TSN Use-Case: Commercial Aircraft Cabin

802.1 TSN – P802.1DP

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Why an independent cabin use-case?

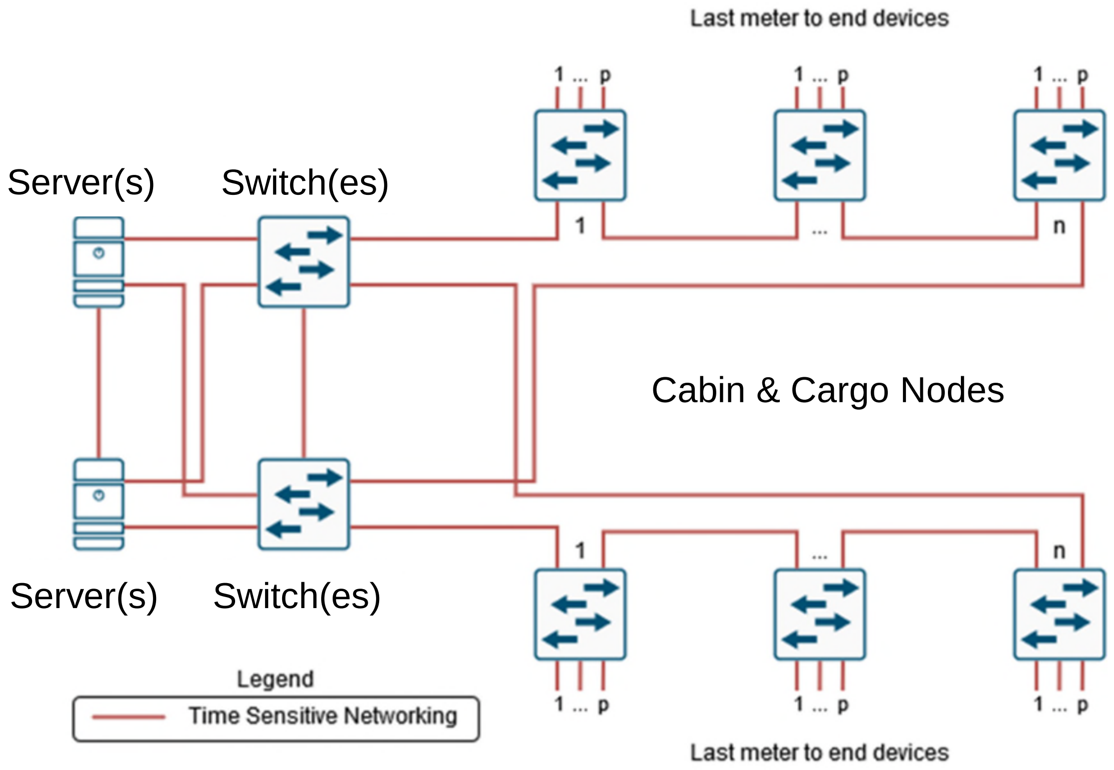
- **Safety Level:** the safety criticality of the use-cases in cabin is **DAL C in maximum** (exception: cargo smoke detection DAL B).
- **Security:** Cabin use-cases cover all three domains as per ARINC664-P5 (ACD, AISD, PIESD); esp. the network provides **untrusted interfaces** to passengers. For this reason, **high security standards** must be kept especially for the gateways between different networks and between different domains, respectively.
- **Configurability:** Cabin layouts are highly customer dependent. Network configuration for cabin shall be **easy to change and maintain per head of version**. Ideally, it would be **self configuring** or at least provide **“plug’n’play”** mechanisms to support self-configuration. On the other hand, strict **determinism is not required**.
- **Life-Cycles:** Typically, the cabin of a commercial aircraft is overhauled **every 7 years**, including exchange of (network) equipment. Software Lifecycles can be shorter, upcoming products like open software platform principles will allow for frequent **remote software changes**, e.g. in an overnight stop. This requires **flexibility in network configurations** as well.
- Commercial off the shelf **(COTS)** hardware and open standards are preferred to **reduce cost**. Lack of reliability may be recovered by sufficiently redundant network architectures.
- **Wireless:** to support layout flexibility as well as mobility of users, wireless networks as WiFi and Bluetooth gain more and more importance in the aircraft cabin. To support use-cases end to end, a TSN profile for commercial aircraft cabin shall support wireless networks as well.

