MBSE2021

Functional Chain Approach for Avionics Modelling & Simulation

Sept. 2021

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CONTENTS

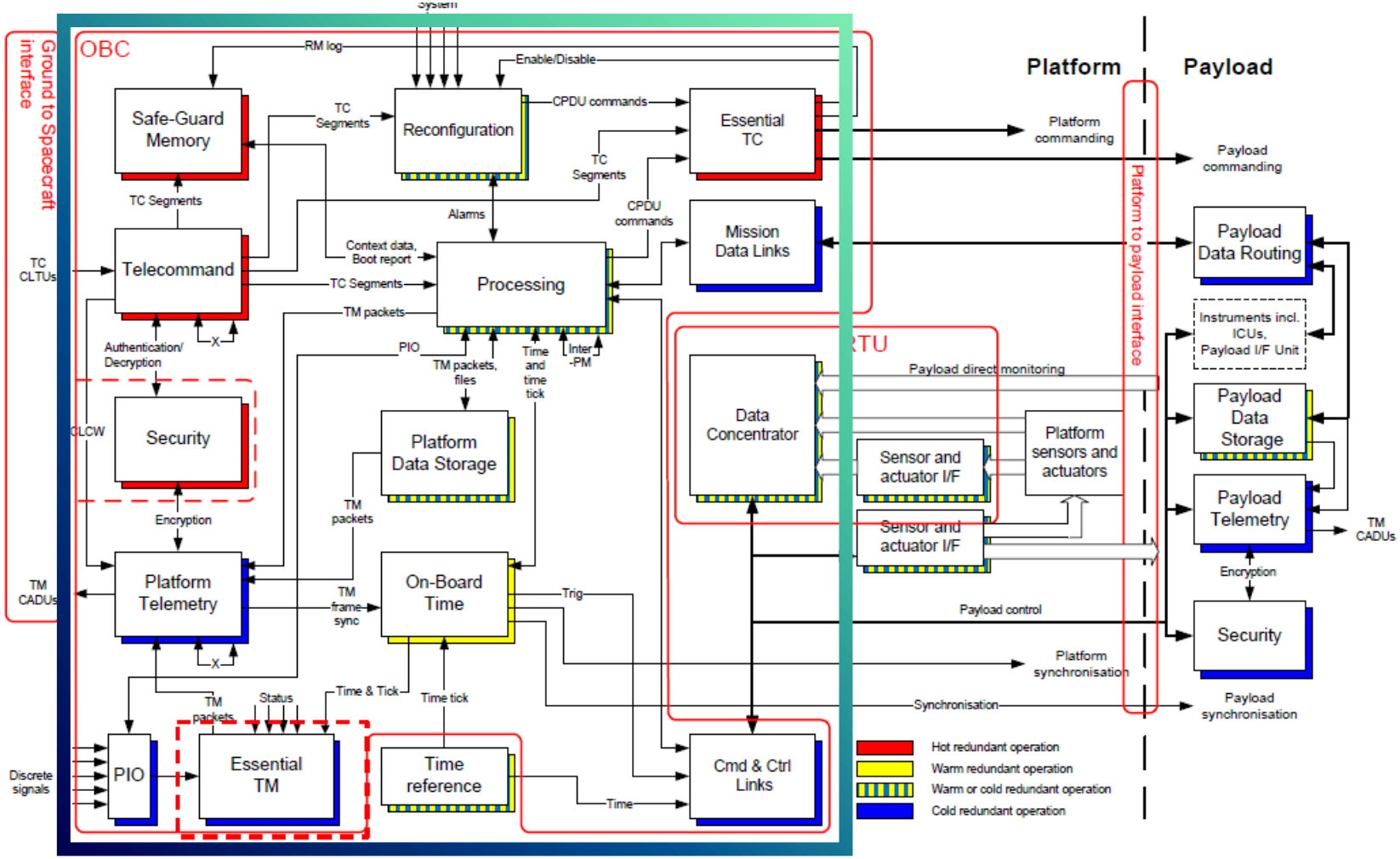
1

CONTEXT

CONTEXT ABOUT SOCS AND FATI STUDIES

Context

Classical avionics architecture



Context

A new kind of avionics architecture

On-Board Computer

Board 1

Function 1

Function 2

⋮

Board N

Function 3

Function 4

MPSOC

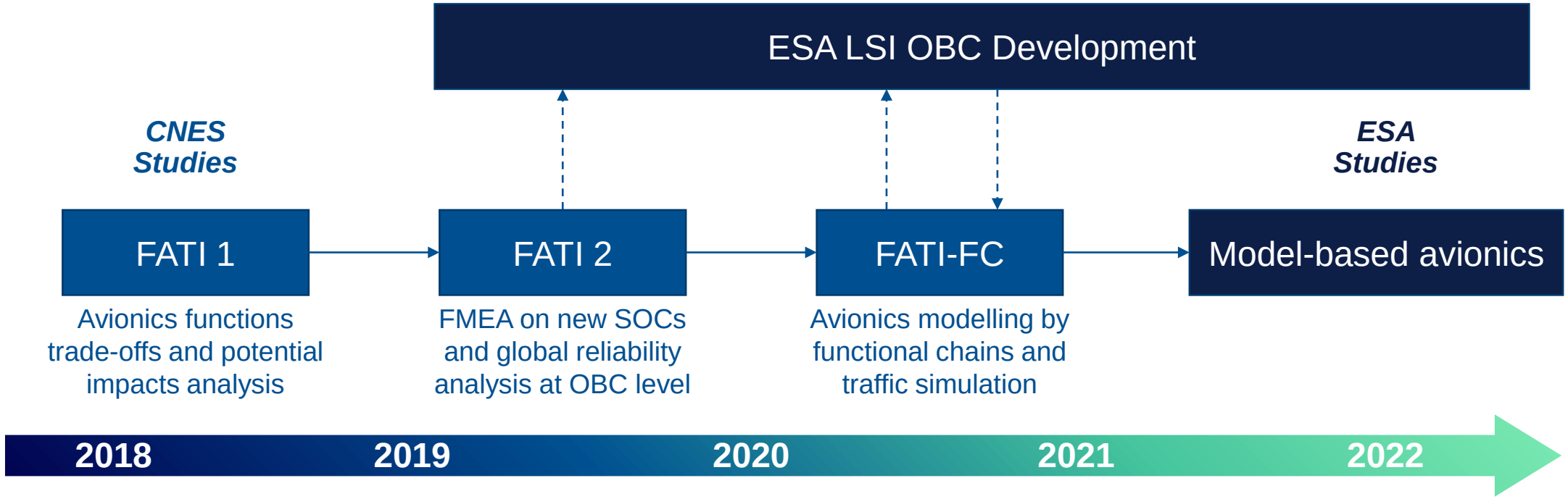
"Multi-Processor System On Chip"

