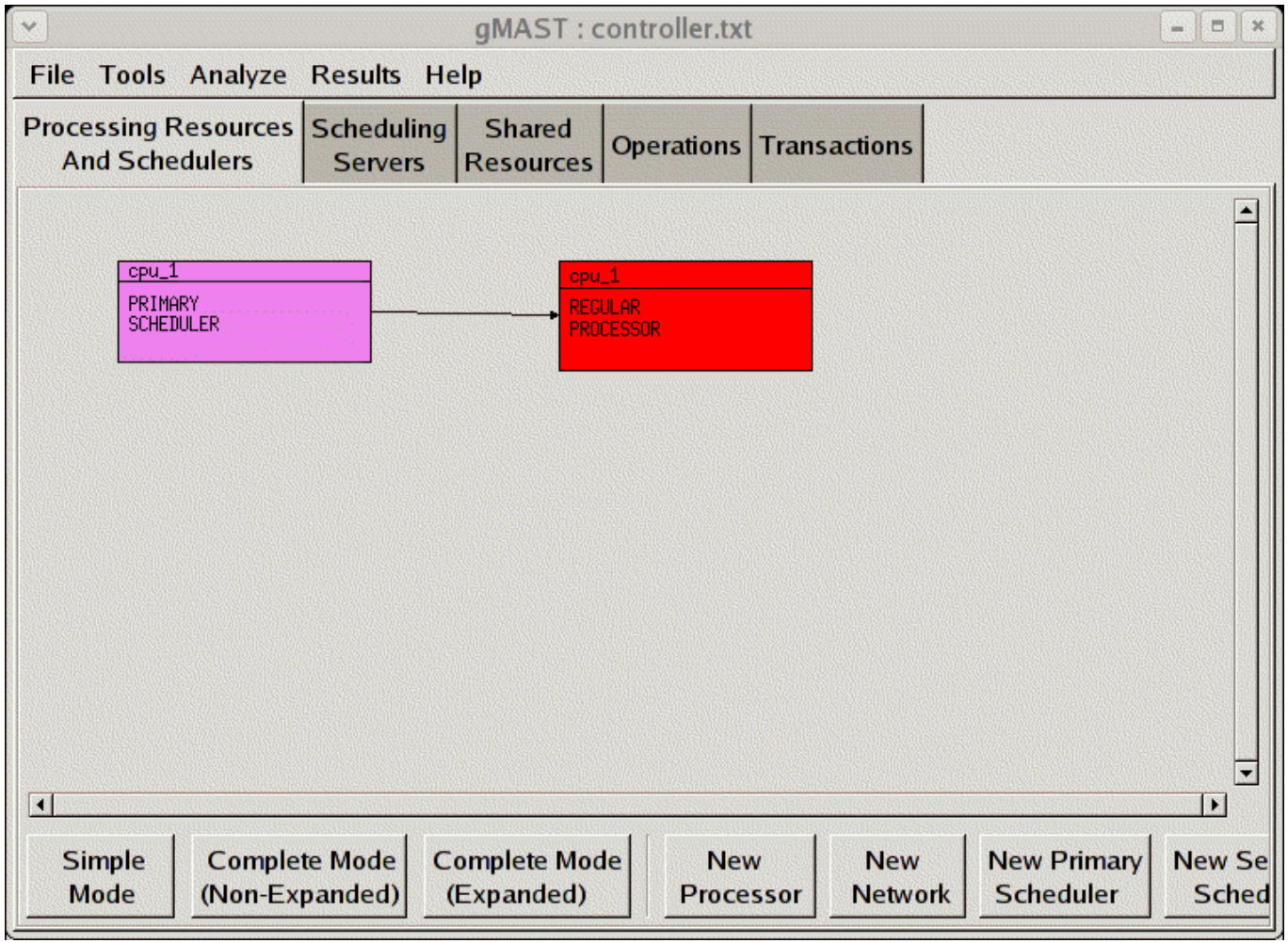
Schedulers


Scheduler
Name
1
Policy
Scheduling_Policy
Primary_Scheduler
Secondary_Scheduler
Host
1
Server
1
Processing_Resource
Scheduling_Server

