



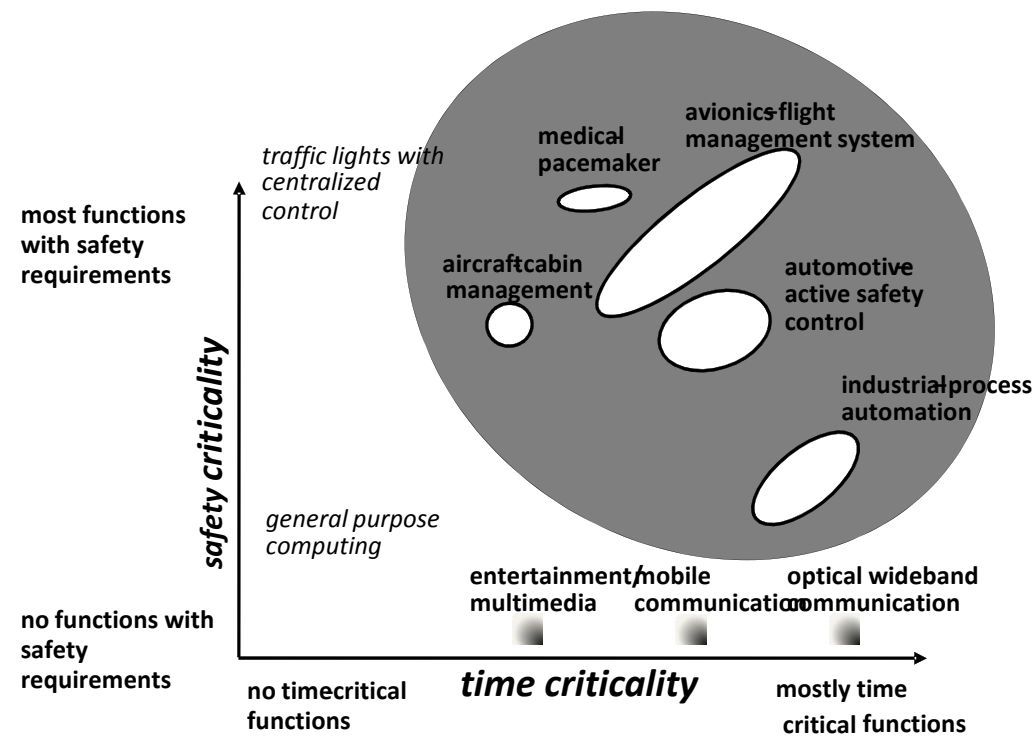
# Industrial issues of Hybrid/Heterogeneous Critical Systems

L.Rioux, A. Koudri

**THALES**

## Hybrid Critical Systems for THALES

- ◆ **Safety critical missions**
  - Failure have could have catastrophic consequences
- ◆ **Timing critical missions**
  - Timing failure may have strong impact on the functional capabilities of the system



# Safety critical missions

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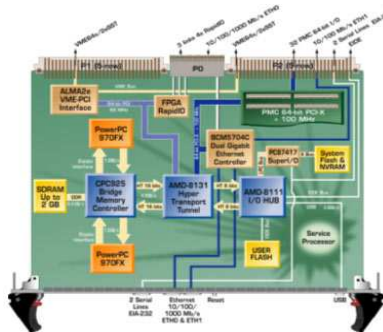