Processor

FPGA

Context
FATI Studies at CNES

FATI (Future Highly Integrated Avionics) studies aimed to help developing future highly integrated avionics architectures and analyzing their impacts.



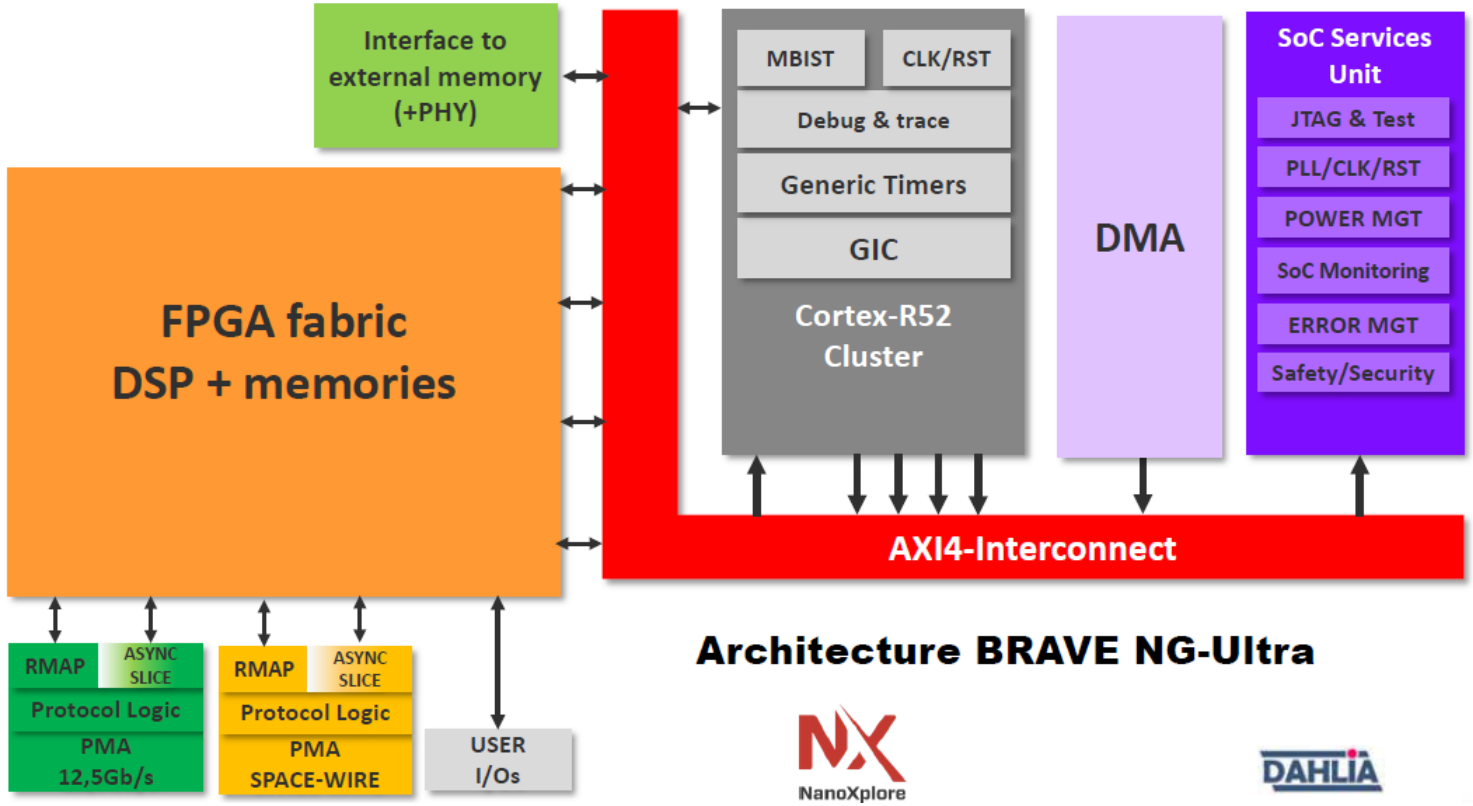
2

WHY MBSE ?

