

4. Modelling Real-Time Systems

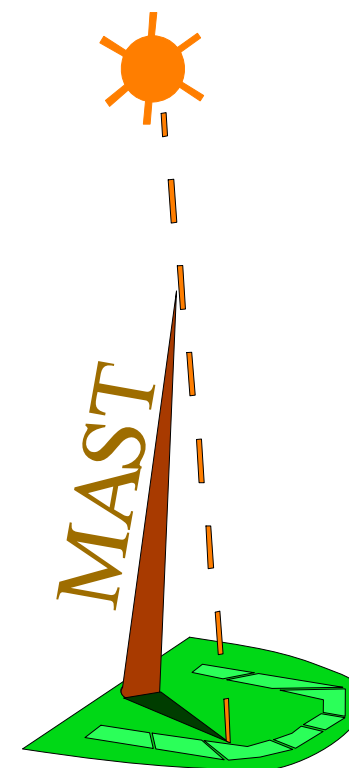
4.1 Overview of the real-time model

4.2 The platform model

4.3 Modelling the software modules

4.4 Modelling the activities

4.5 Analysis tools



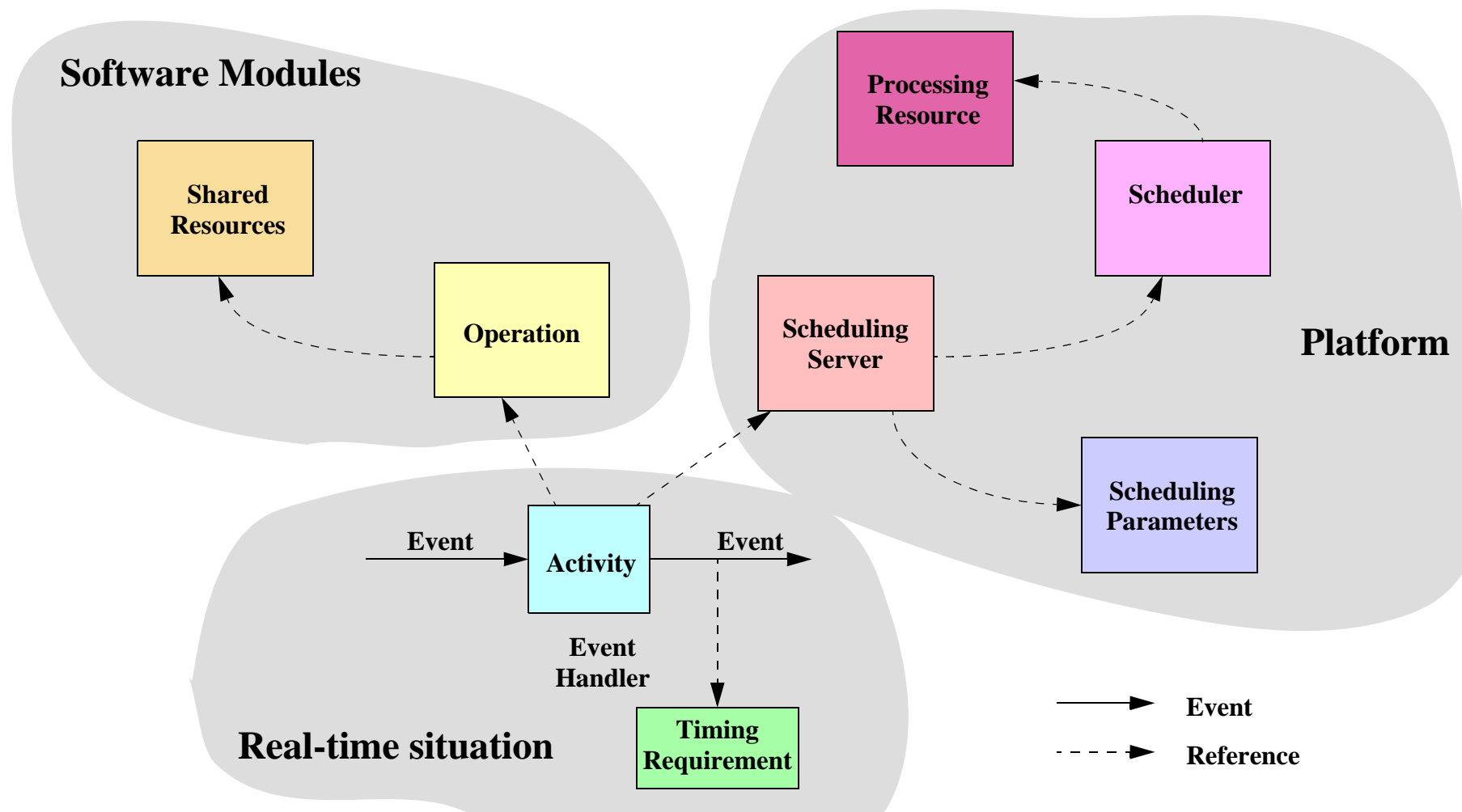
4.1 Overview of the Real-Time Model

The real-time system model contains three independent parts:

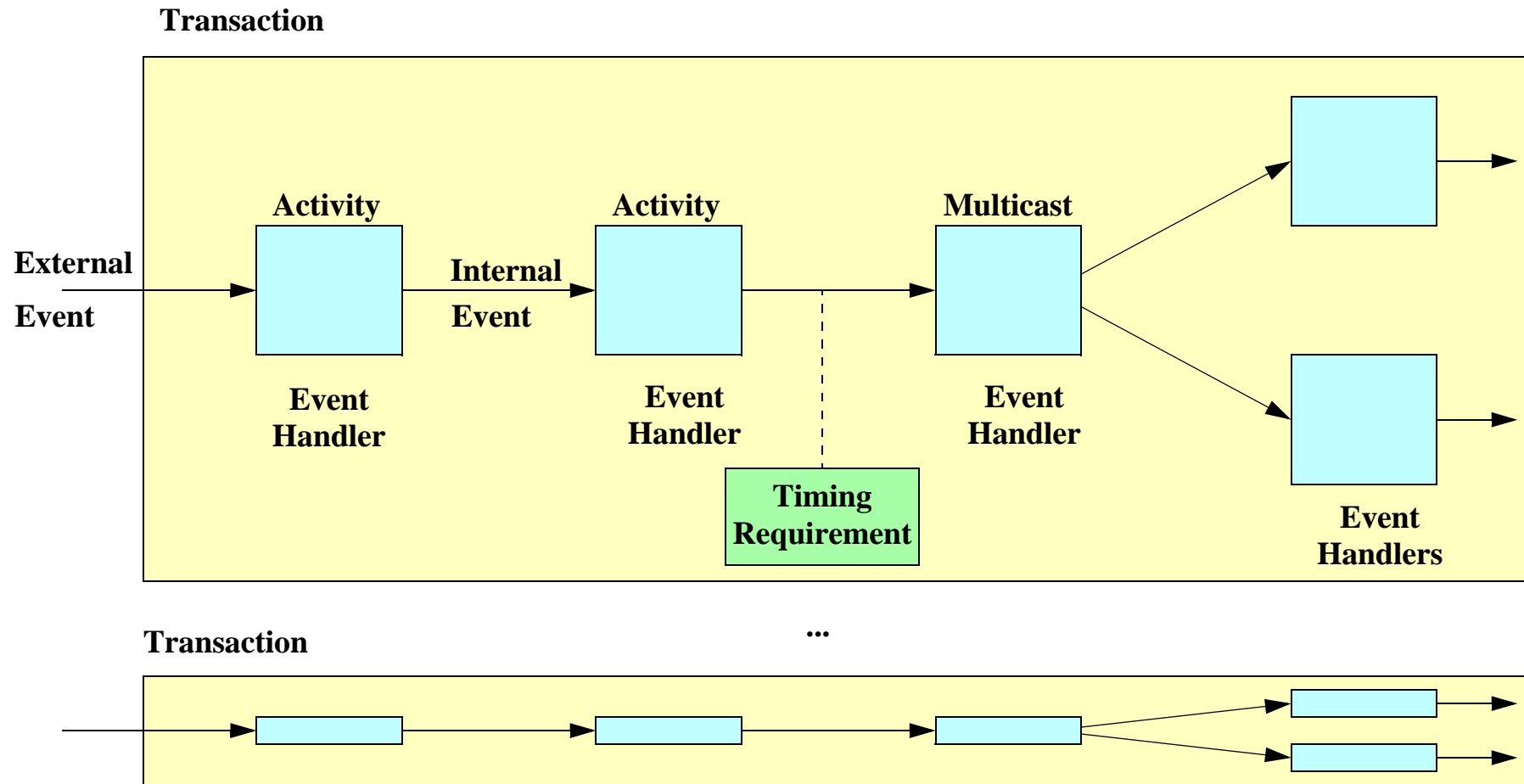
- Platform
- Software modules
- Real-time situation
 - representing a particular mode of operation of the system
 - composed of a set of *transactions*

