

Asynchronous modeling in railway systems

emmanuel.gaudin@pragmadev.com



Different types of models

Models are targeting a specific goal:

- Requirements
- Architecture
- Specification
- Property verification
- Design



Different modeling technologies

- SysML Requirements
- AADL Architecture
- ASN.1 Interfaces
- SDL Functional behavior
- Matlab Control laws
- Lustre Logical control
- B Mathematical predicates



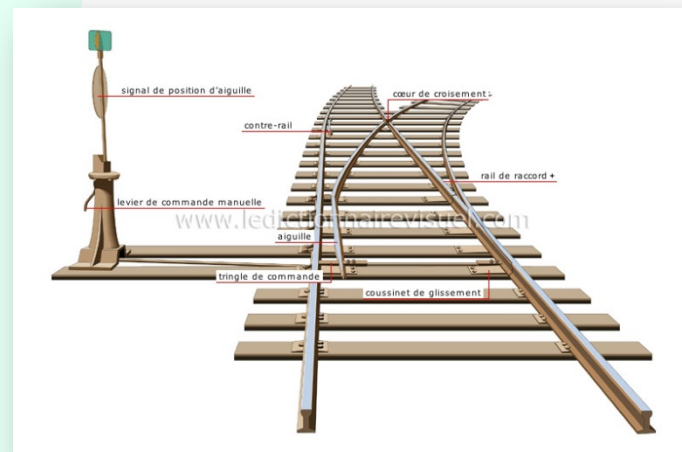
Precision

Basic train systems

- Mainly binary information
- Logical operation



*Open door if facing a
platform*

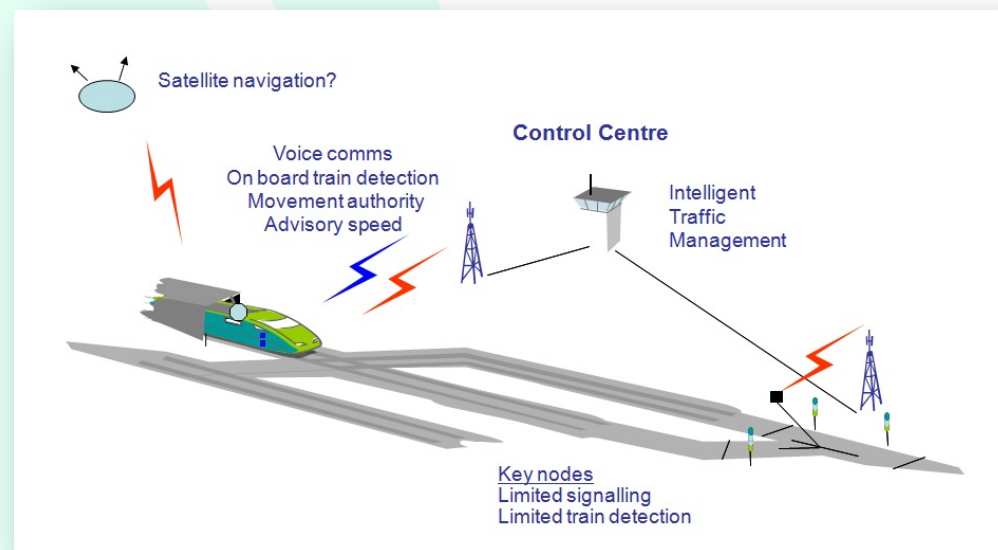


*Needle position
depending on train
presence*

Upcoming systems

ERTMS: European Rail Traffic Management System deals with:

- Speed
- Acceleration
- Communication



Needs

- Higher abstraction models
- Asynchronous high level representation
- Synchronous locally (GALS)



Solution

- SDL models
 - Asynchronous semantic of execution
 - Executable => verifiable
- Use SDL to describe the overall behavior
- **How does it relate to a local synchronous approach ?**



