AeroMACS

Aeronautical Mobile Airport Communication System

Standardized Solution for the Airport Surface

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22 November 2018

AeroMACS Evolution

1. Study

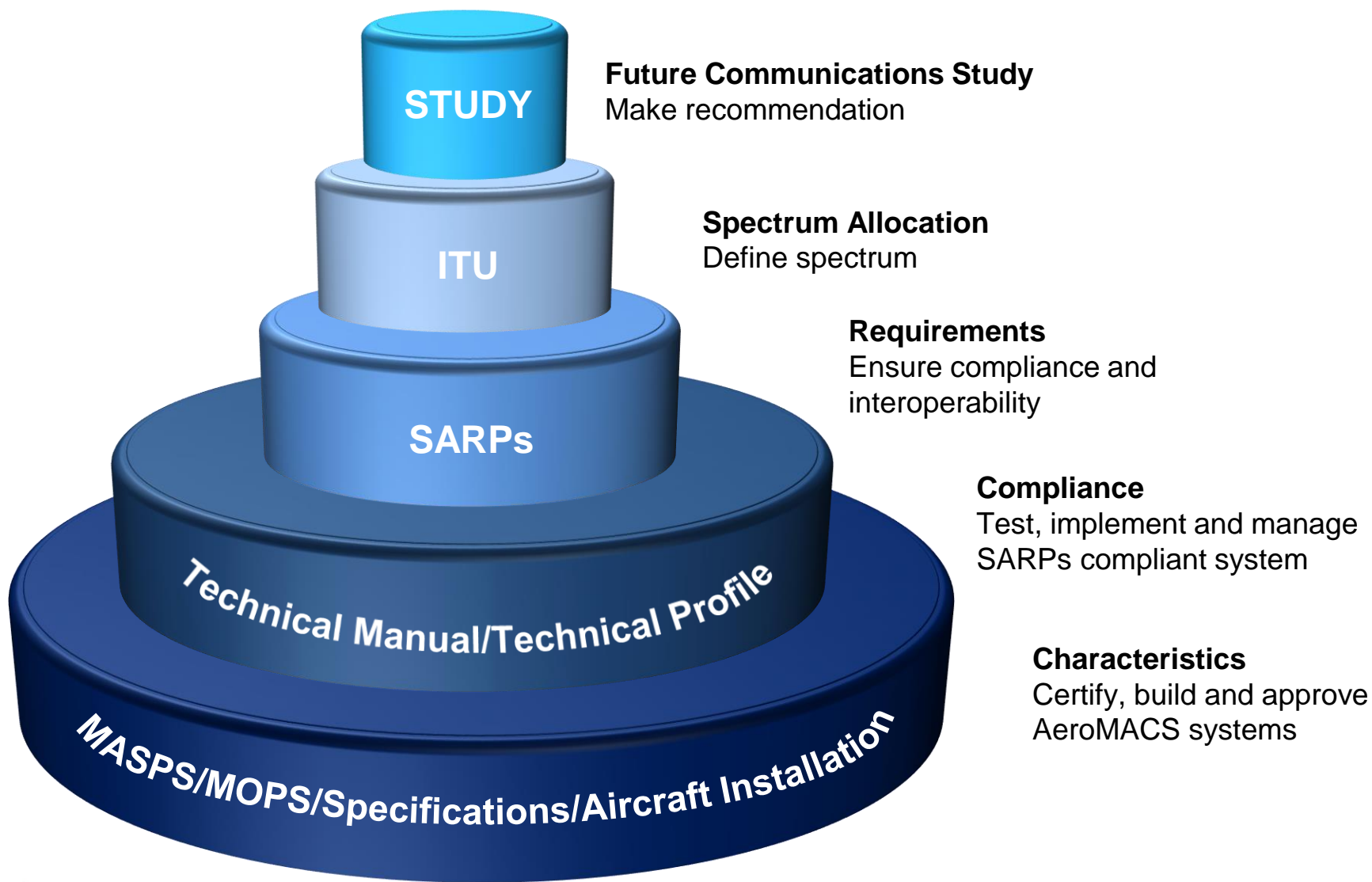**2. Spectrum**

3. Harmonization

4. Security

5. Deployments

6. Regularity

Over a Decade Setting Parameters

STUDY

Future Communications Study
Make recommendation

ITU

Spectrum Allocation
Define spectrum

SARPs

Requirements
Ensure compliance and
interoperability

Technical Manual/Technical Profile

Compliance
Test, implement and manage
SARPs compliant system

MASPS/MOPS/Specifications/Aircraft Installation

Characteristics
Certify, build and approve
AeroMACS systems

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Systems Assessment

	ACARS	Wi-Fi Gatelink	Cellular	AeroMACS
Control	⬆	⬇	⬇	⬆
Reliability	⬆	⬇	⬇	⬆
Performance	⬇	⬅➡ ⬆	⬅➡ ⬆	⬆
Capacity	⬇	⬅➡ ⬆	⬅➡	⬆
Global availability	⬆	⬆	⬅➡	⬆