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

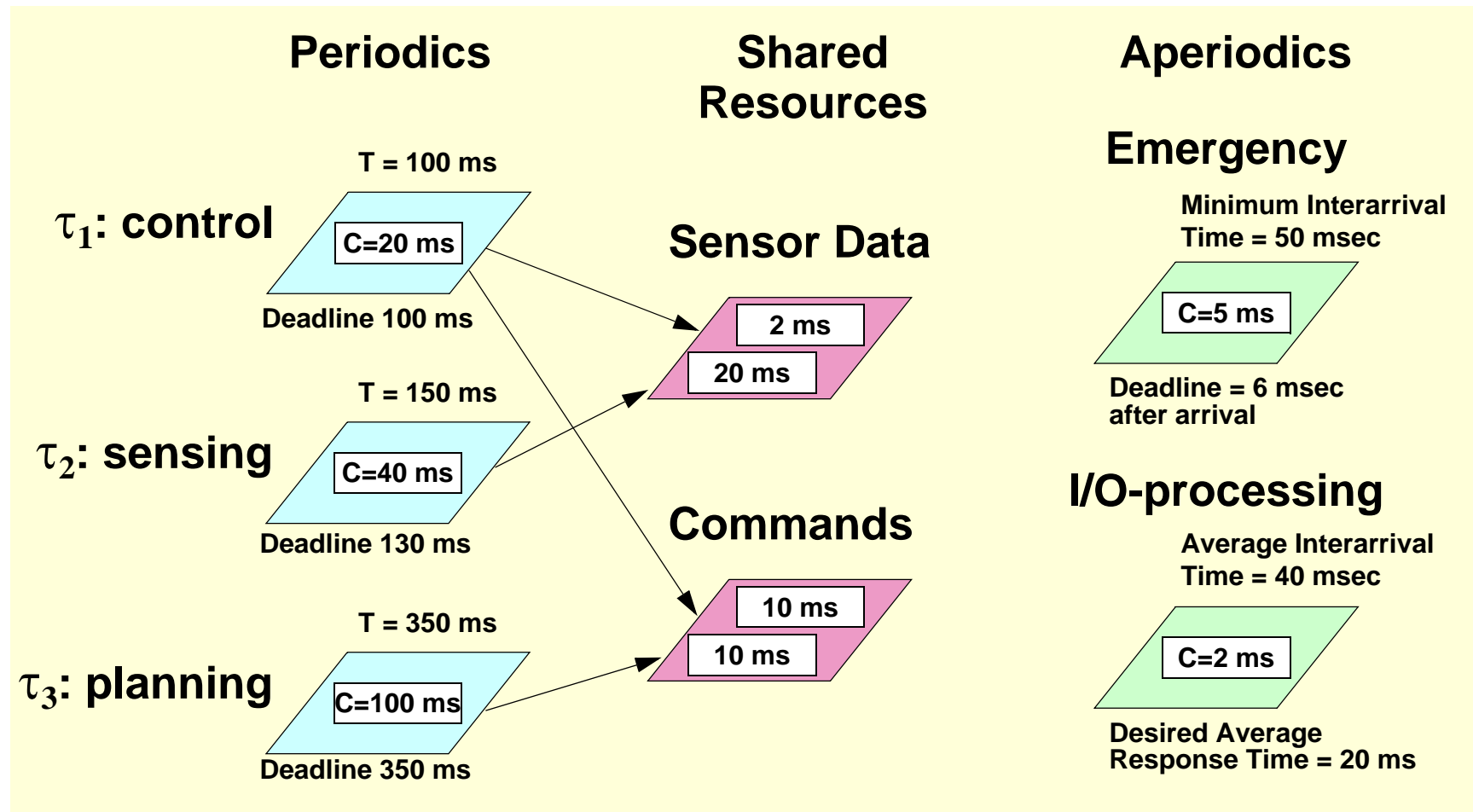
Real-Time Model: Overview



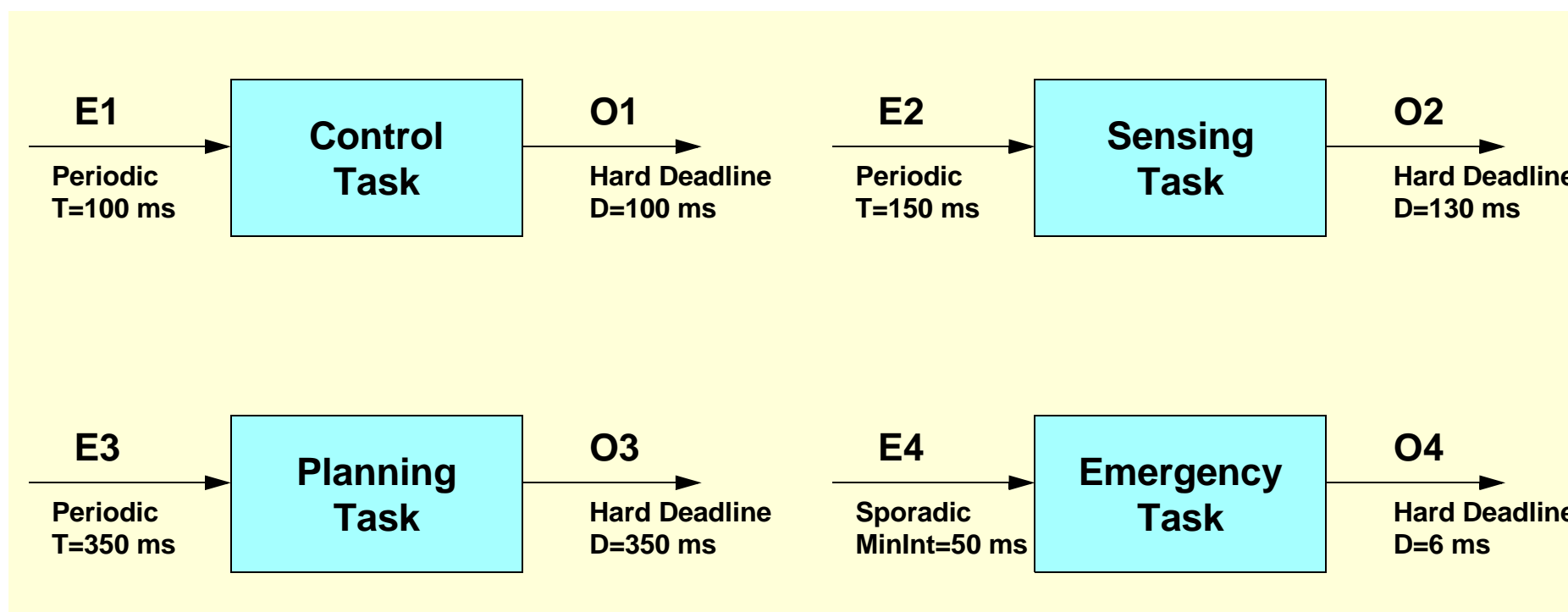
Real-Time Situation



An example



Transactions in this example



Elements of the MAST Model

Platform

1. Processing Resources
2. System Timers
3. Network Drivers
4. Schedulers (primary, secondary)
5. Scheduling policies (fixed priorities, EDF, ...)
6. Scheduling Parameters (priorities, deadlines)
7. Synchronization parameters (preemption levels, ...)
8. Scheduling servers (tasks, processes, threads,...)

Elements of the MAST Model (cont'd)



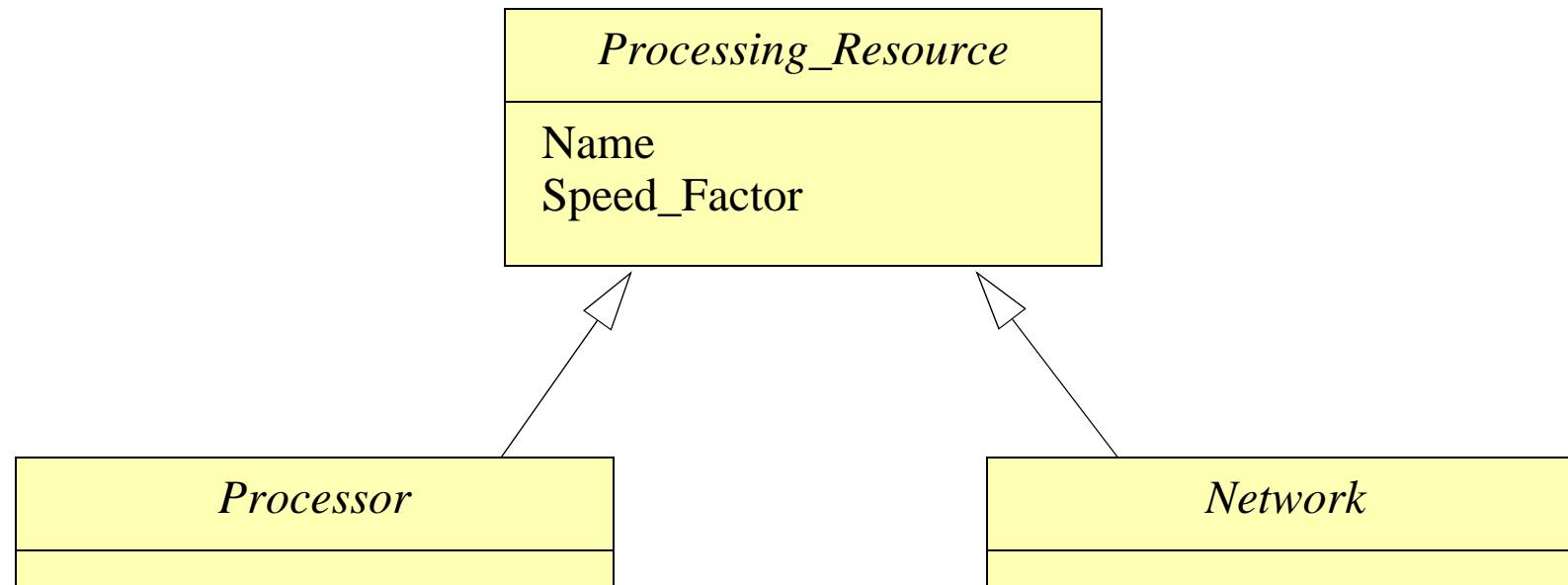
Software modules

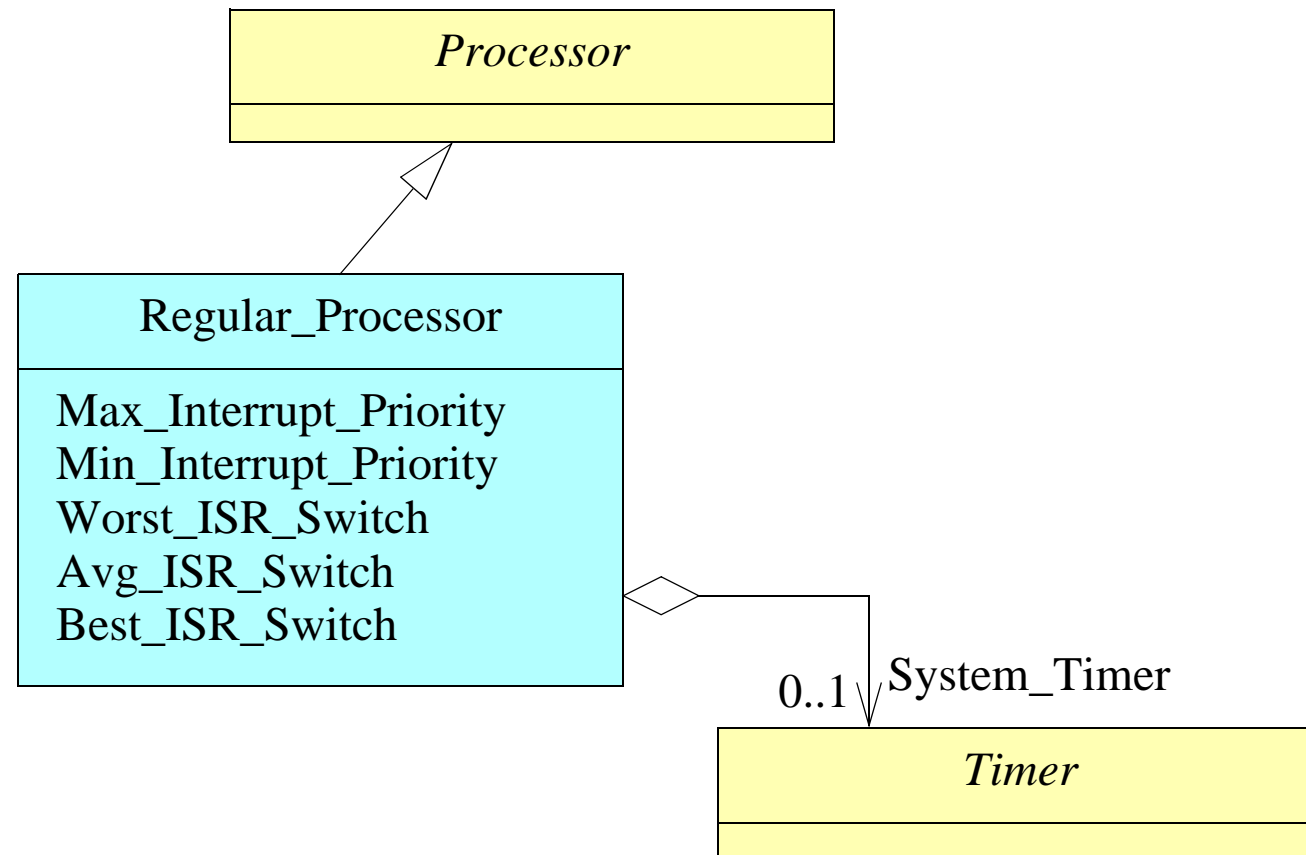
- 9. Shared resources (mutually exclusive)**
- 10. Operations (procedures, functions, messages)**

Real-time situation

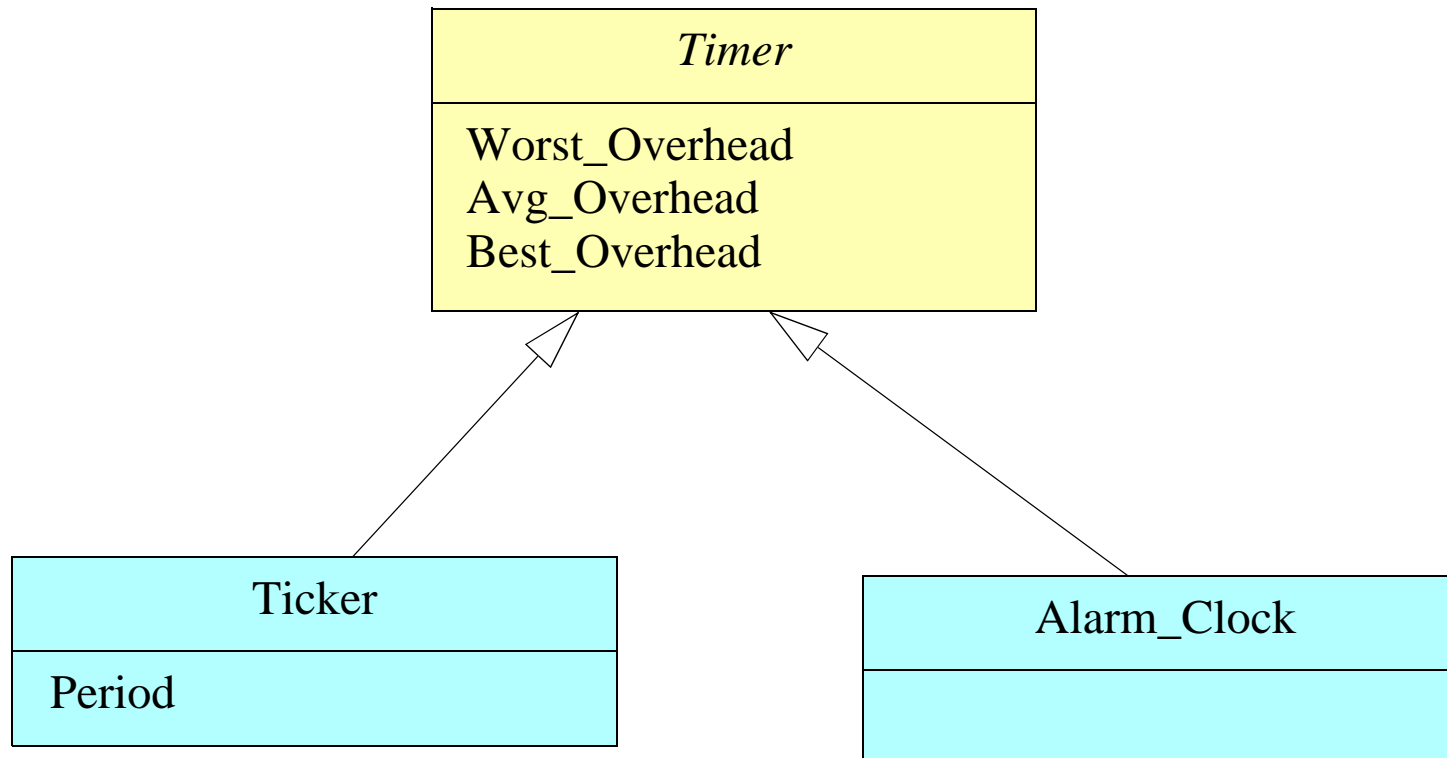
- 11. Events**
- 12. Timing Requirements**
- 13. Event Handlers**
- 14. Transactions**
- 15. Overall system model**

