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Xavier Rebeuf

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Introducing Behavior in Function Blocks

X. Rebeuf

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Zhejiang University 2002

Introduction

Distributed industrial-
process control



Compose hardware and
software components

PB: Interoperability between components

Introduction

Distributed industrial-
process control



Compose hardware and
software components

PB: Interoperability between components

- Abstraction of elementary component = Function block
- Composition of function blocks = Functional Requirement Diagram

 Structural architecture

Introduction

Distributed industrial-
process control



Compose hardware and
software components

PB: Interoperability between components

- Abstraction of elementary component = Function block
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 Structural architecture



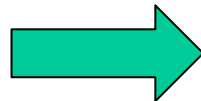
Validation of static interoperability



Not enough to validate temporal interoperability



Behavior modeling



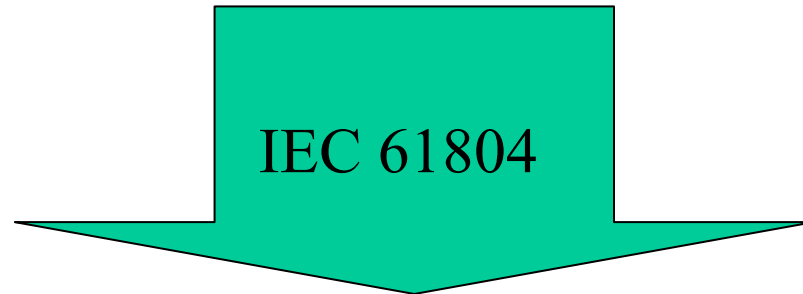
Application simulation

- **Description of the standard**
- **Adaptation taking into account the behavior**
- **Simulation of the application**
- **Example**
- **Conclusion**

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Function block concept

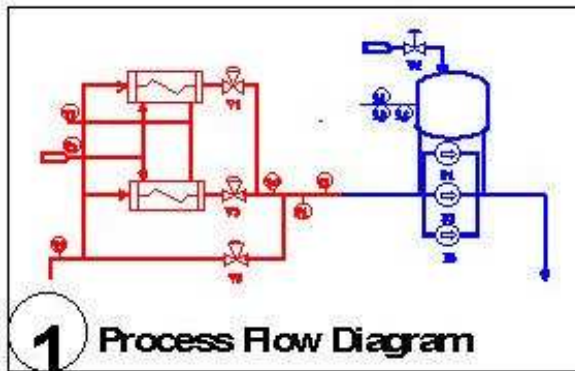
Goal: Have a common standard by which the users can be assured of compatible, interworkable, interconnectable, interoperable and interchangeable of the device they choose



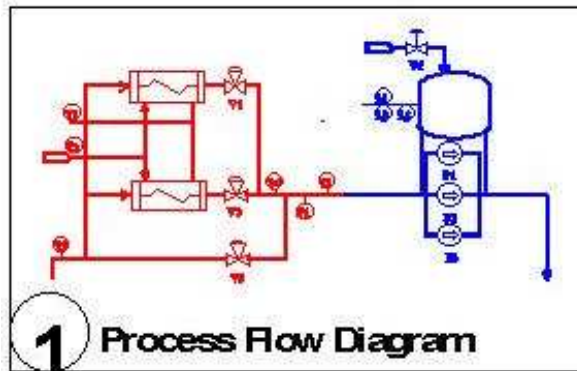
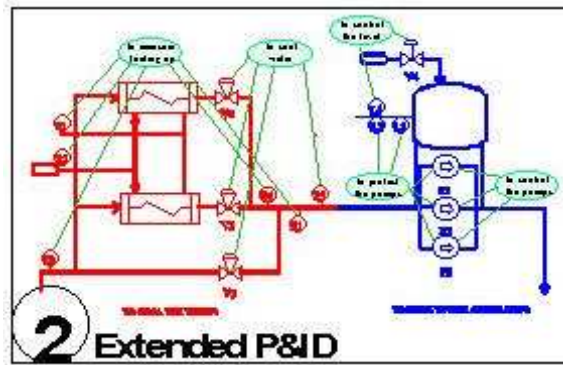
« function block is an encapsulation of data and algorithms to provide a specific function, which can be self understanding »



