What does the space industry expect from RISC-V?

Airbus Defence and Space

Antoine Certain

RISC-V and open Hardware solutions, Scientific days

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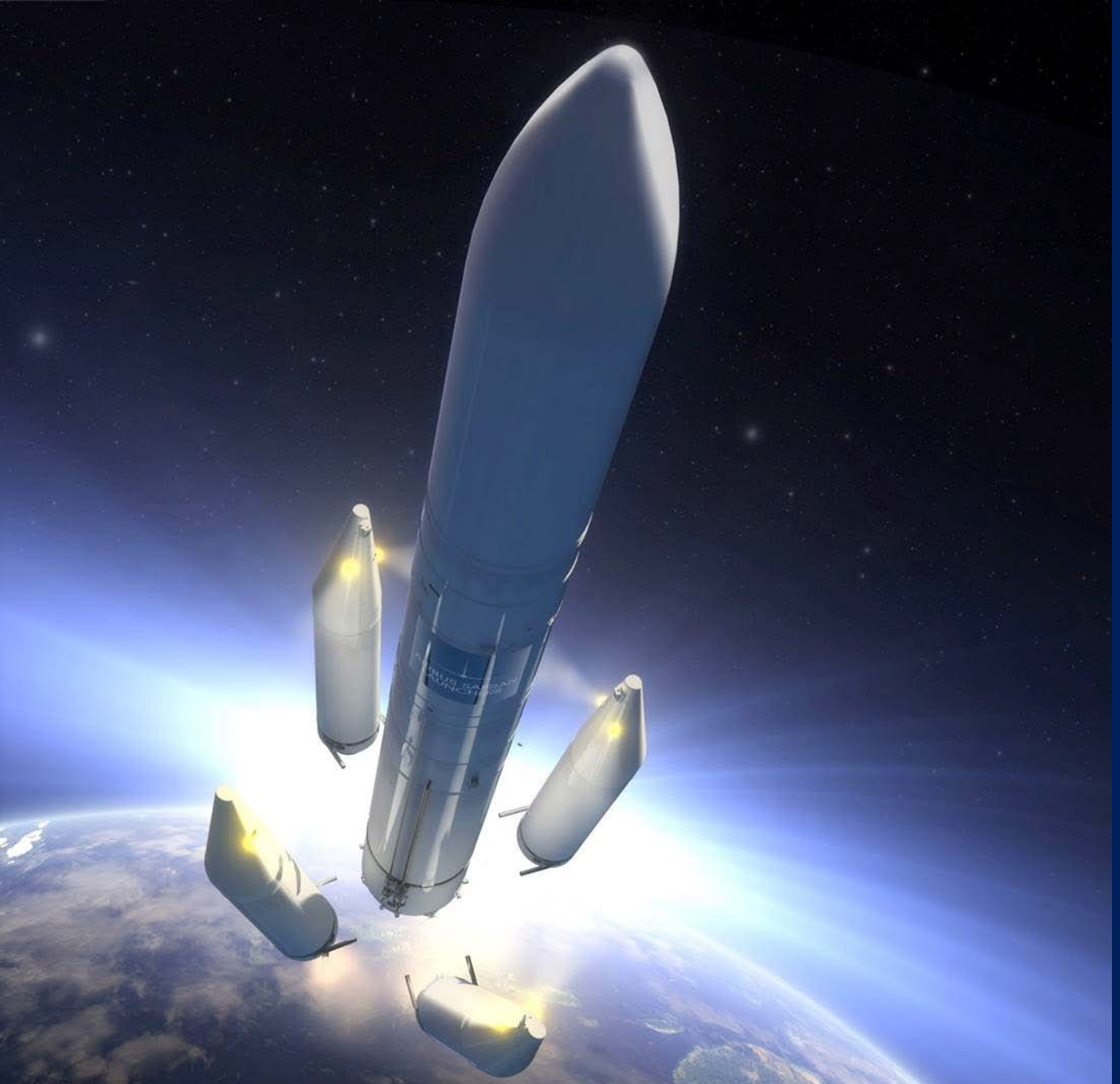

Agenda

- What’s constraints for space industry ?
  - Environmental
  - Technical
  - Industrial
- What’s now ?
  - Legacy
  - New space
- What are needs trends ?
  - Functionnal evolutions
  - Reduce development costs
  - Increase modularity
- What’s next ?