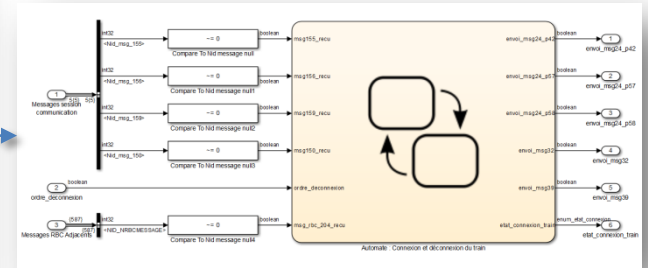
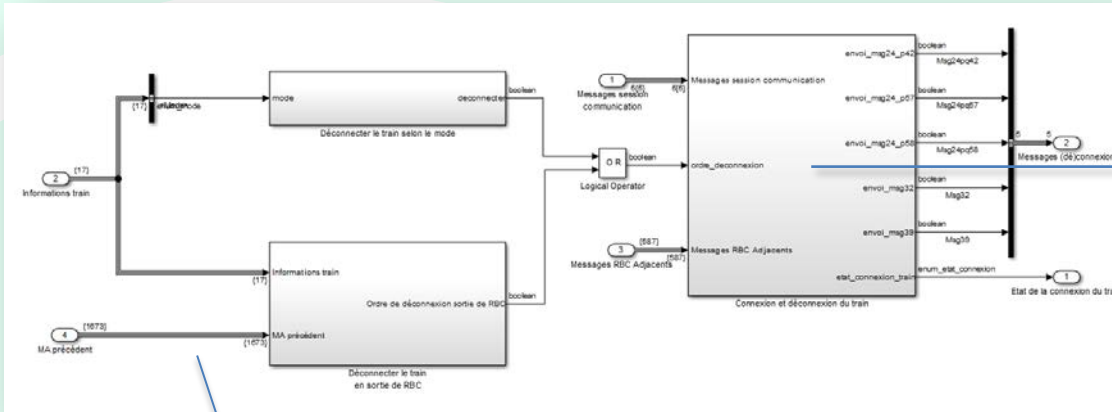
*Specification and
Description Language
is an ITU-T
recommendation*

Experiment

Radio Block Center from ERTMS recommendation

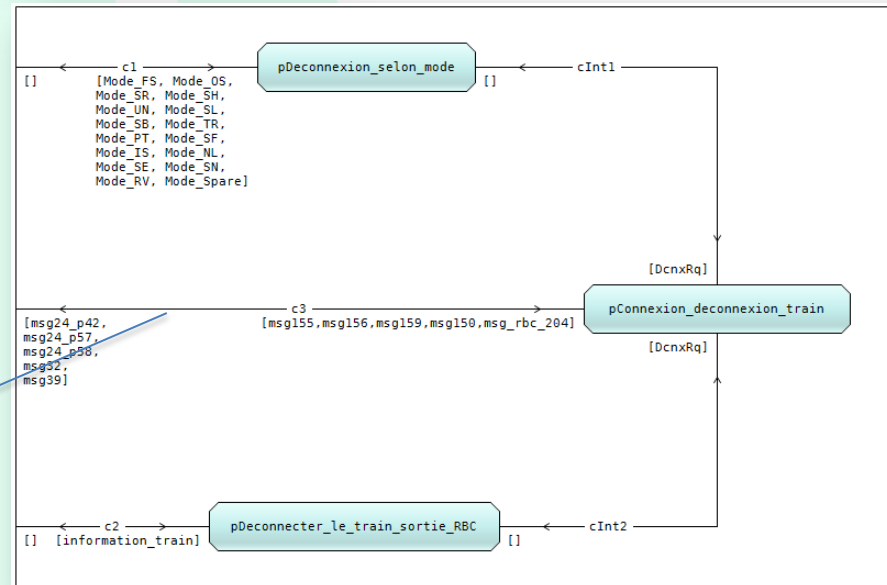
- Matlab model with synchronous state machines
- Translated to an SDL model with asynchronous state machines

