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Industrial issues of Hybrid/Heterogeneous Critical Systems

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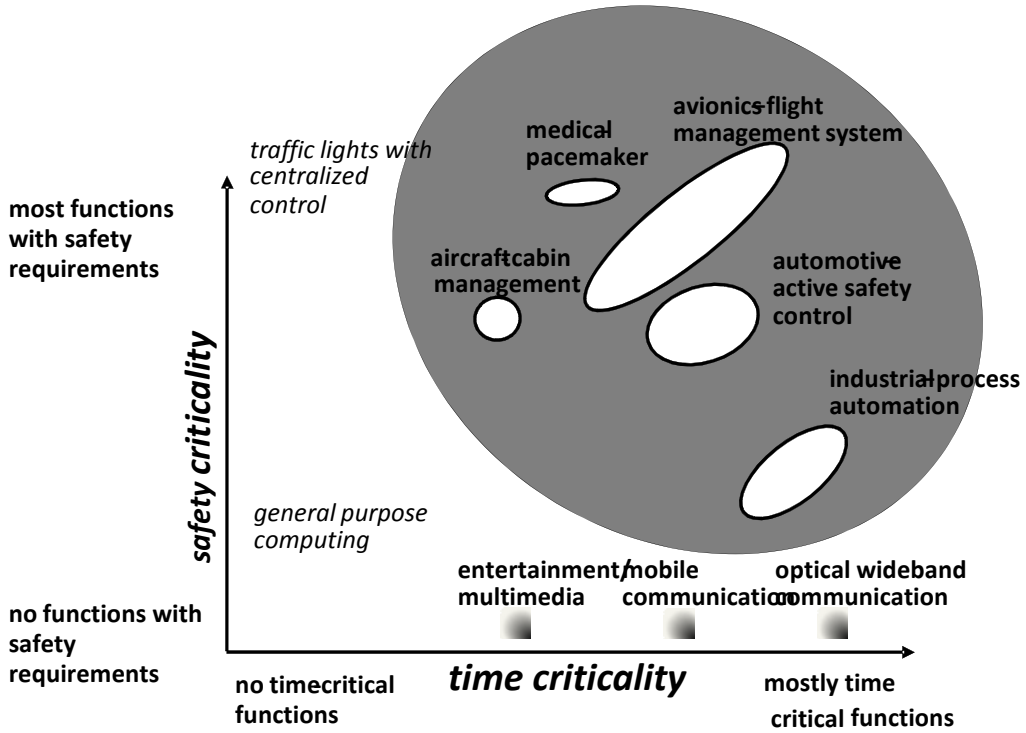
Hybrid Critical Systems for THALES

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



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Safety critical missions

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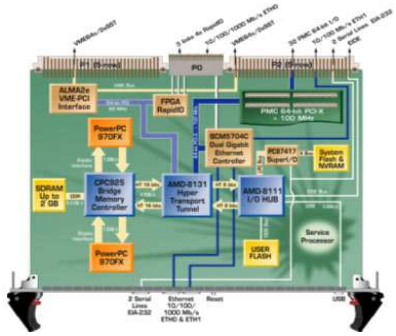
Safety critical mission: FMC