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Tolerance to radiations for On-Board Electronics

Problems

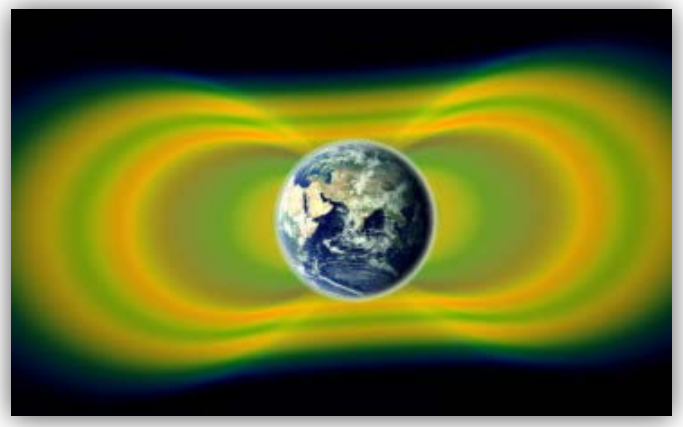
- Destructive effects (latch-up)
- Cumulated radiation dose
- Transients errors due to space particles

Solutions

- Robust silicon technologies
- Fault-tolerant design inside the chips
- Fault-tolerant systems architecture with COTS components

Drawbacks

- Poor electronics components and devices catalogue
- Lower processing performance
- Radiation characterisation & qualification



What's constraints for space industry ?

Environmental Constrains:

- Radiations
- Energy
- Mechanical and thermal

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Energy

- **Solar Energy only**
- **Becomes rare when far from the Sun**
- **Unpredictable on Planetary surfaces**

Mechanical and Thermal constraints

- **Vacuum and thermal variations**
- **Extreme and variable operational conditions**
  - **Assembly Integration and Tests**
  - **Ground, air and sea Transport**
  - **Launch**
  - **Orbital LEO short night/day cycles, GEO, Deep Space**

What's constraints for space industry ?

Environmental Constraints:

- Radiations
- Energy
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- **Time and Synchronisation**
  - Synchronisation on a time reference (e.g. GPS)
  - Accuracy of time distribution and synchronisation on board
  - Synchronisation with distant systems
- **Performances**
  - Increased Attitude and Control systems agility
  - Fast growing instruments data processing
  - Low performance processors (radiations)
- **Communication**
  - Bandwidth availability
  - Complex communication paths with ground
  - Data protection: data security function management
- **On-board Data management, routing and storage**
  - Data rates and volumes increase a lot with new generations of instruments
  - On-board Network management, communication protocols
- **Maintainability**
  - Need for on-board reprogrammability
    - with software today; also with FPGA's in the near future

What's constraints for space industry ?

Technical Constraints:

- Time and Synchronisation
- Performances
- Communication
- On-board data handling
- Maintenability

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- **Variety of missions**
  - Generic platforms: Requirement domain without precise mission selection
  - Standard Product families: customisation for adaptation to mission
- **Make or Buy decision**
  - Interfaces standardisation, inter-operable products catalogue
  - International partnerships, GEO return, ITAR constraints
  - European independency
- **Testability**
  - Complexity of systems makes full test coverage difficult
  - Improvement of production, integration and validation methods and tools
- **Quality**
  - Rigorous standards for development and manufacturing processes
    - cost of non-quality is very difficult to predict and it is not easy to repair defects in space
- **Obsolescence**
  - Maintenance of critical components manufacturing capability
  - Strategic stocks for key products

What's constraints for space industry ?

Industrial Constraints:

- Variety of missions
- Make or Buy decision
- Testability
- Quality
- Obsolescence