Security	⬆	⬅➡ ⬆	⬅➡ ⬆	⬆
Per-bit cost efficiency	⬇	⬆	⬆*	⬆
Coverage radius	⬆	⬅➡	⬅➡	⬅➡

⬆ High ⬇ Low ⬅➡ Medium

* With the exception of roaming traffic

Real-World Network Speeds (Kbps)

Network	Speed
VDLM2	31.5
Swift BB	432
3G	100
4G LTE	1000
WiFi	2000
AeroMACS	7000

Approved for Safety Services

AeroMACS Systems have the capacity, speed, performance, security and reliability needed to support a multitude of fixed and mobile applications on the airport surface.

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AeroMACS Spectrum Allocation

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

- 5091 MHz – 5150 MHz: AeroMACS Spectrum has been **Internationally Allocated by ITU at WRC-07** in 2007 (Co-primary AM(R)S allocation)

- 5000 MHz – 5030 MHz: possible national allocations

(Possibly) National Allocations

Current International Allocation by ITU
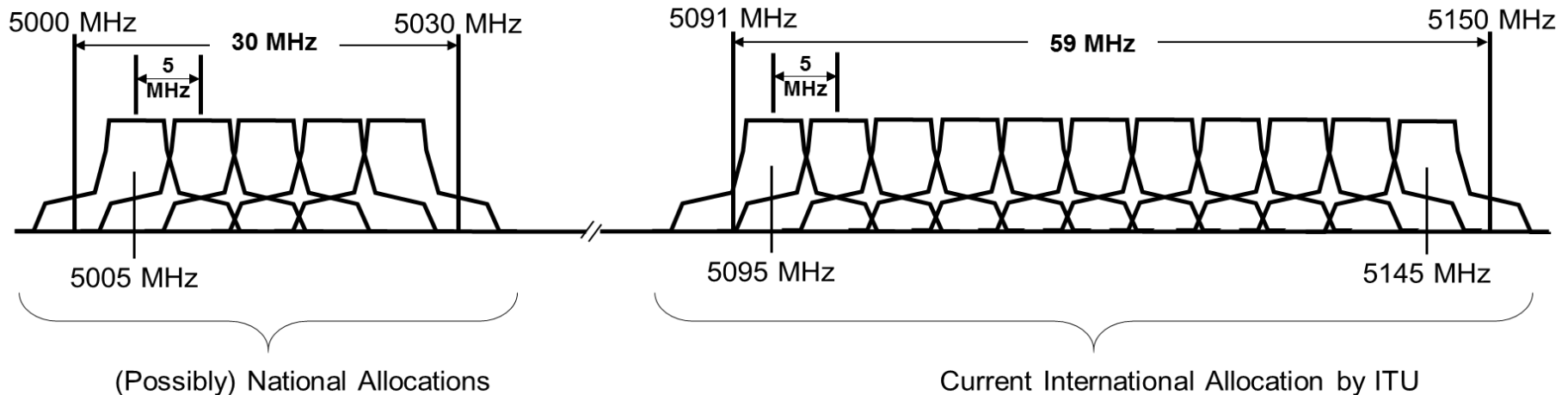
Global Coordination & Harmonization