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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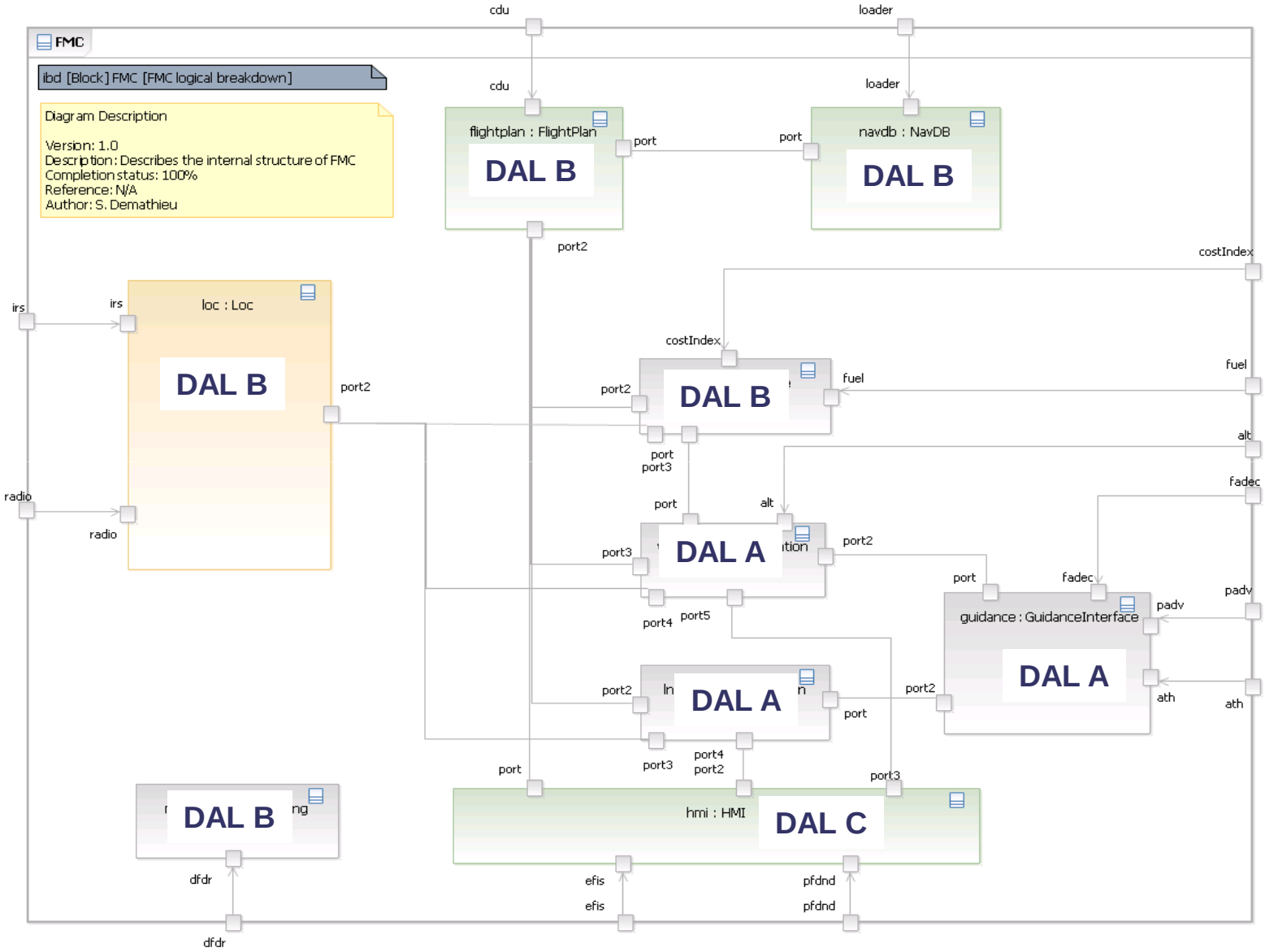
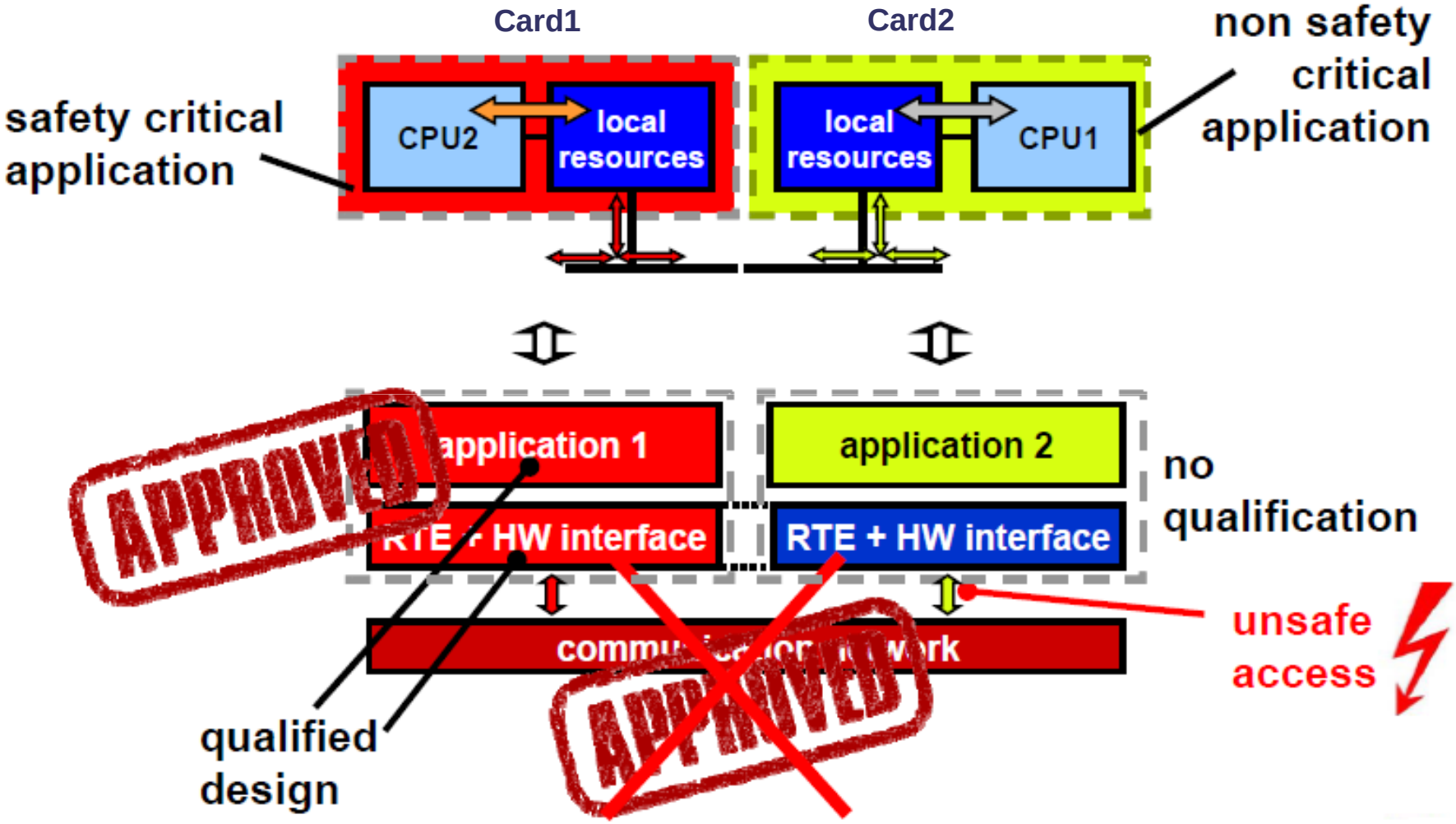
Generic FMC



