

AeroMACS

Aeronautical Mobile Airport Communication System

AeroMACS At Glance ... Moving Towards the Airport 3.0



Declan Byrne - WiMAX Forum President - July 2018

AeroMACS - WiMAX Forum®

- **Industry-led**, not-for-profit organization that certifies and promotes the compatibility and interoperability of broadband wireless products based on IEEE Standard 802.16 across various industries from Telecommunications (WiMAX) to Energy (WiGRID) and **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 WiMAX Forum Members such as the **EUROCONTROL**, **FAA**, and **ICAO** participate in our aviation-centric events in which industry leaders, experts and technology providers are able to collaborate and share real-world experience, focused specifically on the deployment of standardized and secure broadband networks for the aviation industry.

AeroMACS at a Glance



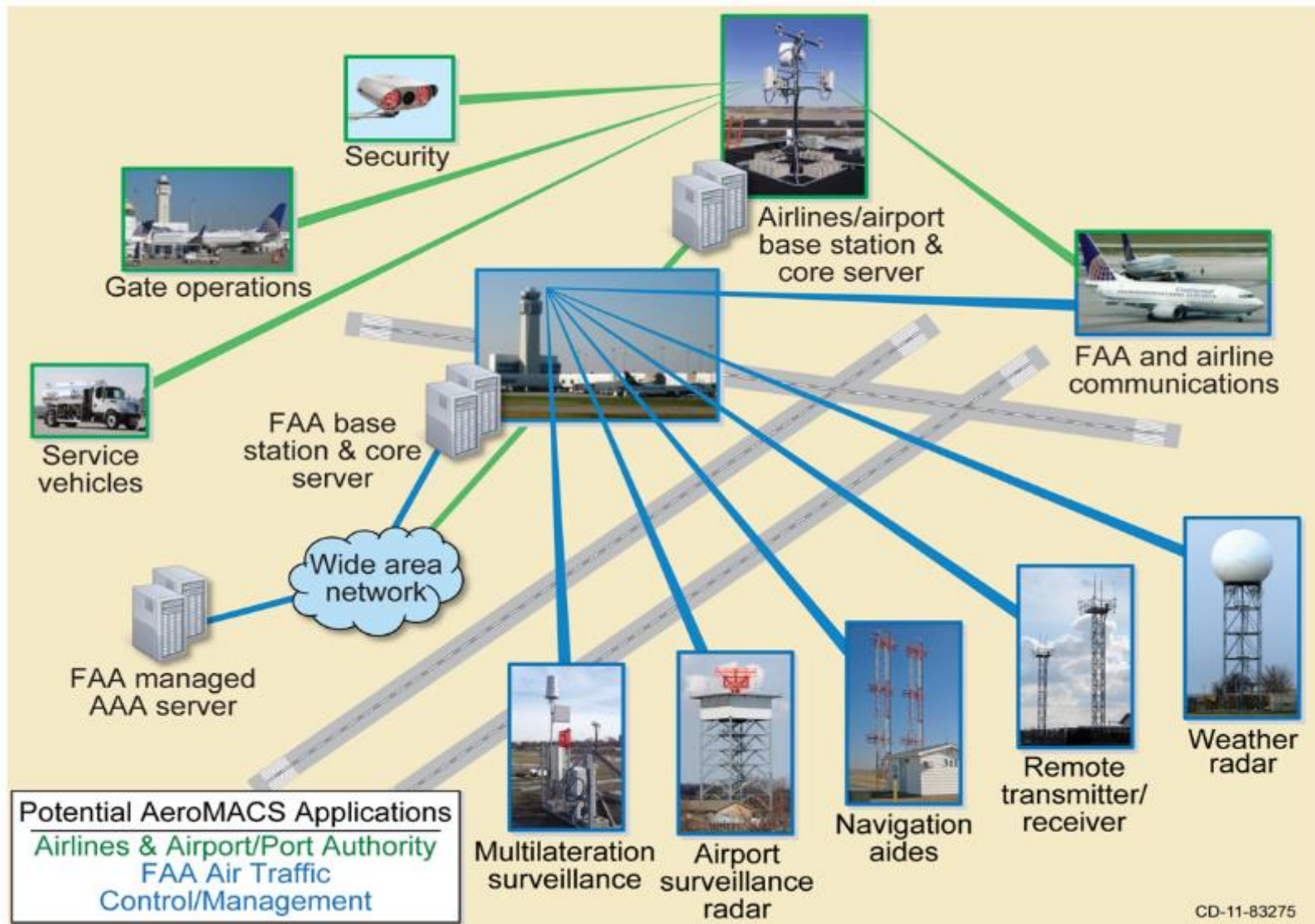
Globally standardized datalink, offering high capacity and secure communications on the airport surface.

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

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

Part of wider aviation communication infrastructure approved to support the safety and regularity of flight.

AeroMACS Applications



AeroMACS Evolution



1. Standards



2. Security



3. Certification



4. Deployment

Global Coordination & Harmonization



ICAO Aeronautical Communications Panel, Recommendation Future Communications Study

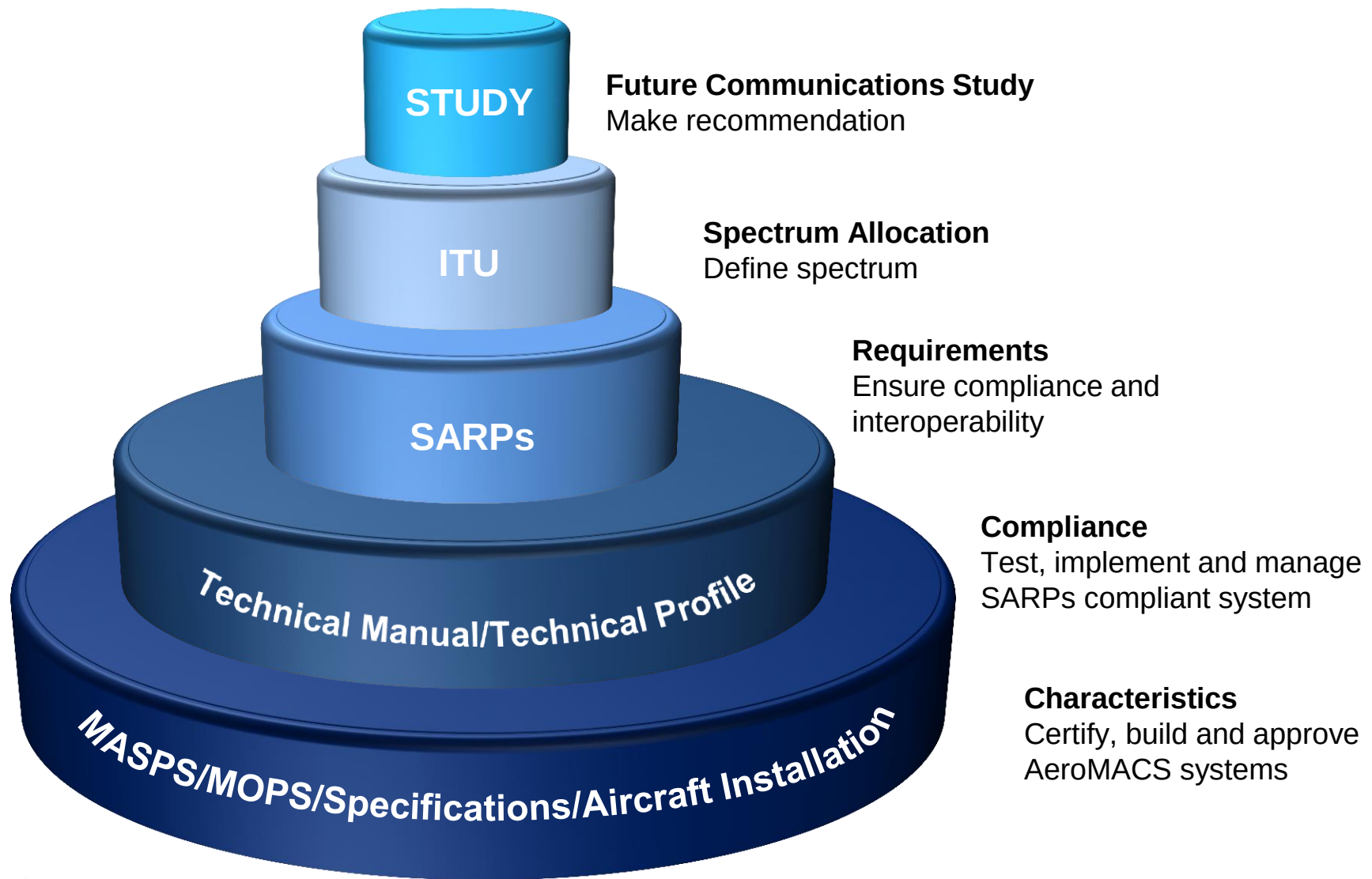
ITU WRC-07 approved spectrum allocation for 5091-5150 MHz for AeroMACS