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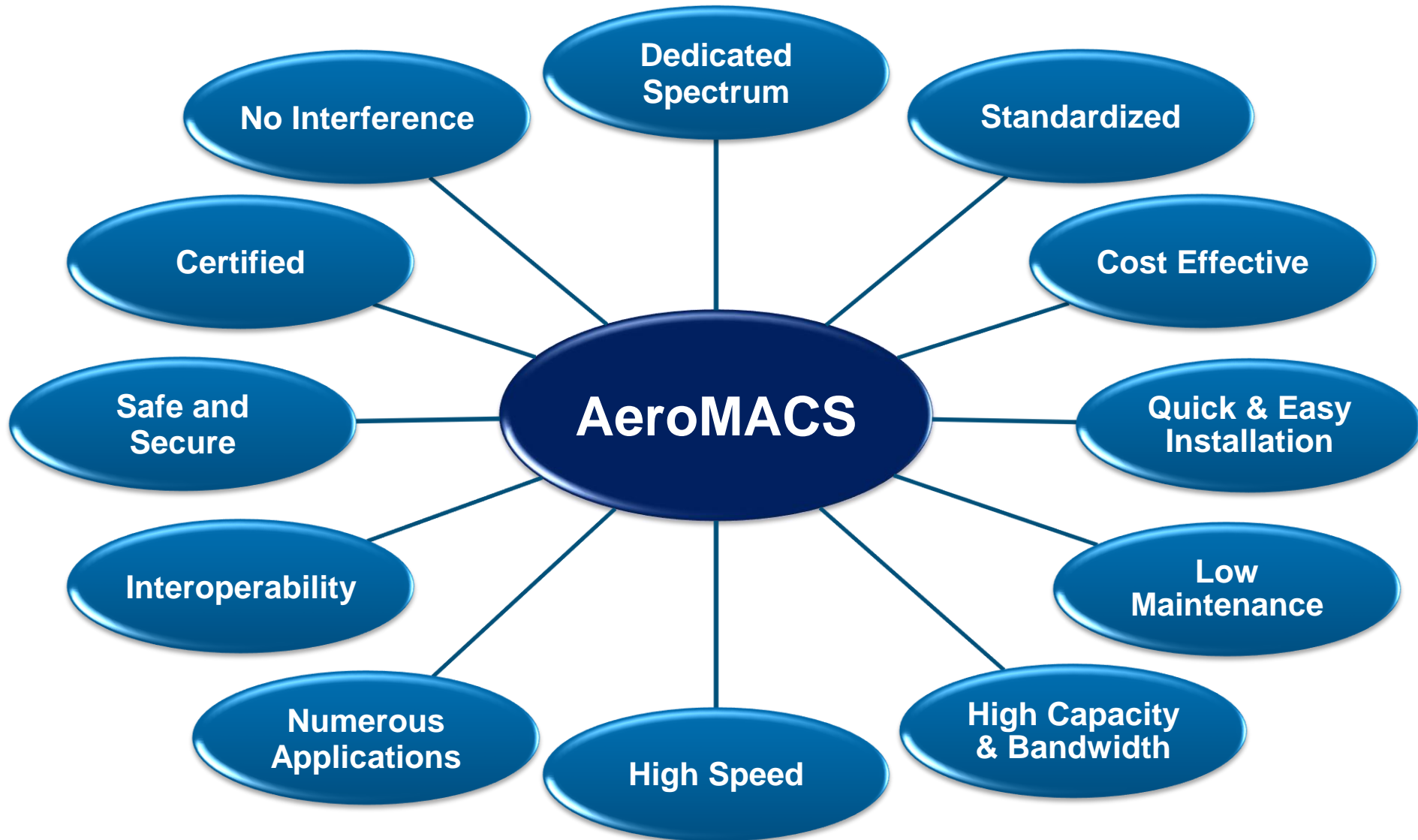- **ARINC AEEC** AeroMACS Working Group
  - ARINC 766: Aeronautical Mobile Airport Communication System (AeroMACS) Transceiver and Aircraft Installation Standards

Over 330 Applications Identified

	Air Traffic	**Air Carriers**	**Airports**
Mobile Apps	✓ AT Comm. ✓ AAtS ✓ ATIS ✓ Gate Clearance ✓ NOTAMS ✓ Surface 4 DT	✓ Baggage ✓ Catering ✓ EFB ✓ Flight Info. ✓ Fueling ✓ Weather	✓ Coordination ✓ Fire & Rescue ✓ Mobile Security ✓ RWY Status ✓ Surface Mgmt. ✓ Wild Life Mgmt.
Fixed Apps	✓ Navigation Aids ✓ Surveillance ✓ Terminal Sensor ✓ Visual Aids ✓ Weather	✓ Data uploads and downloads ✓ Flight Ops. ✓ Ramp Mgmt. ✓ Ramp Services	✓ Construction ✓ Data backhaul ✓ Lighting ✓ NOTAM-D ✓ Security Gates

