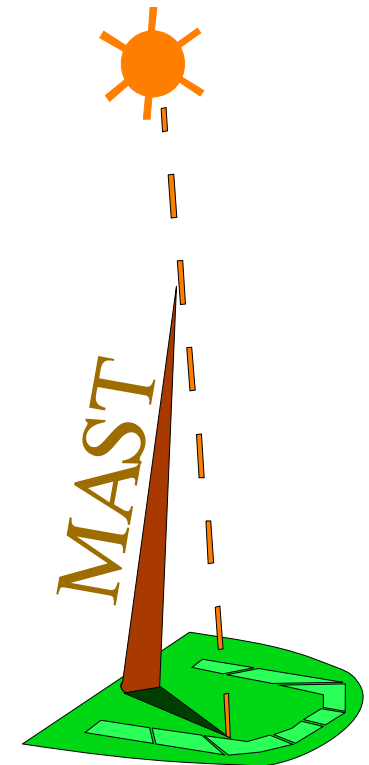

Modelling and analysing real-time systems with MAST: Overview and future extensions

By:

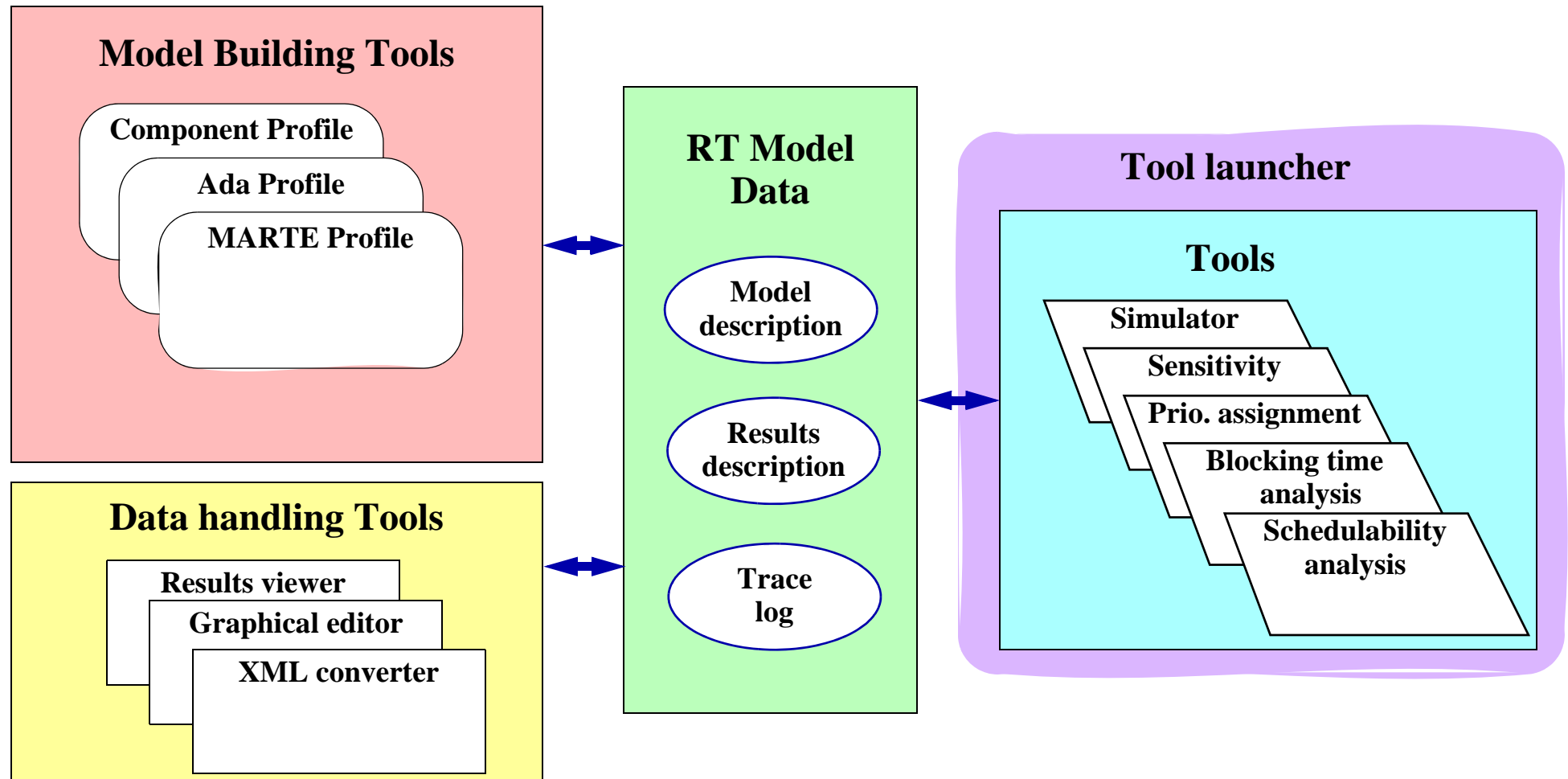
Michael González Harbour
Universidad de Cantabria, Spain
<http://mast.unican.es/>

1. Introduction: Objectives of MAST

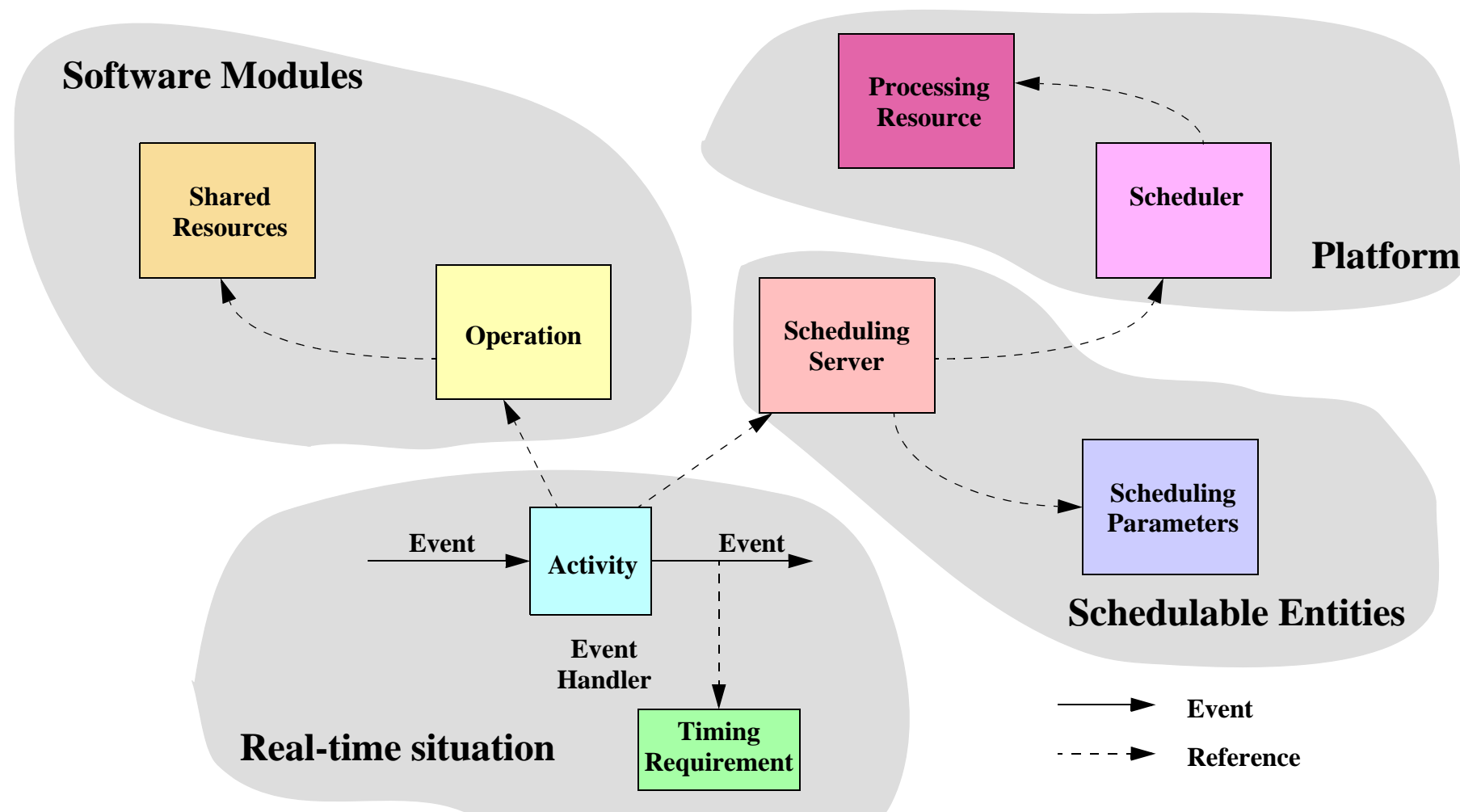
- Develop a **model** for describing the timing behavior of event-driven distributed real-time systems
 - composable software modules
 - separation of architecture, platform, and software modules
- **Open model** that may evolve to include new characteristics or points of view of the system
- Develop a set of **tools** for analyzing the timing behavior of the application



