

The image features a background of an aircraft cockpit with various instruments and screens. Overlaid on this is the text 'Avionics FOR NEXTGEN'. 'Avionics' is in a large, blue, italicized sans-serif font. 'FOR' is in a smaller, light blue, spaced-out sans-serif font, positioned between two horizontal lines. 'NEXTGEN' is in a large, blue, spaced-out sans-serif font.

# Avionics

FOR

# NEXTGEN

[www.AvionicsForNextGen.com](http://www.AvionicsForNextGen.com)

## Aeronautical Mobile Airport Communication System (AeroMACS)



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## WiMAX Forum®

Our nature, our business

- **Industry-led**, not-for-profit organization, certifies and promotes the compatibility and interoperability of certain wireless broadband technologies across various industries ranging from Telecommunications (WiMAX) up to **Aviation** (AeroMACS) since **2001**.
- With regards to Aviation industry, the WiMAX Forum has been instrumental in **all stages** of AeroMACS' growth, from its initial launch, when we facilitated the development of a system profile, to current global expansion efforts.
- Key authorities such as the **Federal Aviation Administration (FAA)**, **EUROCONTROL**, and the **International Civil Aviation Organization (ICAO)** regularly attend our aviation-centric events in which industry leaders, experts and technology providers are able to collaborate and share real-world knowledge, focused specifically on the deployment of standardized broadband networks for the aviation industry.

## WiMAX Forum Members

### Our AeroMACS Members

Major aviation ecosystem players are among our member companies which has positioned us as a significant influencer on this evolution.

#### Key Members in Aviation

- American Association of Airport Executives (AAAE)
- Austro Control
- Aviation Data Communication Corporation, China (ADCC)
- Civil Aviation Safety Authority of Australia
- CelPlan
- Comodo Group Inc.
- ConvergenX Technologies
- DFS Deutsche Flugsicherung
- Embry Riddle Aeronautical University
- EonTi
- EUROCONTROL
- FAA
- GAL Air Navigation Services (GALANS)
- Harris
- Hitachi
- Honeywell
- Jezetek
- Leonardo (Finmeccanica/SELEX)
- Metropolitan Washington Airport Authority
- MITRE Corporation
- NASA
- Powertech Labs
- Sequans
- Shinsei Corporation
- Siemens
- Symantec
- Telrad Networks
- The Second Research Institute of CAAC
- United Airlines



## AeroMACS Ecosystem

### Big Brands



## Aviation Working Group (AWG)

WiMAX Forum®

### WiMAX Forum AWG Aviation Focused Events:

**AeroMACS Washington**  
Washington, DC, USA – 2013

**AeroMACS Brussels**  
Hosted by EUROCONTROL  
Brussels, Belgium – 2014

**AeroMACS Sendai**  
Hosted by Hitachi, JCAB and ENRI  
Sendai, Japan – 2014

**AeroMACS Track China**  
Hosted at Wireless China Summit  
Beijing, China – 2014-2015-2016-2017

**AeroMACS Interoperability Event**  
Hosted at Powertech Labs  
National Harbor, USA – 2015

**AeroMACS Workshop**  
Hosted at DECEA  
Rio de Janeiro, Brazil – 2015

**AeroMACS Madrid**  
Hosted at World ATM Congress  
Madrid, Spain – 2015-2017

**AeroMACS National Harbor**  
Hosted at ATCA Congress  
National Harbor, USA – 2015-2016-2017

### WiMAX Forum AWG AeroMACS programs in process:

AeroMACS Certification

AeroMACS X.509 Public Key Infrastructure (PKI)

AeroMACS FCC Service Policy Petition

AeroMACS Seminars

# **AeroMACS Genesis**

## New Applications: Bandwidth Demand



**CURRENT COCKPITS**  
MONOCHROME SCREENS, TELETEXTS



**FUTURE COCKPITS**  
SMART AND CONTENT-RICH SCREENS

Several companies have announced their roadmaps for new generations of cockpits with large, interactive, and smart devices and screens.

Dedicated wireless broadband data links for these new cockpits are the fundamental enablers for delivering rich content.

## Solution: AeroMACS Applications

Globally standardized datalink, offering high capacity communications on the airport surface.

Operation in a regulated spectrum (5GHz) offering protection from interference (safety and regularity).

Supports Air Traffic Control, Airline Operations Communications, & Airport communications using single technology.

Part of the wider future aviation communication infrastructure, expecting to share network, security, and etc.



