Wireless Avionics Intra-Communications (WAIC)

An Overview and Application Examples

AVSI
AEROSPACE VEHICLE SYSTEMS INSTITUTE

Agenda

- AVSI and WAIC
- Scope of WAIC
- Motivation for WAIC
- Example WAIC Application Areas
- Airworthiness Aspects

What is the Aerospace Vehicle Systems Institute (AVSI)?

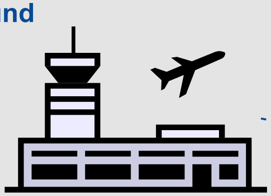
- Aerospace Vehicle System Institute - A cooperative of companies, academia and government agencies:
  - Airbus, BAE Systems, Boeing, Bombardier, Embraer, General Electric, Goodrich, Gulfstream, Honeywell, Lockheed Martin, NASA, Rockwell Collins, United Technologies, US Department of Defense, US Federal Aviation Administration.
- Focus on developing improved aerospace vehicles.
- Creates an environment for collaboration on research and development projects; investigates emerging technologies; and influences standards and policies to promote cost effective systems development and certification.

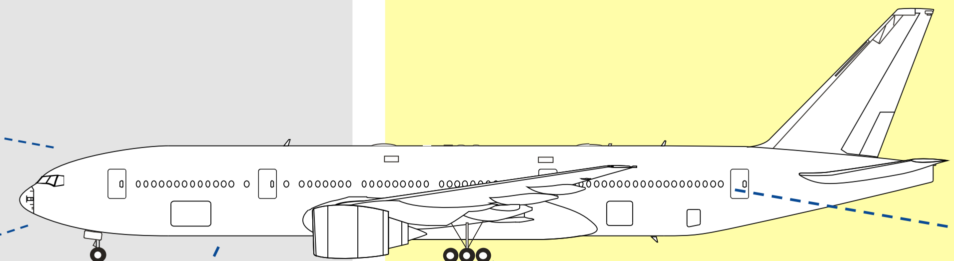
Examples of Aircraft Wireless Applications – Traditional systems vs. WAIC systems

Current Aircraft Communications:

- Safety-related communications
  - HF/VHF/Satellite communications
- Non-safety related communications
  - Passenger connectivity

Communications with Ground





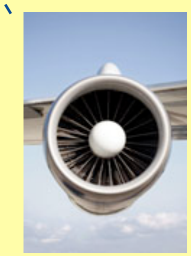
Operational Communications

Internet Connectivity

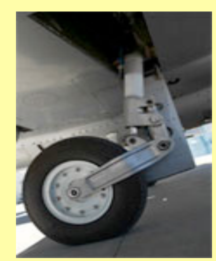
WAIC Systems:

- Safety-related applications, e.g.
  - Sensors/Actuators
  - Additional wireless redundancy for wired communications

Proximity Sensors



Engine Sensors



Landing Gear Sensors

What is Wireless Avionics Intra-Communications?

