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SCOLA: a Scenario Oriented LAnguage for railway system specifications

Melissa Issad (melissa.issad@siemens.com)

Antoine Rauzy (ECP), Leila Kloul (UVSQ) and Karim Berkani (Siemens)

Laboratoire de Génie Industriel, Ecole Centrale Paris

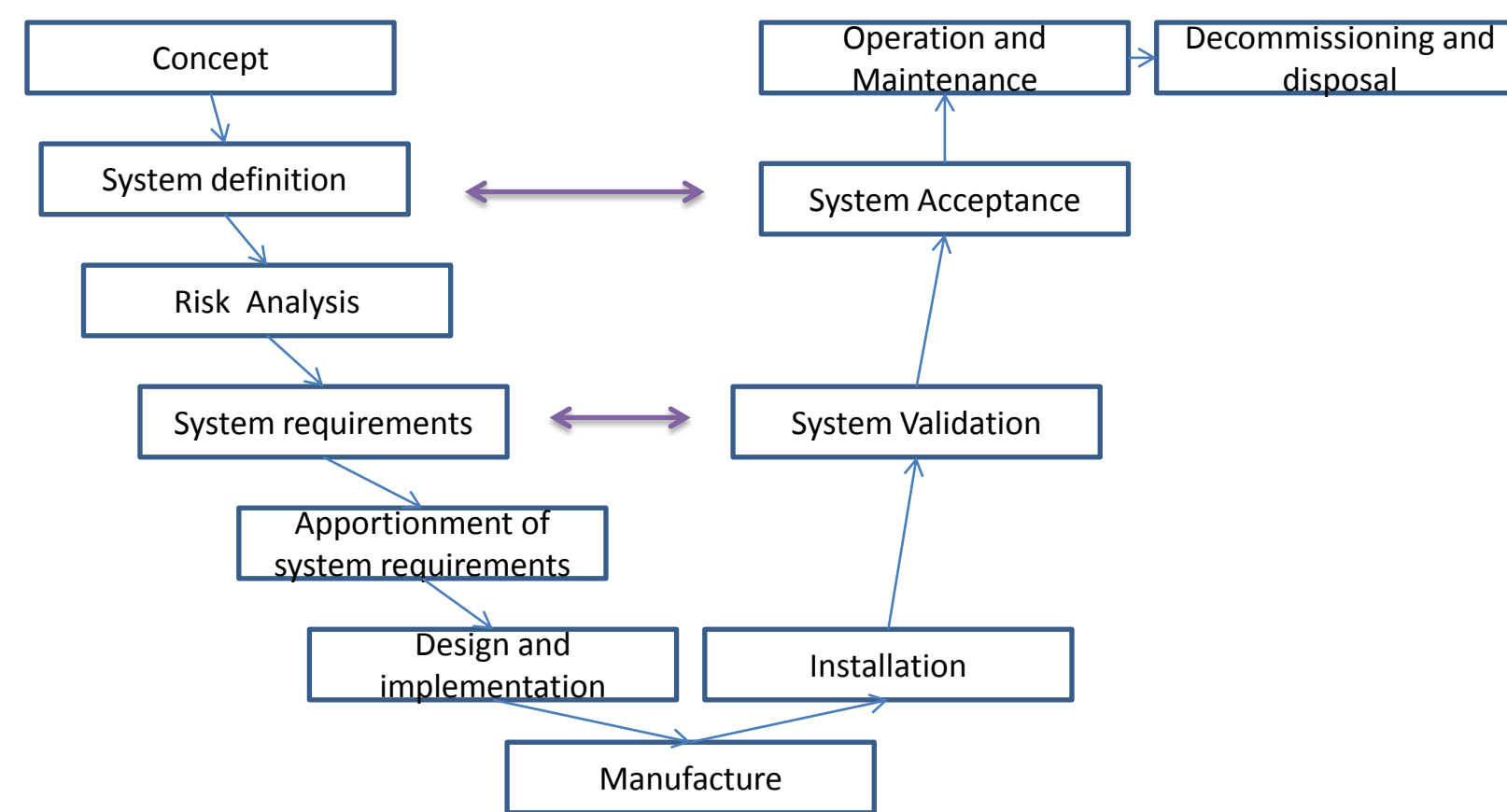
Siemens Mobility

1. Context



Siemens
Railway
Automation
solutions

- PA 135 (Paris, Mexico, Lyon, Santiago, Caracas, Praha)
- SACEM (Paris, San Juan, Mexico, Hong Kong)
- Trainguard MT CBTC (Paris, New York, Barcelona, Budapest, Algiers, Sao Paolo)



System specifications

- Written in a natural language.
- Ambiguous.
- Non-modular.