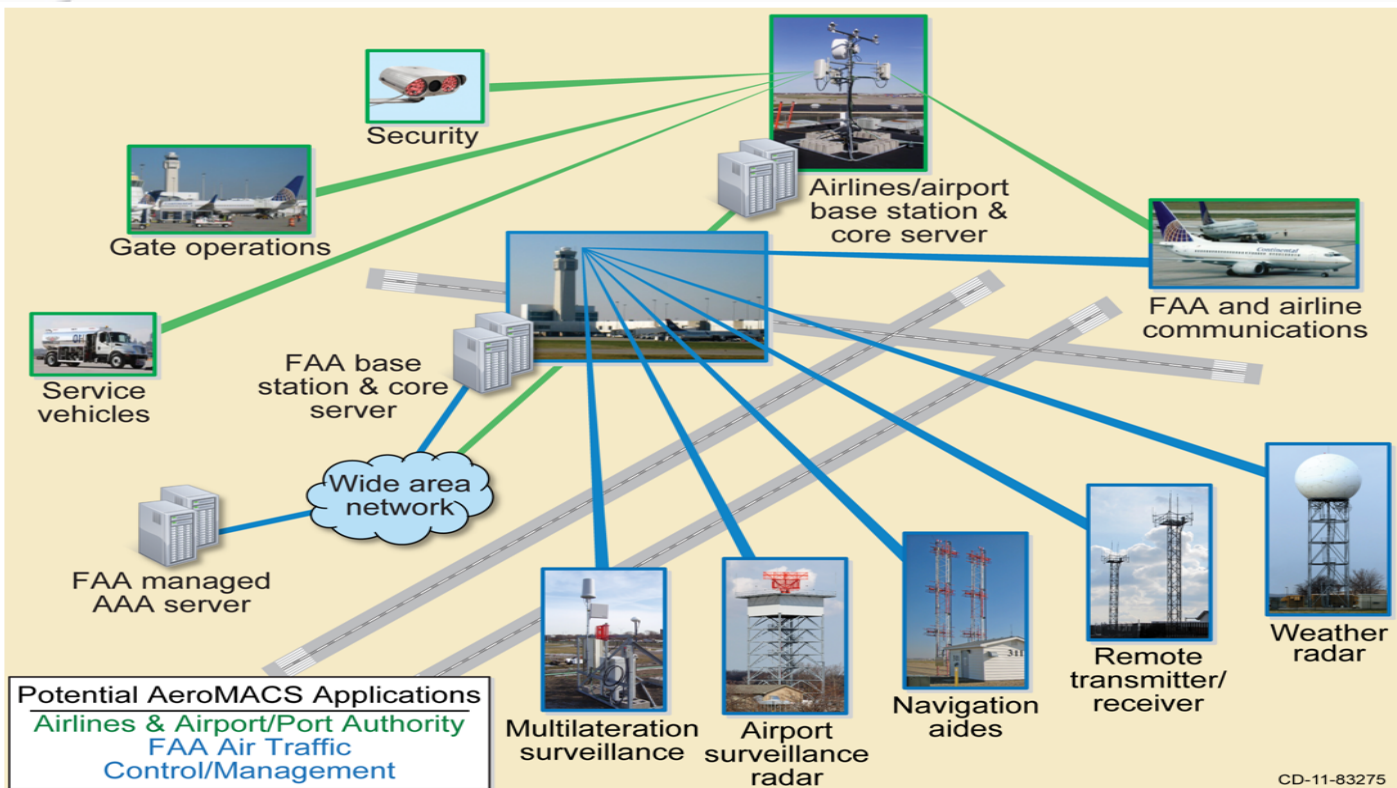
## AeroMACS Applications: Mobile & Fixed



	<b>Air Traffic</b>	<b>Air Carriers</b>	<b>Airports</b>
<b>Mobile Apps</b>	<ul style="list-style-type: none"> <li>✓ AT Comm.</li> <li>✓ AAtS</li> <li>✓ ATIS</li> <li>✓ Gate Clearance</li> <li>✓ NOTAMS</li> <li>✓ Surface 4 DT</li> </ul>	<ul style="list-style-type: none"> <li>✓ Baggage</li> <li>✓ Catering</li> <li>✓ EFB</li> <li>✓ Flight Info.</li> <li>✓ Fueling</li> <li>✓ Weather</li> </ul>	<ul style="list-style-type: none"> <li>✓ Coordination</li> <li>✓ Fire &amp; Rescue</li> <li>✓ Mobile Security</li> <li>✓ RWY Status</li> <li>✓ Surface Mgmt.</li> <li>✓ Wild Life Mgmt.</li> </ul>
<b>Fixed Apps</b>	<ul style="list-style-type: none"> <li>✓ Navigation Aids</li> <li>✓ Surveillance</li> <li>✓ Terminal Sensor</li> <li>✓ Visual Aids</li> <li>✓ Weather</li> </ul>	<ul style="list-style-type: none"> <li>✓ Data uploads and downloads</li> <li>✓ Flight Ops.</li> <li>✓ Ramp Mgmt.</li> <li>✓ Ramp Services</li> </ul>	<ul style="list-style-type: none"> <li>✓ Construction</li> <li>✓ Data backhaul</li> <li>✓ Lighting</li> <li>✓ NOTAM-D</li> <li>✓ Security Gates</li> </ul>