Architecture



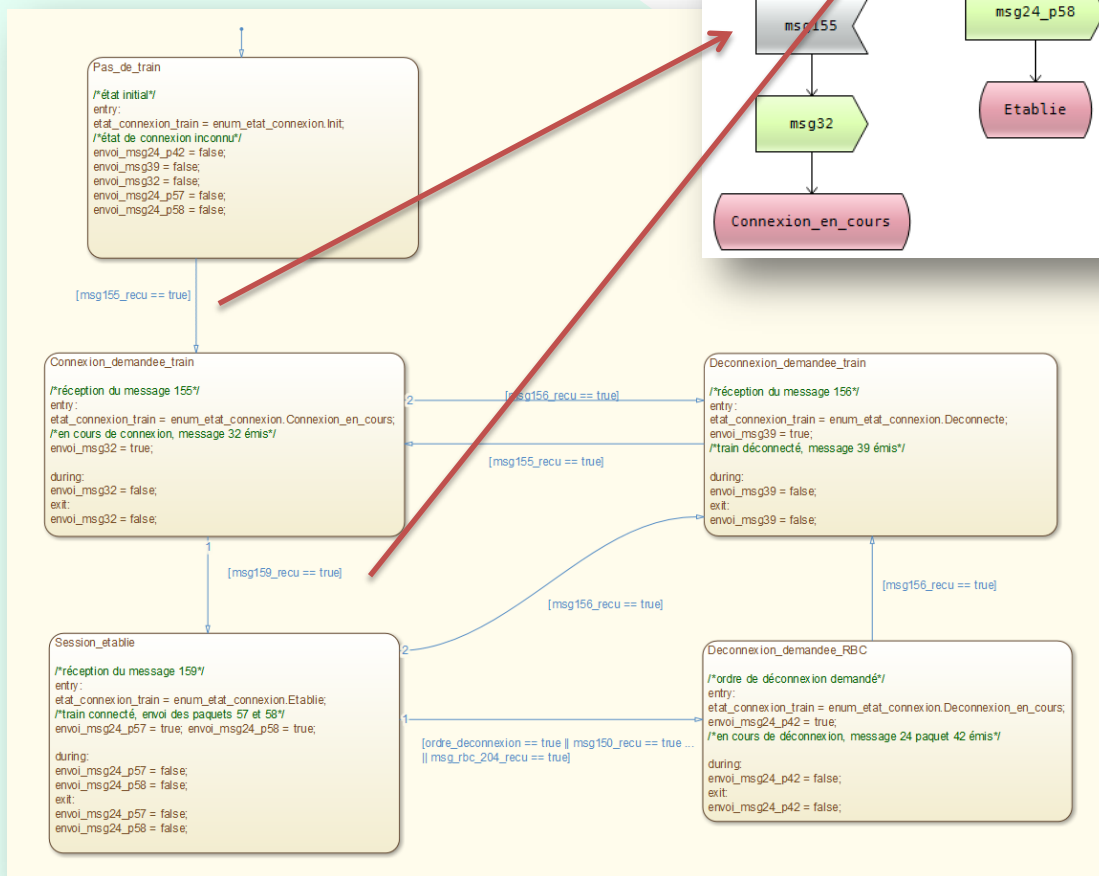
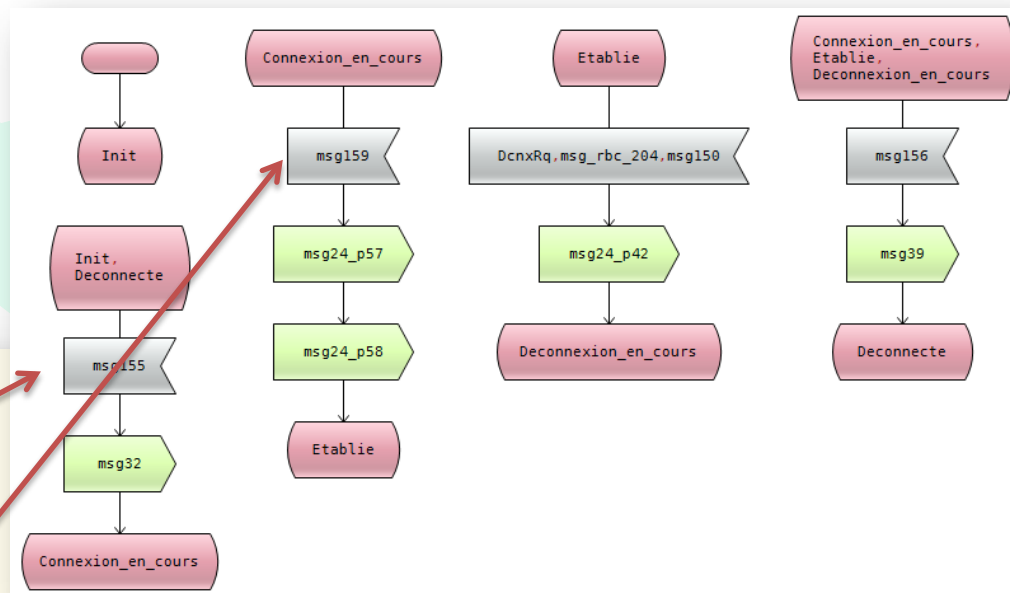
Synchronous
 port: logic
 based

