Introducing Behavior in Function Blocks

Xavier Rebeuf

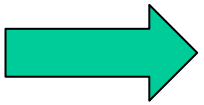
Introducing Behavior in Function Blocks

X. Rebeuf

(Xavier.Rebeuf@loria.fr)

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
- Composition of function blocks = Functional Requirement Diagram

→ Structural architecture


Validation of static interoperability


Not enough to validate temporal interoperability


Behavior modeling → Application simulation

Plan

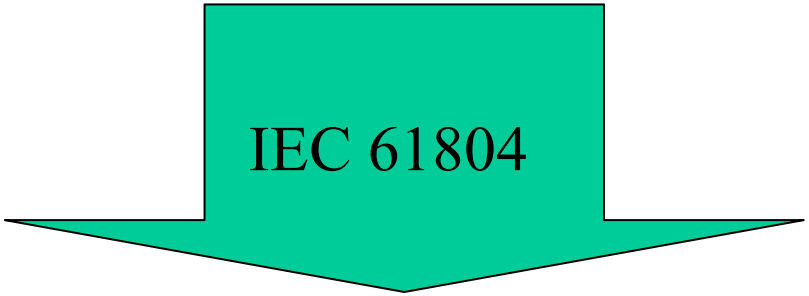
- **Description of the standard**
- **Adaptation taking into account the behavior**
- **Simulation of the application**
- **Example**
- **Conclusion**

Plan

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

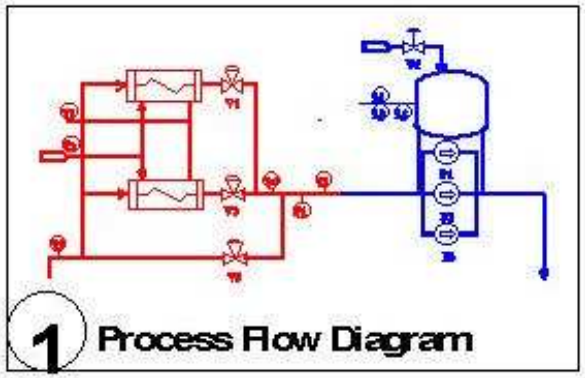
Function block concept

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

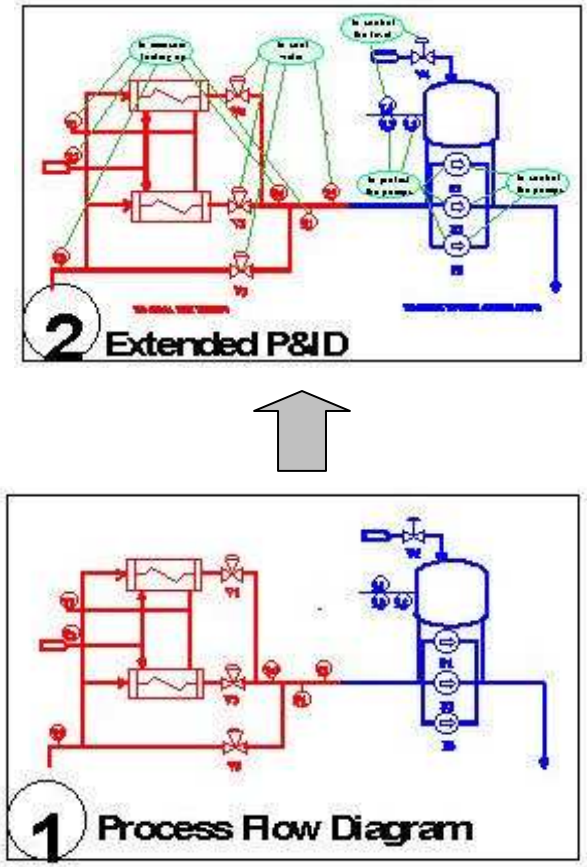


« function block is an encapsulation of data and algorithms to provide a specific function, which can be self understanding »