## Network View: More Connections

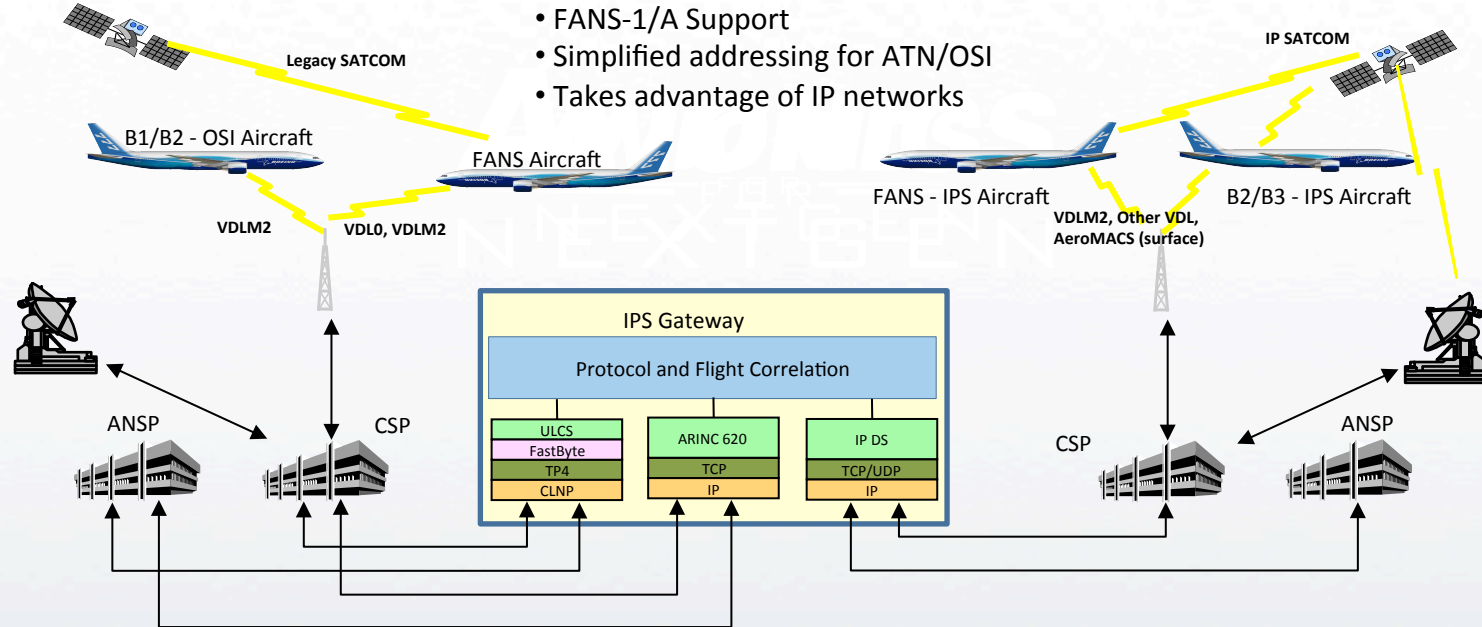


**Avionics**  
FOR  
NEXTGEN  
**ATN/IPS**

## Transitioning from ACARS to ATN/OSI to ATN/IPS

Key features:

- Application data untouched – important for cert
- Correlation of ATN/OSI – ATN/IPS peer systems
- FANS-1/A Support
- Simplified addressing for ATN/OSI
- Takes advantage of IP networks



## Defining ATN/IPS

- ICAO Doc 9896 (IPS) provides the technology path for datalink applications intending to use TCP/UDP and IP
- Move away from OSI-based protocols with no changes to existing or future applications (e.g., CPDLC, B2 CPDLC and B2 ADS-C)
  - Avoid modifications to flight decks and aircraft applications
  - Create a logical transition path to future IP-based communication links
  - Support AOC, FANS-1/A, B2 and B3 applications
  - Provide a common security framework (e.g., IPsec)
- IPS Roadmap is the first step (2017)
- IPS Standardization is an intermediate goal (2019 or 2020)
- End Goal - IPS Implementation – mid-2020s and beyond

# Global Coordination

## Global Coordination – ATN/IPS and AeroMACS



ICAO Aeronautical Communications Panel, Recommendation Future Communications Study – 2007

ICAO Standards Roundtable



EUROCONTROL

ITU WRC-07 approved spectrum allocation for 5091-5150 MHz for AeroMACS

AeroMACS profile based on IEEE 802.16e - 2009 standard

NASA-led AeroMACS Trials and Demonstrations in Cleveland (2007 to present)

WiMAX Forum facilitates coordination among AeroMACS providers and users

FAA and EUROCONTROL



- TSO-C207a – AeroMACS Airborne Mobile Station (AMS) Equipment

RTCA SC-223 and EUROCAE WG-82

- DO-345/EUROCAE ED-222: *AeroMACS Profile*
- DO-346/EUROCAE ED-223: *AeroMACS MOPS*
- EUROCAE ED-227: *AeroMACS MASPS*



ICAO Aeronautic Communications Panel Surface Datalink Working Group (WGS)

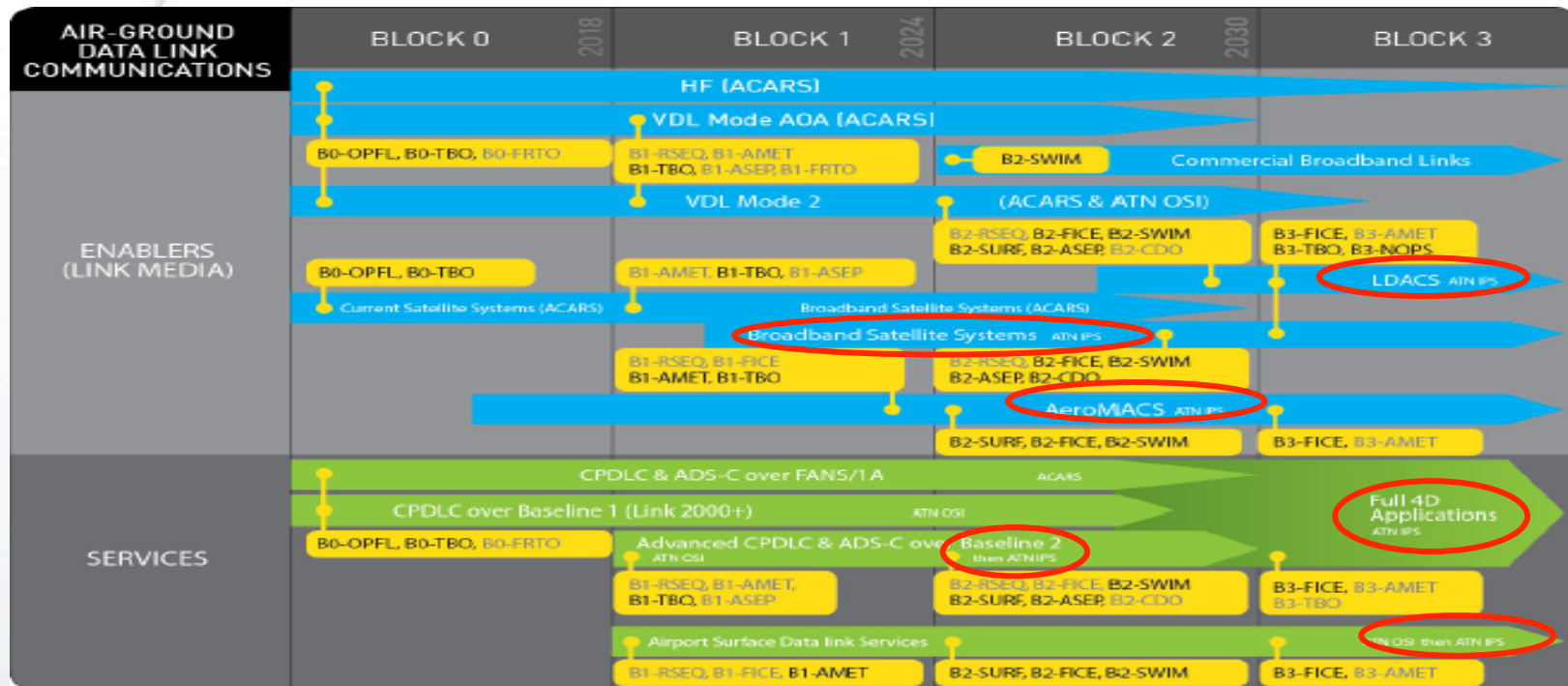
- ICAO Doc 10444 – AeroMACS Technical Manual
- ICAO ANNEX-10, Volume III, Chapter 7: *AeroMACS SARPs*