Asynchronous
 port: message
 based



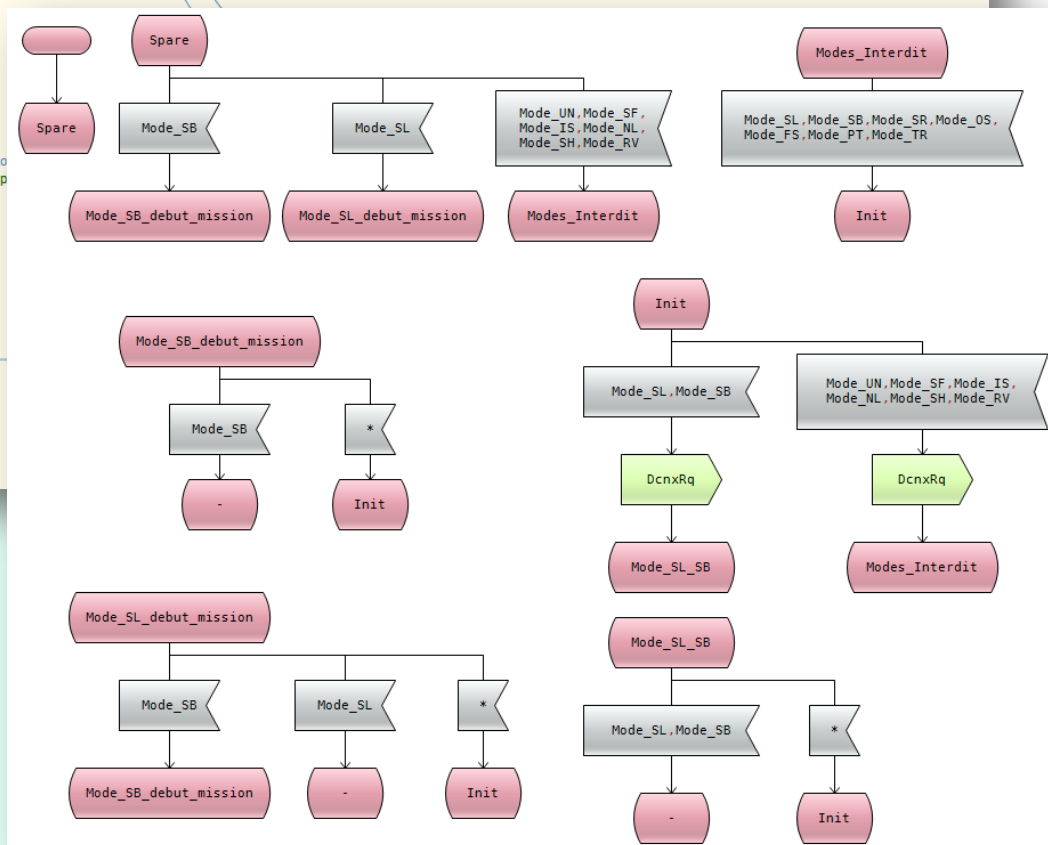