AeroMACS profile based on **IEEE 802.16e - 2009 standard**

- **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*
- **ARINC AEEC AeroMACS Working Group**
 - ARINC 766: Aeronautical Mobile Airport Communication System (AeroMACS) Transceiver and Aircraft Installation Standards



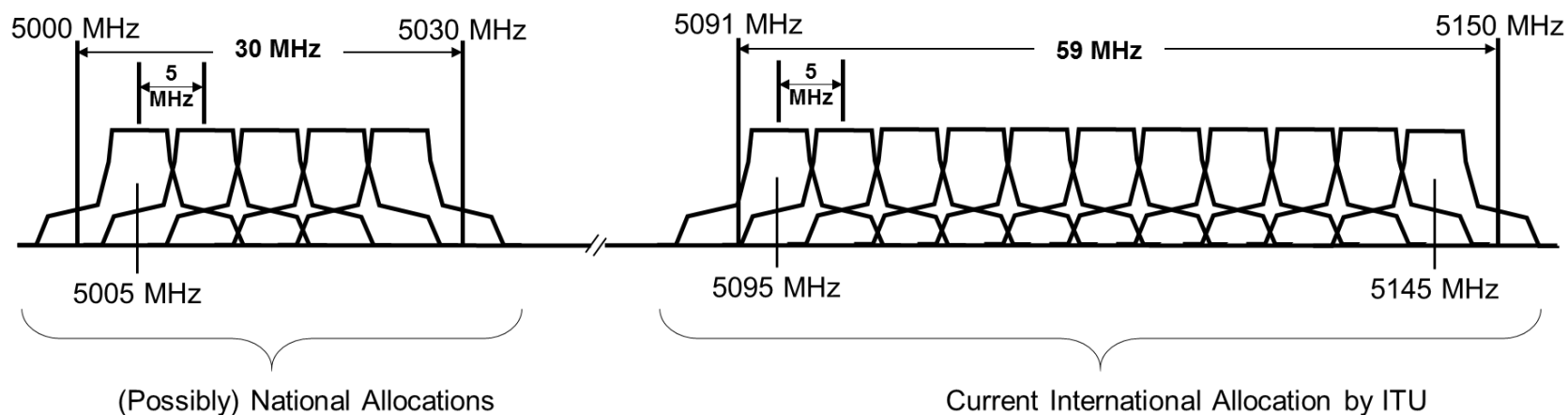
Over a Decade of Standardization



AeroMACS Spectrum Allocation

AeroMACS SHALL support 5 MHz channels in the 5091 MHz – 5150 MHz band

- 5091 MHz – 5150 MHz: Internationally allocated by ITU at WRC-07 in 2007 (Co-primary AM(R)S allocation)
- 5000 MHz – 5030 MHz: possible national allocations

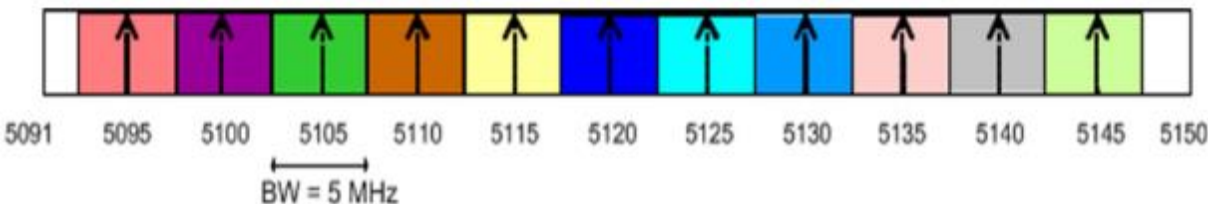


Frequency & Channel Distribution

The channel spacing is 5 MHz without a guard band between adjacent channels.

The frequencies listed are available for AeroMACS operation after registration with, and assignment by, the Channel Manager.

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

Why AeroMACS



Installation



Turn-key



Network
Management

ECONOMICAL, FAST, EASY, SCALABLE

Technical Values	Business Values	Values
Broadband	No management cost for telephone number	Certification program
Broad NLoS coverage	Low cost for installation & maintenance	Hardware-based PKI credential
Data Oriented Architecture – also supports mobility	Simple mobile station ⇒ Easy airworthiness certificate	Multiple Certification Authorities
Always-on connectivity	Easy IOT due to standardized profile	Revocable and replaceable certificates
Low failure rate (QoS)	No legacy systems	Certificate Hierarchies