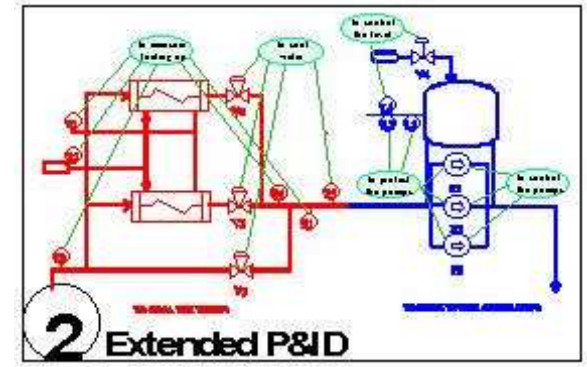
Function Blocks – How to use

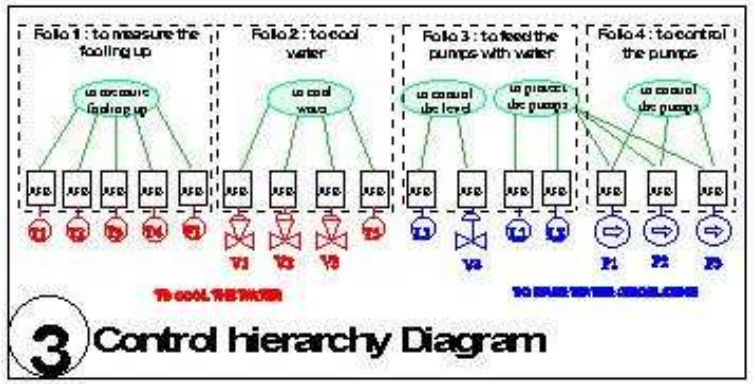


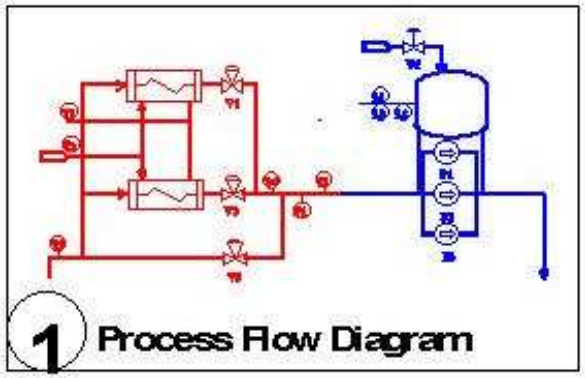
Function Blocks – How to use



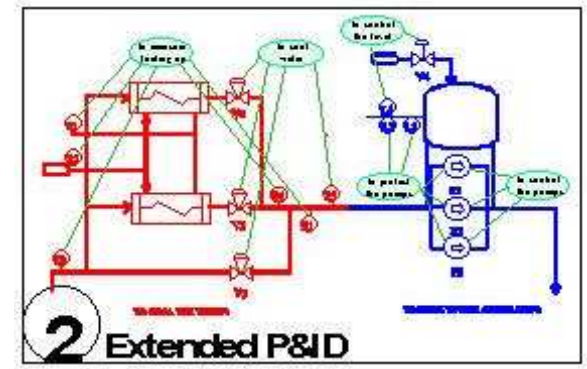
Function Blocks – How to use