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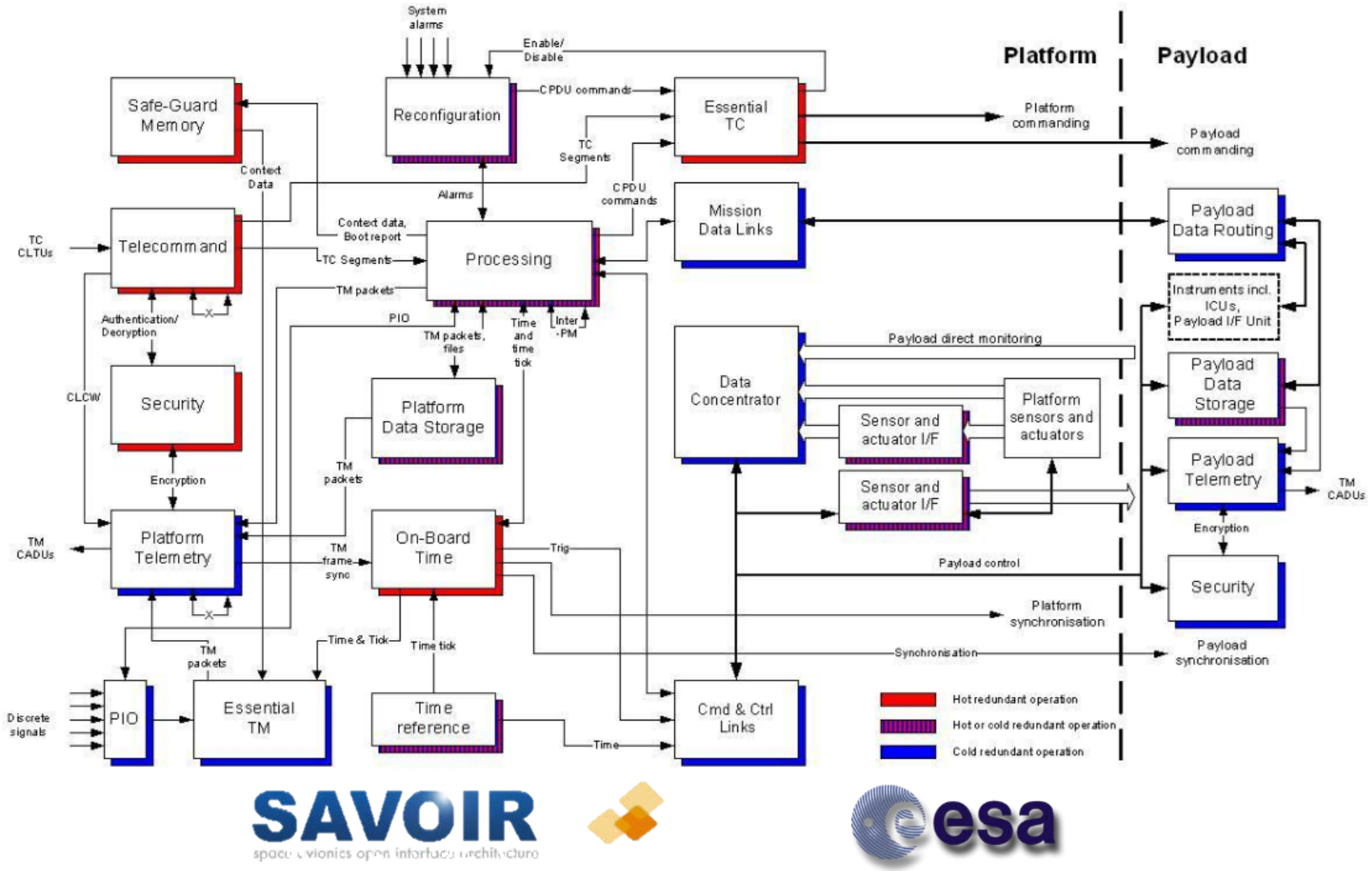
Functionnal Overview of an On Board Computer



What's now ?