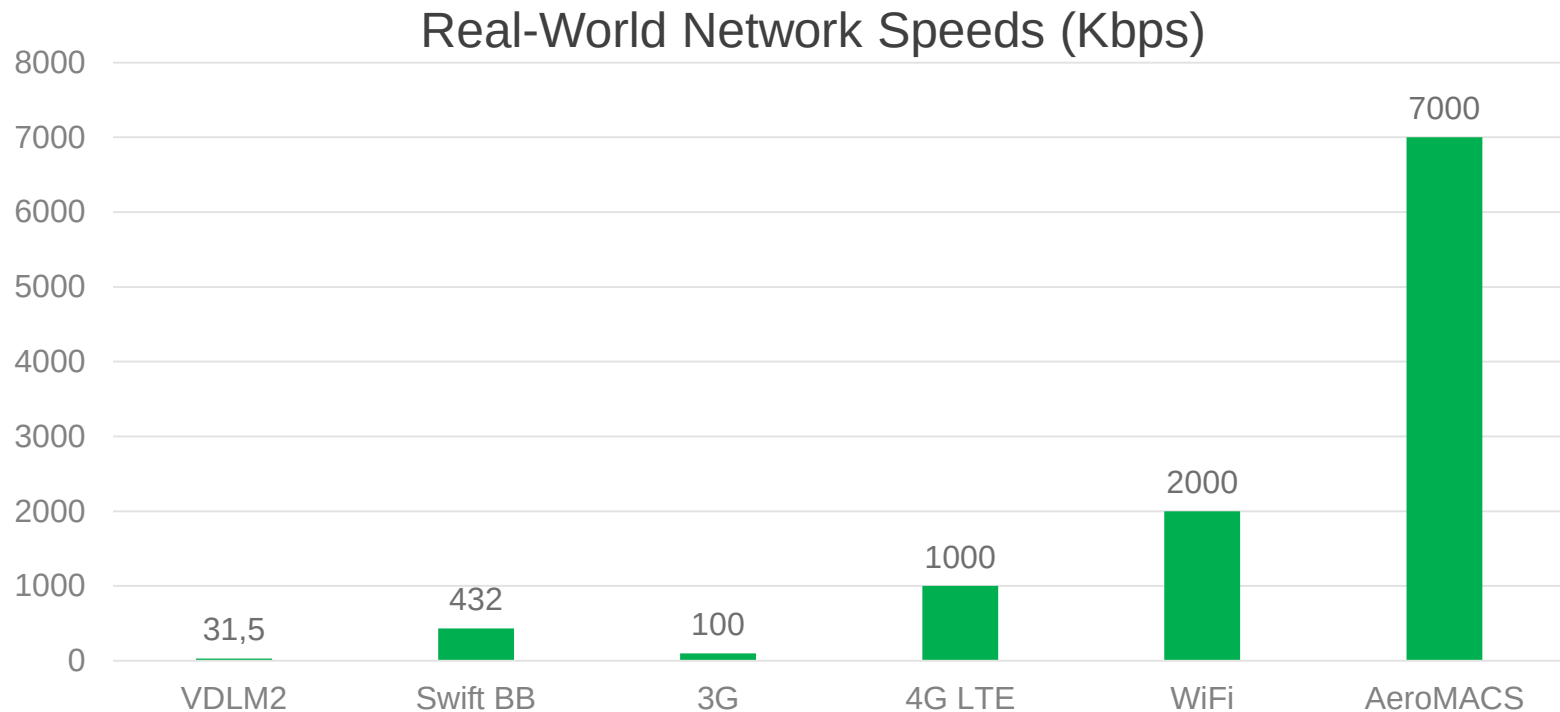
AeroMACS vs. Other Systems



AeroMACS is the only globally standardized aviation technology designed to support the safety and regularity of flight, ATS, AOC and Airport Authority communications simultaneously.

	ACARS	Wi-Fi Gatelink	Cellular	AeroMACS
Control	↑	↓	↓	↑
Reliability	↑	↓	↓	↑
Performance	↓	↔ ↑	↔ ↑	↑
Capacity	↓	↔ ↑	↔	↑
Global availability	↑	↑	↔	↑*
Security	↑	↔ ↑	↔ ↑	↑
Per-bit cost efficiency	↓	↑	↑**	↑
Coverage radius	↑	↔	↔	↔
↑ High ↓ Low ↔ Medium * Potential ** With the exception of roaming traffic				

Network Comparison



Approved for
Safety Services

Source: Honeywell

FAA Has Identified

Over 330 AeroMACS Applications

Name	Mobile/Fixed	Description
Current ACARS		
OOOI	M	Provides time of out, off, on, in
Pre De		
Flight Deck		
D-AUS	M	Data link Aeronautical Update Services
D-OTIS		
4DTRA		
Ground Operations & Services		
D-TAXI Service		
Convec	Fueling	M Coordination of fueling operations.
Forecs	De-Icing	
D-SIG Guidan		
FAR 139 Safety Self Inspection		
FMS and databa	Navigation Aids System Maintenance	M Reporting status of airport runway/taxiway lights, monitor equip status
D-LIGH	FOQA	
Aerodr	Signage	
Airport Surface Infrastructure		
Aircraft M		
GTG	Airport Surface Detection (ASDE-X)	F Surface Movement Data
	Parking	F Airport Surveillance Radar
	Asset in	F Far Field Monitor (FFM)
	Flight Op	F ILS monitoring system Data
	Weight &	F Glide Slope
	Police &	F Instrument Landing System Data
	Fire	F Remote Maintenance & Monitoring (RMM)
		F Electronic Equipment Performance Data
		F System control Data
		F Medium Intensity Approach Lighting System
		F Runway Visual Range (RVR)
		F Visibility Data
		F Remote Transmitter Receiver
		F Pilot Controller voice communications

* 47 p

* 96 p

* 123 p

* 33 po

* 33 potential applications currently identified

The U.S. Federal Aviation Administration (FAA) has identified over 330 AeroMACS applications under 5 categories:

- Air Traffic Control/ Air Traffic Management Applications
- Aviation Information Systems/ Meteorology Applications
- Airline Operations Applications
- Safety Applications
- Airport Infrastructure Applications

AeroMACS Network Infrastructure



Regulators

Ensure that air traffic, security and safety management follow regulation



Air carriers

Support air traffic, security and safety applications on aircraft, and carrier applications



