Automata-based decentralised diagnosis of discrete events systems

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and Alban Grastien

(thanks to the slides of Yannick)

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Outline

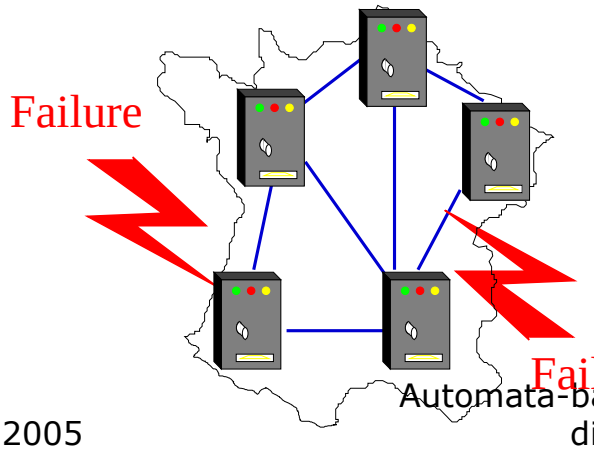
- Context
- Decentralised modeling
- Decentralised diagnosis

Systems to diagnose: the Magda context

Supervision center

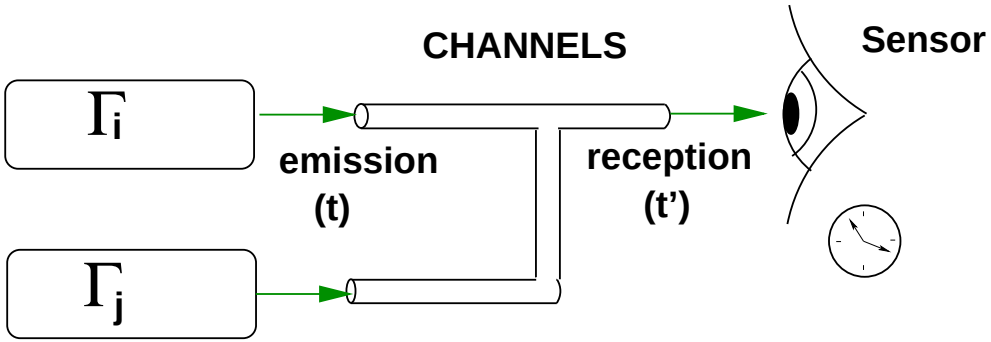
Purpose:
Identify the problems that could have occurred which explain the received alarms

Alarms



Detection,
Localisation,
Identification,
Propagation

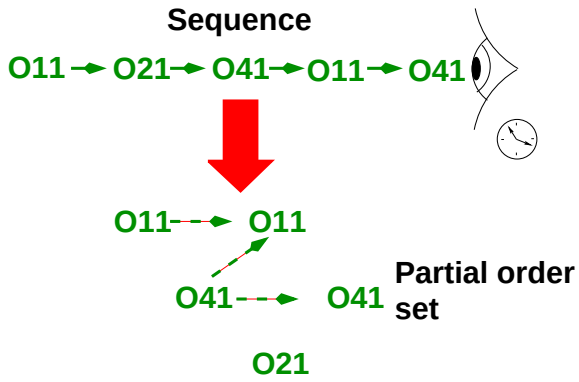
Observations



- Observation channels
  - Different propagation delays
- Observation = reception of a message by a sensor from a component
- Order of reception ≠ order of emission

Observations: partial order

- O: set of observations
  - Observation = message + date
- ≤
  - Partial order relation on the observations
  - Based on the observability



Diagnosis

- The behaviors on the model that explain the observations
  - Synchronisation of the model and the observations
  - Represented by an automaton (for efficiency)

What do we want?

- A unique supervisor $\Rightarrow$ centralised approach
- A modeling by automata

Diagnoser approach
[Sampath *et al.*] [Rozé *et al.*]

- Advantage:
  - Efficient computation
- Problem: impossible to compute
  - N components
  - 2^N states in the model
  - 2^{2^N} states in the diagnoser