4.2 The Platform Model: Processing Resources

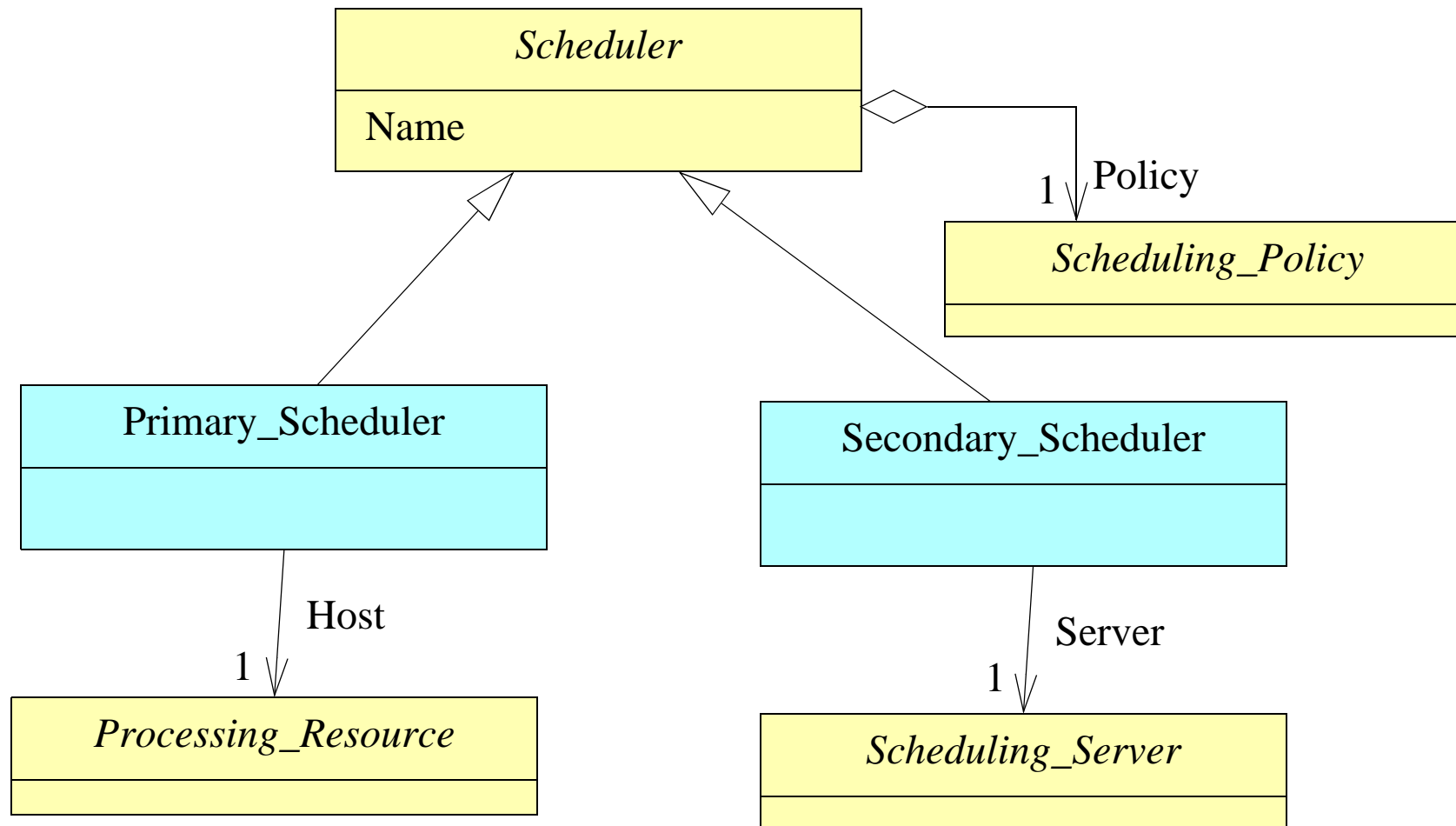




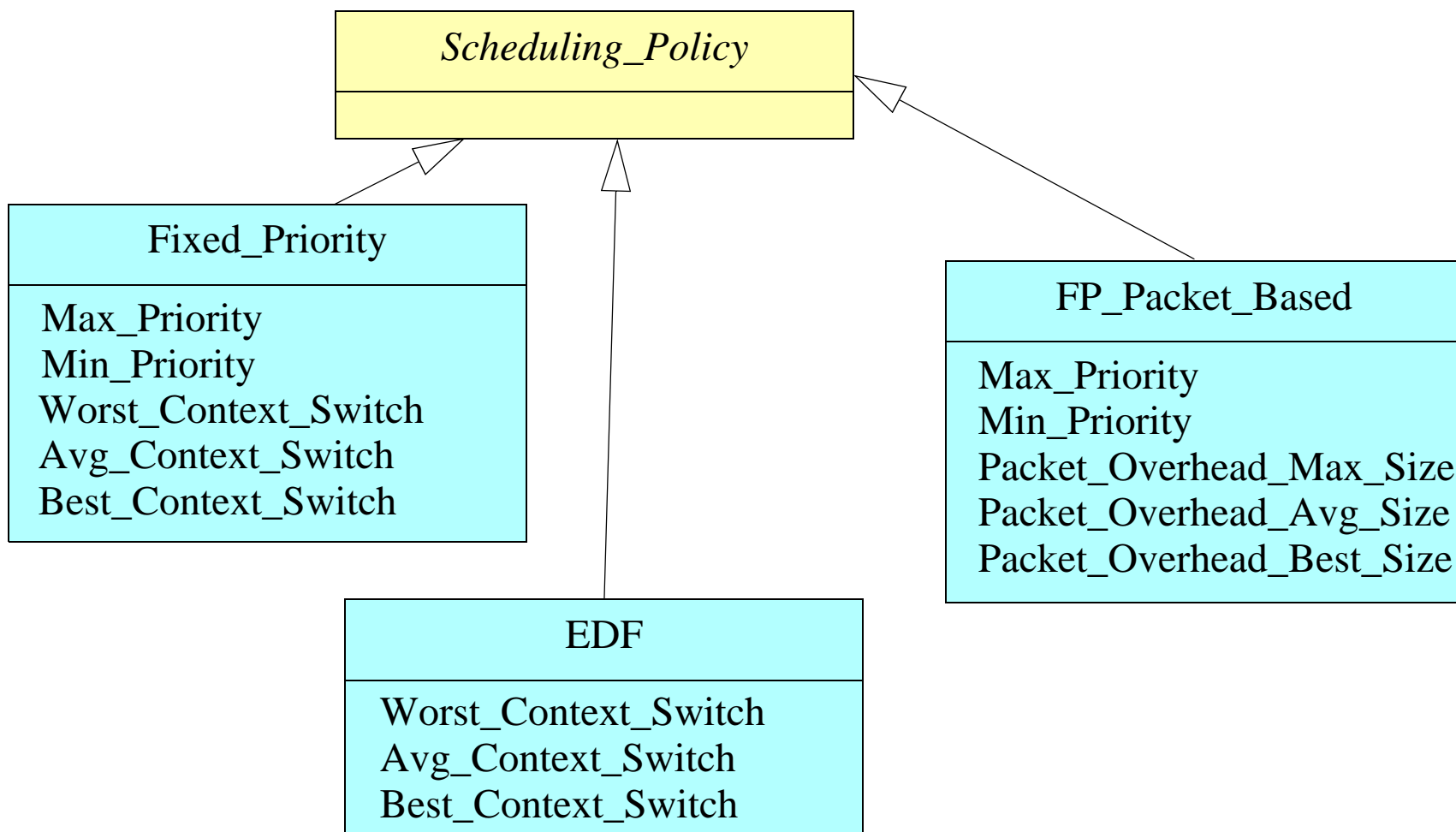
System Timers



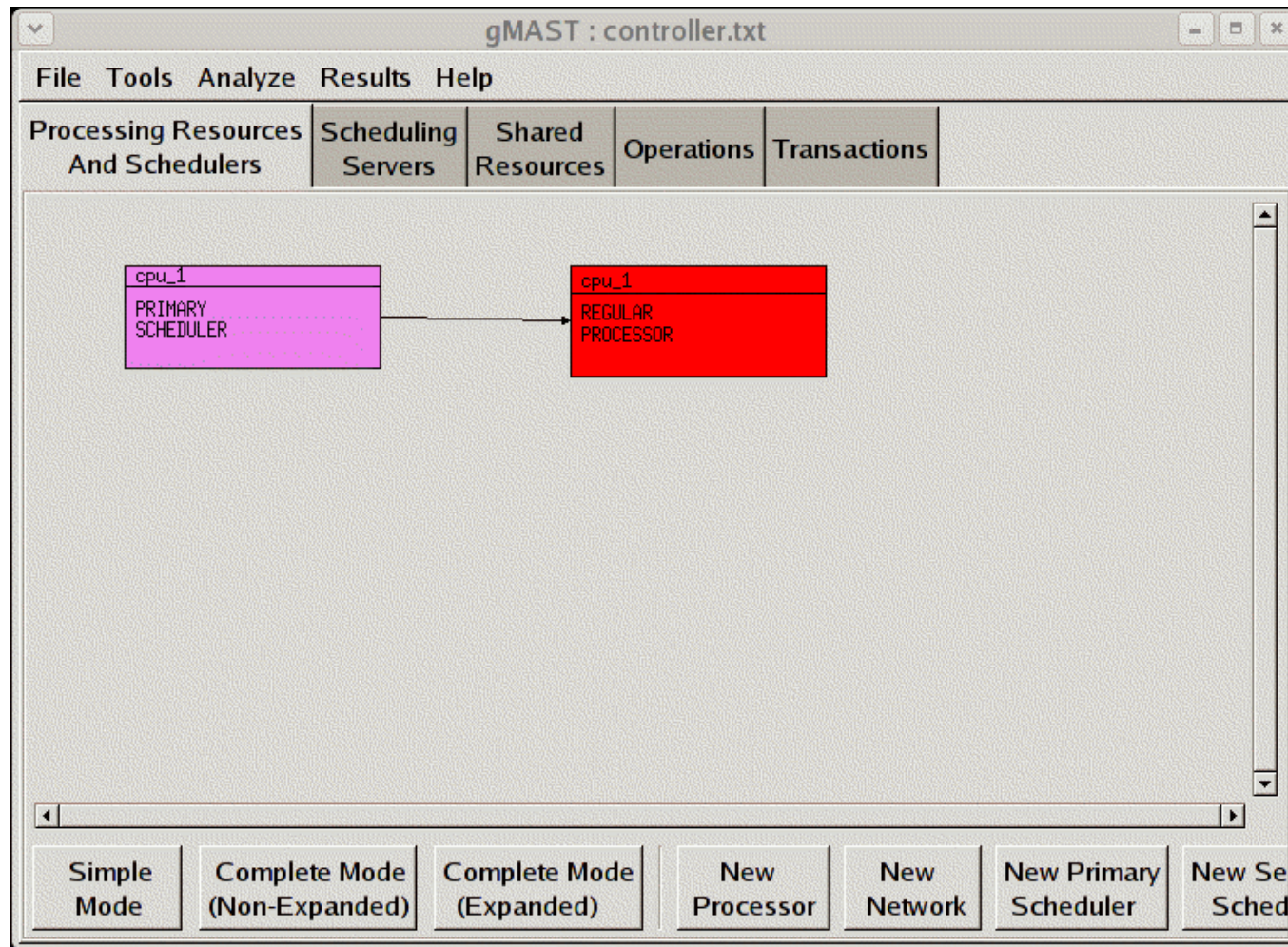
Schedulers



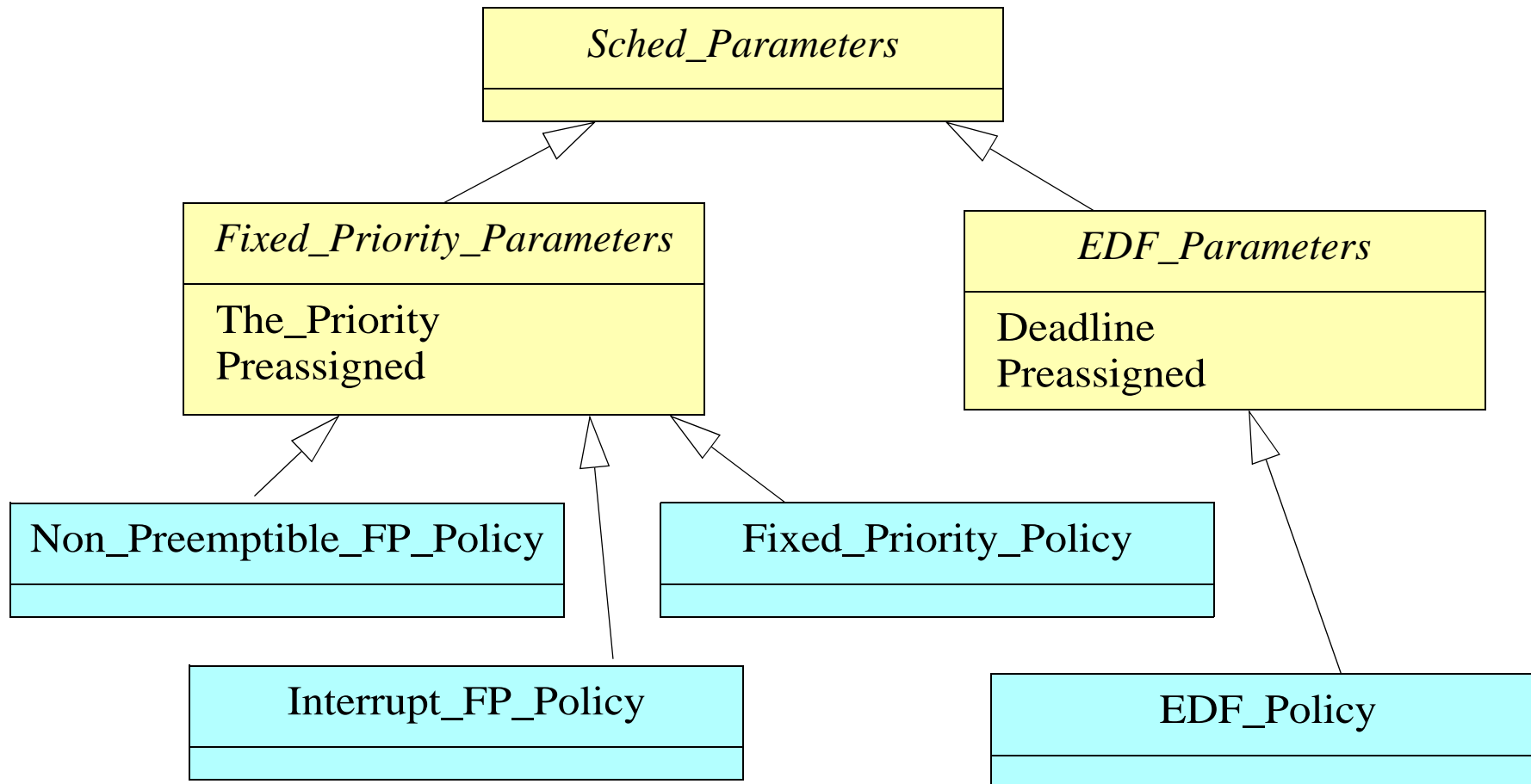
Scheduling Policies