Airports

Support airport operations and any applications mandated by regulators



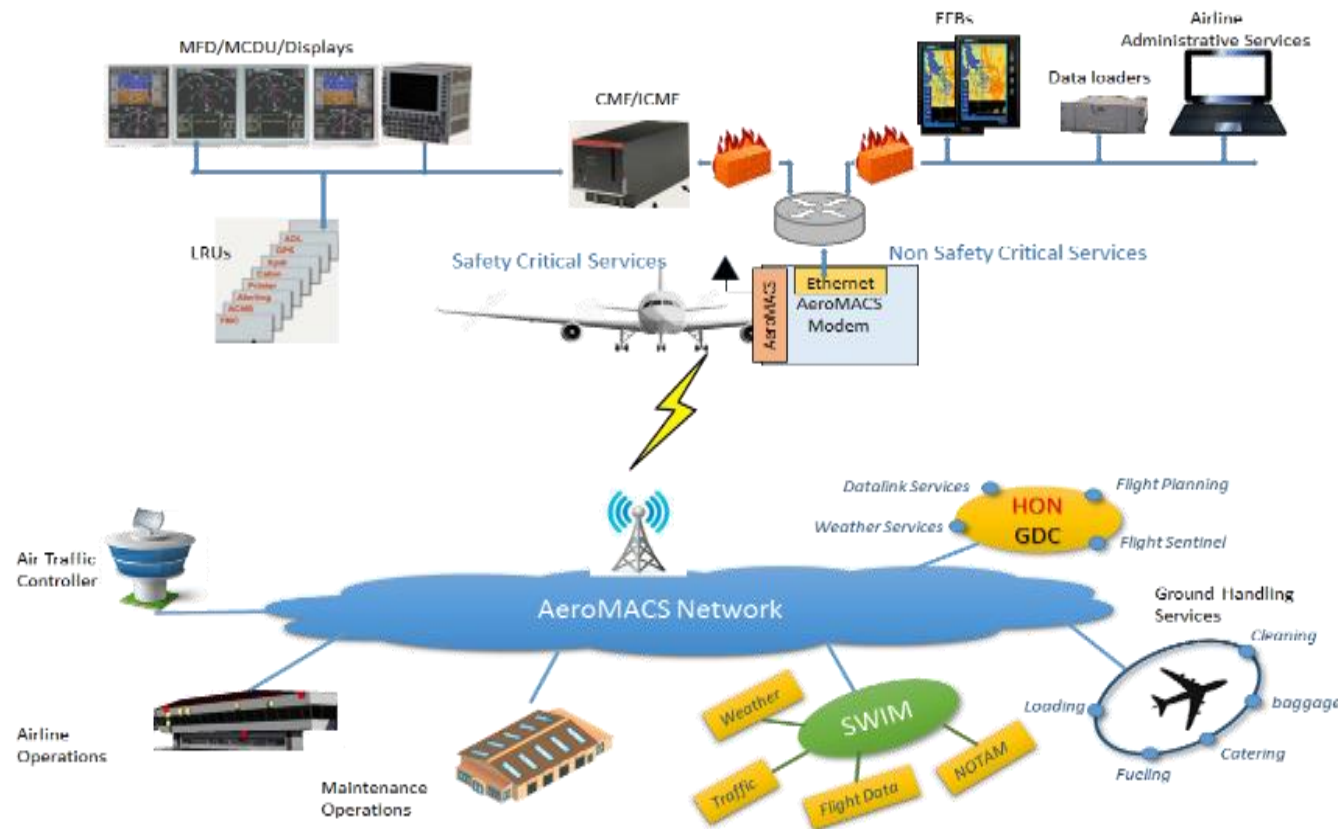
Suppliers

Provide equipment, services, network applications and management tools

Synergy to share the network infrastructure and its benefits

AeroMACS Security

AeroMACS Public Key Infrastructure (PKI) provides the digital certificates to aircraft, ground device, and servers for strong device to device authentication. This mechanism provides the foundation for application authorization, access control, and data confidentiality.

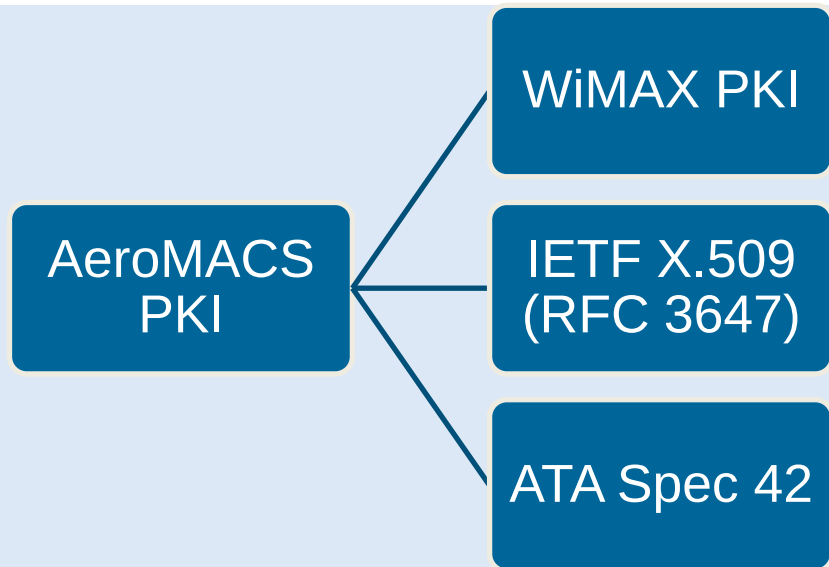


AeroMACS PKI:

- Minimizes cyber threats
- Provides efficient, reliable, and secure broadband connectivity across the entire airport footprint
- Securely collects data from fixed and mobile terminals
- Securely maintains communications with staff and aircraft

AeroMACS PKI Development

Using Internet and Aviation security standards and in collaboration with the industry, WiMAX Forum started AeroMACS PKI solution development.



The AeroMACS Certificate Policy has been accepted in ICAO WG-S and included as an appendix in the Guidance Material of the Technical Manual. Certificate Profile Requirements included in the Technical Specifications section of the Manual

