What does the space industry expect from RISC-V?

Airbus Defence and Space

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RISC-V and open Hardware solutions, Scientific days
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 ?
What’s constraints for space industry?

Environmental Constrains:

- Radiations
- Energy
- Mechanical and thermal

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
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

Environmental Constraints:

- Radiations
- Energy
- Mechanical and thermal
What’s constraints for space industry?

Technical Constraints:

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

**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 ?

Industrial Constraints:

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

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
Functionnal Overview of an On Board Computer
ARM Based On Board Computer

What’s now?
DAHLIA SOC

ARM-based quad-core CPU

Debug & Trace

Cortex-R52
Cortex-R52
Cortex-R52
Cortex-R52

External Memory

DDR
FLASH

On chip Memory

eRAM
eROM

Enhanced AXI Interconnect Cross-Bar

Embedded FPGA

16 channels

DMA

SoC Services

Clock & Reset
V&T Monitor
Error Mgmt
Boot SpW
Security

GPIO
UART, SPI
CAN
GNSS

SpW RMAP
HSSL (SpFi)
1553 BC & RT
CCSDS TM & TC

What's now?
Zinq Ultrascale Plus
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
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?

- Open
  - Flexibility
  - Connection with others tools
  - Standardized
  - Customizable
- Easy to use
- Not dedicated to one target
Thanks you for your attention