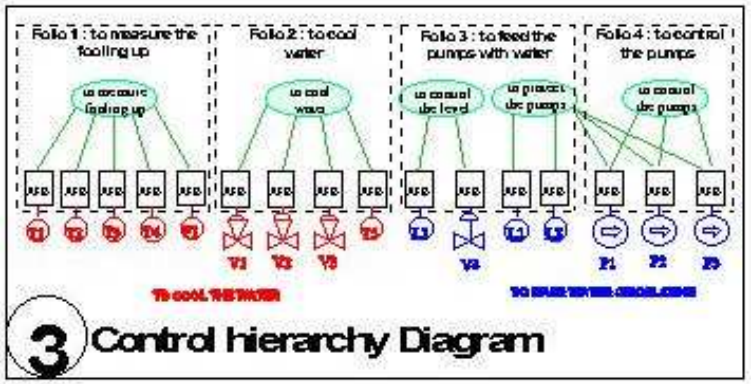


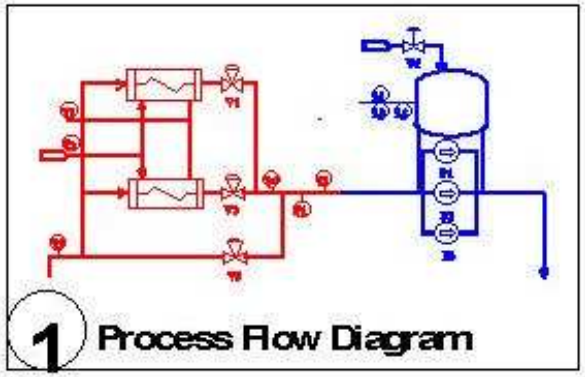


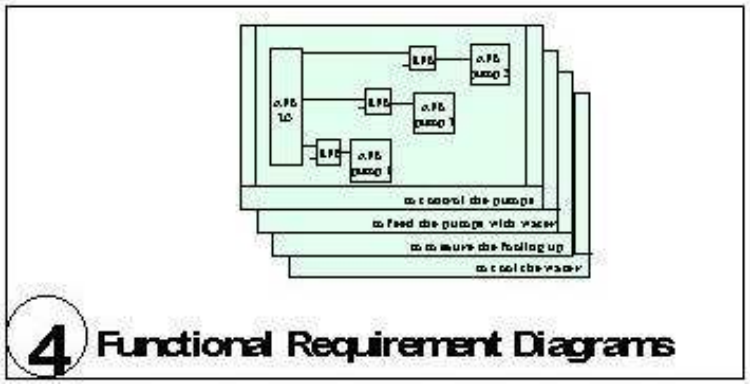


Function Blocks – How to use

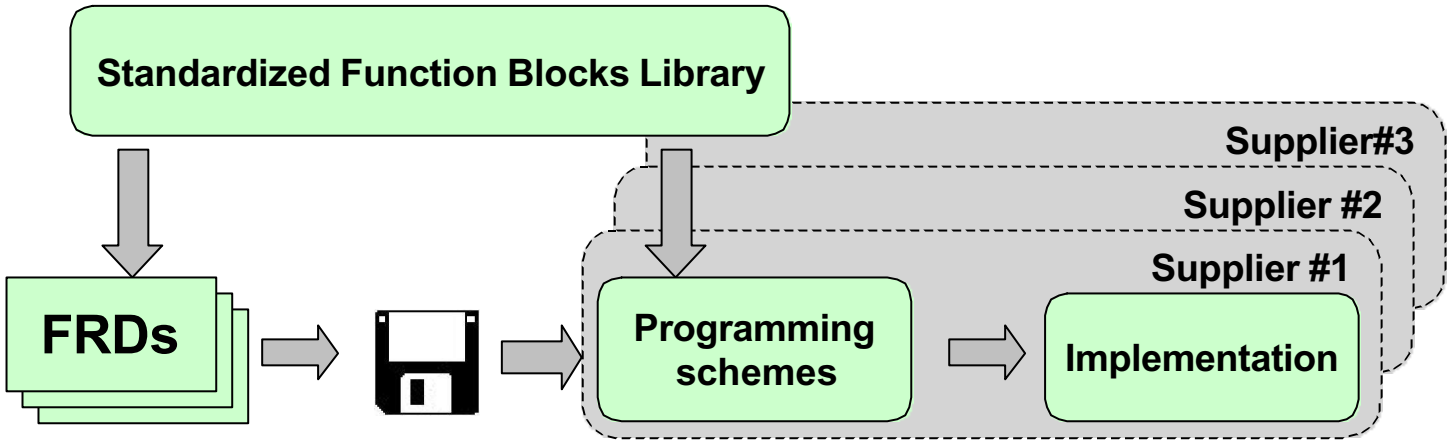








Functional Requirement Diagrams



Objectives of FRDs is to describe:

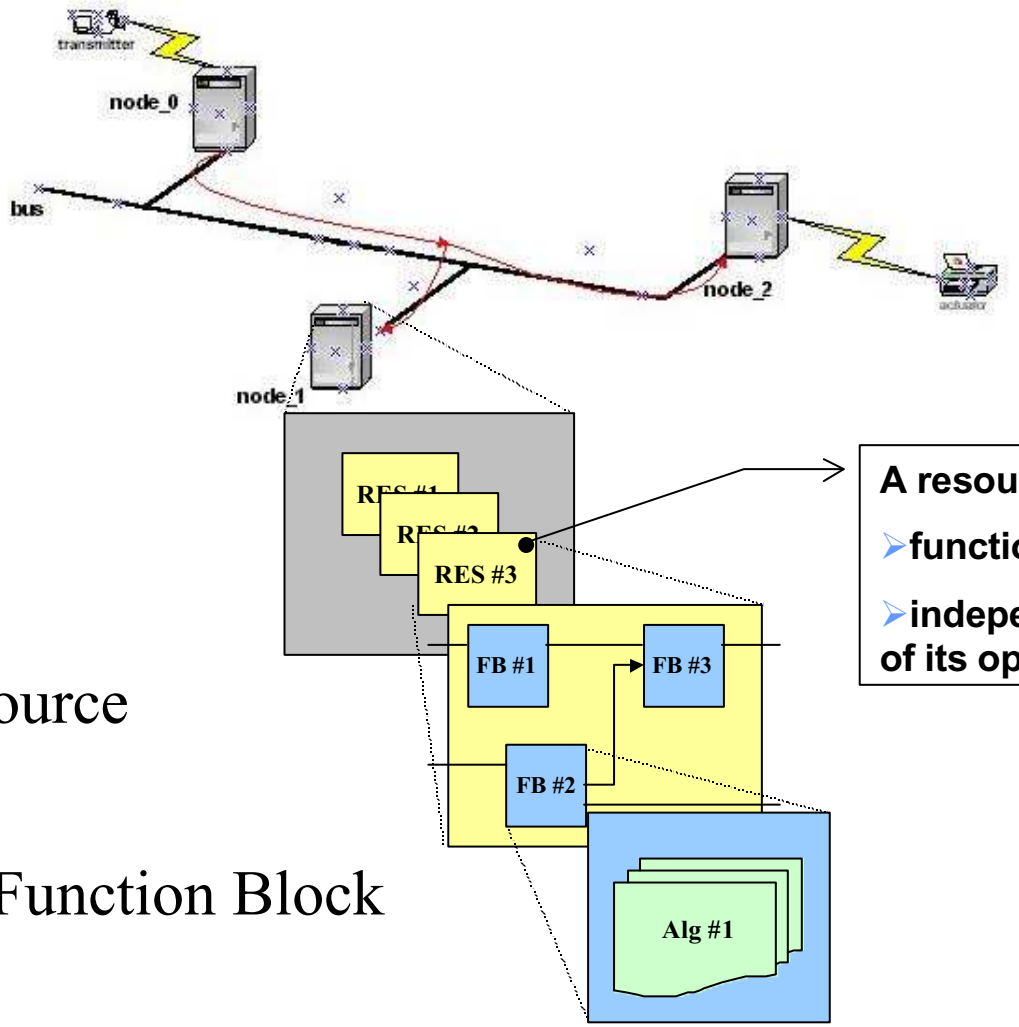
- Control functions
- Performance
- Constraints

Problem:

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

Considered Architecture model

- Network
- Device
- Resource
- Function Block



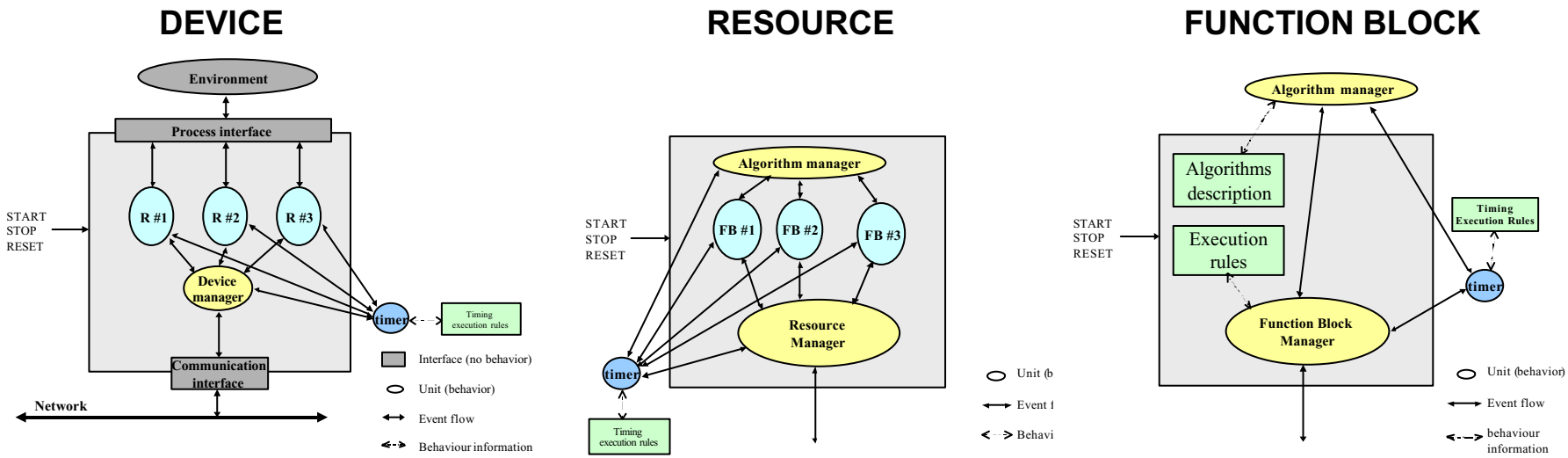
A resource:

- **functional unit**
- **independent control of its operations**

Plan

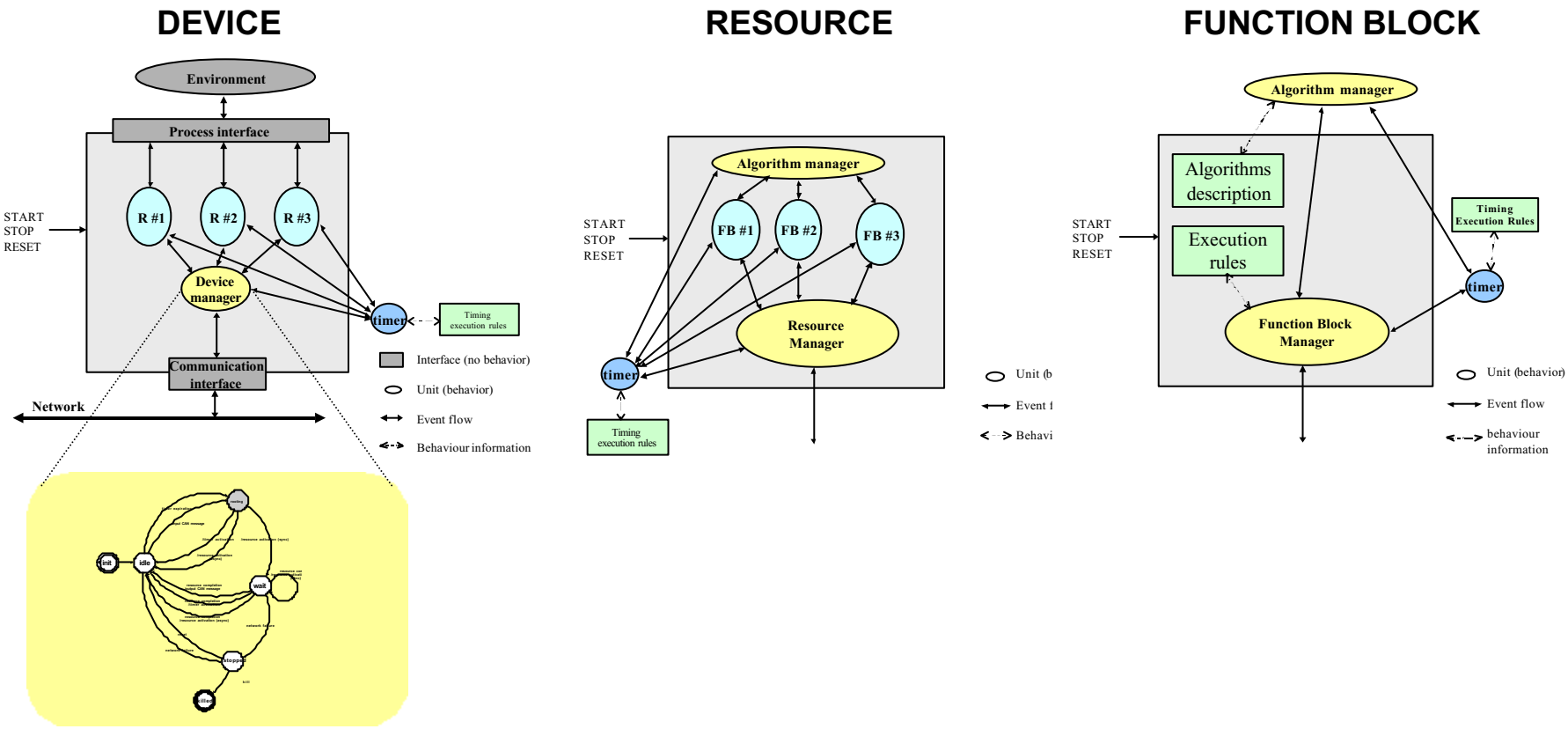
- Description of the standard
- **Adaptation taking into account the behavior**
- Simulation of the application
- Example
- Conclusion