## A software-intensive avionics system

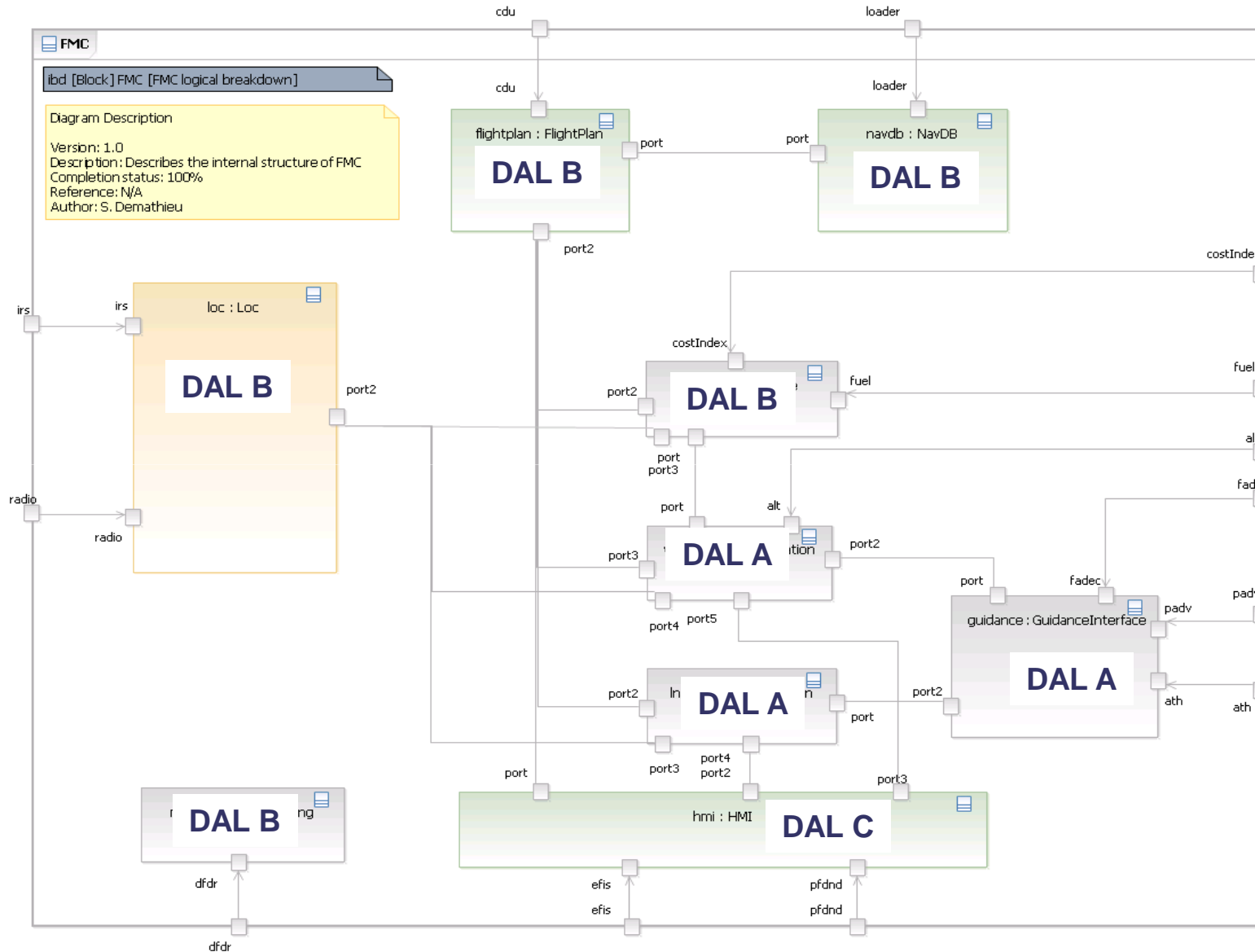
- ◆ Automated navigation (guidance for related devices: AP / FD / ATH)
- ◆ Lateral and vertical trajectory optimizations
- ◆ Fuel consumption and forecast
- ◆ Flight data display

## A safety-critical, hard-real time, embedded system

- ◆ Strict latency on processing and communications
- ◆ Strict jitter constraints
- ◆ Dimensioning of buses, FIFOs and CPU power

