Open Systems Integrated Modular Avionics
the real thing

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Open Systems Architecture

overview
- definition

- trends in avionics architectures
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  - today
  - the future

- advantages
- disadvantages

- conclusions
Open Systems Architecture

definition

- architecture (design) whose specifications are ***public***
- this includes officially approved standards as well as privately designed architectures whose specifications are made public by the designers
- the opposite of open is **closed** or **proprietary**
Trends in avionics architectures: the past

SYSTEM1
SYSTEM2
SYSTEM3
Trends in avionics architectures: the past

**Avionics systems in the past**
- “federated” avionics systems
  - independent avionics components with specific function
  - systems together build up aircraft functionality
- line replaceable units (LRU’s)
- intrinsic partitioning, one processor per system functionality
Trends in avionics architectures: the past

interf{aces
  • dedicated I/O
    – ARINC 429 (point to multi-point, asynchronous)
    – discrete signals
    – analog signals
Trends in avionics architectures: the past

disadvantages

- specific function for each box
- specific hardware and software
  - obsolescence of hardware components
  - little re-use of technology
- weight and power consumption
  - shielding per unit
  - power per unit
- maintenance
  - spare parts
  - not interchangeable
Trends in avionics architectures: today
Trends in avionics architectures: today

avionics systems today

- integrated modular avionics (IMA)
  - line replaceable modules (LRM's)
  - proprietary standard physical module layout (interface, form, fit)
  - proprietary standard modular housing (LRU)
- intrinsic partitioning, one processor per system functionality
Trends in avionics architectures: today

interfaces

- dedicated I/O still used (robustness, availability)
- backplanes
  - ARINC 659 or proprietary busses
- system busses
  - ARINC 629 (lock step, distributed control)
  - MIL-STD 1553 (command / response using bus controller)
  - proprietary busses
Trends in avionics architectures: today

disadvantages

- specific function for each LRM
  - auto-pilot module, flight management module, etc.
  - not interchangeable
- specific hardware and software: obsolescence of components
- proprietary standards
  - changes are expensive
  - supplier monopoly
  - no competition
Trends in avionics architectures: the future

platform

application
Trends in avionics architectures: the future

**Avionics systems in the future**
- **Open systems** integrated modular avionics
- Generic processor hosting several system functionalities
- Partitioned software distributed across the system
- Common digital modules / units with standard I/O
Trends in avionics architectures: the future

CPU / IO module
Trends in avionics architectures: the future

**interfaces**

- packet switched networking
  - e.g. Avionics Full Duplex Switched ethernet (AFDX)
  - all modules / units can talk to each-other (flexible!)

- dedicated I/O
  - interface to legacy equipment
  - interface to dedicated sensors / actuators
  - all translated to standard network !!!
Trends in avionics architectures: the future

**interfaces**
- packet switched networking (e.g. AFDX)
  - local area network (LAN)
Trends in avionics architectures: the future

Physical communication

Logical communication

Open systems IMA
Trends in avionics architectures: the future

open systems IMA: "rack" oriented
- the rack is a Line Replaceable Unit (LRU)
- contains Line Replaceable Modules (LRM)
  - standardized form, fit, function
  - backplane communication
- rack provides environmental protection and backplane
- disadvantage: modules not field-replaceable
Trends in avionics architectures: the future

**open systems IMA: "unit" oriented**
- each module is a Line Replaceable Unit (LRU)
- the unit has its own environmental protection
  - housing / EMC / lightning
  - disadvantages with respect to cost / weight
- units are connected by avionics bay wiring
Trends in avionics architectures: the future

**standardized digital modules / units**
- host several aircraft applications (software)
- fully isolated software partitions
- standardized operating system
  - scheduling, communication, health monitoring
- hardware resource sharing
  - processor (CPU)
  - memory
  - communication and I/O
- application portability
  - application programming interface (API)
Trends in avionics architectures: the future

fault tolerance

- providing fault detection, localization and isolation
  - health monitoring in each partition
  - global fault manager identifying the problem
  - "brick-wall" software partitioning

- reconfiguration possible
  - with static predetermined configurations (determinism)
  - "hot" or "cold" spares
Open Systems Architecture

**definition** (again)

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Open Systems Architecture

advantages

• standard building blocks are interoperable
  – Plug-N-Play
  – mix components from different suppliers
• reduced obsolescence
  – replace hardware modules
  – re-use expensive (mission) software
• third-party add-on development
  – public specifications
• flexible design
  – configuration tables
Open Systems Architecture

disadvantages

- **intellectual property rights !!!**
- standardisation contradicts high performance
- who takes integration responsibility?
  - multiple suppliers ("not my problem!")
  - qualification / certification
- complexity
  - a lot of parameters need to be managed
- use of third-party equipment & software
  - is documentation accurate and complete?
  - not easy to transfer all design data
conclusions

• new technology for avionics architectures required
  – hardware component obsolescence
  – architectures today is mostly proprietary

• new trend is "open systems"
  – common digital modules / units with operating system
  – aircraft functionality performed by the software applications
  – interfacing trend towards ethernet (e.g. AFDX)

• be careful if a supplier states to have an “open system”
  – is it really a public standard that is used?
  – what is in it for you?