Architecture model



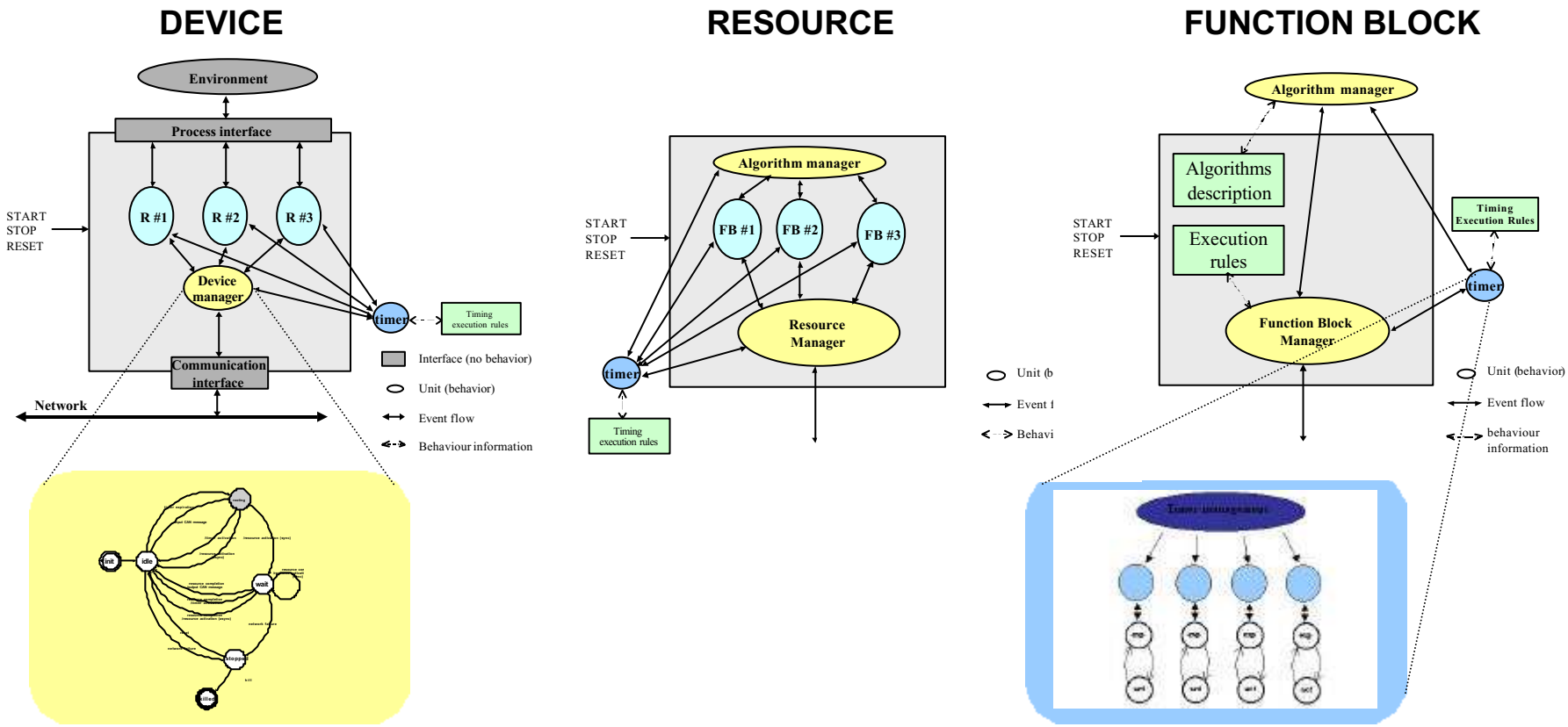
Architecture model

- 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.

