

Higher Avionics Integration Cost saving at the expense of reliability?

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Current Commercial Satellite Market Trend



Mega-constellations require low cost satellites (x100 reduction) and launch opportunities to be financially viable*^a

- Adopt COTS components/systems to keep costs down
- Designed for large scale and rapid manufacturing
- Higher integration of avionics functions is required
- Subsystem level testability to be addressed

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Large operators desire to procure low cost satellites with only 5 year lifetime^{*b}

- Rapidly changing data distribution market requires new technological capabilities in orbit at 5 year intervals to be competitive.
- Cost must be halved compared to a 15 year satellite design



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Cost reduction alternatives concerning avionics



- Integrate functions to be part of the OBC
 - E.g. GNSS, MEMS sensors or Star Tracker processing
- Use lower quality grade components e.g. MIL-PRF 38534 Class L (non-hermetic)
- Apply COTS to achieve state-of-the-art objectives
 - Apply system level hardening techniques to achieve required reliability/availability
 - Significant up-screening and radiation test costs etc. need to be considered
 - Part reliability is a general concern
- Mixed criticality approach to subsystems

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- Apply COTS with system level hardening techniques
- Functional safety approach as in IEC61508



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Compact Reconfigurable Avionics (CoRA)

- 1. Compact Reconfigurable Data Handling Core (EMITS 16.1ED.02)
- 2. Model Based Avionics Development (EMITS 16.132.05)
- 3. SMART AOCS & GNC Elements (EMITS 16.1EC.03)

Cross sectorial collaborative activities

4. Fault tolerant and commercial of the shelf-based on-board computer (16.1TT.08)

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- How is moving to a more integrated avionics architecture affecting the responsibility of the unit testing?
 - Is it problematic to transfer the responsibility of the unit testing e.g. IMU sensors to the OBC supplier?
 - Should there be concern about the reliability?
 - Due to increased design complexity?
 - Due to transfer of responsibility related to test?
 - Is it ultimately cost saving?
- Design for Testability to be introduced as a systemlevel discipline beyond ASIC-FPGA ?

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Concerning higher integration:

- Is it a trend that should be followed even on single shot missions?
 - E.g. taking profit of new H/W and S/W computer features (high CPU performance & large memory capacity, TSP), with the benefit of reduced mass?
- Will the availability of versatile and powerful MCUs make our future designs de-centralized again ?
- How do we find a metric to compare centralized (powerful processor, 'stupid' slaves) vs. decentralized (small processors, microcontrollers everywhere) embedded systems in term of total industrial COO ?
- Single Core high performance, Multi core and Asymmetric Multi-Processing (where all embedded world is going) vs. Symmetric Multi-Processing (our only curent choice).
 - Are we doing the right integration ?

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COTS definitions (examples)

Commercial off-the-shelf (COTS) is a term used to describe the purchase of packaged solutions which are then **adapted to satisfy the needs of the purchasing organisation, rather than the commissioning of custom made solutions**. (Wikipedia)

COTS - An assembly or part designed **for commercial applications** for which the item **manufacturer or vendor solely establishes and controls the specifications for performance**, **configuration**, **and reliability** (including design, materials, processes, and testing) without additional requirements imposed by users and external organizations. For example, this would include any type of assembly or part from a catalog without any additional parts-level testing after delivery of the part from the manufacturer. (NEPP) *c

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COTS definitions (examples)

COTS Plus - A **COTS part supported by test data available to end users** establishing random failure rate assumptions, performance consistent with the manufacturers data sheet and **methods to exclude infant mortal parts, parts with latent defects, weak parts, or counterfeit parts**. For example, automotive electronics council-certified or compliant automotive parts are one type of COTS Plus. (NEPP)*^c

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Concerning reliability:

- It is considered important to maintain the possibility to calculate the overall reliability figure of an equipment, this in order to have the possibility to compare different architectural choices and to assess the suitability of a solution to a specific mission or project
- If standardized quality levels are used, the estimation of the failure rate at component level becomes possible and consequently a reliability prediction for the complete unit or subsystem can be calculate
- If we combine COTS and qualified components in an unit how do we calculate the overall reliability?
- How to assess the reliability of new technologies and/or processes?

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The price tag after lower reliability:

Insurers have never before faced such an industry-wide generational change of rockets and architecture, a worry given that new rockets and architectures tend to fail more frequently than flight-proven vehicles.

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references

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