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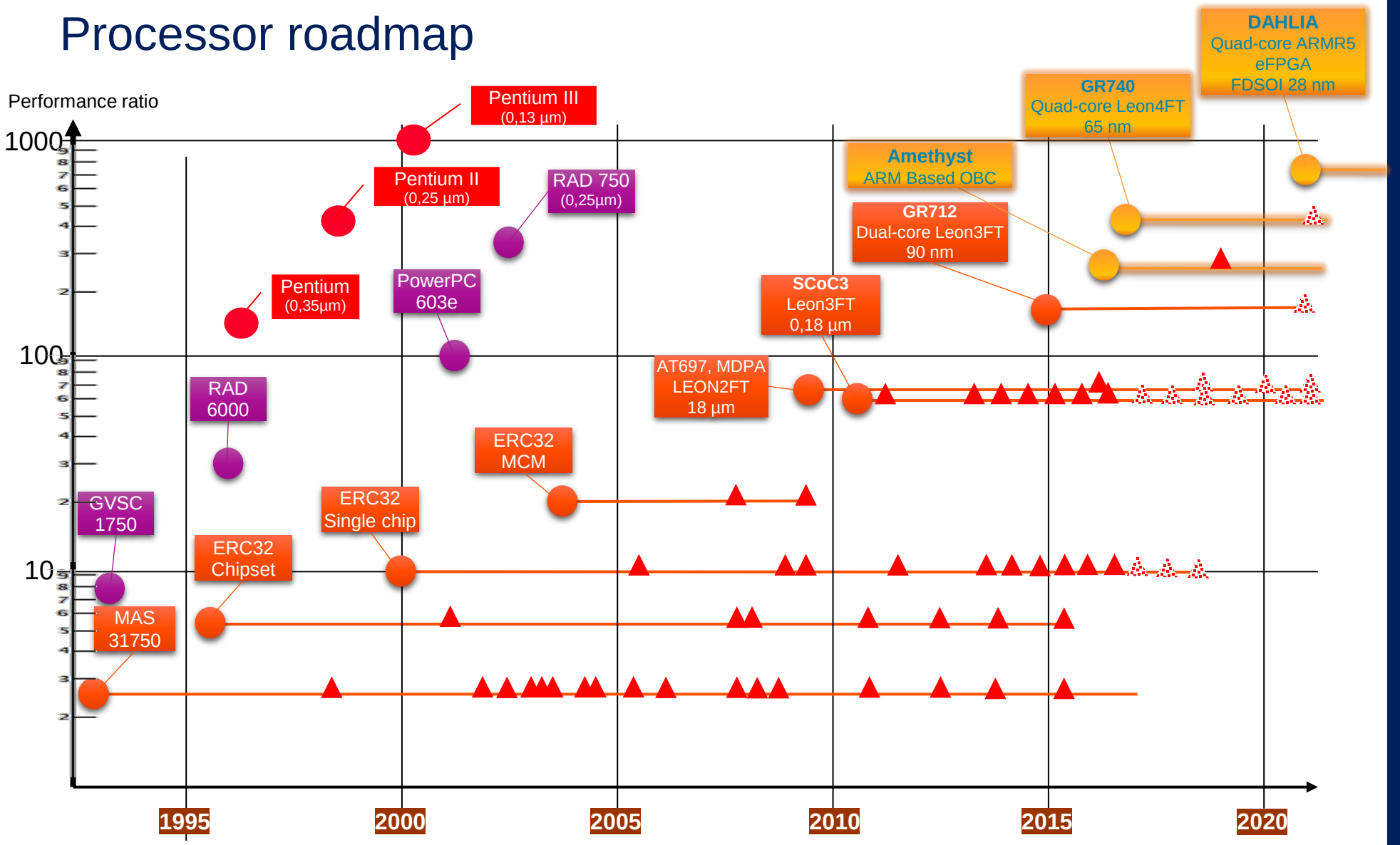
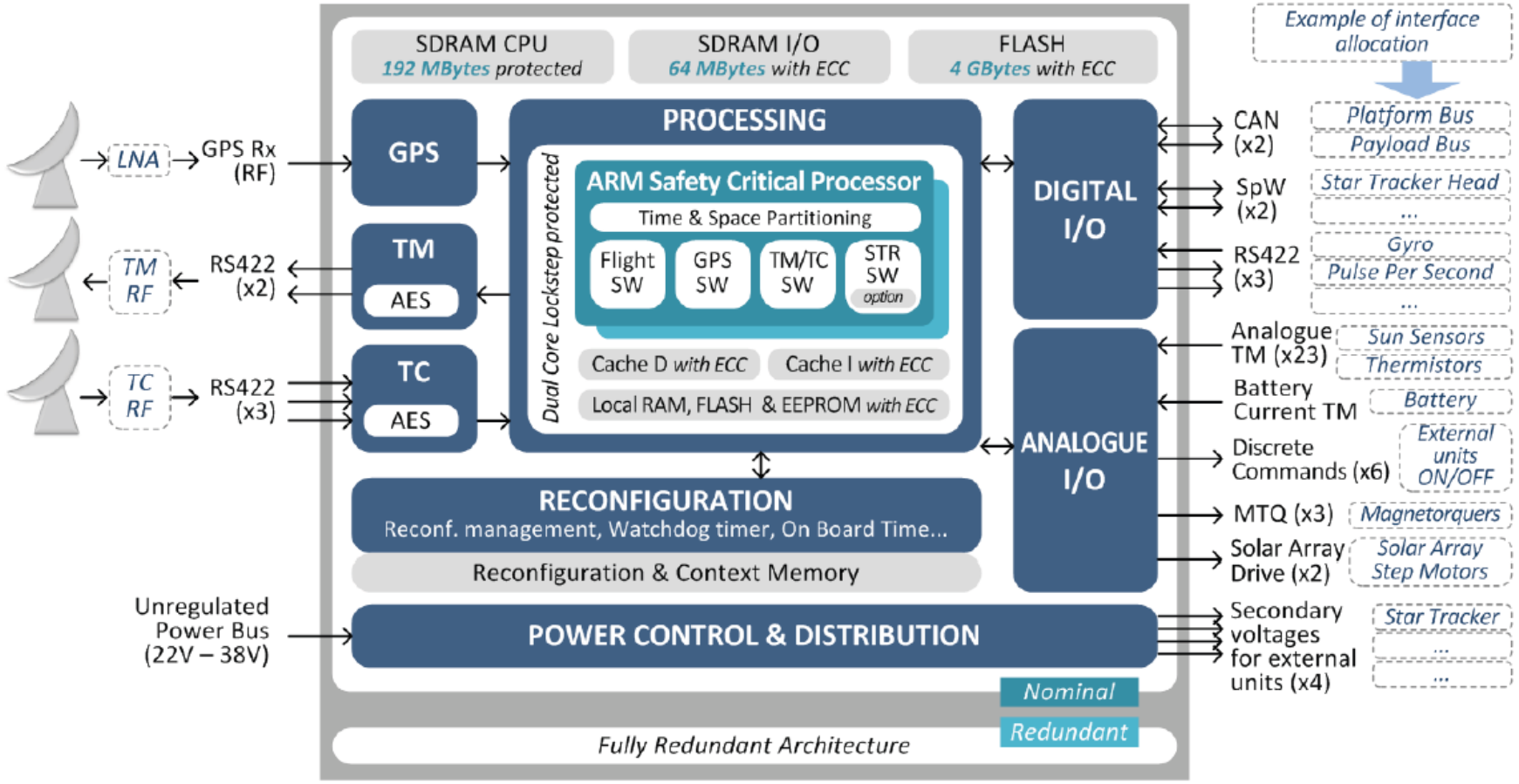
Processor roadmap



What's now ?