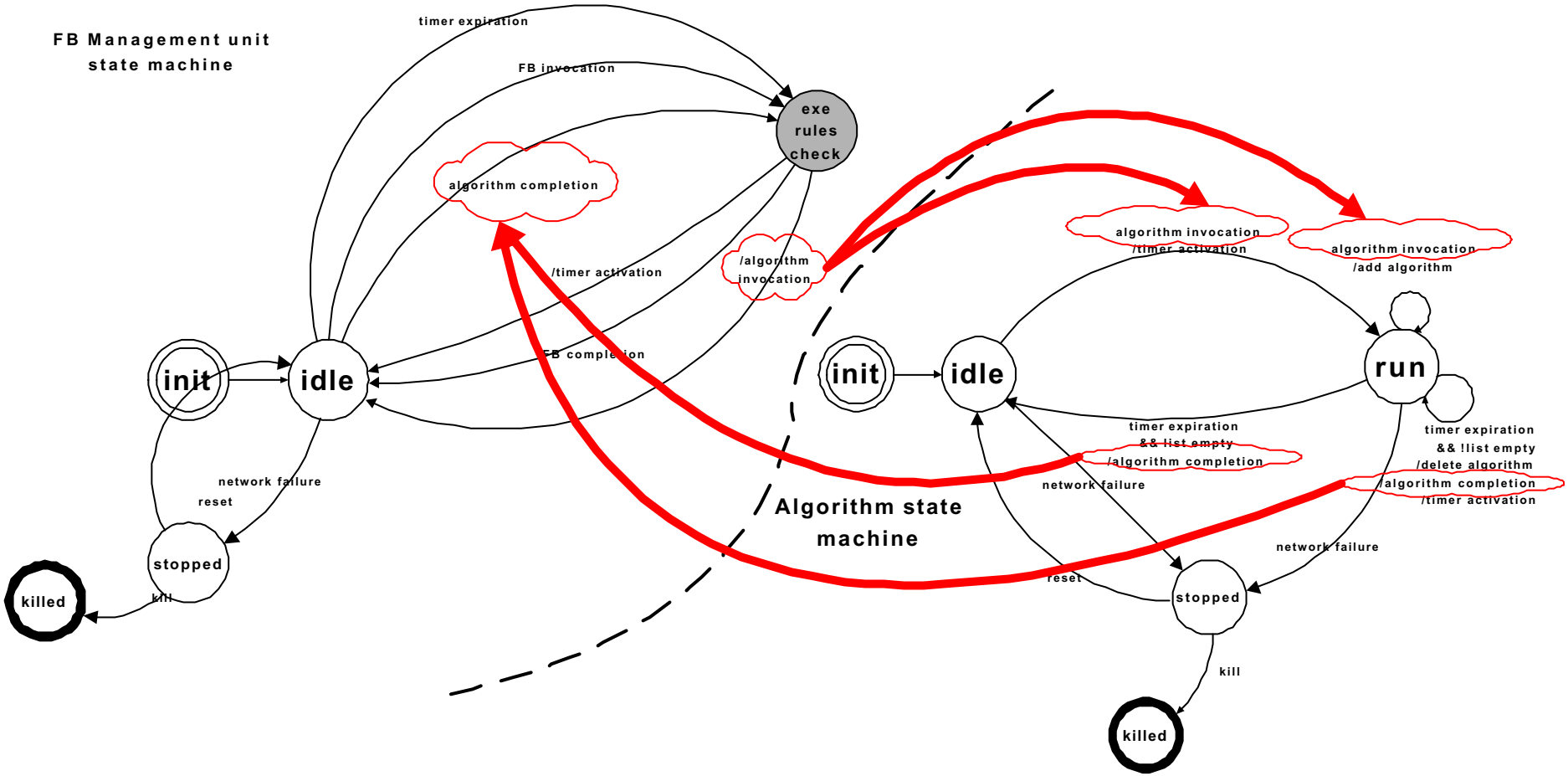


Execution model

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

Execution model

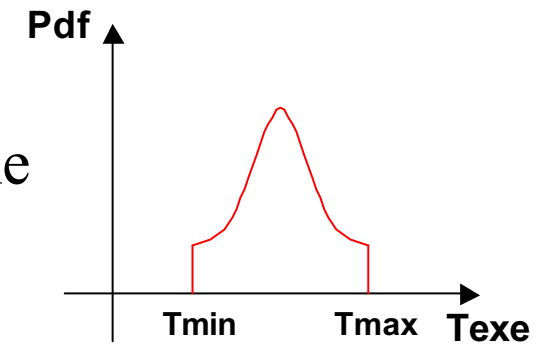
- We only consider events *(necessary for the execution scheduling)*
  - Synchronous/asynchronous
  - Cyclic/acyclic



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* »

