
CONNECTED AIRCRAFT
A FRAMEWORK FOR INNOVATION

Need

The future ATM system will rely on extensive information exchange

New entrant community is especially dependent on data communications

Current voice and data communication systems do not scale to meet anticipated demand

Purpose

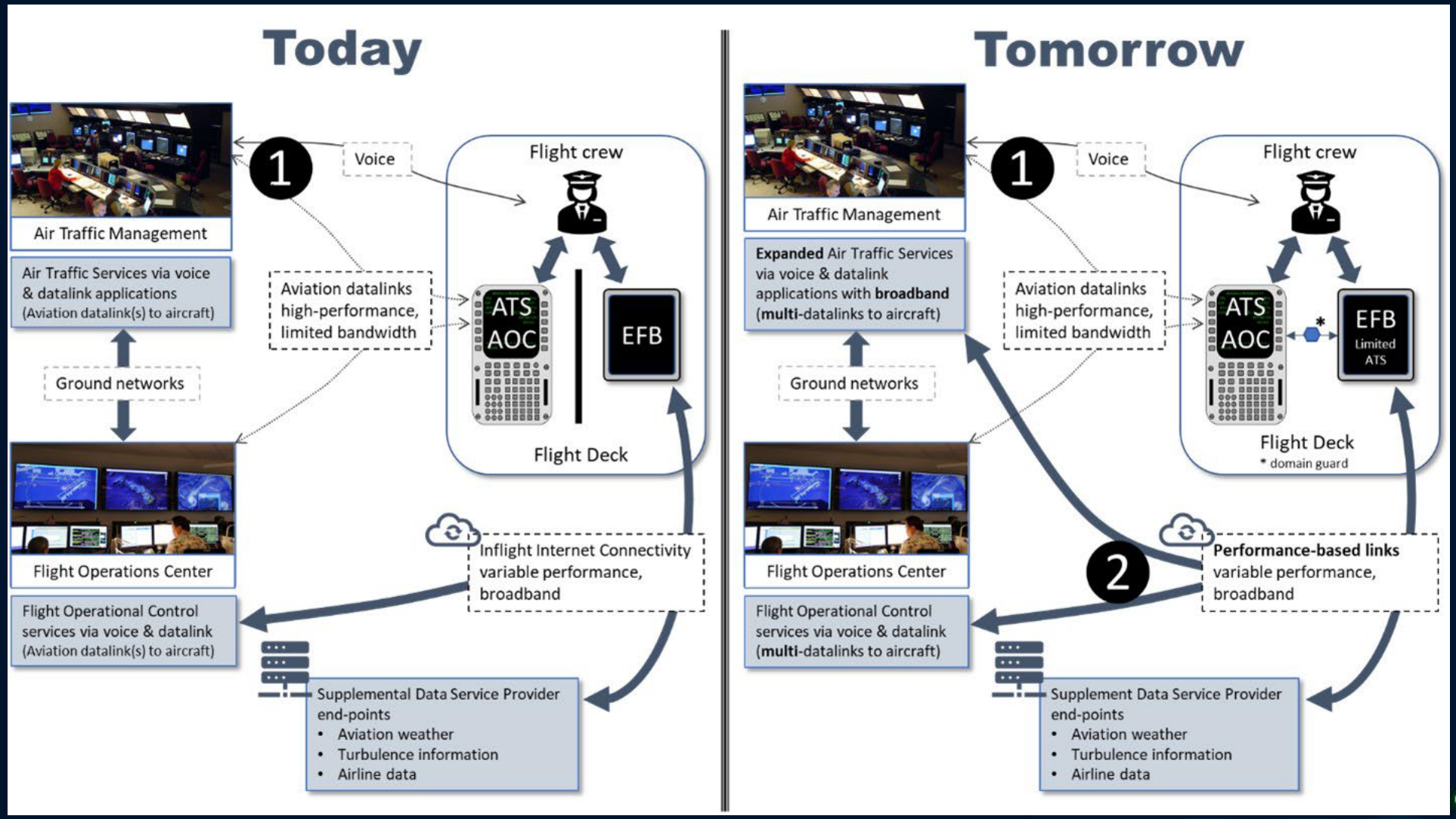
The Connected Aircraft (CA) concept: a framework to accommodate the expected growth in demand for information exchange between the aircraft and relevant aviation stakeholders.

Our goal: Improve airline/operator operational efficiency & sustainability, and accommodate the needs of the new entrant community.

- Use new and existing connectivity solutions enabled through performance -based requirements
- Enable digital interaction between stakeholders
  - Support Trajectory based operations (TBO)
  - Provide enhanced weather/situational awareness
  - Communications to support new entrant operational needs
- Complement CPDLC

Opportunity

Opportunities to improve the Air -Ground information exchange of tomorrow



Overarching Principles

CONCEPT

The CA concept enables stakeholders to use both aviation -specific and commercial communication systems in concert to meet their A/G information exchange needs.

ATTRIBUTES

The key performance attributes offered by CA will be able to be tailored to the individual needs of the application (data integrity, availability, continuity, confidentiality, and transaction time).

USE OF INFORMATION

Specific performance requirements are determined by the use of information.

