A Conceptual Infrastructure for Global Airspace Management and Control.

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Commercial Aviation Air-to-Ground Communications

For complete airspace awareness we need to broaden our thinking about what communications solutions may look like as we move forward.

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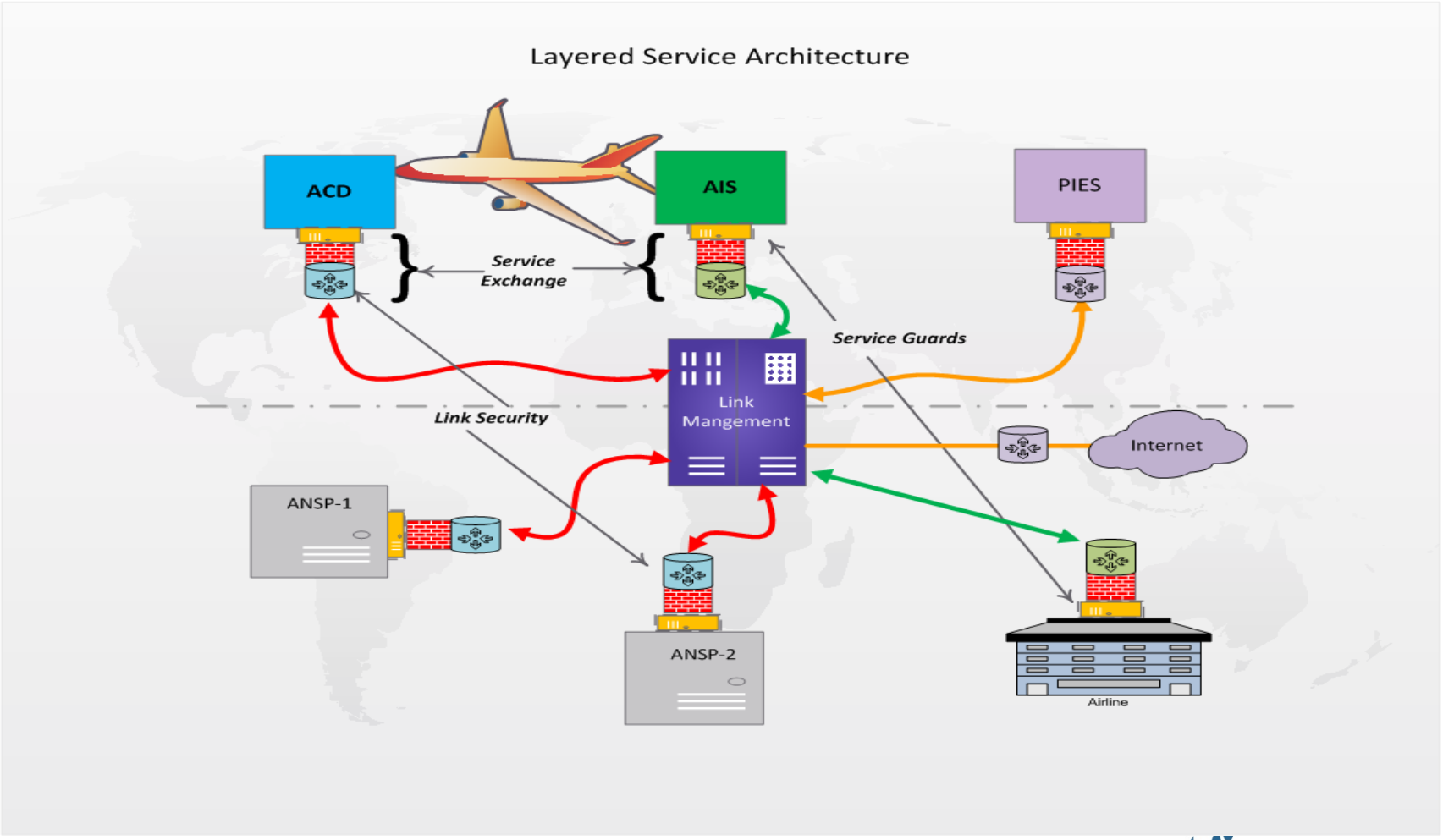
Infrastructure Challenges