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AeroMACS Characteristics

Dedicated Spectrum

No Interference

Standardized

Certified

Cost Effective

Safe and Secure

AeroMACS

Quick & Easy Installation

Interoperability

Low Maintenance

Numerous Applications

High Speed

High Capacity & Bandwidth

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AeroMACS Worldwide Roadmap

2009
- CLE

2010
- TLS

2012
- SFO

2014
- CTU
- MLB
- OBF
- SDJ
- SYR

2016
- KWL
- MXP
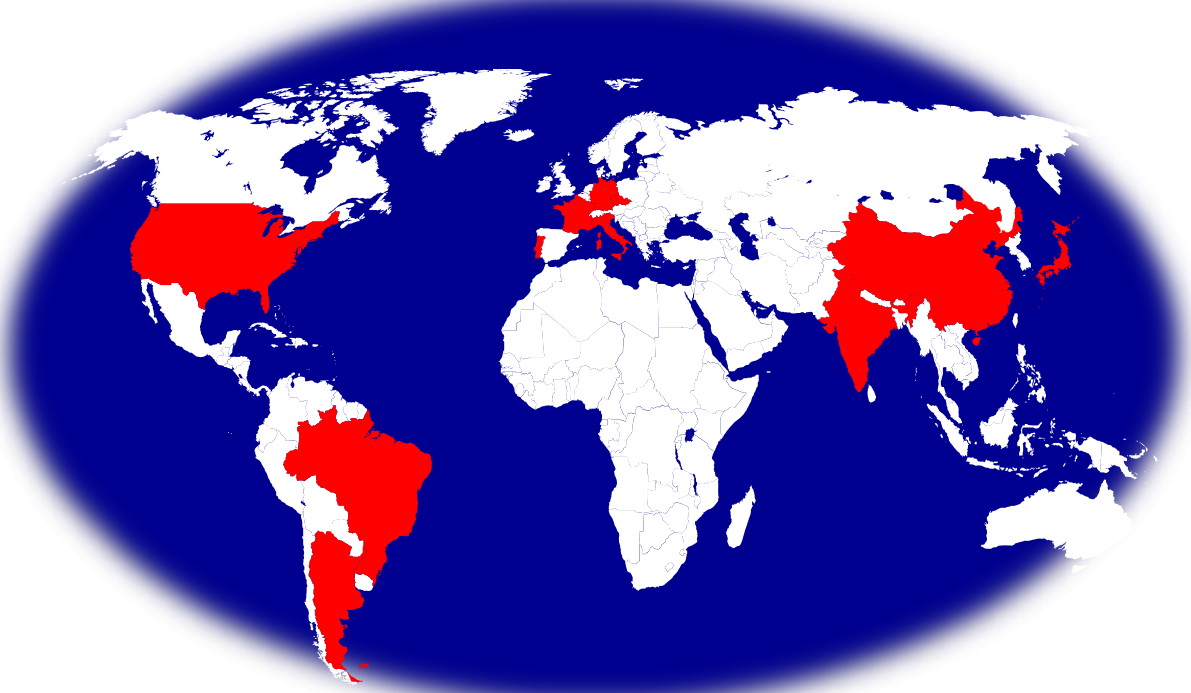
2017
- CIN
- CKG
- HND
- INC
- KWE
- PEK
- SHE
- TSN
- XIY
- XNN

2018
- GIG
- HAK
- LIS
- MCI
- MSY

2019+

ACY	CAN	EZE	HNL	PDX
ADW	CGO	FOC	HRB	PHL
ANC	CVG	GZC	KML	PIT
BLR	DAB	HGH	NKG	PRG
BOS	DLC	HHA	NNG	PVG

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CLE - Cleveland Airport - NASA