# Industry Roadmaps

## ATN/IPS in ICAO Global Air Navigation Plan (GANP)



Note: ATN/IPS on ICAO Roadmap - 2025

## Different Viewpoints and Strategy for ATN/IPS

Strategies: Go directly to ATN/IPS -or- migrate gradually after ATN/OSI is implemented

Current situation:

- Priority for Europe is to understand and solve current European VDL2 issues first rather than introduce additional complexity and cost (ELSA)
- ATN/OSI over VDL2 and possibly ATN/OSI over SATCOM is considered for ATN B2 first deployment in Europe
- FAA wants to investigate going directly to ATN/IPS as a candidate for Segment2 Data com

Time schedules for Implementation:

- Be ready for mid-2020s - IPS capability in USA

Work towards AOC, FANS-1/A, B2 and B3 programs with IPS

Define transition strategies (e.g., Ground Gateways, etc)

# ARINC Standards

## ARINC Standards on the Roadmap to ATN/IPS

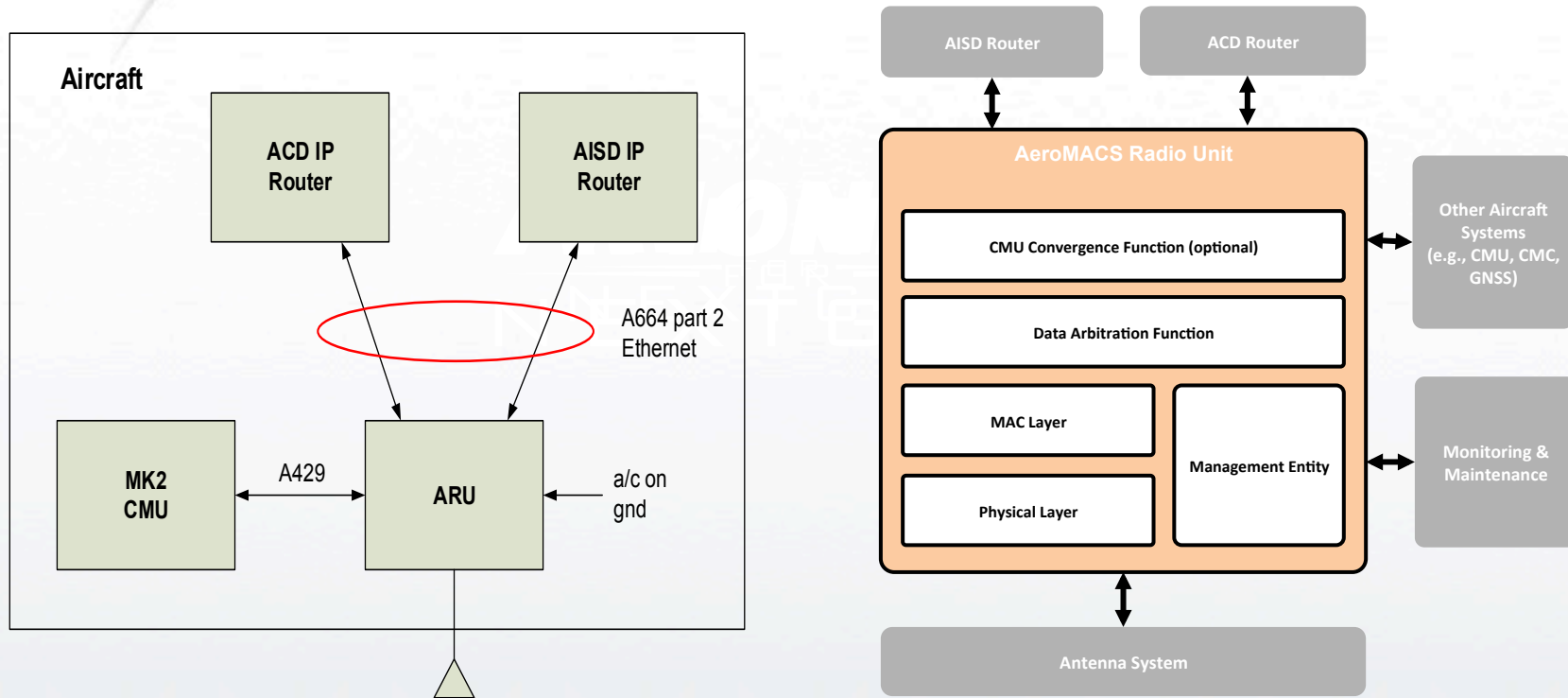
- **Published:**
  - ARINC Characteristic 766: AeroMACS Transceiver and Aircraft Installation Standards
  - ARINC Report 658: Internet Protocol Suite (IPS) for Aeronautical Safety Services - Roadmap Document
- **In-Progress:**
  - ARINC Project Paper 858: Internet Protocol Suite (IPS) for Aeronautical Safety Services - Technical Requirements
  - ARINC Project Paper 686: Roadmap to IPv6
- **Near Future**
  - ARINC Characteristic 758: Communications Management Unit (CMU)
  - ARINC Characteristic 771: Low-Earth Orbiting Aviation Satellite Communication System
  - ARINC Characteristic 781: Mark 3 Aviation Satellite Communication System
  - Others TBA

