IP Technologies

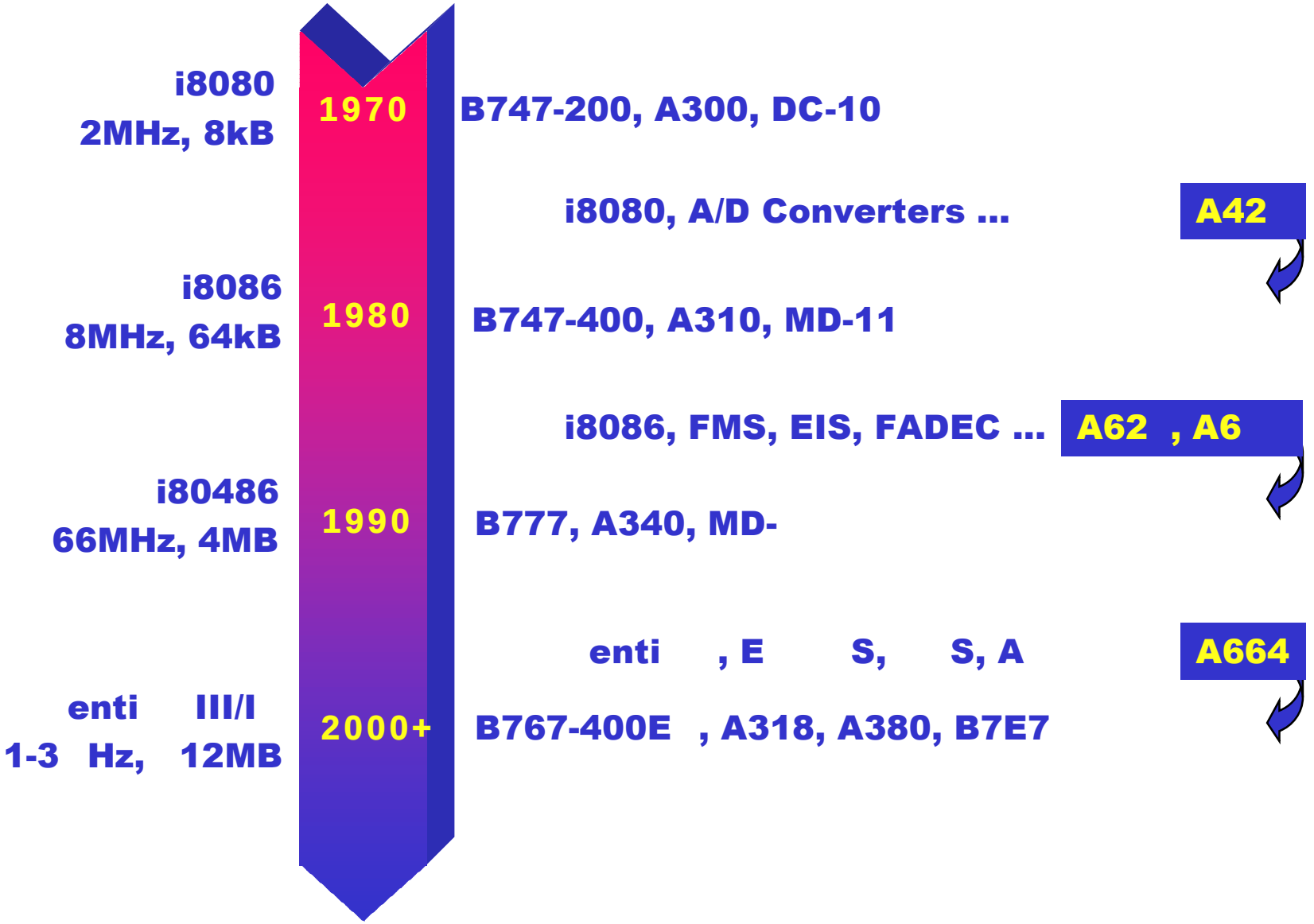
Aircraft Data Networks (ADN) Working Group

Jean-Paul Moreaux,
Arinc/AEEC ADN Chairman

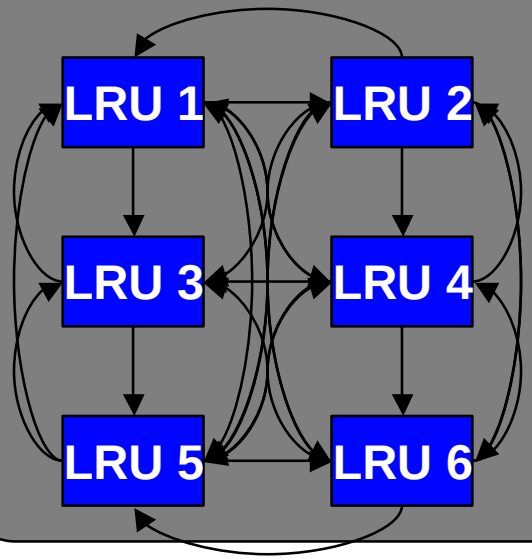
Overview

- Commercial Technology and Aviation
- Transition From A429 To A664
- Ethernet Technology and Avionics
- Avionics Full Duplex (AFDX) Characteristics
- Example Avionic Architecture
- Example Cabin Architecture
- ADN Domain Model – Overview and Details
- Matching the Real World: Domains and Communication
- Air/Ground Datalink and Architectures
- ARINC/AEEC ADN Working Group
- ARINC /AEEC ADN Part 5 Mobility and Security
- ARINC/AEEC Aircraft Information Security (SEC) Working Group
- Summary