CONNECTED AIRCRAFT USE CASE SCENARIOS

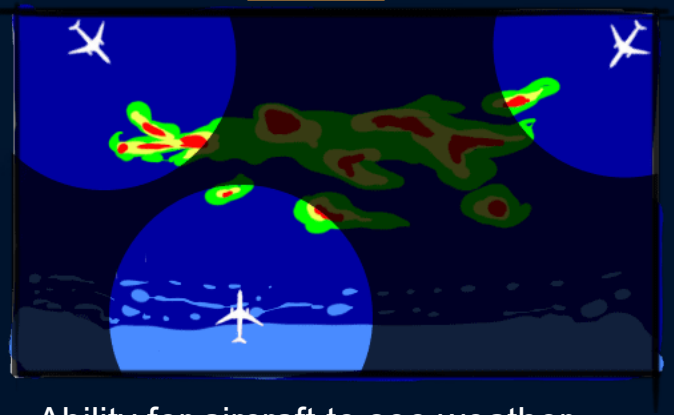
SCENARIO

Connected Aircraft data sharing and crowdsourcing

SCENARIO

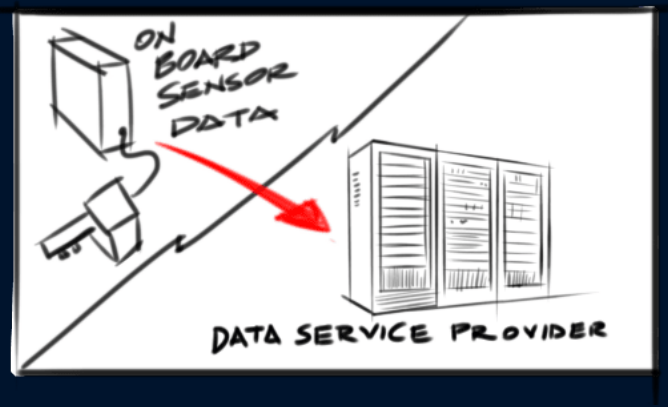
Connected Aircraft data sharing and crowdsourcing

01



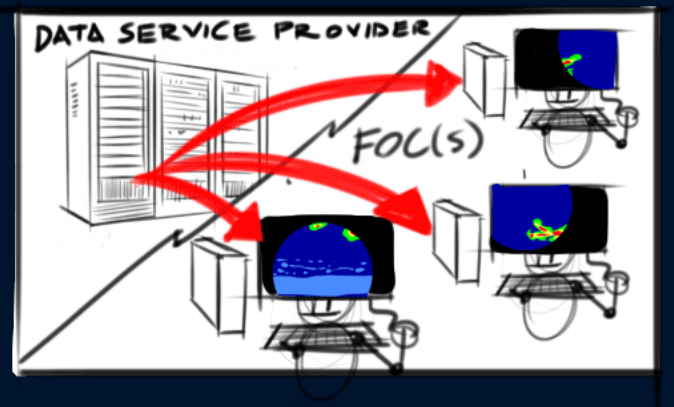
Ability for aircraft to see weather activity is limited by range of on-board weather radar

02



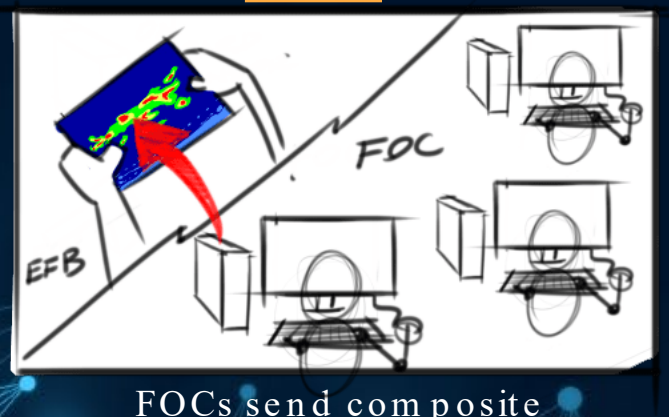
Participating aircraft send weather radar data to Data Service Provider (DSP)

03



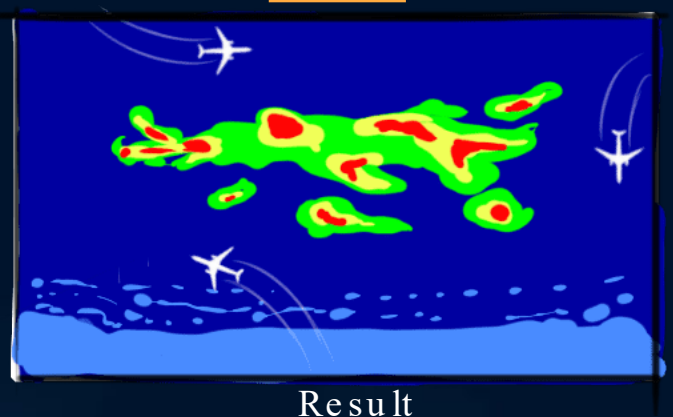
DSP provides composite radar picture to participating FOCs

04



FOCs send composite information to their aircraft

05



Result

ADDITIONAL CONSIDERATIONS

Importance of Interoperability and Standardizations

- Technology will evolve and be incorporated by stakeholders at different rates
- Important to consider mixed environment
  - Equipment on aircraft
  - ATM infrastructure
- Interoperability is critical to achieving widespread adoption of these capabilities
- Standards should be adaptable to keep pace with evolving technology

Keys to Success

01

Focus on performance to enable advanced information exchanges (technology - agnostic)

02

Facilitate participation with current stakeholders and emerging airspace users

03

Harness new and existing connectivity solutions, regionally and globally

04

Ensure standards are adaptable


Internet Protocol Suite (IPS)
Next Generation Networking for the Future of Aviation