- An interoperable global security infrastructure
- No impact to in-service aircraft
- Secure legacy ACARS and ATN (FANs, CPDLC)
- Support new and operator custom AIS and ACD capabilities (Aircraft capability will diverge!)
- SWIM access
- Share appropriate data between domains
- Manage new entries into the airspace

Key Missing Pieces

- A base ATM/ATC application implementation concept
- A permanent unchangeable digital aircraft identity!
  - This is NOT related to the transponder code
- A canonical DNS name for the aircraft
  - Flight number based alias points to true tail name
- The use of IETF topology abstracting protocols like HIP
- Interfaces to existing ATM/ATC systems (ground & air)
- Global ICAO IPv6 address allocations
- Global harmonization of IP link implementations
- Global IP security standards including appropriate compartmentalization

Conceptual Infrastructure



Architecture

- Members-only Single Global Private Virtual Network
- IPv6 based within a single global space.
- Globally interoperable cyber security
- Message oriented "smart" communications
  - No IP directly to flight critical systems!
- Link Management for sharing/separating IP networks
- Loosely coupled ecosystem that enables continuous evolution
- Custom "security guard systems" not firewalls or anti-virus
- "Exchange" points to interface messages to both legacy infrastructure and between SWIM, ACD, AIS, and PIES
- Bus based messaging to and from "flight critical systems"

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Architecture Components

Members-only Single Global Private Virtual Network

- IPv6 based within a single global space.
- Built-in foundational cyber security
- Helps ensure all members operate their segments to ICAO requirements.
- Requires ICAO usage policies to be developed
- Common implementations to facilitate global airline operations
- Ensures minimal conflicts in usage
- Facilitates identification of intruders or unauthorized usage.

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Architecture Components

IPv6 based within a single global space.

- IPv4 routable space is totally allocated.
- IPv4 RFC 1918 non-routable "10 space" over used
- Simplifies routing management (200 different networks or 1?)
- Improves cyber security management
- Managed by ICAO like current A/C addresses

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Architecture Components

New ATM/ATC functions use "smart messaging"

- Carried over IP links to aircraft or ANSP
- Link terminated at "message processor"
  - Receives and transmits "messages" with A/C buses
- Minimizes cyber "attack surfaces"
  - No IP directly to flight critical systems!
- Easier protected and checked for message validity
- System can carry different message versions and types
  - "Smart receiver" determines if valid for that specific A/C

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Architecture Components

Link Management

- Securely shares data link/s with ACD/AIS/PIES
- Separates IP networks
- Minimizes A/C communication weight/power
- Link sharing software requires minimal system
- Allows message prioritization over link

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Architecture Components

Custom "security guard systems"

- Is not traditional IT firewalls or anti-virus - SCADA/ICS related
- Validates message type/version destination is for that A/C
- Sanity checks message for validity based type/version
- Can implement unique security checks on message type/version
- Check message for authentication.
- Can provide "overnight" implementation of cyber protection for new threats/vulnerabilities identified. (Avoids model grounding)

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Architecture Components

"Exchange Systems"

- Processes "message type/version"
- Validate destination and authentication
- Messages to and from legacy infrastructures
- Between SWIM, ACD, AIS, and PIES as permitted
- Minimizes transitional requirements to implement new ATC
- Protects legacy aircraft from impacts of new implementations

