

Automotive and Aerospace Electronics

Similarities, differences, potential for synergies

B. FOUCHER
08/09/2011



Automotive & Aerospace Electronics



Electronics is a necessary evil for systems makers, not a product in itself

- Field ruled by “consumer electronics”, mobile phones & personal computers
 - Aerospace : below 1% of global component market, almost stable
 - Automotive : ca. 8%, growing
- Enabling new functions but adding:
 - Complexity (design, development, manufacturing, certification, maintenance)
 - Obsolescence & configuration management
 - Specific risks (availability, life cycle management, supply base, regulations)
- “Aerospace” is a generic word, hiding very different situations
 - Military
 - Commercial airliners / helicopters
 - Space

Automotive & Aerospace : differences and similarities



Mass production

- Aerospace: ~2000 units / year, very small series of components
- Automotive: ~60 million vehicles / year, small series of components

Lifespan

- Space : 15 years continuous service with no failure
- Aeronautics: minimum 30 years, above one hundred thousand hours of operation for commercial aircraft
- Automotive: 6 years model life + 15 years support, couple thousand hours of operation (300 000 km at 50 km/h = 6 000 hours...)

Cost of electrics and electronics

- An order of magnitude difference in parts costs, two in some cases
- Aerospace: ~20 (civilian) to ~50% of production cost, stable
- Automotive: ~15 to ~30% of production cost, growing

Automotive & Aerospace : differences and similarities



Environment

- Space: very harsh (temperature $\sim -40^{\circ}\text{C} + 120^{\circ}\text{C}$, high vibration (1 to 5 g^2/Hz) & shock levels during launch, for safety critical systems 10 errors in 10^9 hours due to radiations, 250 kRAD integrated dose).
 - As a reminder: designed to “no failure over lifespan”
- Aeronautics: harsh (temperature $\sim -40^{\circ}\text{C} + 120^{\circ}\text{C}$, high vibration levels (0,1 to 0,4 g^2/Hz), moderate resistance to radiation, several kRAD integrated dose)
- Automotive: same as aeronautics with no specs for radiation
 - Note: radiation hardness is becoming an issue at ground level (smaller and more integrated components become more susceptible to natural radiations)

Automotive & Aerospace : differences and similarities



Processing

- Space: need for small size, very high speed, low thermal losses, ruggedized, extreme dependability in harshest environment
- Aero: high speed, very high dependability in harsh environment
- Automotive: an order of magnitude less stringent and formal (certification), but changing

EE Architecture

- Aerospace: stabilized architecture today for complex systems, will change in a not too distant future (dependability)
- Automotive: ongoing architecture change: less ECUs (from ca. 60 down to maybe ca. 20), more supervision

Automotive & Aerospace : differences and similarities



Digital links: common needs

- Lowest cost, low data rate, low reliability
- All purpose, low cost, mid data rate (i.e. CAN, Flexray for image distribution)
- For safety critical applications: ethernet based AFDX, time triggered (TTP, for i.e. life support systems)

Certification

- Aerospace: mandatory and structured within aerospace for a long time
- Automotive: less formal processes, but growing needs, processes inspired from aerospace and special (military, nuclear...) industries. Self certification already mandatory for the US market, new regulations expected in 2012/2013

Customers

- Trained specialists vs. “my grandmother”

Supply base

- Consolidated supply base for automotive vs. smaller vendors for aerospace

Automotive & Aerospace : differences and similarities



Compliance with RoHS & REACH

- Aerospace: for RoHS, waiver for aerospace products but need to comply for obsolescence management. REACH is mandatory and seen as a competitive disadvantage, i.e. US vs. EC
- Automotive: no way around, has to comply
- Upcoming regulations all over the world. Very unstable situation

Trends

- Aerospace: mandatory use of COTS, with risk mitigation measures. Feasibility and performance risks
- Automotive: mandatory increase of dependability. Complexity management, cost risks
- Need for stable base of European suppliers for electronic components and circuit boards, including power electronics (ITAR & regulatory issues)
- Growing common interests !

Potential areas of cooperation – System level



Safety critical systems: aerospace safety at automotive cost

- Dependable architecture
- Design, simulation and test tools
 - Standards (Integrated Modular Architecture, Autosar ...)
 - Formal proof
 - Automatic coding
 - Certifiable tools
- Goals: automotive: become “certifiable” and introduce new functions (X by Wire, chassis control...), aerospace: reduce cost

Power distribution

- Global trend towards “more electrical systems”
 - Fuel economy & greenhouse gas reduction
 - Weight reduction
 - Maintenance reduction
- Dependable power distribution architecture principles, power network quality rules, energy storage
- Design, simulation & test tools, especially for harnesses and EMC
- Common goals: save design time & costs, better efficiency
- No real common actions as of today

Potential areas of cooperation – System level



Diagnostics

- Goal: predictive maintenance is key to reduce down time
- Potential collaboration on
 - Diagnostics principles
 - Data handling, storage, on-line and off-line processing
 - Human Machine Interface for diagnostics

Modeling, simulation and testing of complex systems

- Goal: save development, testing & tooling costs
- Virtual product engineering
- Hardware in the loop
- Methods and tools
 - Most problems are very similar
 - Common tools

Potential areas of cooperation – System level



Driver / pilot assistance

- Human workload management : different workloads acceptable by automotive and aerospace, but common problems
 - Acquisition, extraction, computation, presentation of relevant data
 - HMI principles (standards ?)