Need and Opportunity

The future ATM system will rely on extensive information exchange

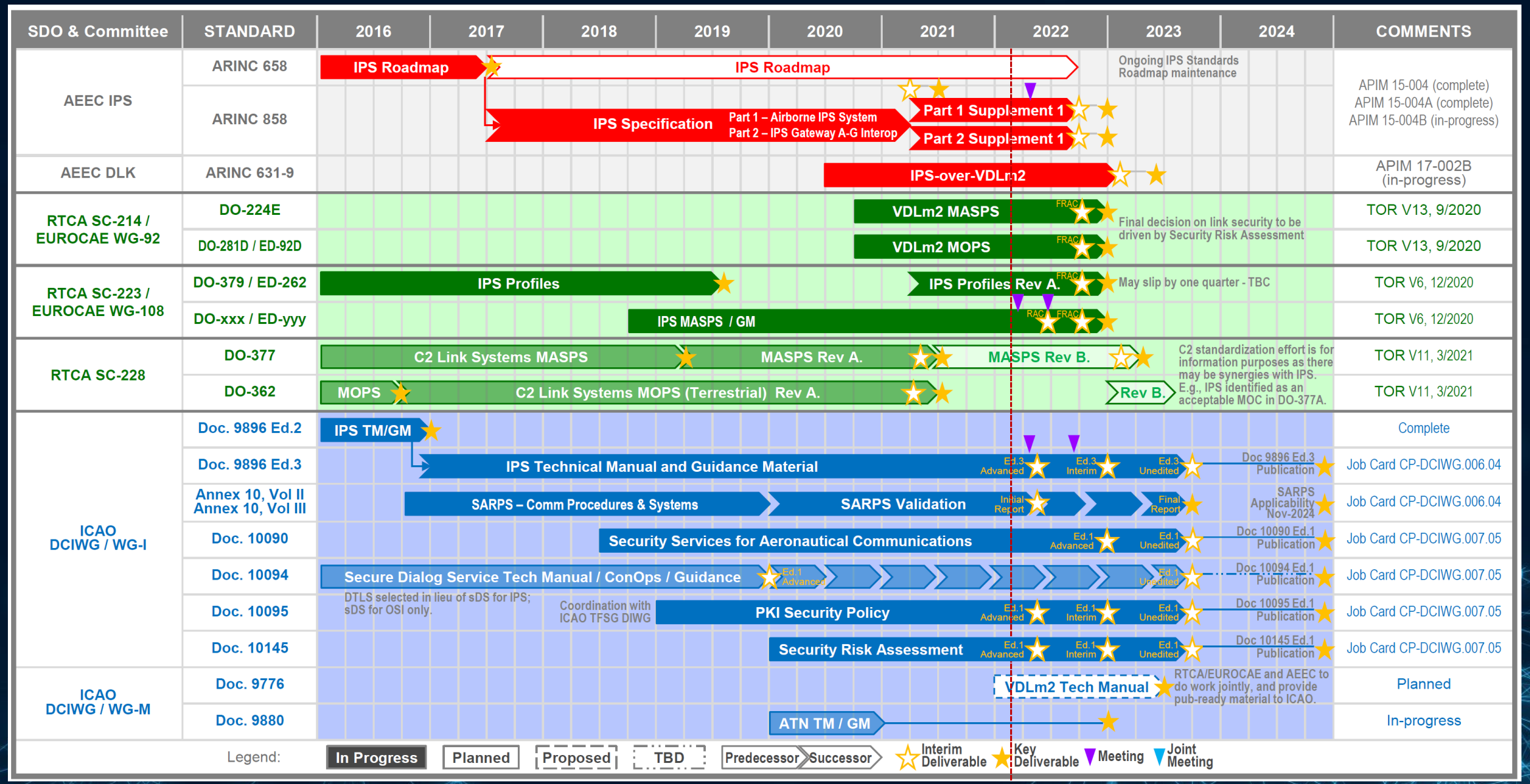
- IPS enables increased throughput on aviation subnetworks