Impact of Commercial Technology on Aviation



Transition From A429 To A664



ARINC 429, Ahh…for the good old days...

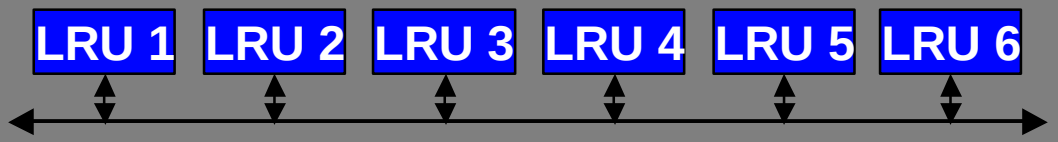
ARINC 429 digital buses connecting LRU's have served us well and are still the mainstay of our industry, yet...

- They are limited in bandwidth (100 kbps)
- They result in (too) many wires because connections are mostly "point-to-point" (or point-to-several, at best)

ARINC 629 was a big improvement

First used on the B-777, ARINC 629 connected multiple LRU to a single, digital bus, yet...

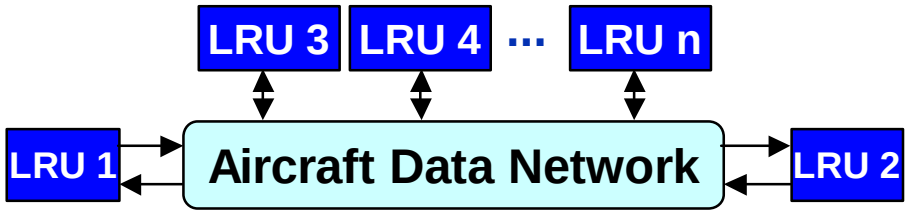
- Bandwidth is technically limited and is shared by all users
- ARINC 629 is expensive



Transition From A429 To A664, cont'd

What Makes Ethernet Different and Attractive?

- Ethernet is widely used in terrestrial networks; COTS components, equipment and software are readily available.
- Ethernet "equipment" is not dependent on the network topology. This flexibility is a big advantage.
- An Ethernet link replaces the (many) point-to-point ARINC 429 bus connections with throughput from 100 kbps up to 1Gbps



- During the A429/A629 periods, early Ethernet, based on shared-media, used data-packet collisions for arbitration. Full duplex technology emerged in the early '90, eliminating these collisions, which are not acceptable to avionics
- Hence, Ethernet became a candidate for use in Avionics, such as by means of AFDX

Avionics Full Duplex Networks (AFDX)

- **Avionics Systems require that the information be delivered "Reliably" and "On-Time"**
- **The "natural" transmission scheme used since A429 is that Avionics Systems periodically (2 - 50 Hz) multicast data to the receivers/users**
- **AFDX periodic multicast transmissions use UDP:**

  If a packet does not pass its integrity check (or isn't delivered), there is NO retransmission of that specific packet, the normal periodic transmission stream is sufficient for random bit errors.

- **"On-time" is achieved with sufficient bandwidth and switch throughput coupled with flow-control mechanisms in the switches and end-systems. Thus a concept of bounded latency is achieved:**

  Packets may be delayed by other traffic in the switched network, but only by a designed, pre-determined amount.