## ARINC 766 - AeroMACS Standardization

- Airborne IP-based transceiver that supports Air Traffic Services (ATS) and Aeronautical Operation Control (AOC) communications with airport while the aircraft is on the ground.
- Product: ARINC Characteristic 766: *Aeronautical Mobile Airport Communications System (AeroMACS) Transceiver and Aircraft Installation Standards*
  - AeroMACS to operate in protected aeronautical frequencies: 5091-5150 MHz using IEEE 802.16e WiMAX protocol.
  - Benefits: Upgrades aging airport surface communications infrastructure
    - Part of FAA NextGen and SESAR
    - Offloads congested VHF frequencies (50% of DLK communications occur while aircraft is on the ground).
    - Supports CPDLC, FANS 1/A and B, SJU DLS IR (Link 2000+), VoIP, FIS, ADS-B on airport surface, AIS/MET, AAC, EFB applications and AOC/ACARS operation
- ARINC Characteristic 766 - Standard form, fit, function and interface (F3I)
  - Two AeroMACS Radio Unit (ARU) Options (for new aircraft and retrofit)
    - 2 MCU
    - Flange Mount
  - Antenna
    - Performance
    - Mounting
- ARINC Characteristic 766 published: July 7, 2017



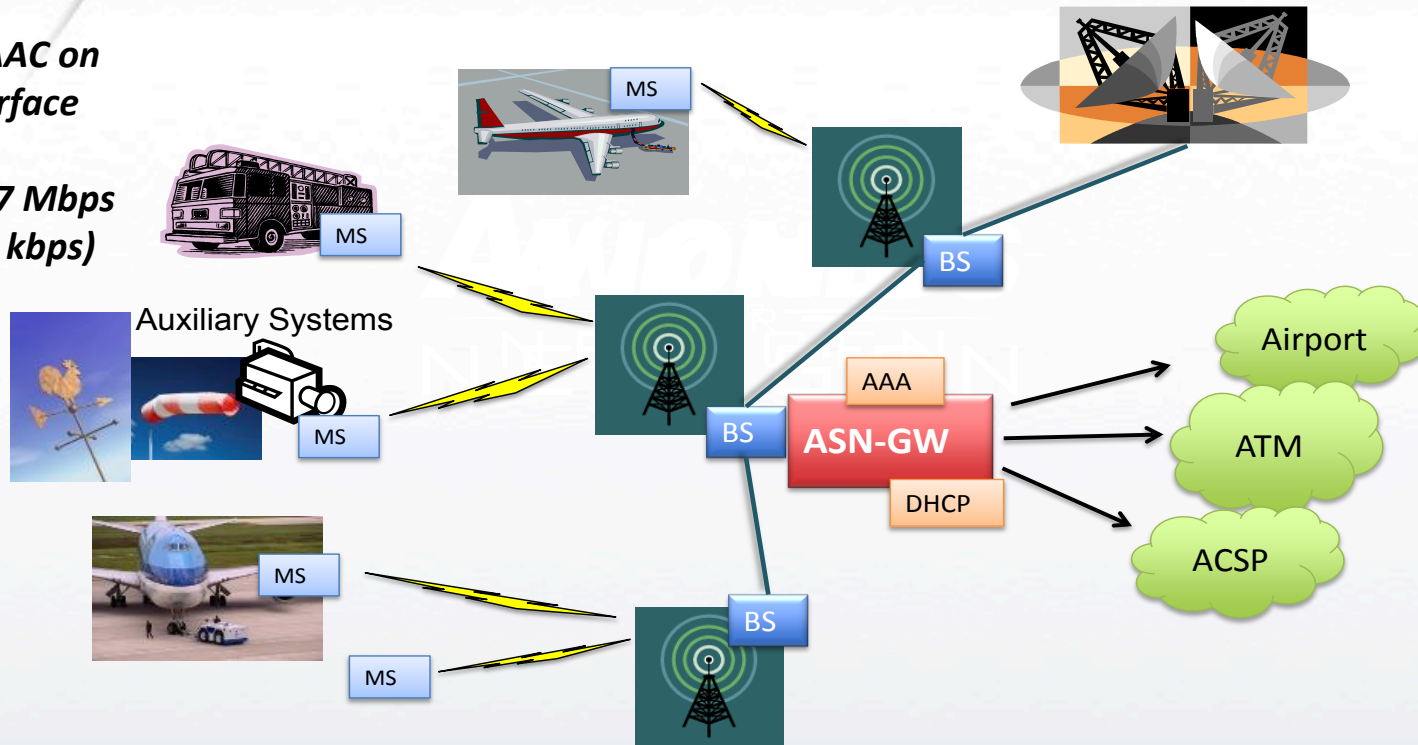
## ARINC 766 - AeroMACS Radio Unit (ARU) - Aircraft Side