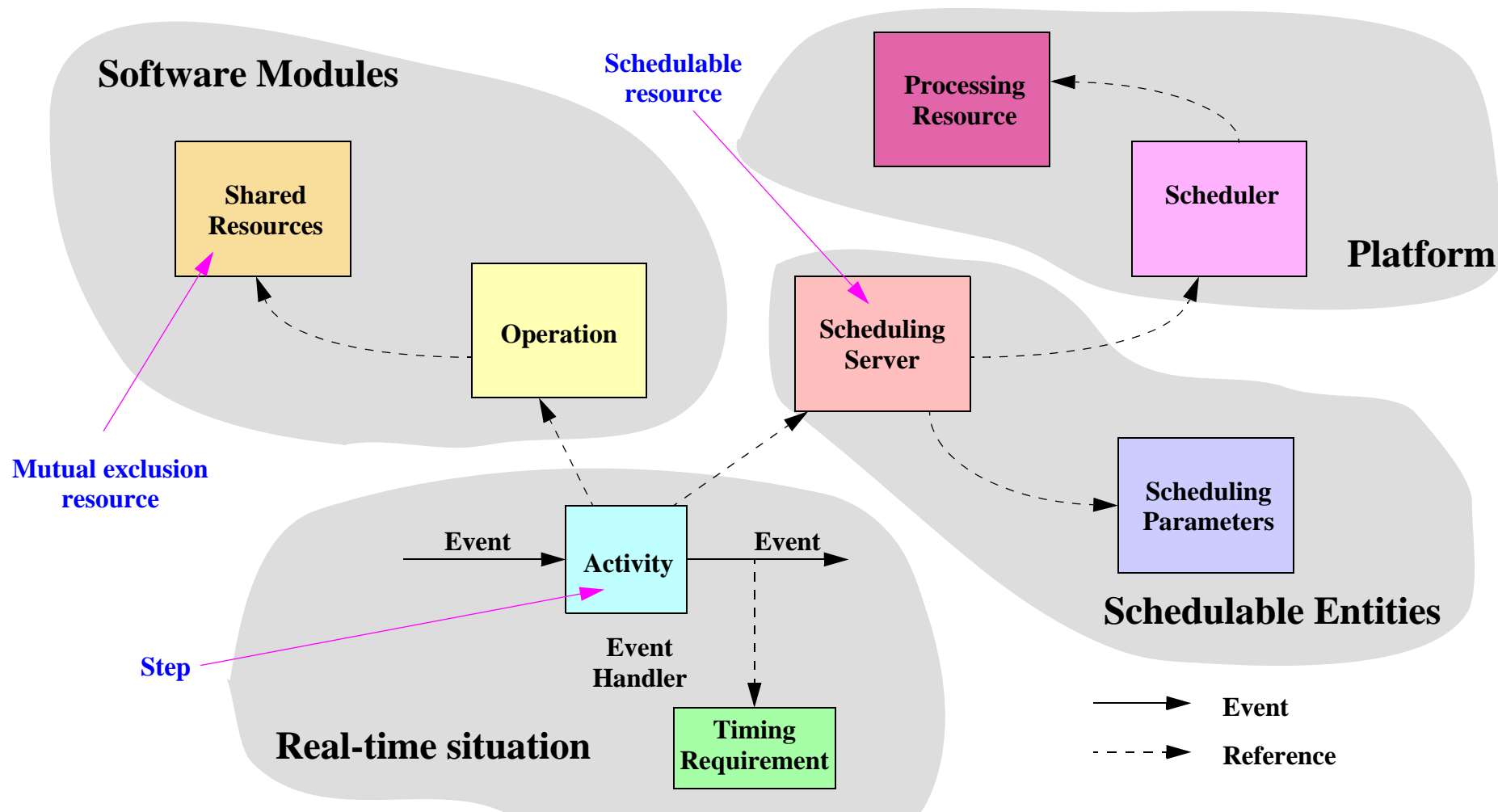
MAST Environment



2. Real-Time Model: Overview

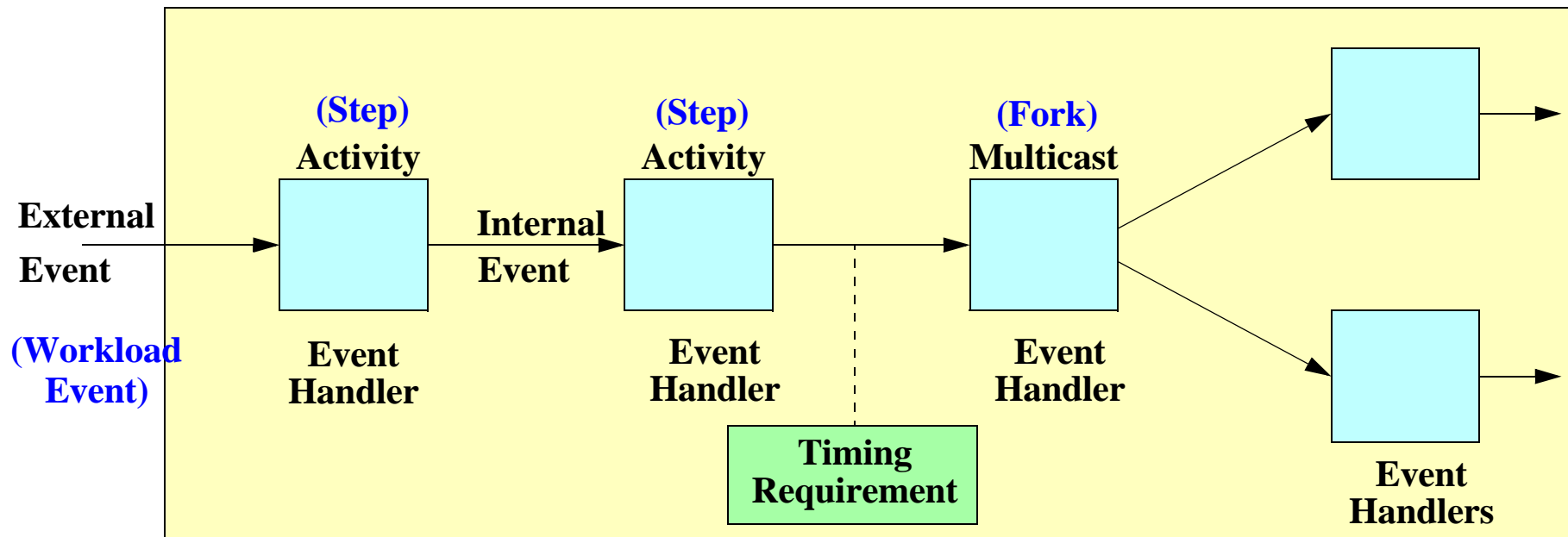


2. Real-Time Model: Overview



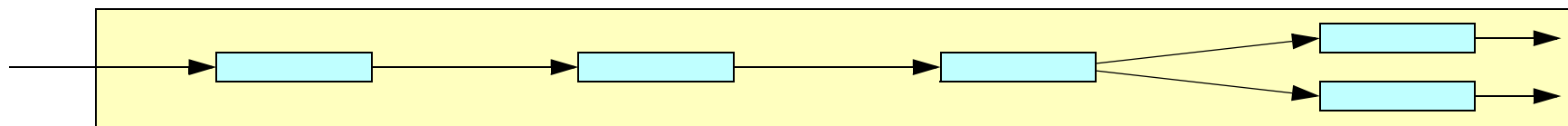
Real-Time Situation

Transaction (End-to-end Flow)