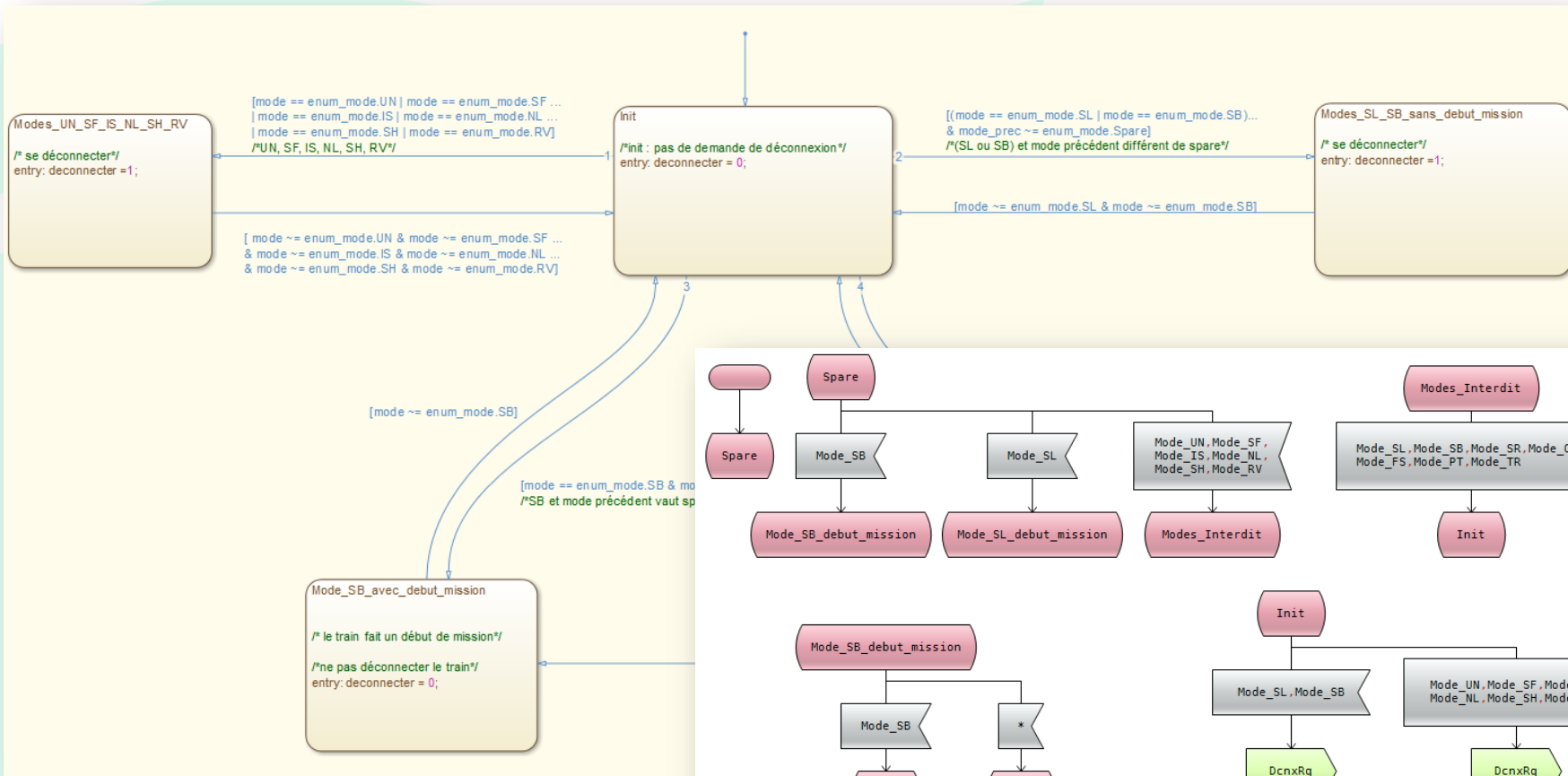