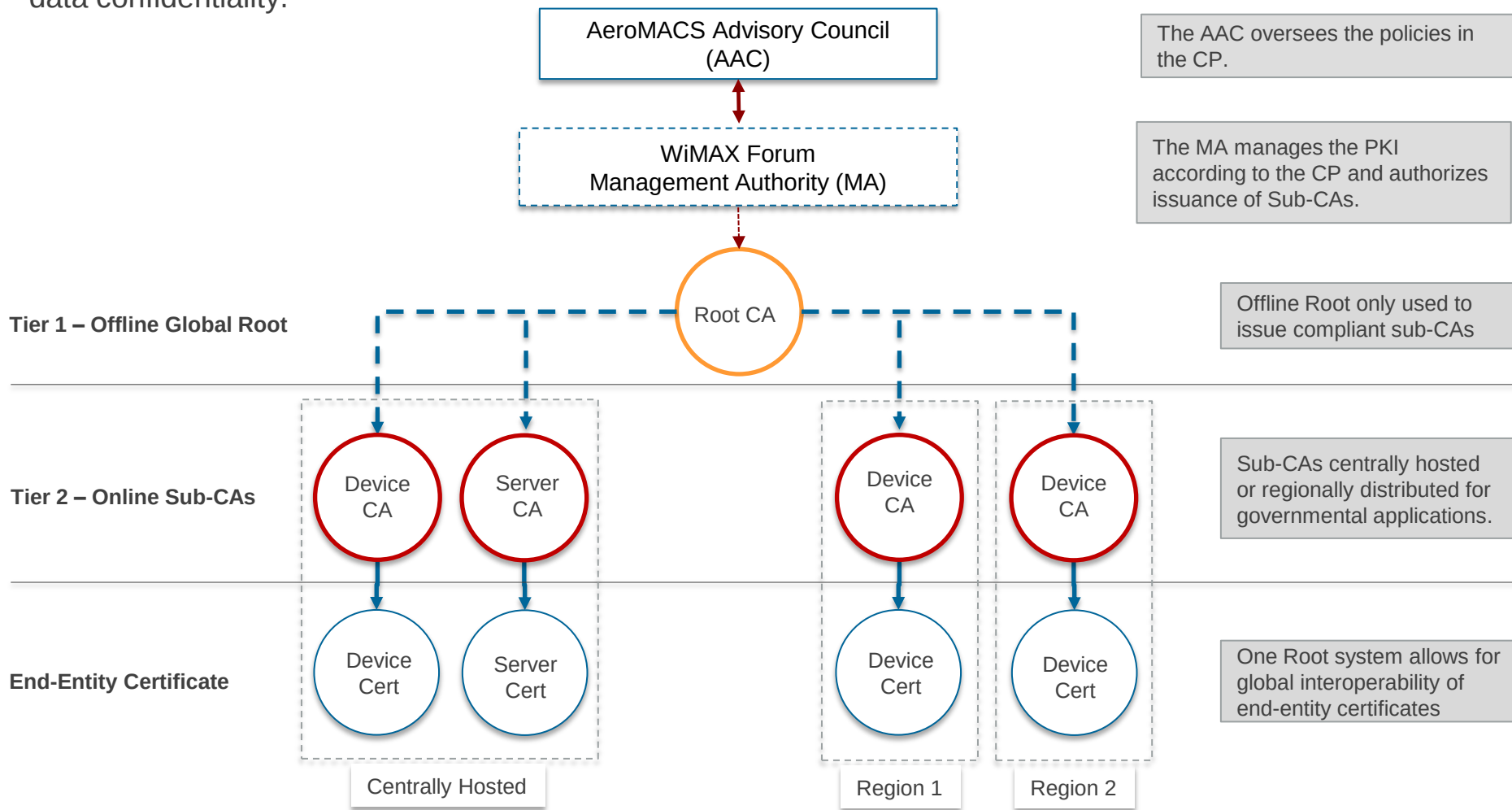
WiMAX Forum Alliance with ICAO



- In December 2017, the WiMAX Forum formed an alliance with ICAO to promote effective AeroMACS PKI program to Deliver Secure Networks.
- As the AeroMACS Management Authority (MA), the WiMAX Forum, with the support of Eontic Inc. will implement and manage the AeroMACS PKI.
- AeroMACS Advisory Council (AAC) to provide oversight to the AeroMACS Public Key Infrastructure (PKI) program developed in accordance with industry standards.

AeroMACS PKI Digital Certificates

The PKI provides the digital certificates to aircraft, ground device, and servers for strong device to device authentication. This mechanism provides the foundation for application authorization, access control, and data confidentiality.



A single Root CA system provides a highly secure, trusted, and globally interoperable PKI

AeroMACS Certification

To certify global interoperability for AeroMACS equipment against specific applications and requirements.

2018
Full
Certification

WiMAX Forum Background

- For Mobile WiMAX all testing is performed in WiMAX Forum Designated Certification Laboratories (WFDCL).
 - Radio Conformance Testing – RCT.
 - Protocol Conformance Testing – PCT.
 - Interoperability Conformance Testing – IOT.
- Certification Requirements Status List (CRSL) Defines Tests for specific profiles.
- Protocol Implementation Conformance Statement (PICS) Specifies a list of protocol elements required as a realization of a system profile.

AeroMACS Certification

- AeroMACS Certification encompasses:
 - Radio Conformance Testing,
 - Protocol Conformance, Testing
 - Interoperability Conformance Testing,
 - Security and Network Elements.
- All based on the forum's AeroMACS Certification profile in compliance with the requirements of industry standards.
- AeroMACS Certification will be a requirement of FAA.

Key Milestones

- Initial Interoperability demonstration (**MIDE**) event took place in 2015.
- AeroMACS Certification will initially occur in two phases.
 - **Wave 1** – RCT Certification now available in the WiMAX Forum AeroMACS Designated Certification Laboratory (ADCL).
 - **Wave 2** - PCT, IOT, Security and Network testing the ADCL occurring in 2018.
- **Siemens and Telrad Networks** have received **Wave 1** AeroMACS Certification.