WHAT WAS THE OBJECTIVE, WHICH TOOL

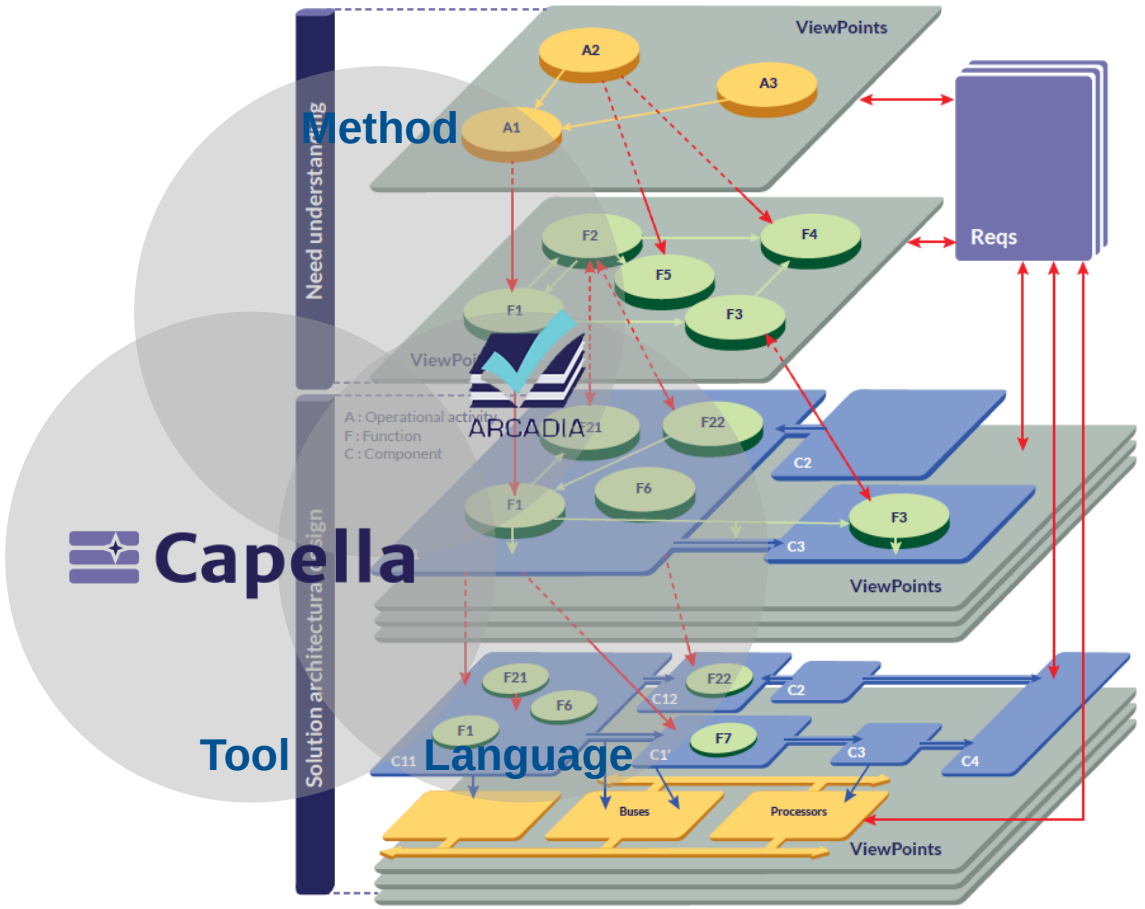
Why MBSE ?
A matter of complexity

Using SOCs = Higher level of integration = Higher complexity



Why MBSE ?

Capella Tool



Operational Analysis
What the users of the system need to accomplish

Functional & Non Functional Need
What the system has to accomplish for the users

Logical Architecture
How the system will work to fulfill expectations

Physical Architecture
How the system will be developed and built

3

THE FUNCTIONAL CHAIN APPROACH

DEFINITION AND METHODOLOGY

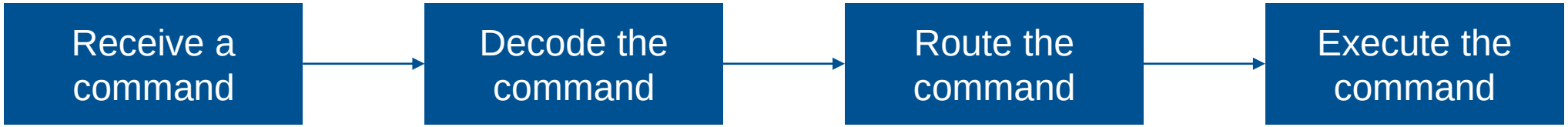
The Functional Chain Approach

What are functional chains ?

Functional chain:

Set and succession of functional blocks involved in the realization of a particular functionality/process of the system.

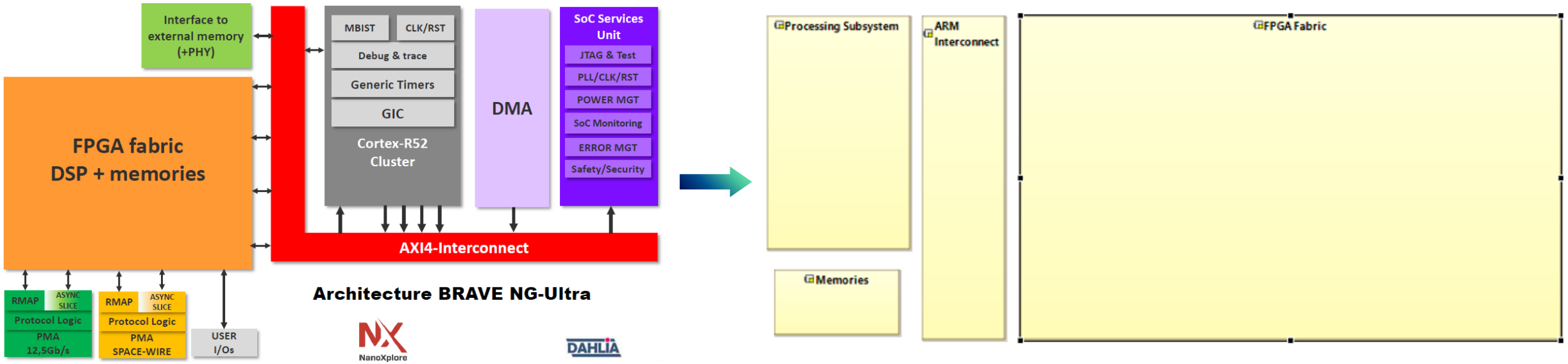
Example: functional chain that describes the functionality of the system to process an external command that it receives.