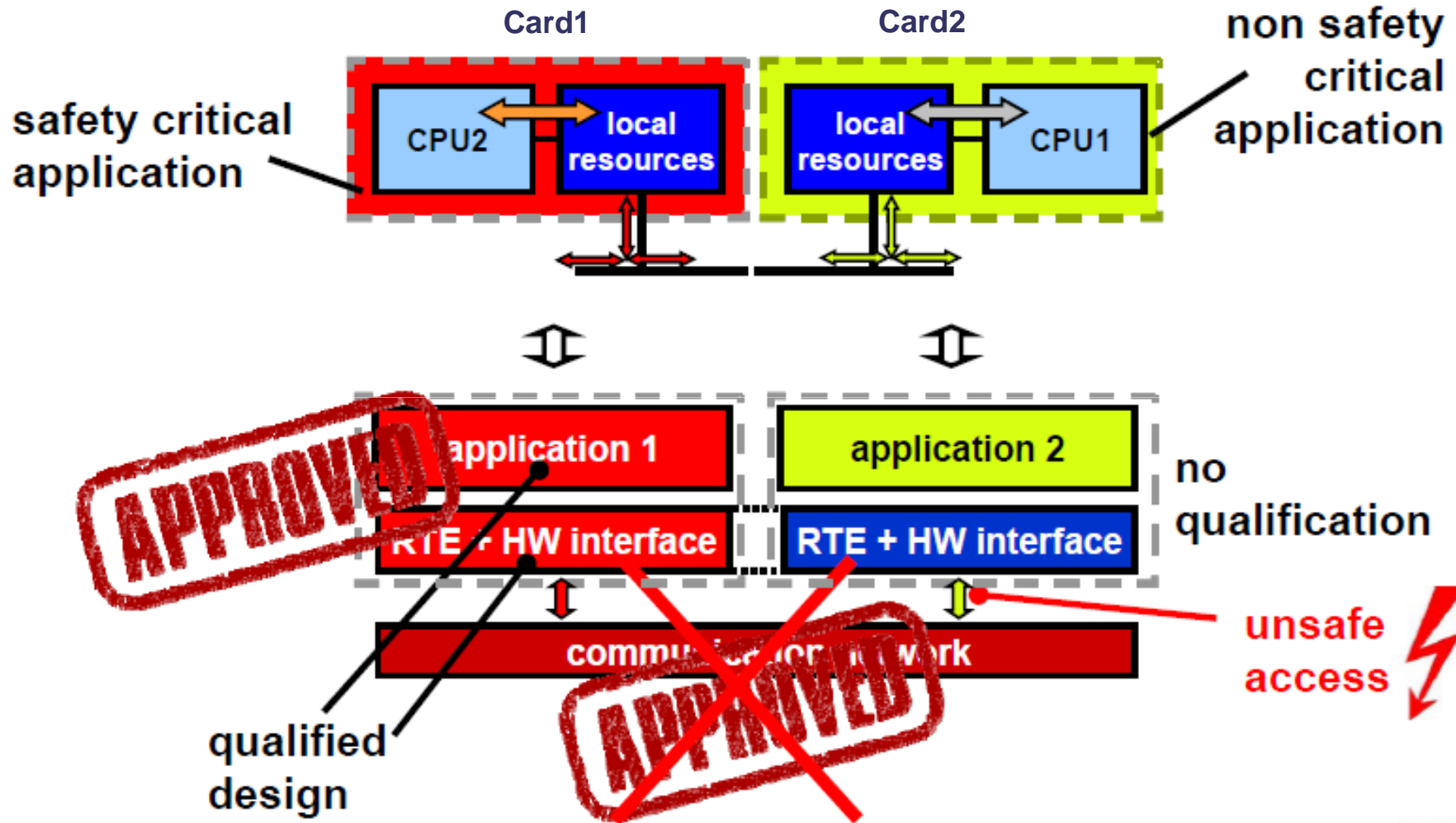


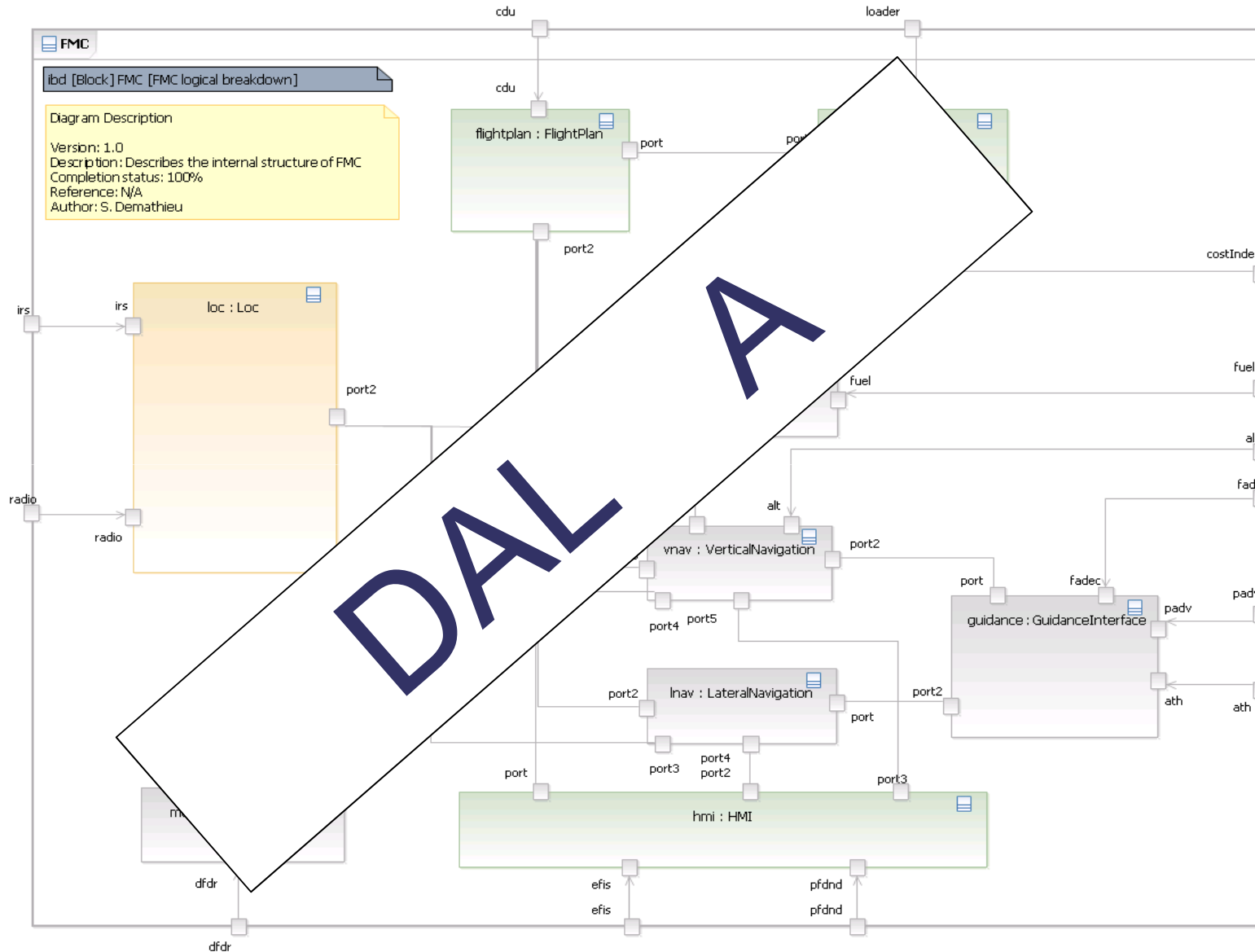