AeroMACS Validation



AeroMACS Global Contributors



2009



CLE

2010



TLS

2012



SFO

2014



CTU



MLB



OBF



SDJ



SYR

2016

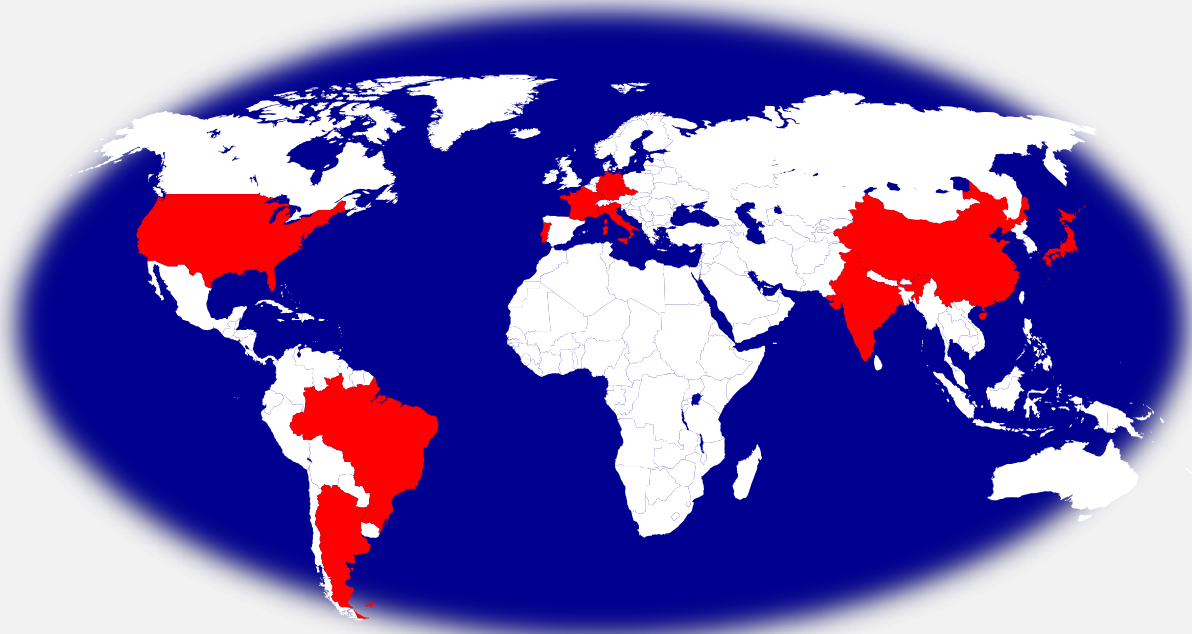


KWL



MLB

AeroMACS Worldwide Roadmap



2017



CKG



HND



INC



KWE



PEK



SHE



TSN



XIY



XNN

2018



HAK

2018+



ACY



CAN



EZE



HHA



MSY



PRG



ADW



CGO



FOC



HRB



NKG



PVG



ANC



CVG



GIG



KML



NNG



SHA



BLR



DAB



GZC



LIS



PDX



SYX



BOS



DLC



HGH



MCI



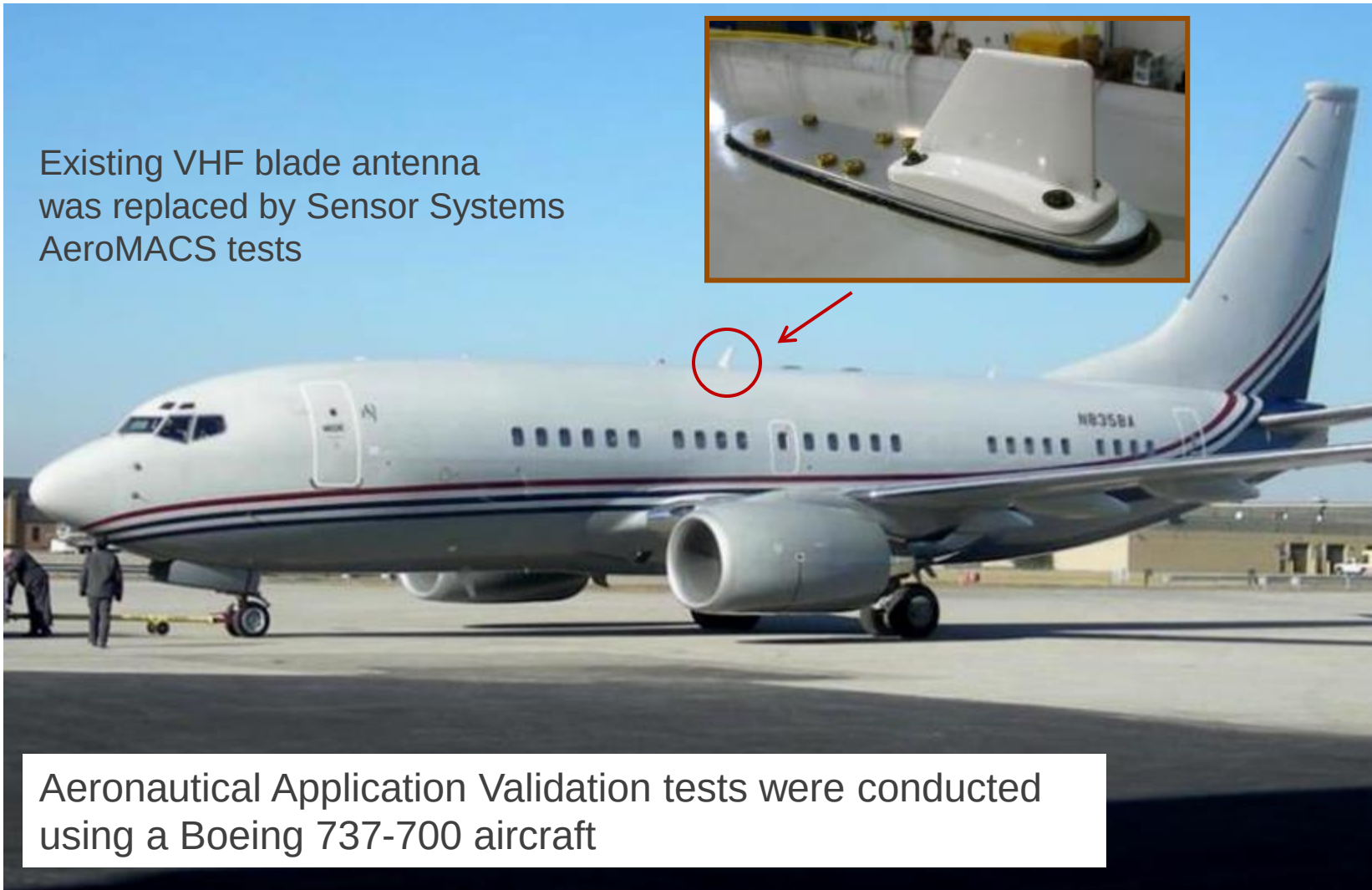
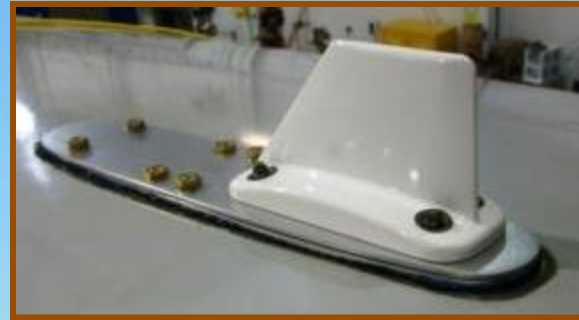
PIT



TAO

Boeing AeroMACS D-Taxi Tests

Existing VHF blade antenna
was replaced by Sensor Systems
AeroMACS tests



Aeronautical Application Validation tests were conducted
using a Boeing 737-700 aircraft

FAA Bombardier Testbed

NASA's Glenn Research Center has successfully transmitted route options, weather information and other data via AeroMACS to an FAA Bombardier Global 5000.

The demonstration was conducted at NASA's Communications, Navigation and Surveillance (CNS) test facility in collaboration with the FAA and Hitachi.



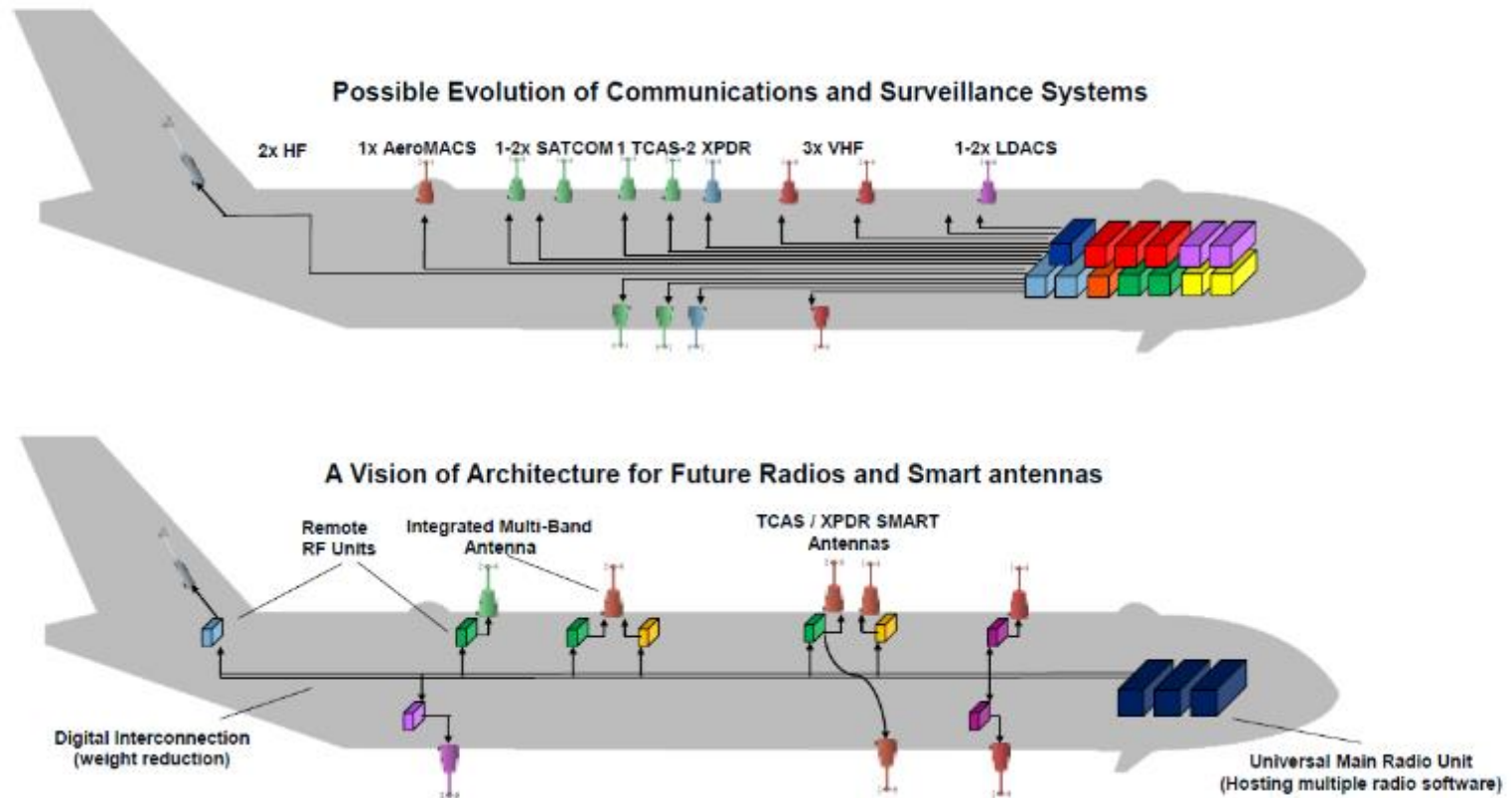
Airbus Aircraft Installation and Rational