New entrant community is especially dependent on data communications

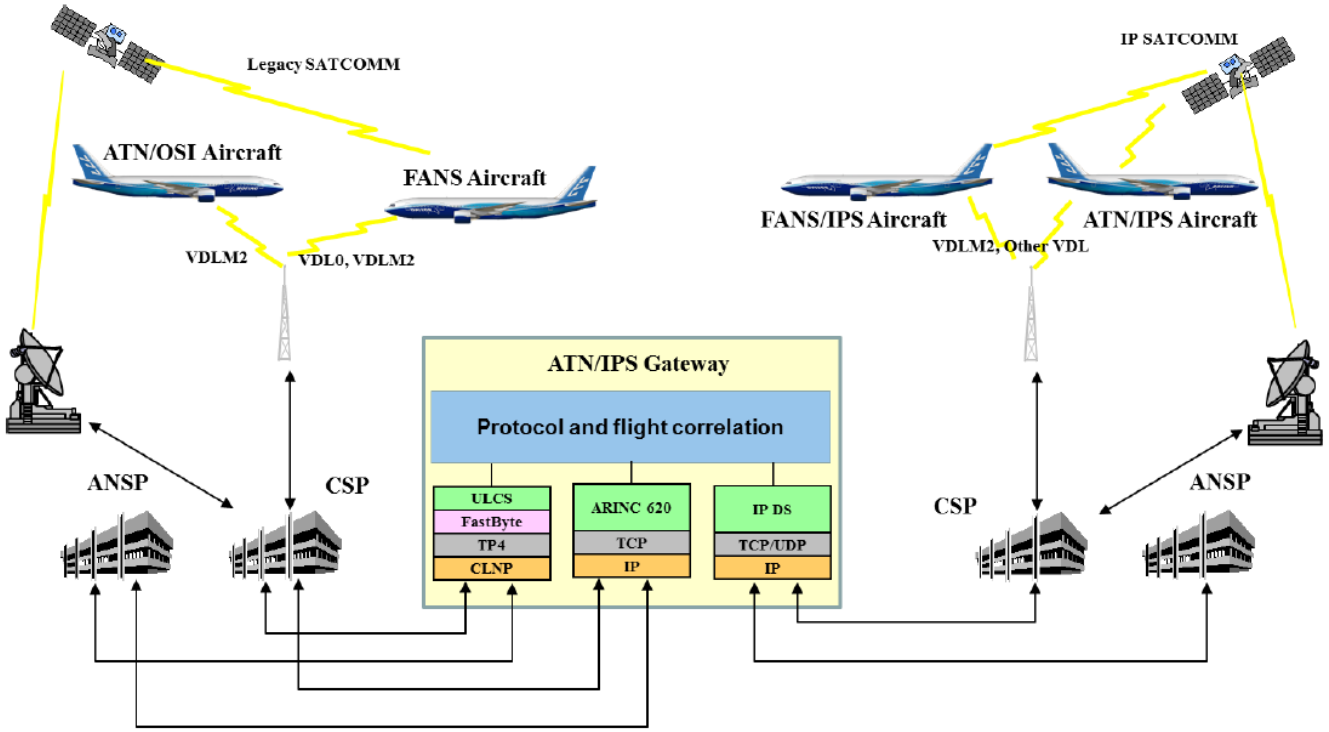
- IPS could enable ground connectivity between ATM and UAS ground controllers

Current voice and data communication systems do not scale to meet anticipated demand

- IPS contributes secure networks
- IPS enables use of aviation and commercial subnetworks at multiple levels of performance


SDO & Committee
STANDARD
2016
2017
2018
2019
2020
2021
2022
2023
2024
COMMENTS
AEEC IPS
ARINC 658
IPS Roadmap
IPS Roadmap
Ongoing IPS Standards Roadmap maintenance
ARINC 858
IPS Specification
Part 1 – Airborne IPS System
Part 2 – IPS Gateway A-G Interop
Part 1 Supplement 1
Part 2 Supplement 1
APIM 15-004 (complete)
APIM 15-004A (complete)
APIM 15-004B (in-progress)
AEEC DLK
ARINC 631-9
IPS-over-VDLm2
APIM 17-002B (in-progress)
RTCA SC-214 / EUROCAE WG-92
DO-224E
VDLm2 MASPS
FRAC
TOR V13, 9/2020
DO-281D / ED-92D
VDLm2 MOPS
FRAC
Final decision on link security to be driven by Security Risk Assessment
TOR V13, 9/2020
RTCA SC-223 / EUROCAE WG-108
DO-379 / ED-262
IPS Profiles
IPS Profiles Rev A.
FRAC
May slip by one quarter - TBC
TOR V6, 12/2020
DO-xxx / ED-yyy
IPS MASPS / GM
RAC
FRAC
TOR V6, 12/2020
RTCA SC-228
DO-377
C2 Link Systems MASPS
MASPS Rev A.
MASPS Rev B.
C2 standardization effort is for information purposes as there may be synergies with IPS. E.g., IPS identified as an acceptable MOC in DO-377A.
TOR V11, 3/2021
DO-362
MOPS
C2 Link Systems MOPS (Terrestrial) Rev A.
Rev B.
TOR V11, 3/2021
ICAO DCIWG / WG-I
Doc. 9896 Ed.2
IPS TM/GM
Complete
Doc. 9896 Ed.3
IPS Technical Manual and Guidance Material
Ed.3 Advanced
Ed.3 Interim
Ed.3 Unedited
Doc 9896 Ed.3 Publication
Job Card CP-DCIWG.006.04
Annex 10, Vol II
Annex 10, Vol III
SARPS – Comm Procedures & Systems
SARPS Validation
Initial Report
Final Report
SARPS Applicability Nov-2024
Job Card CP-DCIWG.006.04
Doc. 10090
Security Services for Aeronautical Communications
Ed.1 Advanced
Ed.1 Unedited
Doc 10090 Ed.1 Publication
Job Card CP-DCIWG.007.05
Doc. 10094
Secure Dialog Service Tech Manual / ConOps / Guidance
Ed.1 Advanced
Ed.1 Unedited
Doc 10094 Ed.1 Publication
Job Card CP-DCIWG.007.05
DTLS selected in lieu of sDS for IPS; sDS for OSI only.
Doc. 10095
Coordination with ICAO TFSG DIWG
PKI Security Policy
Ed.1 Advanced
Ed.1 Interim
Ed.1 Unedited
Doc 10095 Ed.1 Publication
Job Card CP-DCIWG.007.05
Doc. 10145
Security Risk Assessment
Ed.1 Advanced
Ed.1 Interim
Ed.1 Unedited
Doc 10145 Ed.1 Publication
Job Card CP-DCIWG.007.05
ICAO DCIWG / WG-M
Doc. 9776
VDLm2 Tech Manual
RTCA/EUROCAE and AEEC to do work jointly, and provide pub-ready material to ICAO.
Planned
Doc. 9880
ATN TM / GM
In-progress
Legend:
In Progress
Planned
Proposed
TBD
Predecessor
Successor
Interim Deliverable
Key Deliverable
Meeting
Joint Meeting