ARM Based On Board Computer



What's now ?

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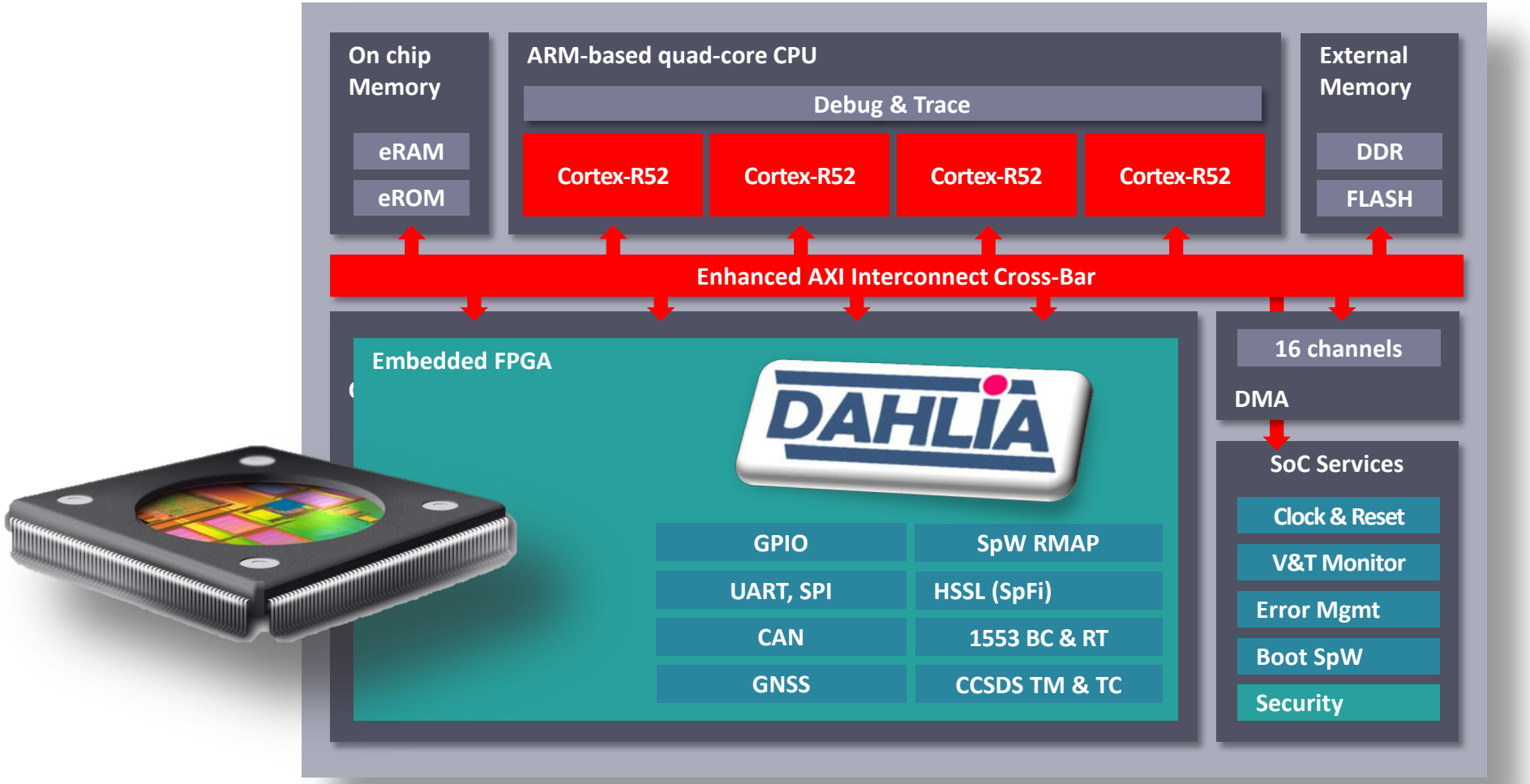
DAHLIA SOC



What's now ?