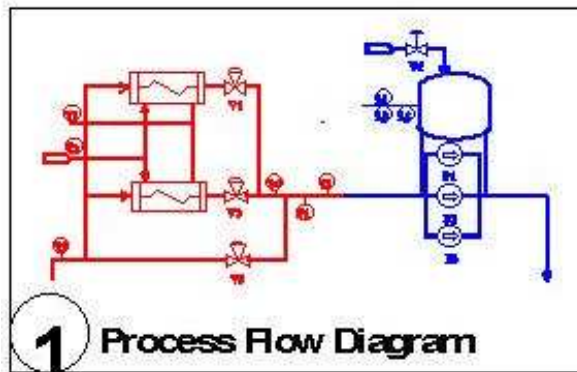
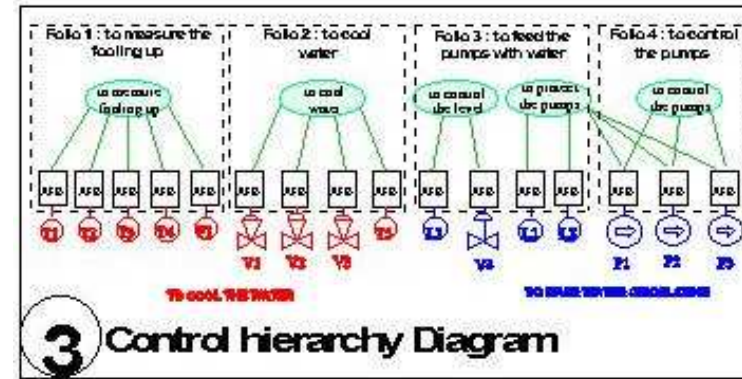
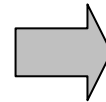
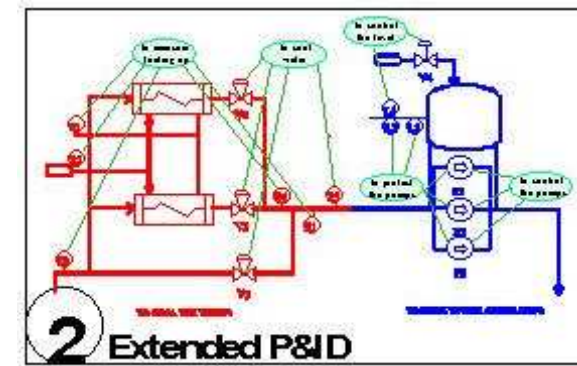
Function Blocks – How to use



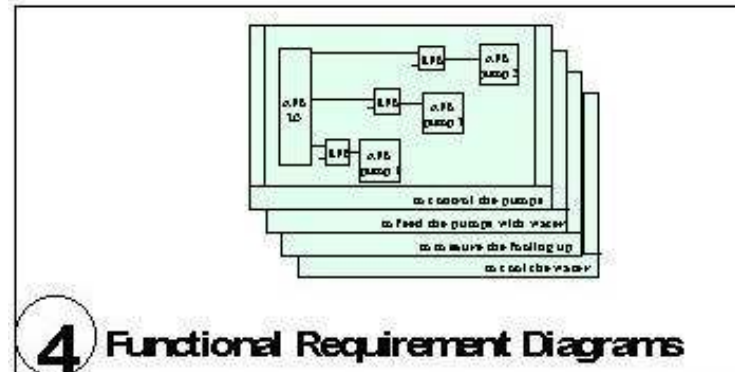
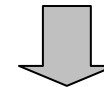
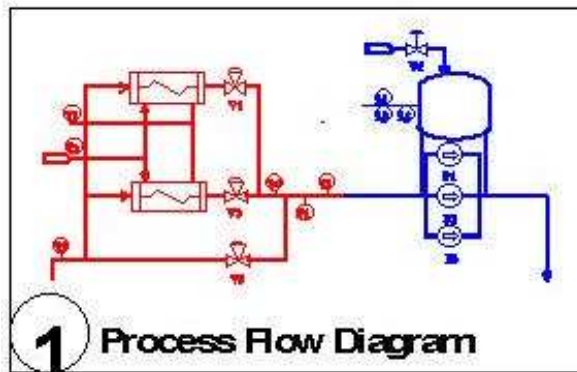
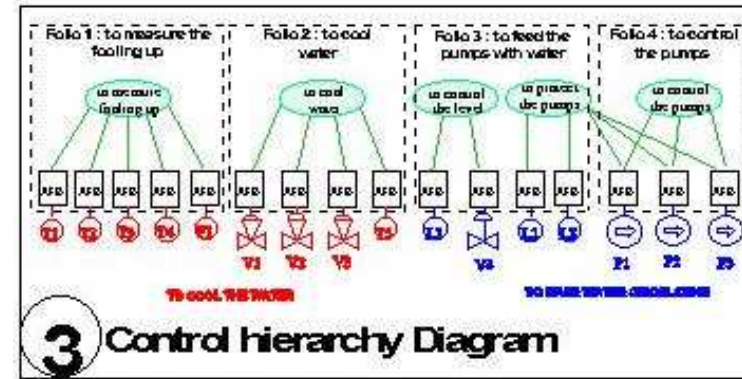
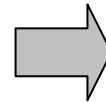
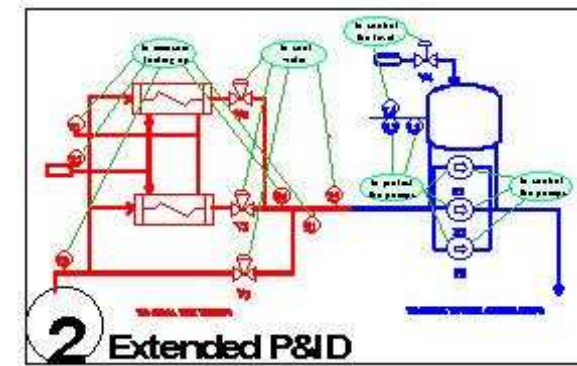
Function Blocks – How to use