The Functional Chain Approach

Proposed Methodology

1) Identify and define the physical elements that are common to all functional chains, which will be used to allocate the different functions and behavioural components of the system.

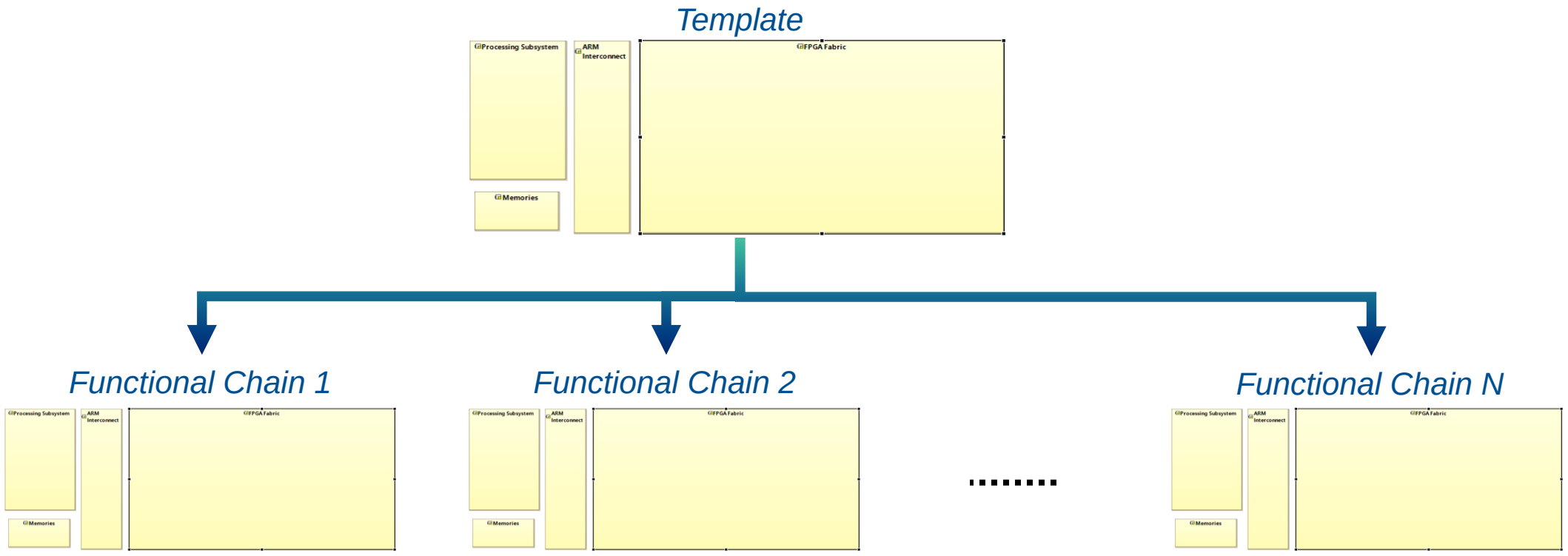


In our case we needed to model the SOC internal elements used to host the functions

The Functional Chain Approach

Proposed Methodology

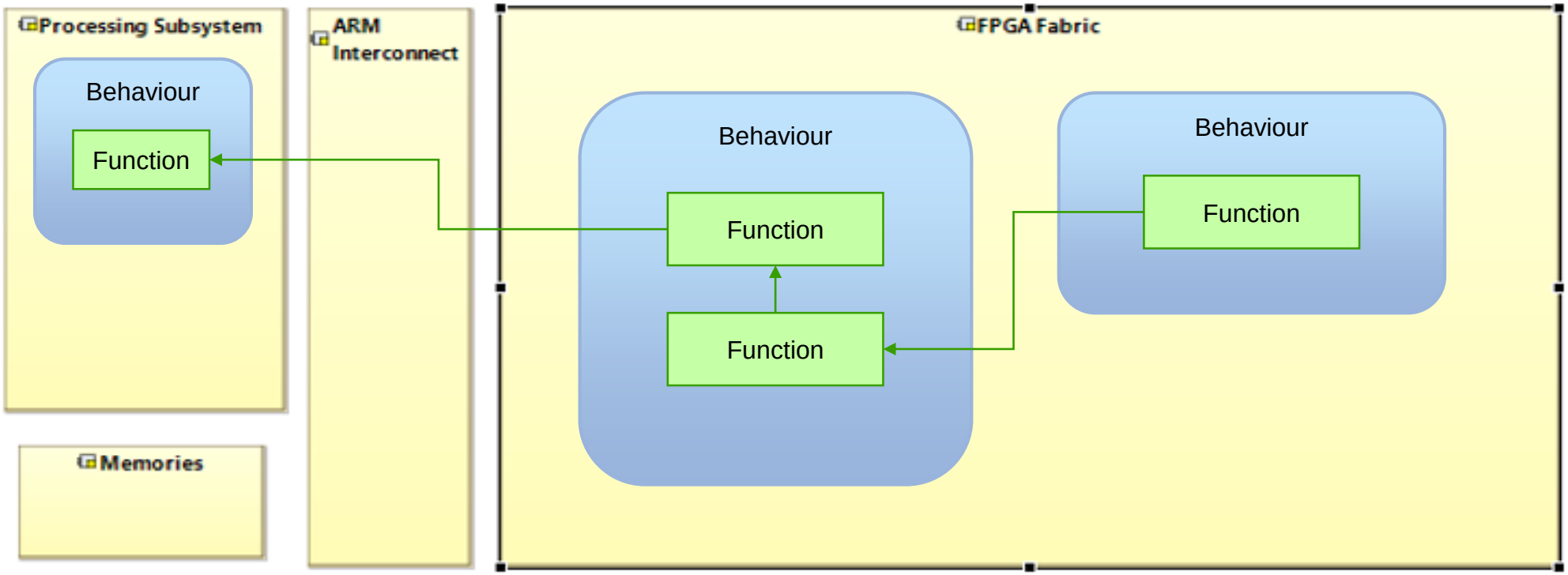
2) Initialize one physical architecture diagram for each functional chain