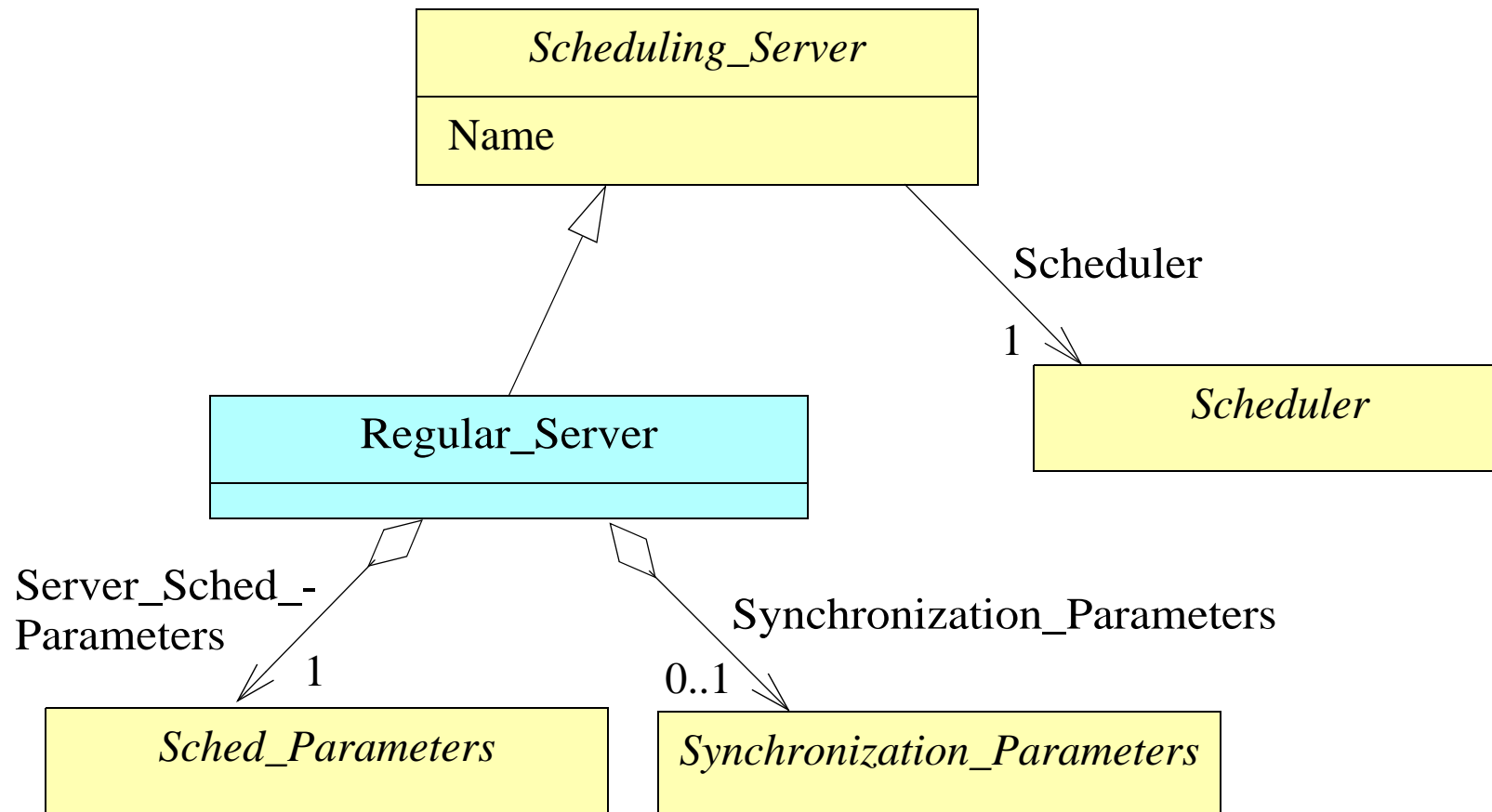
Processing resources, schedulers, drivers, and timers



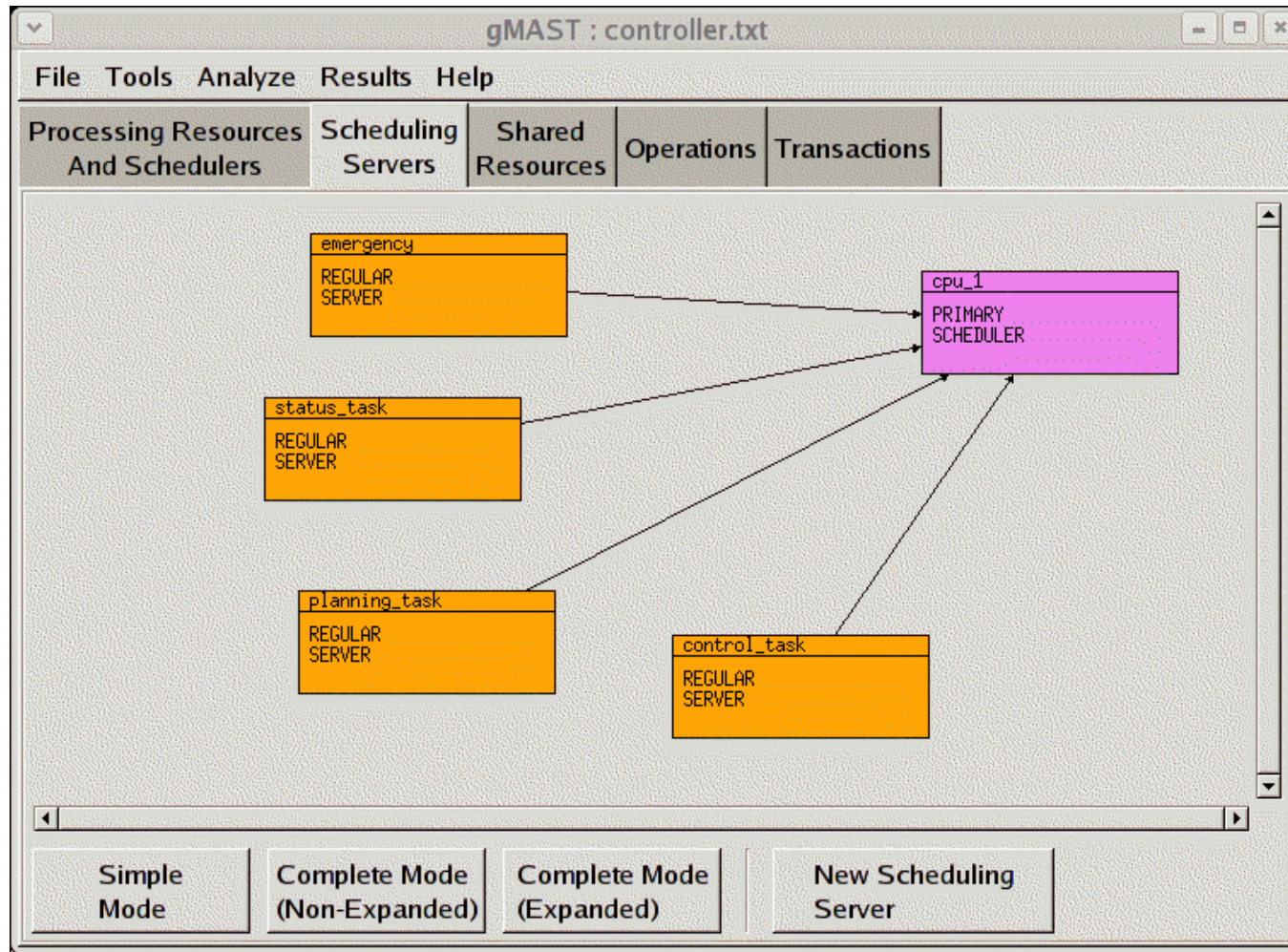
Scheduling Parameters



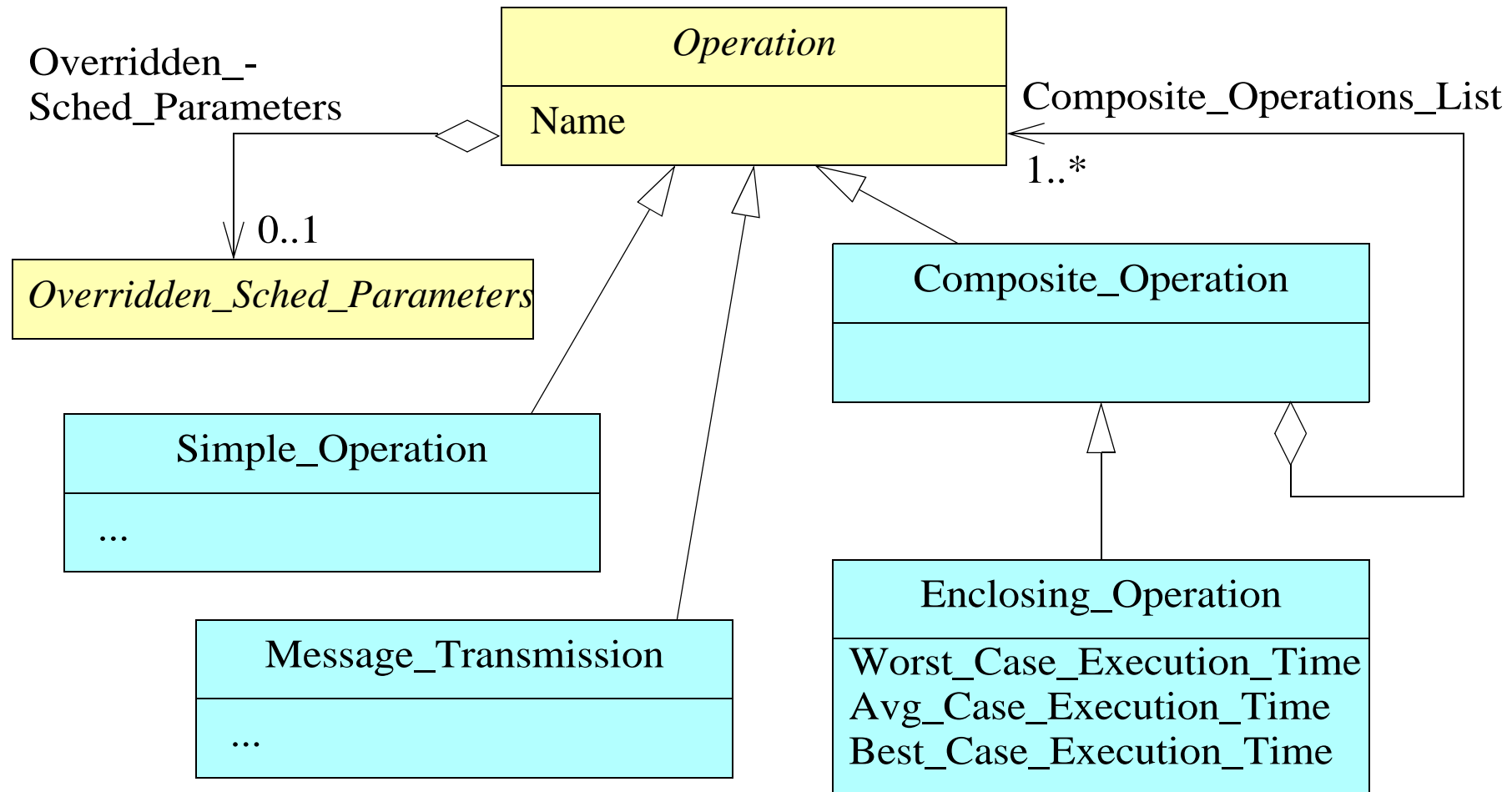
Scheduling Servers (tasks, processes, threads, ...)