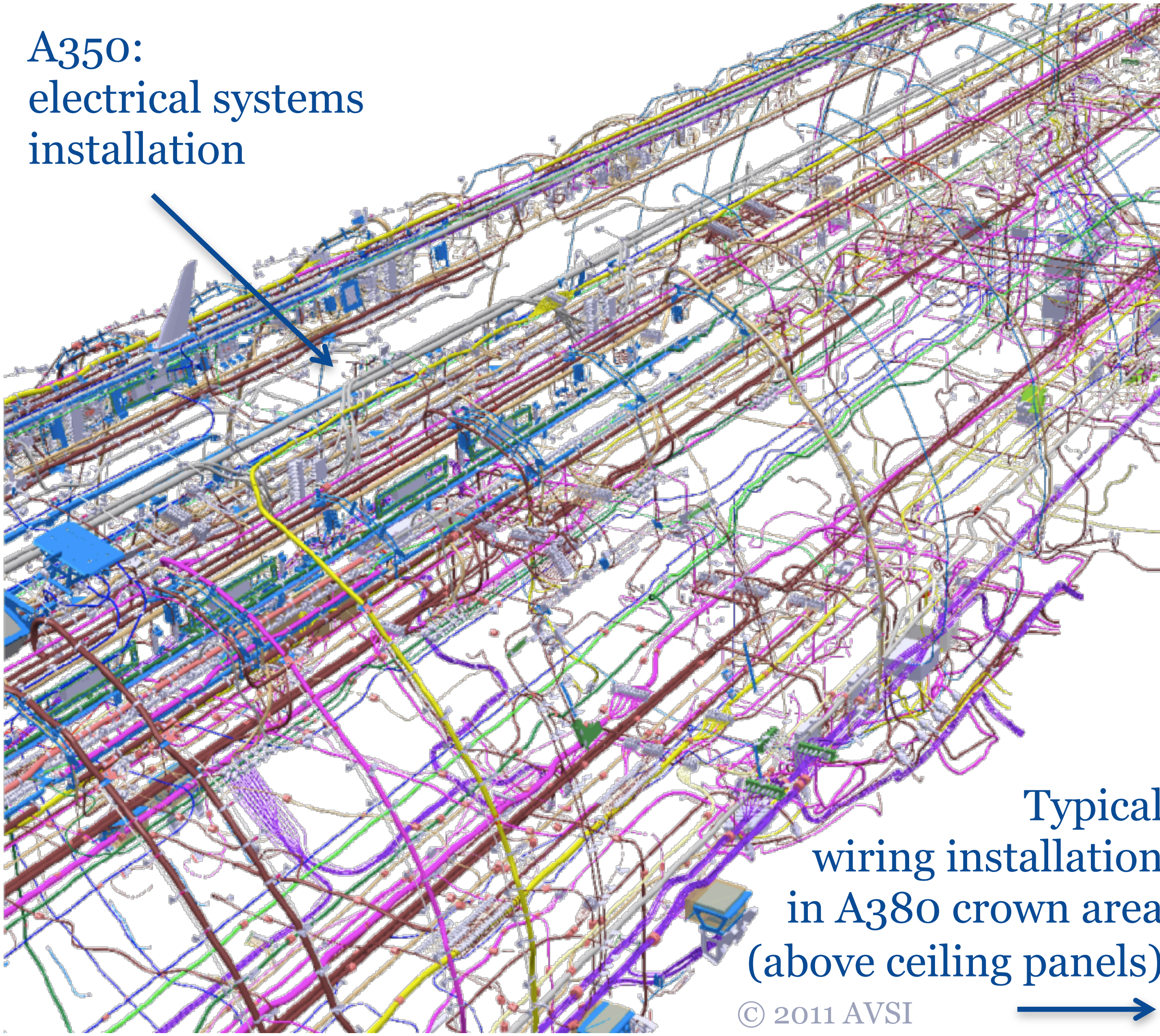
- Radiocommunication between avionics components integrated or installed onboard one and the same aircraft
- Radiocommunication in a closed exclusive network between two or more points on a single aircraft
- Covers only safety and regularity of flight related applications
- Does not provide air-to-ground, air to satellite, or air-to-air communications
- Not for passengers communications or in-flight entertainment
- Low transmission power (10dBm)
- ITU-R Report M.2197 contains technical characteristics and operational objectives for WAIC systems

Aviation industry's motivation

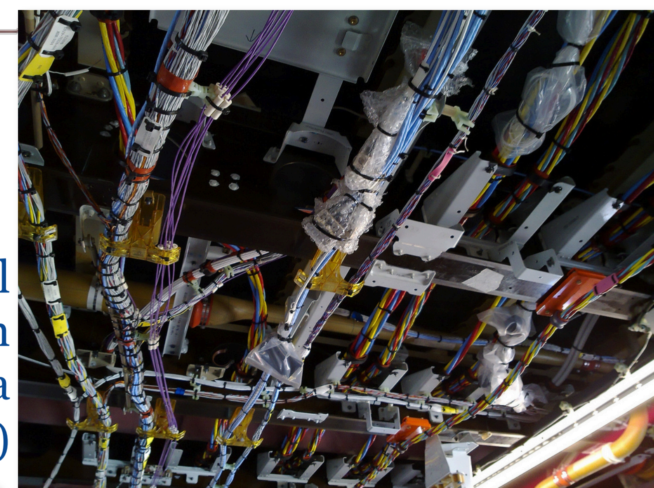
- Reduction of complexity of electrical wiring and harness fabrication with the associated weight saving and higher overall fuel efficiency
- Significant gain in reconfigurability through improved installation flexibility e.g. for cabin elements.
- Reliable monitoring of parameters belonging to moving or rotating parts
- Improved reliability of aircraft systems through mitigation of common mode failures by means of dissimilar redundancy

Complexity of electrical wiring in modern aircraft (1/2)

A350:
electrical systems
installation



Typical
wiring installation
in A380 crown area
(above ceiling panels)



Complexity of electrical wiring in modern aircraft (2/2)