Plan

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

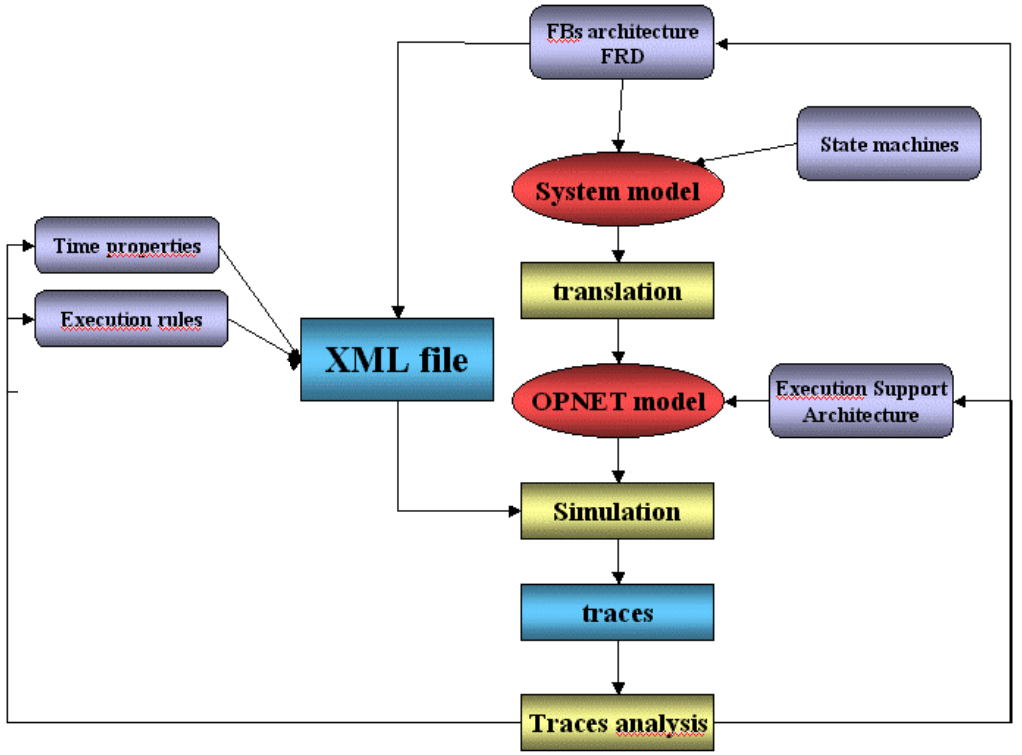
Simulation

Goals

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

OPNET tool

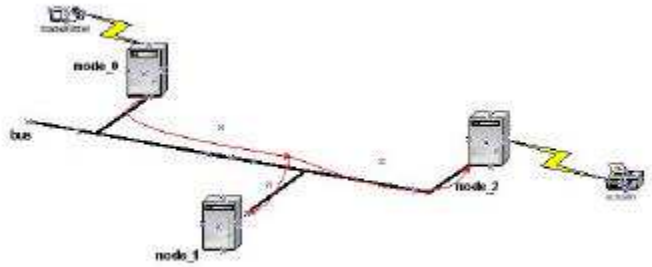
- performance evaluation
  - Communication networks
  - distributed systems

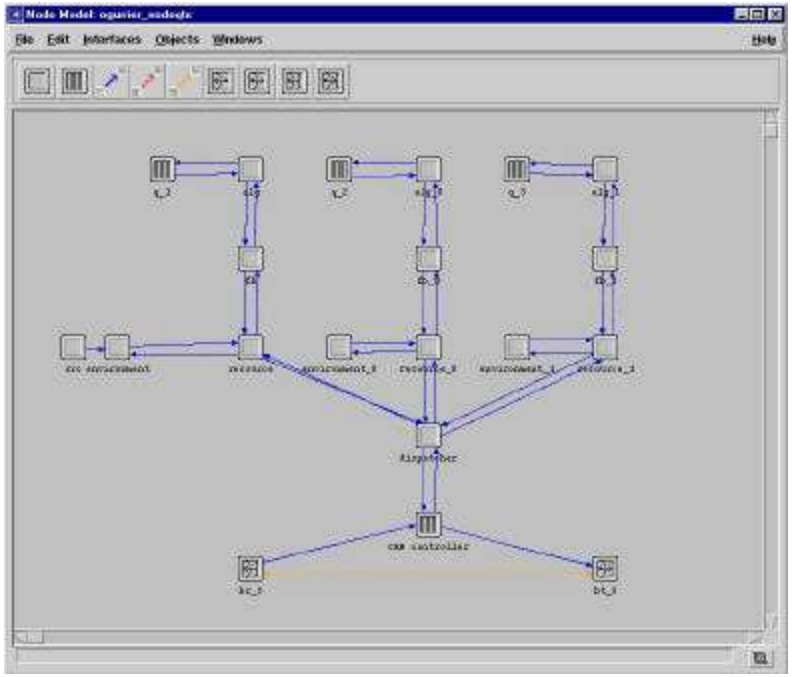


Plan

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

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)*