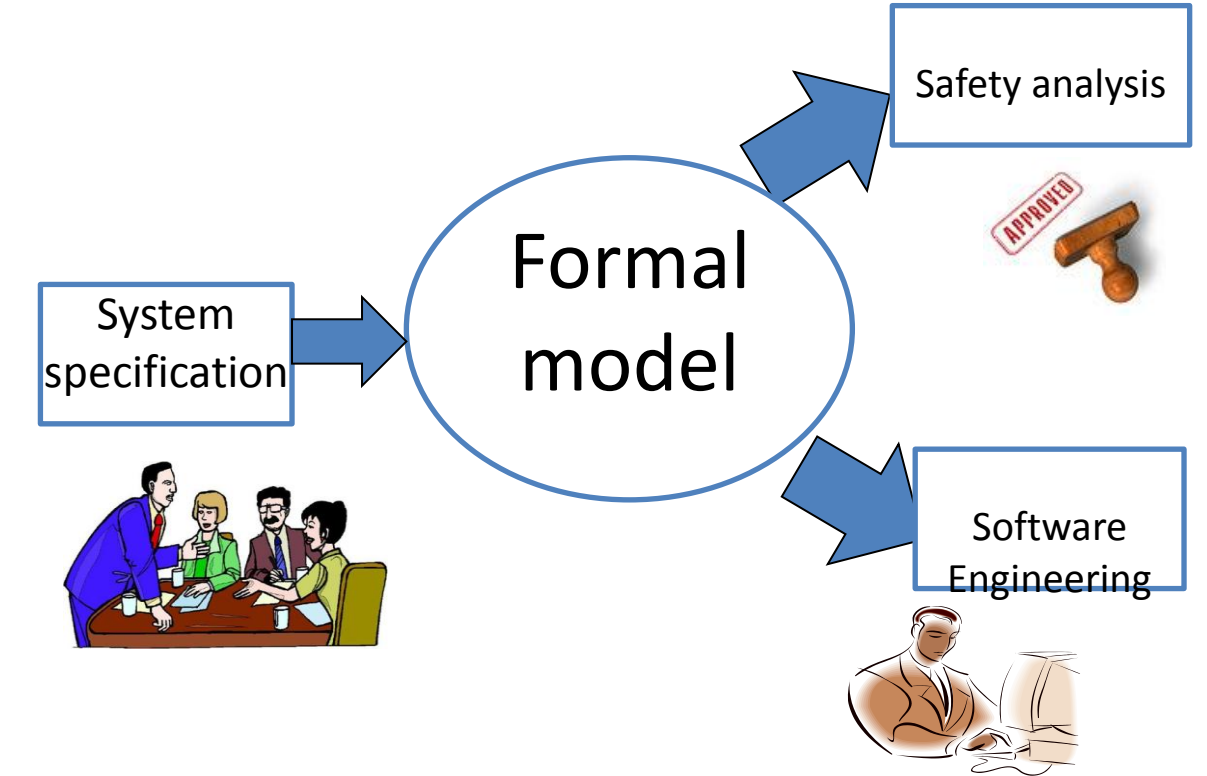
System engineering process

- Unlinked phases.
- Each phase uses a different process which increases its runtime.

System validation

- Late detection of the errors:
- Expensive
- Lack of automation

2. Objective



Formalize the informal

Unify the system description

Link with formal tools

Obtain a graphical representation

3. The idea

How?

When?

- System architecture:
- Functional view
- Structural view
- Behavioral view
- Functional scenarios