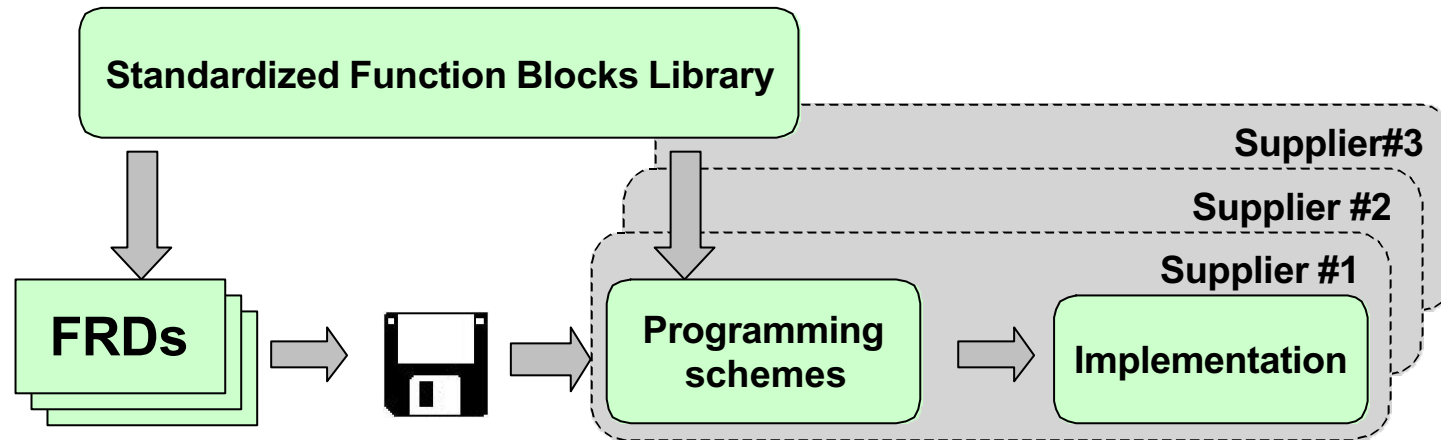


Function Blocks – How to use



Function Blocks – How to use





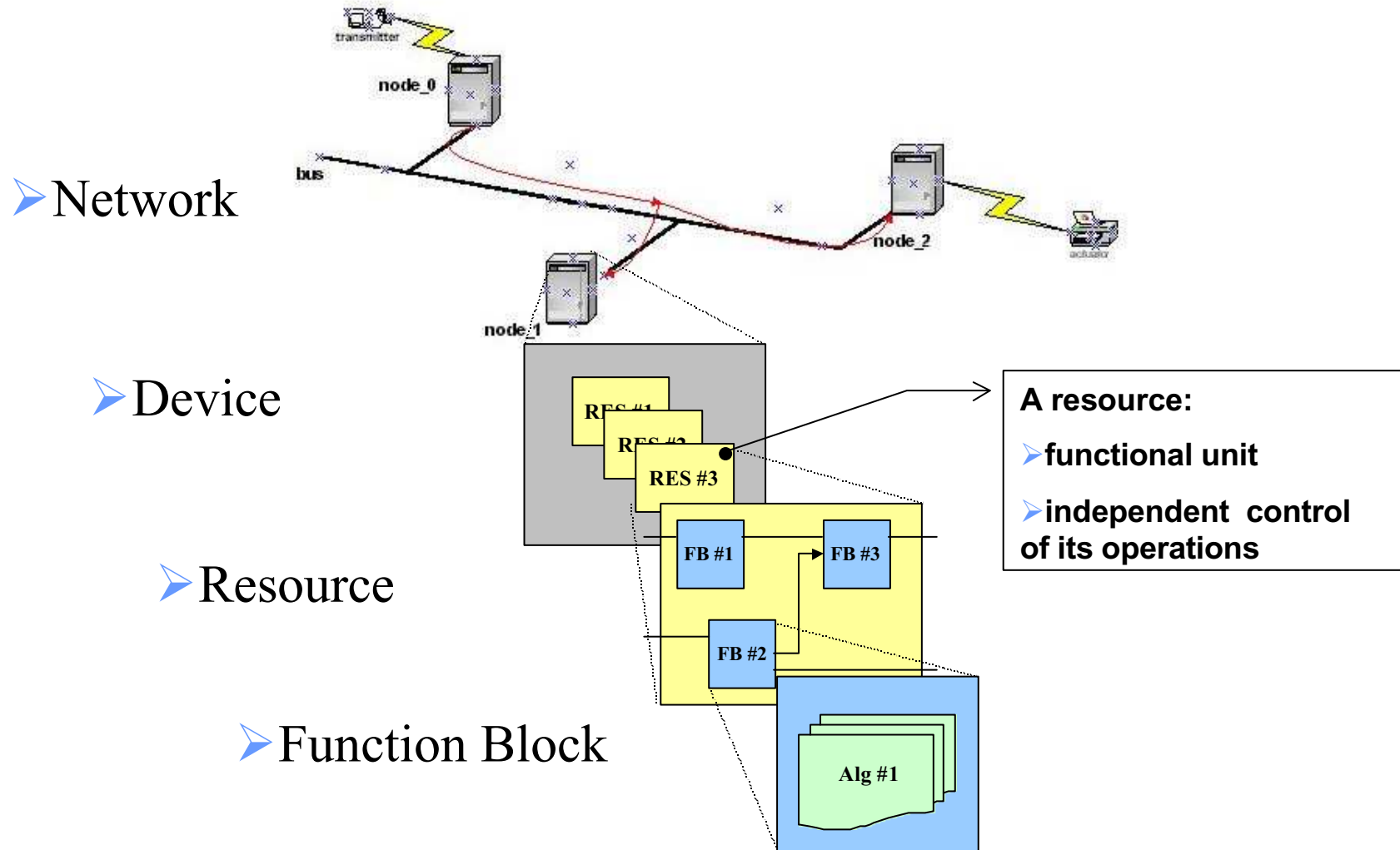
Objectives of FRDs is to describe:

- Control functions
- Performance