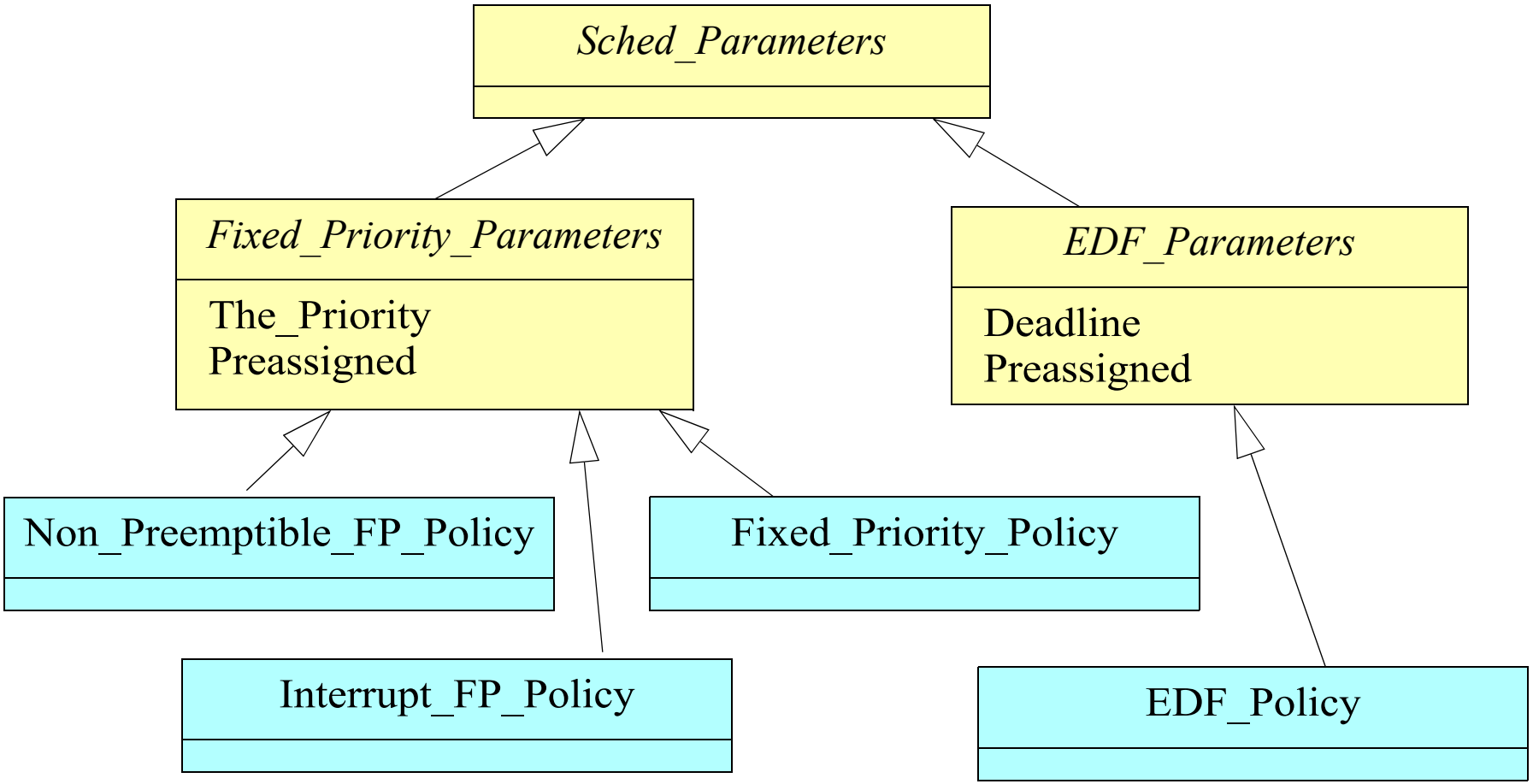
Scheduling Policies



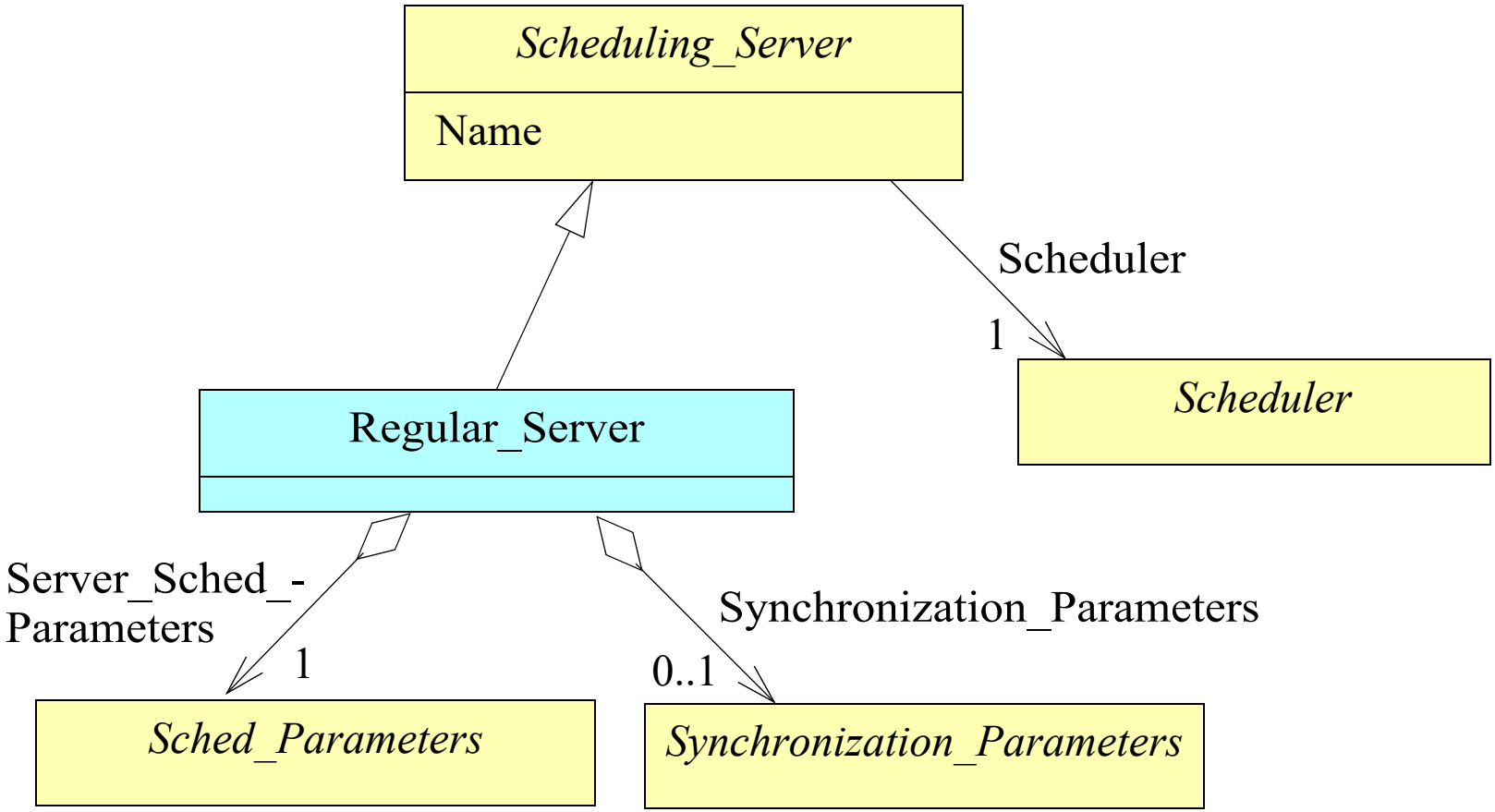
Processing resources, schedulers, drivers, and timers



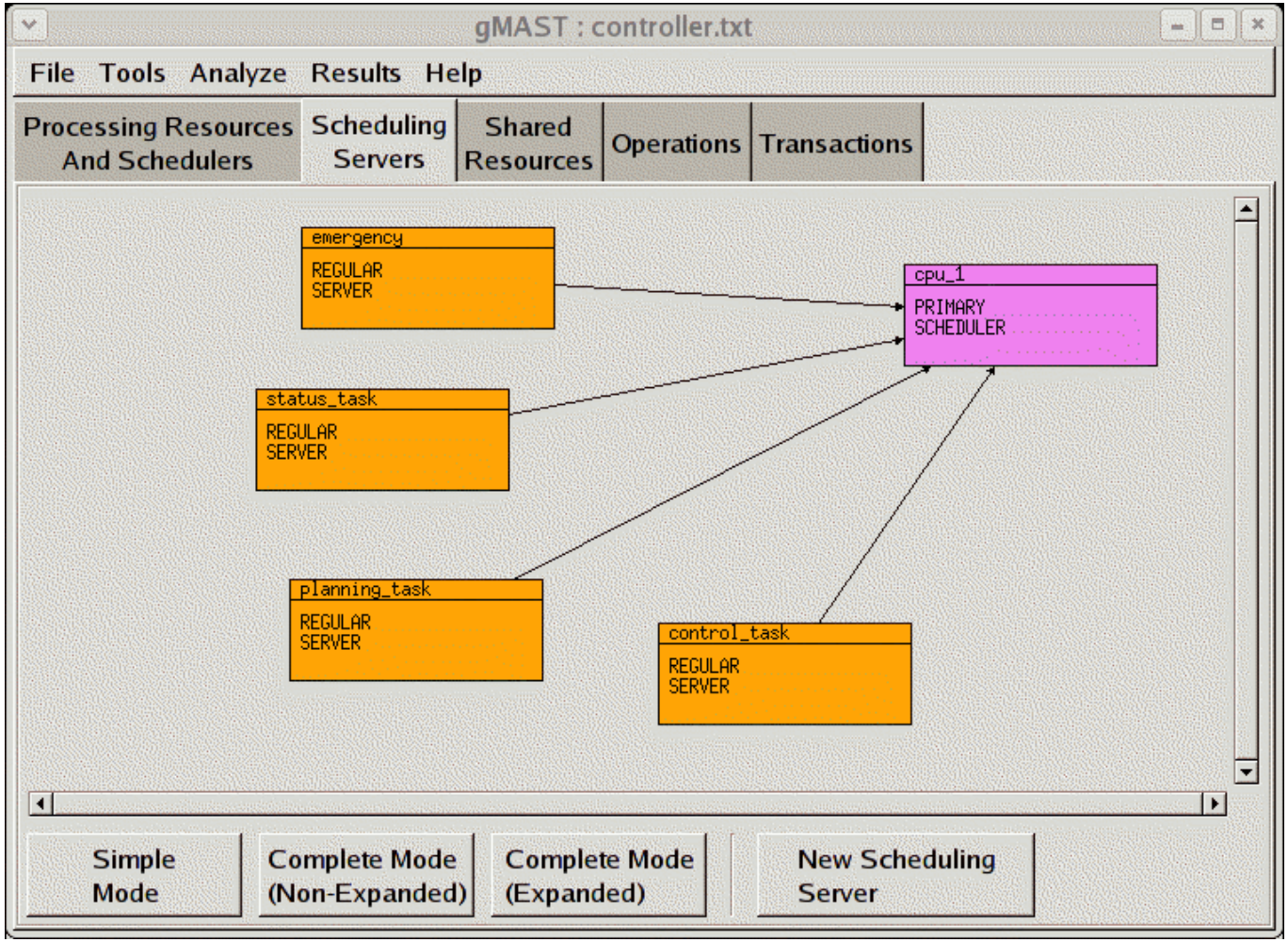
Scheduling Parameters



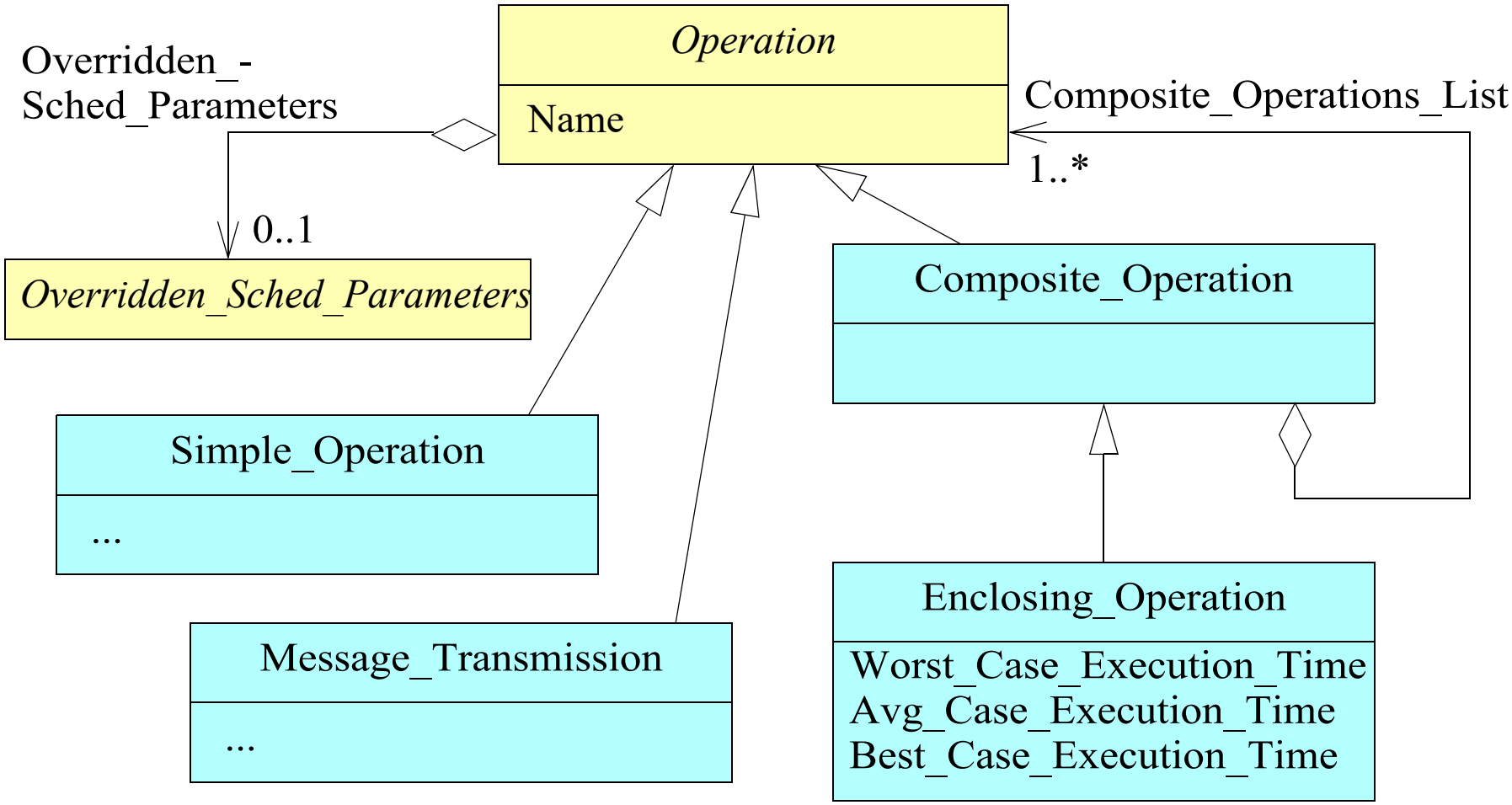
Scheduling Servers (tasks, processes, threads,...)