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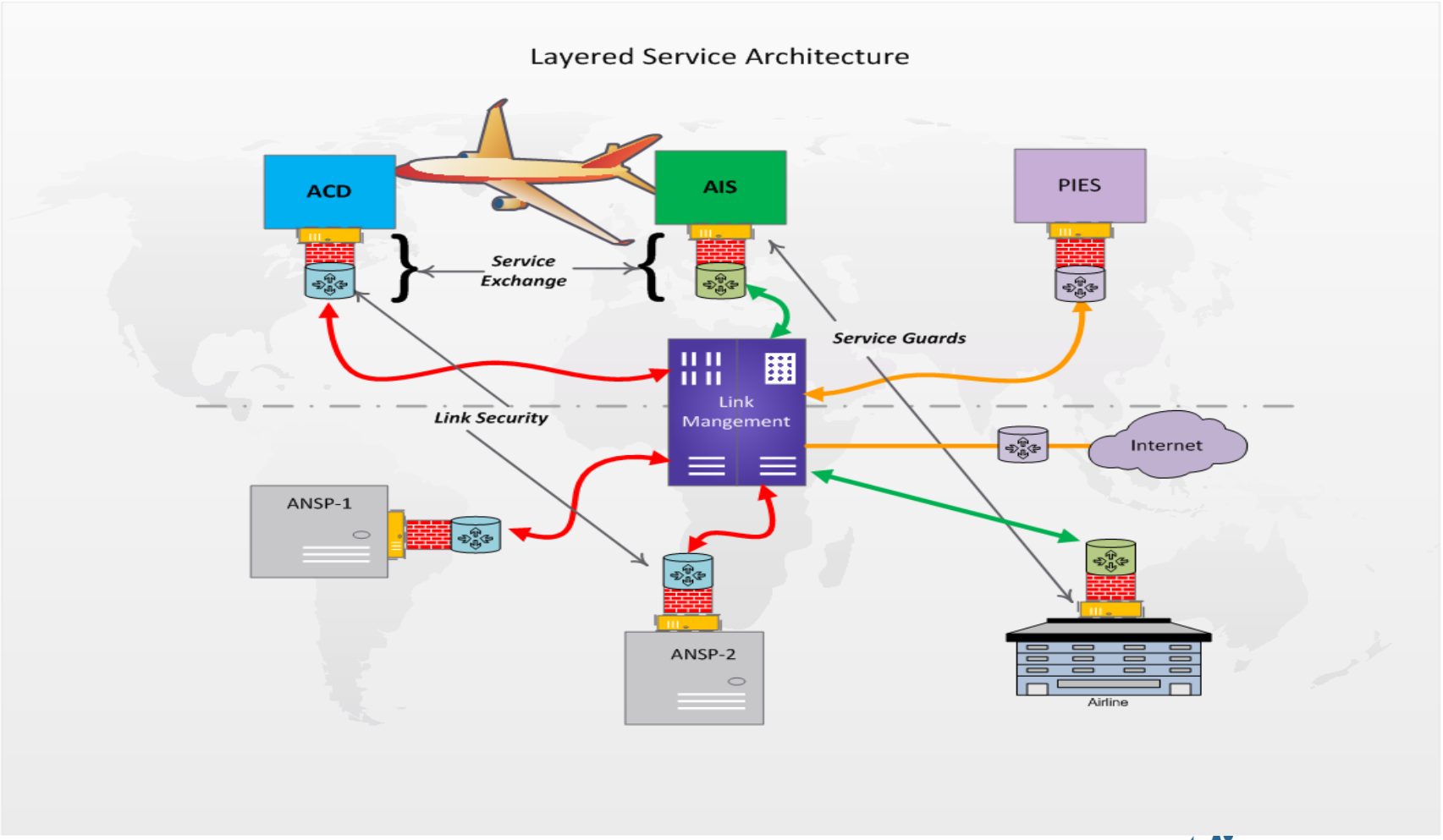
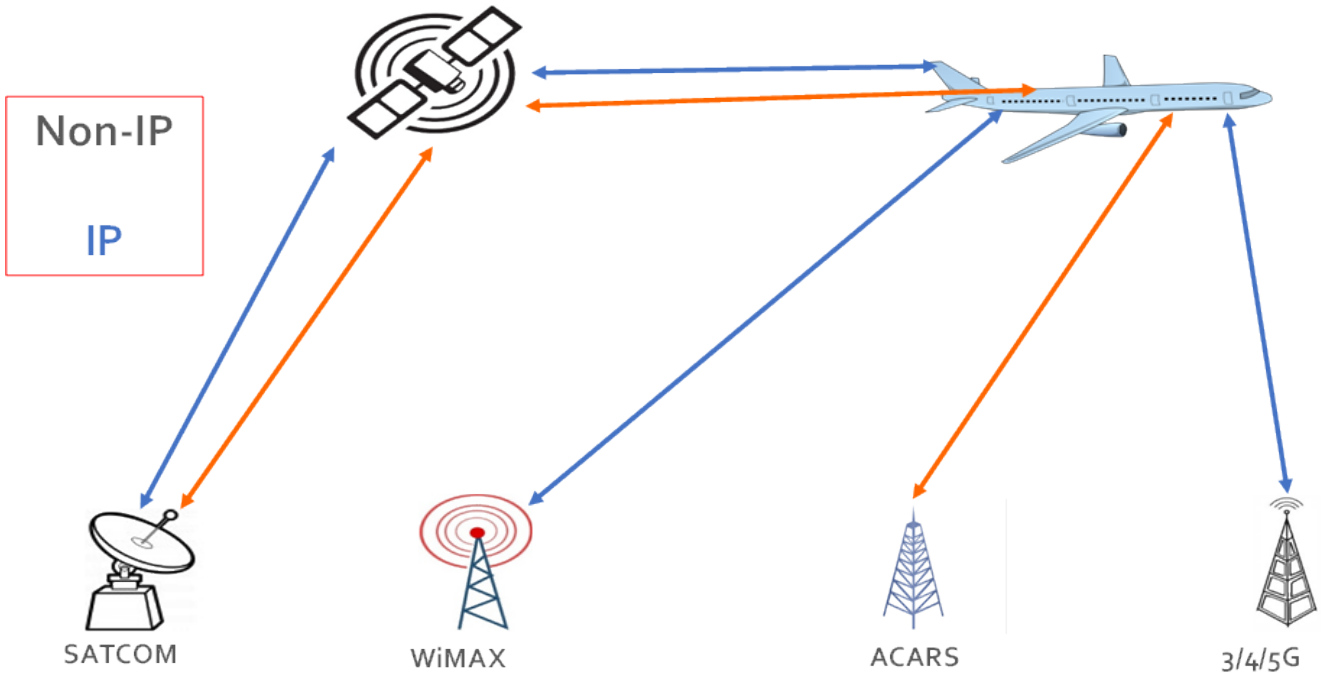
Conceptual Infrastructure