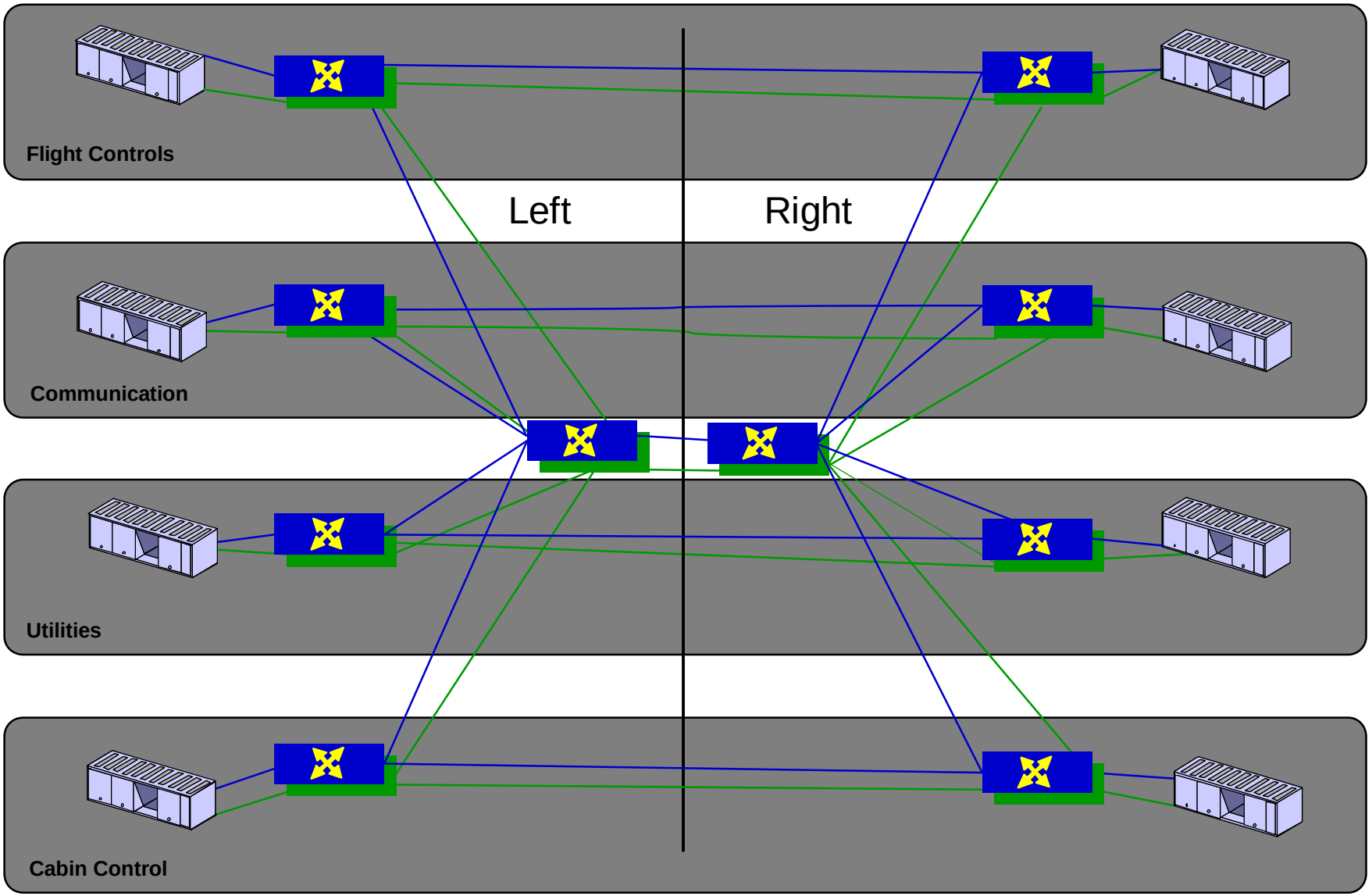
Current Airbus and Boeing Implementations

- **"Avionics" Networks (requiring bounded latency) are only a portion of the Aircraft Data Networks:**
  - **Passenger Information and Entertainment Services (PIES) Systems, largely COTS based, with limited life-cycle:**
    Audio on demand (AOD), Video on Demand (VOD), Email, etc.
  - **Airline Information Services:**
    Non-Essential Cockpit Data, Airline Operational Data