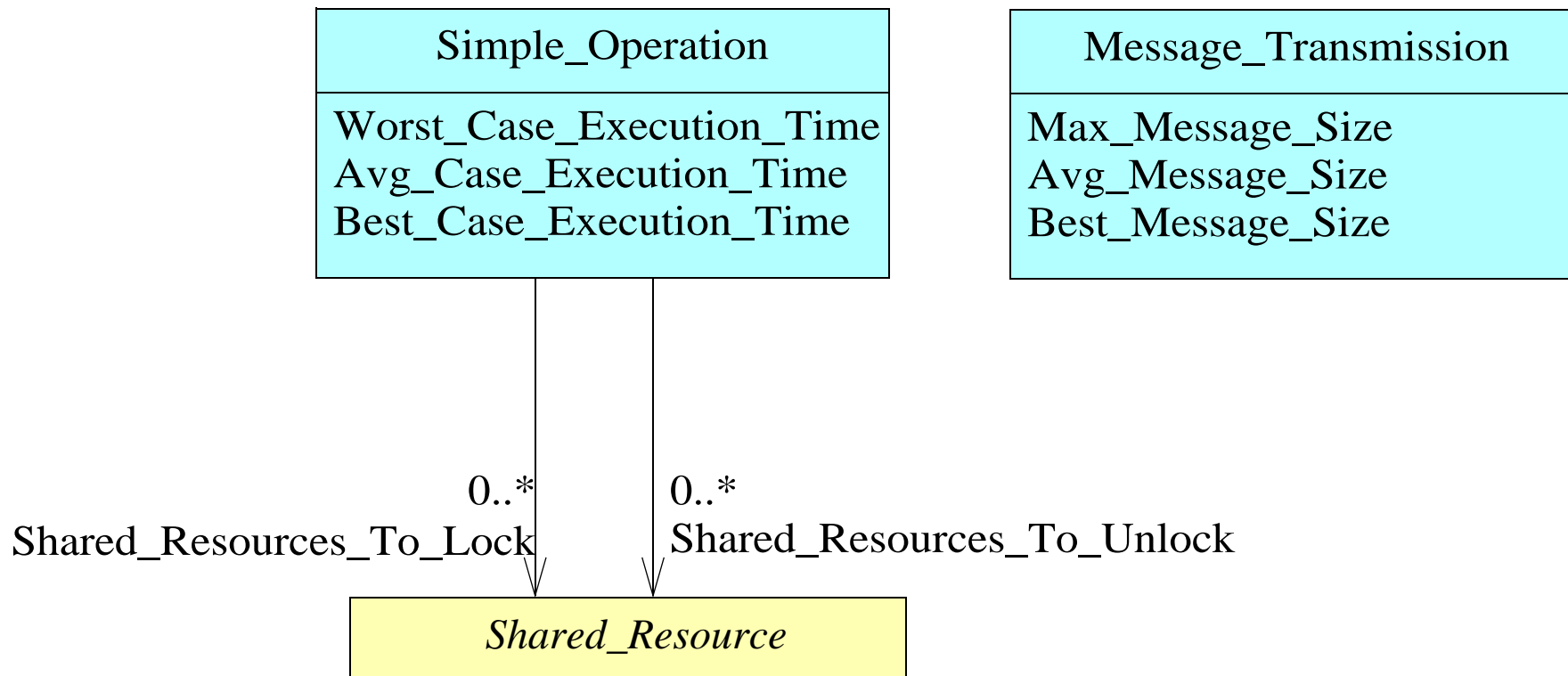
Scheduling servers



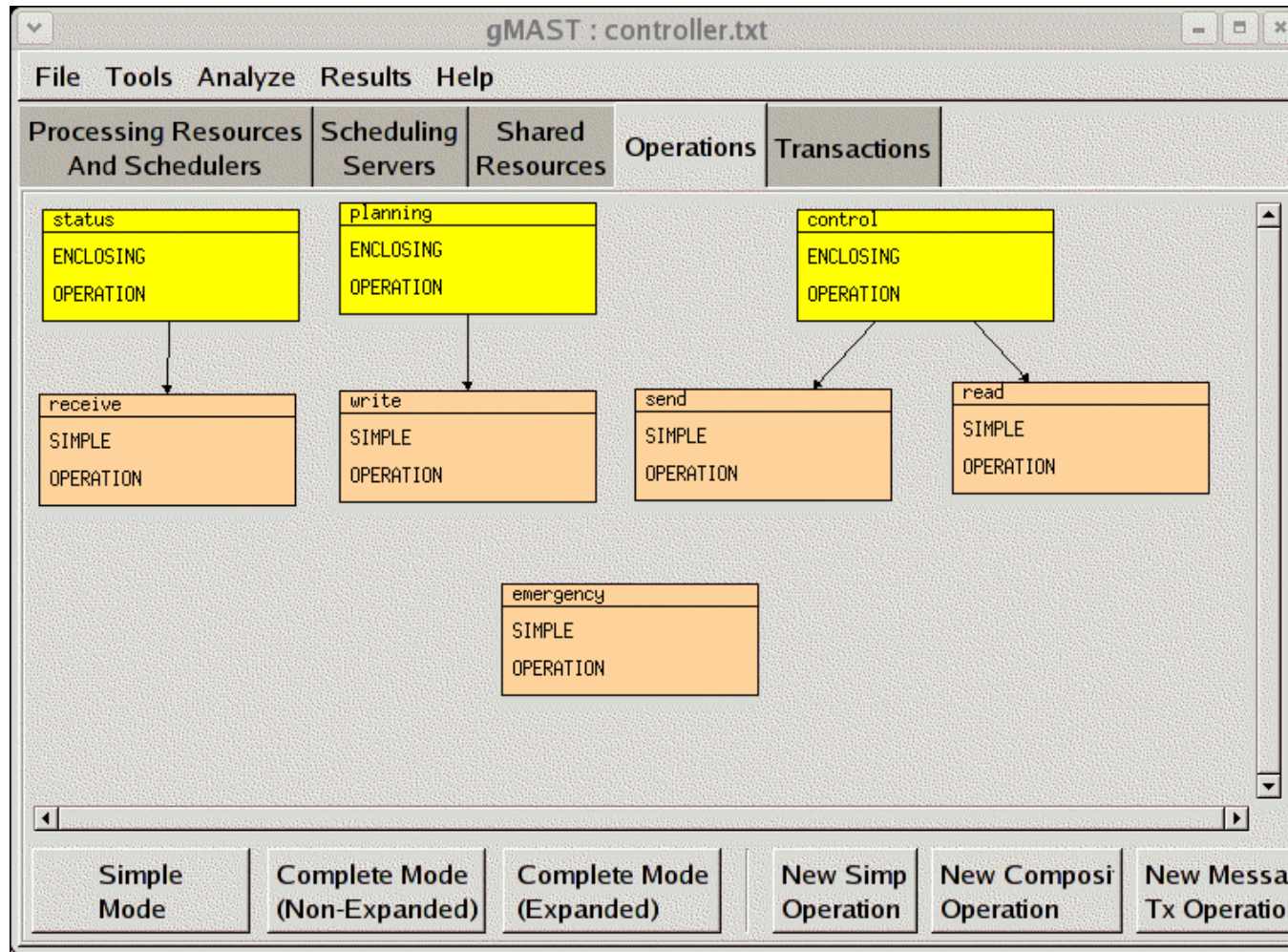
4.3 Modelling the Software Modules: Operations (functions, messages)



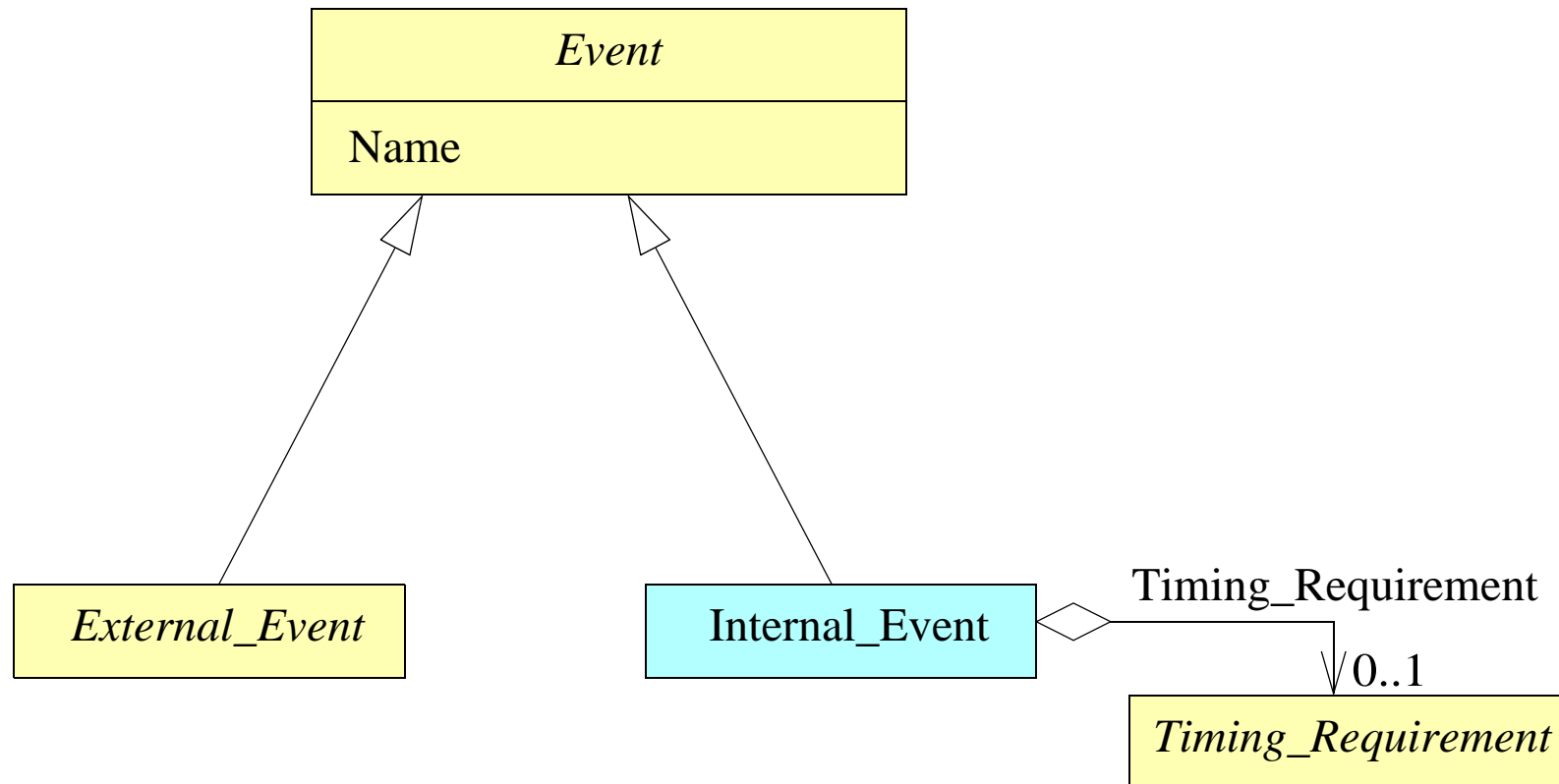
Operations (cont'd)