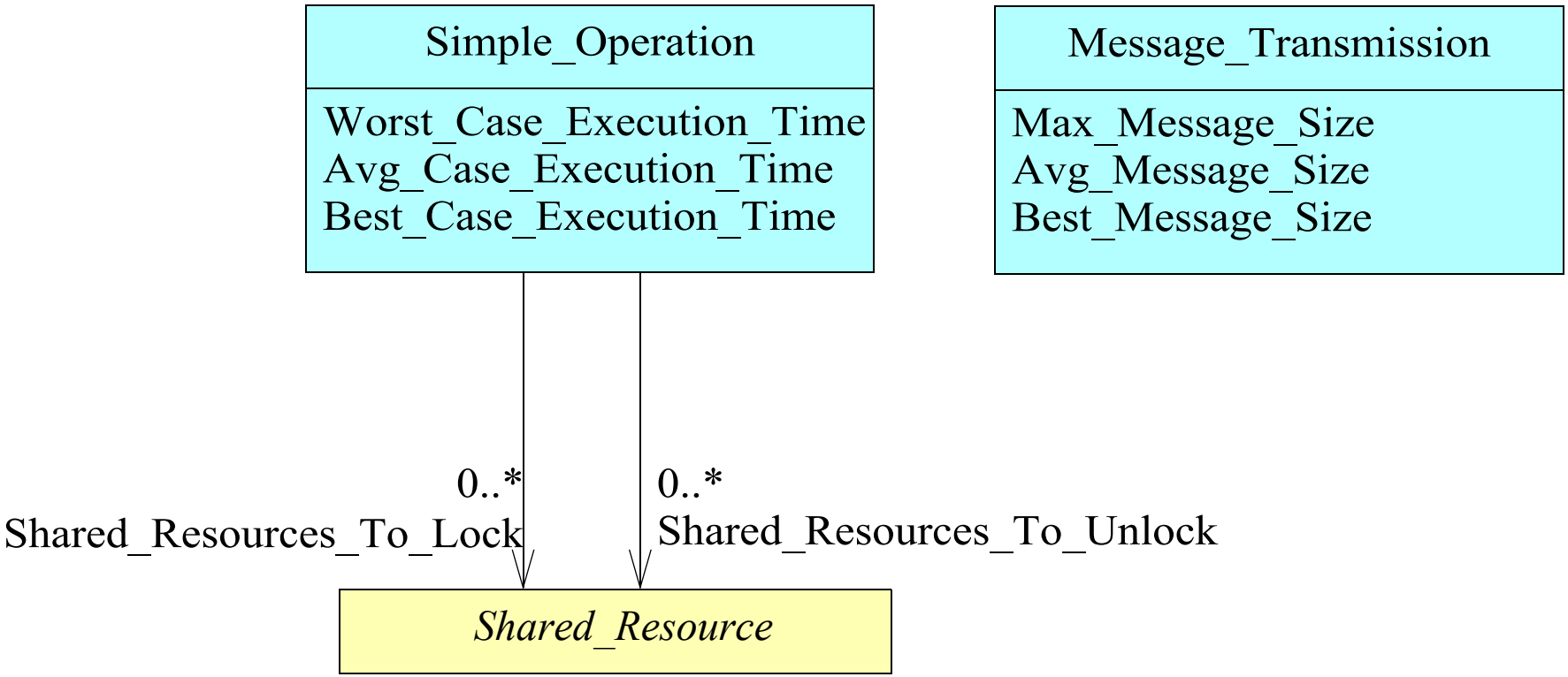
Scheduling servers



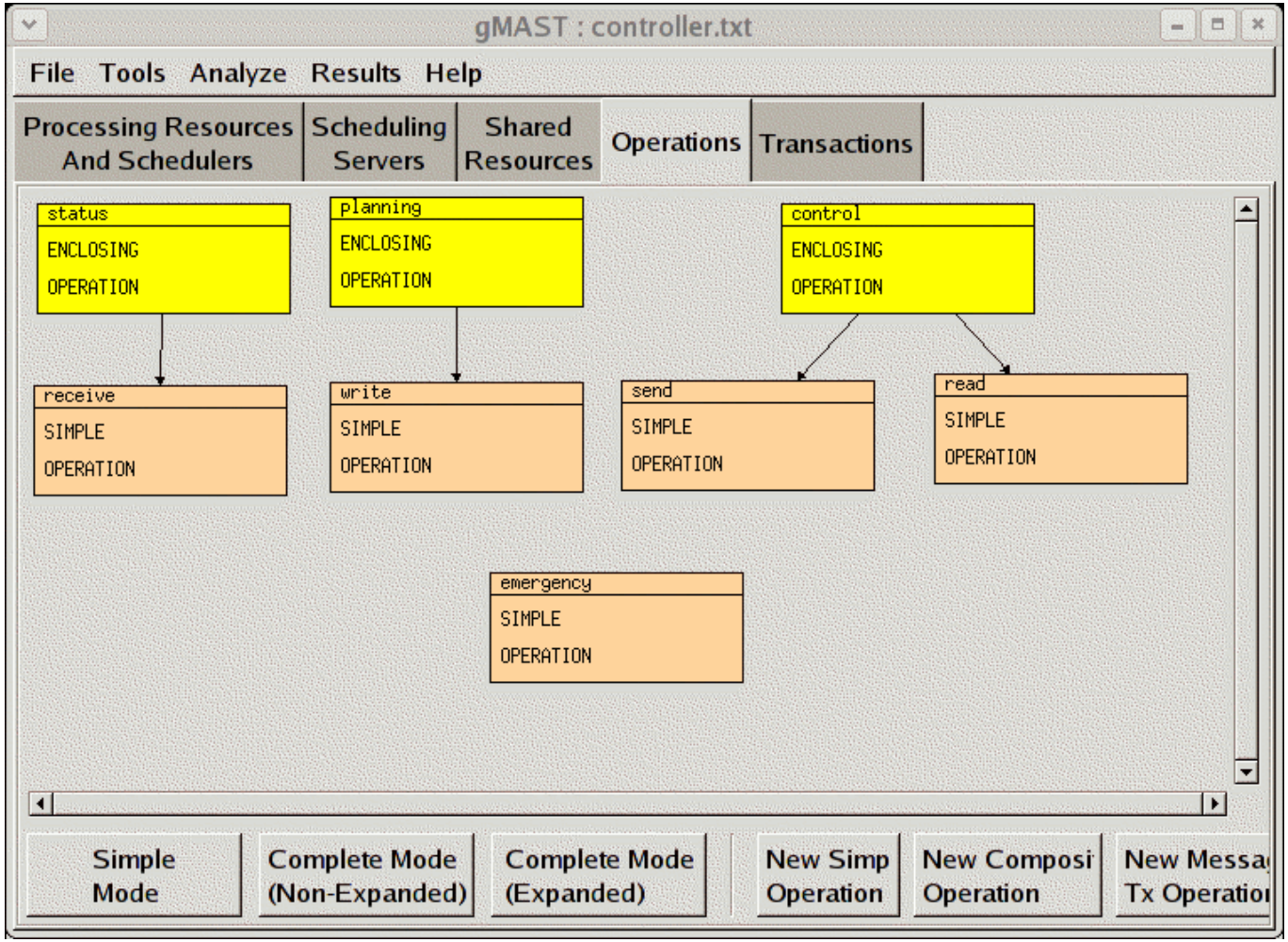
3.3 Modelling the Software Modules: Operations (functions, messages)



