OBDP 2019

Next Generation Data Handling System – OBC-SA / SPINAS (On-Board Computer – System Architecture / SPace INfrasructure And Software)

DEFENCE AND SPACE

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Objectives

Next Generation Data Handling System

- Flexible HW architecture
- Flexible SW architecture
- Deterministic high speed and secure bus system for exchanging data
- → obvious: this is not only related to solely HW or SW. Its both and more →architecture necessary to focus on the end-to-end chain during the development
- \rightarrow How do we want to achieve this?

Objectives II

Three ingredients

- 1. Flexible HW architecture
- \rightarrow Integrated Modular Architecture (IMA) \rightarrow HW (and SW)
- → IMA used in several and Airbus and Boeing Aircraft Families widely adopted, makes it more robust, reduces complexity and harness

- \rightarrow Not single board but "platform" is needed
- 2. Flexible SW architecture
- \rightarrow No monolithic SW package
- → Time-Space Partitioning
- → Reusable SW Framework core Flight System (cFS)
- 3. Deterministic high speed and secure bus system for exchanging data
- → Deterministic Bus System (TT-Ethernet)

IMA – HW SPINAS OBC/SA

<u>SPINAS</u> – Space Infrastructure and Software <u>OBC/SA</u> - On-Board Computer – System Architecture

3U Compact size / small footprint Mass < 5kg, Dimensions (L x B x H) [mm]: 230 x 230 x 135

Consists of:

- Computer Board LEON4 GR740
- IO Board TTEthernet
- Power

Connected by standardized backplane "cPCI serial space" →boards are exchangeable, e.g. if DAHLIA (or other board) comes to market, CPU board can be exchanged and all other components remain

Status: TRL6 is expected for March 2019 Most of EQM Tests executed in Q4 2018

2019-02-25





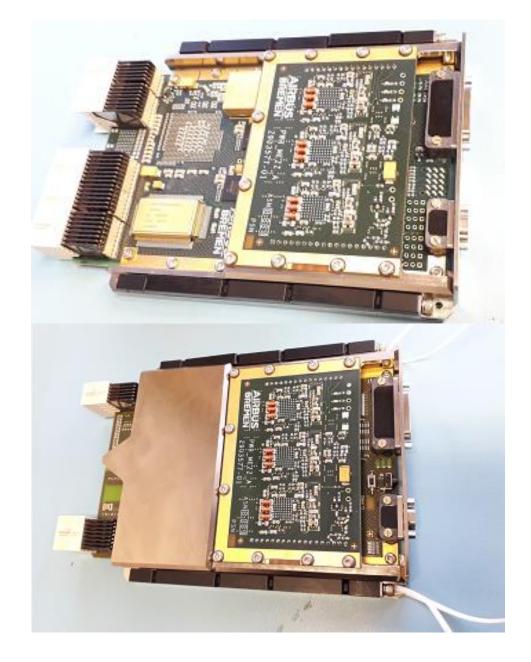
IMA – HW SPINAS OBC/SA II

CPU Board

- High reliability SPARC V8 CPU LEON4
- 4 cores @ 250 MHz
- 459 DMIPS per core
- 256 MiB SDRAM (+EDAC)
- 4 Partition with 64MiB NOR-Flash
- 2x Gigabit Ethernet
- 8x Spacewire up to 300Mbit/s
- Redundant MIL-STD-1553B
- 2x CAN, 2x RS422

IO Board

- Xilinx Virtex 5 FPGA
- 3x Gbit TTEthernet / Ethernet
- 1x Ethernet
- 2x SpaceWire
- 1x RS422
- 1x SPI





IMA - SW

Goals which needs to be achieved

No monolithic SW package Integration needs to be made easy Easier to maintain Easier configuration management Many different vendors / "App Store Concept" Ease testing – simulated and original equipment at the same time / exchange whenever necessary

(Part of the) Solution

Multicore, Time Space Partitioning Open Architecture Building Blocks

At the end

 \rightarrow Many applications on one computer

 \rightarrow Many different criticalities on computer



IMA – SW – Operating System

Necessity

- Each application must not interfere another application
- OS is either certified or certifiable.