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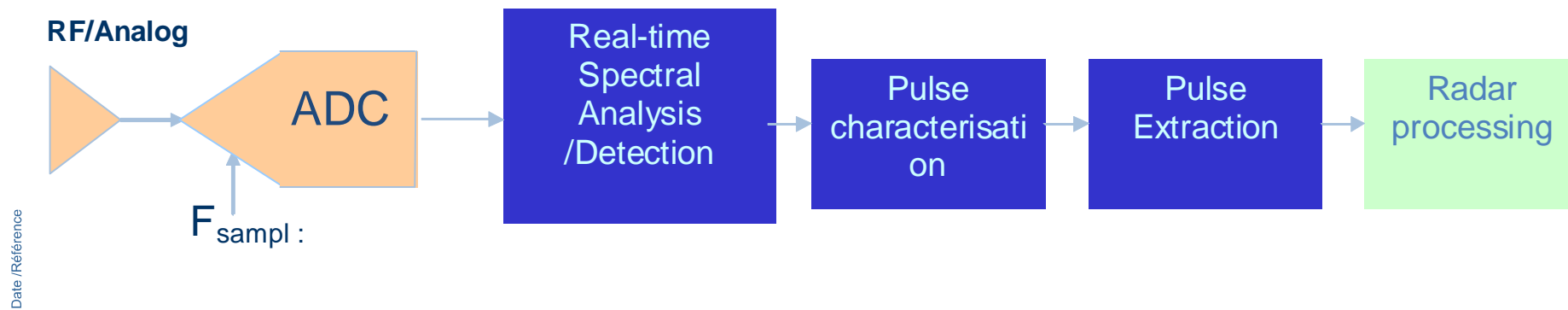