- Constraints

Problem:

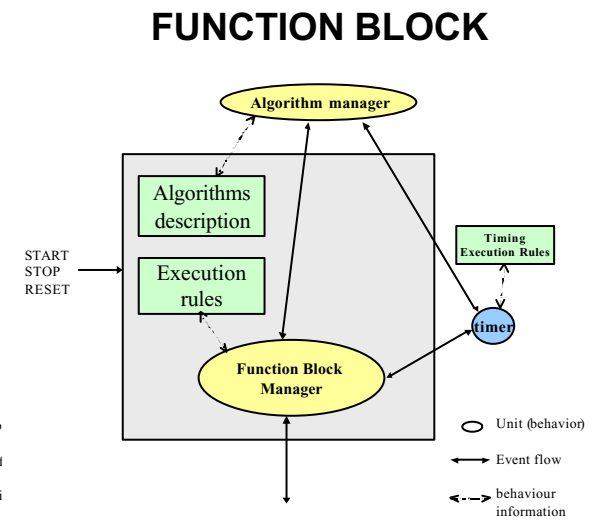
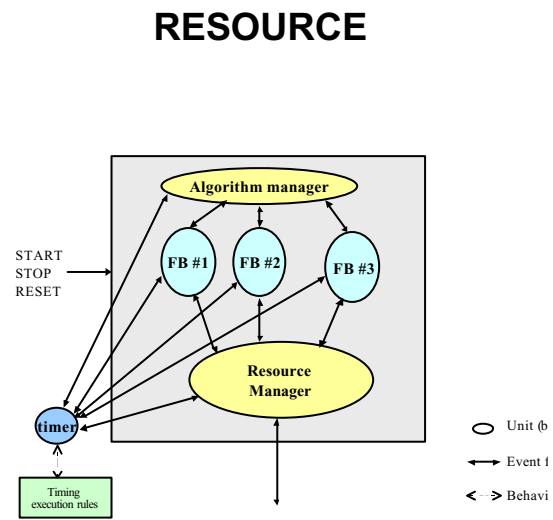
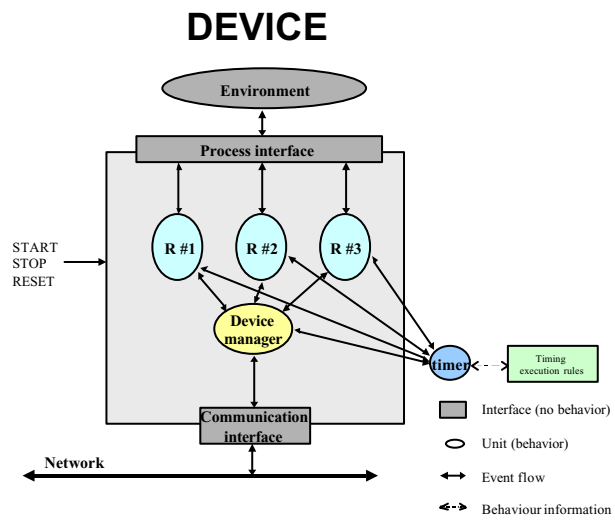
- FRDs consider only static aspects
- How to describe temporal characteristics