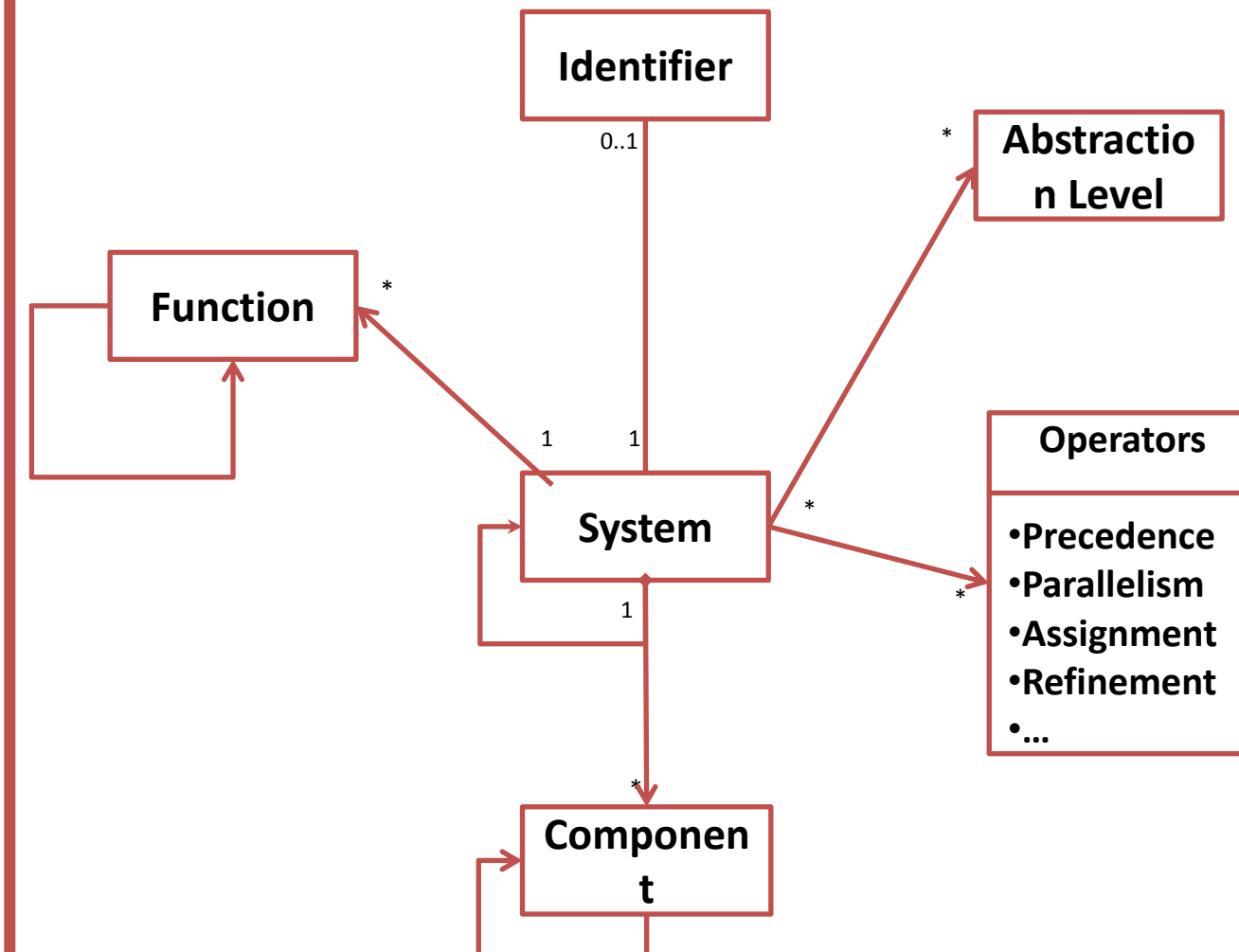
- Identifying the abstract concepts of the system and their relationships

- At the very first steps of the system design

Where?

- ❑ Instead of looking at systems **options**, we must identify systems **concepts**
- ❑ Build a formal modeling language based on the concepts and that fits the behavior of the system