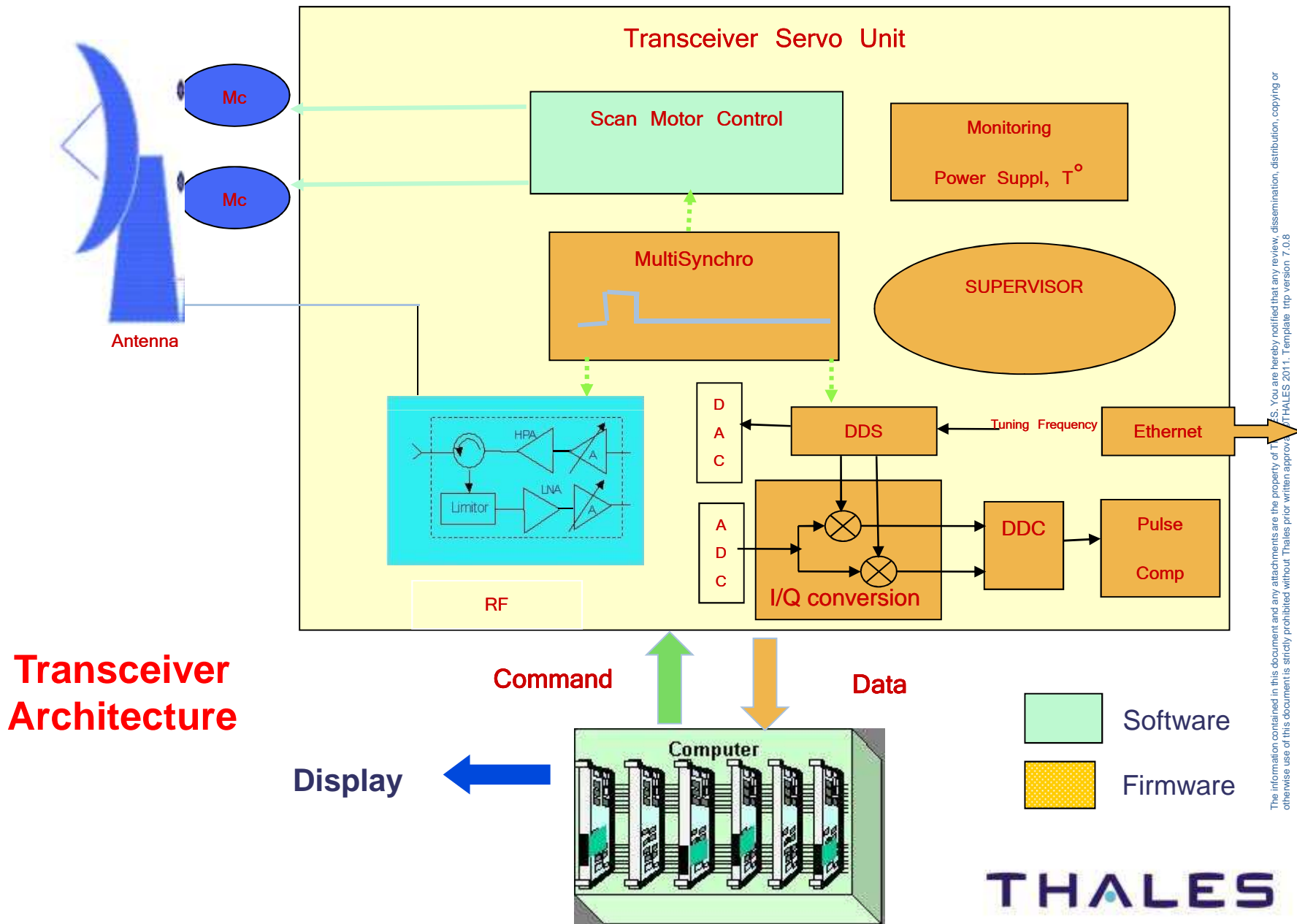


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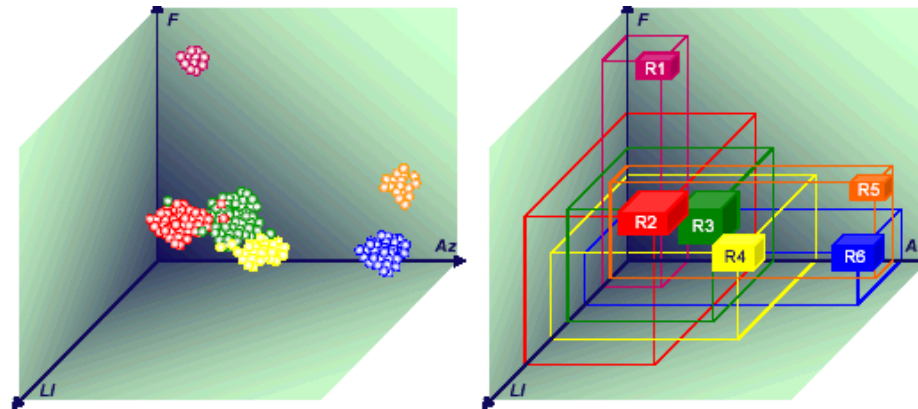
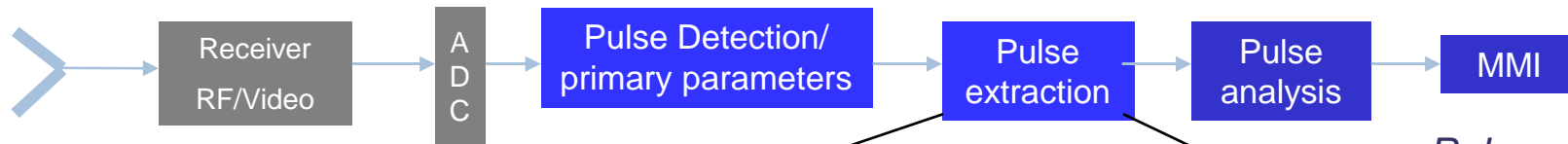
# Timing critical missions