Heterogeneous integration



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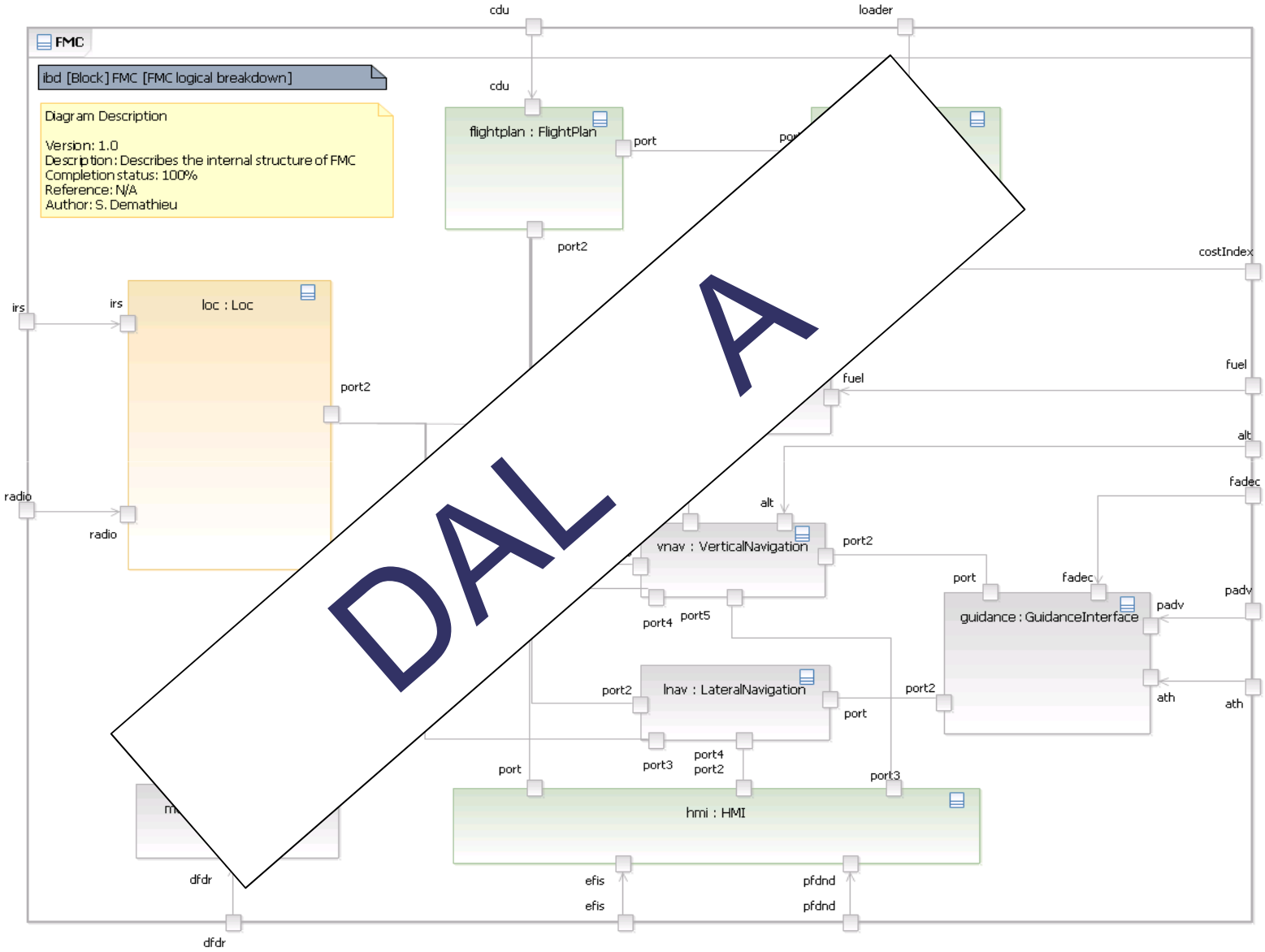
Generic FMC