## AeroMACS Ground Network (Not defined by ARINC 766)

*ATS, AOC, AAC on  
Airport Surface*

*(potentially 7 Mbps  
versus 31.5 kbps)*



# China Activities

*Volume in PRC Will Drive Manufacturing Innovation and Lower Cost*

## ADCC China

# ADCC Introduction - Data link service

- The 3<sup>rd</sup> air ground data link communication service provider in the world
- ACARS data link service
  - More than 220 RGSs in 120 airports and en-route points
  - Provide data link service to more than 100 Airlines and more than 3,000 aircraft per day and more than 600,000 datagram per day
  - Provide one base frequency and four back up frequency in China
  - Provide VDL Mode 2 data link ( 12+ ) communication service since 2009
- ADS-B service
  - More than 150 ADS-B ground stations in China, 1 ADS-B ground station in Singapore airport and 3 ADS-B stations in Thailand's Bangkok airport, Chiang Mai Airport and Phuket island airport



## ADCC China Plans

# 2017-2018 AeroMACS Construction Plan

Chinese AeroMACS frequency is centrally controlled and the licenses are released by State Radio Regulatory Commission(SRRC) and CAAC, ADCC has been formally authorized to 110 airports AeroMACS frequency from 2017 to setup AeroMACS network and provide service in China. At the first step, ADCC will setup AeroMACS in the airports with top 30 traffic rank before 2019.



[www.adcc.com.cn](http://www.adcc.com.cn)

# AeroMACS Spectrum Matters



## AeroMACS Spectrum Highlights

The frequencies listed below are available for AeroMACS operation after registration with, and assignment by, the Channel Manager. Channel spacing is 5 MHz without a guard band between adjacent channels.

***SOME level of Radio Regulatory coordination will be advised in all countries as potentially competitive users will seek to acquire spectrum.***

Lower AeroMACS Sub-Band (5000 MHz to 5030 MHz)	
Channel Number	Channel Center Frequency ( $f_c$ )
1	5005 MHz
2	5010 MHz
3	5015 MHz
4	5020 MHz
5	5025 MHz
Upper AeroMACS Core-Band (5091 MHz to 5150 MHz)	
Channel Number	Channel Center Frequency ( $f_c$ )
6	5095 MHz
7	5100 MHz
8	5105 MHz
9	5110 MHz
10	5115 MHz
11	5120 MHz
12	5125 MHz
13	5130 MHz
14	5135 MHz
15	5140 MHz
16	5145 MHz

## Recent AeroMACS Milestones - 2017

- **April 4 - The WiMAX Forum Files FCC Petition for AeroMACS Service Rules Adoption**
  - <http://wimaxforum.org/Page/News/PR/20170404> The WiMAX Forum Files FCC Petition for AeroMACS Service Rules Adoption.
- **April 18 – AeroMACS Test at Embraer**
  - [http://files.wimaxforum.org/Document/Download/Relatorio\\_Embraer\\_AeroMACS-rev5\\_English](http://files.wimaxforum.org/Document/Download/Relatorio_Embraer_AeroMACS-rev5_English).
- **June 14 - FCC WRC-12 AeroMACS Implementation Report and Order**
  - <https://www.federalregister.gov/documents/2017/06/14/2017-09887/wrc-12-implementation-report-and-order>.
- **July 13 - ARINC 766 Defines Aircraft Installation Standards for AeroMACS Implementation**
  - <http://wimaxforum.org/Page/News/PR/20170713> ARINC 766 Defines Aircraft Installation Standards for AeroMACS Implementation.
- **July 19 - WiMAX Forum Initiates Global Strategic Partnership with Eonti To Secure AeroMACS Networks**
  - <http://wimaxforum.org/Page/News/PR/20170719> WiMAX Forum Initiates Global Strategic Partnership with Eonti To Secure AeroMACS Networks.
- **July 24 - Important Message to AeroMACS Ecosystem – FCC Requests Comments on AeroMACS Petition**
  - <http://wimaxforum.org/Page/News/PR/20170724> Important Message to AeroMACS Ecosystem - FCC Requests Comments on AeroMACS Petition.

## Recent AeroMACS Projects

- **ADCC China**
  - ADCC has been formally authorized to 110 airports to install AeroMACS. ADCC will setup AeroMACS in the airports with top 30 traffic rank before 2019.
- **ANA - VINCI Airports Portugal**
  - AeroMACS project expansion approved for 2018 in Lisbon's airport
- **Boeing Eco-D next year**
  - Eco-D planned for 1Q18.
- **EANA Argentina**
  - Currently RFP selecting vendors to provide AeroMACS solution to the Buenos Aires Ezeiza Airport.
- **Europe Multiple Participants**
  - SESAR Deployment Manager potential support for the ENAV, NLR, Honeywell, Leonardo Company, SITA in 2018.
- **FTI Approval by FAA**
  - FAA approval Siemens-enabled Harris FTI solution based on AeroMACS.
- **WiMAX Forum Agreement with ICAO**
  - Agreement in final phase to Shape AeroMACS PKI Program to be announced.



