Introduction to Aerospace Networks and Requirements/Constraints

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Overview of Aerospace Networks

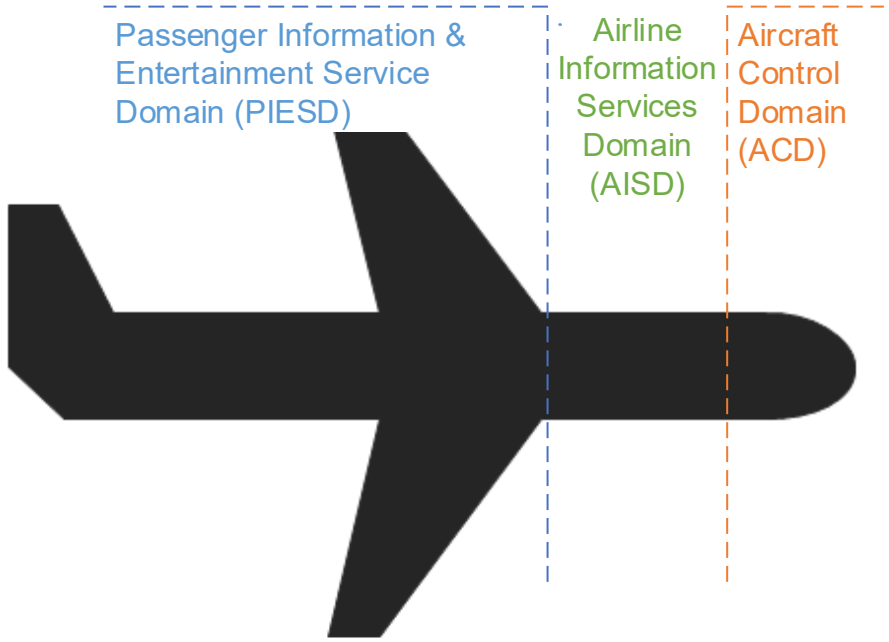
Following slides provide high level overview, but there are many delineations that change the vehicle architecture:

- Commercial vs Military
- Fixed Wing vs Rotary Wing
- Small vs Large
- Manned vs Unmanned
- Passenger vs Cargo

Overview of Aerospace Networks – Commercial Aircraft

3 Domains on Modern Commercial Aircraft

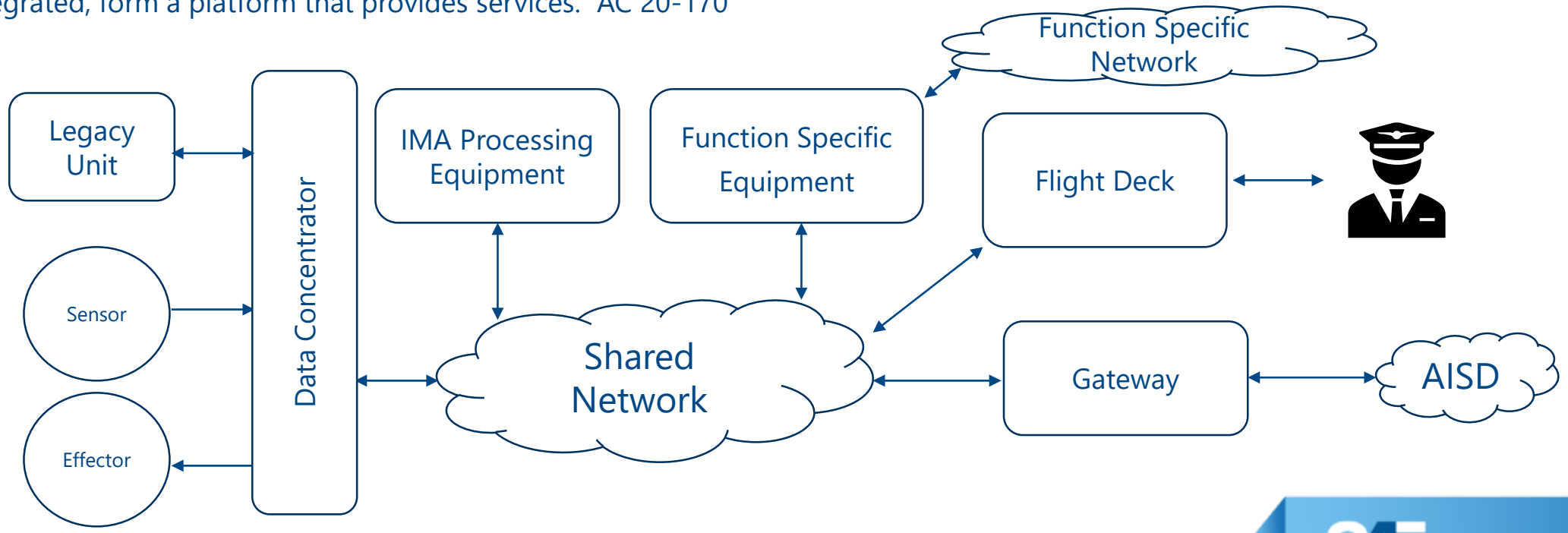
- **Aircraft Control Domain – safe flight of the aircraft**
- Airline Information Service Domain – non-essential airline activities and connectivity
- Passenger Information & Entertainment Service Domain