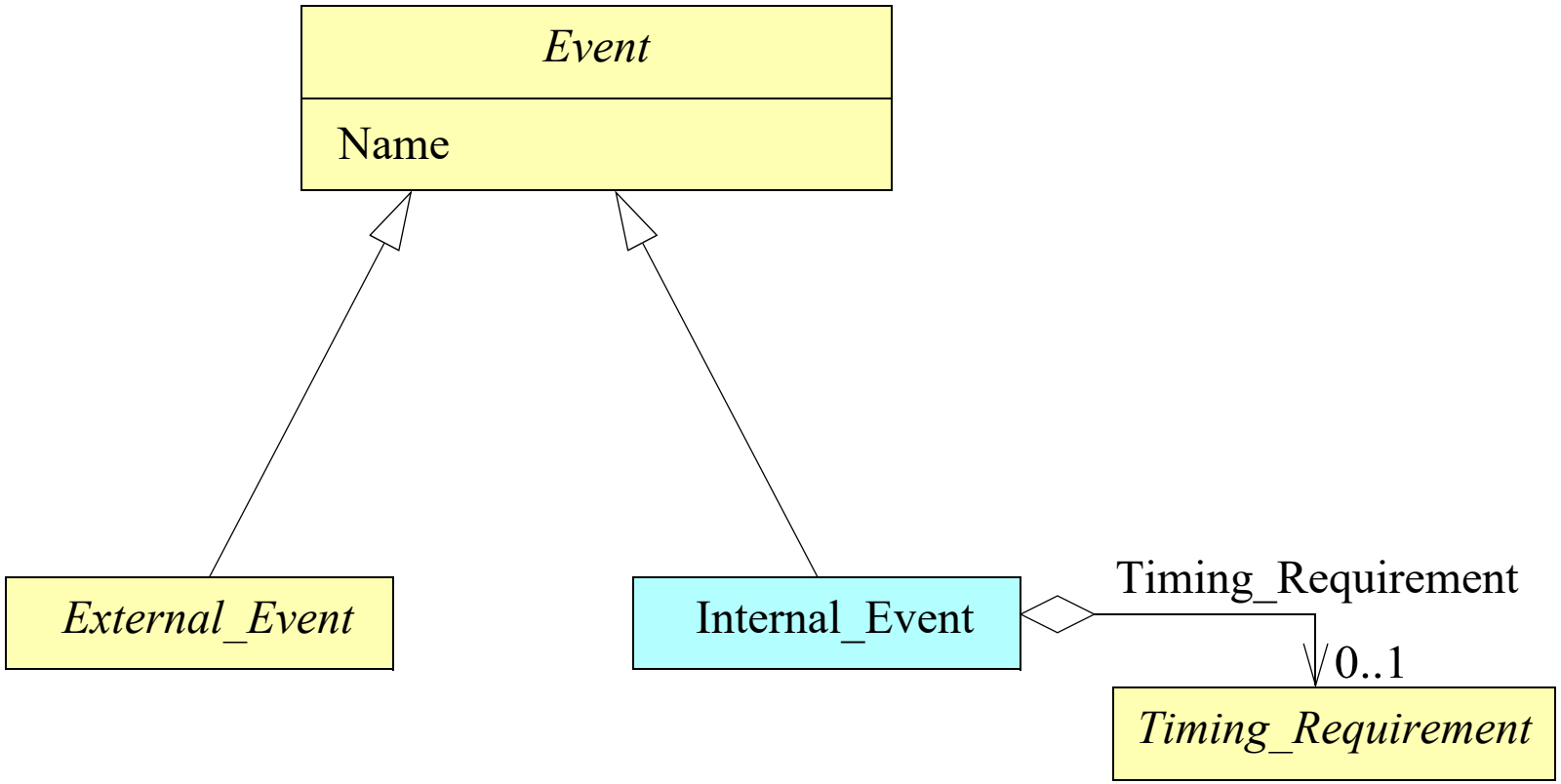
Operations (cont'd)



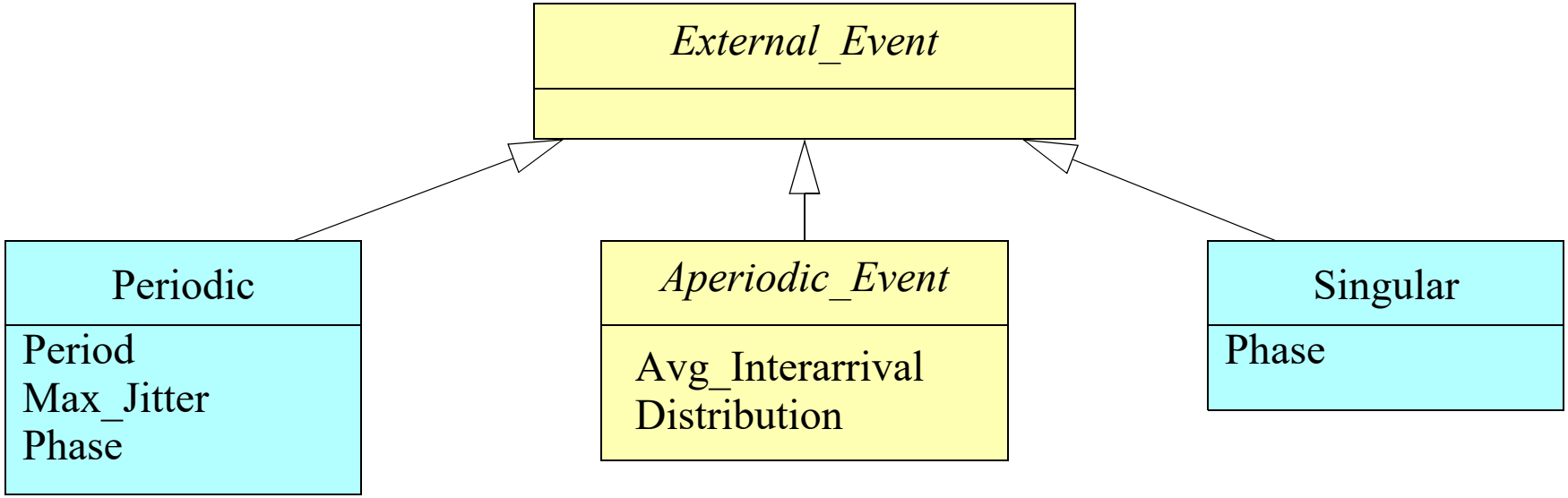
Operations


gMAST : controller.txt
File Tools Analyze Results Help
Processing Resources And Schedulers
Scheduling Servers
Shared Resources
Operations
Transactions
status
ENCLOSING
OPERATION
planning
ENCLOSING
OPERATION
control
ENCLOSING
OPERATION
receive
SIMPLE
OPERATION
write
SIMPLE
OPERATION
send
SIMPLE
OPERATION
read
SIMPLE
OPERATION
emergency
SIMPLE
OPERATION
Simple Mode
Complete Mode (Non-Expanded)
Complete Mode (Expanded)
New Simp Operation
New Composi Operation
New Messa Tx Operatio