ITU/SPbPU seminar - Aviation Communication

June 2018

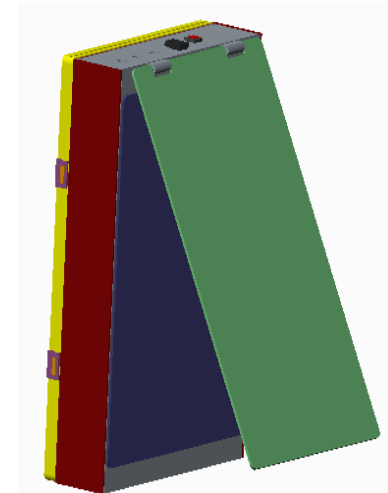
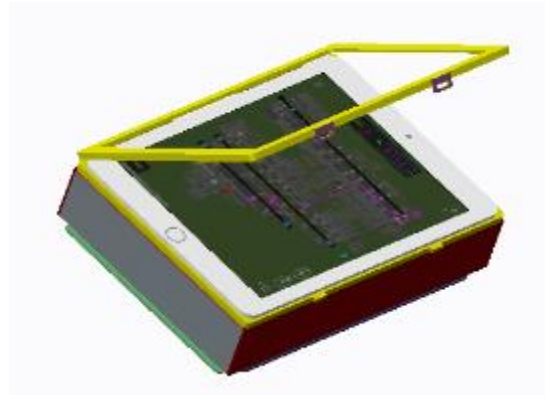
Installation and Rationalization

Vision of a future globally distributed radio architecture for CNS



AIRBUS

Honeywell Portable AeroMACS D-Taxi App

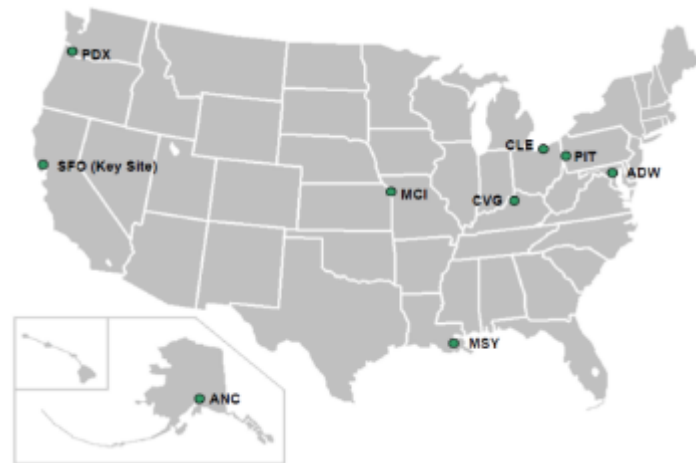


- Future-proof D-Taxi Application is fully compliant with ATN-B2 message set RTCA SC-214/DO-350A EUROCAE ED-228A
- Supports IPS communications over AeroMACS
- Integrates multiple applications on the EFB/iPad: d-Taxi, A-SMGCS with moving map display, baggage handling and airline operations optimization, vehicle management, VoIP, Video
- Conducted safety assessment and mitigation for taxi guidance on COTS iPad
- Prototype AeroMACS portable unit can be used for vehicles, Ramp management staff and for aircraft trials
- ARINC 766 compliant AeroMACS avionics radio under development

Prototype Integrated AeroMACS with iPad EFB – about 1.5” thick

Airport Surface Surveillance Capability

- Leverages Airport Surface Detection Equipment
- On contract to deploy ASSC at 9 airports, and 3 support systems with options for up to 58 more
 - Completed Site Acceptance Test (SAT) at SFO which is the key site
 - Production activities well underway for the next 8 Airports and the support systems



FAA Hosts Chinese Delegation

CHINESE DELEGATION VISIT FOCUSES ON BENEFITS OF AEROMACS SYSTEM

The FAA hosted a unique gathering from October 24-27, 2017. The visit brought together key representatives from several Chinese government aviation agencies including the Civil Aviation Authority of China (CAAC), Air Traffic Management Bureau (ATMB) and Aviation Data Communication Corporation (ADCC), as well as FAA program specialists and industry representatives.

The visit centered around wireless communication for aviation use. This topic of common interest between

the US and China reflects a growing recognition of the power and importance of the Aeronautical Mobile Airport Communication System (AeroMACS). AeroMACS aims to

bring wireless, broadband connectivity to airports for surface operations and eventually on the aircraft to interact with avionics systems.

The Chinese delegates presented briefings on the outcomes of their proof-of-concept trial using AeroMACS in the cockpit for the departure and arrival taxi stages at Beijing Capital Airport. The test, conducted from October 1-7, utilized 56 flights from Air China, China Eastern, Hainan Airlines and Shandong Airlines and showed positive results.



Beijing Airport D-Taxi

Air China, China Eastern Airline, Hainan Airline and Shandong Airline attend the D-TAXI assistance system cockpit trial in the period of departure and landing taxi stage via AeroMACS.