 \rightarrow Operating System is needed which, together with the features of the processor, ensures this goal.

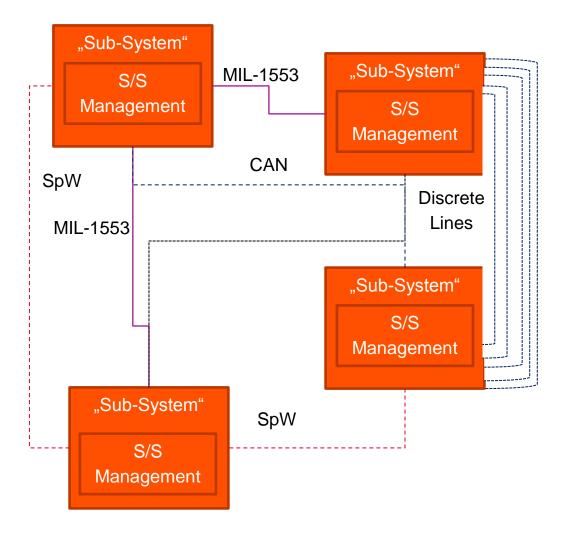
- PikeOS 4.x
- VxWorks 7
- (RTEMS 5.x)

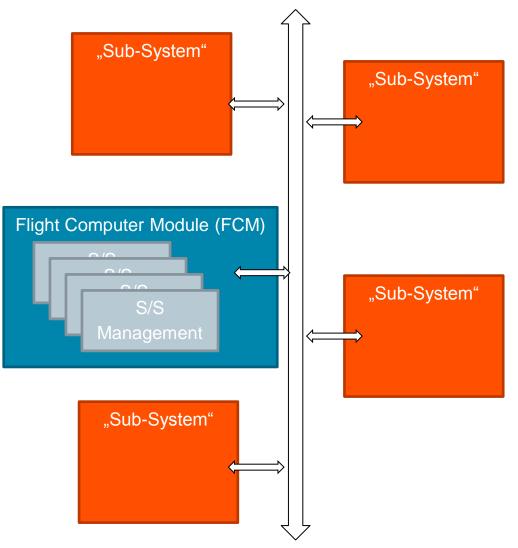
Candidates / next steps

- VxWorks 653
- XtratuM

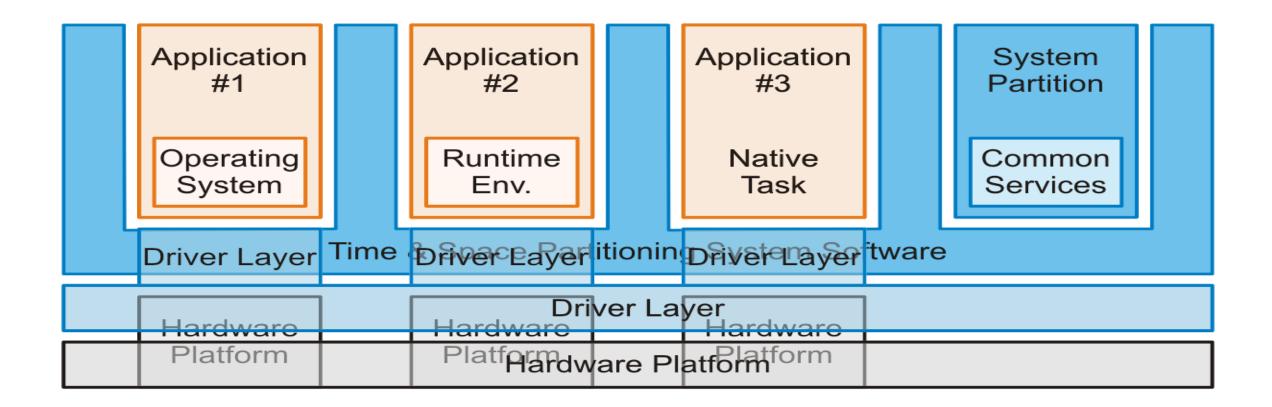


"Boxes" ./. "IMA"