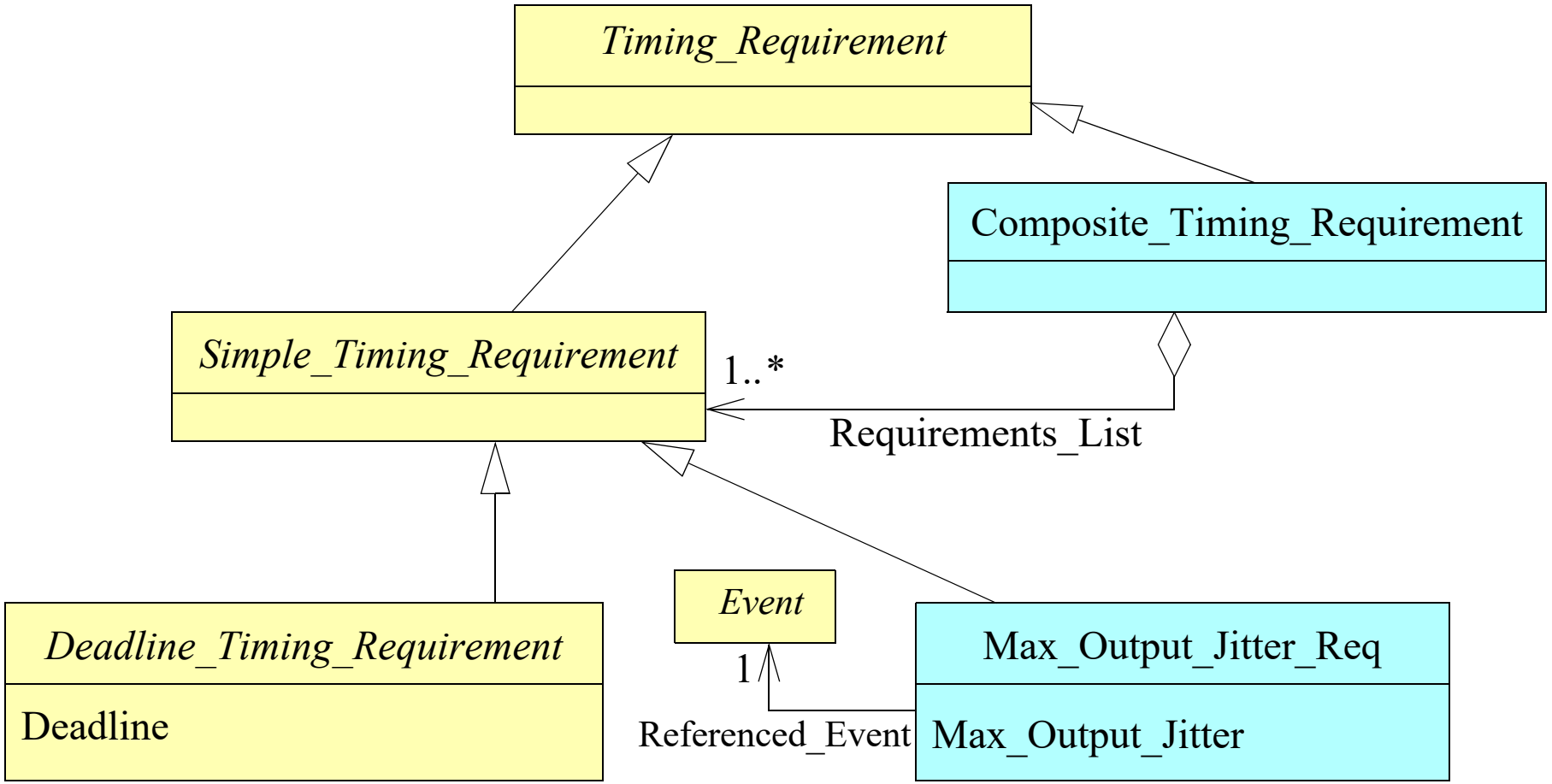
3.4 Modelling the Activities: Events



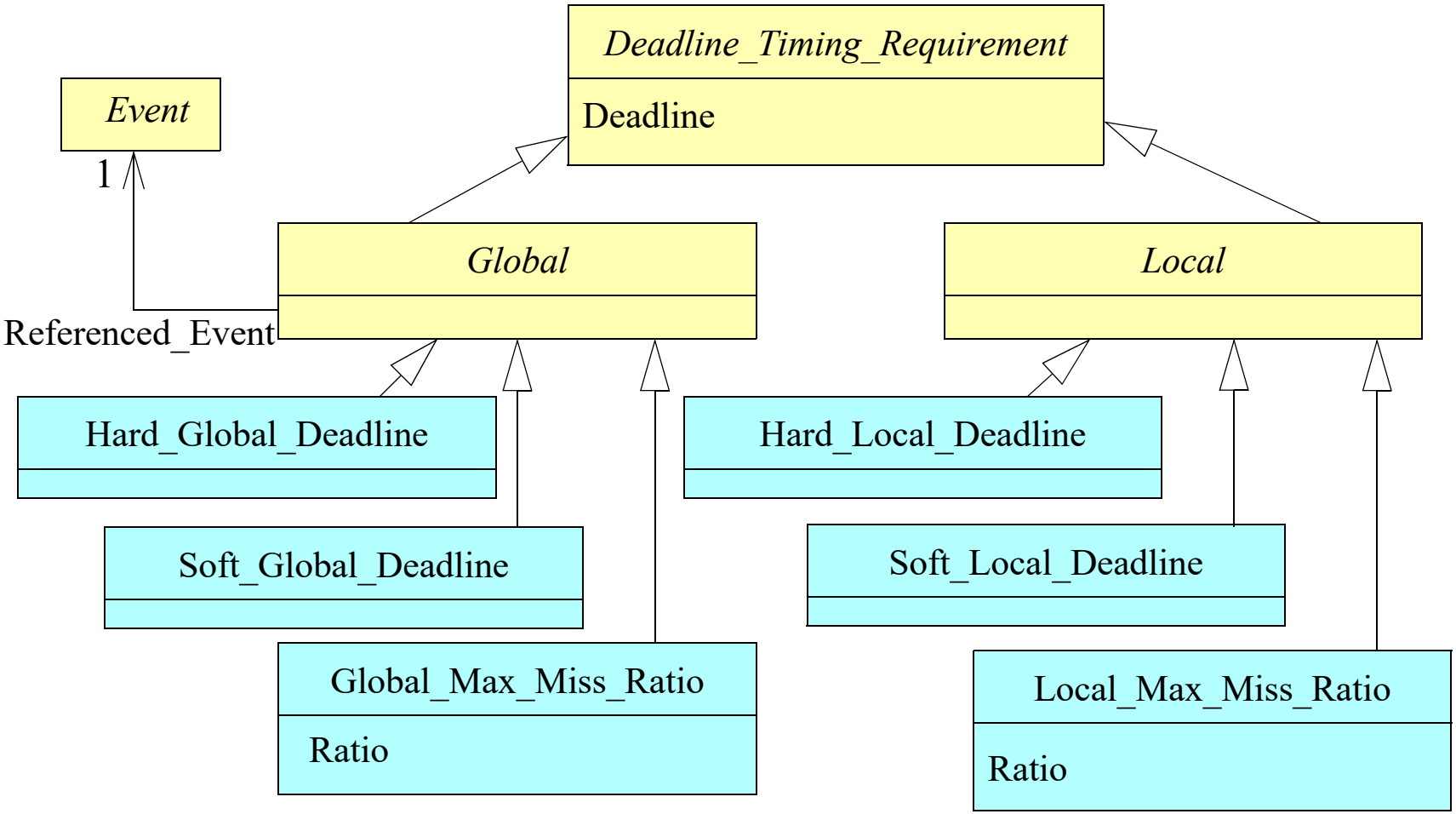
External Events



Timing Requirements



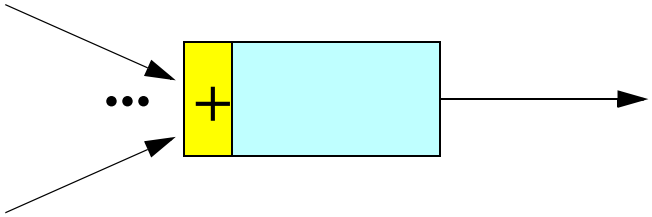
Deadline Timing Requirements



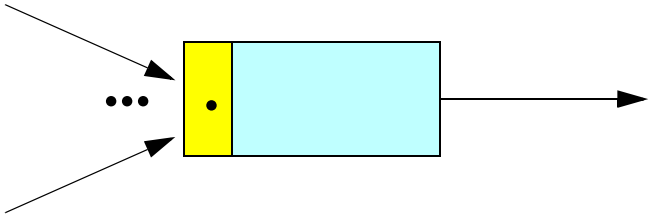
Event Handlers

Activity / Rate Divisor / Delay / Offset