Timing critical missions

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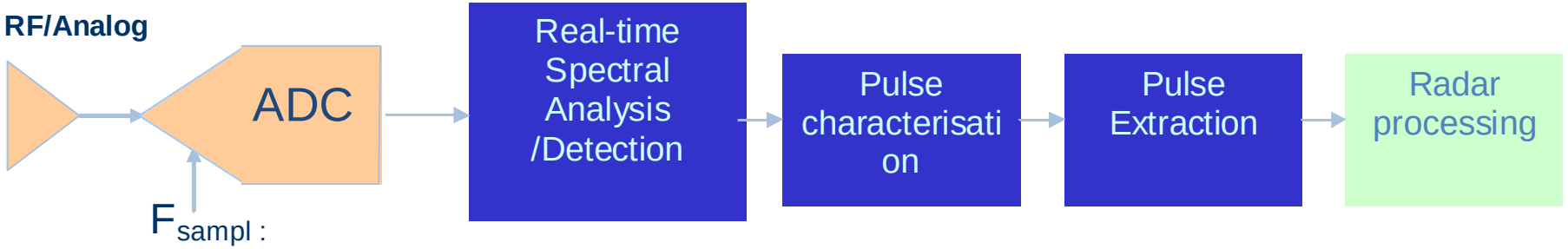
Radar: Front-end processing



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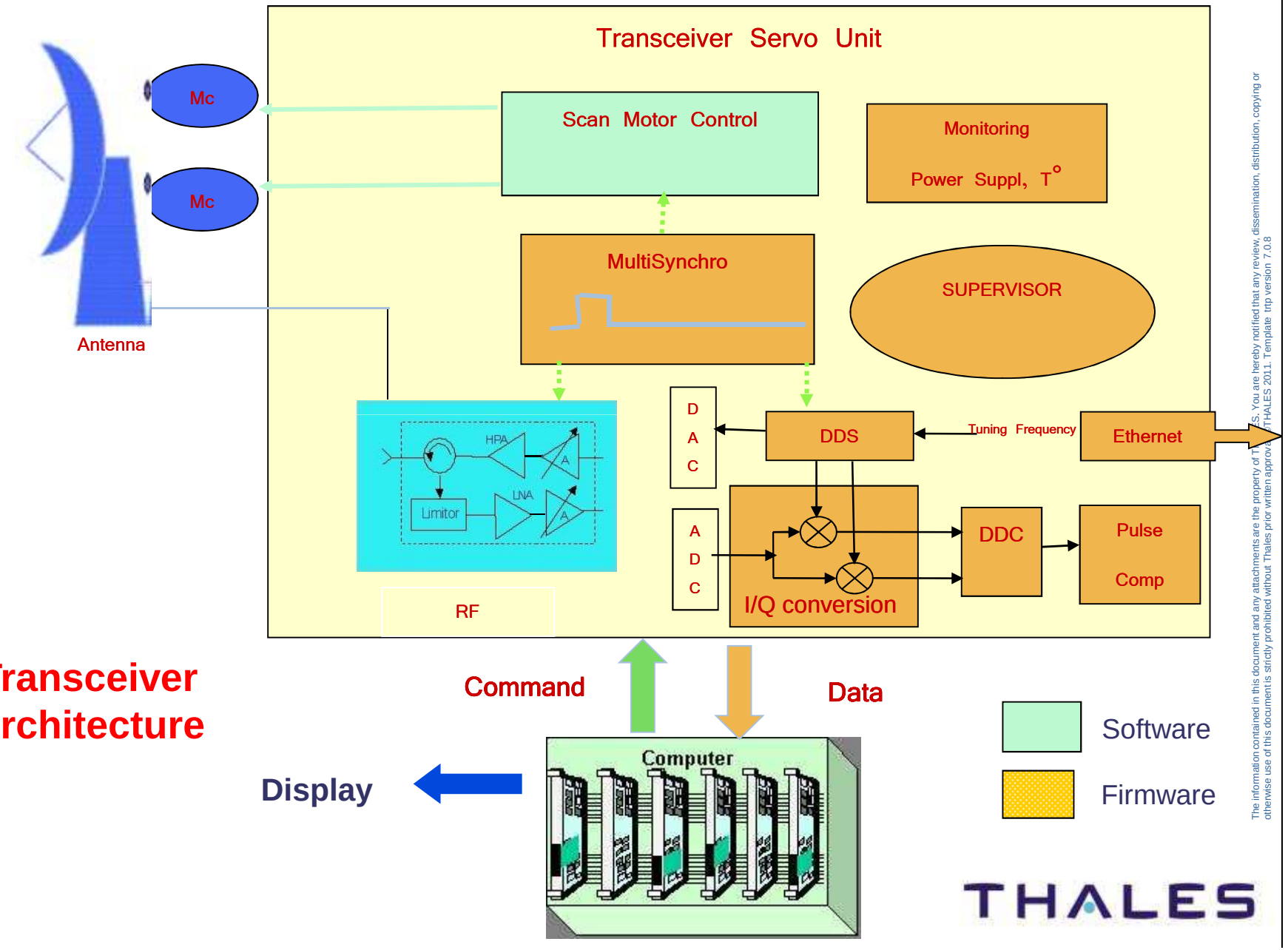
Radar application



