Avionics technology trends
R&T axes

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Agenda

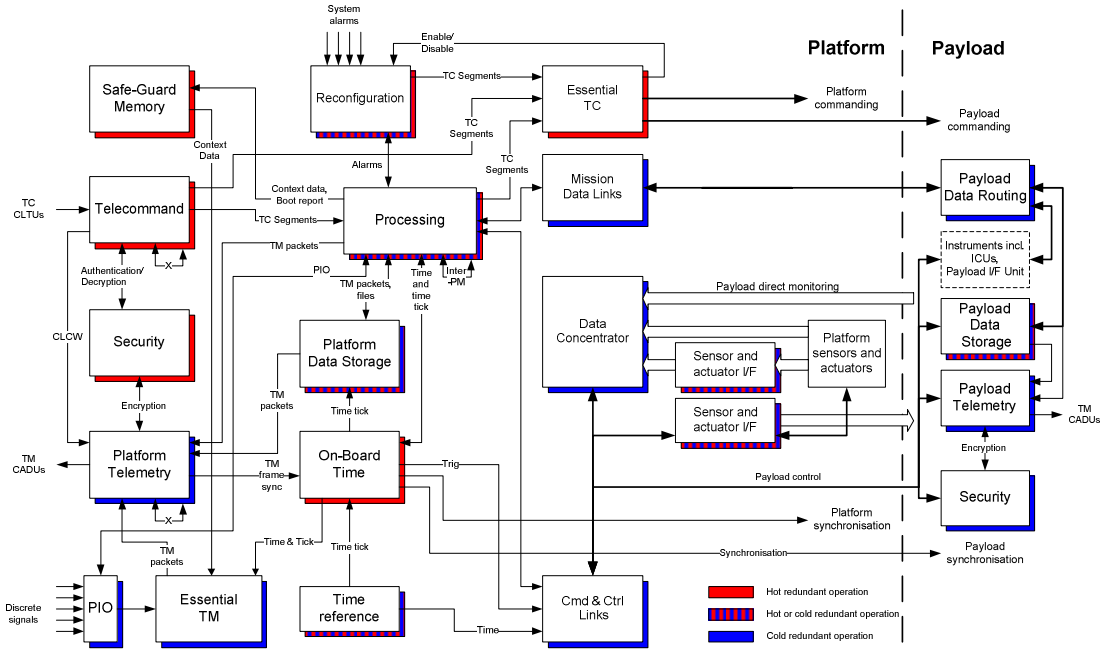
- State of the art & R&T axes
- New challenges & Evolution of the Avionics needs
- New Technologies for future avionics architectures
- Recommendations

Satellite Avionics : state of the art

Today's avionics:

- Complex architecture with Heterogeneous networks, segregation between platform & payload
- A lot of variability due to options and alternative non interchangeable solutions
- Communications data network based on MIL STD 1553B, CAN, SpaceWire
- LEON3-based processors

- Issues :
  - Competitiveness and non rec costs
  - Performances limitations for future needs
  - Low level of integration due to techno constraints
  - Flexibility require to maintain different communication interfaces