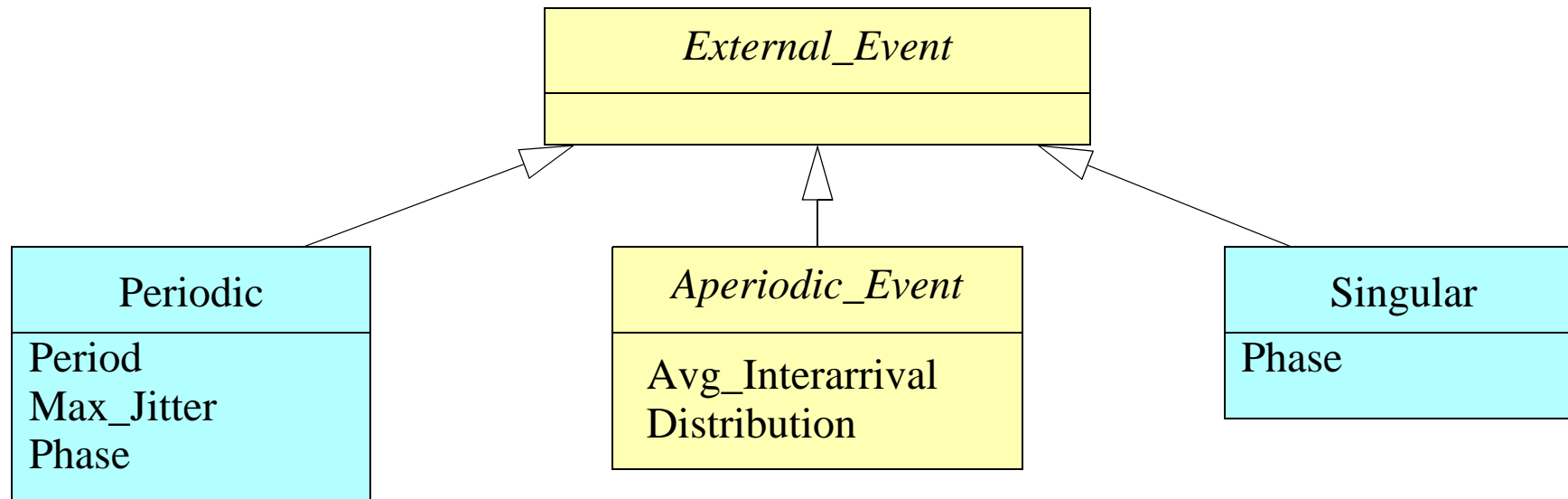
Operations



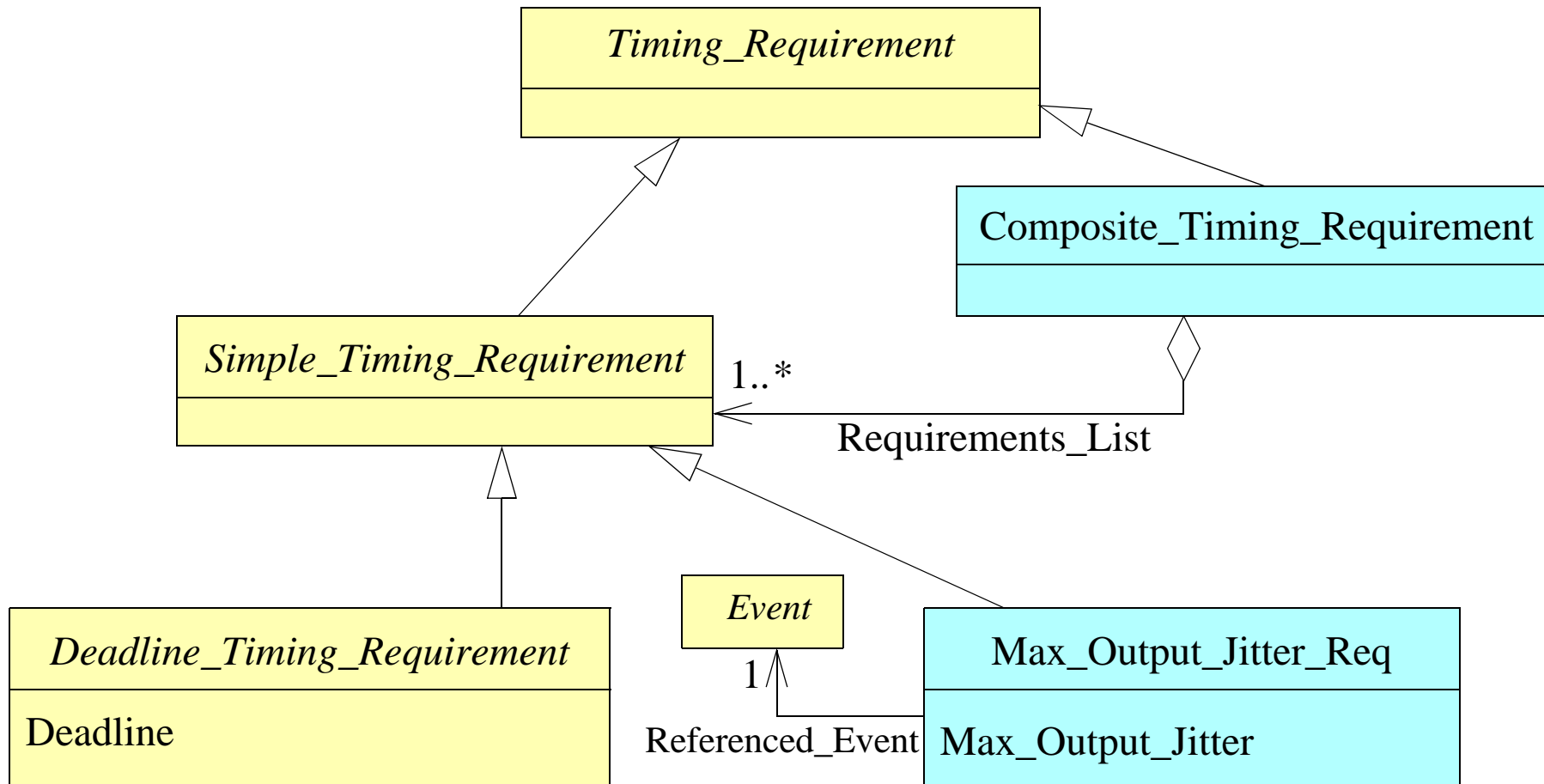
4.4 Modelling the Activities: Events



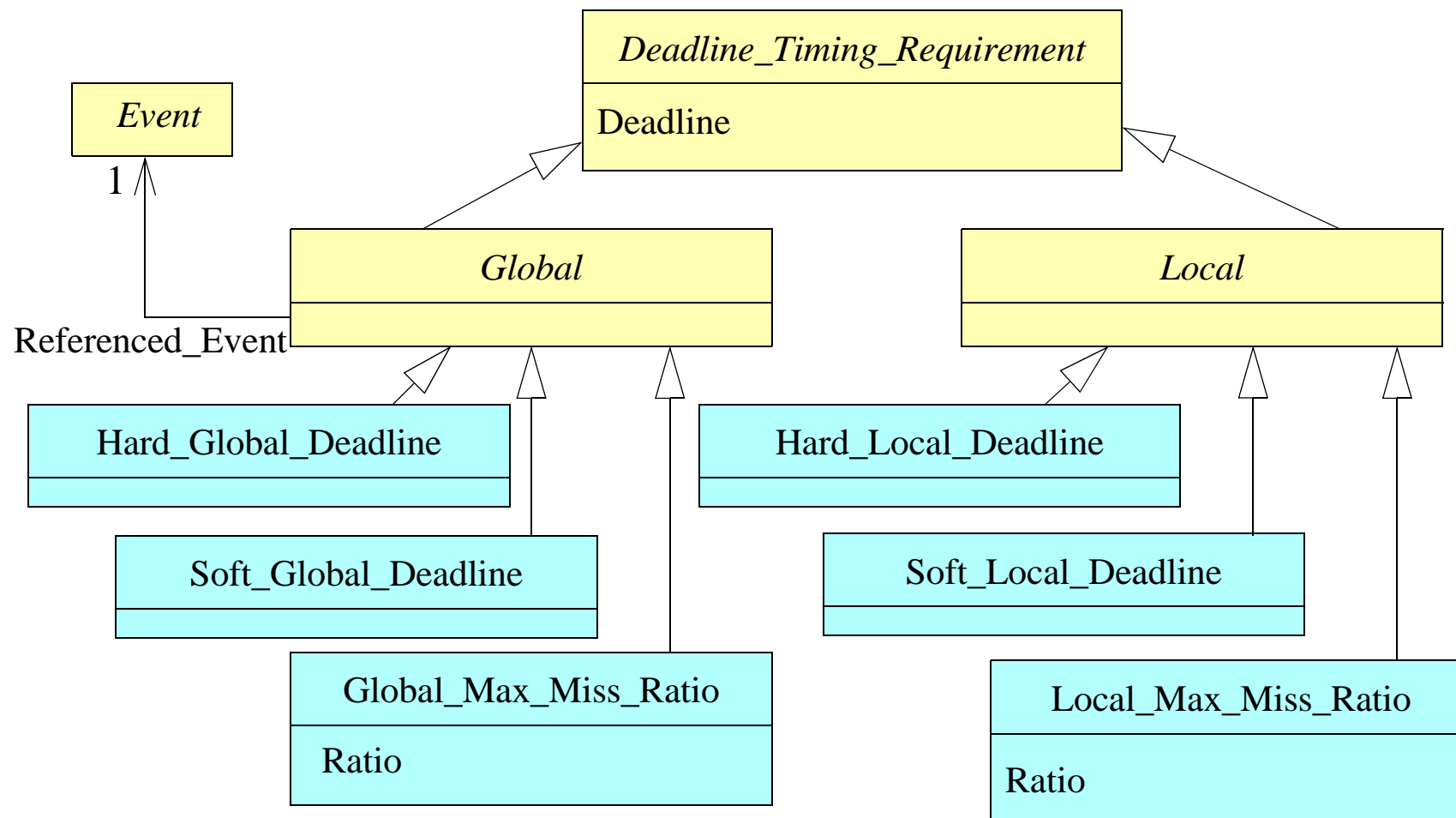
External Events



Timing Requirements



Deadline Timing Requirements

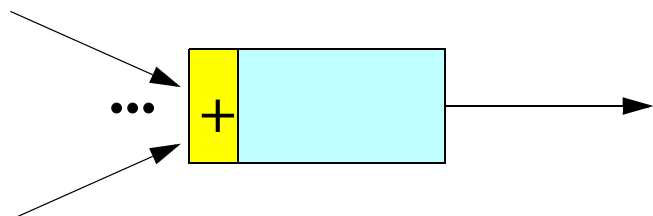


Event Handlers

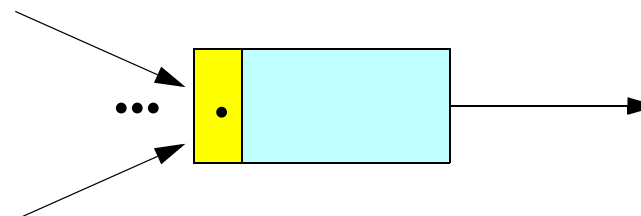
Activity / Rate Divisor / Delay / Offset



