COMMON IPS RADIO INTERFACE

Motivation and requirements

MICHAL SKOŘEPA
ZDENĚK JAROŇ

AEEC IPS
DEC 8, 2021

Honeywell

PROBLEM STATEMENT

Envisioned IPS-enabled radios

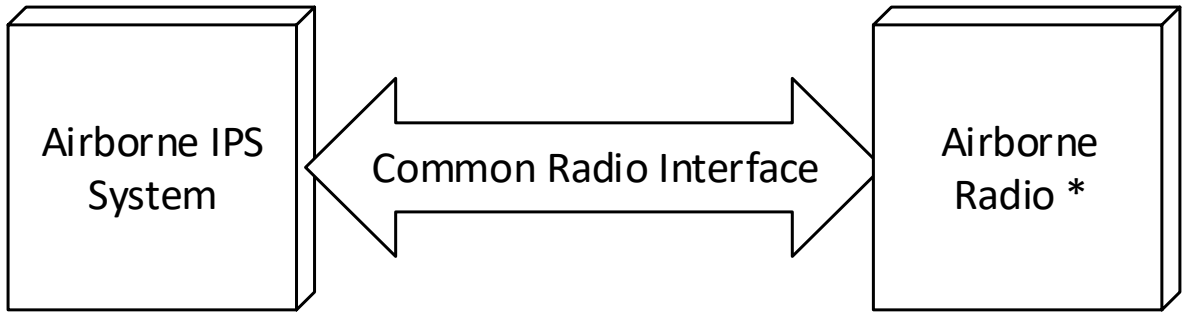
- feature a variety of radio-specific interface definitions with little-to-no commonality
- create diverse environment where not all radios provide the same information or capabilities
- have different interface specification to which the Airborne IPS System needs to adapt

Optimum solution Airborne IPS System to Airborne Radios interface

- suits the needs of IPS – mainly for multilink and Quality of Service
- allows Plug&Play style of interfacing
- is extensible and future-proof

Areas of concern

- Control plane
- Data plane
- Flow control



* For VDLm2 the term Radio represents both the VDR part and the CMU part

APPLICABILITY

Envisioned IPS-enabled radios & relation to Common Radio Interface

Airborne Radio			Airborne IPS System - Radio Management Interface	
			Radio-specific Adaptation	**Common Radio Interface Protocol**
Legacy (non-IP) Radio	VDR	A750	Y [1]	N
IPS-enabled Radio	AeroMACS	A766	Y [1]	O
	LDACS	*Future*	*TBD*	O [2]
	Certus	A771	Y [1]	O [3]
	SB-Safety	A781	Y [1]	O [3]
IP-enabled Radio	Gatelink WiFi	A822A	[4]	
	Gatelink Cell	A822A		
	A-G Cellular	N/A		
	Ku/Ka SATCOM	A791/ A792		

[1] For existing radios without Common Radio Interface Protocol support, the Airborne IPS System provides adaptation

[2] For future LDACS standard the radio interface may be specified as the Common Radio Interface Protocol

[3] If supplements to A771 and A781 are necessary to support IPS in general, the Common Radio Interface Protocol support may be added

[4] Potential interface between Airborne IPS System and IP-enabled radios in AISD envisioned via an intermediary device (e.g., AISD router or AID)

REQUIREMENT'S SUMMARY [1/4]

The Common Radio Interface protocol **shall/should** enable the Airborne Radio to:

- REQ 1. report datalink operational status to the Airborne IPS System
  - "UP" and "DOWN" at a minimum
- REQ 2. report degraded operational statuses
  - e.g., "UP" and "DEGRADED"
- REQ 3. report operational status separately for multiple services* (if provided by the datalink)
  - Satcom will use dedicated services for RCP/RSP-bound (e.g, ATS services) and for non-RCP/RSP-bound (e.g., AOC services) communication
- REQ 4. report the current communication service provider
  - For mobility and multilink signaling (e.g., AGMI) and link selection in the aircraft

* This concerns datalink safety services

REQUIREMENT'S SUMMARY [2/4]

Data plane

The Common Radio Interface protocol **shall/should** enable the Airborne IPS System to:

- REQ 5. exchange data-plane packets with Airborne Radio
- REQ 6. indicate a service for air-to-ground packets passed to the Airborne Radio
  - e.g., to distinguish RCP/RSP-bound vs non-RCP/RSP-bound communication in the Satcom

Flow control

The Common Radio Interface protocol **shall/should**:

- REQ 7. enable the Airborne Radio to inform the Airborne IPS System about the volume of data that it can accept in a flow
  - throttle flow of packets from the Airborne IPS System to the Airborne Radio
- REQ 8. support flows of all air-to-ground packets belonging to a single service
- REQ 9. support a flow of all air-to-ground packets (regardless of the service).