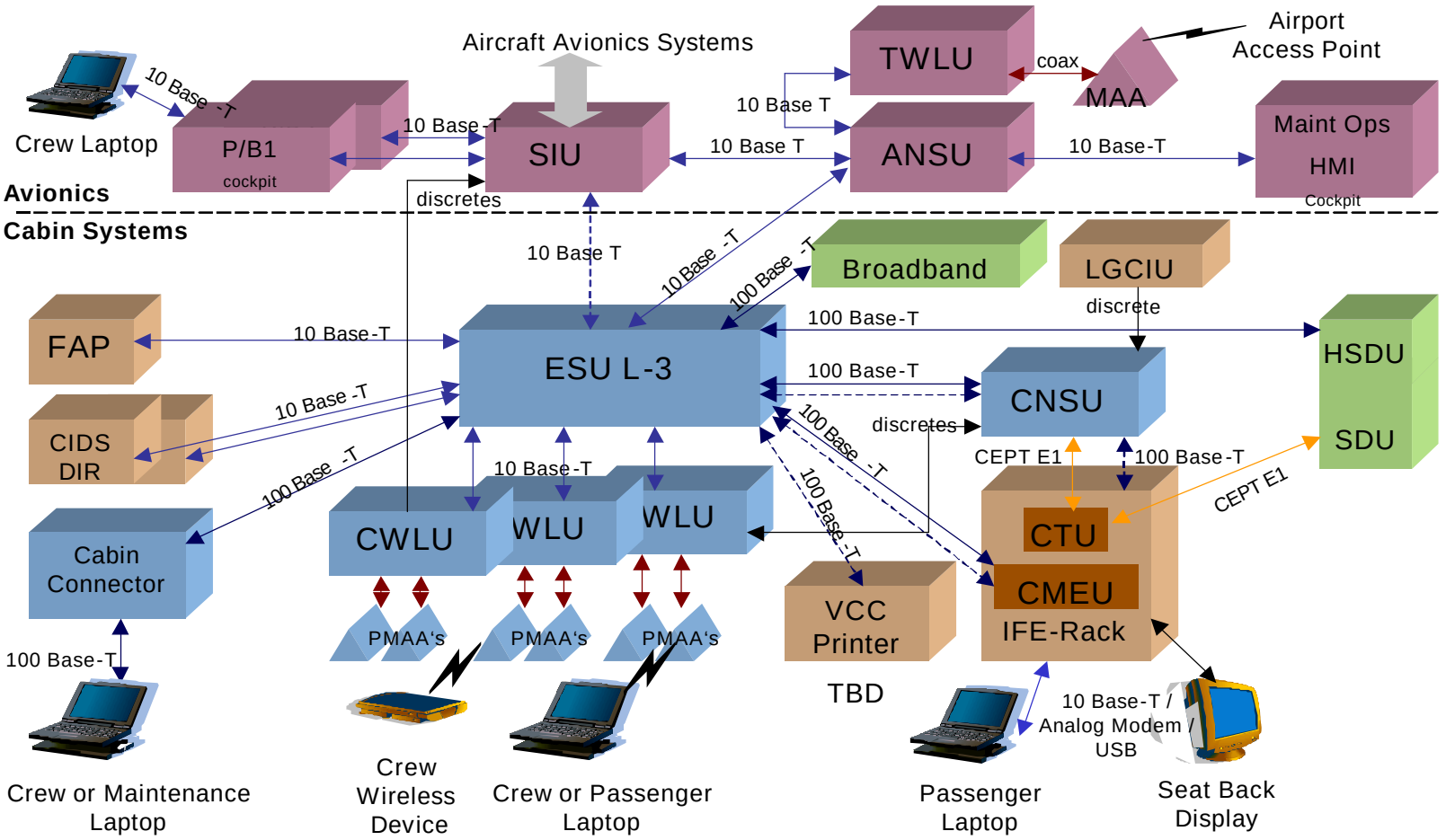
- **Affected Airbus Programs**
  - **A340-500, -600, A318, A319, A320, A321 Cabin Entertainment Networks**
  - **A380 and beyond!!**

- **Affected Boeing Programs**
  - **B-777 AIMS Update**
  - **B-747, B-767, B-777 IFE Programs**
  - **Boeing EFB**
  - **B-7E7 and beyond!!**