➔ Decentralised approach

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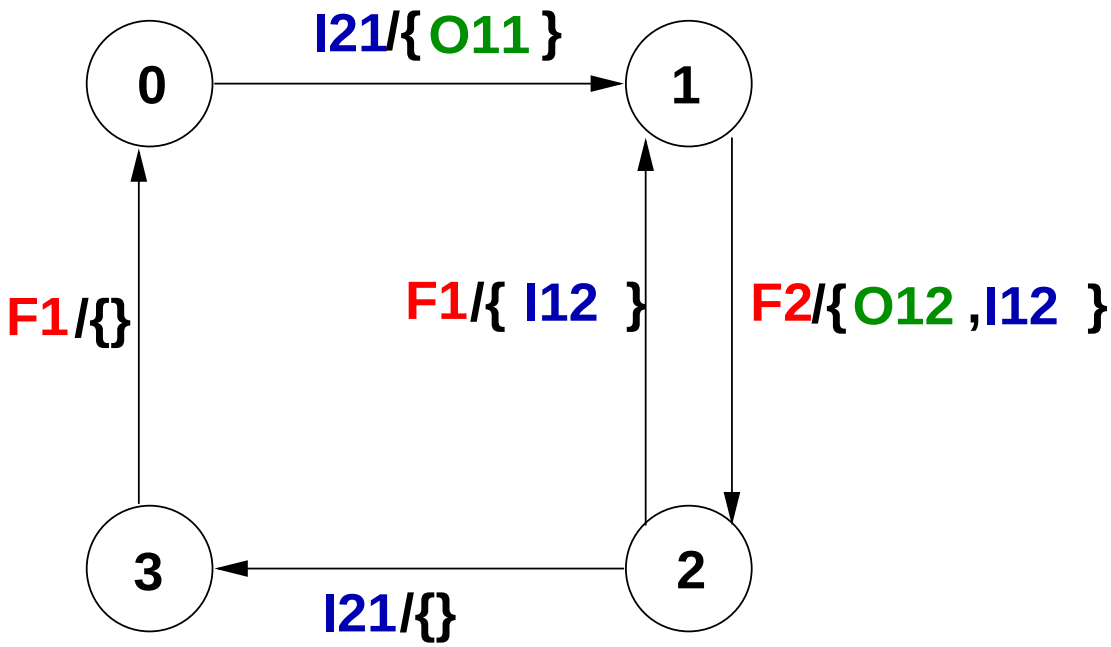
Model of a component (example) [Pencolé *et al.*]



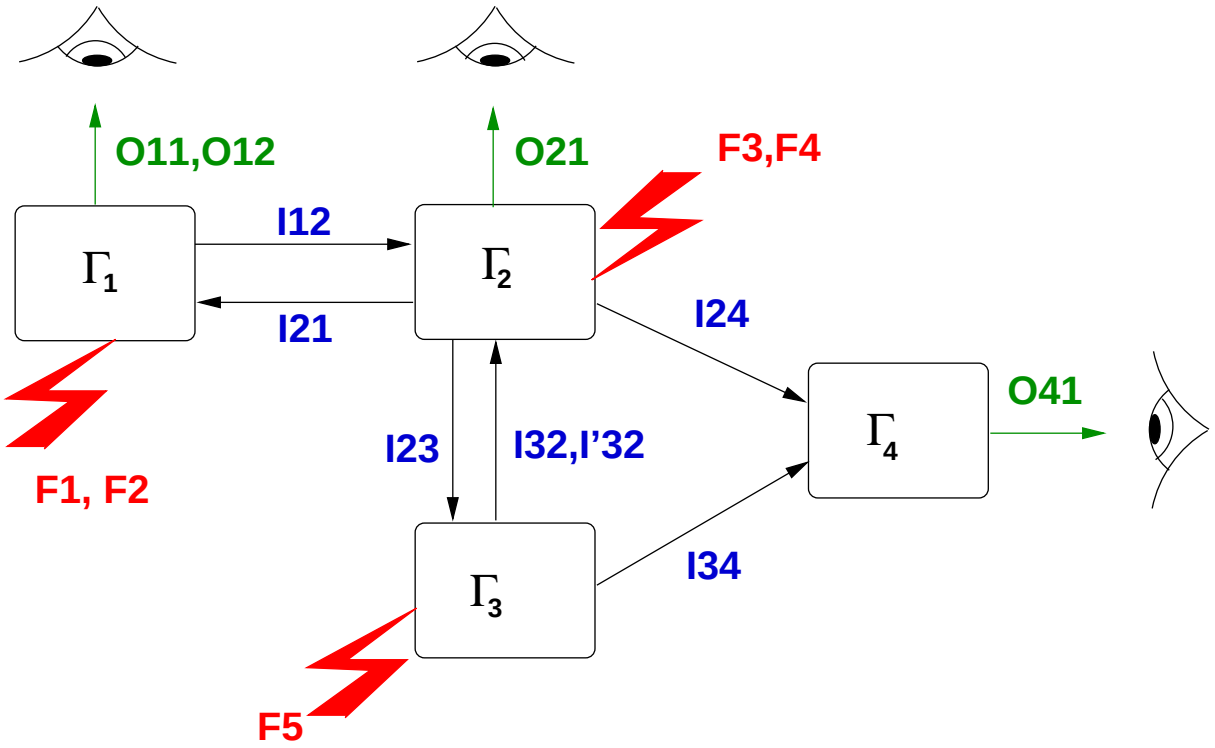
- Exo_i: **F1 F2**, Rcv_i: **I21**
- $Emit_i$: **I12**, Obs_i: **O11 O12**