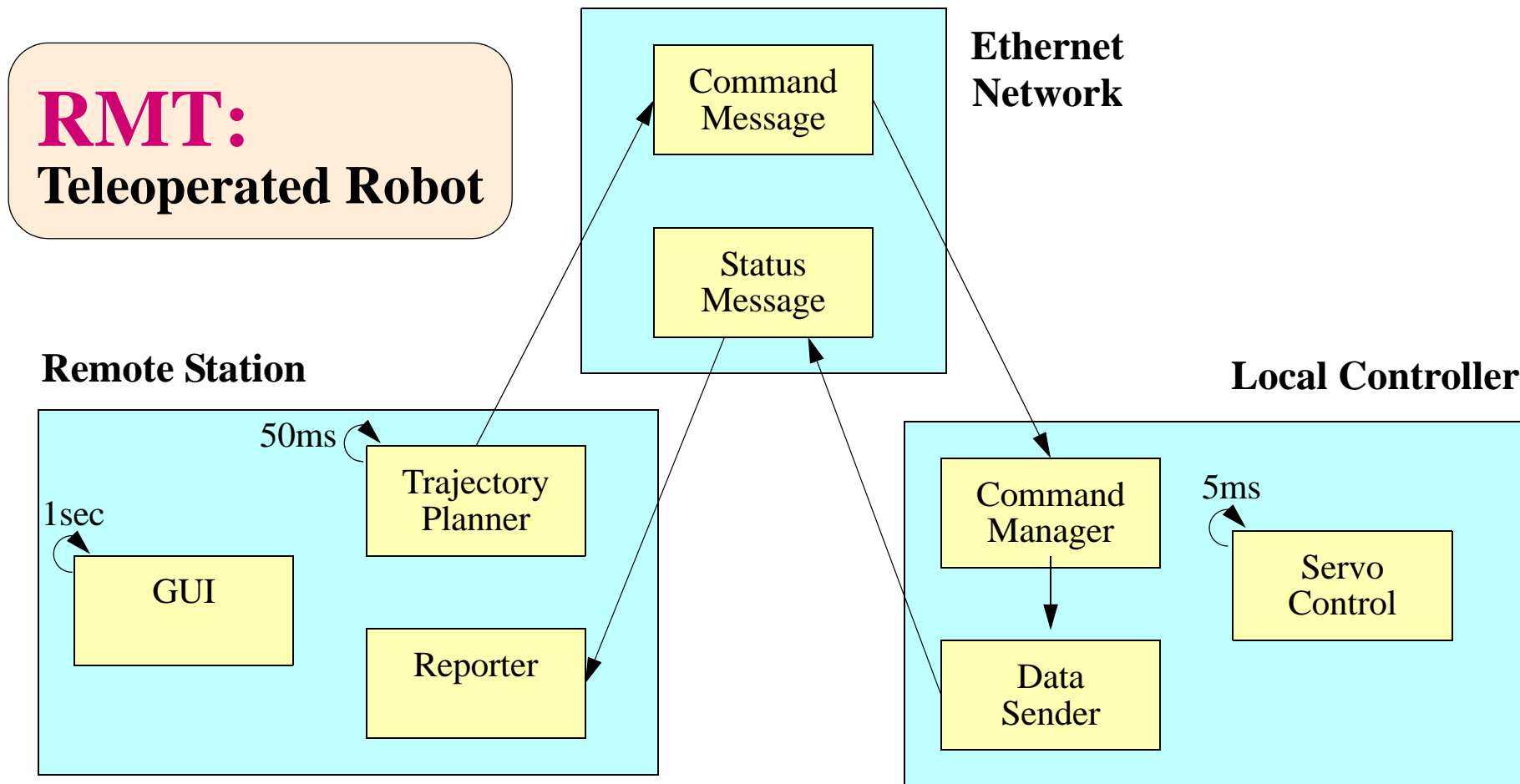


Transaction

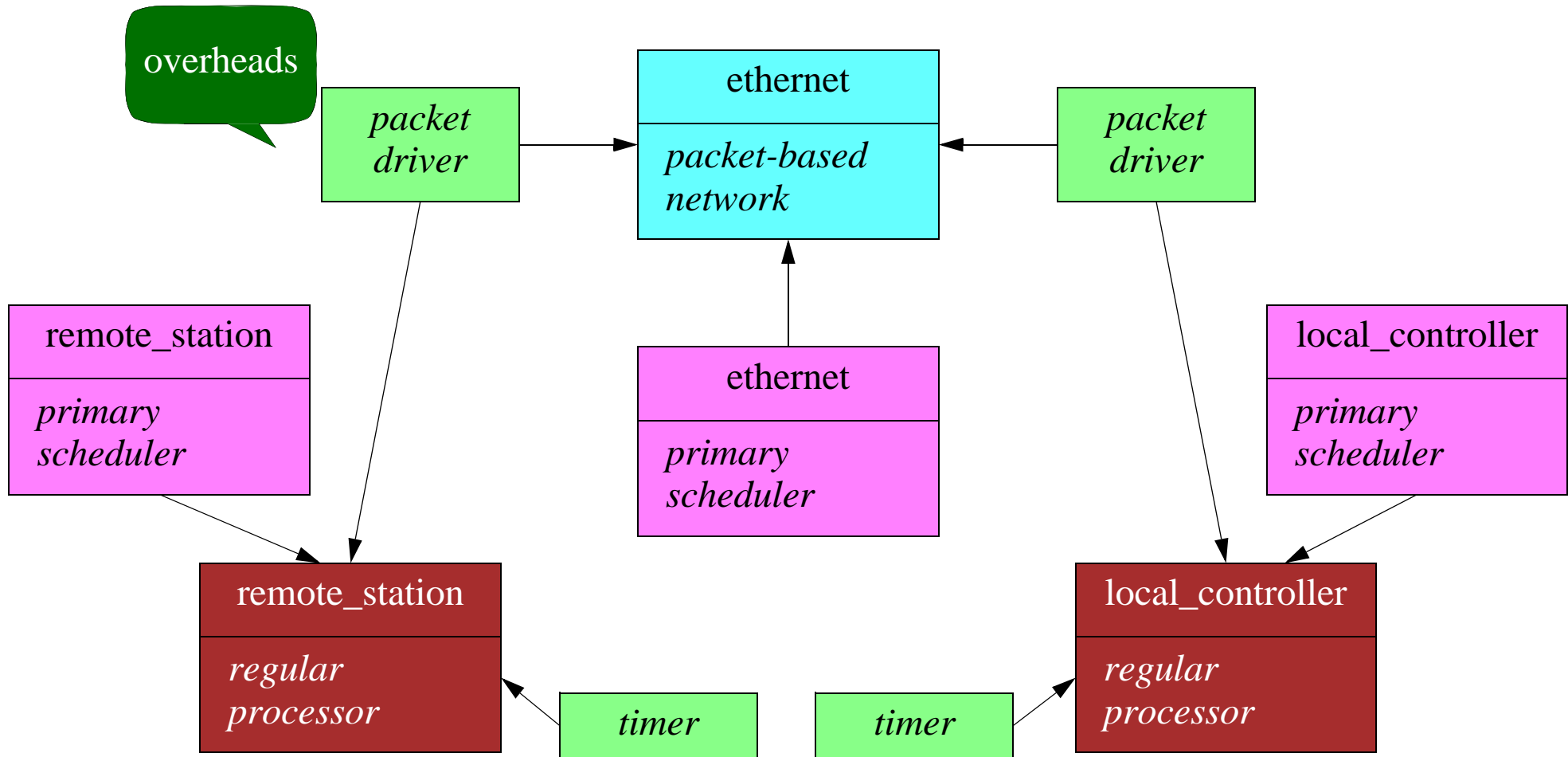
...