Considered Architecture model



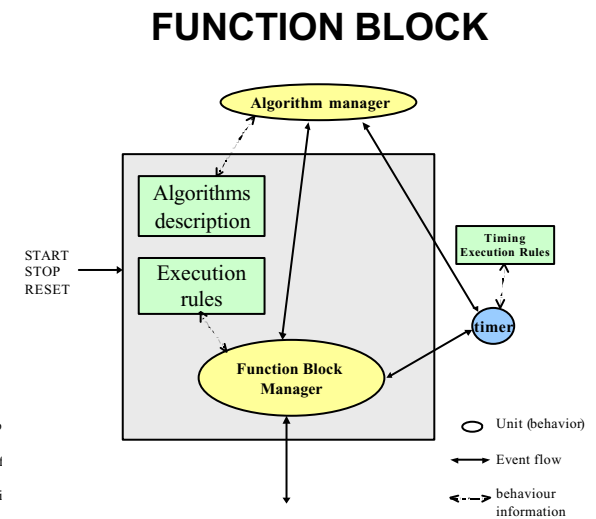
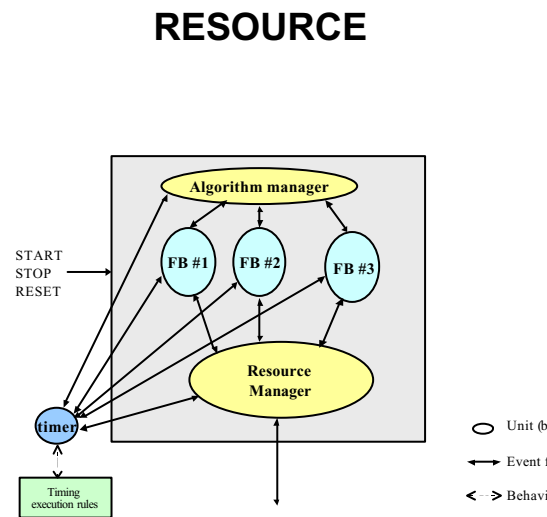
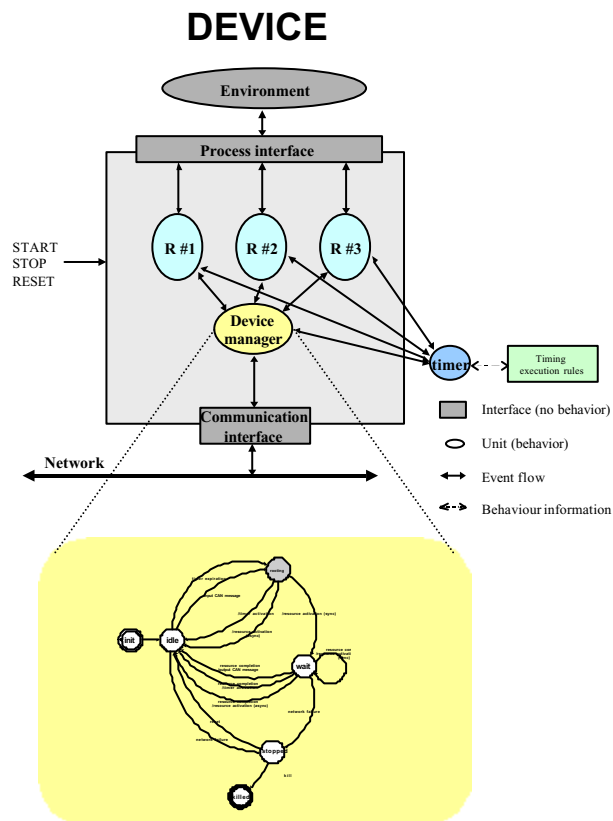
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Architecture model