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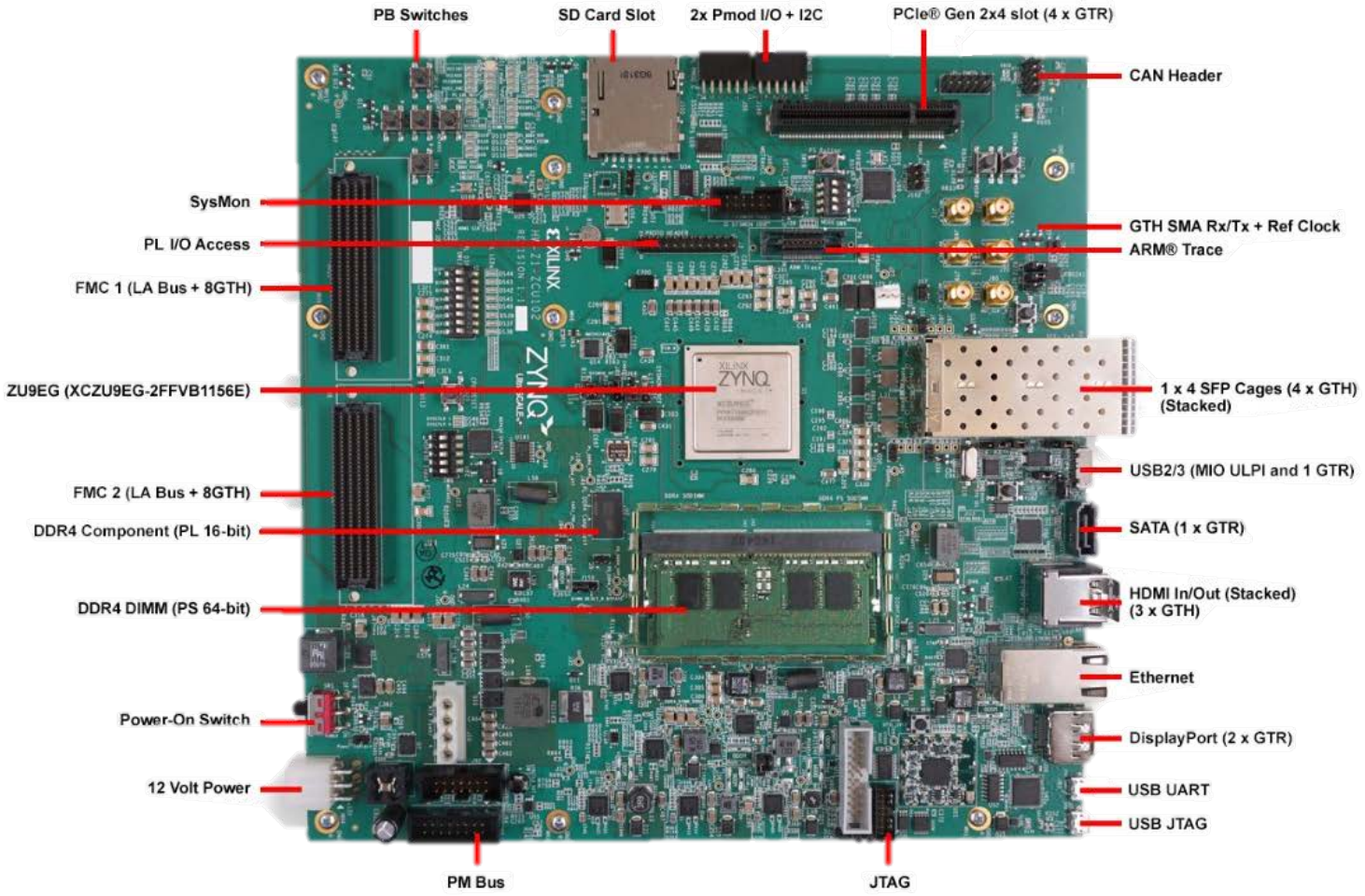
Zinq Ultrascale Plus



What's now ?

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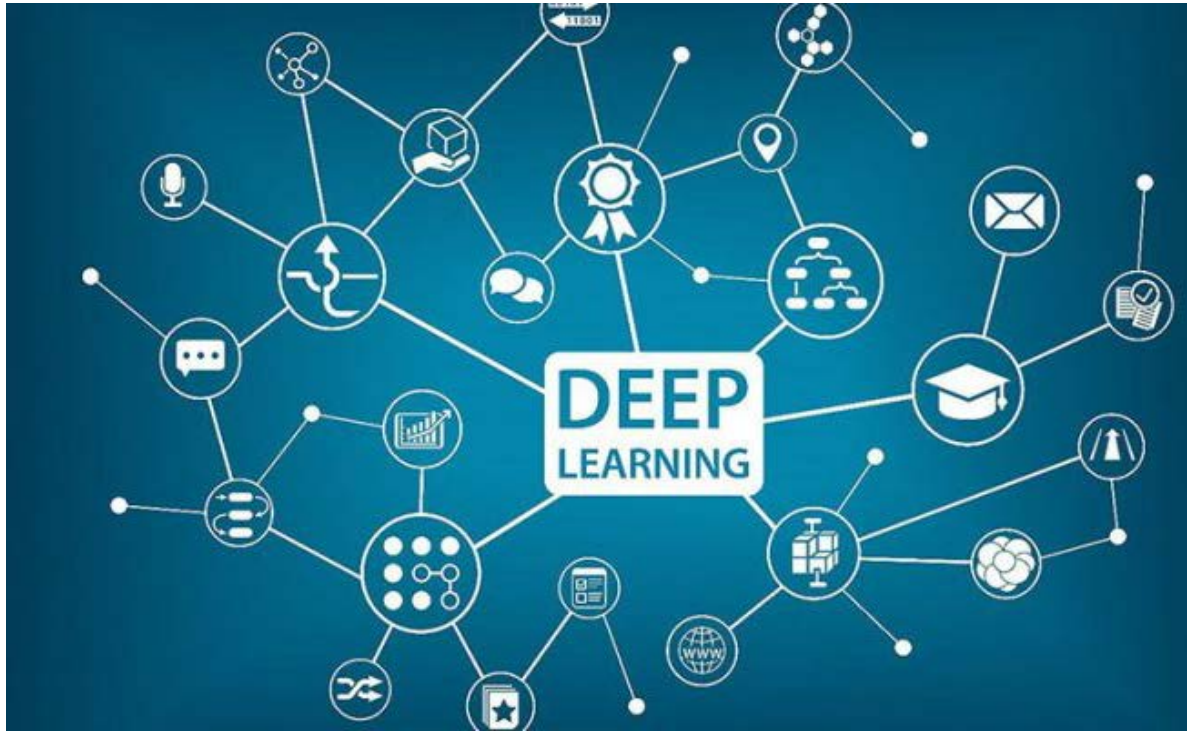
Functionnal