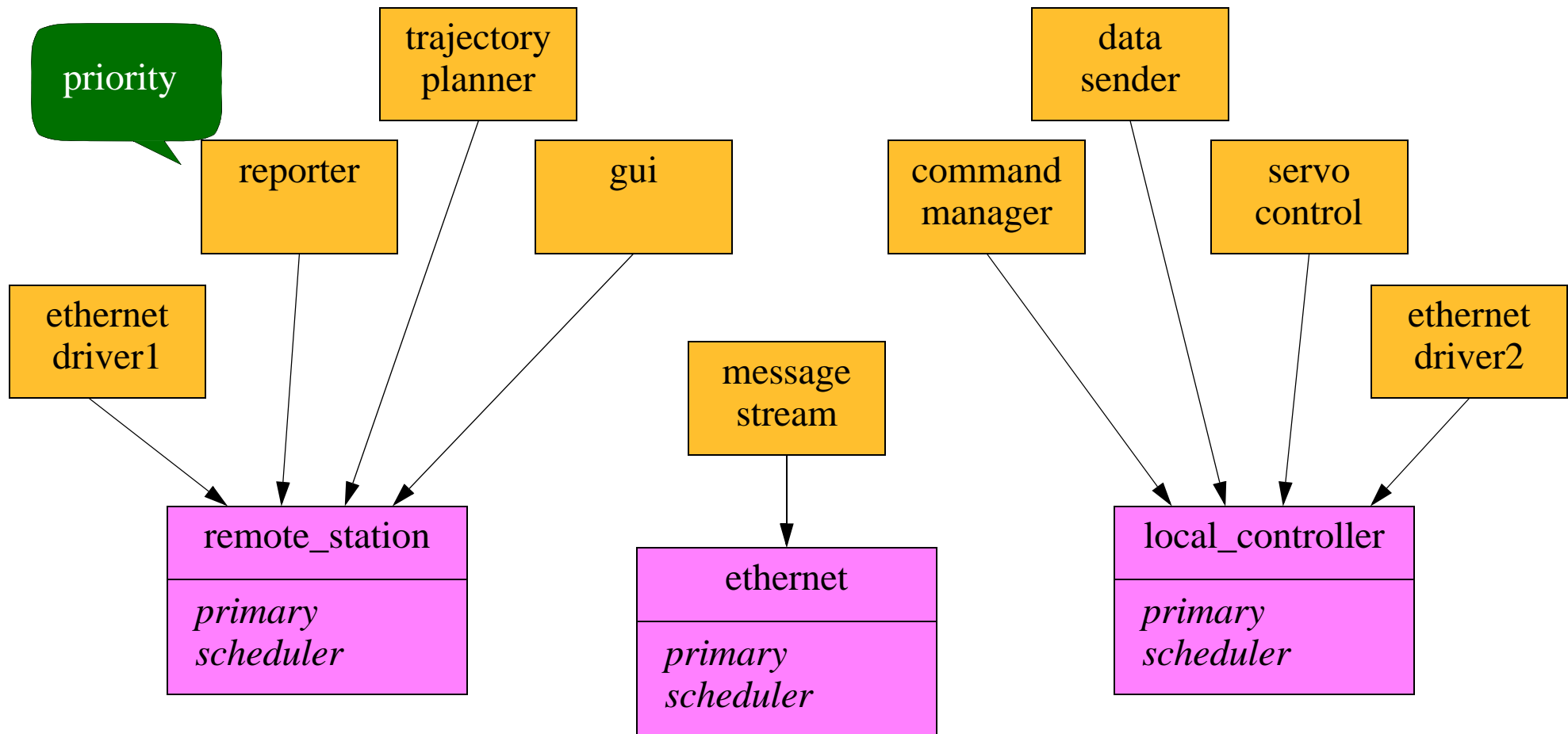
3. Elements of the MAST model: Example



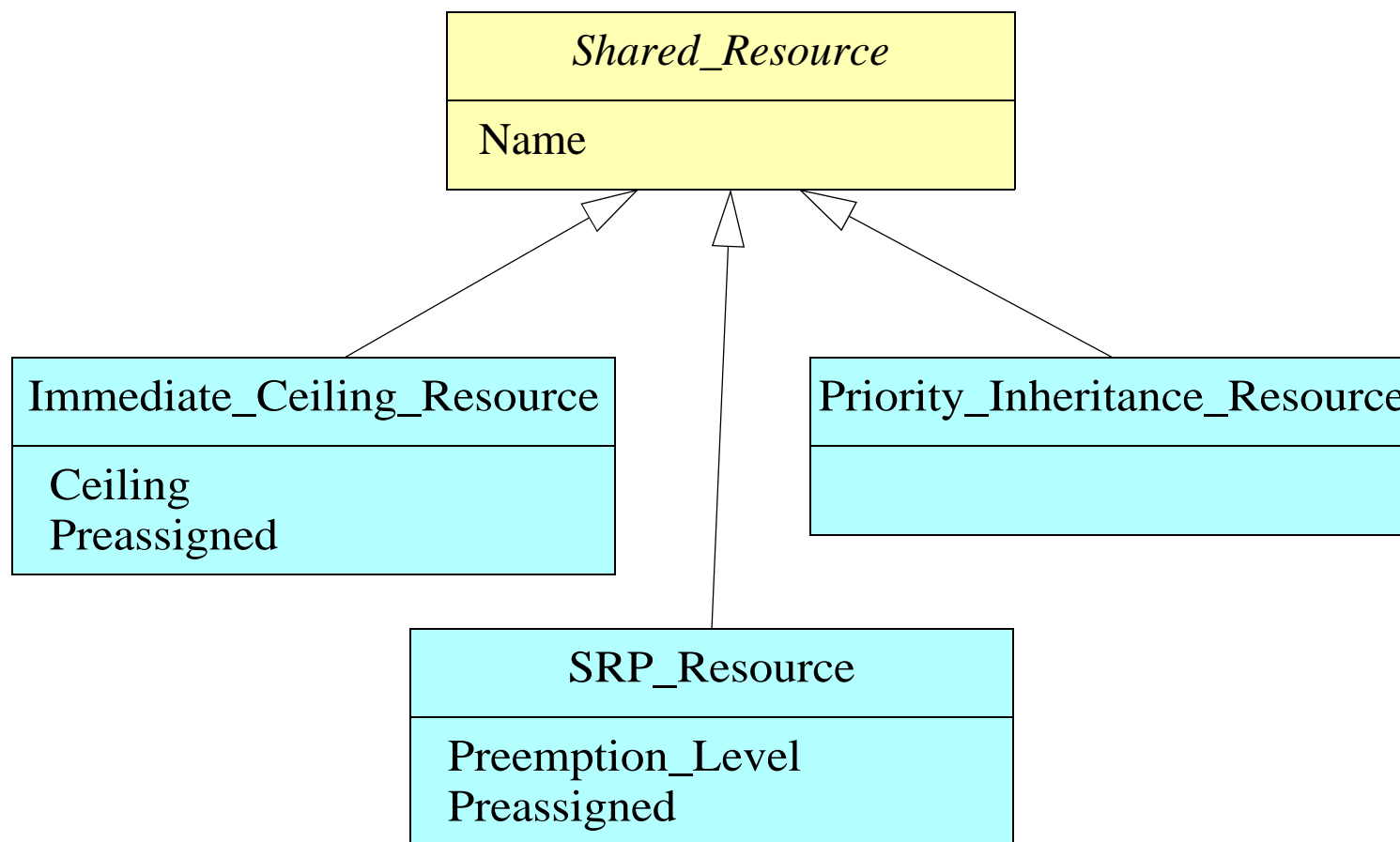
Processing resources, schedulers, drivers, and timers