Potential areas of cooperation - Subsystems



Data networks (field bus)

- Goal: standardized field bus to reduce the number of networks used to get better component prices, the numbers of tools and the investment in people training
- Physical layers: look for a small number of common physical layers
- Protocols: look for common protocols, especially for secure applications

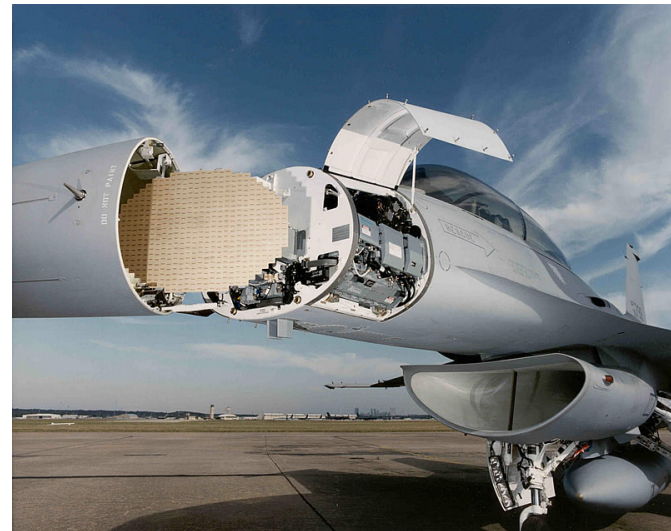
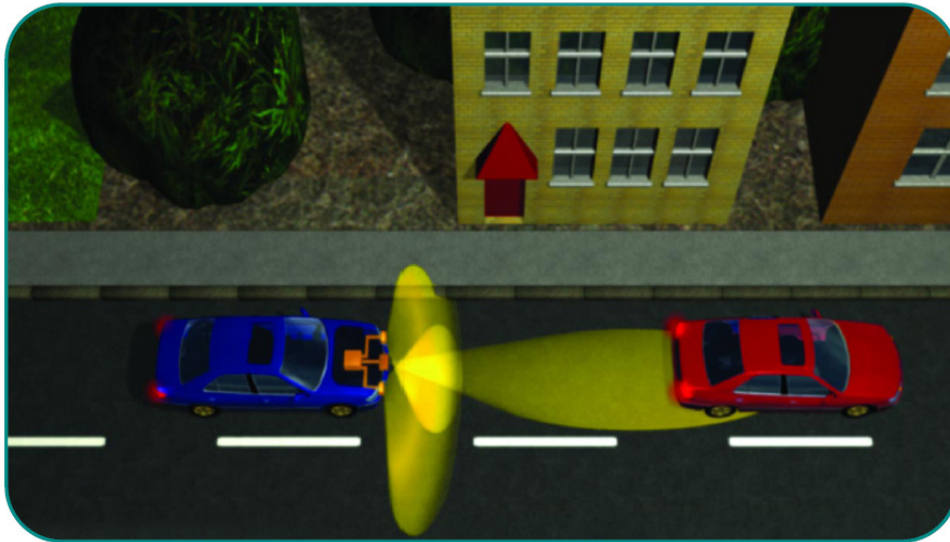
Wireless

- Reducing wiring while enabling networked sensors clusters
- In vehicle and vehicle to infrastructure communications
- Common future standards

Potential areas of cooperation - Subsystems

Radar

- Aerospace begins to use (very) low cost automotive radar components for active short range sensing
- Automotive could benefit from specialized components and signal processing algorithms available in Aerospace



Potential areas of cooperation - Subsystems



Actuators

- Electrical actuators have a bright future (planes, launchers, cars...)
- Common grounds for low cost dependable actuators

Braking

- Braking system architecture, especially for electromechanical brakes
- Braking materials (disks, pads)

Sensors

- All kinds of common sensors possible
- Depending upon power, reliability and environmental requirement

Potential areas of cooperation - Subsystems



Navigation

- Navigation based driver / pilot assistance
- Maybe some degree of autonomous control

Vision / Image based systems

- Image based driver assistance systems
 - Lane departure warning
 - Lane following
 - Navigation enhancement

Autonomous driving

- Data fusion based assisted driving (example radar + vision or radar + infrared)
- Enabling technologies for dependable autonomous flying/driving

Potential areas of cooperation - Components



Components & manufacturing processes

- Goals :
 - team up to get significant volumes
 - get leverage on electronics industry
 - promote a European supply base for critical components
- Harmonize requirements, especially those related to environment (vibration, shock, temperature, radiation...) to look for common components
- Digital as well as Power electronics

Energy storage & power components, new fuels

- Batteries, supercaps
- Solid State Power Converters (SSPCs)
- Integrated starter generators

Conclusion

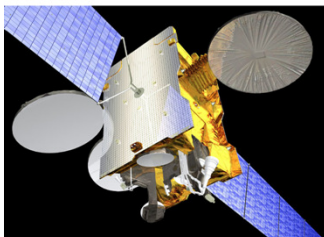


Many common interests and challenges

- Dependability
- Cost
- Position common fields of interest onto ICT4FEV roadmap

Differences driving progress

- Performance, availability, radiation hardness for Aerospace
- Low cost, modular & efficient designs for Automotive



EADS