The Functional Chain Approach

Proposed Methodology

3) Add only the element of interest in the dedicated diagram, i.e. only the elements that concerns the related functional chain



The Functional Chain Approach

TC Chain Example

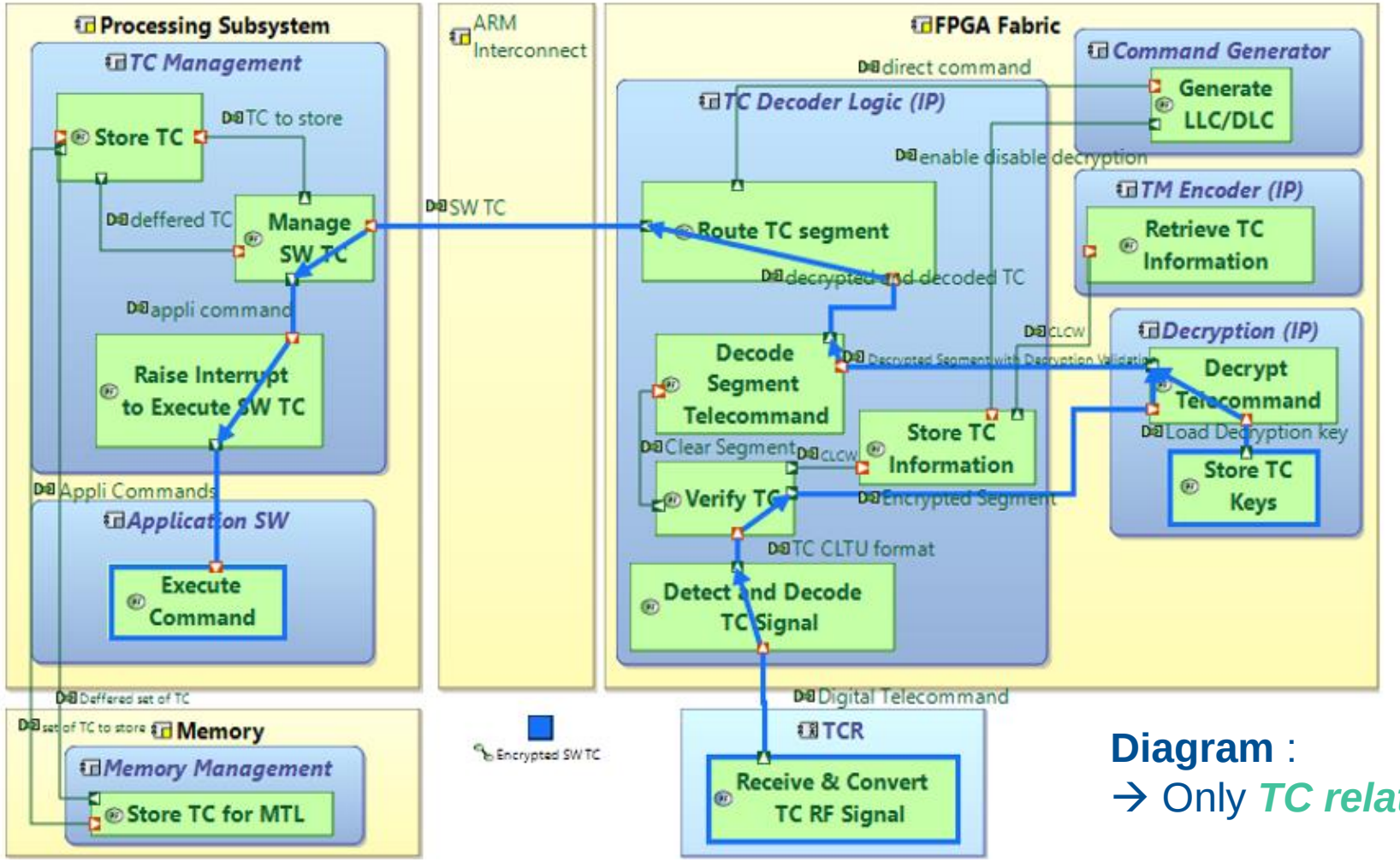


Diagram :
→ Only ***TC related*** functions

4

USE CASES

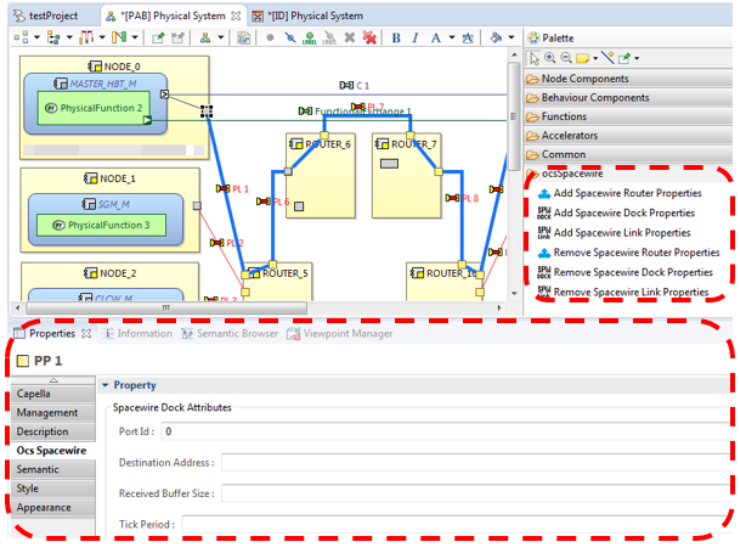
APPLICATIONS OF THE FC APPROACH

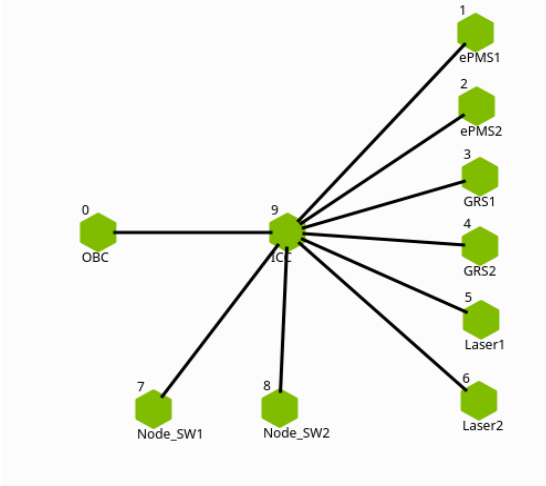
Use Cases

Data traffic and End-to-End latencies simulation

MOST (Modelling of On-Board Space Traffic):

- Tool developed by Thales under ESA funding.
- Based on NS3 (open source tool for networks simulation).