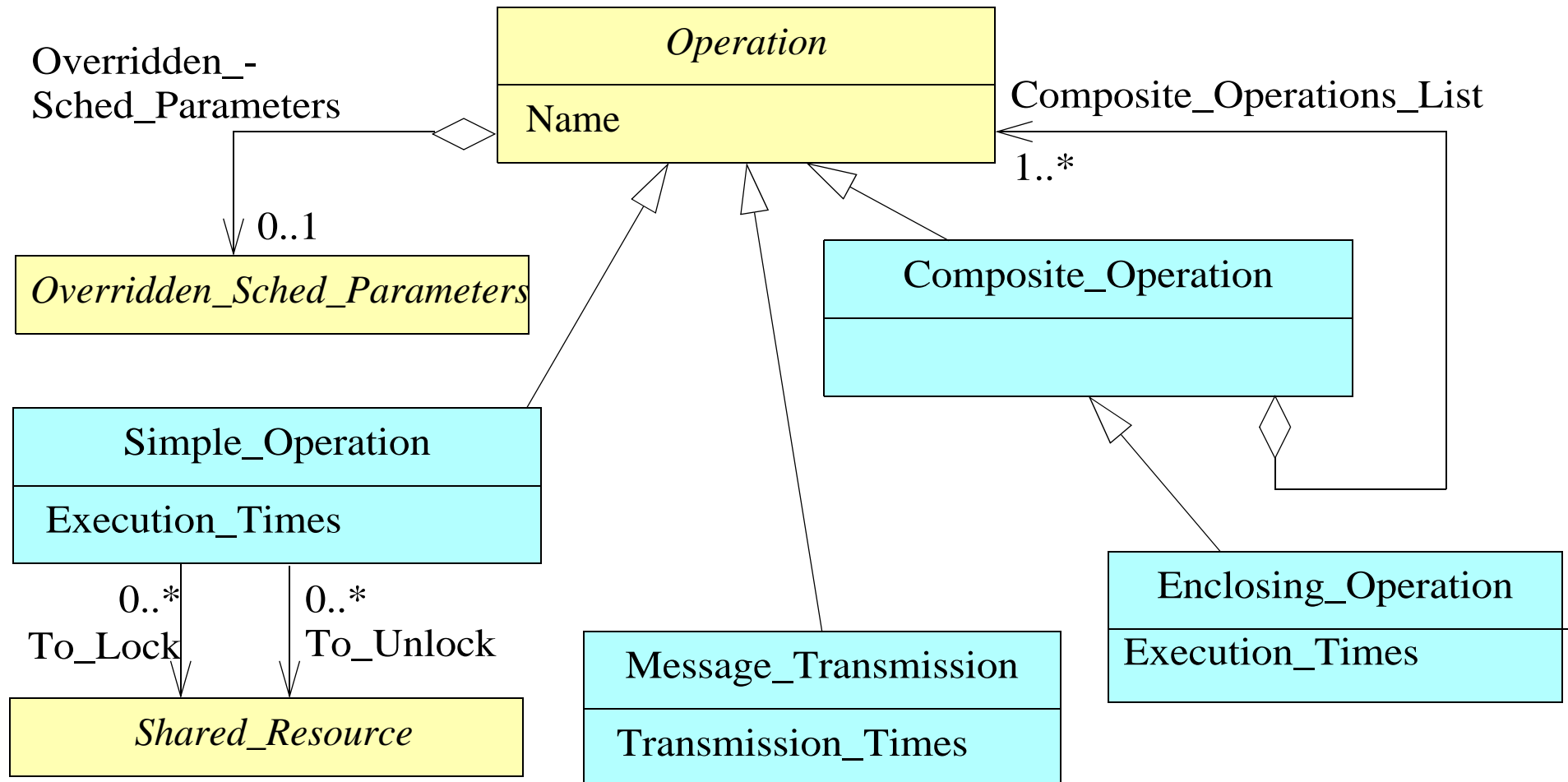
Scheduling servers (schedulable resources)