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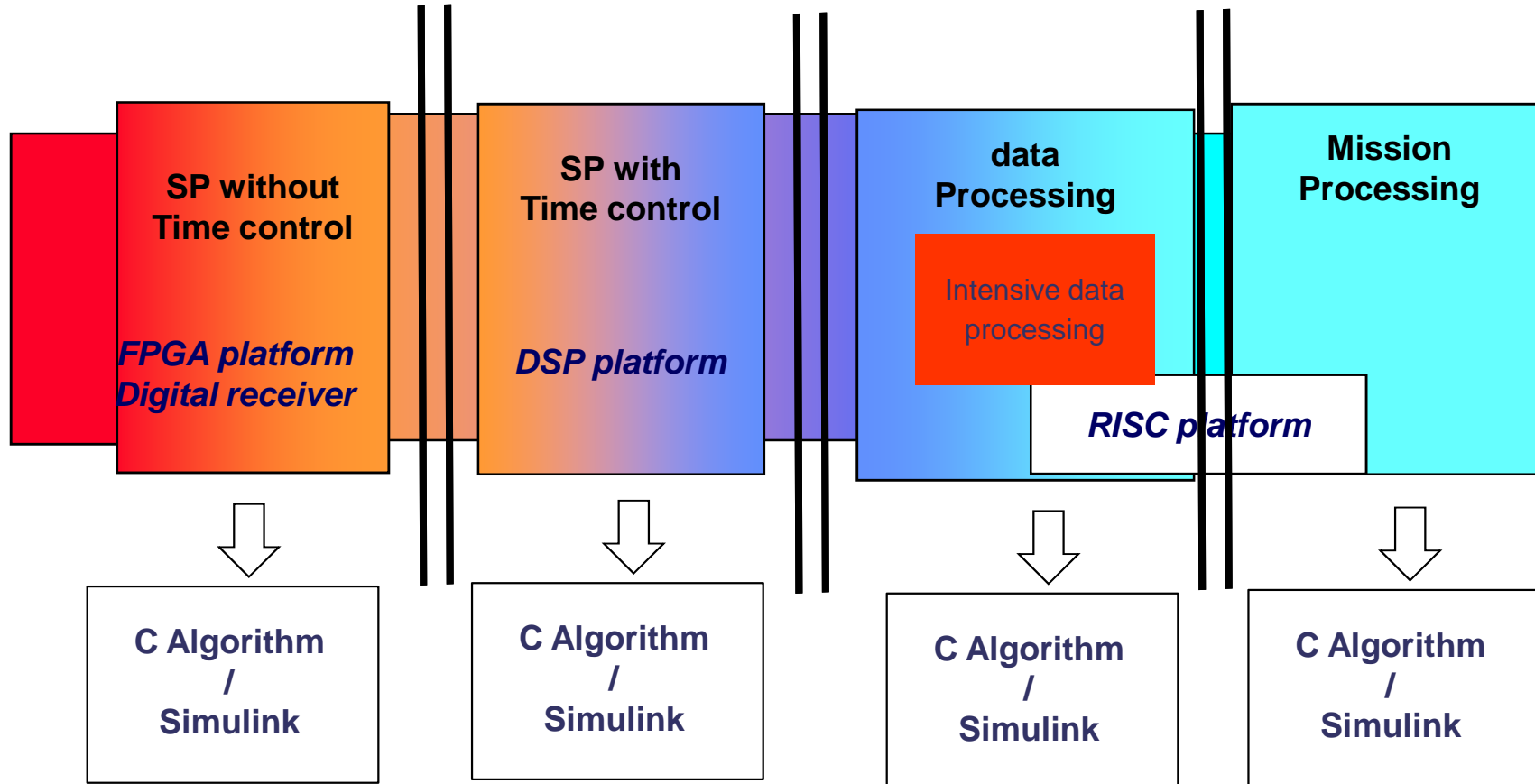


*Pulse parameters change from system to system according to the type of Receiver*