- Allow to simulate data traffic for space communication links.
- Currently supports ***Spacewire*** and ***Spacefiber***
- Other protocols supported soon.



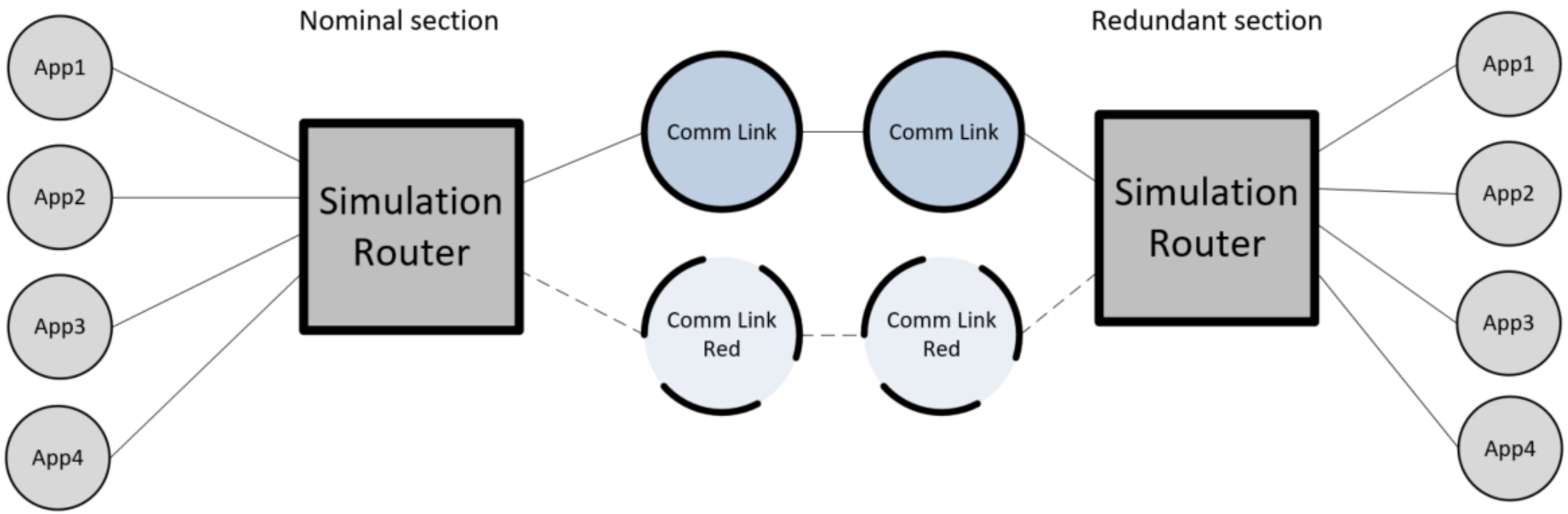


Viewpoint in development to use Capella as MOST GUI

Use Cases

Data traffic and End-to-End latencies simulation

Simulation topology definition



→ Represents the data transmitted through the link connecting the nominal and the redundant SOCs

Use Cases

Data traffic and End-to-End latencies simulation

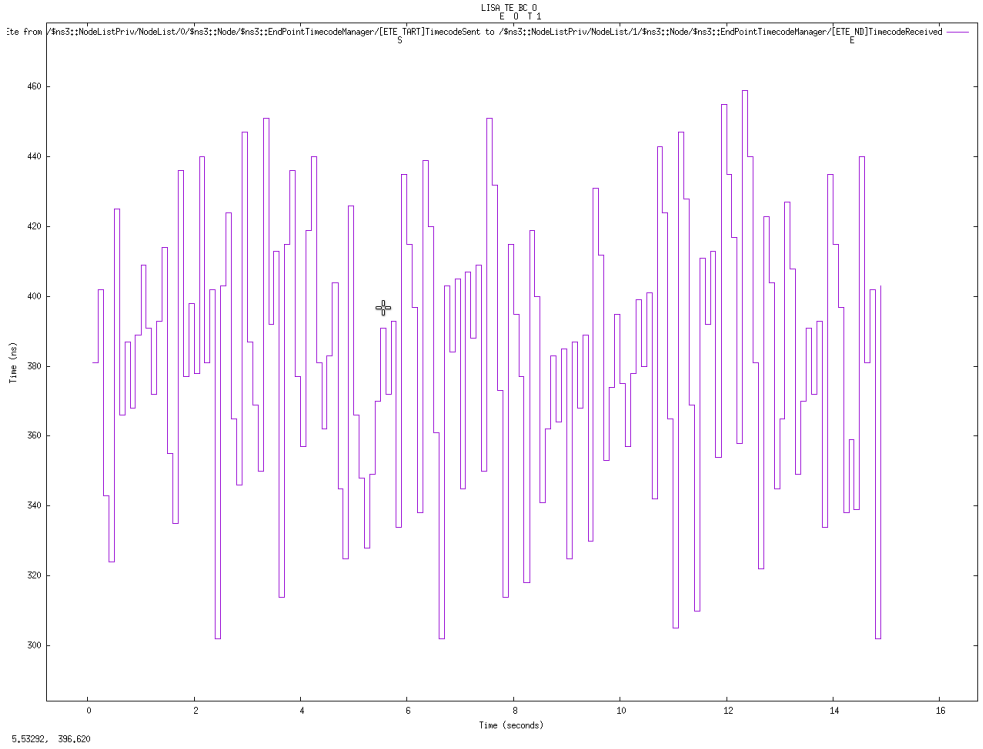
Verification on the definition of the Functional Chain