Electrical wiring:
some statistics for the example of the A380-800

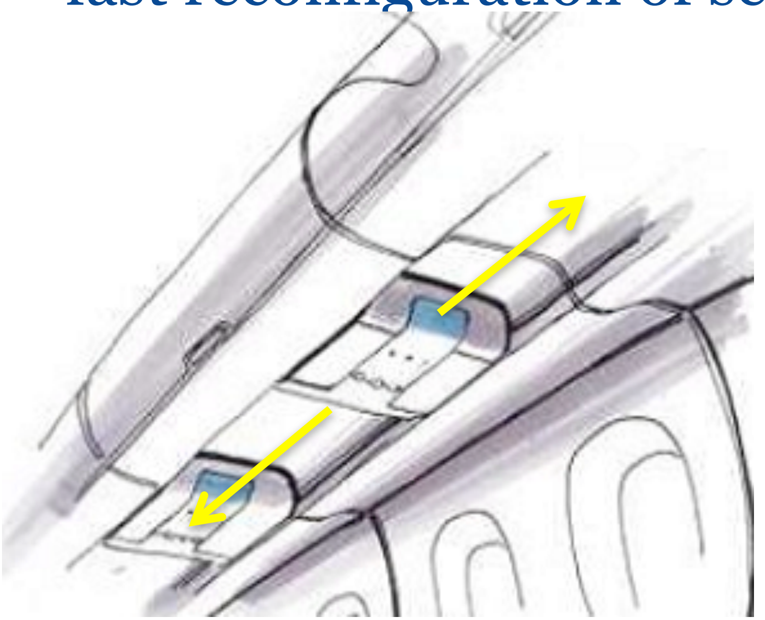
- Total wire count: ~100 000
- Total wire length: 470 km
- Total weight of wires: 5 700 kg
- About 30% of additional weigh for harness-to-structure fixation

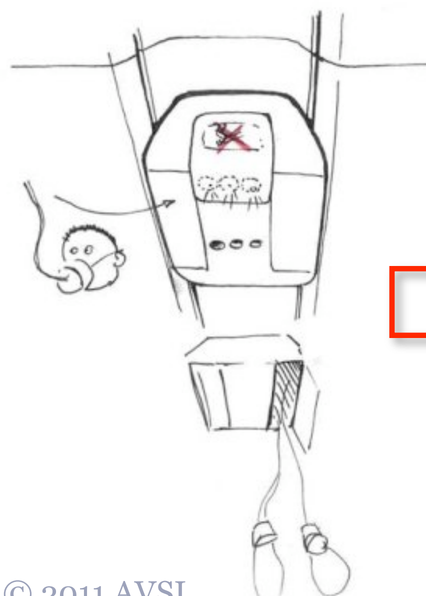
About 30% of electrical wires are potential candidates for a wireless substitute!

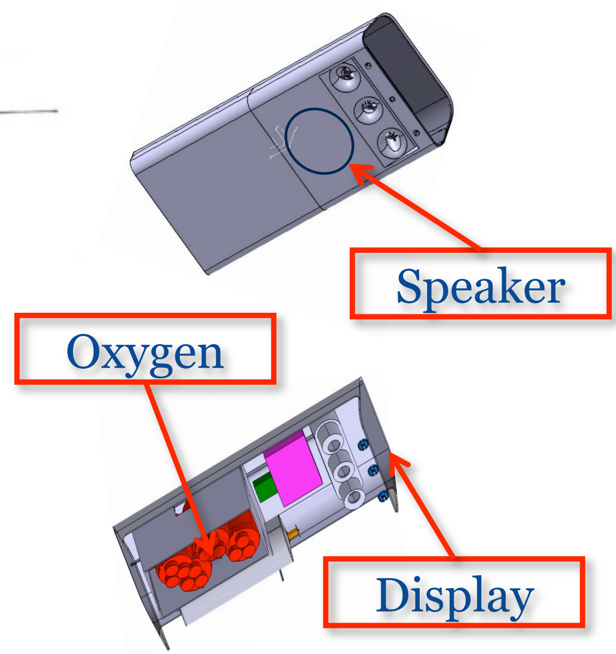
Reconfigurability

Example: Wireless Supply Unit

- Release of oxygen masks and trigger of oxygen flow
- Passenger Address Function (audio announcement)
- Display providing safety information to the passenger
- Needs to feature flexible installation locations for allowing fast reconfiguration of seat layout