*=> Take into account data structure change*

Data-driven

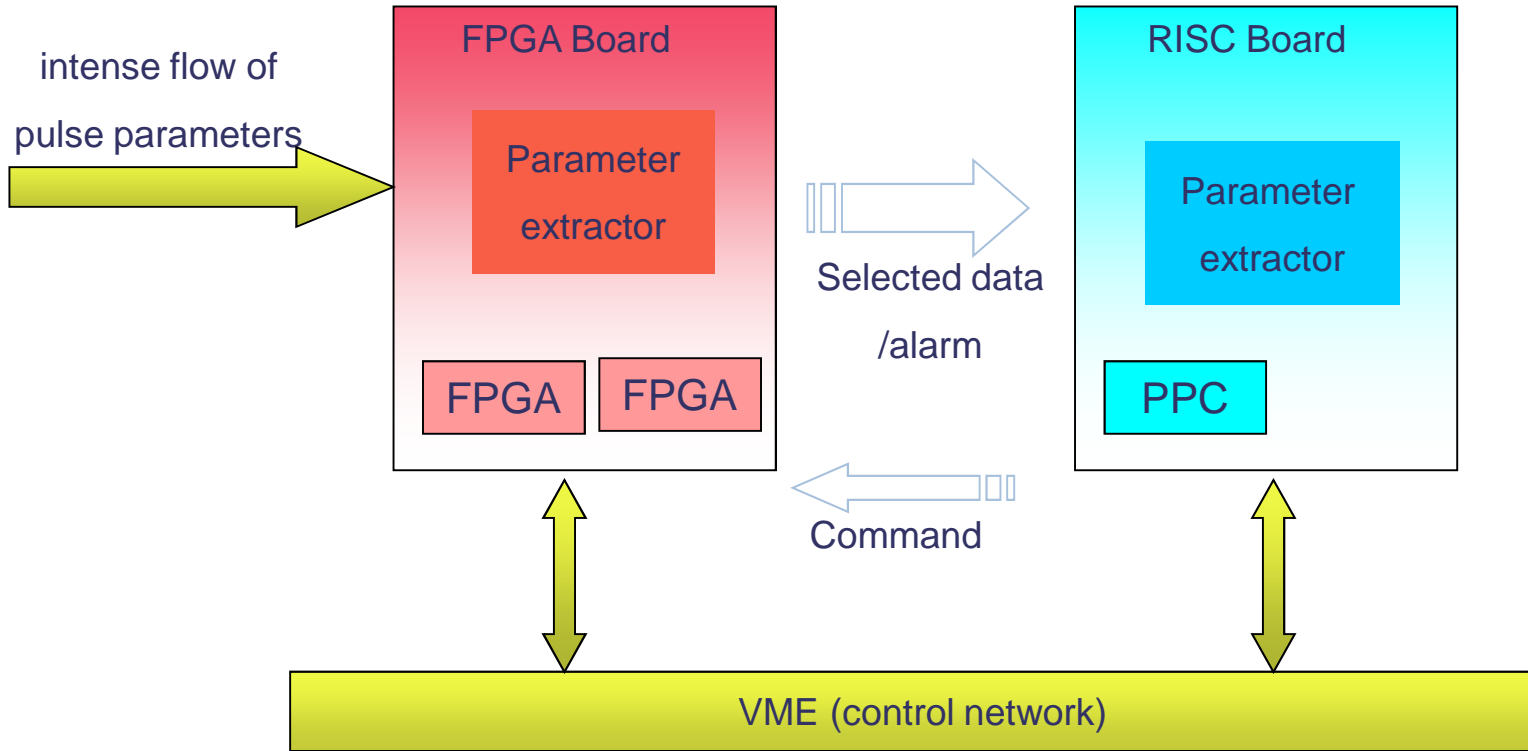
Control-driven



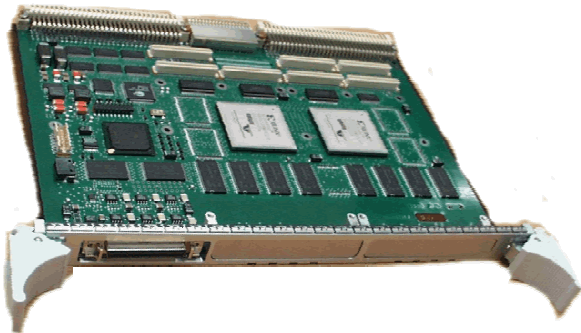
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Heterogenous Model of Computations

- Timing exchange issues ? How to analyse the global system ?



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## According to IEEE, a system is:

« a combination of components that act together to perform a function not possible with any of the individual parts »

## Real-time embedded systems are inherently heterogeneous, mixing:

- ◆ Analog and digital parts
- ◆ Hardware and Software parts
- ◆ Data-dominated and Control-dominated parts
- ◆ Synchronous and Asynchronous behaviour (GALS)

## Real-Time embedded interacts with the environment

- ◆ Environment could be multi-physics (then heterogenous).

## Increase of the numbers of antennas

- ◆ Example: New Beam forming

## Increase of the data sampling rate

## Migration from Analog to Digital technology

- ◆ Example: Digital receiver

## What the impact is the architecture ?

- ◆ Is timing processing enough ?
- ◆ Timing processing / synchronisation still maintained ?
- ◆ Response time still valid ?
- ◆ Hardware architecture still valid ?