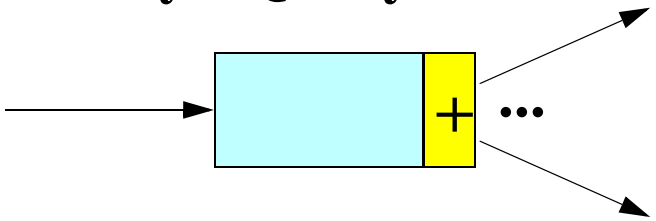
Concentrator



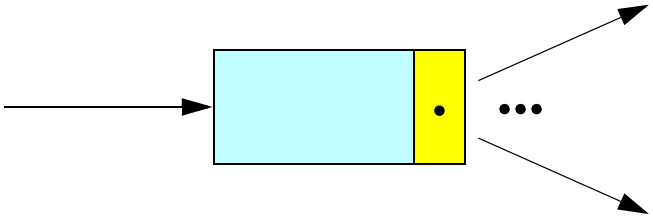
Barrier



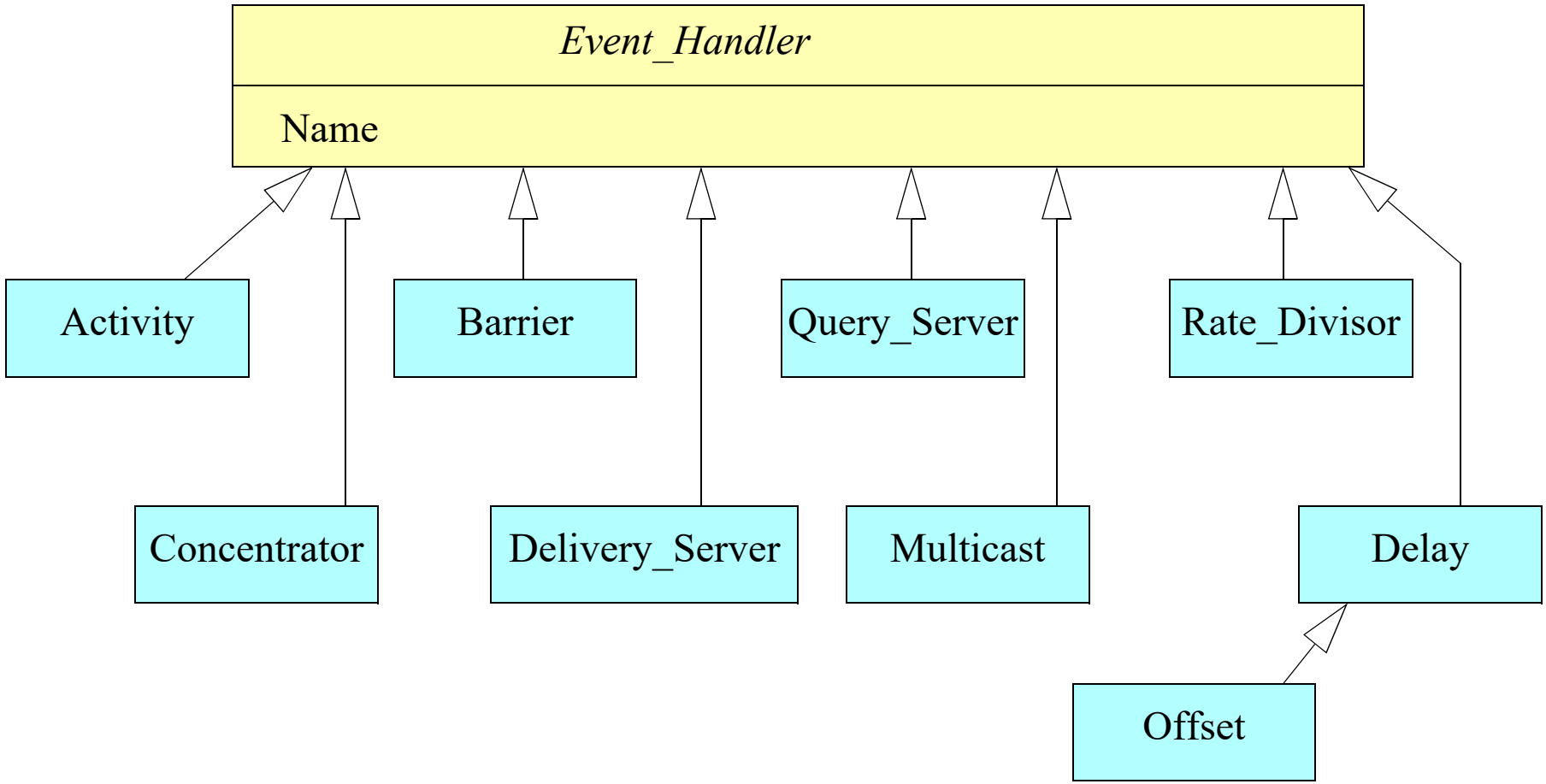
Delivery / Query Server



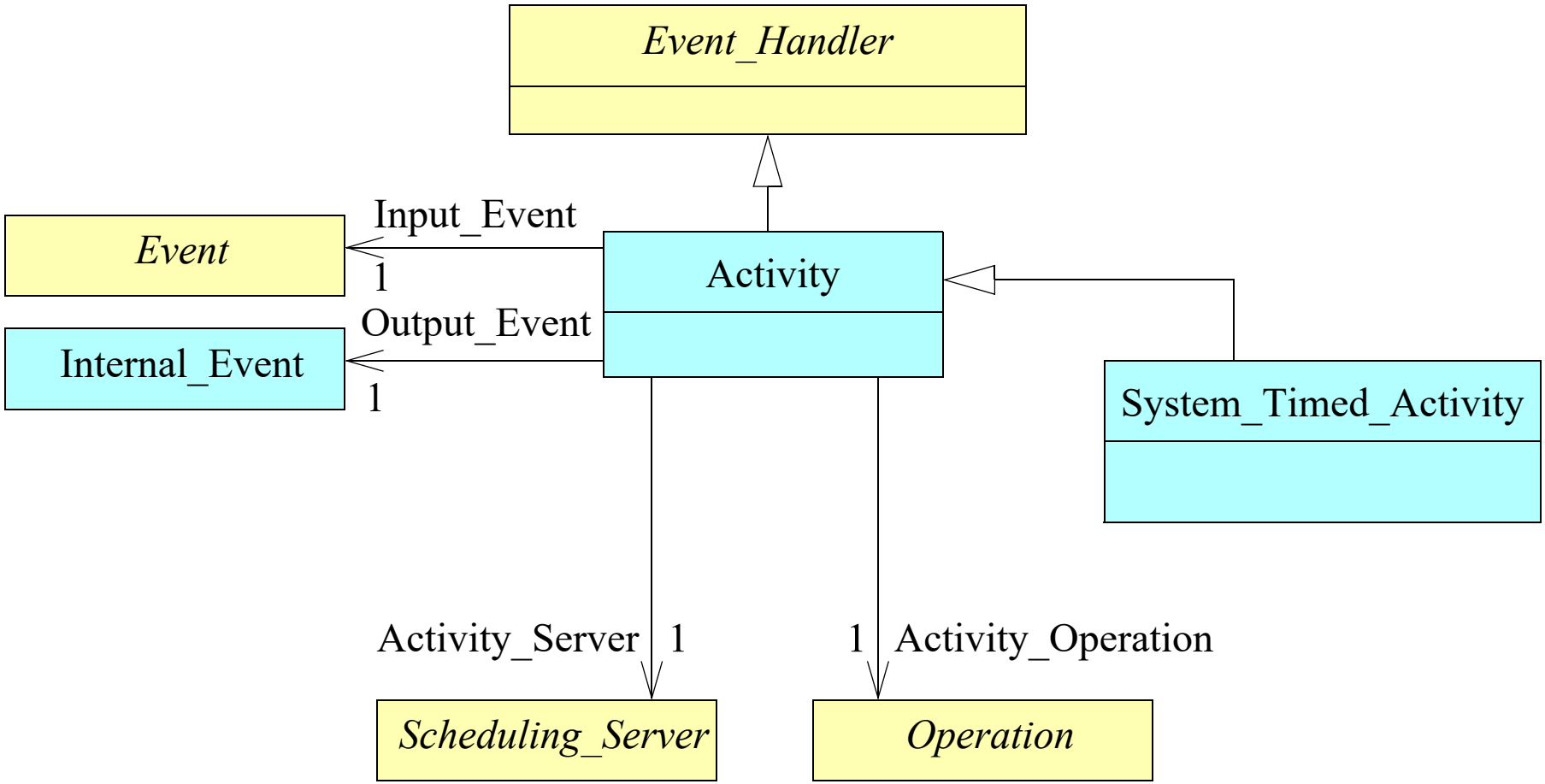
Multicast



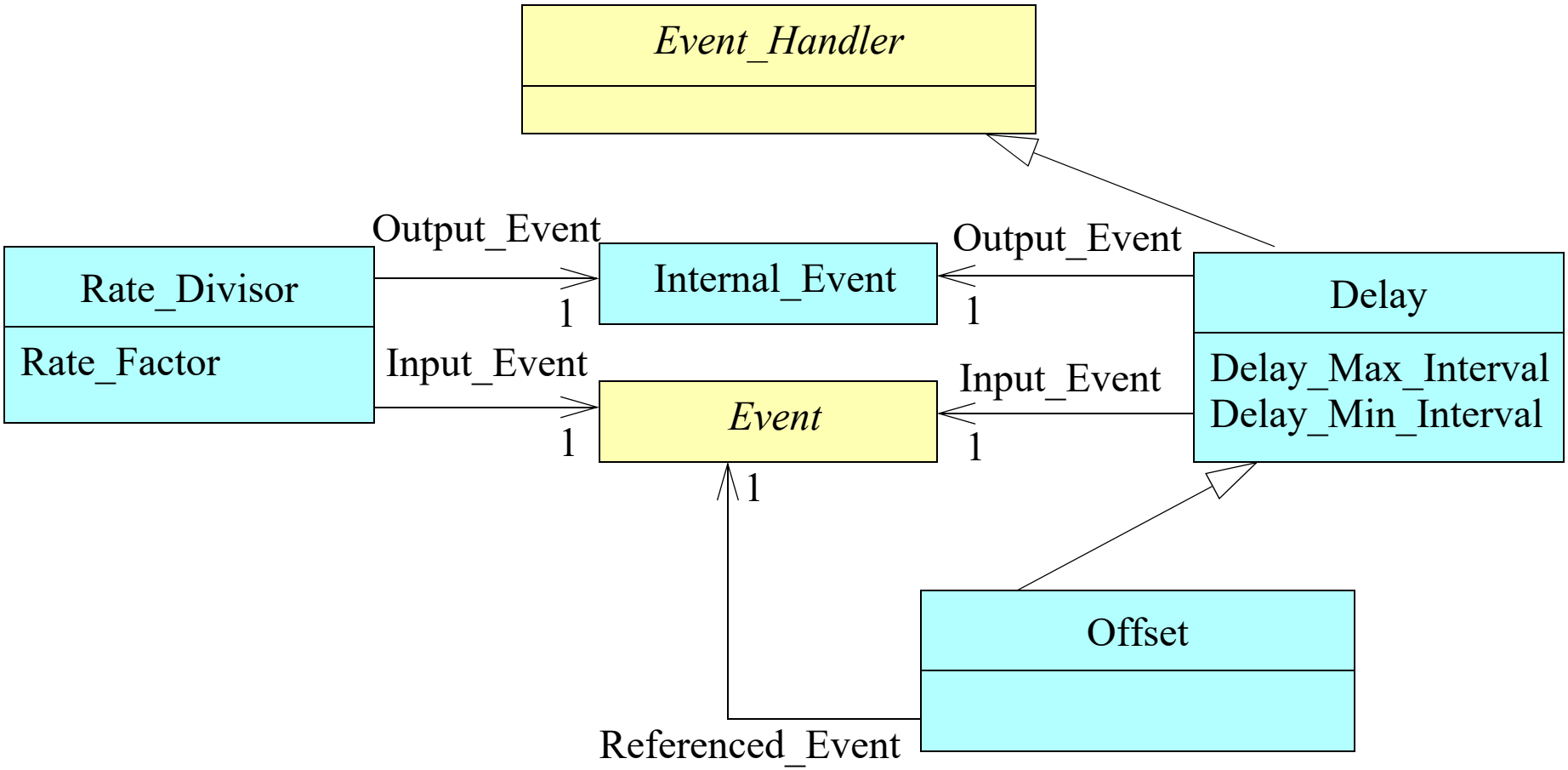
Event Handlers (cont'd)