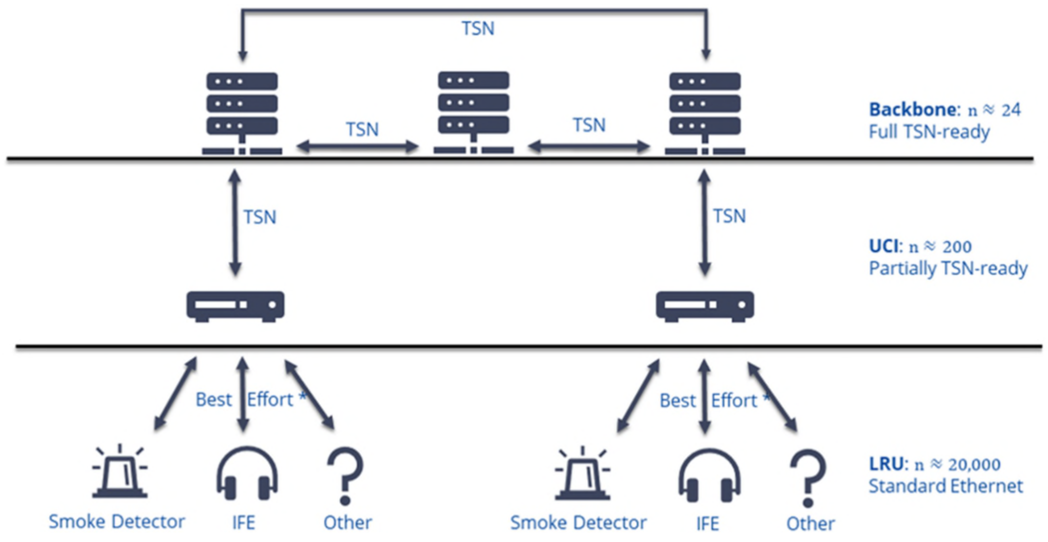
Typical Cabin Use-Cases

- the **Cabin Management System**, providing all functions to monitor and control the aircraft cabin (e.g. lights and temperature control, passenger announcements, crew intercommunication, crew alerting, signs, …).
  Main challenges:
  - **quasi realtime audio** applications with low latency (<20ms) to assure lip synchronizity and avoid echoes.
  - Audio as well as lighting control require tight time synchronization (some ms) between many end devices.

  Design Assurance Level (DAL) between C and D.
- the **In-Flight Entertainment System**, providing video (and audio) streams to every passenger seat and/or personal device, either wired or wireless. This is often combined with a connectivity system, providing (internet) connectivity during flight, most often using satellite links.
  DAL D-E.
  Main challenge: provide a high number (1 per PAX) of (HD) on-demand video streams in parallel to some control signals without interruption.
- **Video Surveillance System**, which interconnects several surveillance cameras within the cabin with suitable monitoring devices (e.g. the Flight Attendant Panel or a mobile cabin crew device) and (optionally) a video recording device. DAL D in most cases.
  Challenge comparable to IFE, with much less network participants and predictable streams.
- **Wireless Networks**: as already mentioned, WiFi networks in the cabin are mainly used for In-Flight-Entertainment purposes. However, usage for mobile cabin crew operations is intended as well. In general it is expected, that the number of wireless use-cases in the cabin will grow in coming years, e.g. regarding Internet of Things applications.
- **IoT Sensor data**, mainly for predictive maintenance. May become a significant network load factor in future (as part of Cabin Mgt. System?).
  Challenge: (many) short messages and many network participants
- IFE, Video and Wireless systems are mainly buyer furnished equipment, for more detailed descriptions and as support to achieve a broad standards acceptance, the related manufacturers should be involved.

Cabin Network Backbone Architecture





Main network characteristics:

- Redundant servers
- Ring backbone architecture, based on 2.5 - 10Gbps fibre optic (several rings per Aircraft, e.g. 1 x ACD + 4 x AISD + tbd x PIESD)
- Backbone Nodes provide interfaces for respective cabin regions

- Physical segregation of domains on the backbone (cross-domain interfaces in the servers)
- TSN on the backbone, not neccessarily on the „last mile“
- **U**niversal **C**abin **I**nterfaces as local gateways / controllers (e.g for a module like galley, lavatory, …)

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Thank you