What’s the need trends ?

- Improve autonomy
- Improve on board processing
- Reduce Downlink Bandwidth
- Increase on board data handling
- Improving on board data storage
- Improve on board security

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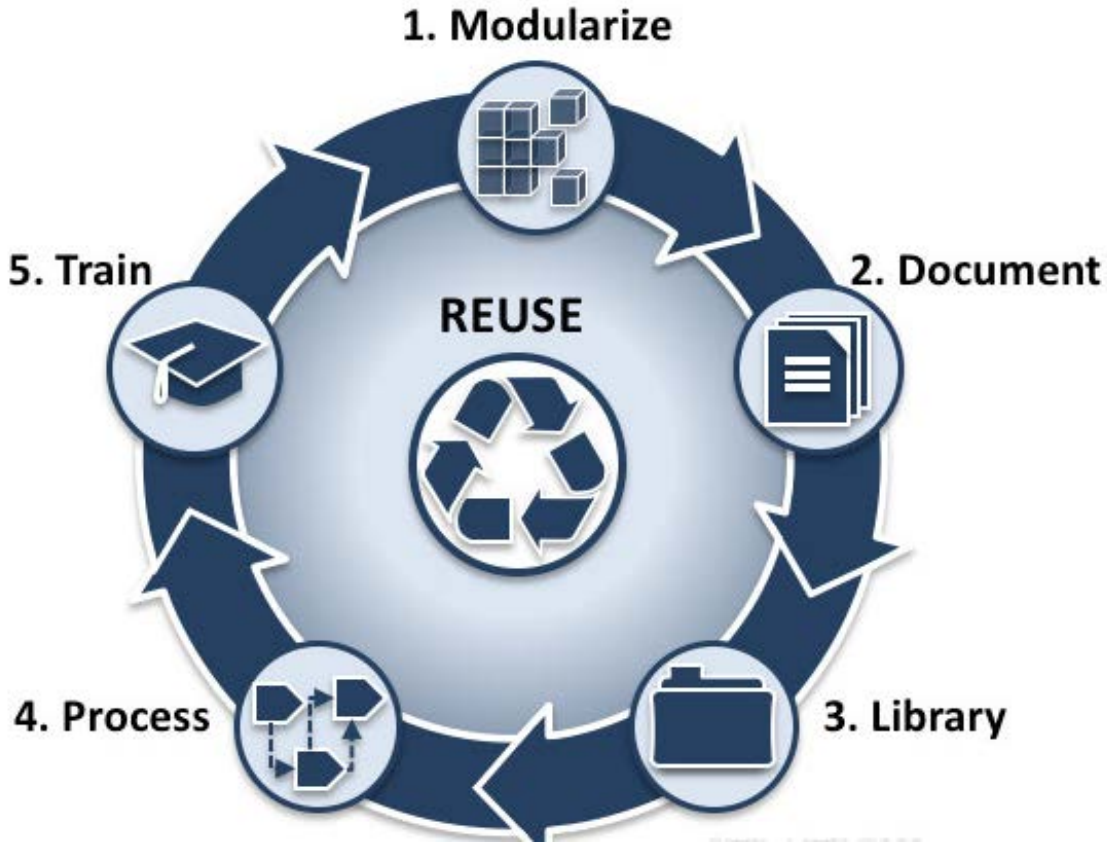
Industrial



What's the need trends ?