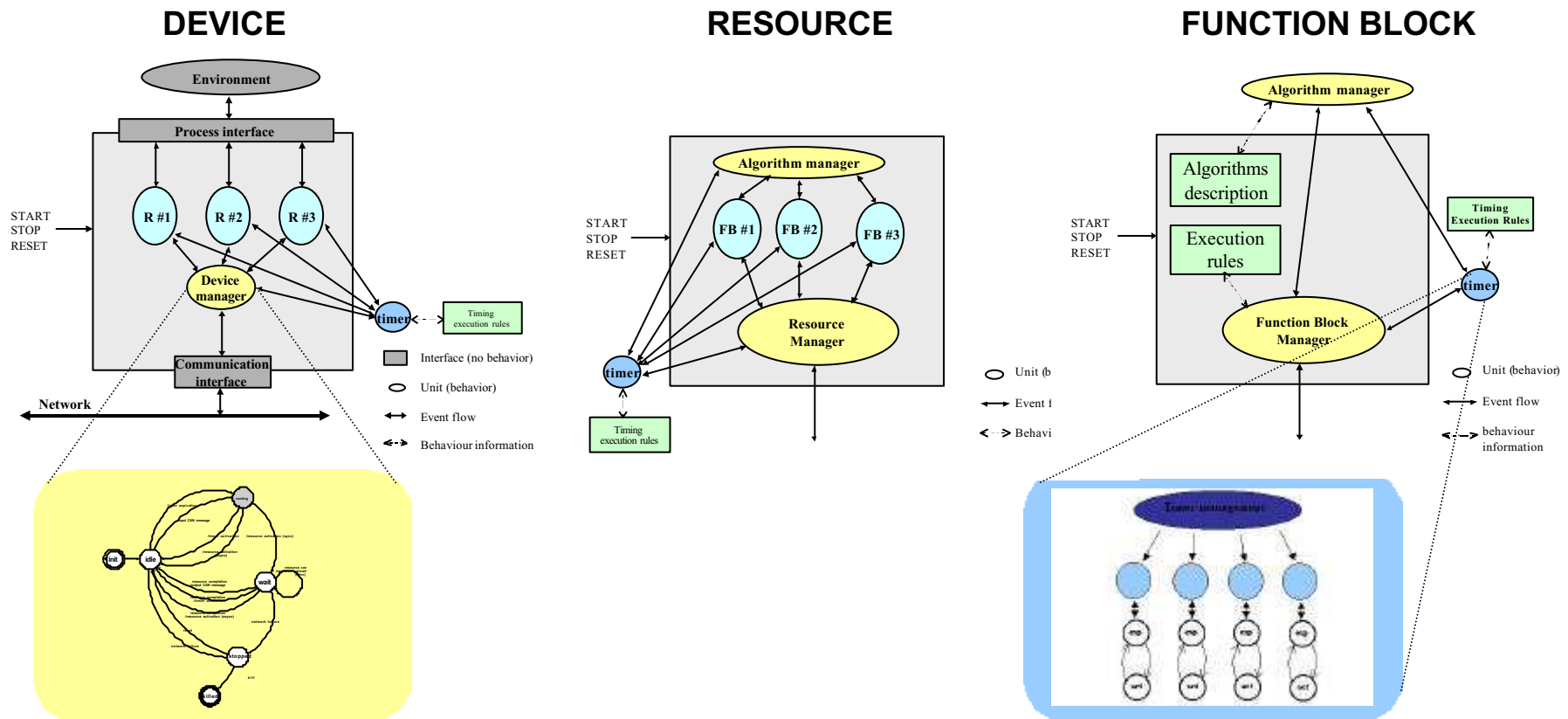
Architecture model

- For each level : introduction of a unit to manage the behavior;



Architecture model

- For each level : introduction of a unit to manage the behavior;
- Introduction of a global timer to modelize real timer and synchronization management.