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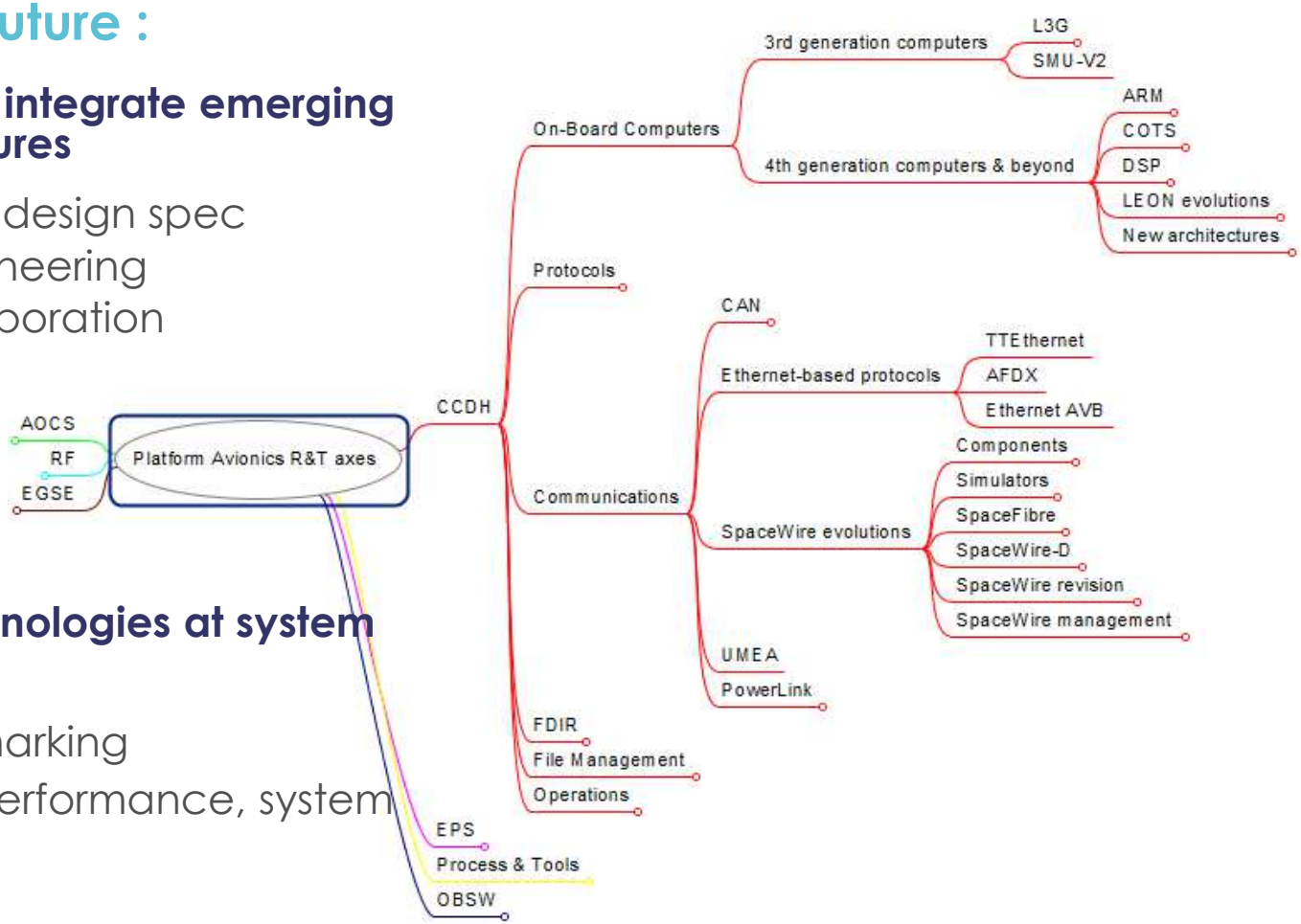
Satellite Avionics: R&T axes, short & long-term

R&T roadmap to prepare the future :

- **Avionics and system design must integrate emerging technologies in the new architectures**
  - System Specifications : avoid design spec
  - Promote Co-design / Co engineering
  - Participation to standards elaboration

- **Anticipate evaluation of new technologies at system level**
  - Test, breadboarding, benchmarking
  - Evaluation of benefits (cost, performance, system trade-offs)



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Satellite Avionics: new challenges

What about tomorrow's needs?

Telecommunication market:

1. **Reduction of costs to face global competition (HW, SW , engineering support, IVV, OPS)**
2. **Increase processing capabilities** to support new functions
3. **Increase optimization & integration of the avionics for the large constellations**
   ➔ new paradigm / global redundancy
   ➔ Promote COTS-based solutions to allow high level of integration and cost reduction

Science & observation market:

1. **Reduction of development costs and planning**
   ➔ simplify architectures , FDIR and redundancy schemes ,
   ➔ Promote re use buildings blocks and standard solution
2. **Increase processing and data network performances** to support autonomy requested in advanced projects

Innovation is key to improve competitiveness and reduce non-recurrent & recurrent costs

Satellite Avionics : evolution of the system needs

Need for higher processing performance

- To support higher software integration within a single computer >100/200MIPS
- To support and increased autonomy : ie to perform complex operations on-board (image processing, high frequency computing)
- Provide computing capabilities to payload / hosted payload

Investigations:

- Software : IMA-TSP concepts & multi-core handling

  ➔ Need for a reliable/qualified OS, both for payload and platform applications

- Assess new processor architectures (LEON++, ARM, PowerPC, DSP, …) through benchmarking activities based on representative application software (and not only Dhrystone)
- Fault Management , Redundancy strategies & rad-hard or rad-tolerant technologies