Transceiver Architecture

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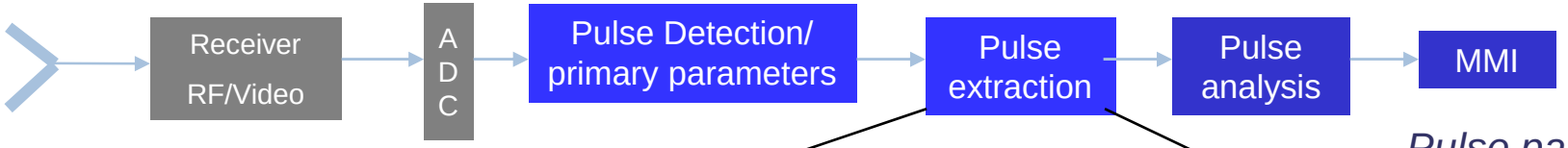
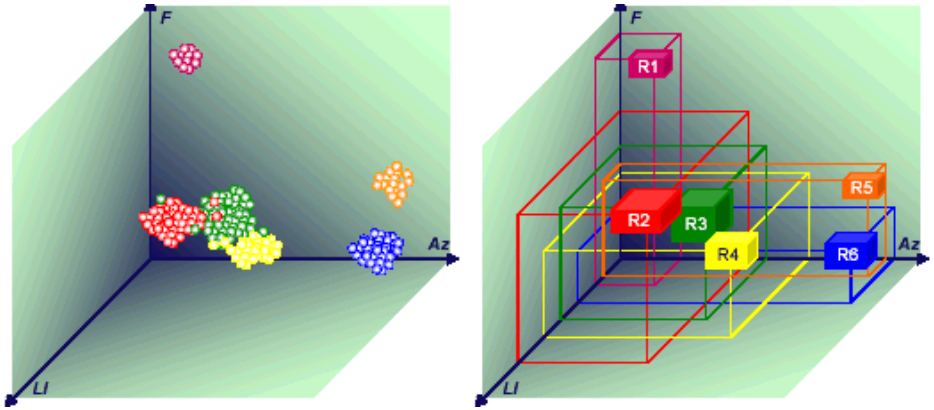
Radar: Back-end processing