ATN/IPS Gateway High-level Architecture

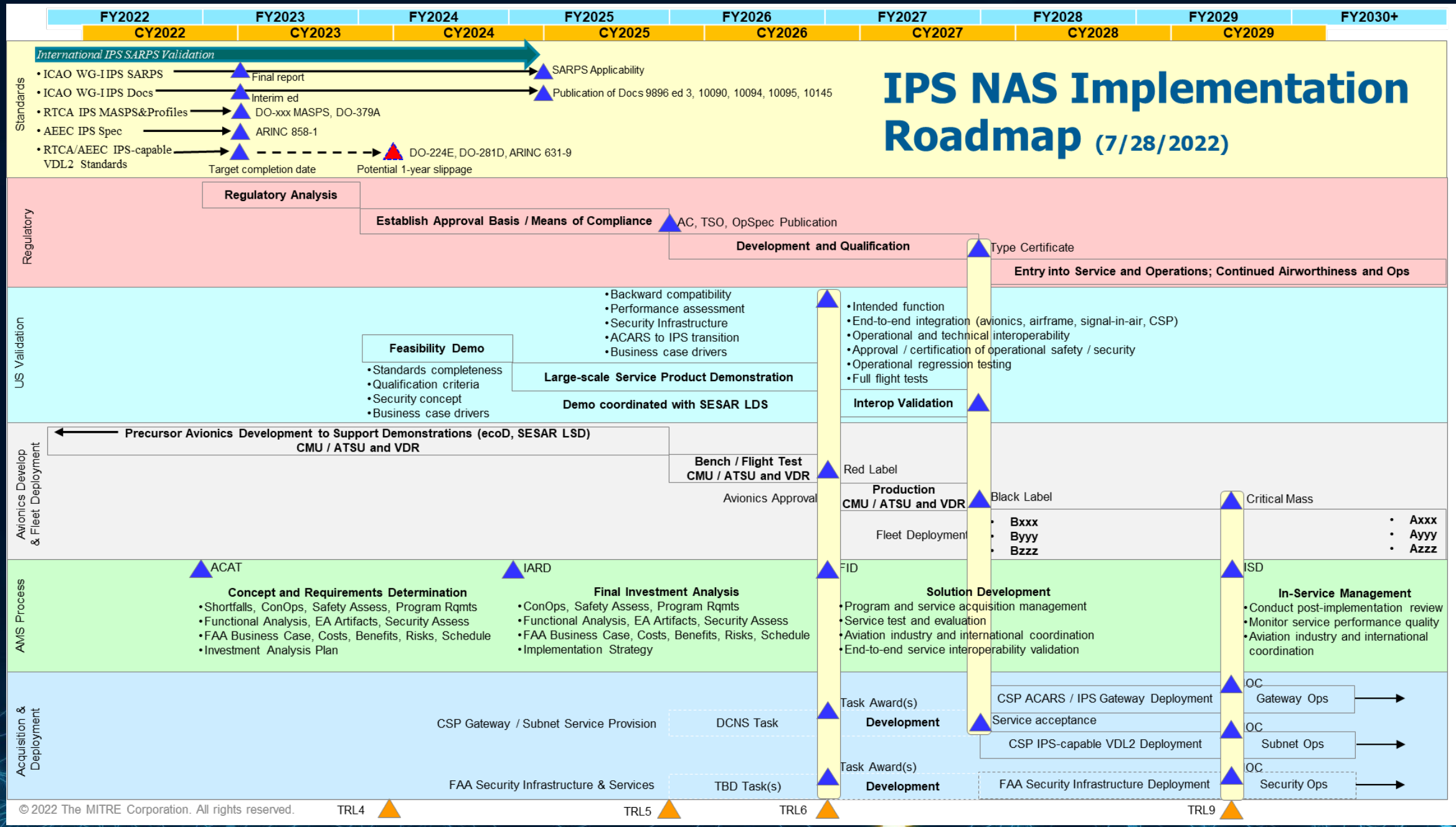


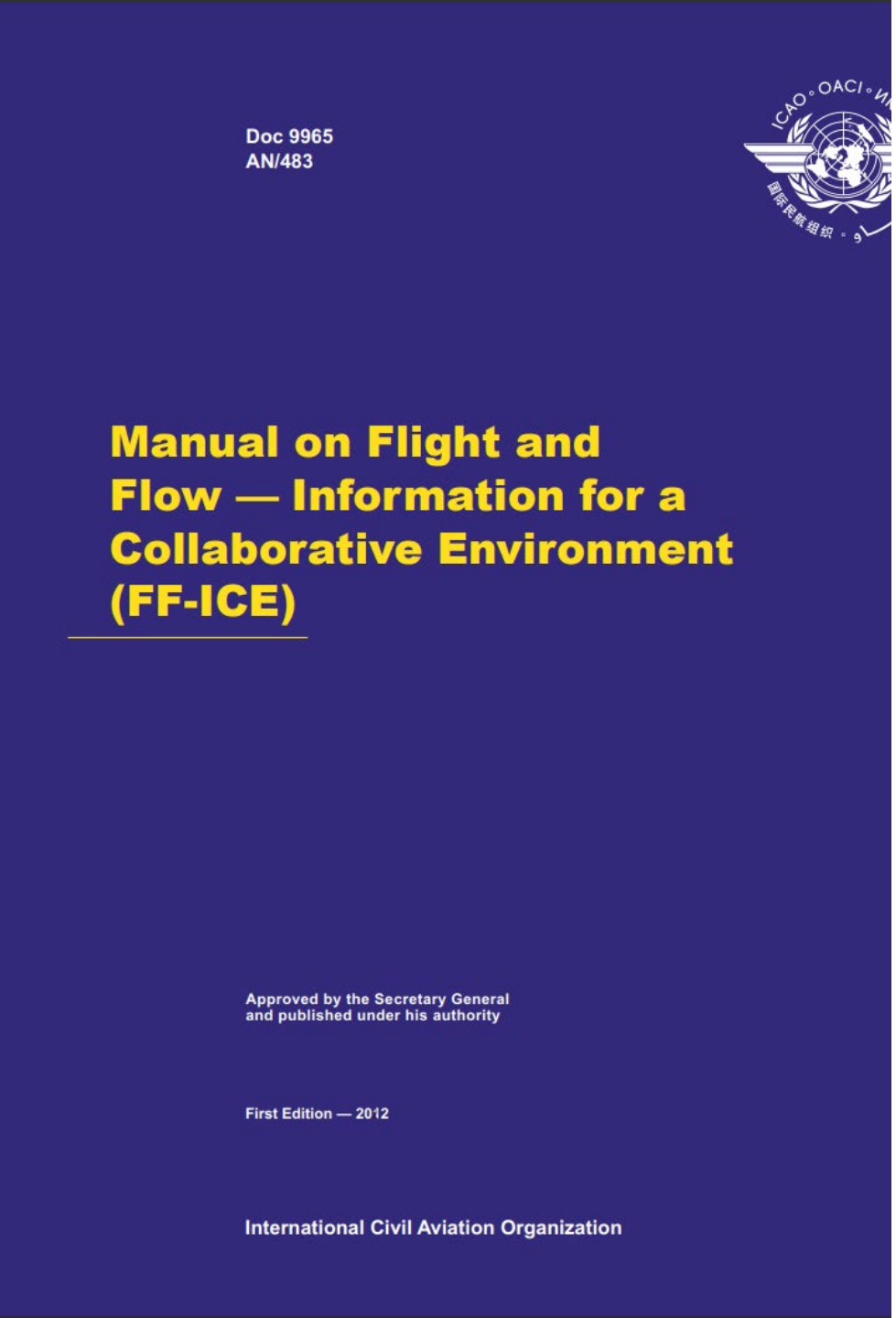
ANSP = Air Navigation Service Provider (e.g. FAA)
CSP = Communications Service Provider (e.g. ARINC, SITA)
ULCS = Upper Layer Communication Service
ASE = Application Service Element

Boeing ecoDemonstrator Activities

- Test FANS-1/A and B1 messaging over IPS using VDLM2 on continental US flights, connected to FANS-1/A over IPS ground end system
- Test B1 messaging over IPS using VDLM2 on European continental flight, connected to B1 over OSI ground end system