Overview of Aerospace Networks – Generic Architecture in ACD

Diagram shows a generic architecture of a network in Aerospace

- Data Concentrator – typically exist to interface to legacy I/O interfaces (analogs, discretes, ARINC 429, CAN / ARINC 825) for sensors/effectors/legacy units
- Function Specific Equipment / Network – dedicated to a given system (e.g. Flight Controls, Engine Controller)
- Integrated Modular Avionics (IMA) – "Shared set of flexible, reusable, and interoperable hardware and software resources that, when integrated, form a platform that provides services." AC 20-170



Overview of Aerospace Networks – Military Aircraft

- Air Vehicle System – Similar to Commercial Avionics ACD

- Mission System – varies by aircraft type and mission
  - Weapons systems potentially driving higher design assurance
  - High Performance mission computers
  - Communication systems

Current Network Segmentation

1. ACD (avionics) on ARINC 664 (profiled Ethernet)
2. PIESD/AISD (Cabin/passenger systems) on commercial Ethernet
3. Higher performance & reliability subsystems on non-Ethernet buses like FireWire, Fibre Channel
4. Legacy buses. For example1553, 1760, FC

Goal is for TSN to address network requirements from all 4 categories…to the extent such requirements are supported by TSN standards

Aerospace Network Considerations

- Performance – Bandwidth / Latency / Jitter – Captured in Use Cases
- Cost – Development Cost might outweigh Component Cost
- Longevity/Obsolescence – 20 to 50 years
- Availability and Maturity
- Safety Critical – Needs to support system failure rates for Major (1E-5/hr), Hazardous (1E-7/hr), and Catastrophic (1E-9/hr and no single fault)
- Certifiable
- Deterministic
- Ease of Integration
- Flexible / Mixed Assurance Network

Aerospace Considerations – Process and Certification

Certification Standards / Guidance

- ARP-4754 – Guidelines for Development of Civil Aircraft and Systems
- ARP-4761 – Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment
- DO-178 – Software Considerations in Airborne Systems and Equipment Certification
- DO-254 - Design Assurance Guidance for Airborne Electronic Hardware
- DO-297 – Integration Modular Avionics (IMA) Development Guidance and Certification Considerations
- DO-160 – Environmental Conditions and Test Procedures for Airborne Equipment
- DO-330 - Software Tool Qualification Considerations
- AC20-156 – Aviation Databus Assurance