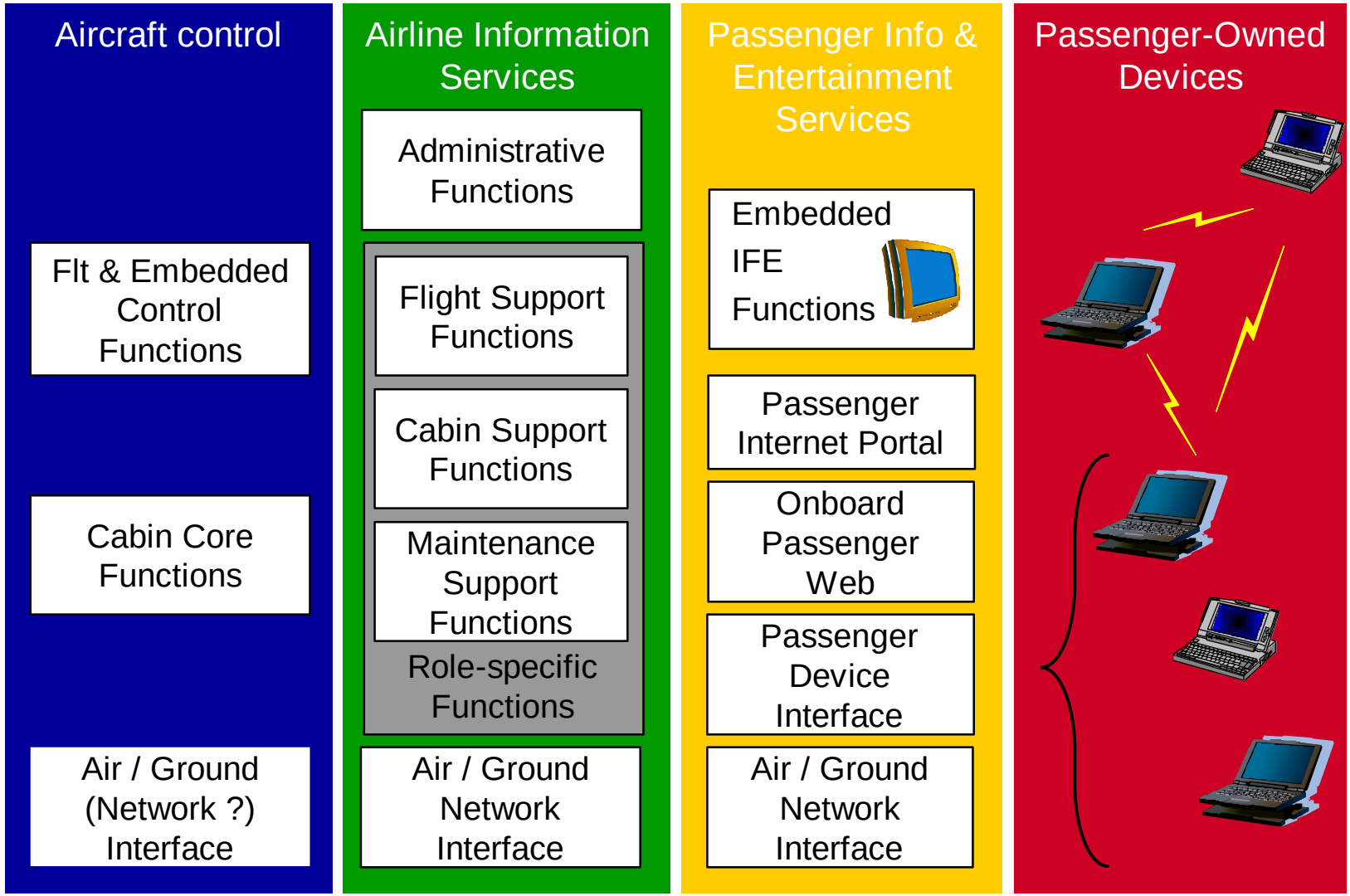
Example Avionic Architecture



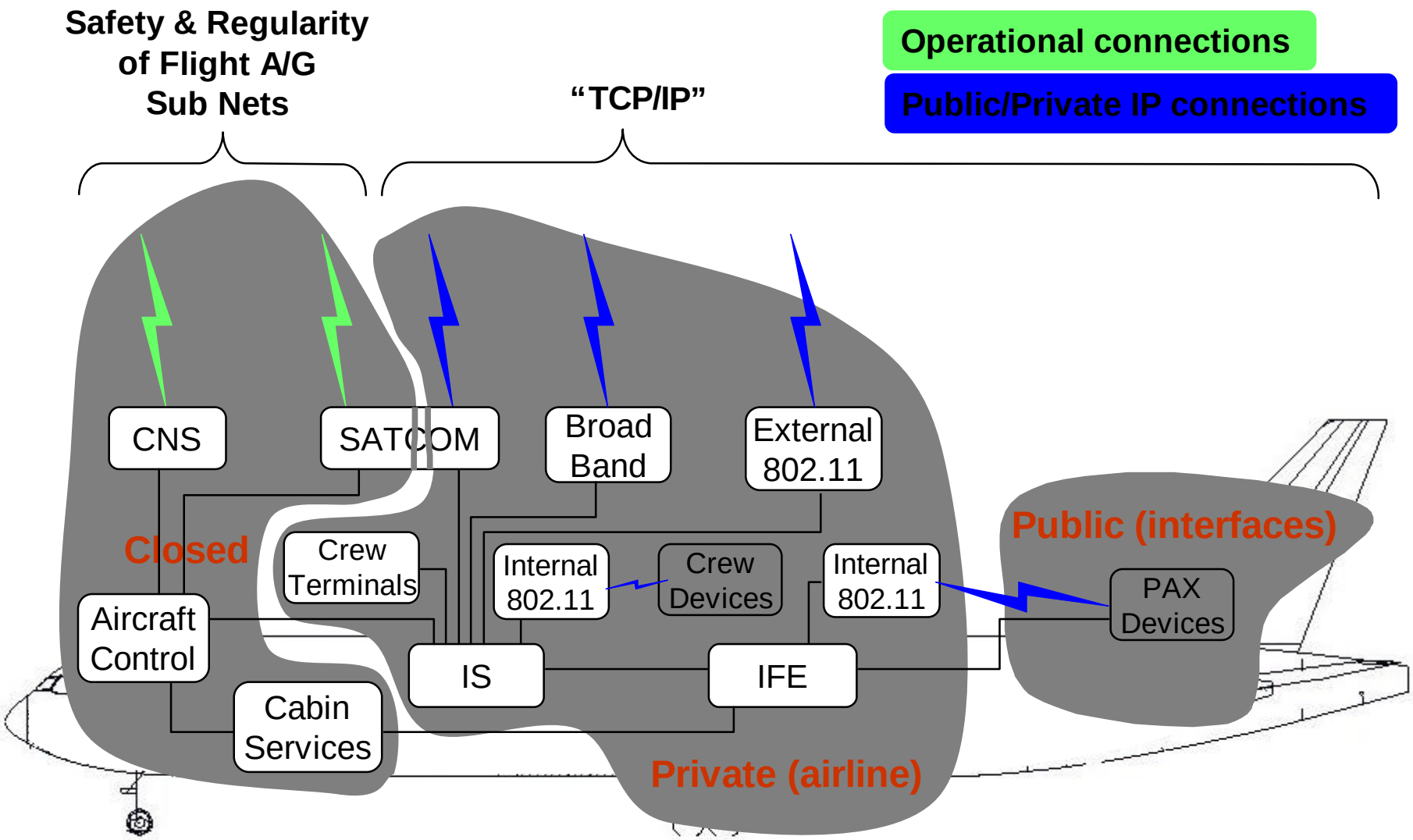
Example Cabin Architecture



ADN Domain Model - Details

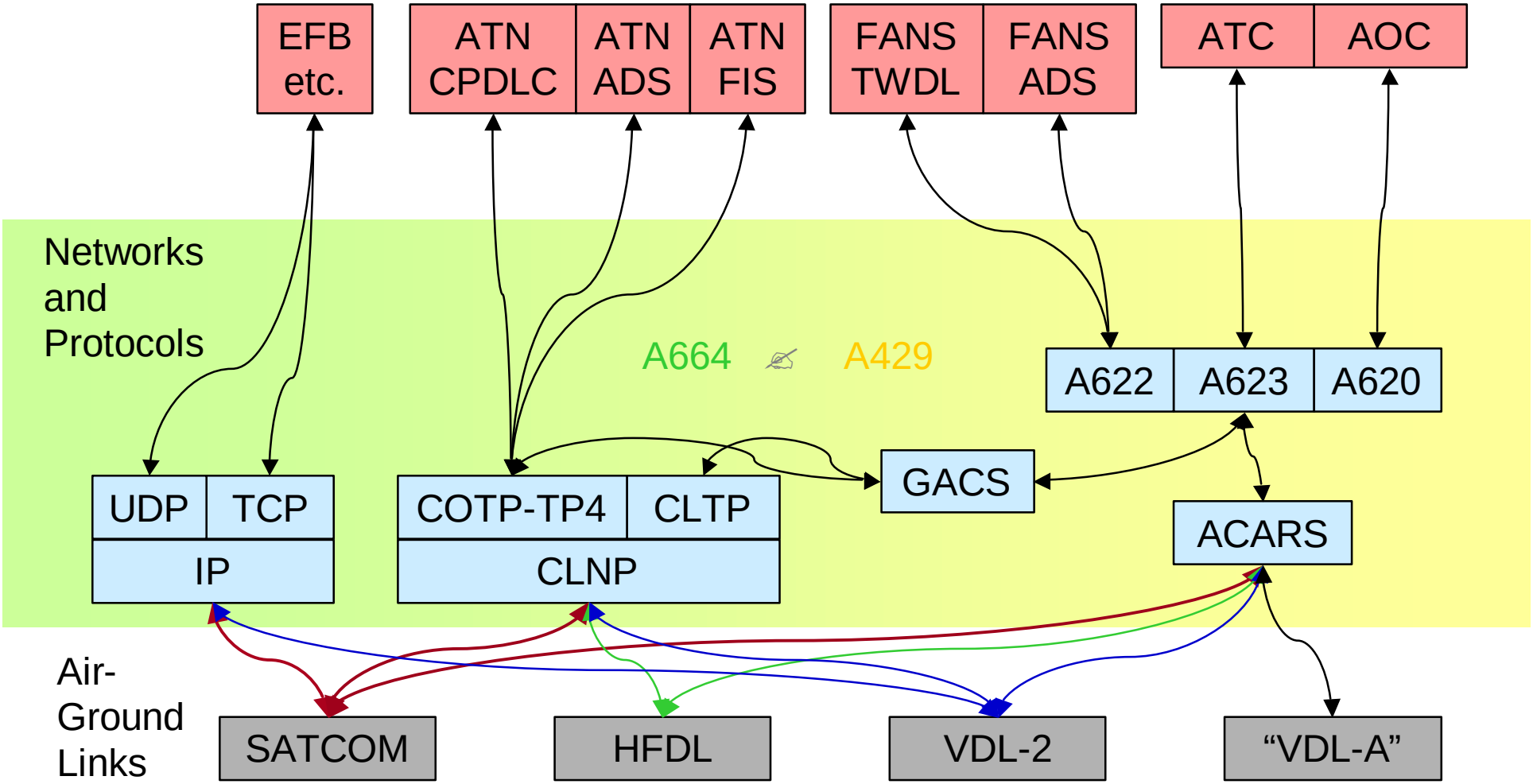


Matching the Real World: Communication



Air/Ground Data Link and Architectures

Applications



ARINC/ AEEC ADN Working Group

- **In 1996 AEEC formed the Subnetwork W/G - later renamed to Aircraft Data Networks (ADN) W/G by combining the FMC/CMU I/F and the A429 working groups, to update Aircraft Networking Standards**