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

=> Take into account data structure change

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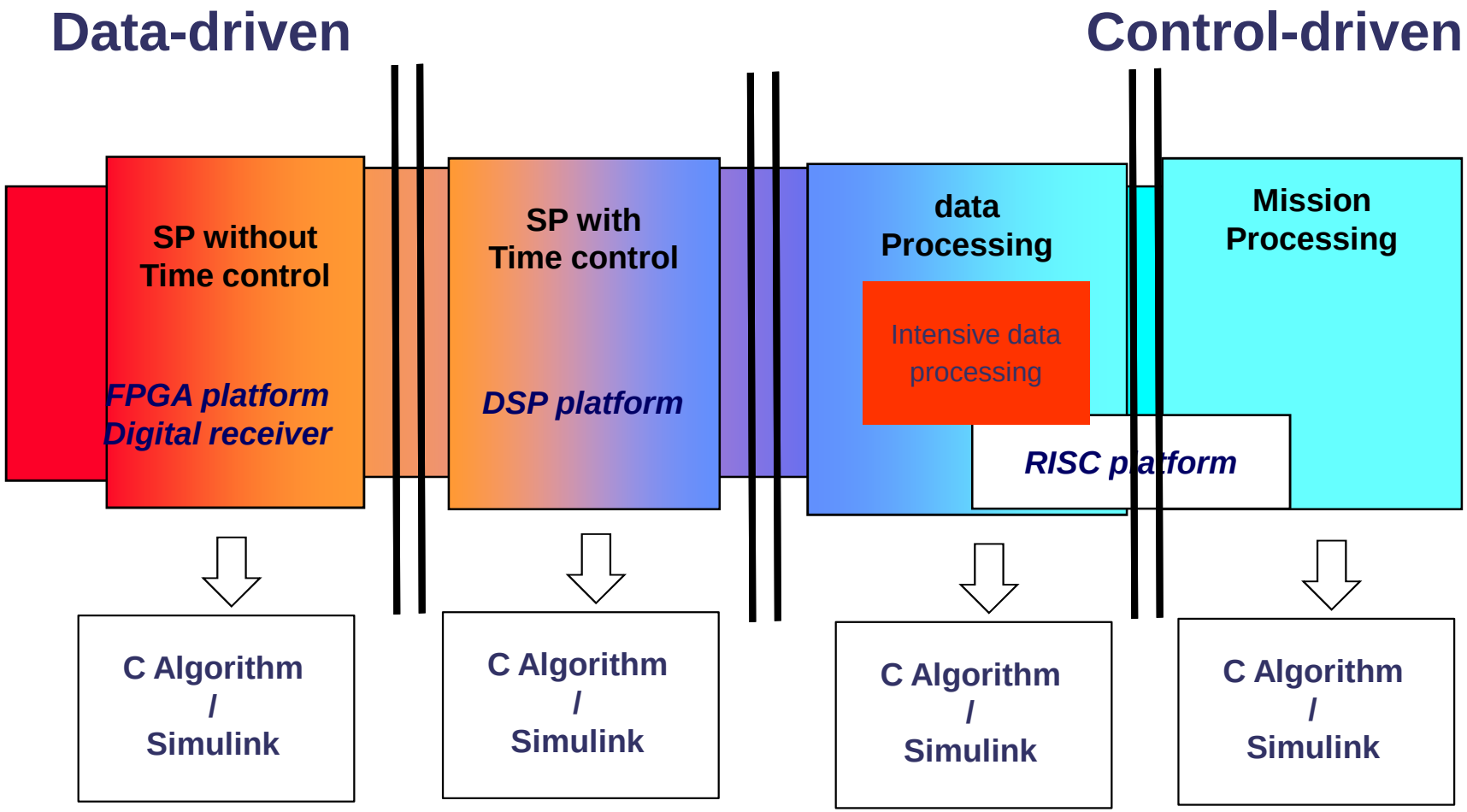
System Architecture



Heterogenous Model of Computations

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

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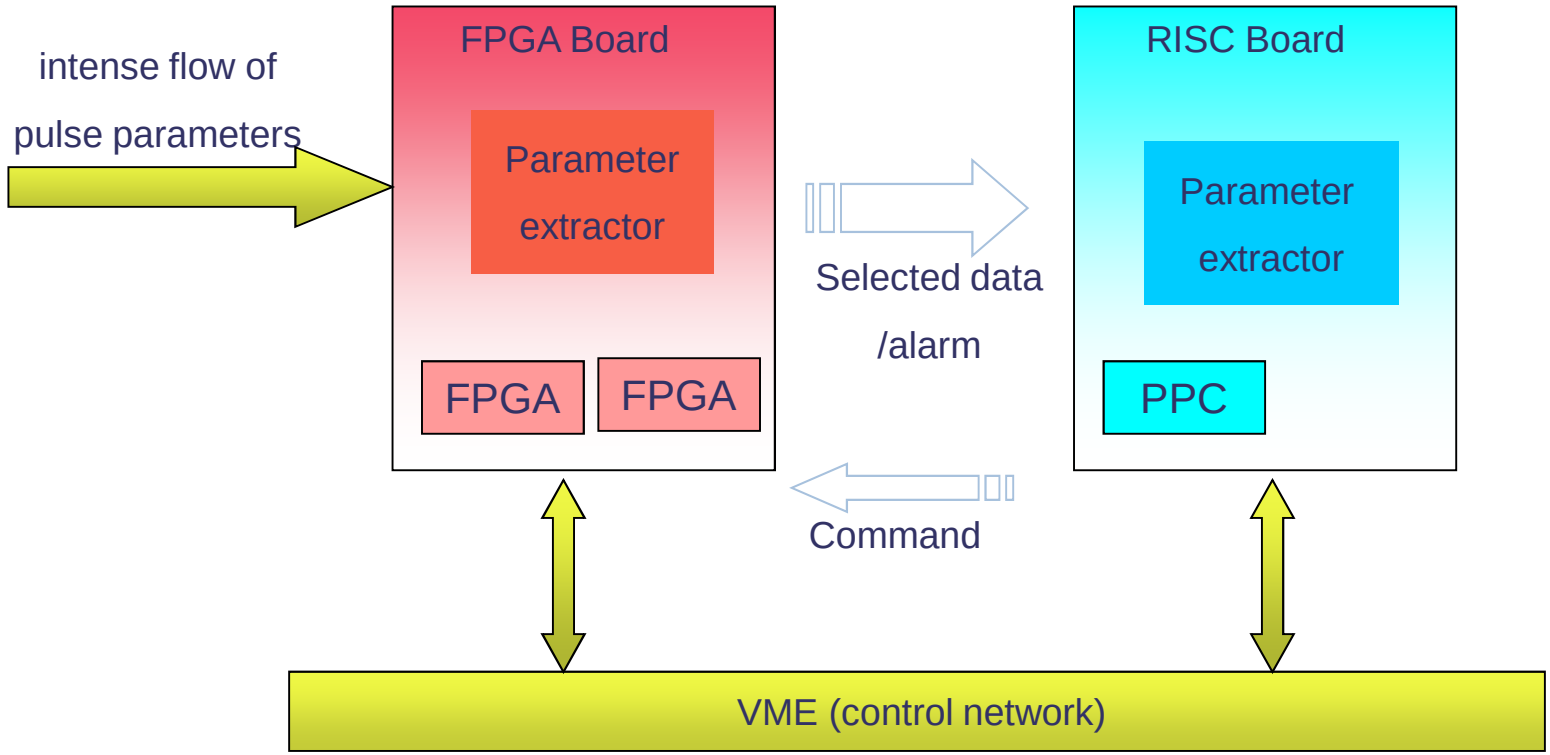
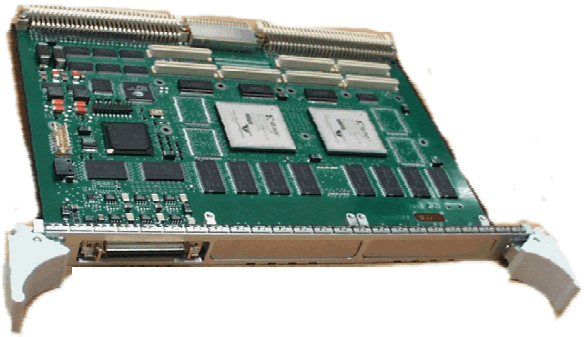
Conventional architecture