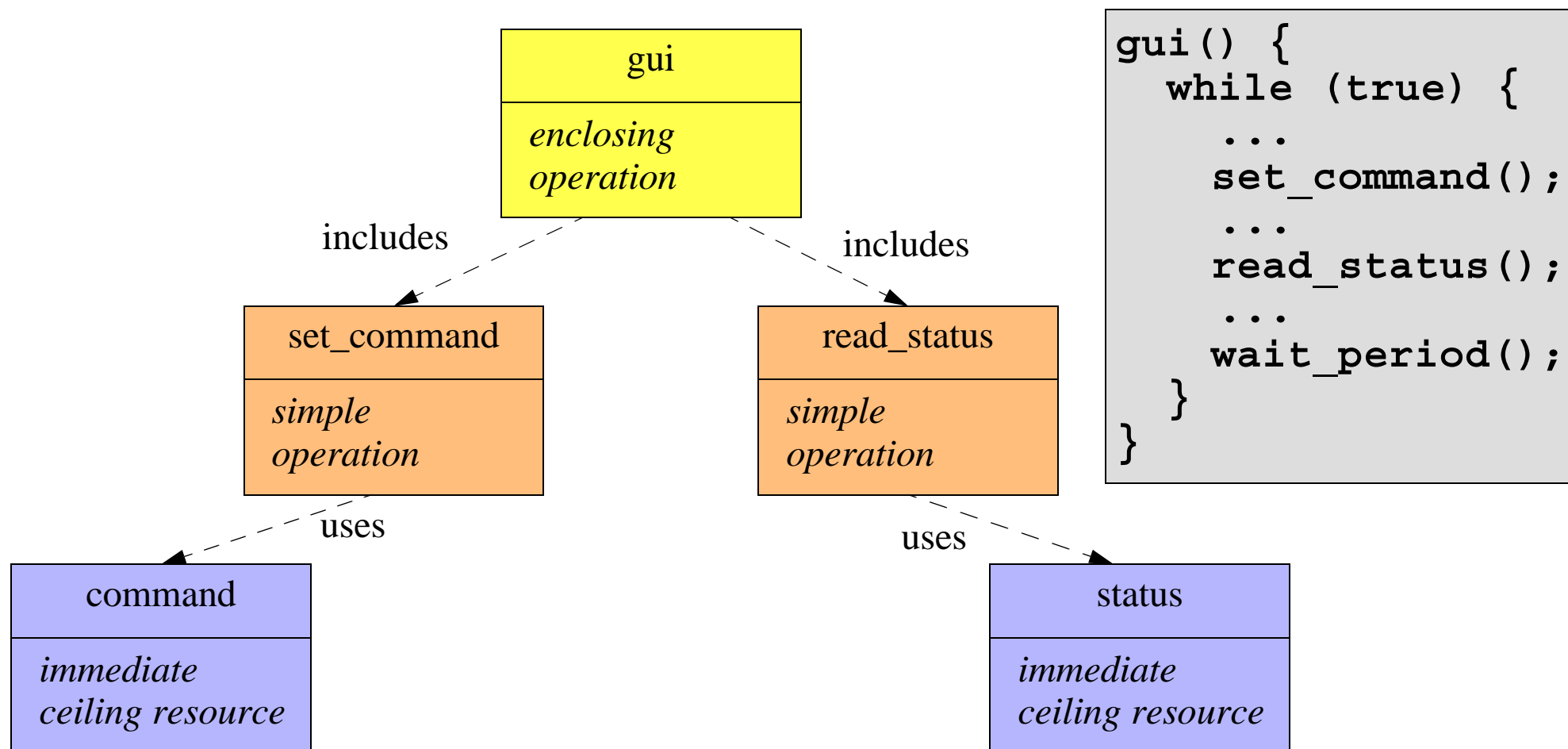
Shared (mutual exclusion) resources



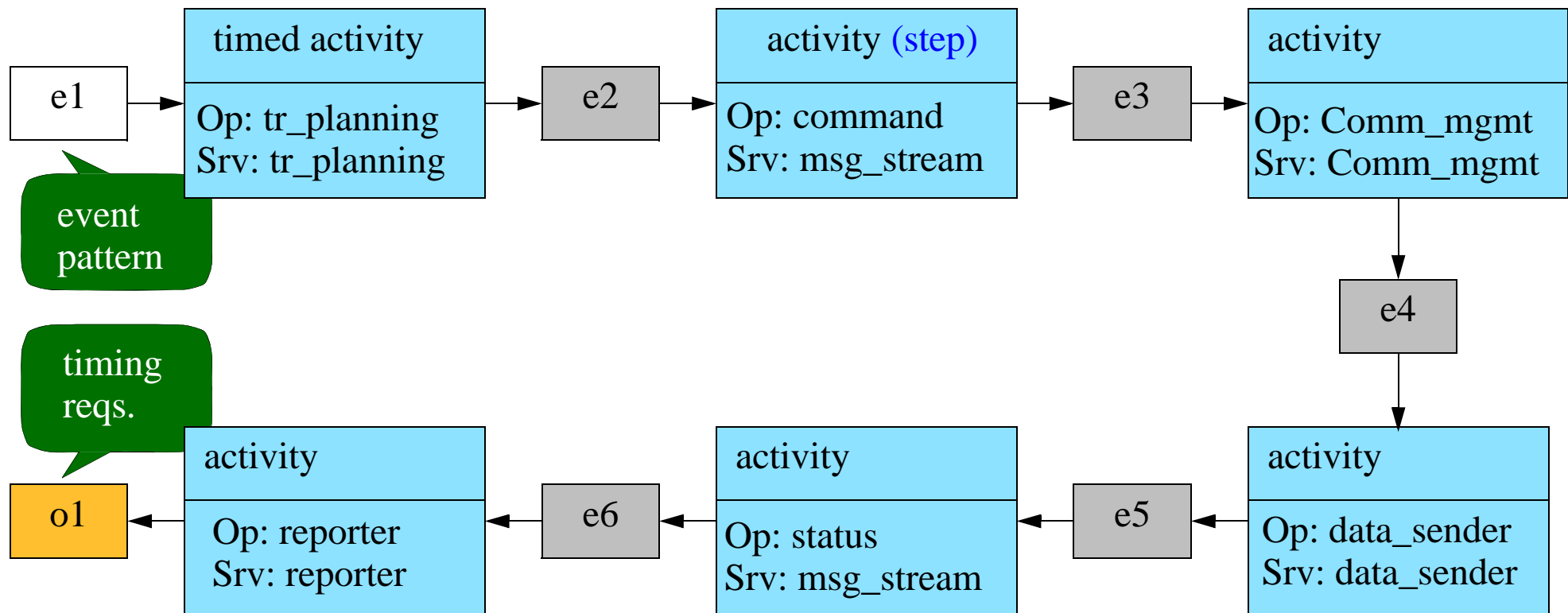
Operations



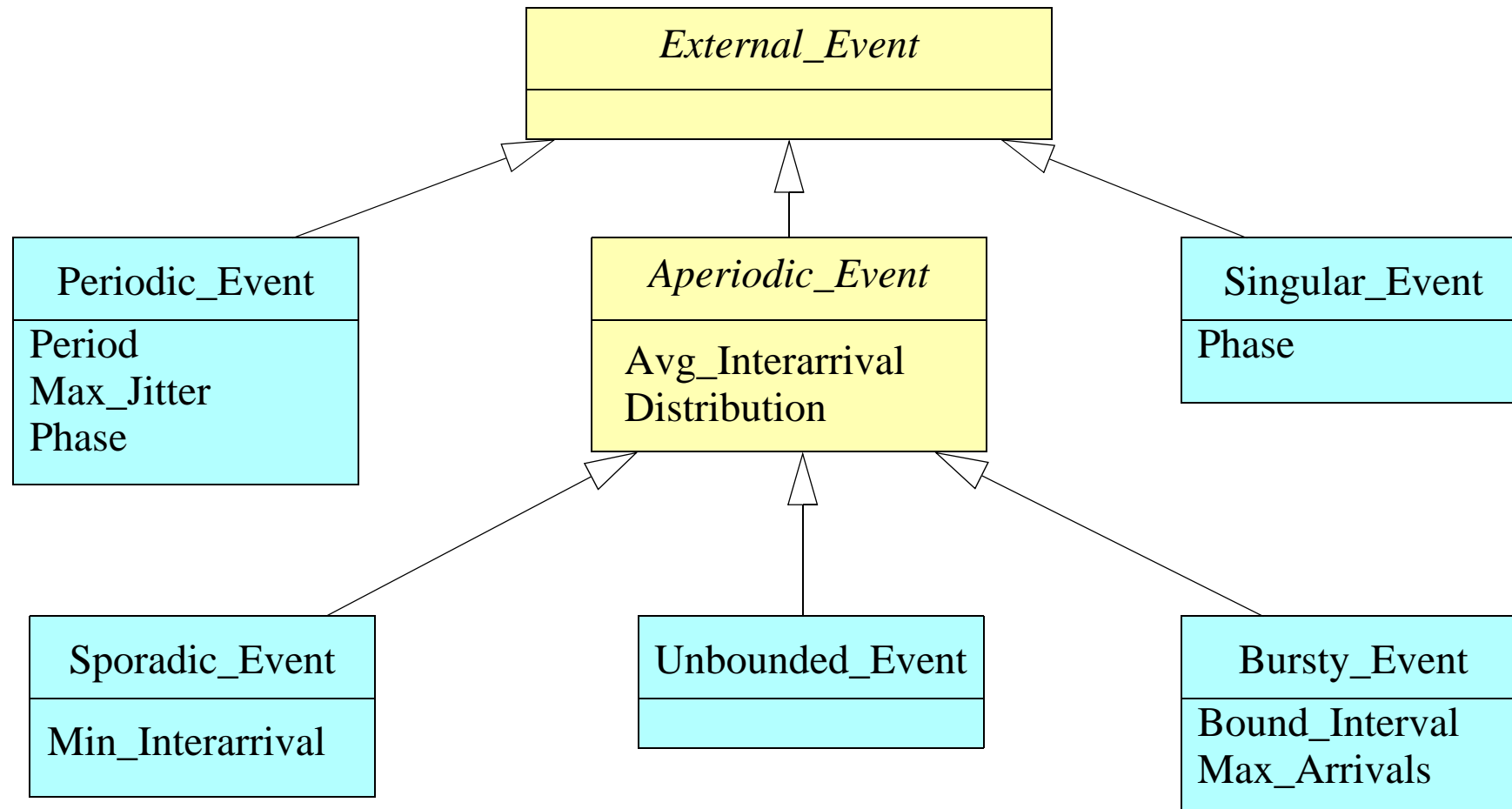
GUI operation in the example



Transactions (end-to-end flows): Distributed transaction in the example



External (workload) Events

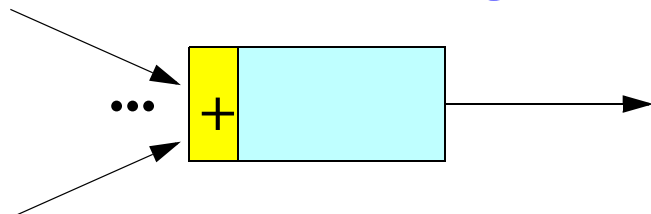


Event Handlers

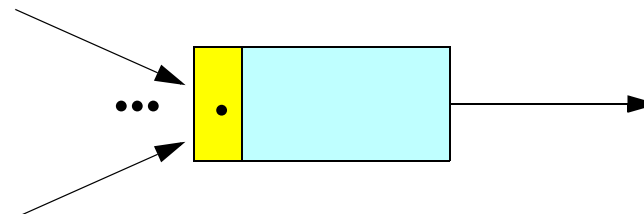
Activity (**Step**) / Rate Divisor / Delay / Offset