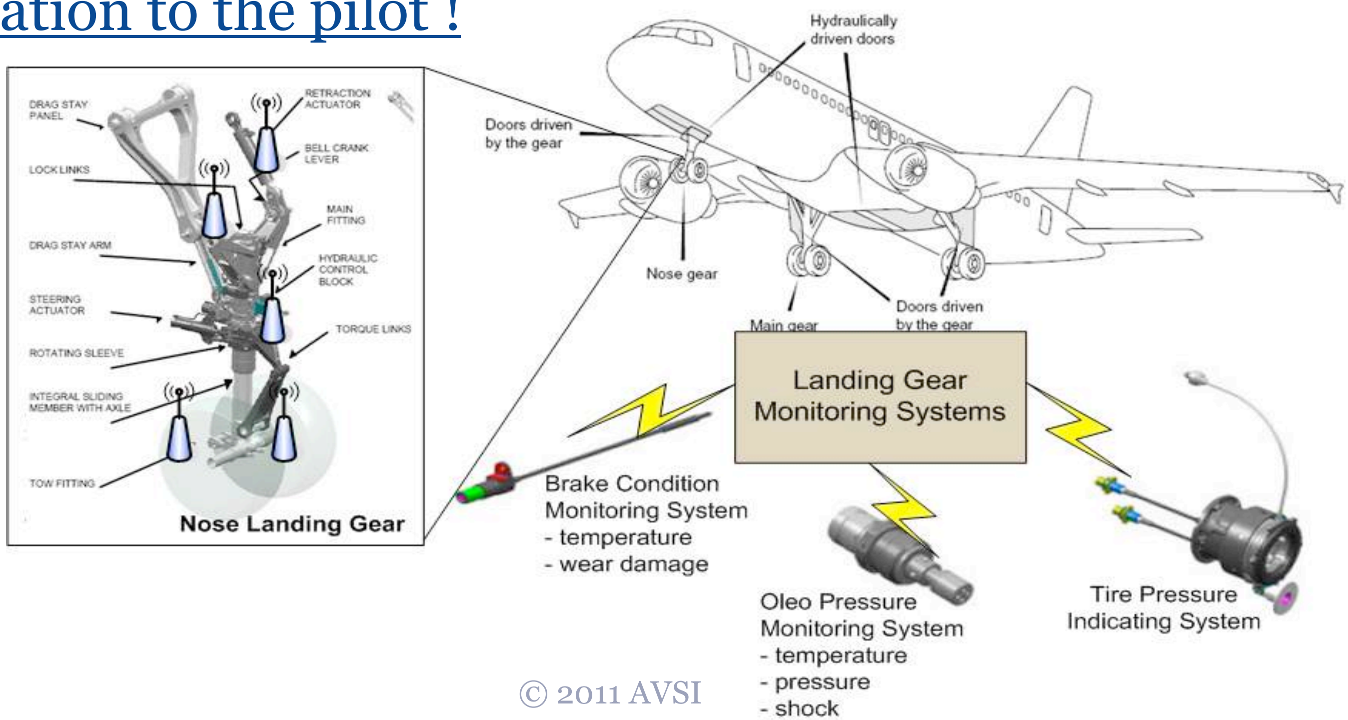


Monitoring moving and rotating parts

Example: Landing Gear Monitoring

- Brake condition monitoring
- Oleo pressure monitoring
- Tire pressure Indicating

<u>All functions above deliver real-time safety-related system status information to the pilot !</u>



Wireless can enhance reliability (1/2)