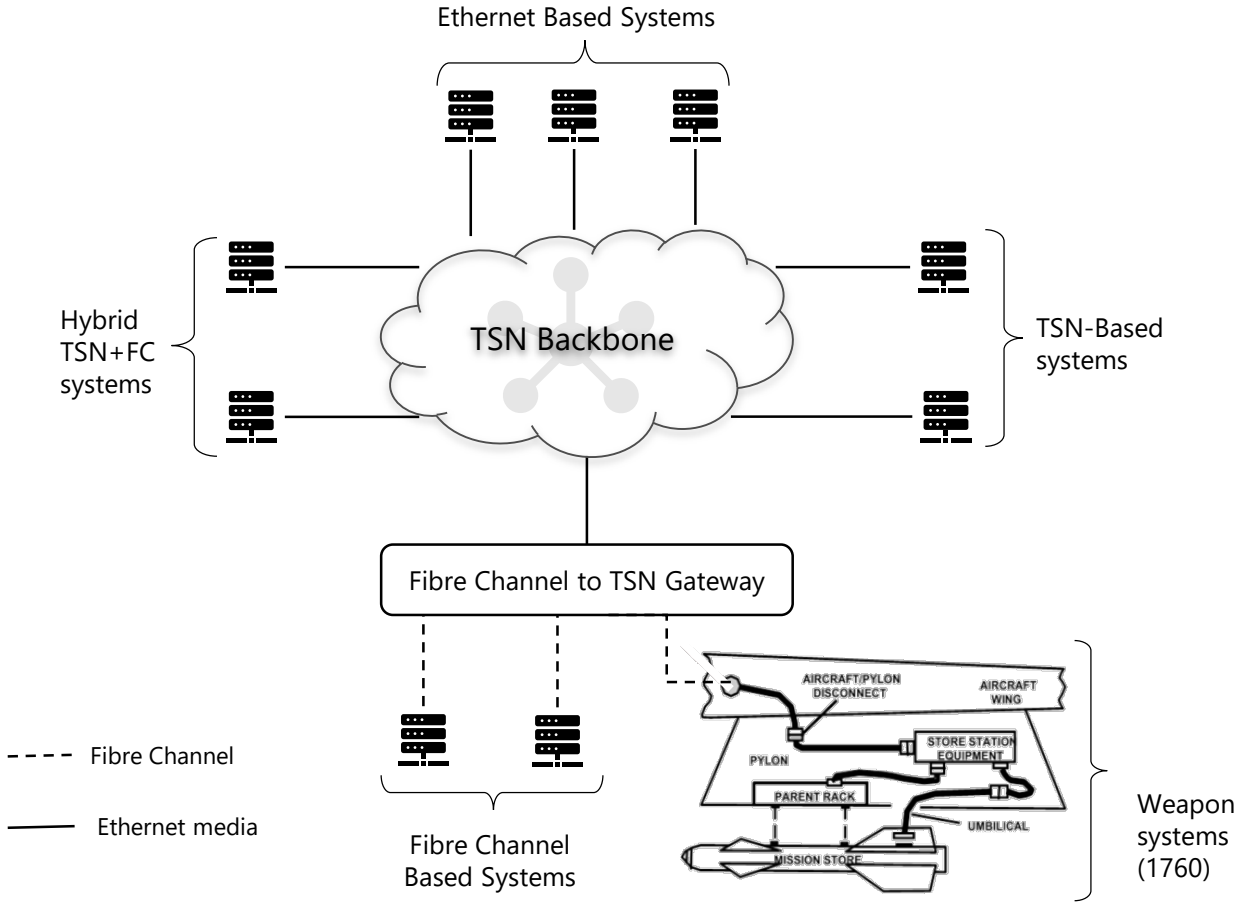
Process and Certification drives the system and product development costs

Added complexity will increase development costs

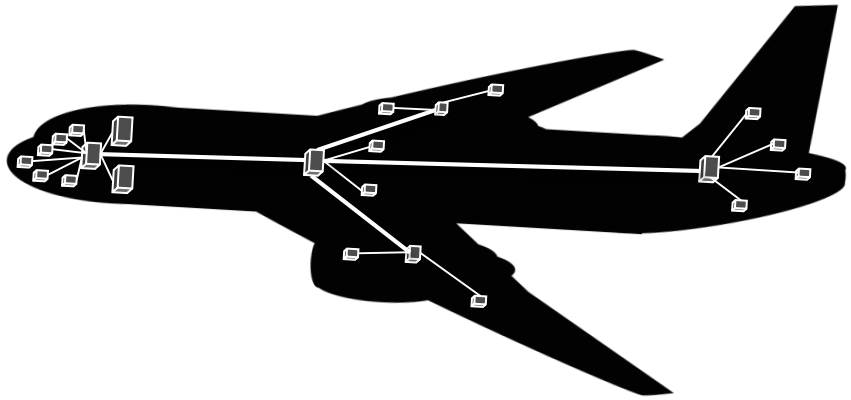
Takeaway: Affordable certification requires a tailored profile(s) of TSN

TSN Use in Aerospace: Vision

Convergence of legacy buses on a deterministic, high performance backbone



Certifiable, standards-based, deterministic, high bandwidth network



Potential: Future aerospace networks primarily based on TSN

TSN Profile for Aerospace

Objectives

- Meet aerospace network requirements (use cases and reqs in progress)
- Certifiability (reduced complexity and code)
- Interoperability
- Increased vendor base
- Lower “lifecycle” cost
- Security: neutral or positive impact
- Timely completion (AS6509 dependency, active programs and acquisitions)

Uniqueness

- Smaller number of use cases
- Smaller user community
- Smaller topologies
- Consensus driven by Integrators and certification
- Unique environment
- Long lifecycle (20yrs min, 50yrs expected)

Goal: Well defined TSN profile for aerospace – leading to cost effective certifiable solution for both civil and military use cases

Thank You!

Background

Information from SAE AS-1 to IEEE 802.1 presentation:

http://www.ieee802.org/1/files/public/docs2020/new-Jabbar-TSN-for-Aerospace-0520-v01.pdf

https://www.ieee802.org/1/files/public/docs2020/new-Jabbar-TSN-for-Aerospace-0720-v01.pdf