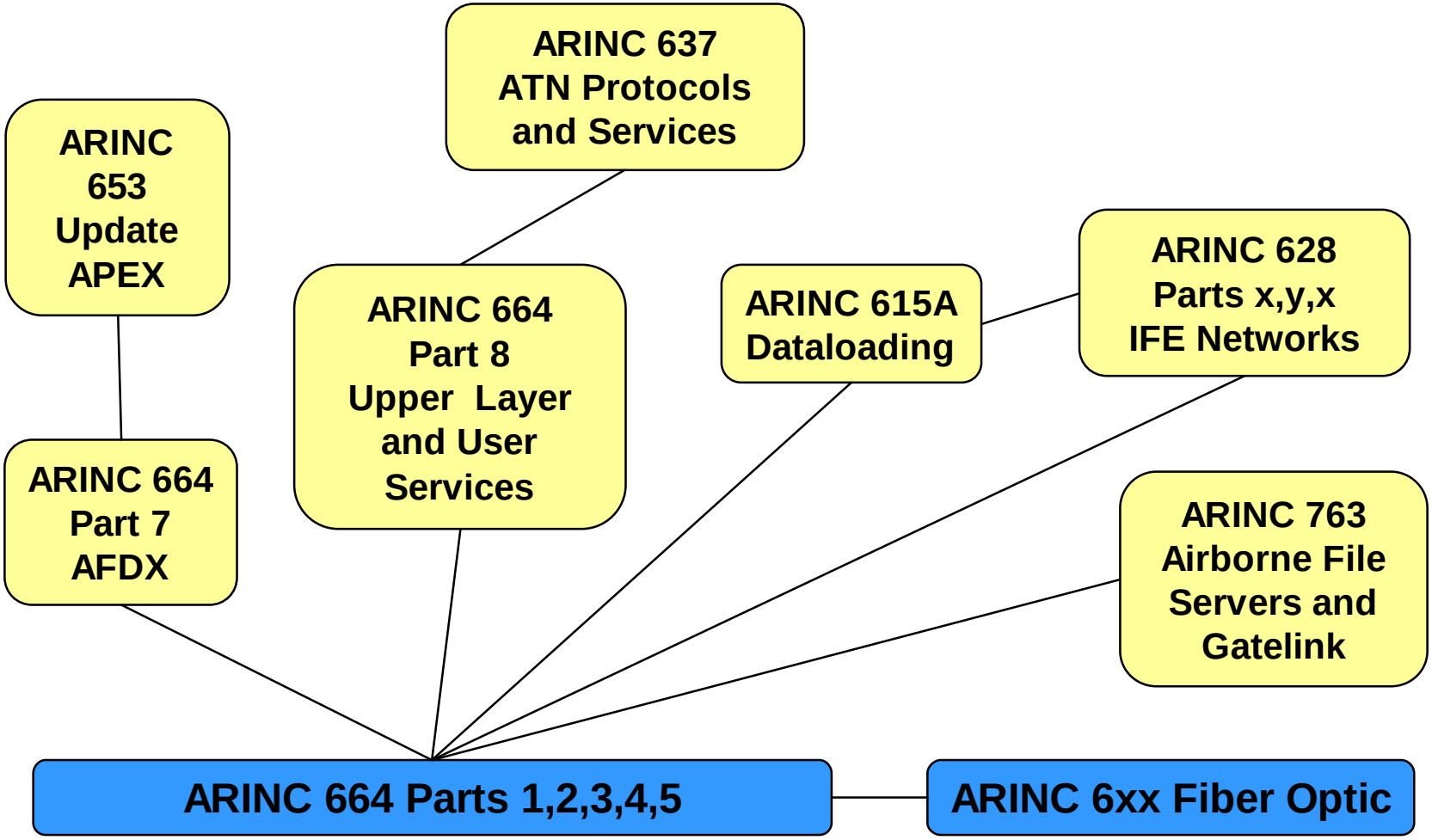
- **The ADN Charter:**

  "The role of ADN is to develop networking standards recommended for use in commercial aircraft installations that define methods, means and services for the transport of data, including quality and security."