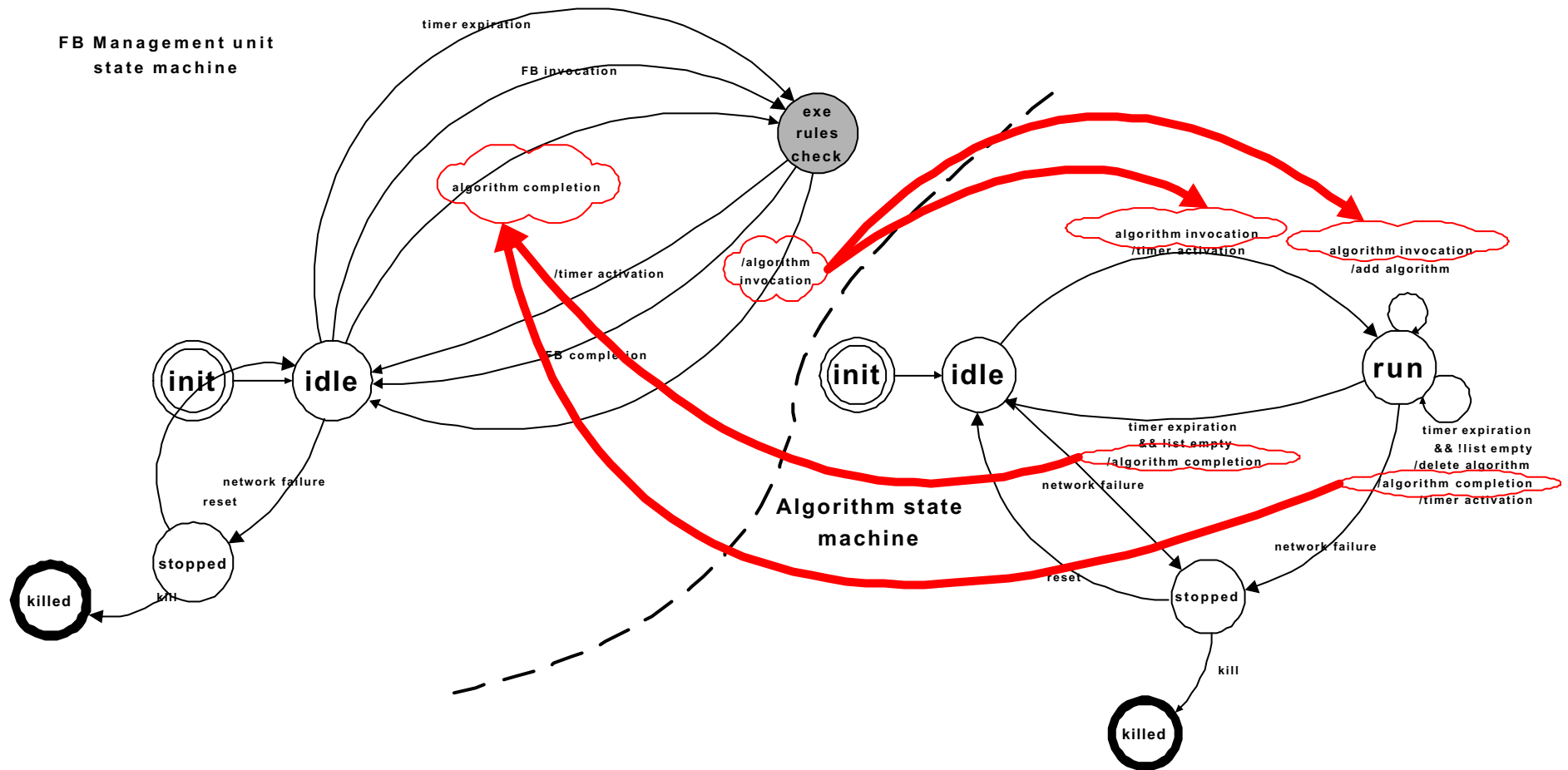


Execution model

- We only consider events (*necessary for the execution scheduling*)
 - Synchronous/asynchronous
 - Cyclic/acyclic

Execution model

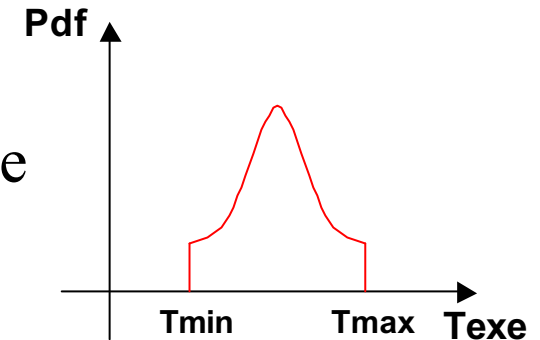
- We only consider events (*necessary for the execution scheduling*)
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Application behavior

Algorithm description

- Algo#ID: algorithm identifier
- [MinTime,MaxTime]: bounds of execution time
- Probability density function: distribution



Execution rules

« ON *event* IF *condition* DO *action* »

- Action to perform when an event occurs
- Condition: predicate on local variables
- Action: operations on local variables / event sending

« ON FB_invocation(num_port) DO Send (Algo_invocation(algoID), channelID) »

- Extensions

« AT *time* IF *condition* DO *action* »

« EACH *time* IF *condition* DO *action* »