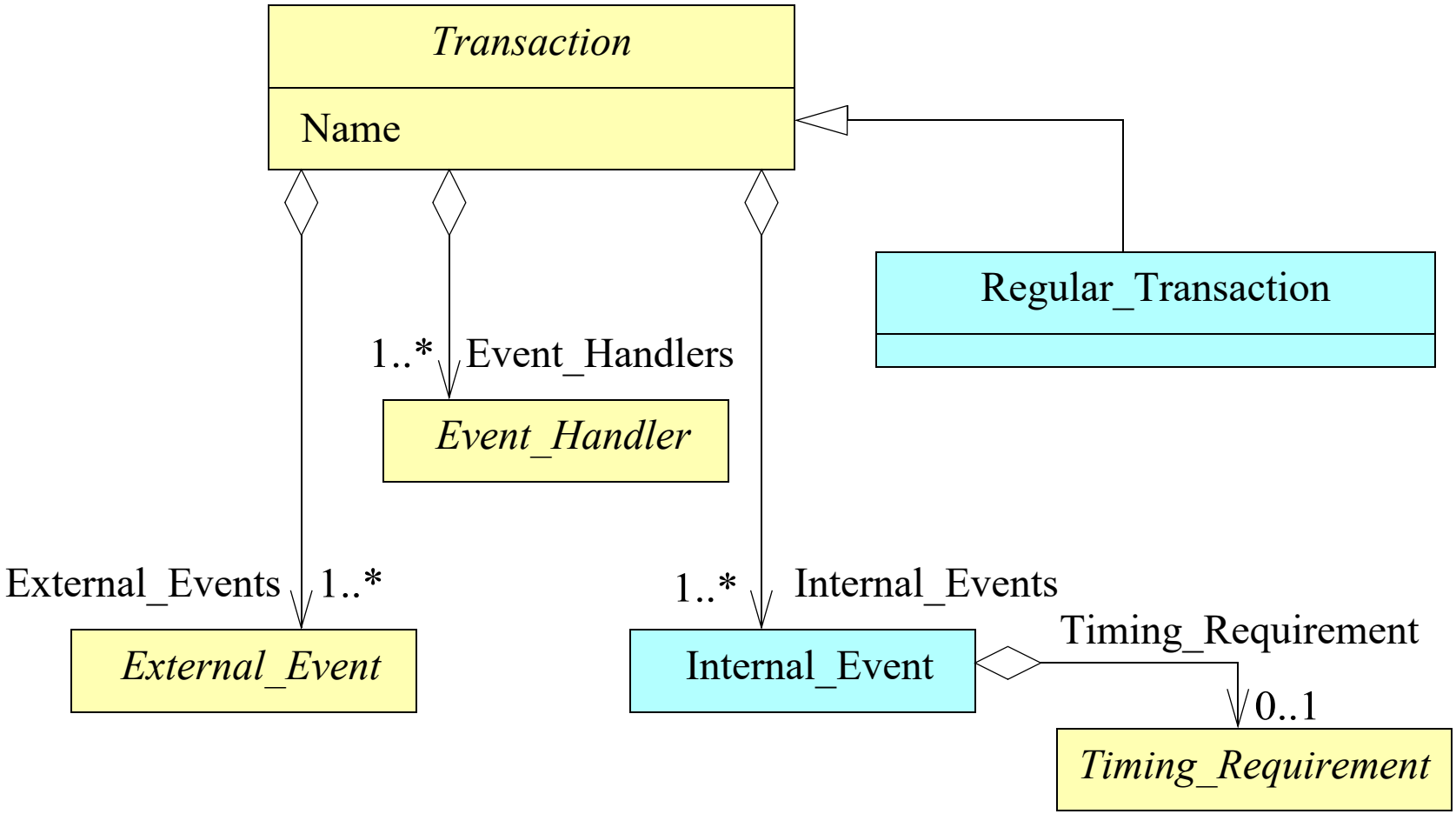
Activities


Event_Handler
Input_Event
Event
1
Activity
Output_Event
Internal_Event
1
System_Timed_Activity
Activity_Server
1
1
Activity_Operation
Scheduling_Server
Operation