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In general: Real-time Embedded Systems

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 heterougenous).

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Requirements for future RADAR applications

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 ?

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(MDE) Engineering Issues

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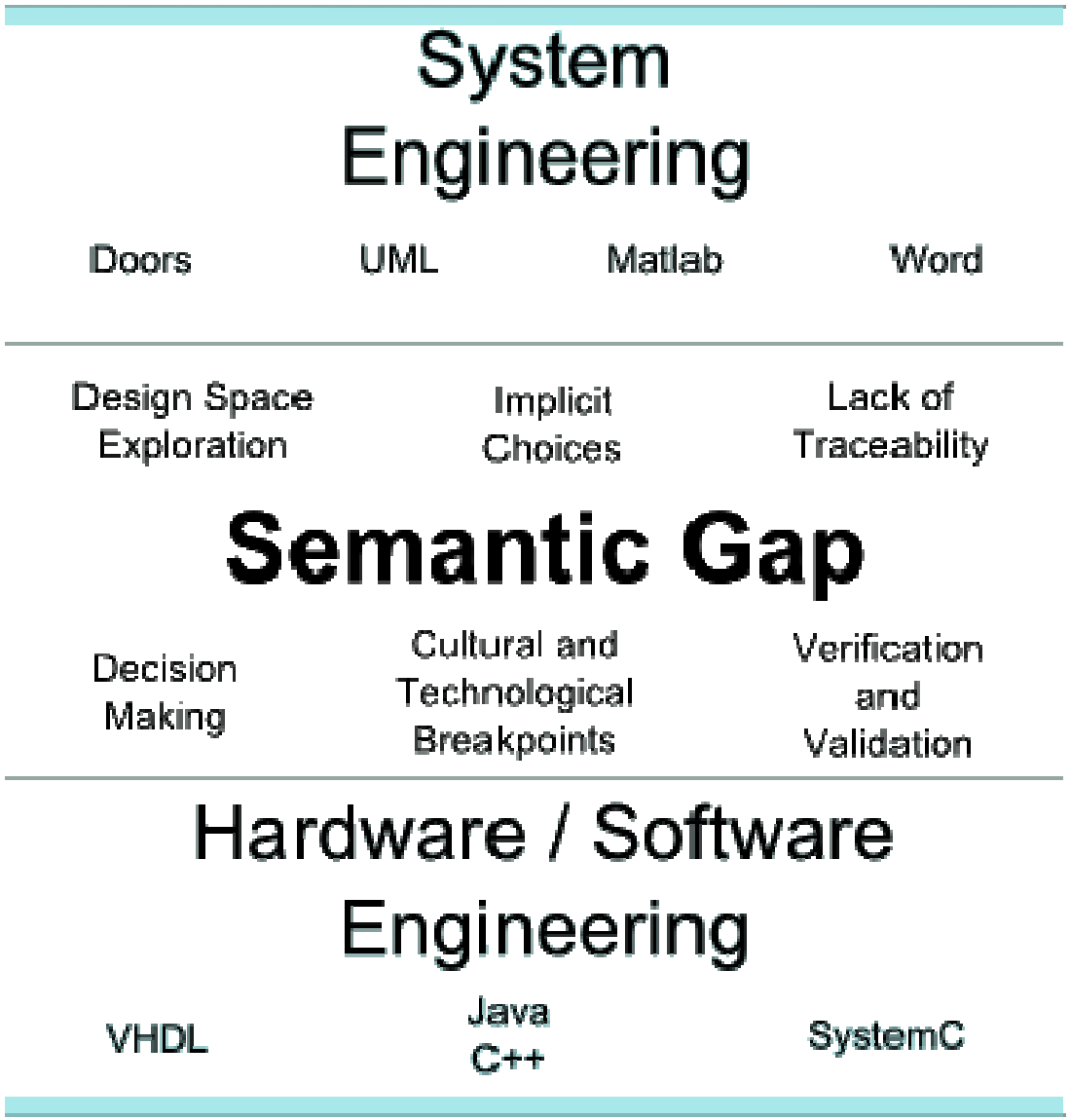
Achieving a true System Level Design