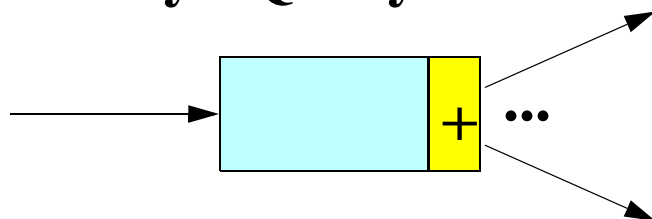
Concentrator



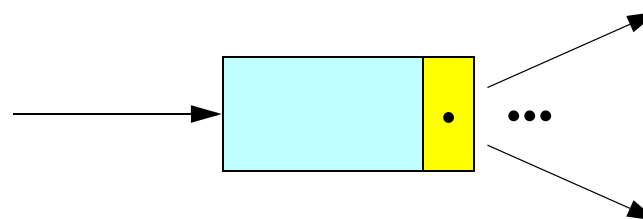
Barrier



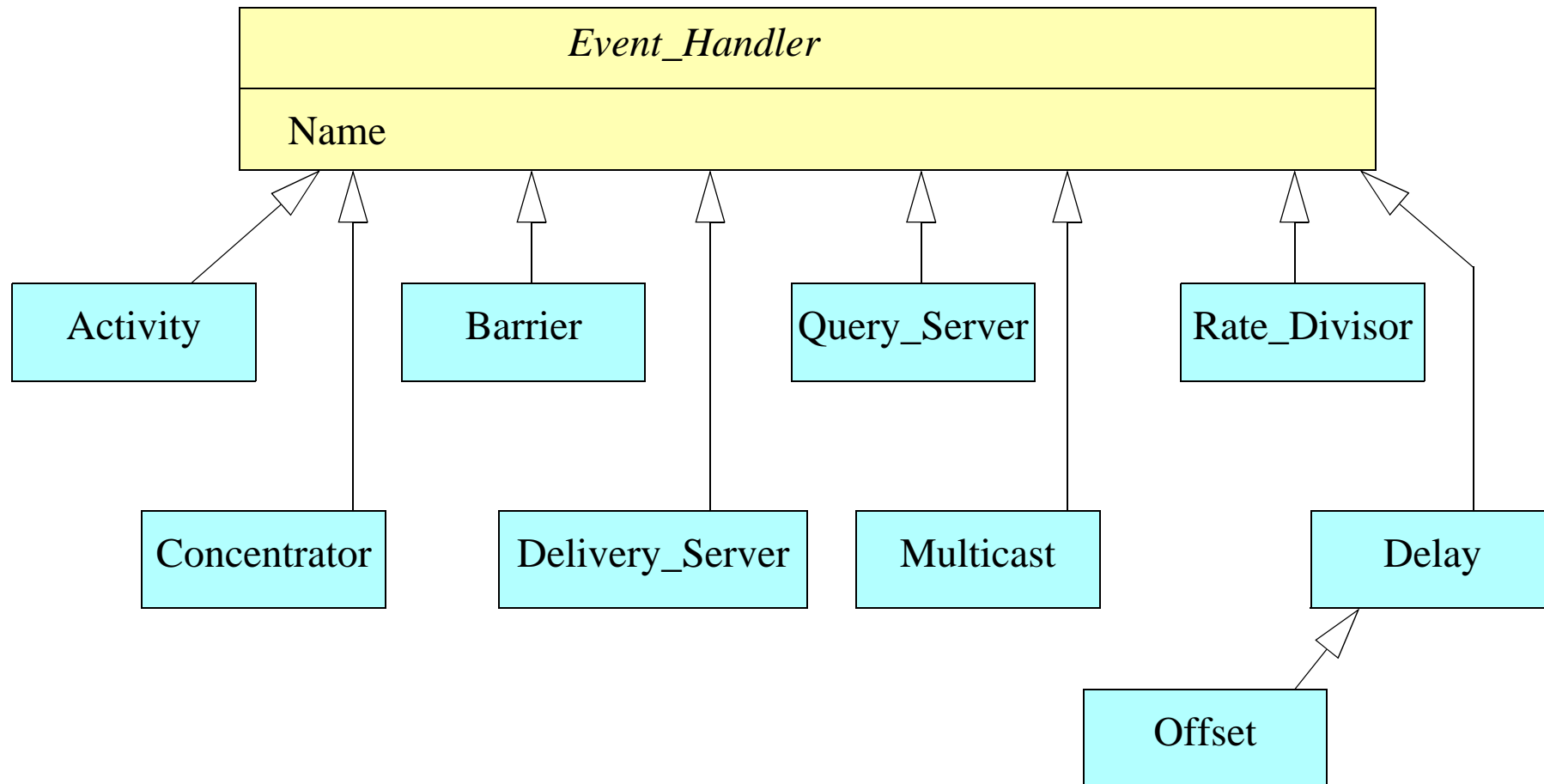
Delivery / Query Server



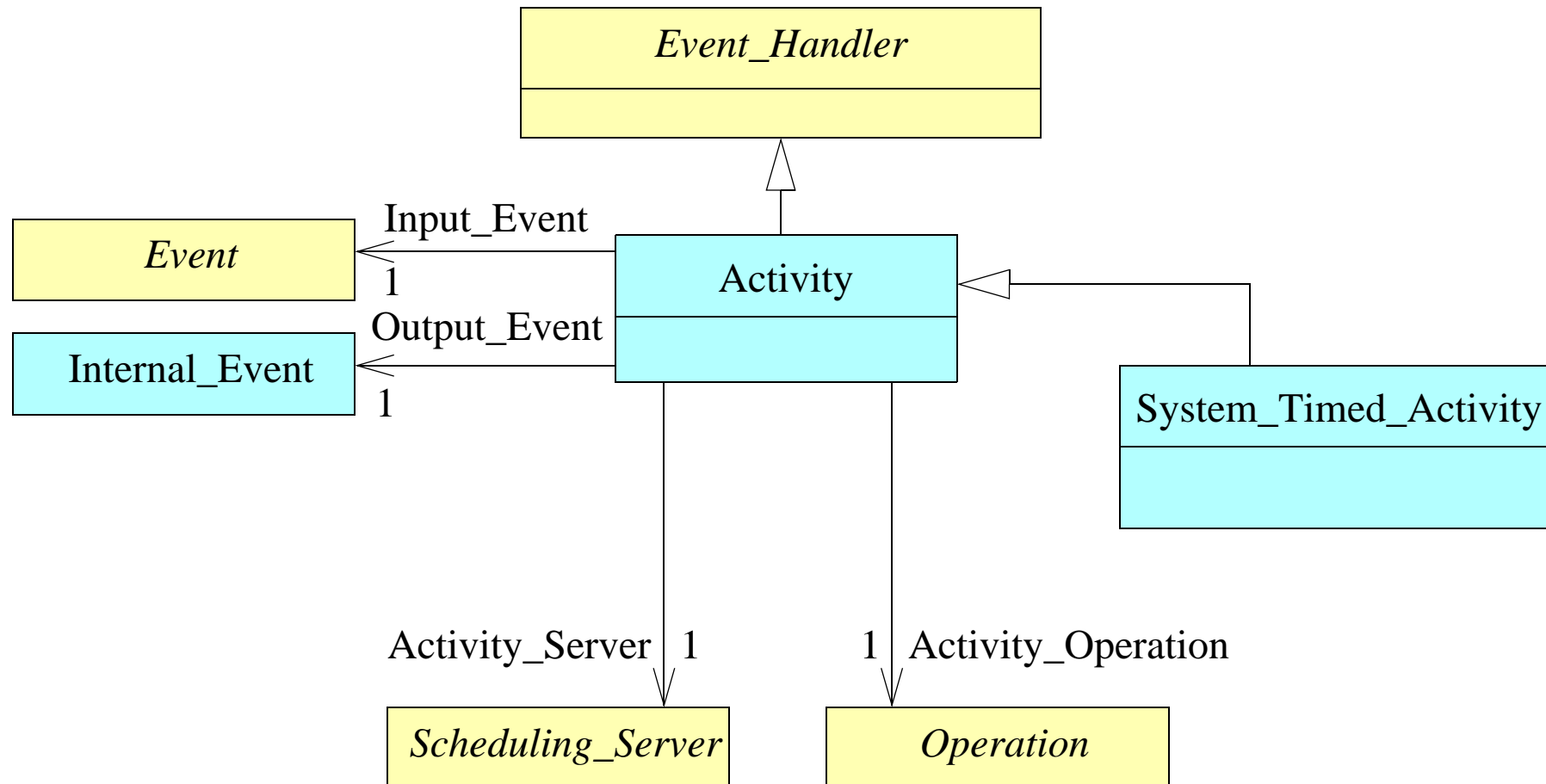
Multicast



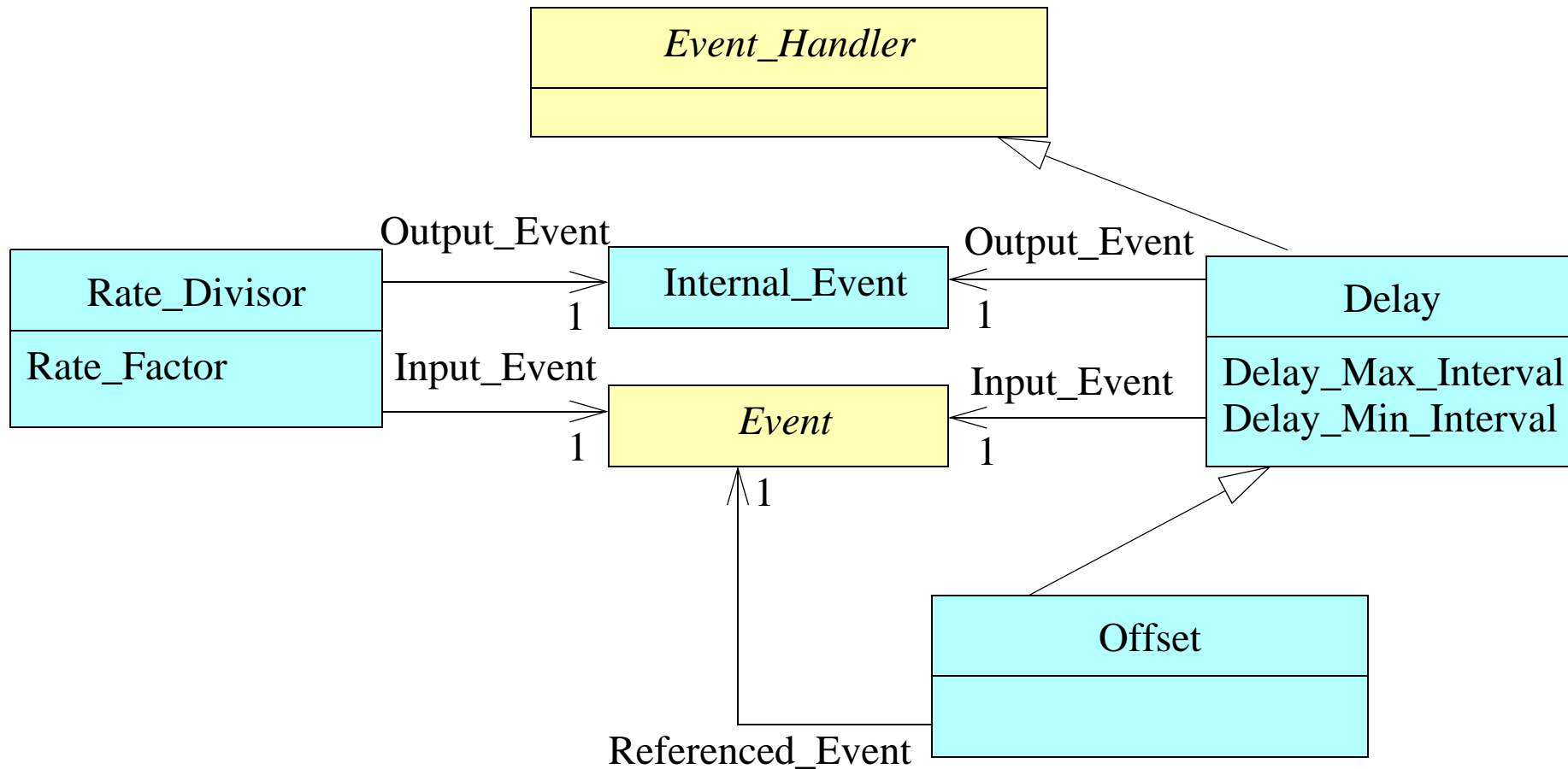
Event Handlers (cont'd)