Satellite Avionics : evolution of the system needs

Reduce the complexity of the architectures thanks to integration and interface standardization

- **Increase the integration level / reduce the number of units**
- **Centralize command/control functions related to the payload and platform**
- **Provide a new communication networks to simplify architectures and SW**
  - **Platform needs:** low rate & high determinism for closed-loop control : < 1 Mbps (CAN & MIL 1553)
  - **Telecom Payload needs:** low rate for payload command & control: CAN is often sufficient
  - **Observation & science missions**: SpaceWire networks (~100Mbps) or Wizardlink for higher rates

New technologies will allow to simplify architectures

- **New processor will be available (ARM, LEON4 multicore, Power PC,..)**
- **Communication technologies**

co engineering (System , HW, SW, IVV, Operations) including Model Based Engineering to share the building block vision

- **Need for tools and process to support co engineering**

Satellite Avionics : new communication technologies

Opportunities related to the « new » communication technologies

- **Most of them (SpaceFibre, SpaceWire-D, AFDX, TT Ethernet) include interesting features to simplify avionics development and validation :**
  - **Define priorities**: some telecommands and telemetries need to be transmitted with low latency
  - **Allocate bandwidth**: to avoid congestions on TC & TM flow
  - **Define Virtual Channels**: to route the traffic close to the final application and not only the final node (useful for TSP software)
  - **High speed communications**: > 100 Mbps
  - **High-level interface** based on packets transfer: to simplify the software
  - **Guardian capability at switch level: to avoid failure propagation** on the network and massive congestion, some technologies have developed failure resilience capabilities
  - Capability to broadcast a clock with ~µs accuracy

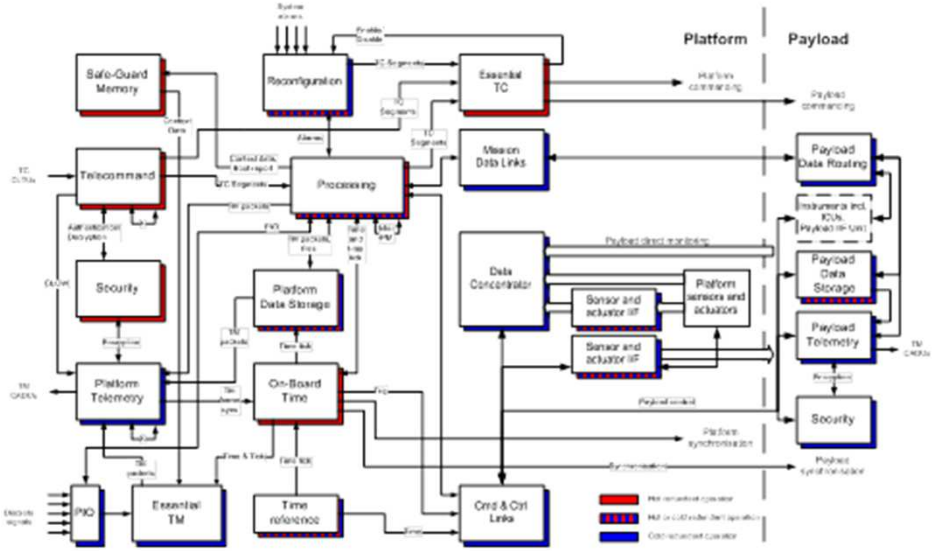
Develop a standard High Speed Data Network for Space Applications is a key

- **objective is to select a solution compatible with missions needs in order to optimize both development and recurrent costs of the future avionics**

Satellite Avionics : future Avionics trends

2025?

- Centralization & integration
- Use of COTS parts associated to fault tolerant architecture
- Low power technologies
- Simplified redundancy scheme
- Increasing processing and SW modularity and partitioning : IMA-TSP
- High Speed Data Network with VC routing
- Plug & Play Building Blocks
- Companion processing
- µRTU concept
- File-based operations
- Satellite data base and mission tailoring process & tools
- Optimized validation effort thanks to MBSE design and simulations …