Model of a component (formal)

$$\Gamma_i = (\Sigma^i_{dec}, \Sigma^i_{émis}, Q_i, E_i)$$

- Σ^i_{dec} set of received messages (Exo_i,Rcv_i)
- $\Sigma^i_{émis}$ set of emitted messages ($Emit_i$,Obs_i)
- Q_i set of states
- E_i set of transitions

Model of the system $\Gamma = \{\Gamma_1, \ldots, \Gamma_n\}$



- Implicit topology
- Synchronous communications!!

In Laurence Rozé's and Alban Grastien's modelings

- Each component has a set of ports
- An event is a pair *(message,port)*
- The topology is explicit
- Still synchronous

- The global model is computed in Laurence Rozé's works

Conclusion on decentralised modeling by automata

- Global model $||\Gamma||$
  - Size exponential in the number of components $\Rightarrow$ Impossible to compute
- Decentralised model
  - Size linear in the number of components
- Easy to model the reconfigurations

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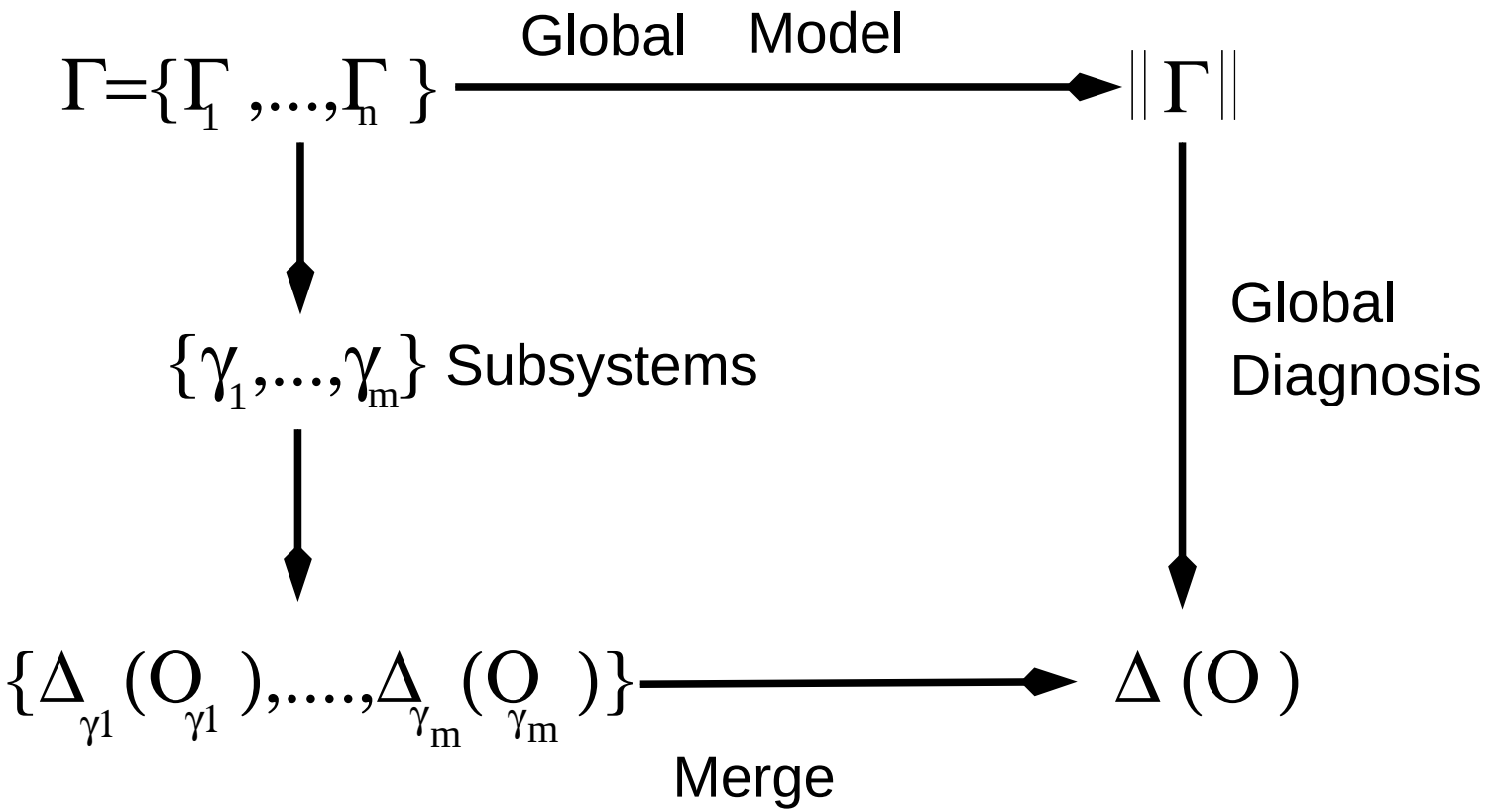
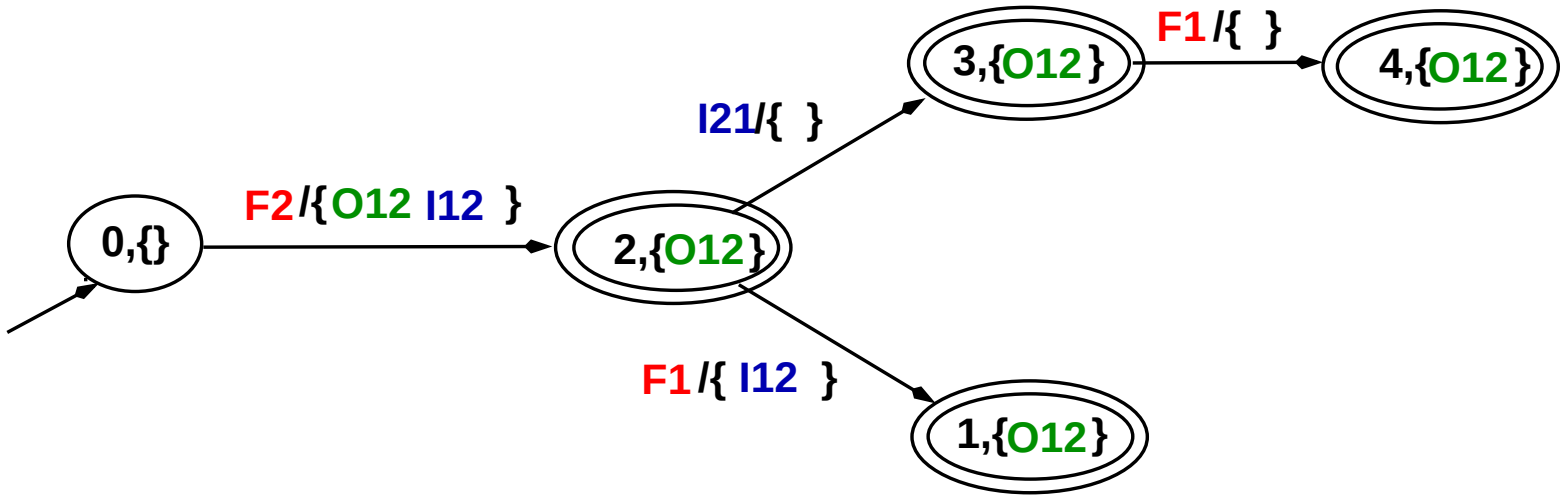
Principe of the decentralised approach for diagnosis