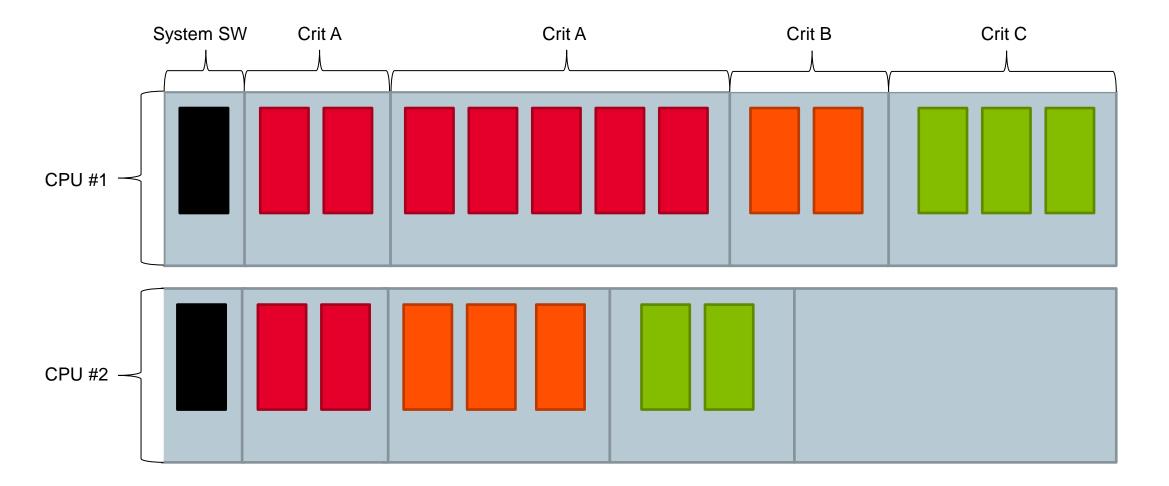




IMA – SW – Time Space Partitioning



IMA – SW – Time Space Partitioning II

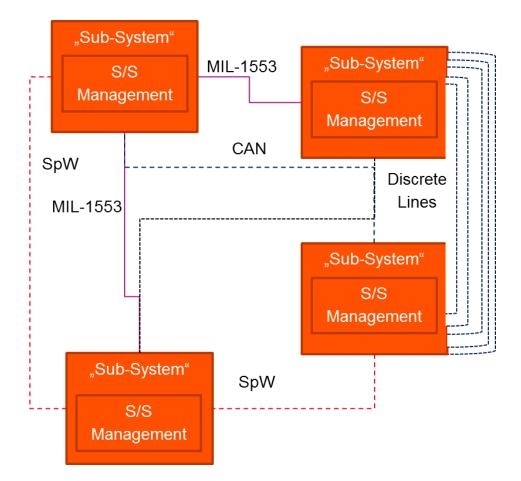




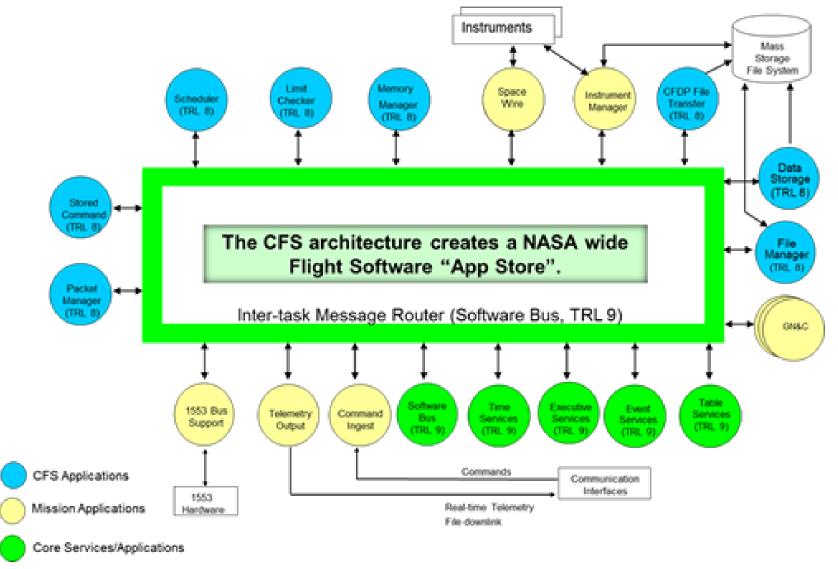
IMA

What is not IMA?

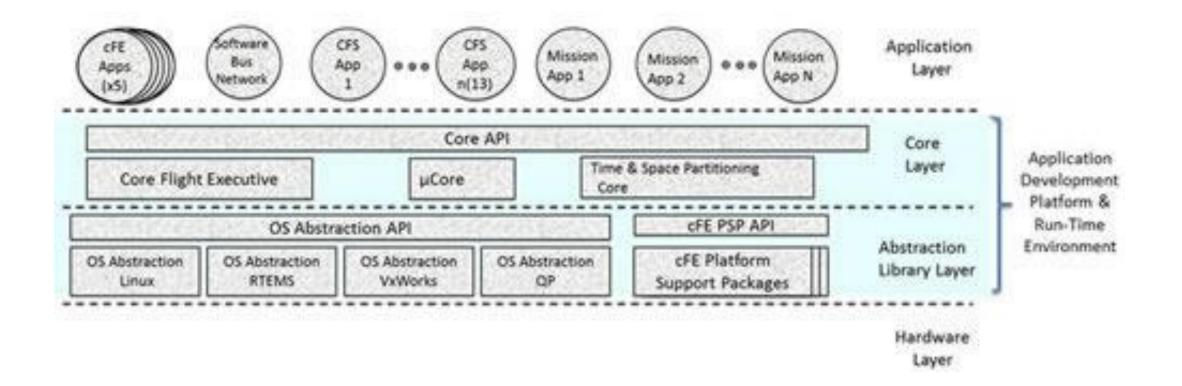
- Take some existing boards and place them into one housing
- Create some kind of connectivity between these boards
- Run existing SW on boards which do not have a common architecture
- Bridge existing SW components via proprietary connections which cannot be reused later on



Reusable SW Framework – core Flight System



Reusable SW Framework – core Flight System II



Study – Gateway **GATEWAY** An exploration and science outpost in orbit around the Moon F 20 Power and **Propulsion Element:** G Power, communications, attitude control, and orbit control and transfer capabilities for the Gateway. Orion: U.S. crew module wth ESPRIT: ESA service module that will take humans Science airlock, additional propellant storage with refueling, farther into deep space NASA-led architecture and integration than ever before. and advanced lunar telecommunications capabilities. U.S. TBD: U.S. and/or International **Utilization Element:** International Small pressurized volume for additional Gateway Compared to the International Space Station habitation capability. The International Space Station is a permanently crewed research platform that has 11 modules and is the size of a football field. The Gateway is a much smaller. Sample Return Robotic Arm: Logistics and Airlock: more focused Vehicle: Utilization: Enables spacewalks Mechanical arm to platform for berth and inspect potential to extending initial Cargo deliveries of A robotic vehicle capable vehicles, install science accommodate human activities consumables and of delivering small payloads. docking elements. into the area equipment. Modules may samples or payloads Habitation Pressurized volumes with environmental around the Moon. double as additional from the lunar surface to Modules: control and life support, fire detection and utilization volume. the Gateway. suppression, water storage and distribution.