Example: Dissimilar redundancy

–Aircraft wiring features usually twice or triple redundancy

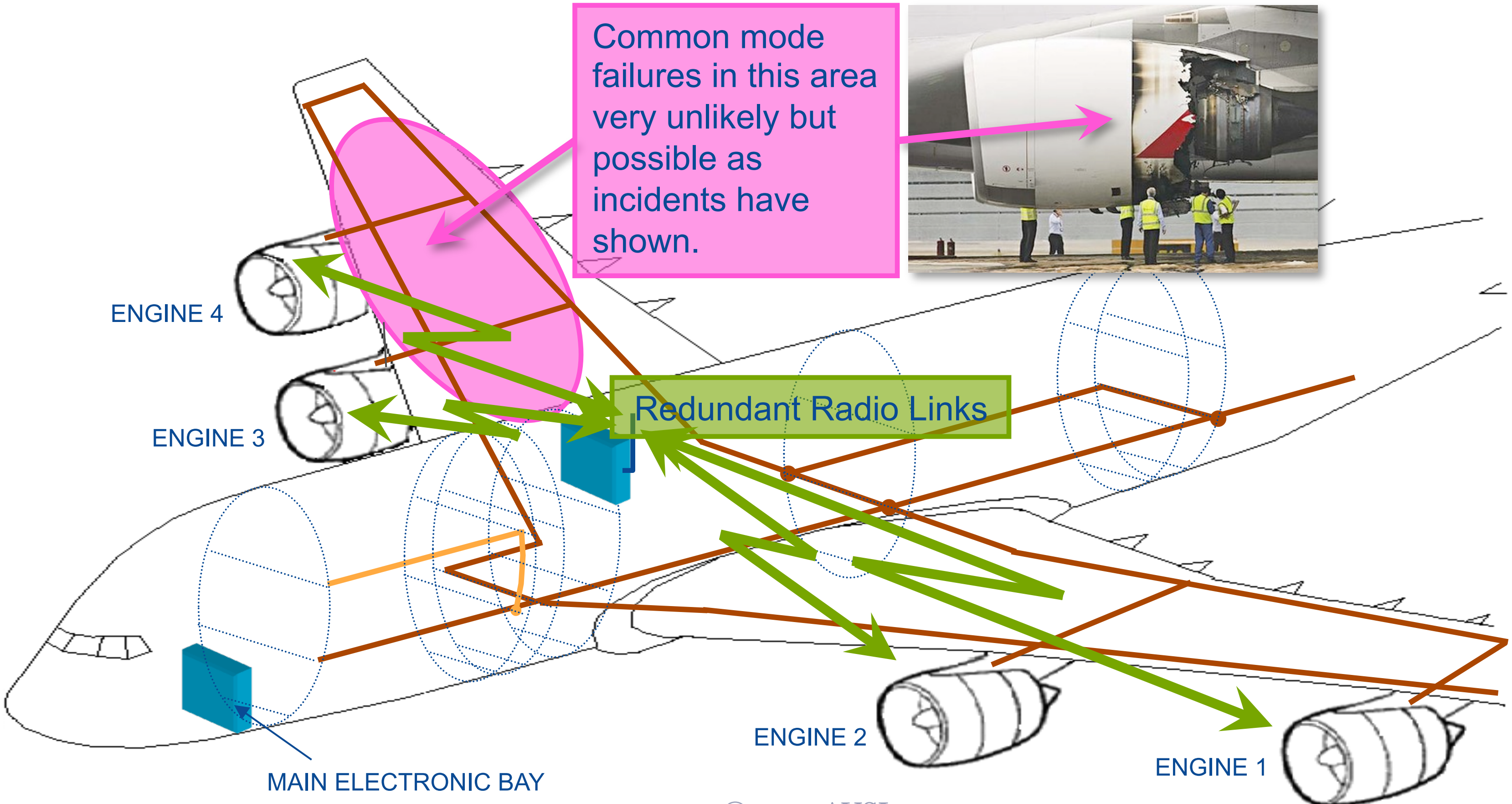
–Redundant wiring routes in different areas within the aircraft structure mitigate risk of single points of failure, caused by defect wiring (e.g. corrosion, chafing of isolation or loose contact) or cut wires (e.g. through particles intruding aircraft structure as in case of an engine blast)

–Wiring routes are segregated to the farthest possible extend allowed by the aircraft geometry

Wireless can enhance reliability (2/2)

Example: dissimilar redundancy (cont' d)

–Route segregation combined with redundant radio links provides dissimilar redundancy and mitigates risk of single points of failure



Other Examples of Potential WAIC Safety Applications [Report M.2197]

- Smoke Detection
- Fuel Tank/Line
- Proximity
- Temperature
- EMI Incident Detection
- Humidity/Corrosion Detection
- Cabin Pressure
- Emergency Lighting
- Ice Detection
- Landing Gear
  (Position Feedback, Brake Temperature, Tire Pressure, Wheel Speed, Steering Feedback)
- Flight Controls Position Feedback
- Door Sensors
- Engine Sensors
- FADEC-to-Aircraft Interface
- Air Data
- Engine Prognostic
- Flight Deck & Cabin Crew Imagery/Video (safety-related)
- Avionics Communications Bus
- Structural Health Monitoring / Structural Sensors
- Active Vibration Control

A few words on Airworthiness

- Aeronautical systems undergo a stringent and precisely defined qualification and certification process defined and supervised by legitimized Authorities such as FAA for the USA and EASA for Europe.
- Airworthiness qualification requirements depend on safety-criticality of a system and the potential consequences of its failure.
- Any system making use of radio communications between its components will have to prove the same level of reliability as its wired counterpart. Assessment of a system or function is carried out in the context of its use.
- ICAO will develop Standards and Recommended Practices (SARPS) for providing the technical basis for certification of future WAIC systems.
- Safety-related radio frequency spectrum is considered as one of the corner stones for the airworthiness of future WAIC systems.

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THANK YOU!