IPS NAS Implementation Roadmap (7/28/2022)





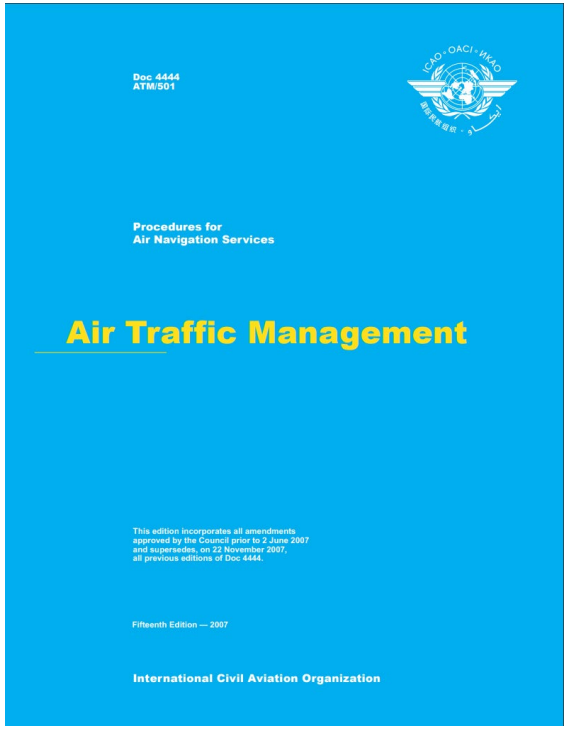
FF-ICE

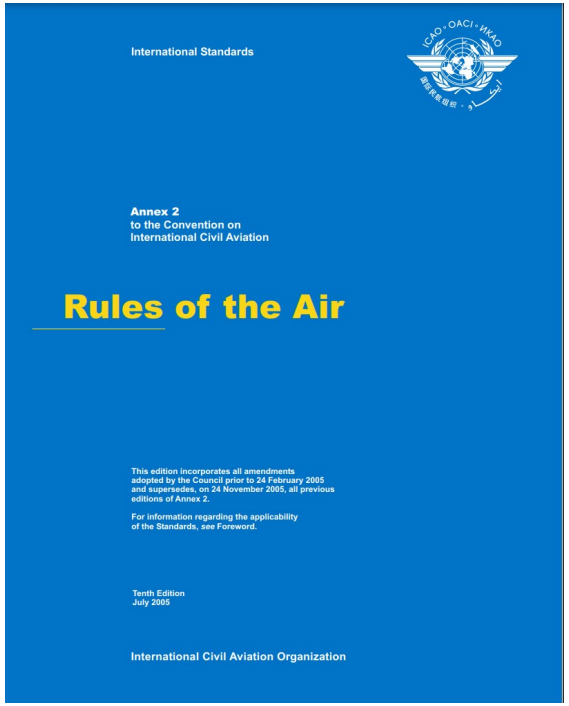
- Modernizing flight planning & filing
- Leverages SWIM to provide machine-to-machine interactions
- Migration from fire-and-forget to continuous, collaborative planning
  - Provides feedback – What will you get based on the proposed filed plan?
- Globally incremental implementation – not a big-bang
- Introduces fit-for-purpose protocols:

Source: Wikipedia
Teletype Model 33

FF-ICE, Release 1 Status

- Release 1: Flight planning and filing
  - Proposals for Amendment to PANS 4444, Annex 2, and consequential amendments completed
  - Guidance material in final review – Vol II to ICAO Doc. 9965
  - Flight Information Exchange Model (FIXM) data standard defined with scheduled release cycle for updates





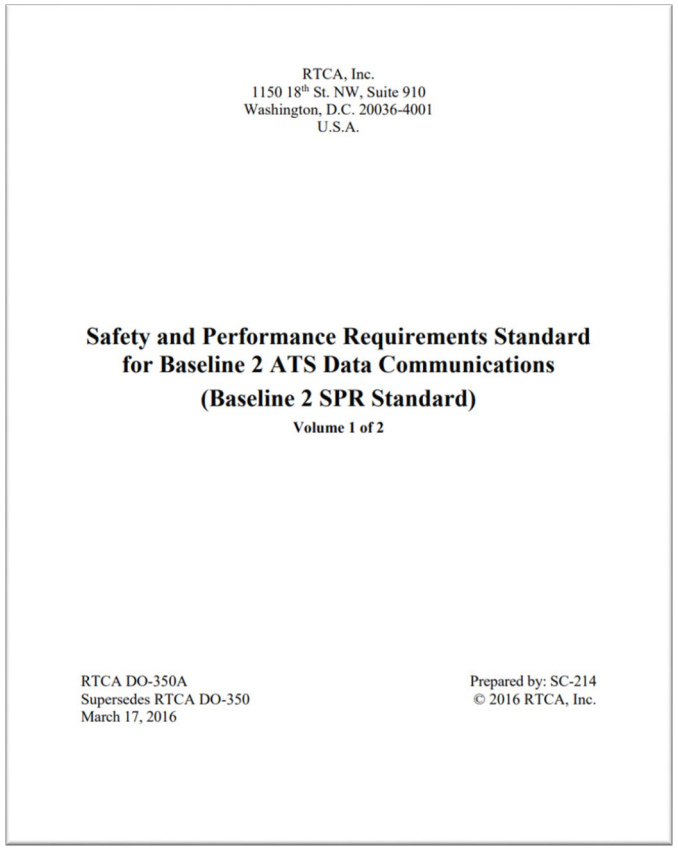
FF-ICE/R2
In-flight strategic replanning

- Defining processes for in-flight replanning
  - Automated interactions
  - Leverage Electronic Flight Bag (EFB)
  - Strategic planning with TFM to obtain Agreed Trajectory
  - Agreed Trajectory continually updated
- Multiple tabletops with operational representation
- Operations Demonstrated within the Multi-Regional TBO Demonstration
  - Incorporated existing systems through Florida Test Bed
  - Planning a live flight demonstration of capabilities within Multi-Regional TBO

Multi-Regional TBO Demonstration (May 2022) included FF-ICE, Release 2 elements

Accelerating Trajectory Sharing

Baseline-2 ADS-C defines Extended Projected Profile (EPP)


RTCA, Inc.
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Washington, D.C. 20036-4001
U.S.A.

Safety and Performance Requirements Standard for Baseline 2 ATS Data Communications (Baseline 2 SPR Standard)