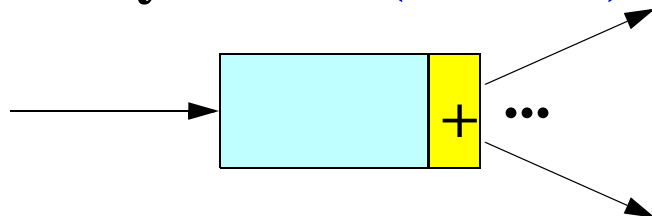
Concentrator (**Merge**)



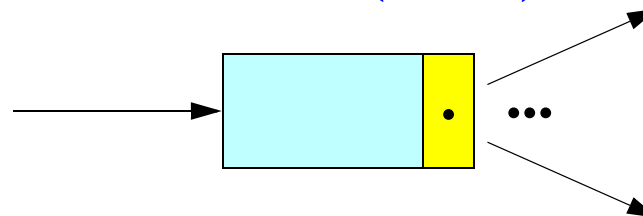
Barrier (**Join**)



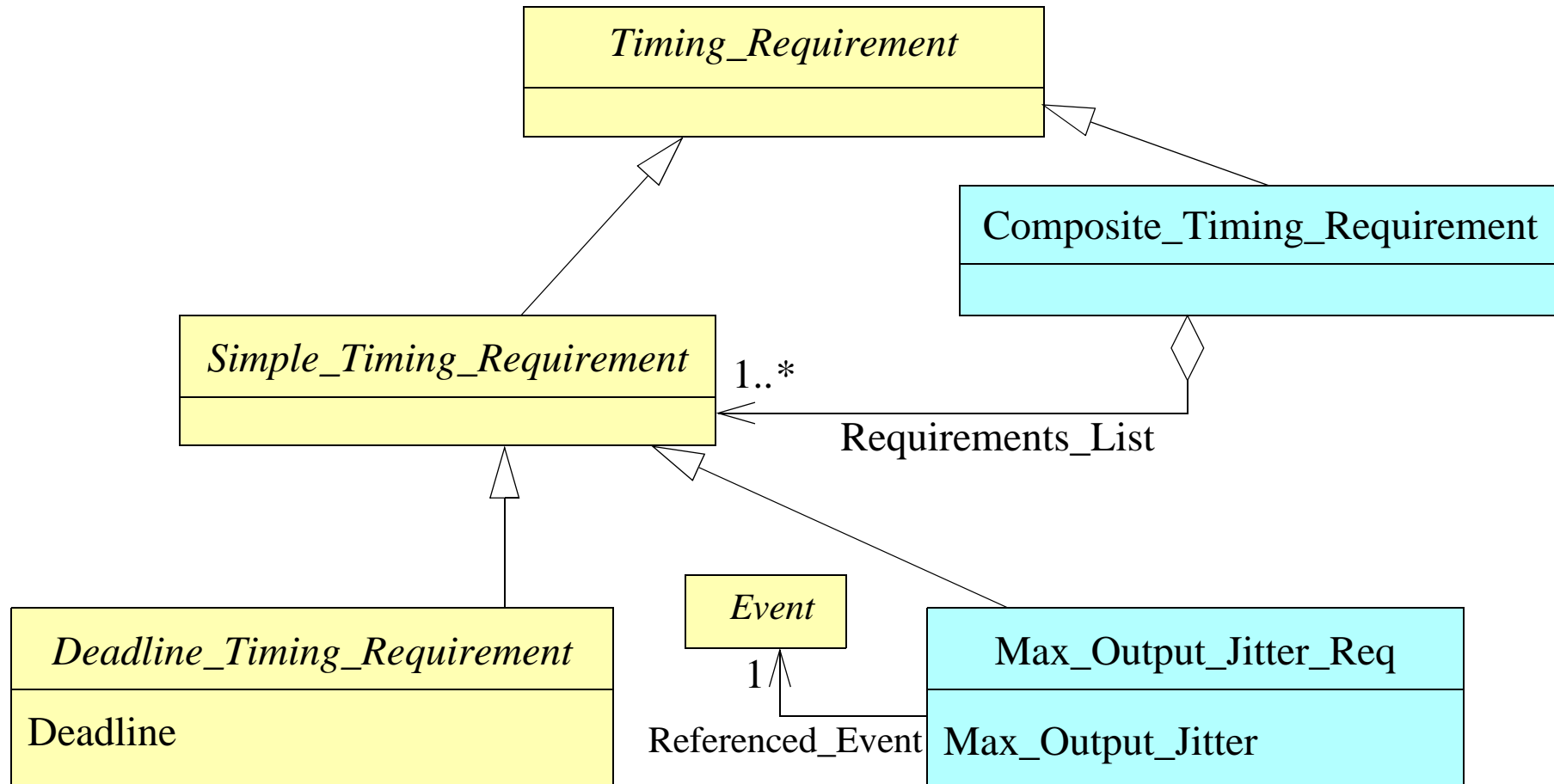
Delivery Server (**Branch**)



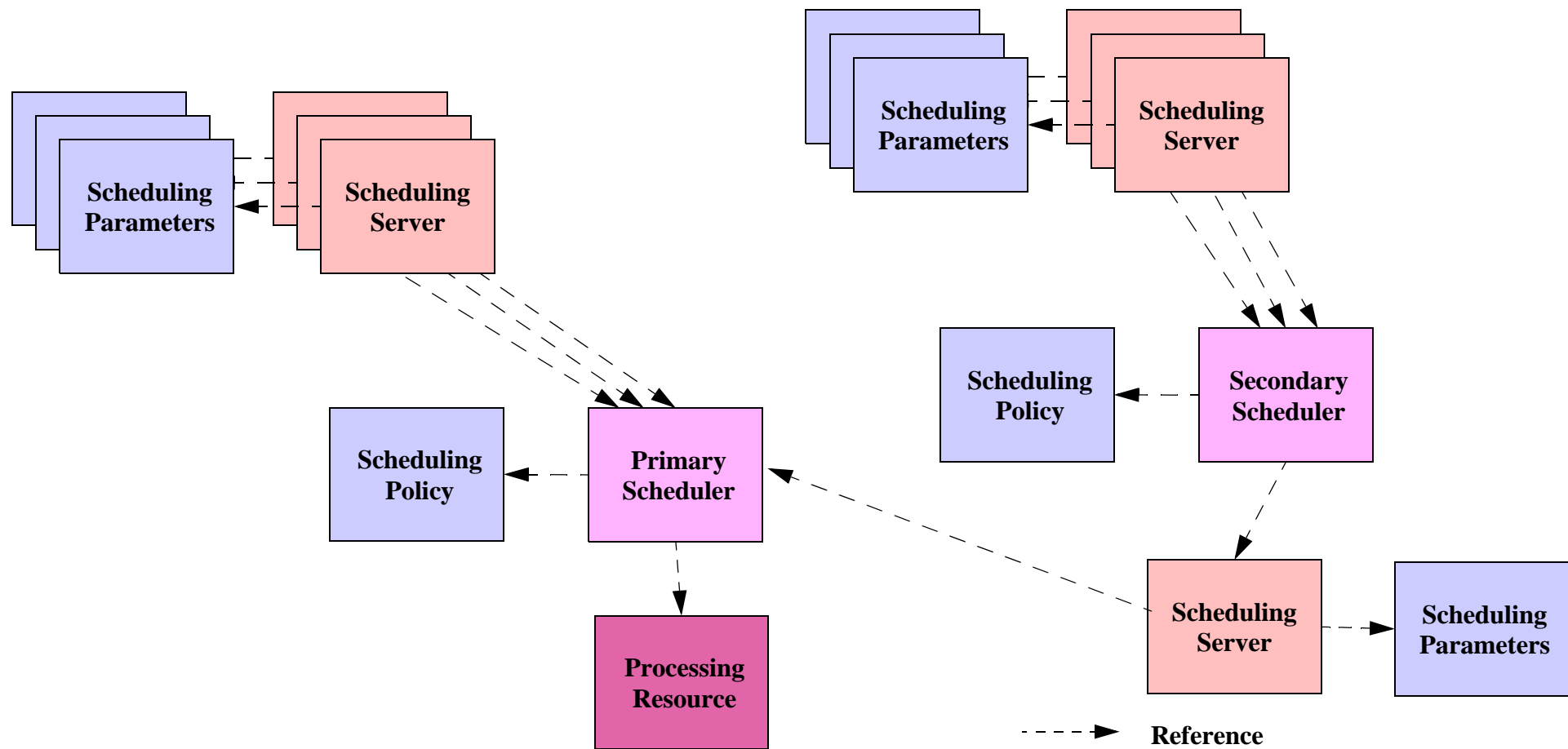
Multicast (**Fork**)