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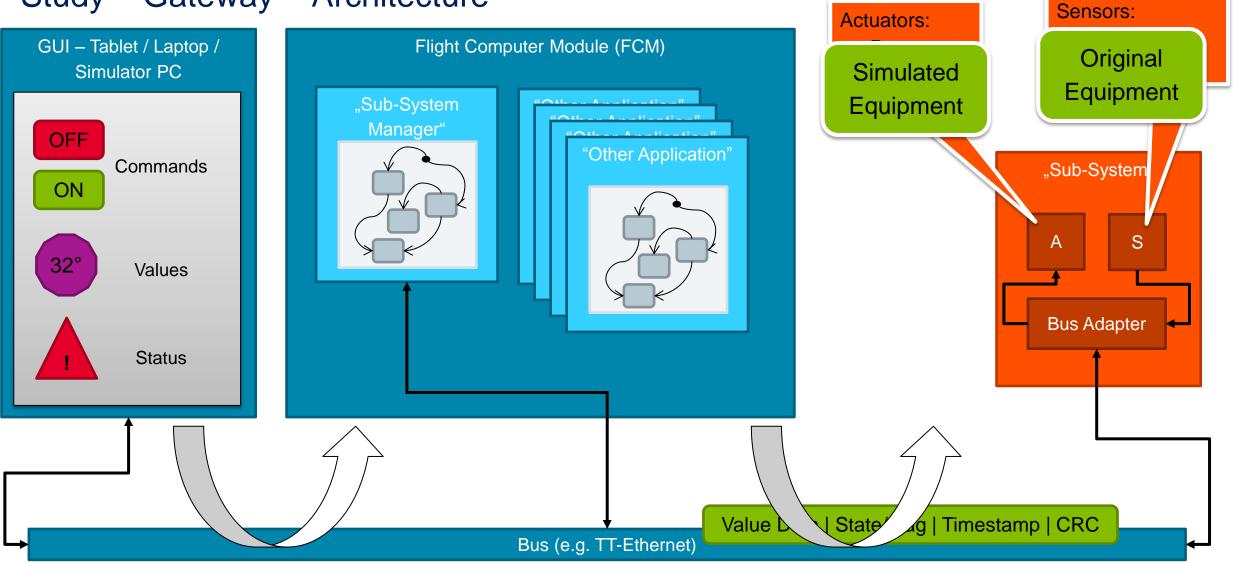
Study – Gateway – Objectives Breadboard Development

AIRBUS

Based on IMA, Spinas, cFS and TT-Ethernet

Scenario 1: Apps running on different partitions Scenario 2: Apps running on different nodes Scenario 3: Load, Start, Stop, Unload cFS Apps in run-time in an FDIR scenario Scenario 4: Shift functionality from one node to another Scenario 5: Resume failed App on node via other App or from Ground