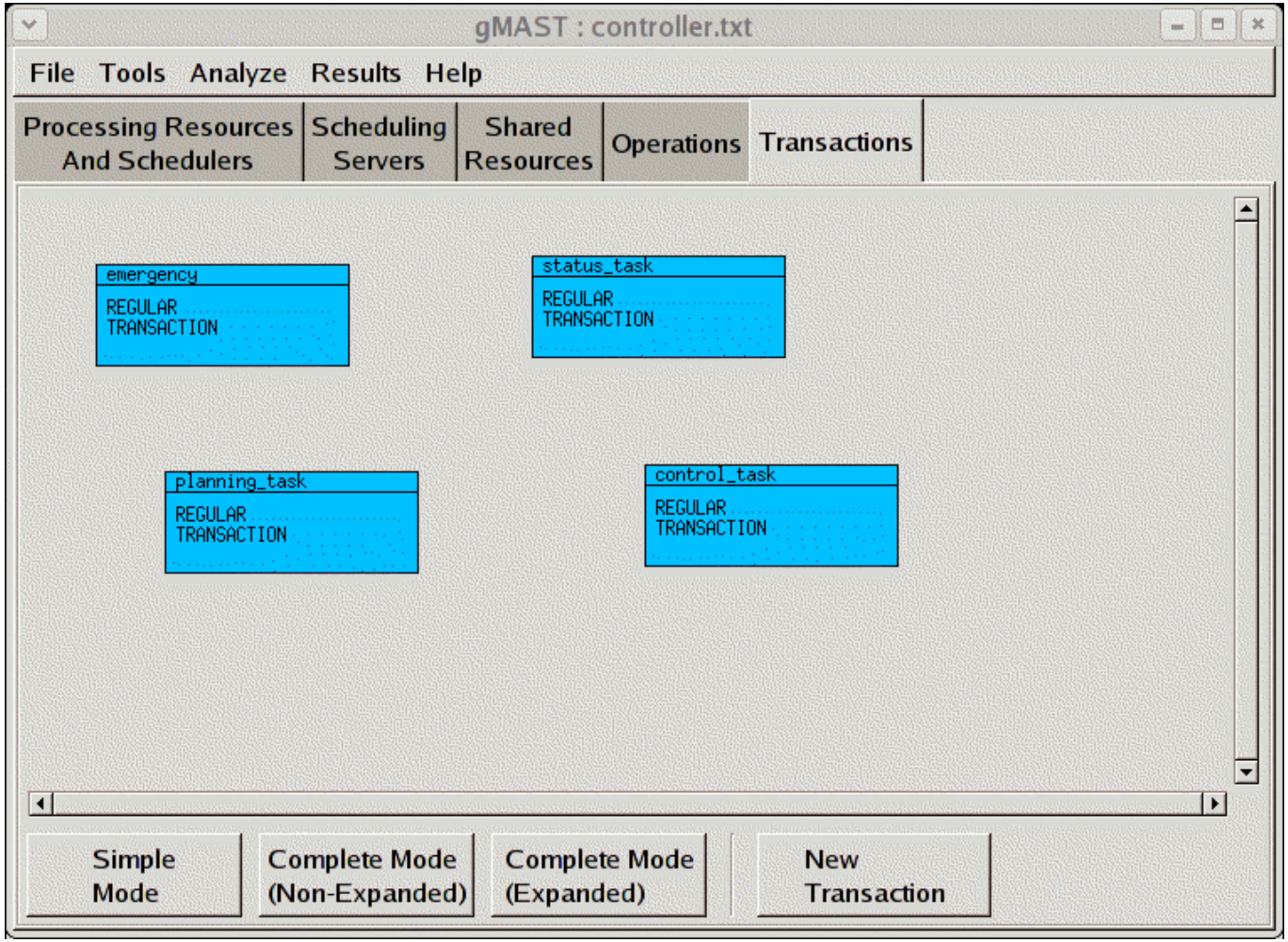
Delays and Rate Divisors



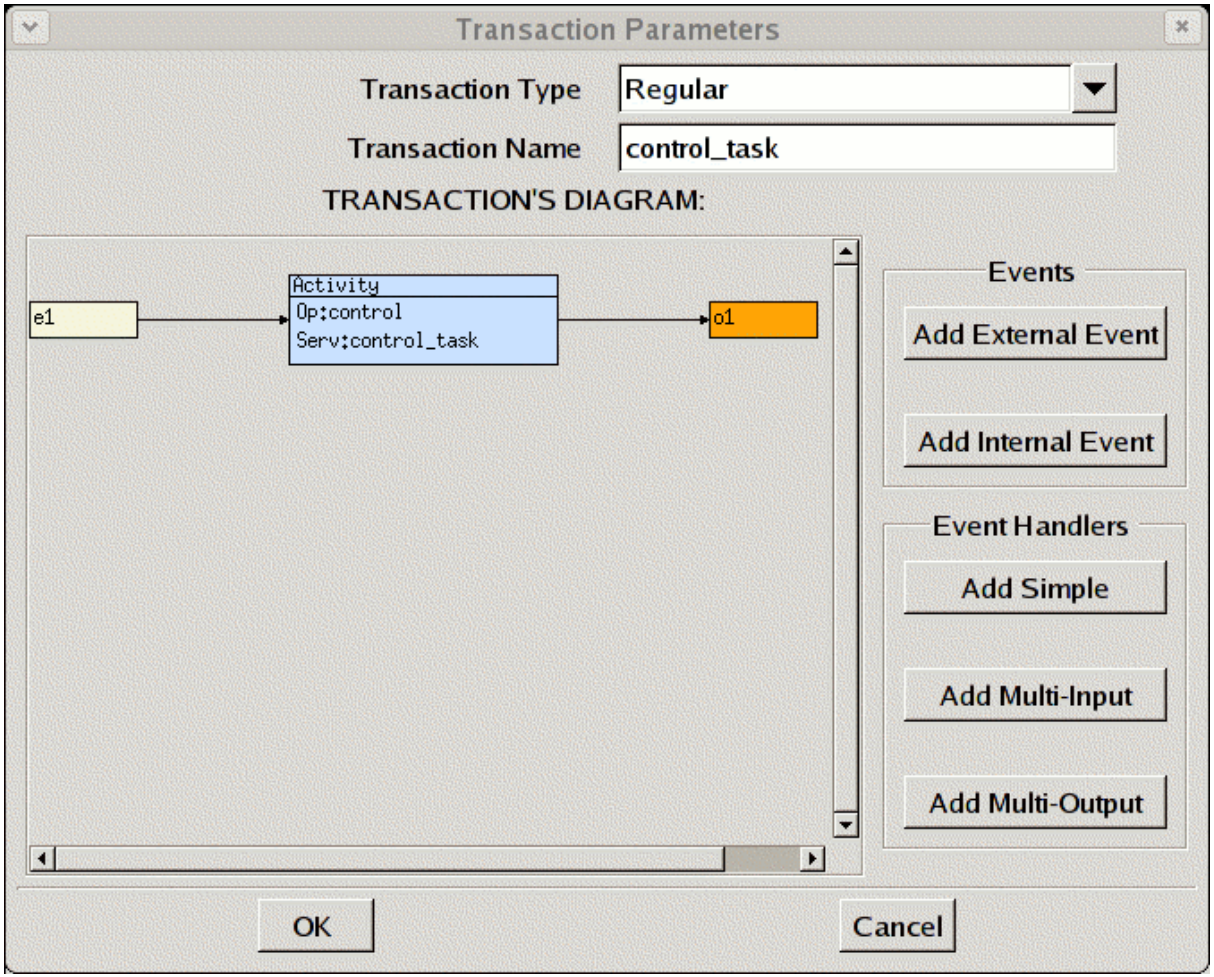
Transactions



Transactions



Transaction graphs



3.5 Analysis Tools: Specification Language

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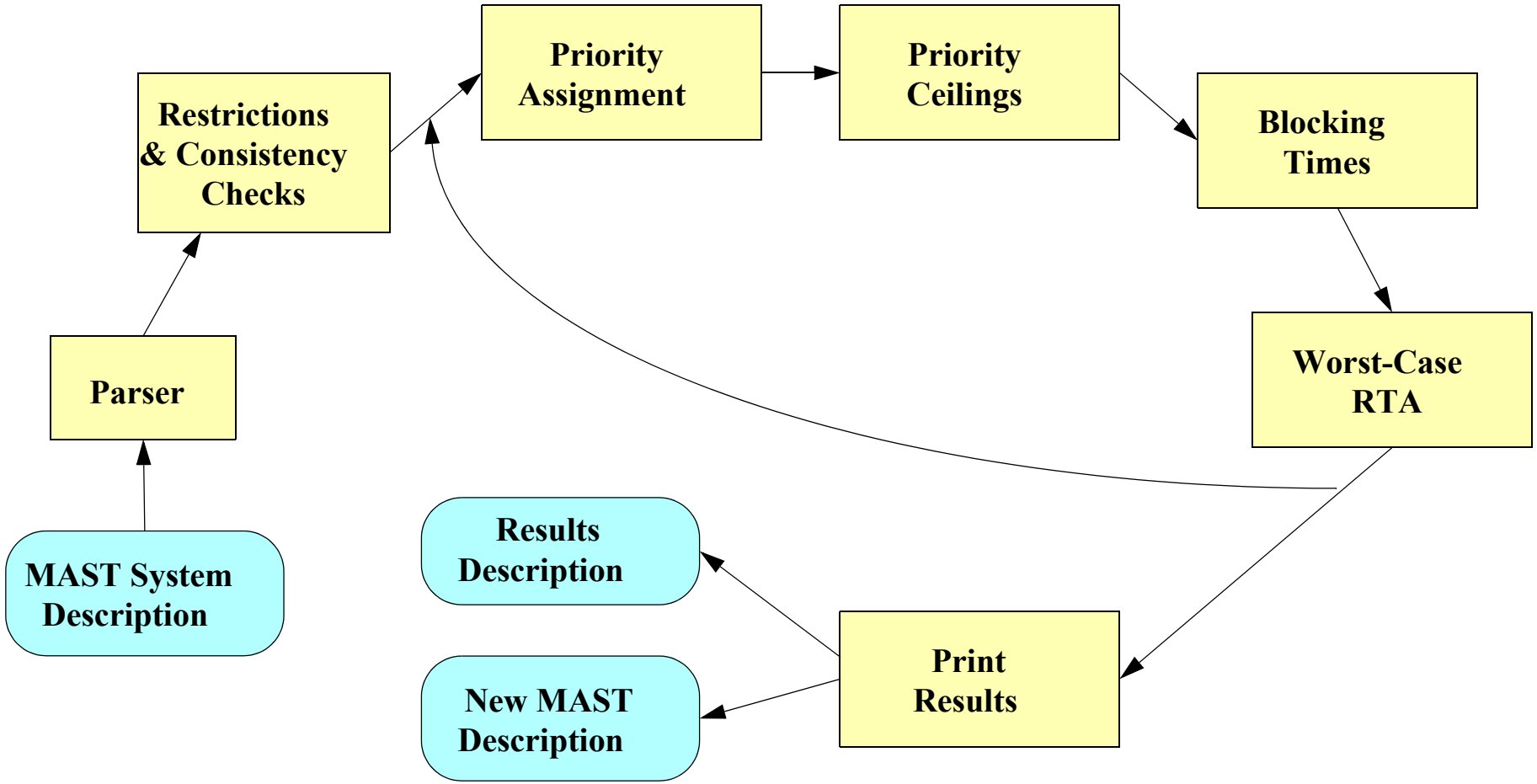
Syntax rules:

- Object format: `Object_Name (Parameters);`
- Objects have a *type* and/or *name* (mandatory)
- Spaces, tabs and line breaks are not considered
- Names like in Ada:
  `letter+(letter | number | underline | period)`
- Names with or without "*quotes*" (mandatory for reserved words)
- Comments like in Ada: `"--"`
- Case insensitive

No need to define an identifier before it is used

An XML version also exists

Schedulability Analysis Tools



Fixed Priority Response-Time Analysis

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Technique	Single-Processor	Multi-Processor	Simple Transact.	Linear Transact.	Multiple Event T.
Classic Rate Mono-tonic	☑		☑		
Varying Priorities	☑		☑	☑	
Holistic	☑	☑	☑	☑	
Offset Based Unopti-mized	☑	☑	☑	☑	
Offset Based	☑	☑	☑	☑	
Multiple Event	☑	☑	☑	☑	☑