Timing requirements



4. Hierarchical schedulers in MAST



5. The MAST Tools

Automatic calculation of blocking times

Schedulability analysis

- fixed priorities
- EDF
- heterogeneous systems
- hierarchical scheduling

Automatic assignment of scheduling parameters

- priorities
- deadlines

Sensitivity analysis

Discrete-event simulator

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	✓	✓	✓	✓	✓

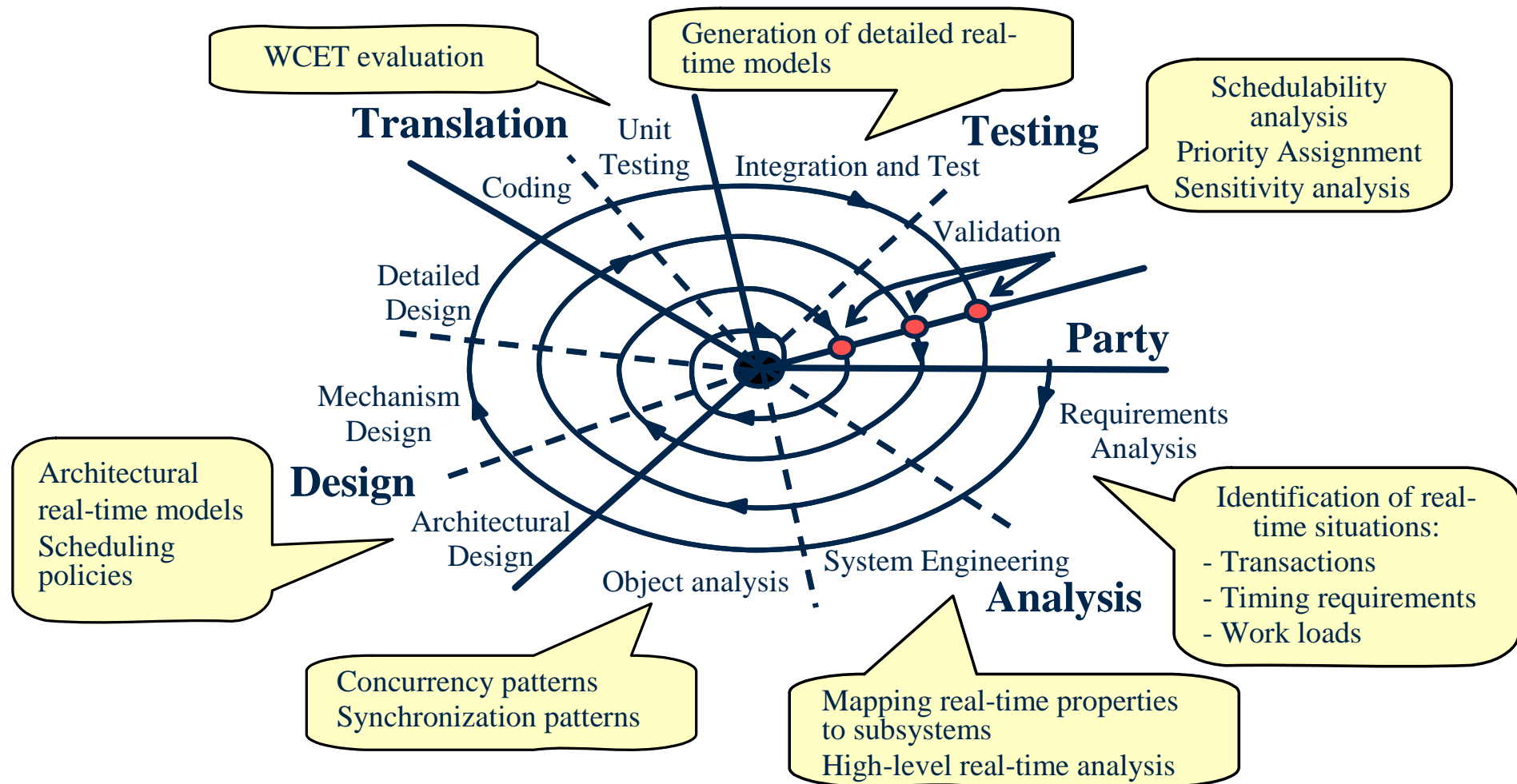
EDF Response Time Analysis Tools

Technique	Single-Processor	Multi-Processor	Simple Transact.	Linear Transact.	Multiple Event T.
Single Processor	✓		✓		
EDF_Within_Priorities	✓		✓		
Holistic local EDF	✓	✓	✓	✓	
Holistic global EDF	✓	✓	✓	✓	
Offset-based local	✓	✓	✓	✓	
Offset-based global	✓	✓	✓	✓	

Scheduling parameters assignment

Technique	Fixed priorities	EDF	Heterogeneous	Single-Processor	Multi-Processor
Monoprocessor	✓	✓		✓	
HOPA	✓			✓	✓
Simulated Annealing	✓			✓	✓
HOSDA		✓		✓	✓
HOSPA	✓	✓	✓	✓	✓

6. Integration into the design process



7. Future Work in MAST-1

Implement missing tools:

- **Multiple-event analysis**
- **Full support for EDF**

Speed up the response time analysis

Enhance error reporting

Future Work in MAST-2

Align names with MARTE

Partitioned scheduling

- support for ARINC 653 systems with hierarchical scheduling
 - fixed priorities on top of timed partitions
- support for TTP networks

Network switches

- support for AFDX deterministic ethernet

Resource reservations

- virtual resources as a new primary scheduler

Future Work in MAST-2 (cont'd)

Enhance modelling capabilities

- support for thread locking from a transaction
 - enable modelling synchronous RPC
- enhanced modelling of timers
 - allow multiple timers

8. Conclusions

MAST defines a model for describing real-time systems

- distributed and multiprocessor
- complex synchronization and event-driven schemes
- composable software modules
- independence of architecture, platform and modules

MAST provides an open set of tools

- hard and soft real-time analysis
- automatic blocking times, priority assignment, sensitivity analysis...

XML specification language allows easy integration with other tools (i.e., UML tools)

Conclusions (cont'd)

MAST is free software

MAST is evolving and will soon cover aspects such as:

- **alignment with MARTE**
- **partitioned scheduling**
- **network switches**
- **additional modelling capabilities**

URL



<http://mast.unican.es>