Single Unit

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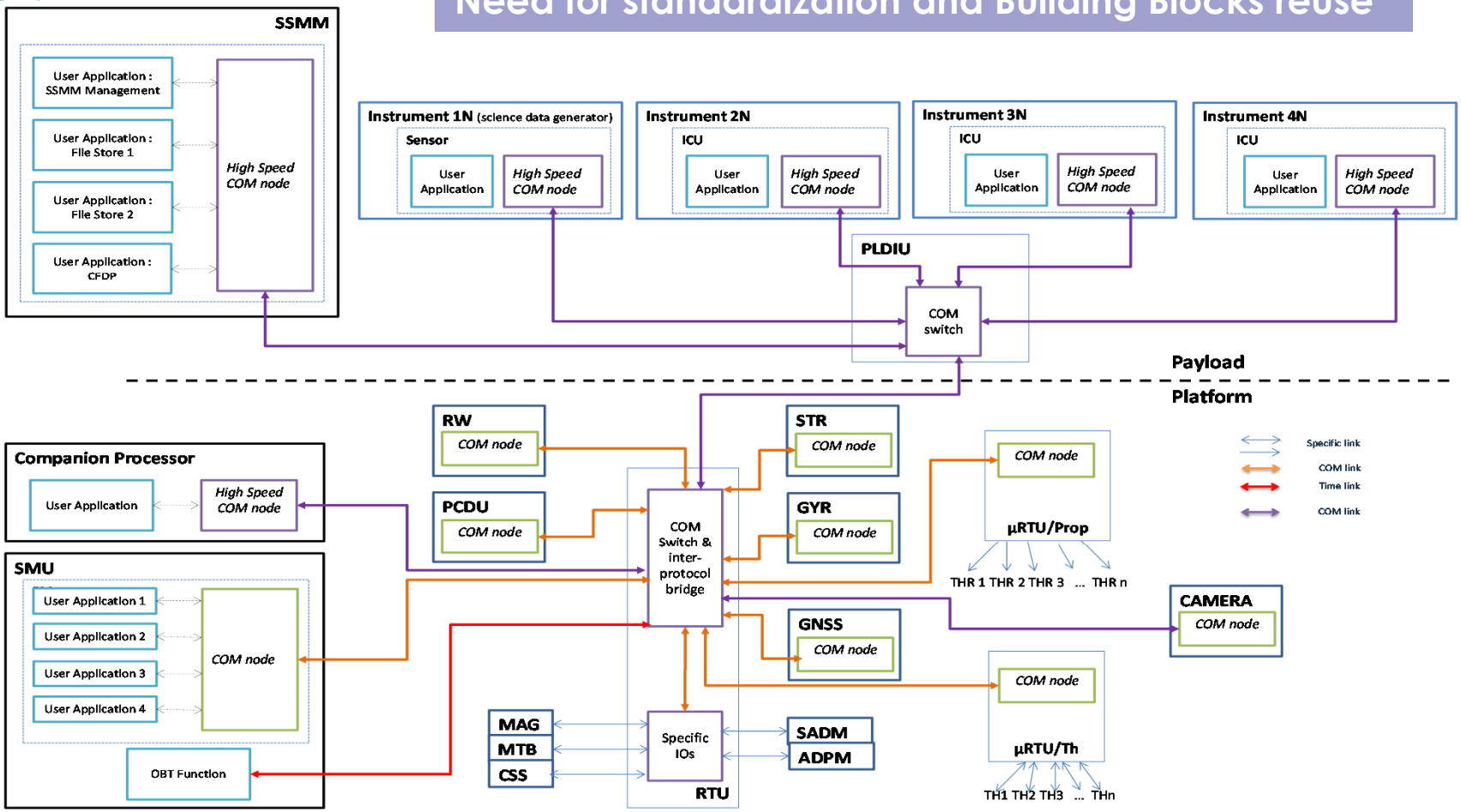
Satellite Avionics : future avionics trends

2025 ?

Need for standardization and Building Blocks reuse



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Recommendations

Introduce COTS and commercial mature technologies to allow breakthrough (ARM, PowerPC, Ethernet-based protocols, EEE parts …)

Qualify new technologies and Building Blocks with respect to space applications needs :

- Robustness to the space environment, rad-hard vs rad-tolerant implementations
- Define generic Fault Tolerant concepts
- Simplicity command/control and operational concepts
- Simplify FDIR management
- Qualify Physical layer robutness & testability to be independent with the system applications

Reduce development cost thanks to the re use of standard buildings blocks

- Share a common definition of Buildings Blocks (HW, SW, interface)
- Share a common vision of the Avionics IVVQ plan (testing & associated EGSE)