	App 1	App 2	App 3	App 4	App 1	App 2	App 3	App 4	Total
Packets sent	42	23	23	17	17	17	17	10	**166**
Packets Received	113	1	1	18	18	2	2	11	**166**

Validation:

- All packets sent are received
- No congestion (no buffer full)

Latencies Validation on Functional Chain

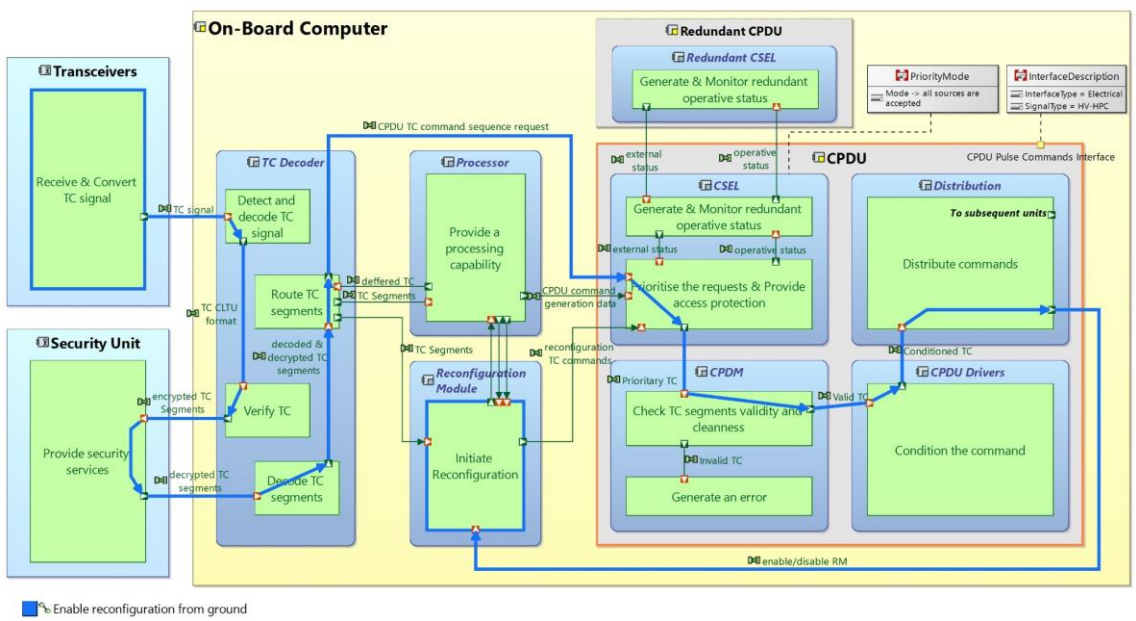


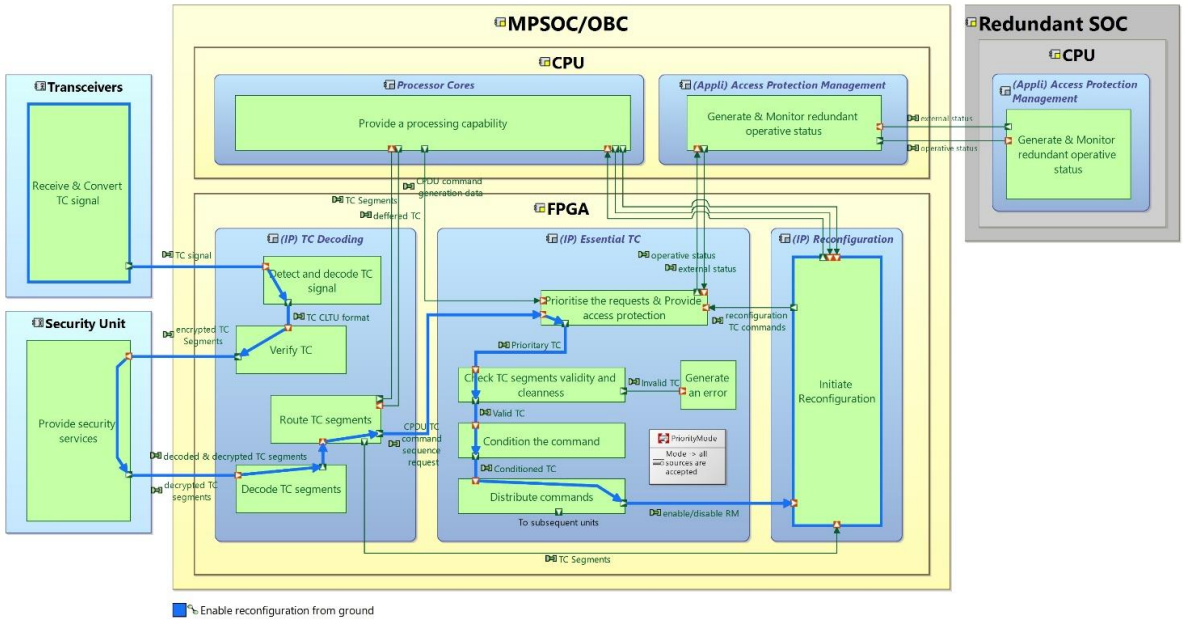
Functional Chain requirements can be validated