REQUIREMENT'S SUMMARY [3/4]

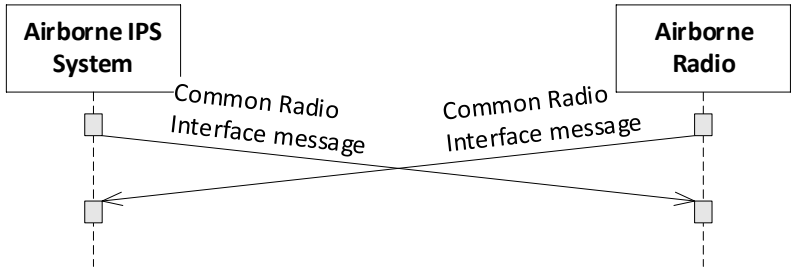
Robustness

The Common Radio Interface protocol **shall/should** be robust against:

- REQ 10.1. restart of Airborne IPS System
- REQ 10.2. restart of Airborne Radio

} (losing its Common Radio Interface-related runtime state)

- REQ 10.3. interleaved messages in opposite directions
- REQ 11. change of message delivery order
- REQ 12. future backward compatible extensions
- REQ 13. future non-backward compatible versions



REQUIREMENT'S SUMMARY [4/4]

General operation

The Common Radio Interface protocol **shall**:

- REQ 14. enable the Airborne IPS System to have up-to-date datalink status information
- REQ 15. enable the Airborne IPS System to detect loss of connection with the Airborne Radio
  - A means of health monitoring between the Airborne IPS System and the Airborne Radio

CANDIDATE SOLUTIONS

Alternatives considered for implementation of the Common Radio Interface

	SNMP	MAGIC / Common Link Interface	Custom L2	TCP	Custom UDP (AIAP)
Control plane support	yes	yes	yes	no	yes
Data plane support	no	no	yes	yes	yes
COTS layers	(L2) IPv6 UDP SNMP	(L2) IPv6 UDP or TCP	(L2)	(L2) IPv6 TCP (modified)	(L2) IPv6 UDP
To be specified / standardized	Operation, MIB	Transport, operation	Transport, operation, message format	Operation	Transport, operation, message format
To be implemented	Operation, MIB	Operation	Operation, message format	TCP modifications	Operation, message format
Protocol complexity	high	high	low	high	low
Approach commonality	high	medium	low	high	medium
Certification Complexity	high	high	medium	high	medium

BACKUP

AIAP protocol summary

PROPOSAL – ATN/IPS AIRCRAFT PROTOCOL (AIAP)

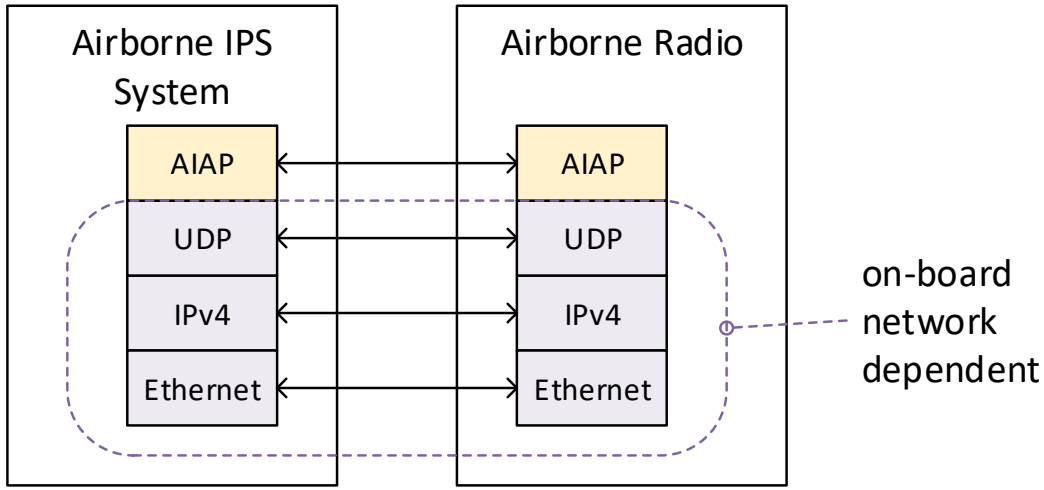
Proof-of-concept solution developed by Honeywell to address the needs of link status signaling and flow control