# EU/US A-G Data Communications Strategy Document

**By: Brent Phillips**

**Senior Systems Engineer; ANG-B2  
Federal Aviation Administration**



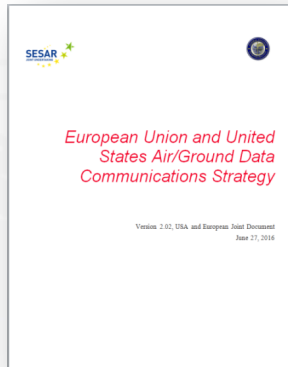
**Federal Aviation  
Administration**



**Federal Aviation  
Administration**

# Status of Harmonization Document (Step 2)

## ACTION CP1.1-1: Joint Air/Ground Data Communication Strategy

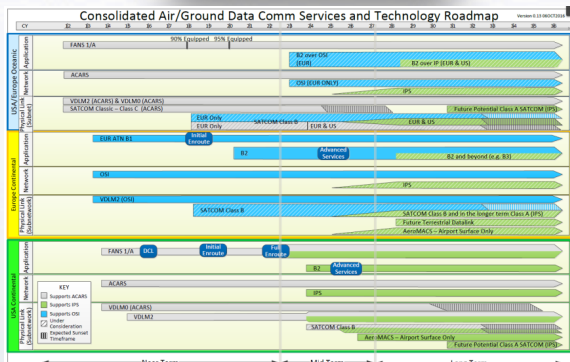


### Main achievements:

- The development of a Joint Roadmap
- Agreement on the final target (B2 services over IPS network)
- List of Challenges and Opportunities for the datacom harmonization

### Status:

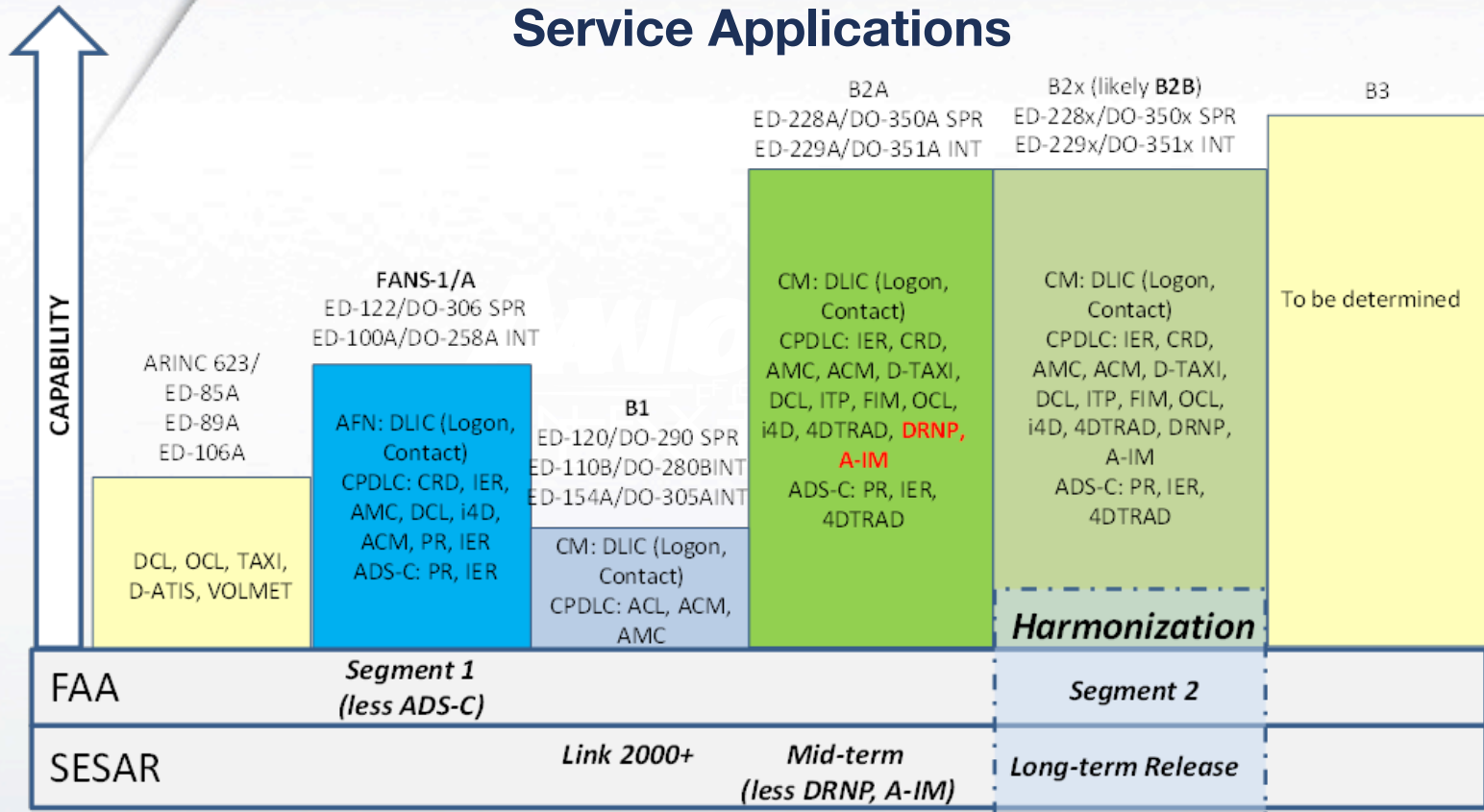
- Received very positive feedback from the CCOM, from the high level committee and various stakeholder groups.
- Document was updated to present optional Harmonization approaches from which FAA and SJU could select.
- Document was approved by June 2017 CCOM.



## Harmonization Elements

- The report identifies three distinct elements in the use of A/G Data Communications from which to harmonize around.
  - the data communications ATM **service applications**
  - the communication **network(s)** over which the applications are running and:
  - the **physical link(s)** over which the applications data are transmitted as well as the networks interface to.