Use Cases

Avionics architecture comparison and requirements mapping

Same functions, different physical implementation



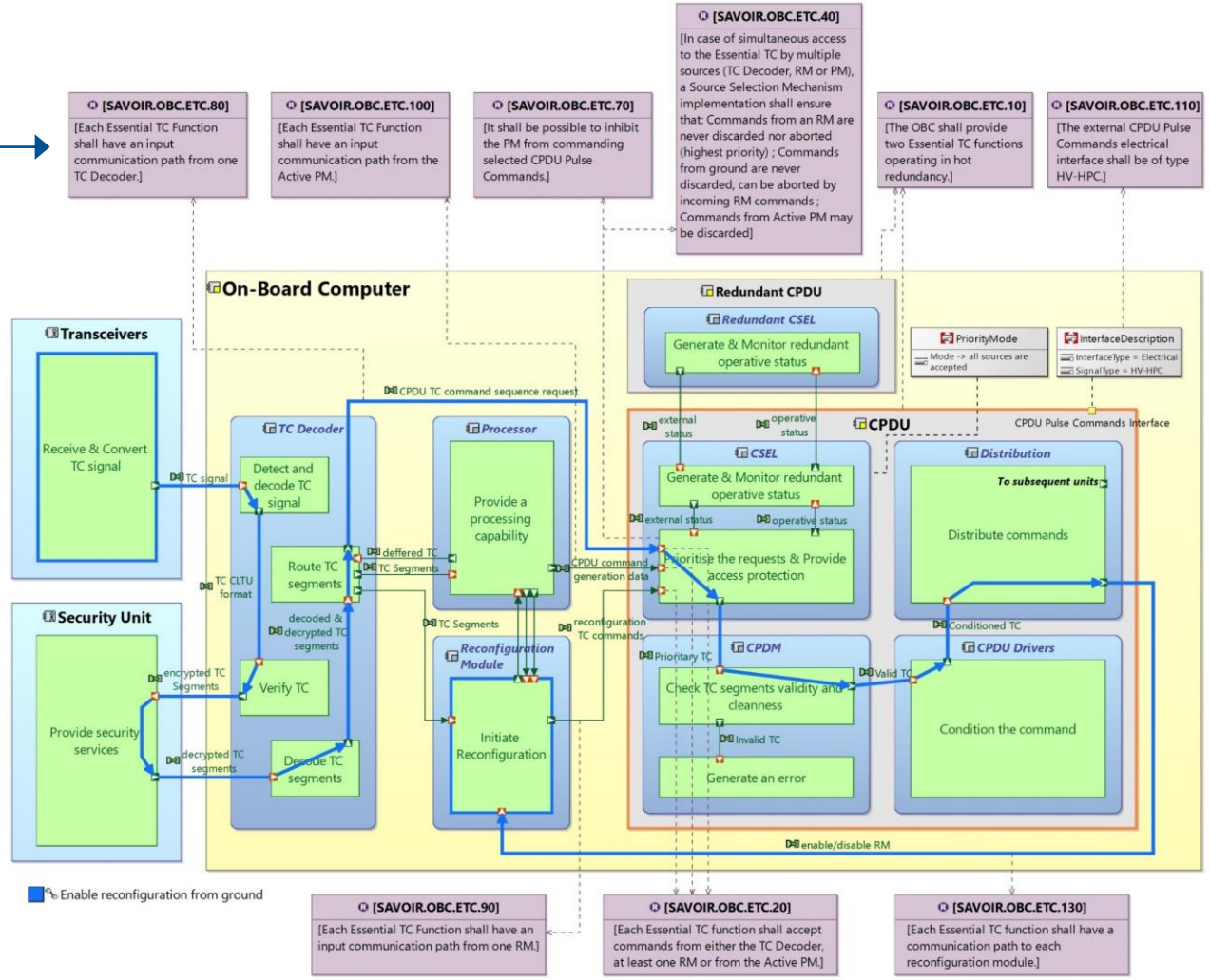


functional chain approach → focus on one specific aspects of the system → complexity easier to handle

Use Cases

Avionics architecture comparison and requirements mapping

Requirement object in Capella



Use Cases

Avionics architecture comparison

Requirement	Allocation status (If field is empty, then no allocation)
SAVOIR.OBC.TC.10 *No of TC Decoders*	**Allocation OK** *Handle Telecommand* *(ID : eb3b8dfb-fb28-4dfa-a371-0ae72f641f5f)* **Allocation OK** *Redundancy type* *(ID : 18b7768d-9030-450d-b127-6b0d270ffd27)*
SAVOIR.OBC.TC.20 *Input selection mechanism*	**Allocation OK** *Select TC receiver inputs* *(ID : 5c055089-0051-4dc0-a1b0-7b6184fcd673)*
SAVOIR.OBC.TC.30 *TC Decoder function*	**No allocation**
SAVOIR.OBC.TC.40 *TC Decoder function*	**Allocation OK** *Decode TC segments* *(ID : 7fdf1ec3-d8e4-4532-968f-6d2175025ab6)*

5

CONCLUSION

ADAPTED FOR COMPLEX SYSTEMS

THANK YOU FOR YOUR ATTENTION

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