## (MDE) Engineering Issues

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## System Engineering

Doors      UML      Matlab      Word

Design Space Exploration      Implicit Choices      Lack of Traceability

## Semantic Gap

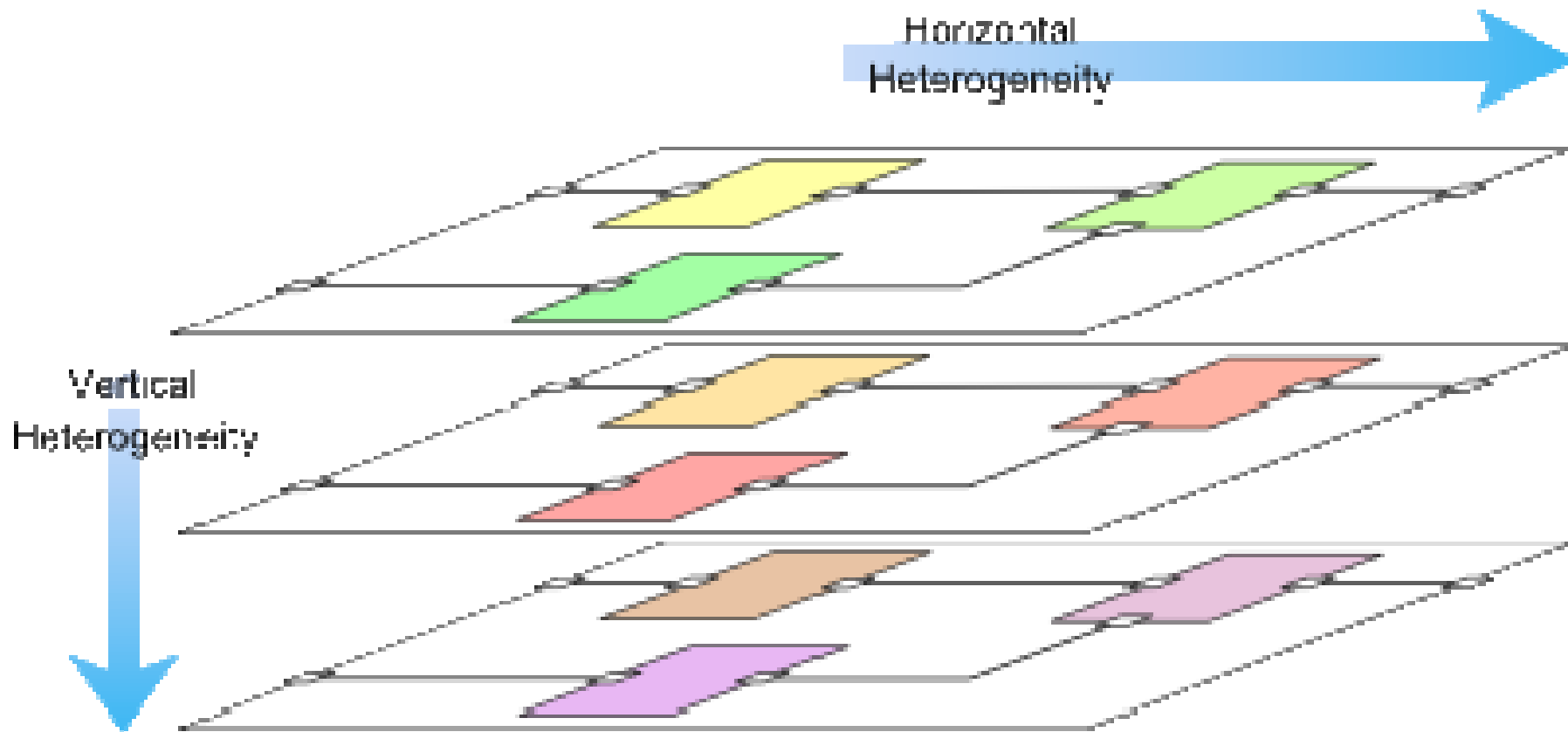
Decision Making      Cultural and Technological Breakpoints      Verification and Validation

## Hardware / Software Engineering

VHDL      Java C++      SystemC

MBE Efforts:  
Formalization,  
Action Language

ESL Efforts:  
Raise Abstractions,  
Verification Libraries



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## Heterogeneous systems are inherently complex

- ◆ Abstraction (vertical approach), hierarchy (horizontal approach)
- ◆ and domains (analytical approach)

## Improve the modeling of heterogeneity

- ◆ Enable the explanation of the Heterogeneous execution semantics
  - ◆ Enable inter-connections of different execution semantics.
  - ◆ Enable the refinements and the mapping of execution semantics between abstract levels
- Precise modeling and formal representation

## Need to improve the early verification of models

- ◆ Support for both simulation and formal verification
    - Formal methods are strongly required to optimise the heterogeneous system
  - ◆ Ease the implementation of the system
  - ◆ Ease the architecture exploration and reuse.
- Verification methods (global versus composition).

## Industrial companies like THALES is facing difficulties to design efficiently « Hybrid Systems »

- ◆ High Overcost
- ◆ Limited capabilities of reuse.
- ◆ High difficulties to identify the adequate architecture

## Current MDE standards and practices do meet our requirement to design, verify and optimise these systems

- ◆ Non Adequate modeling language
  - Need to be more precise (formal)
- ◆ Non adequate analysis techniques
  - Able to integrate « heterogenous hypothesis »
- ◆ Non Adequate model transformation / refinement techniques.
  - Especially between abstraction levels.