- Improve European independency
- Reduce development costs and planning
  - Improve reusability
  - COTS usage
- Reduce Hardware component
  - Mixed criticality
  - Simplify on board communication

My dream

Real time core(s)
Deterministic
Dedicated memory access
-> Dedicated to critical functionalities

Applicative cores
Rich OS enabled
Fast memory access
Memory Management Unit
L1, L2 caches
-> Dedicated to mission handling

SOC Management Unit
Power management
Time management
Debug support Unit with traces
DMA management
Security Management
Reconfiguration Management

Network on Chip (aware of interferences)

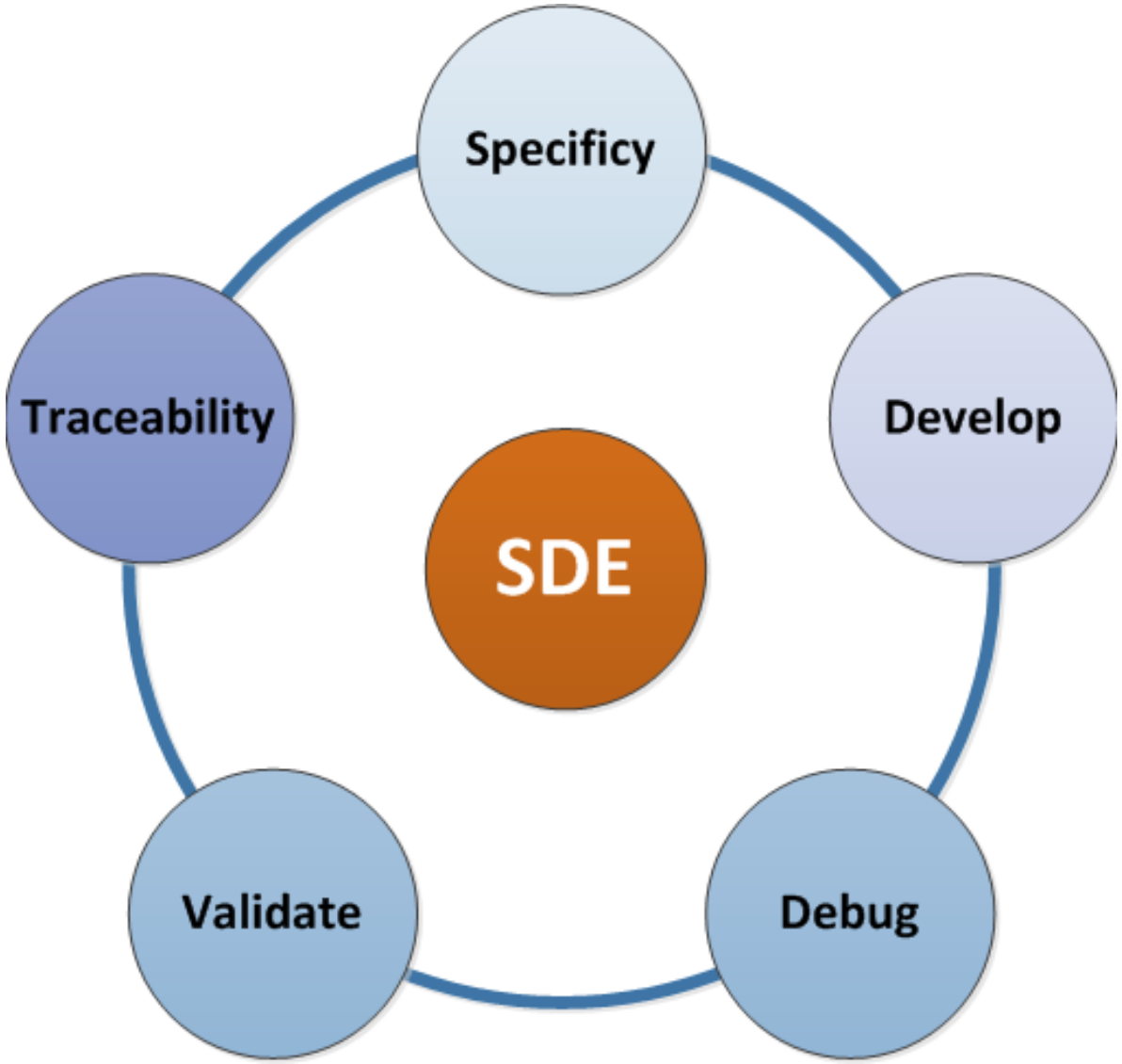
Memories Controller
Nor Flash
Nand Flash
DDR, SRAM

Hardware accelerator
For complex algorithms
(GPU, FPGA, ManyCores)

IO and eFPGA
Ethernet (TSN), Spacewire, legacy interfaces

What's next ?

Software Development Environment



What's next ?

- Open
  - Flexibility
  - Connection with others tools
  - Standardized
  - Customizable
- Easy to use
- Not dedicated to one target

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Thanks you for your attention

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