  Note that only the airborne interfaces of the Air-ground links are within the scope of the ADN Charter

- **Responsible for ARINC 664 Documents, a total of 8 Parts**
- **Next Meeting in December in Florida**

ARINC Document Relationships

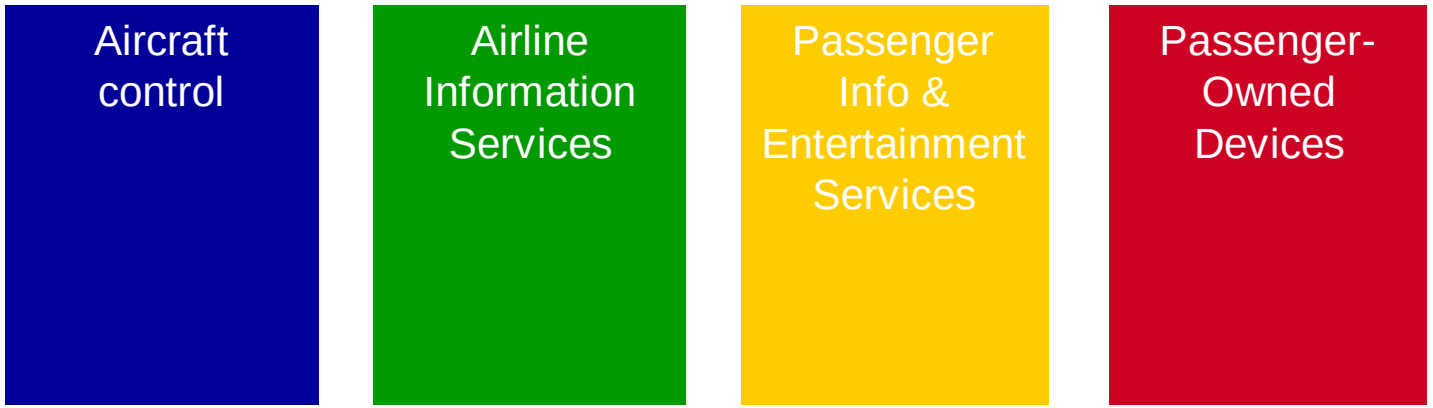


ADN A664 Part 5 Mobility Discussion

- **A664 Part 5 makes the statement:**
  - **“**Unfortunately Mobile IP as defined in IETF standards is, by itself, not sufficient to fully meet the requirements for an ADN ATC and AOC mobile network. Specifically, Mobile IP supports only a single break-before-make link to the Home Agent. The current ICAO requirements call for policy-based routing over multiple simultaneous data links. These requirements must be addressed or relaxed before Mobile IP can be considered a complete solution. This lack of capability is being addressed in current IETF multihoming working groups and a resolution is expected shortly **“**
- **ADN has no direct liaison to the IETF, rather than an indirect one though one of the member companies**
  - **Attempts to influence IETF to include aeronautical requirements**
- **A664 Part 5 Appendix E compares IPv4 and IPv6 Mobility and makes the statement:**
  - “The Network Mobility (NEMO) Working Group is working to resolve issues related to satisfying ICAO mobility requirements.**”**

ADN A664 Part 5 Network Security Discussion

- **Network security architecture - between and within the aircraft Network Domains:**



  - **Accommodates aircraft security architecture for air-ground communications**
  - **Provides background for implementing encryption and other security techniques for aircraft information networks**
- **At AEEC 2003 General Session, ADN encouraged that AEEC take the lead role in addressing the network security challenges of the airline community- Adopted!**
- **ADN Working Group stopped working on the subject and is now deferring to SEC group for Overall Security Guidance**

Aircraft Information Security (SEC) Working Group

- In April 2004, the AEEC sponsored the creation of the Security Working Group (SEC) to:
  - Develop an operational framework for the overall Aircraft Information Security (AIS)
  - Provide overall coordination and guidance for technical working groups specifying the implementation of AIS
  - Produce an AIS Concepts of Operation (ConOps) Document
  - Provide on-going oversight of AEEC technical working groups that will be specifying AIS implementations
  - Evaluate and validate resultant AIS solutions in relation to the operation of the aircraft
  - Examine the possibility of various levels of AIS allowing the airline to implement only the necessary level of AIS.
  - Consider operational concepts when security measures become inoperative
  - Consider operational concepts when a "security event" (breach) occurs
- SEC met in June, 2004 and Sept 7-9 in Seattle and will meet in Toulouse in November.

Summary

- The Aviation Industry has a history of adapting mature, commercial technology in developing aircraft electronics.
- Ethernet and IP based technologies are rapidly entering service in today's aircraft.
- Current next generation Boeing (B7E7) and Airbus (A380) aircraft will use AFDX as the basis for the Avionics System bus.
- Both Boeing and Airbus are developing Cabin Service Systems that are Ethernet/IP based using ARINC 763 as a basis.
- Numerous IFE manufactures are developing IFE system using commercial Ethernet/IP Standards and ARINC 628 guidelines.
- ARINC ADN/664 provides the standards necessary for networking and assures that LRU’s of different manufacturers interoperate.
- ARINC Aircraft Information Security (SEC) Working group formed to develop Aircraft Information Security Operational Concepts.