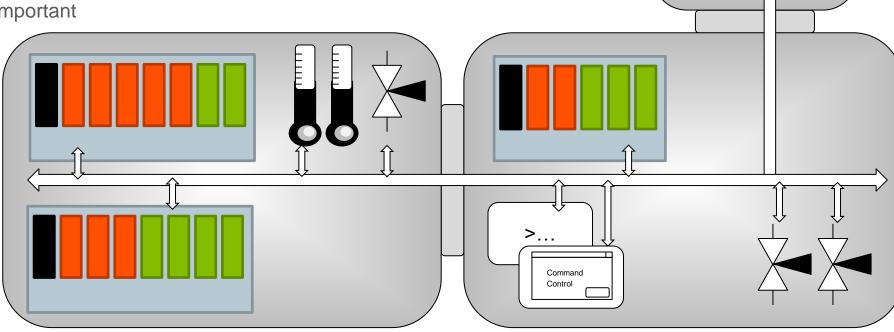
Study – Gateway – Architecture



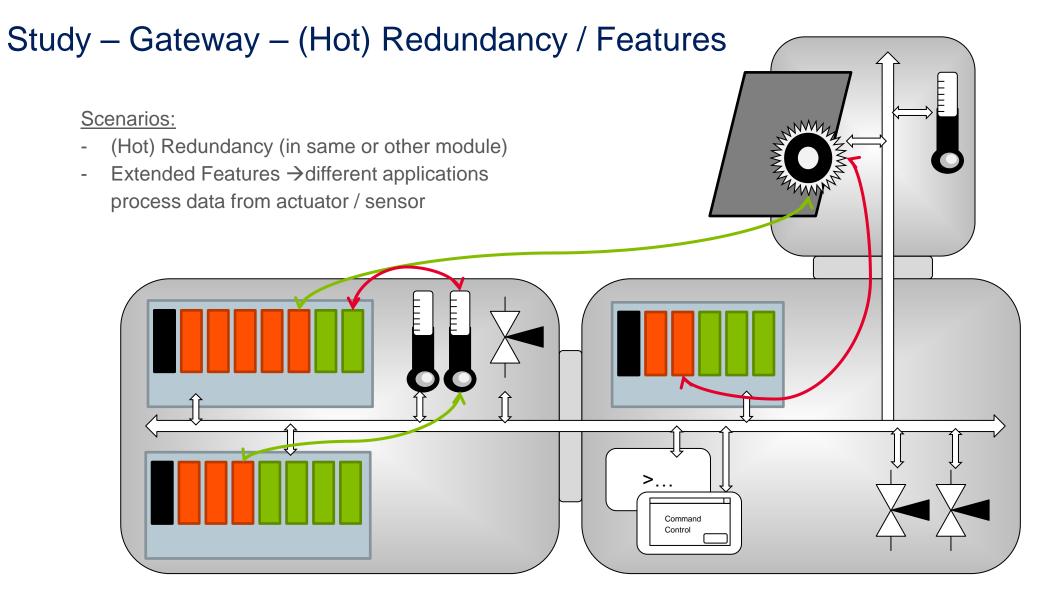
Study – Gateway – Architecture

Architecture:

- Different modules,
- Connected by bus system
- Exchange data between modules
- Location of Management of Actuator/Sensor not important



NMM

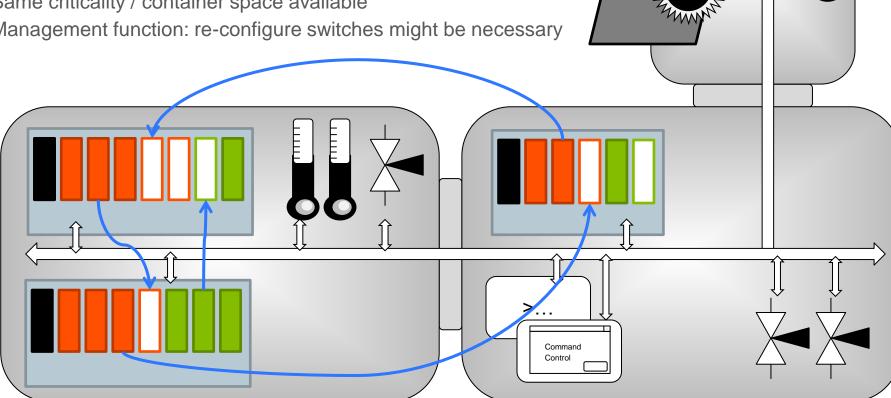




Study – Gateway – Relocation of Applications

Precondition:

- Empty "slot" present -
- Same criticality / container space available -
- Management function: re-configure switches might be necessary -



NMM



Conclusion

Be able to create applications in a distributed environment (e.g. supplier, not everything in-house, SW development across sites, ...)

Secure each part of the SW

Run SW with same criticality in one or more than one container Run SW with different criticality in different containers

Run SW on different platforms

Be able to exchange processor board with next generation processor board

Use deterministic bus system

Ensure deterministic communication by using a high reliable, high performance and also secure network