Local diagnosis

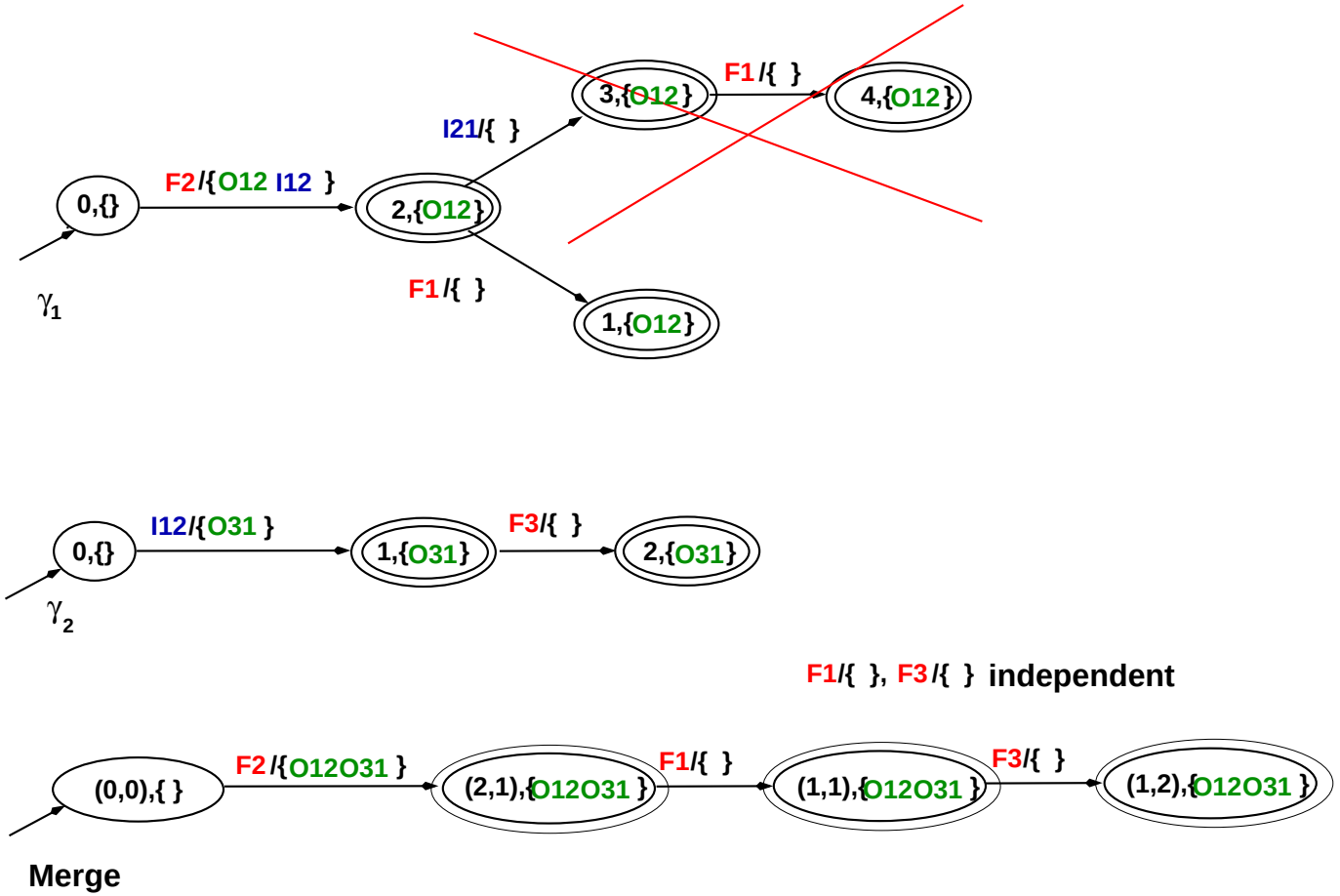
- Example: observation O12



Merging operation
Compute $\Delta_{\{\gamma1,\gamma2\}}$

- Compute the diagnosis of $\gamma = \{\gamma_1,\gamma_2\}$
- Use the local diagnoses $\Delta_{\gamma1}$ and $\Delta_{\gamma2}$
- Synchronise the emissions and receptions of messages
- Check the order of the observations

Merging operation



Merging strategy

- The merging may be not efficient!
- We use a *dynamic* strategy to choose which diagnoses to merge
  - merge dependant diagnoses
  - detect incompatible paths
- *The less I merge, the more efficient I am!* (Yannick P.)

Properties of the approach

- Decentralised model
  - Synchronous communications
- Decentralised diagnosis
  - Deals with partially ordered observations
  - Efficiently deals with concurrency
  - Use a merging strategy

Prospects

- Online diagnosis [Pencolé *et al.*]
  - Incremental diagnosis
- Modeling [Grastien *et al.04*] and diagnosis [Grastien *et al.??*] of reconfigurable systems
  - Easy to represent the modification of the topology or the components