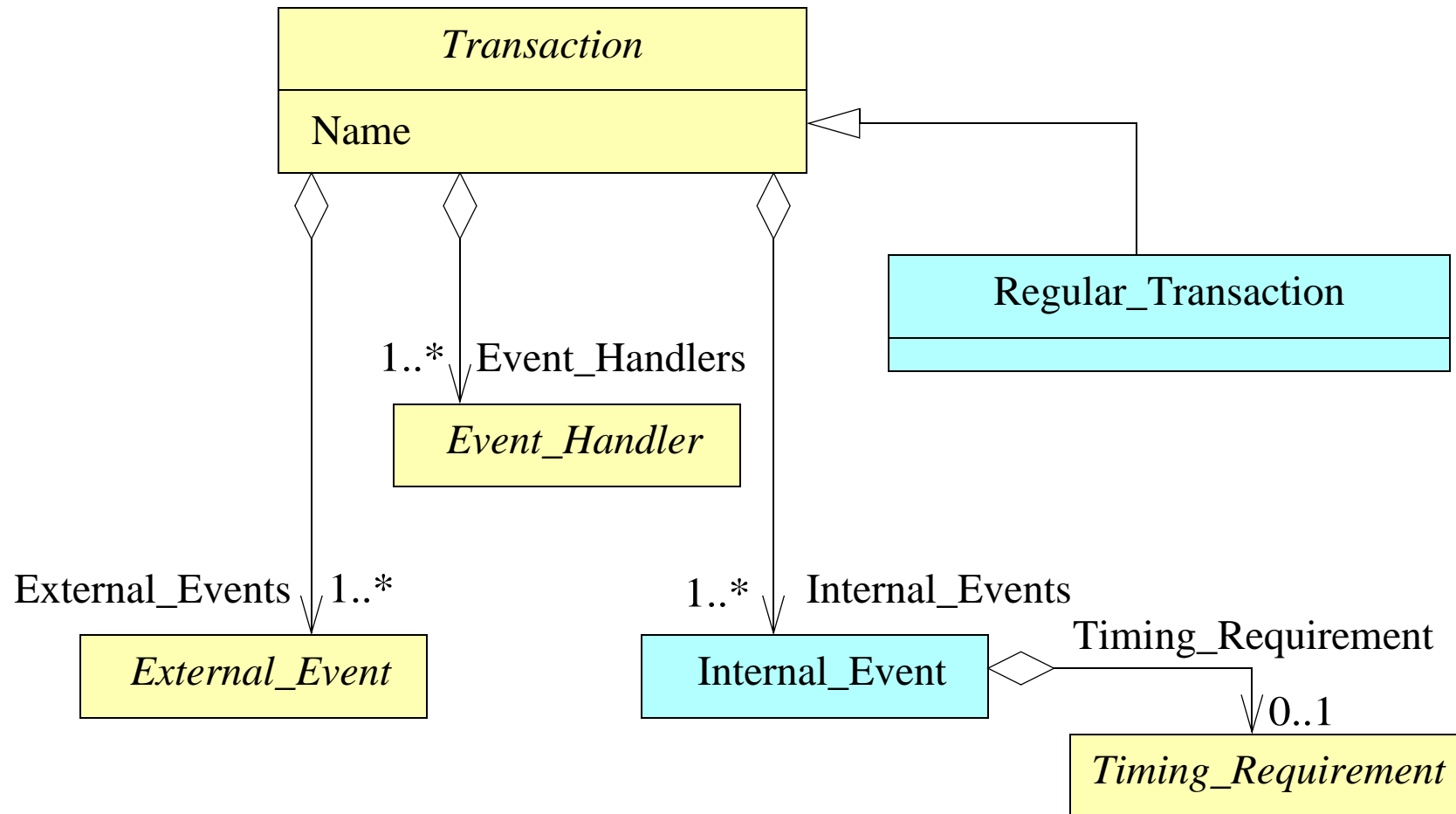
Activities



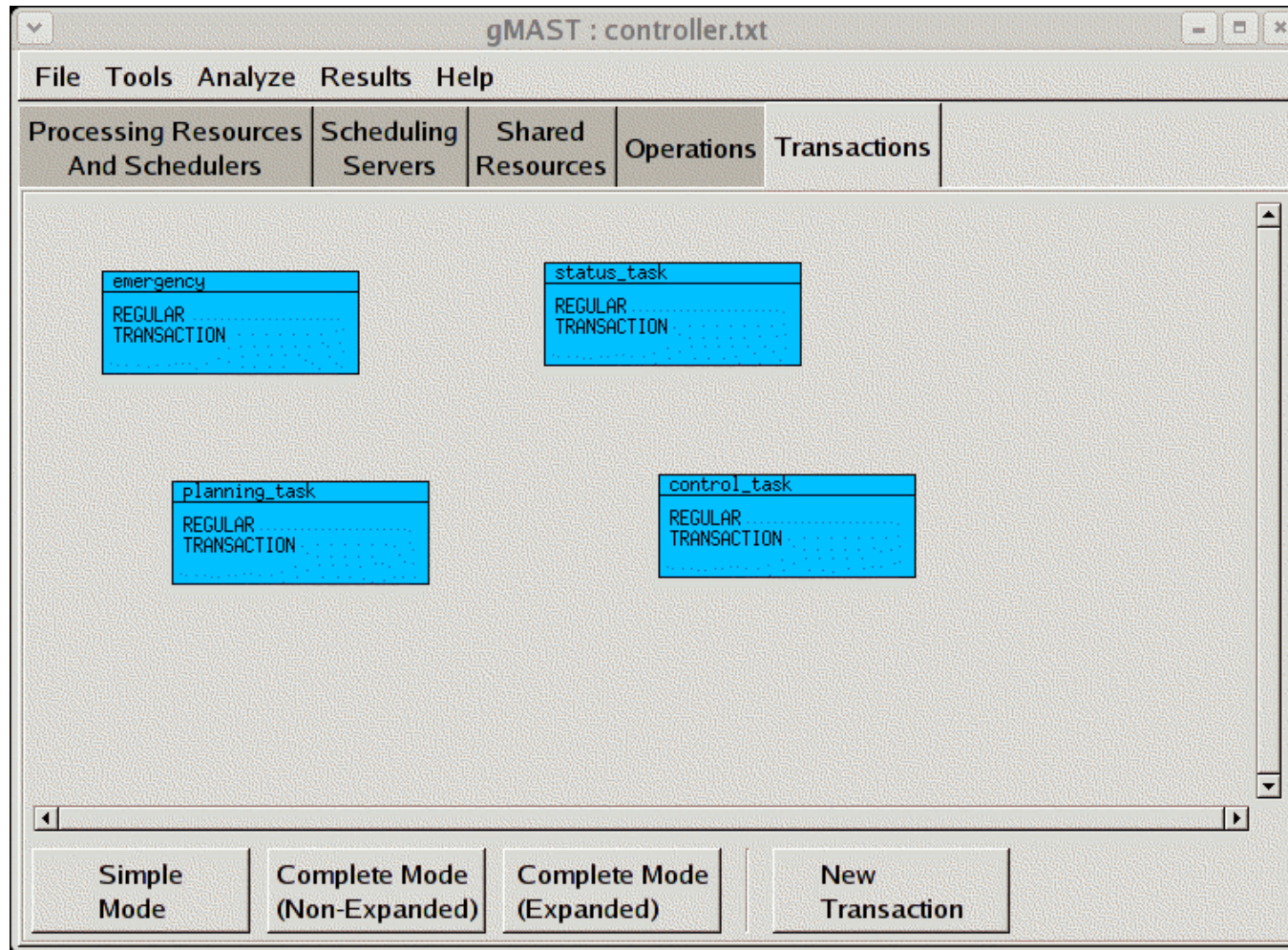
Delays and Rate Divisors



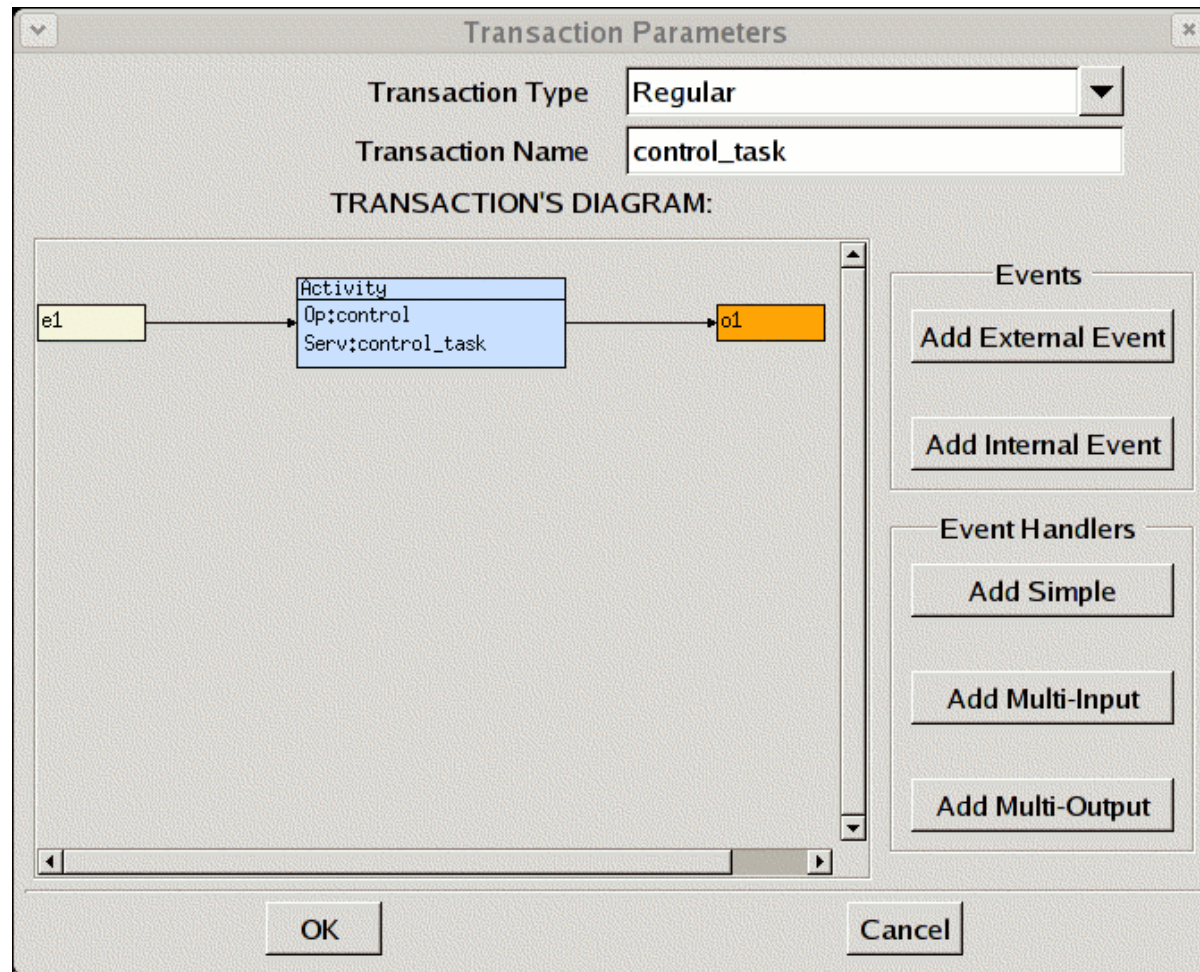
Transactions



Transactions



Transaction graphs



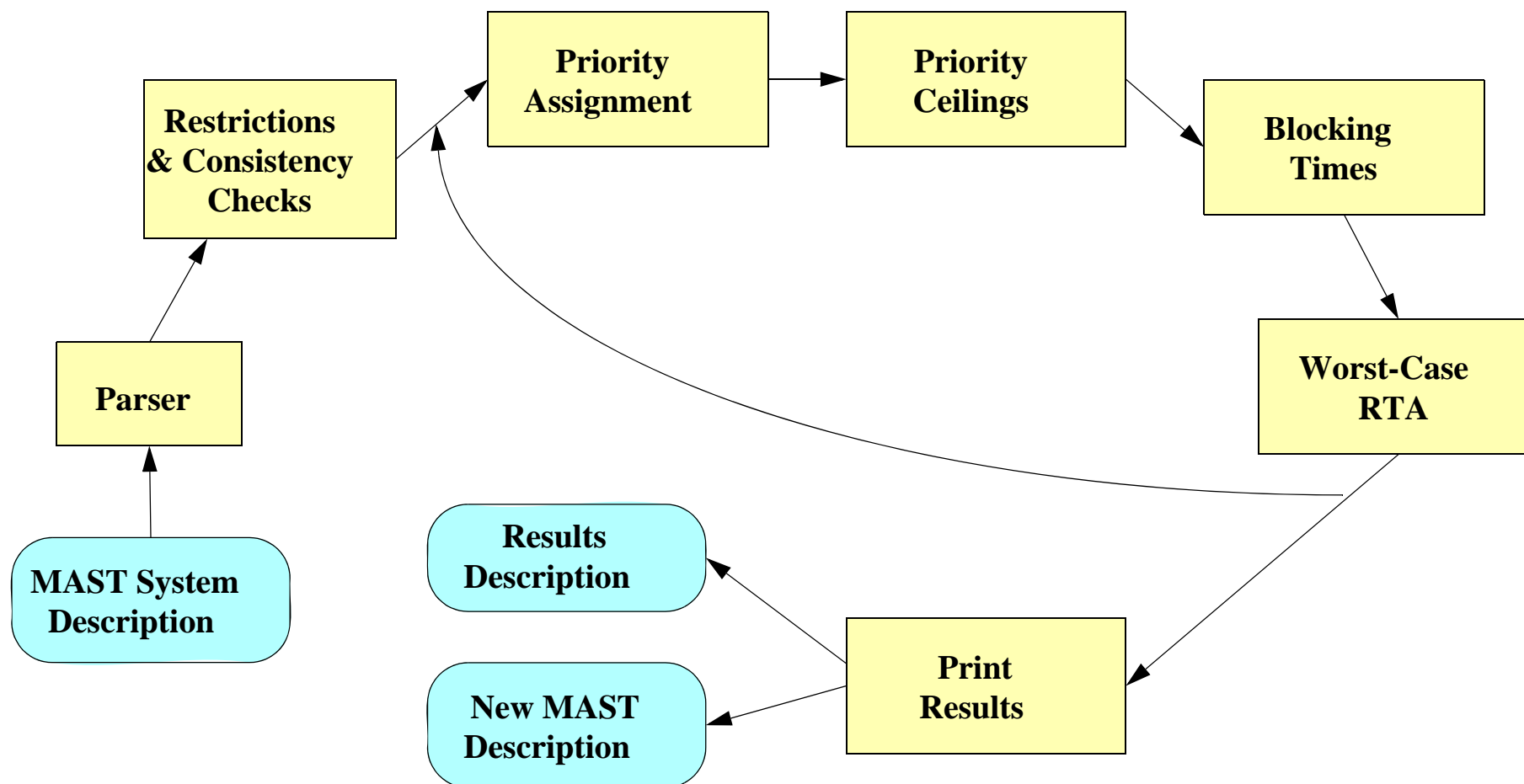
4.5 Analysis Tools: Specification Language

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)
- Referenced names must have been defined previously
- Comments like in Ada: “`--`”
- Case insensitive

No need to define an identifier before it is used

Schedulability Analysis Tools



Fixed Priority Response-Time Analysis

Technique	Single-Processor	Multi-Processor	Simple Transact.	Linear Transact.	Multiple Event T.
Classic Rate Monotonic	✓		✓		
Varying Priorities	✓		✓	✓	
Holistic	✓	✓	✓	✓	
Offset Based Unoptimized	✓	✓	✓	✓	
Offset Based	✓	✓	✓	✓	
Multiple Event	✓	✓	✓	✓	✓