# Service Applications



## Harmonized Environment

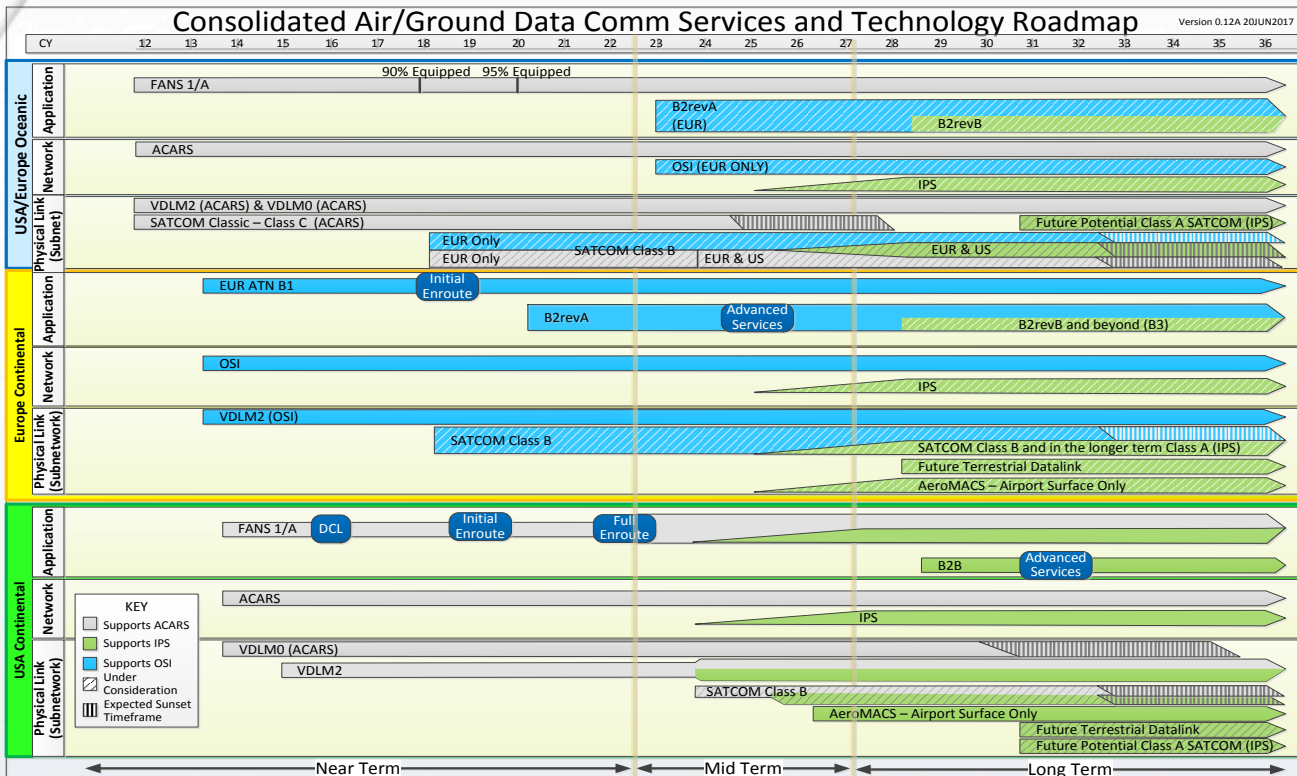
The U.S. and the EU air/ground data communication roadmaps for ATM operations in their respective Continental and Oceanic airspaces points to a harmonized environment based on:

- ATN/IPS for the network
- Baseline 2 (B2) for the ATM operational service applications, and
- a mix of current VDL Mode 2, new high bandwidth SATCOM and a new terrestrial physical data link and other means suitable for ATM operational services





# US/EU A-G Data Communication Roadmaps



## Action #1 to Support Harmonization

- The document identifies a set of actions in order to secure the target environment:
  - Action 1: Develop a joint U.S. – EU definition, validation approach and standardisation position for the required global aviation standards, in particular for ATN/IPS.



## IP Standards Development Status



- ICAO CP WG-I to complete A-G SARPs & Doc 9896: (Planned Completion: Dec 2019)
    - Address mobility, security, multilink capabilities and updates to mandatory/optional system requirements
    - Complete Technical Manual & Guidance document for A-G IPS comm.
  - RTCA Special Committee-223 to complete the IPS Profiles and MOPS: (Planned Completion: Dec 2019)
    - Detailed functional and environmental requirements, test cases for avionics certification
    - Leverage Boeing-Honeywell prototypes for validation of the SARPs and MOPS
      - Update prototypes to IPv6 standards
      - Incorporate mobility, multilink and other relevant IPS functions required for validation
- a) AEEC standards Development: (Planned Completion: Dec 2019)

## Transition Options

- For the transition, the document identifies two scenarios to consider:
  - Wait until operational benefits promote regional transition.
  - Use equipment gateways (ATN/OSI and ATN/IPS) to support early interoperability between interim diverging implementations.
    - Gateway on the ground equipment
    - Gateway on the new SATCOM

## Action #2 to Support Harmonization

- The Report recommends the continued evaluations and detailed considerations of these two options.
  - Action 2: Conduct a study for the first Scenario to help determine the number of airframes over time that will be equipped to support improved ATM operations taking into account the capabilities in the current implementations in the U.S. and Europe, recognizing there are different starting capability baselines. Continue the technical evaluation and economic impact of the gateway options to support European and US decision making to ensure a time and cost efficient transition convergence towards interoperability and harmonisation.