4. A system in SCOLA



5. The concepts of SCOLA

Textual

Graphical

Precedence $f_1 \rightarrow f_2$

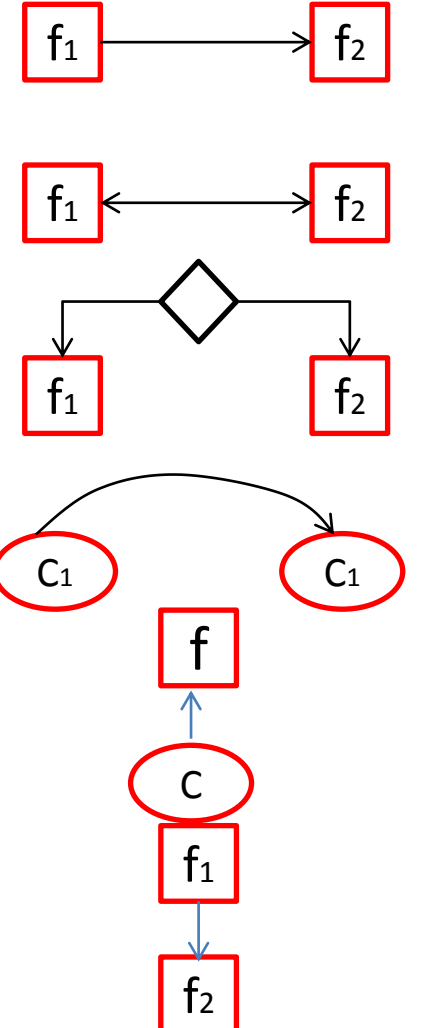
Parallelism $f_1 \parallel f_2$

Choice $f_1 \text{ or } f_2$

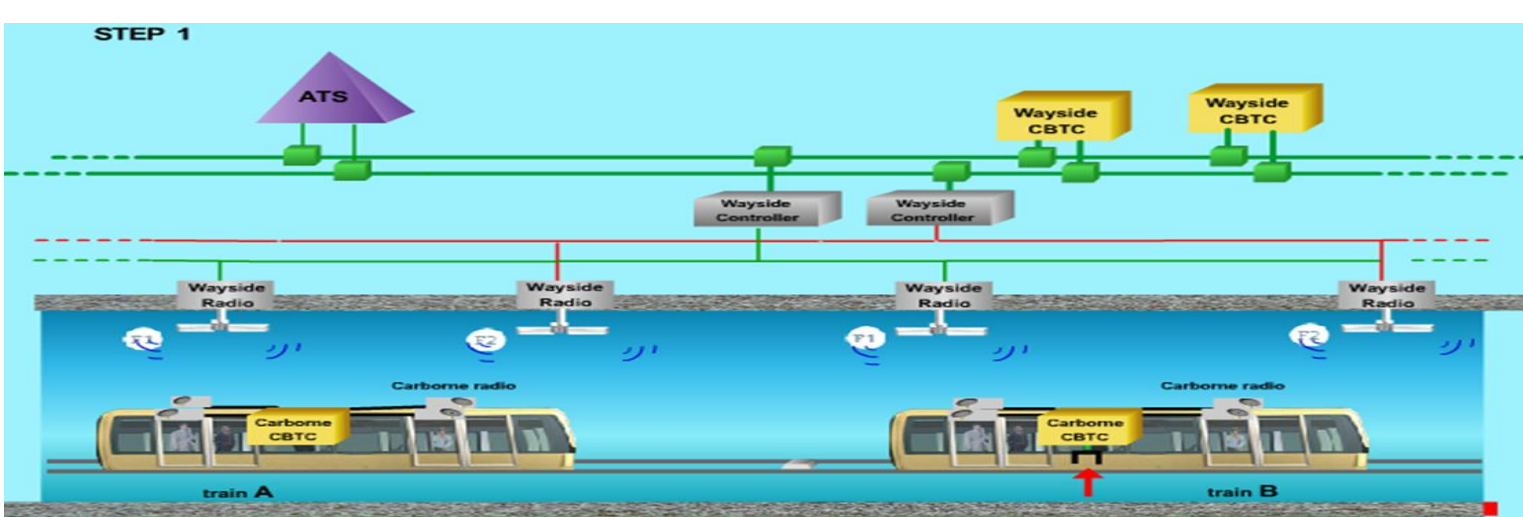
Cooperation from C_1 to C_2

Assignment by C

Refinement $L_n \downarrow L_{n+1}$



6. Case Study



The Arrival At Station Scenario

f0,1: The **wayside** selects the stopping point

f0,2: The **wayside** sends the stopping point to the **train**

f0,3: The **train** triggers the braking system

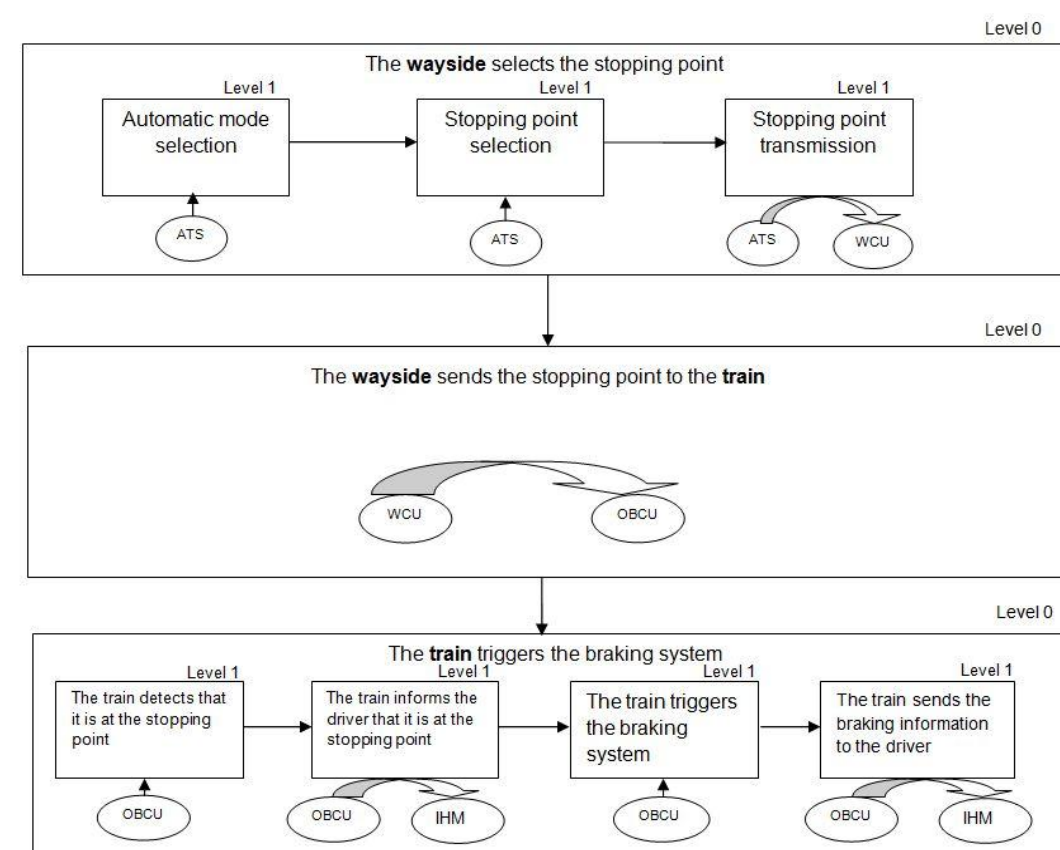
f1: The **train** detects that it is at the stopping point

f2: The **train** informs the **driver** that it is at the stopping point

f3: The **train** triggers the braking system

f4: The **train** sends the braking information to the **driver**

7. Graphical Representation



9. Conclusion

- ❑ A novel scenario based modeling formalism
- ❑ Relies on a formal semantics
- ❑ Provides multiple levels of abstraction
- ❑ Generic enough to be used for all the complex systems
- ❑ A stepping stone for the dysfunctional scenarios modeling

8. Textual Representation

```
Scenario system with TGHT {