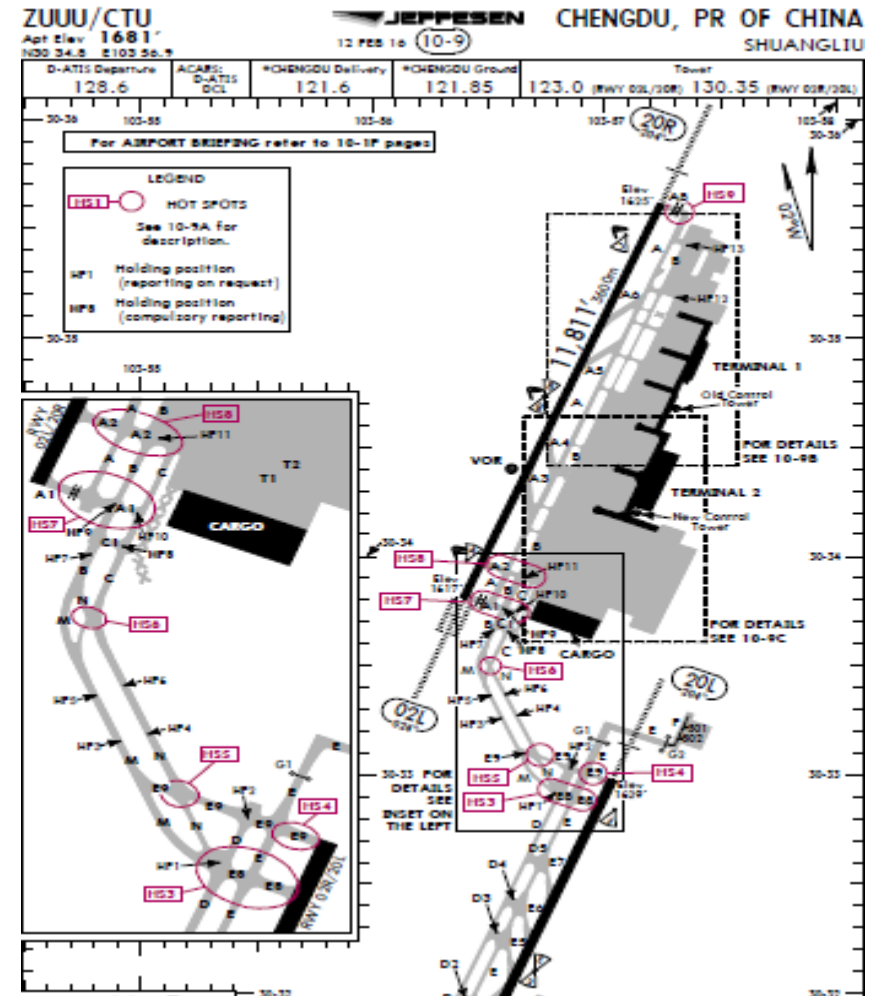
AeroMACS D-Taxi Real-Time Mapping

D-TAXI system provides Beijing Airport surface map, guidance and situational awareness of controllers and pilots in the airport surface area.

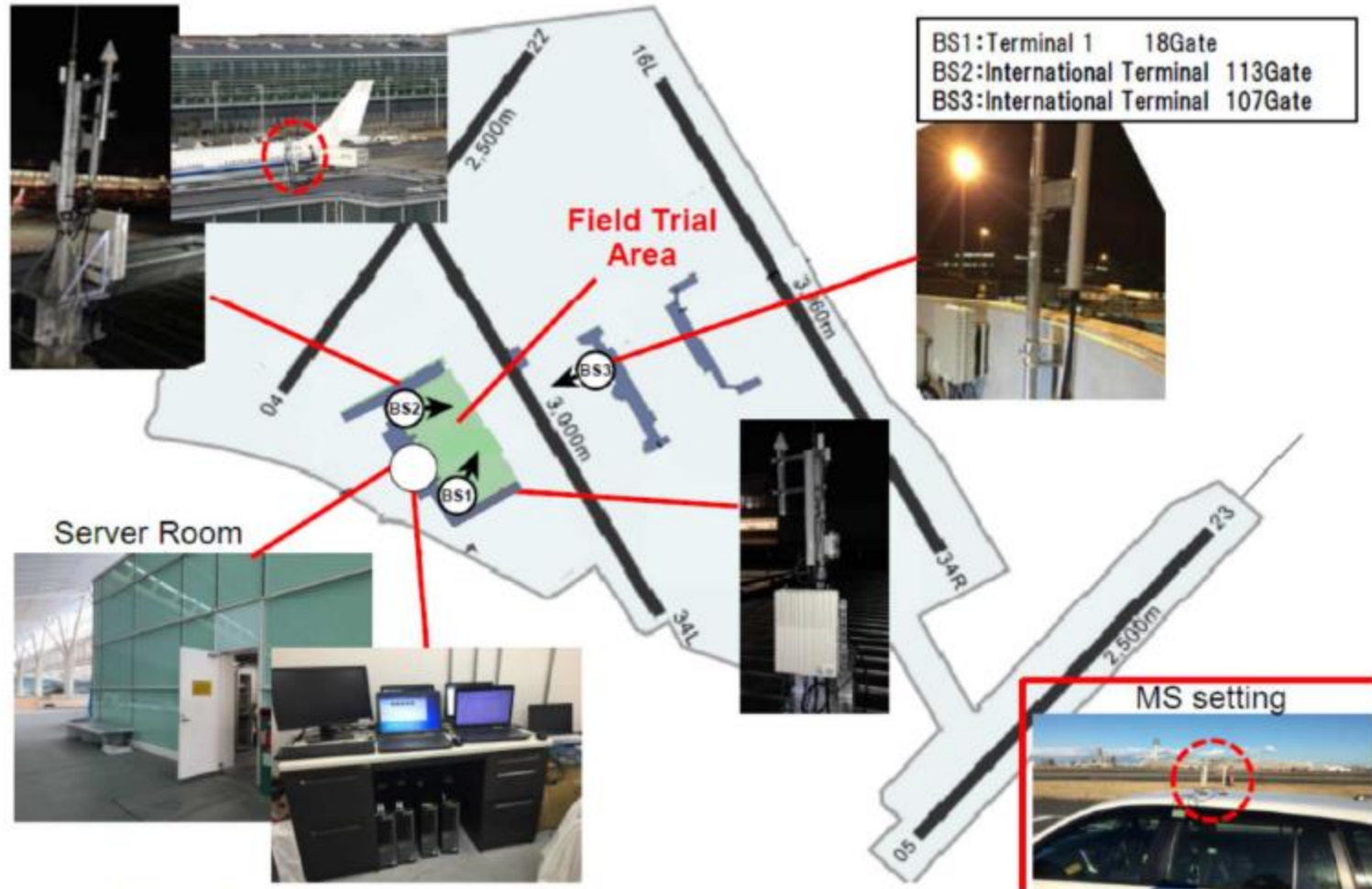
D-TAXI system via AeroMACS provides real-time guidance according to the approved taxi route by the ATC control tower.



Chengdu Airport D-Taxi and A-SMGCS over AeroMACS



AeroMACS at Haneda Airport



Civil Aviation Bureau Japan

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- AeroMACS network is demonstrated to be secured.



【Test results】

- ✓ AeroMACS network is demonstrated to be secured through device certification/authentication.
- ✓ ATC traffic is always prioritized to deliver over any other traffics.
- ✓ There is no area of "Out of Service" on airport vehicle routes.

Civil Aviation Bureau Japan

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AeroMACS is the standardized wireless technology selected to provide safety and regularity of flight on the airport surface globally.



AeroMACS operates in the protected and licensed aviation spectrum band to enable and improve ground communications.



Thank You!

Declan Byrne, President
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