MBE Efforts:
Formalization.
Action Language

ESL Efforts:
Raise Abstractions,
Verification Libraries

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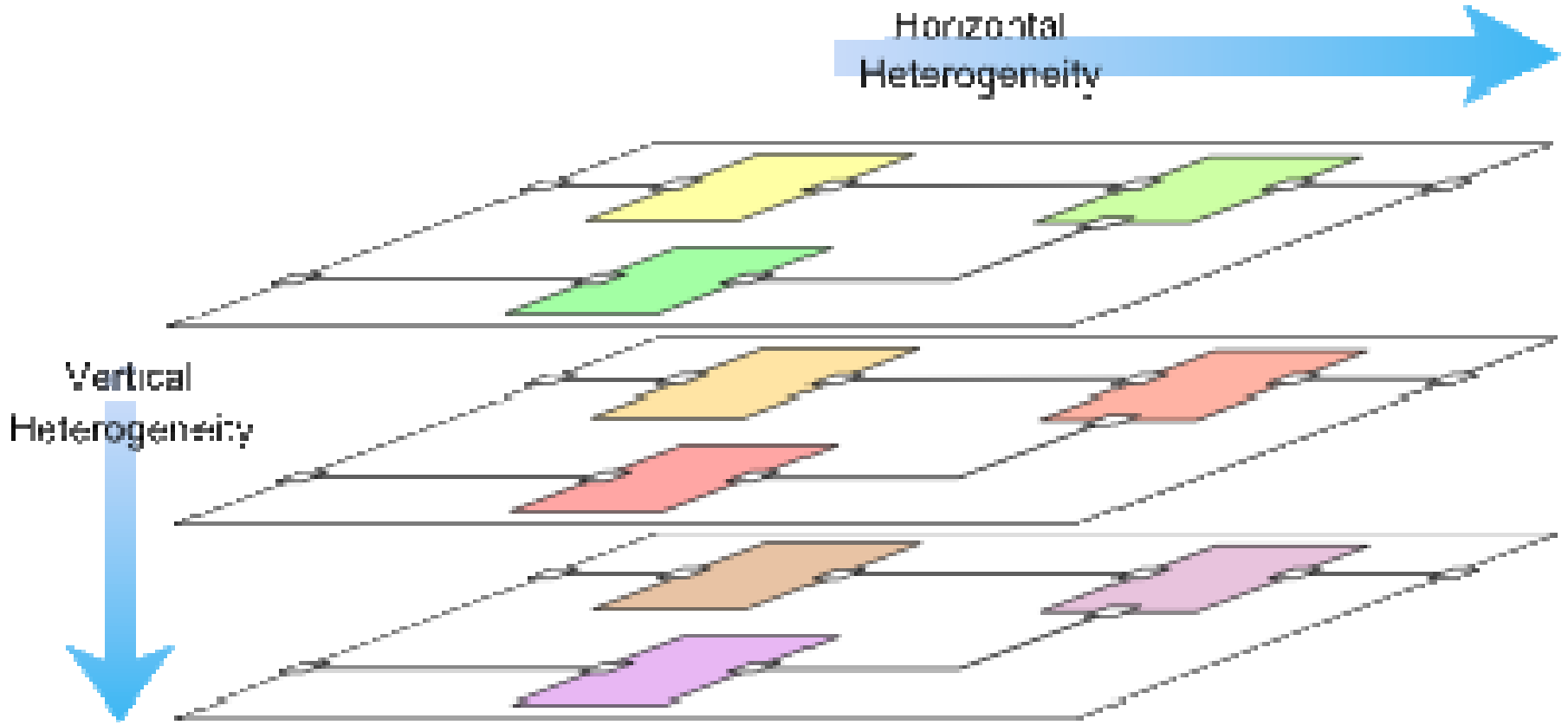
Heterogeneity in Engineering



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MDE: Heterogenous at different abstract levels

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).

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Conclusions

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 pratices 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.

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