Behavior





Inputs

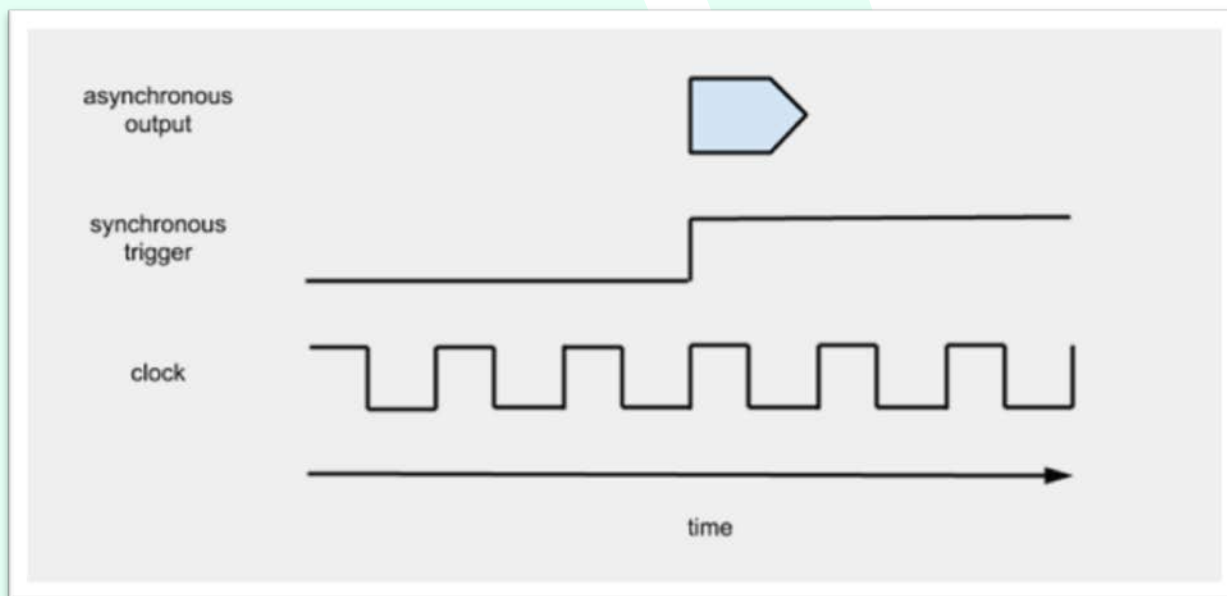


Model simulator showed the behavior was equivalent.



Mapping the semantic

- Sensors are evaluated on a clock base, mapping of synchronous reading to asynchronous information is straight forward.
- Outputs might be sent to synchronous based designs, mapping of asynchronous information to synchronous signals is also straight forward.





Conclusion

The usual synchronous approach can be replaced by an asynchronous one:

- Resulting models are functionally equivalent.

Asynchronous pros:

- Closer to the requirements.
- Easier to read.
- Handles large and complex systems.

Asynchronous cons:

- Difficult to verify but possible on a limited space.
- Not part of the cultural background.