Volume 1 of 2

RTCA DO-350A
Supersedes RTCA DO-350
March 17, 2016

Prepared by: SC-214
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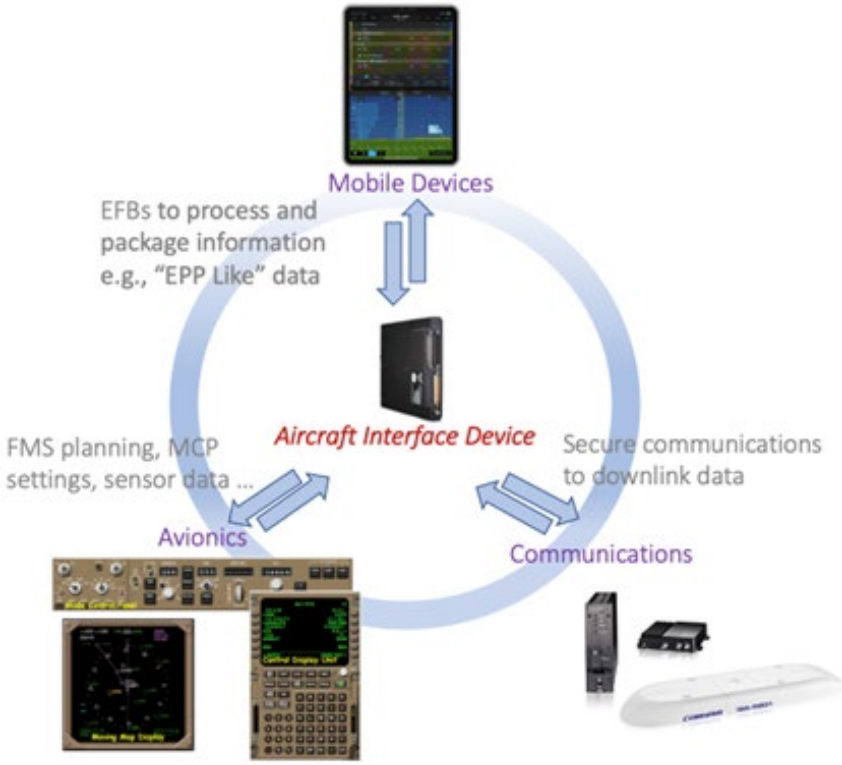
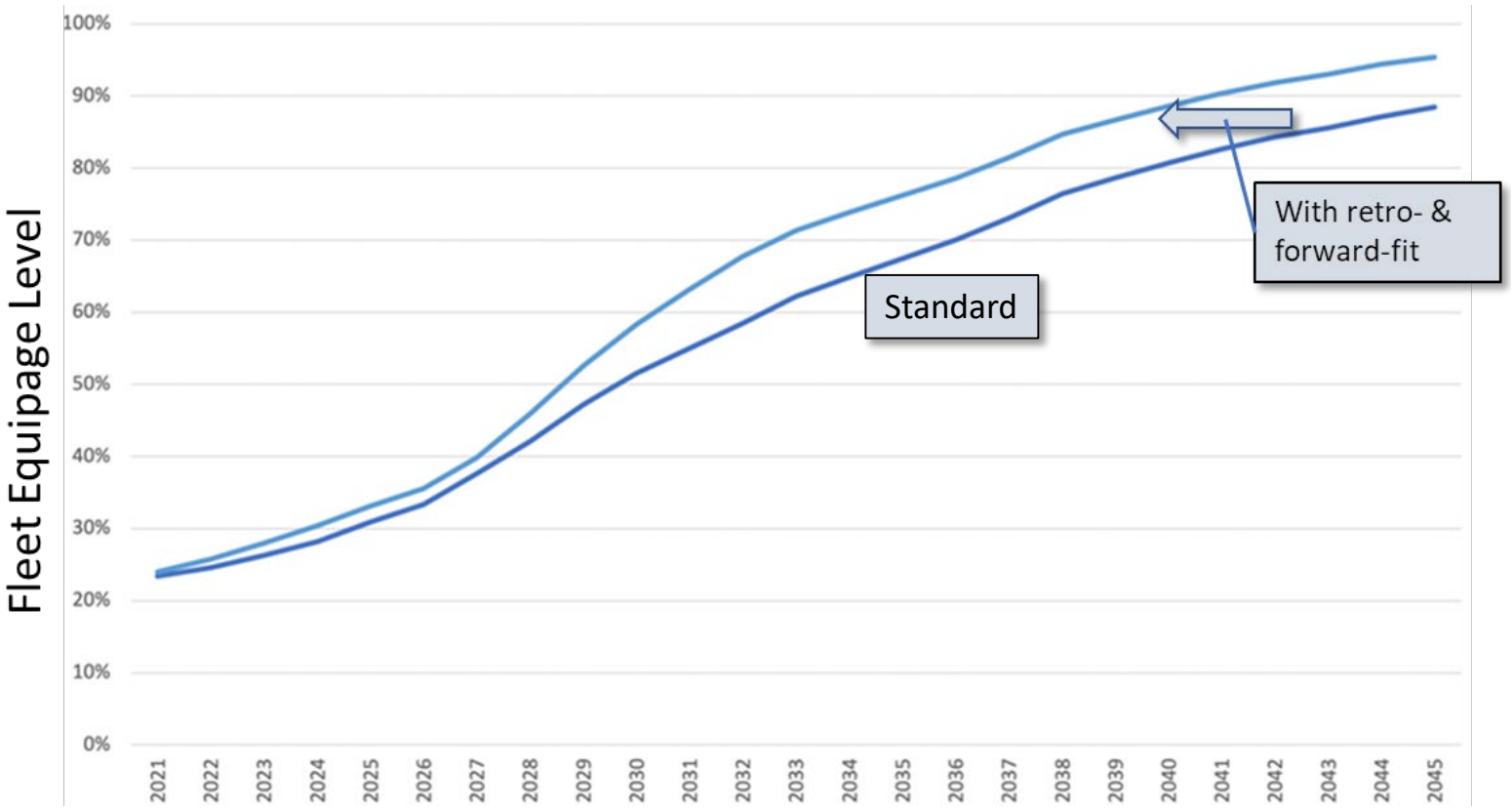
- Improve trajectories through aircraft data
- Baseline-2 defines the EPP
- Investigating alternative means of sharing aircraft-derived trajectory, via:
  - Aircraft Interface Device (AID)
  - Electronic Flight Bag (EFB)
  - Broadband connection
- AID enables access to broader set of data than EPP through avionics beyond the FMS

Leverage New Technologies to Accelerate Trajectory Sharing



Expected Supporting Equipage



- US transport fleet
  - Two-way connectivity (EFB to avionics) dominant in a few years
  - Driven by internal business case – not ATM initiatives
- ATM can leverage to accelerate provision of “EPP-like” data for ATM

Application of Aircraft-Derived Trajectories

UPDATES TO TRAJECTORY PREDICTED BY THE FMS

TRAJECTORY NEGOTIATION UPON REQUEST BY AIRSPACE USER

AUTOMATED SYNCHRONIZATION PRIOR TO CLEARANCE ISSUANCE

EPP	☑	☒	☒
EFB	☑	☑	☑