  Scenario F01 = "The trains calculate their positions" {

    Action F11 = "Train1 determines its position" By TGHT.obcu1 ;
    Action F12 = "Train2 determines its position" By TGHT.obcu2 ;
    Script F11 || F12 ;
  }

  Scenario F02 = "The trains send their position to the wayside" {
    Transfer F11 = "Train1 sends its position to the wayside" From TGHT.obcu1 to TGHT.wcu ;
    Transfer F12 = "Train2 sends its position to the wayside" From TGHT.obcu2 to TGHT.wcu ;
    Script F11 || F12 ;
  }

  Action F03 = "The wayside determines the space limit between the two trains" by TGHT.wayside ;
  Scenario F04 = "The wayside transmits the safe distance limit to the trains" {
    Transfer F11 = "The wayside transmits to train1" From TGHT.wcu to TGHT.obcu1 ;
    Transfer F12 = "The wayside transmits to train1" From TGHT.wcu to TGHT.obcu2 ;
    Script F11 || F12 ;
  }

  If test = "Limit Reached" {Action F05 = "Emergency brake of the train2" By TGHT.obcu2 ;}
  else {Action F06 = "the train determine their speed limit plan" By TGHT.obcu1 ;
  Action F07 = "the train determine their speed limit plan" By TGHT.obcu2 ;}

  Script F01 -> (F02 -> (F03 -> test -> (test.F05 or (test.F06 -> test.F07)))) ;
}
```