Air-to-Ground Links



Most data links with capacity from Fans-IV up can carry IP too.

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Air-to-Ground IP Links

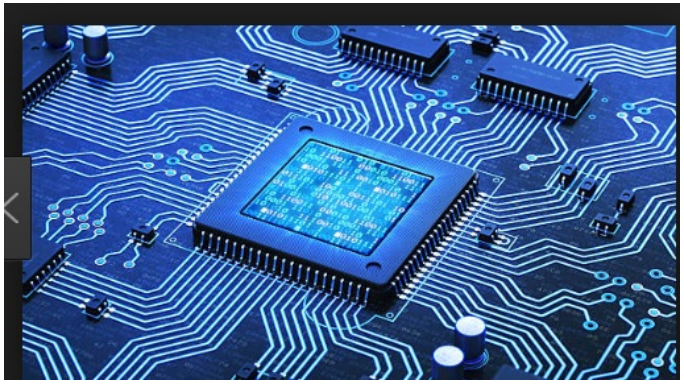
- Legacy protocols may be encapsulated, secured, and prioritized over existing IP links
- Traffic streams can be re-routed to another available link when availability, cost, or performance dictates
- Each stream can be completely independent of the others:
- IP streams can carry customized traffic such as airline specific AIS or be based on equipment capability

If standardized:

- existing ACARS and ATN could be secured to any aircraft with IP links.
- SWIM (AAtS) could be implemented similarly.

Biggest Challenge

Different IP protocol standards for different links!



Questions?

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