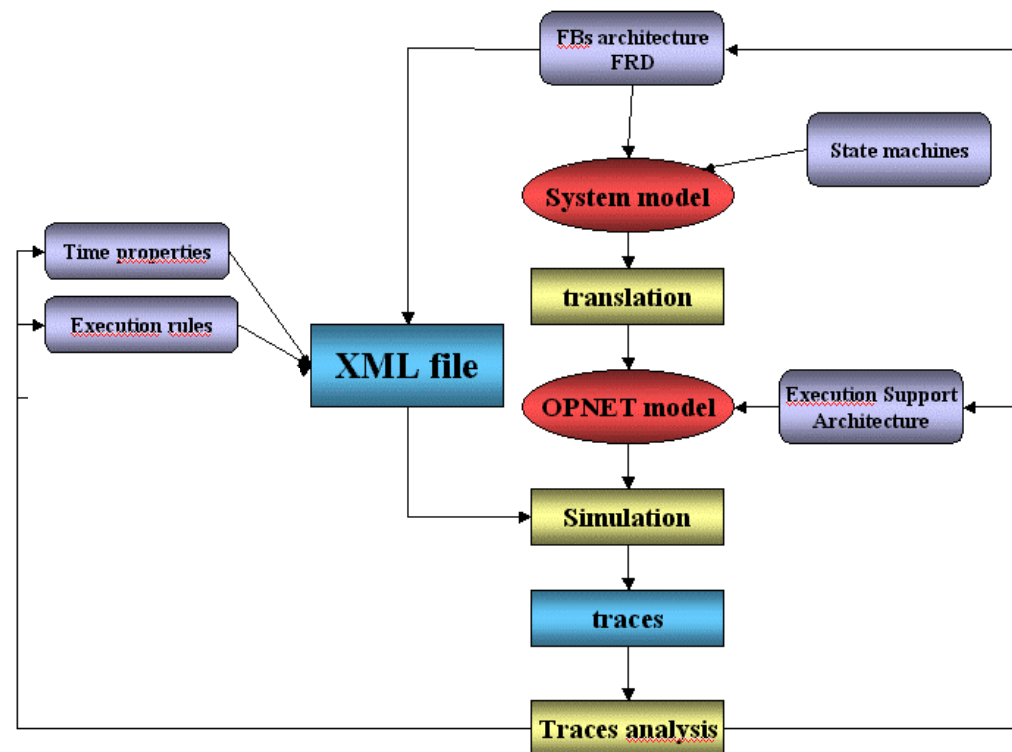
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Goals

- Validating system temporal properties
- System dimensioning regard to execution support architecture
- Distribution over resources

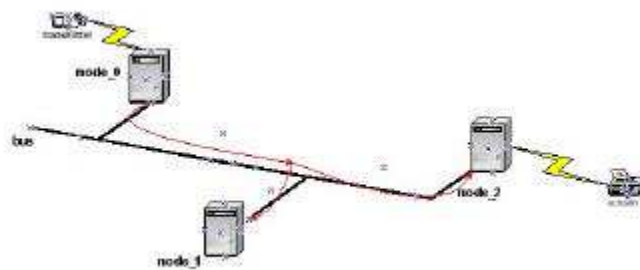
OPNET tool

- performance evaluation
 - Communication networks
 - distributed systems

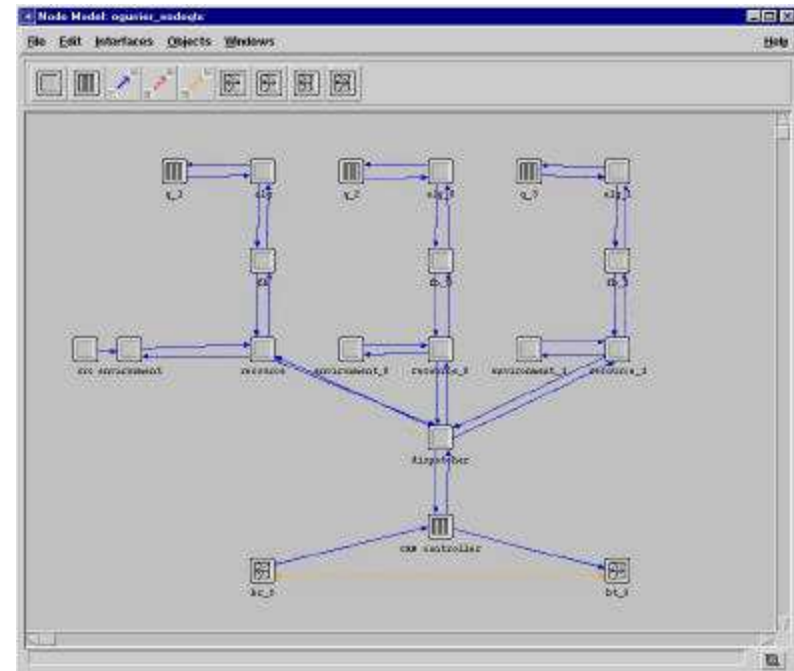


- Description of the standard
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Example



- Network: CAN protocol
- Device: composed by three resources
- Transmitters: random messages



- Delay between transmitter and actuator
- Average values



Delay increases in time

 System is not well dimensioned

Conclusion

Behavior model for Function blocks

- Rely on the structural architecture
- Dynamic behavior of an application = execution rules
- Execution rules used by state machines

Simulation

- Validating system temporal properties
- System dimensioning
- Distribution over resources

Future works

- Simulate complex applications
- Extend to other system features
- Detail the description of the behavior (*operational modes*)
- Time constraints in the execution rules (*timed automata*)