Protocol operation

- Airborne IPS System periodicaly polls the Airborne Radio for status
  - Airborne Radio responds with its status
  - If the Airborne radio does not respond after a configurable no. of retries, it is treated as non-functional

Message format

- TLVs (Type-Lentgth-Value) with multiple Options



Independent of underlying on-board network

- Prototyped and validated on Ethernet with UDP/IPv4 stack
- Well suited for AFDX networks
- May require further considerations for A429

Validated implementations

- Cobham SDU – Boeing ecoDemonstrator 2021
- Frequentis LDACS radio – SESAR FCI validation

AIAP – CONVEYED INFORMATION

control-plane AIAP options

- Datalink ID – identifies the radio/datalink in scope of the aircraft
- Service Status – basic discrete datalink status (e.g., UP, DOWN, DEGRADED)
- Link Instance – identifies the current CSP
- Datalink Context – indicates need to repeat a multilink signaling interface message
- Queue Status – status of a queue for a CoS
- Flow window – part of Flow control mechanism

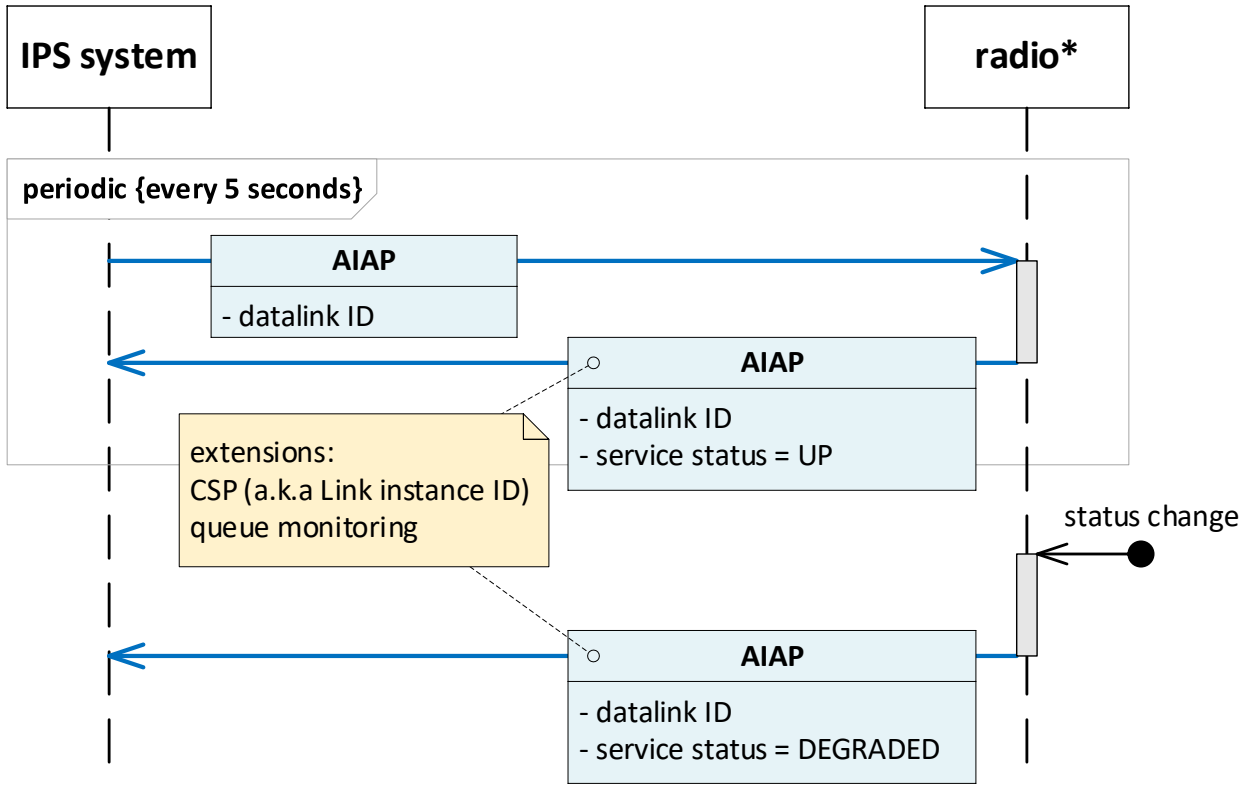
from radio*
to Airborne IPS system

data-plane AIAP options

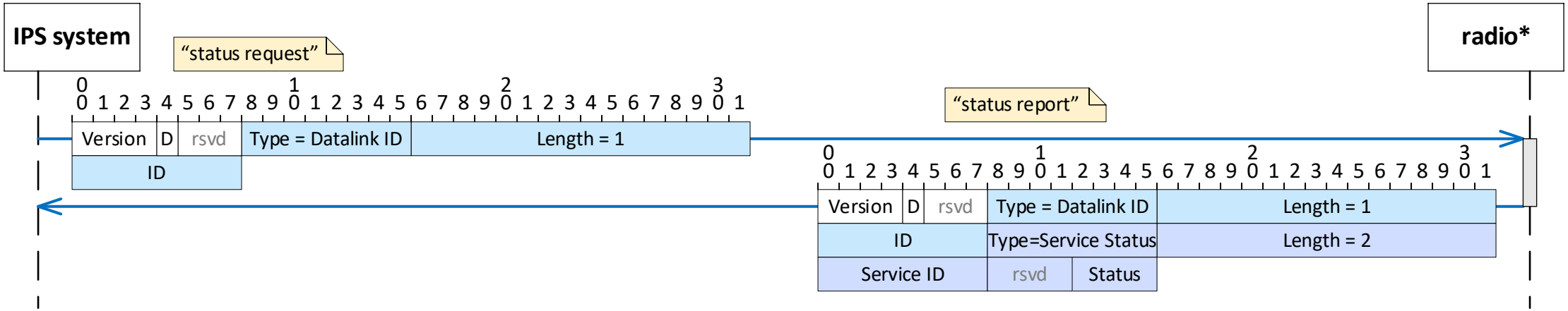
- Packet Data – carries the packet itself
- Packet CoS – identifies class of service of the packet
- Expiration Time – maximum time of packet usefulness
- Flow sequence – part of Flow control mechanism

from Airborne IPS system
to radio*

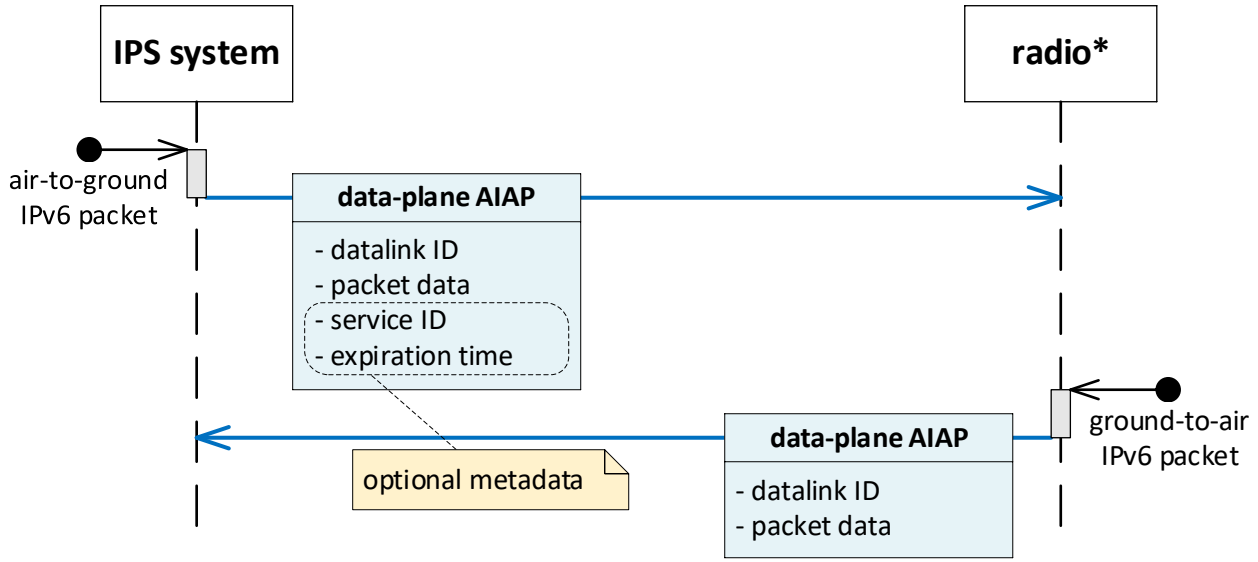
AIAP CONTROL-PLANE MSC



AIAP CONTROL-PLANE MESSAGE STRUCTURE



AIAP DATA-PLANE MSC



AIAP DATA-PLANE MESSAGE STRUCTURE