NASA Glenn Research Center

GRC B500 SS

GRC B4 BS & Backhaul

AZ = 55°

AZ = 200°

GRC B110 Core Server & Backhaul

Private Hangar SS

Consolidated Maintenance Facility SS

Backhaul

AZ = 295°

ARFF BS & Backhaul

AZ = 45°

Terminal C SS

Snow Barn SS

Approach Lighting SS

AZ = 185°

Glycol Tanks SS

Cleveland-Hopkins International Airport

Core Server

Subscriber Stations
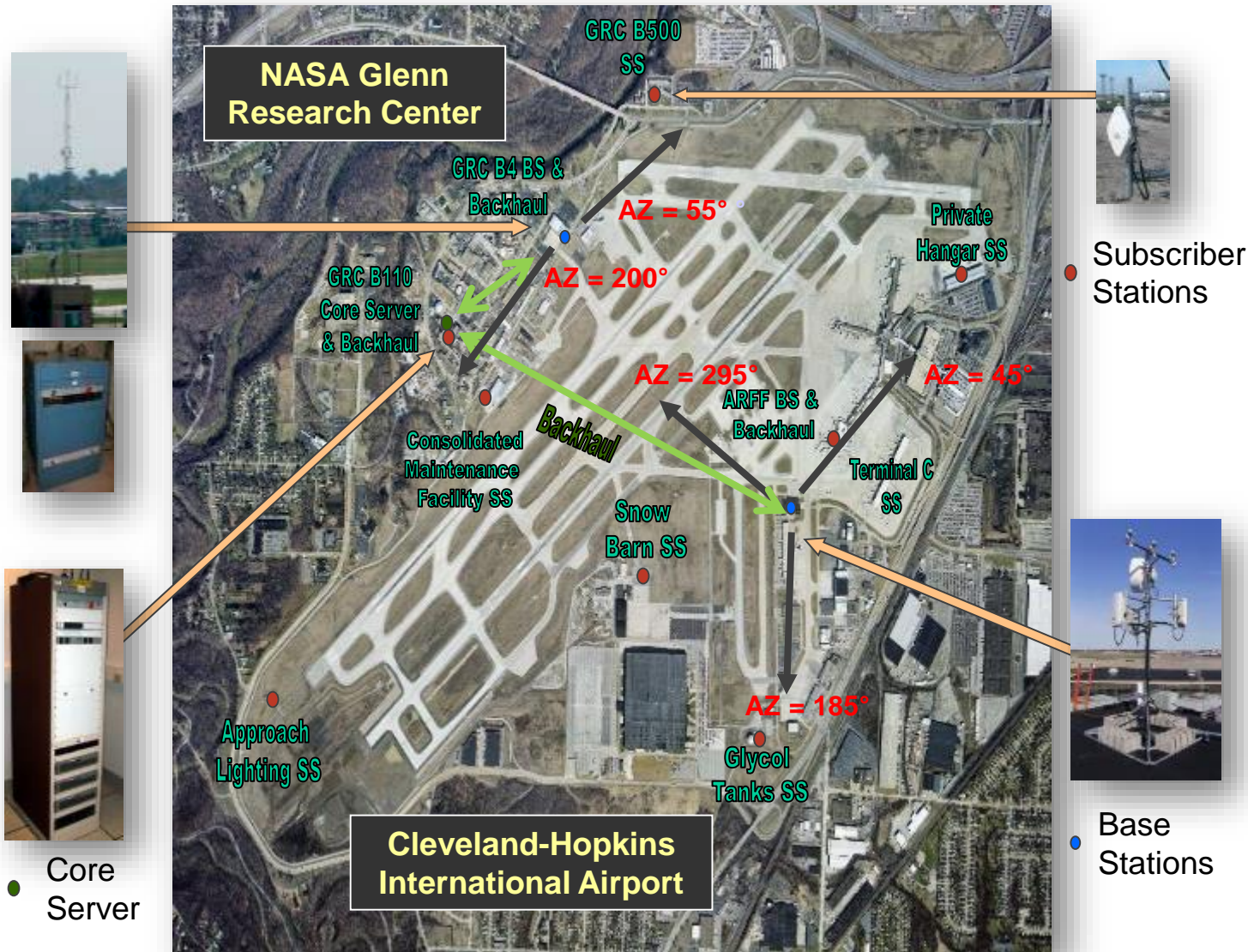
Base Stations

Aircraft Communication

Weather

Moving Maps

Surveillance

Mobility

Voice Over IP

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Airport Surface Surveillance Capability

- On contract to deploy ASSC at **9** airports, and **3** support systems with options for up to **58** more to leverage airport surface detection equipment.

- Completed Site Acceptance Test (SAT) at SFO**,** the key site. Production activities well underway for the next airports and support systems.

SFO - San Francisco Airport

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 AeroMACS frequencies in 2017 to setup **110** airports AeroMACS network and provide services.

ADCC has already setup AeroMACS in **11** Airports in China and plans to install AeroMACS in the top **30** traffic rank before the end of 2019.

中国民用航空局空中交通管理局

民航空局函 [2017] 69号

关于转发《民航局空管办关于机场航空移动通信系统使用频率的批复》的通知

CTU - Chengdu Airport D-Taxi and A-SMGCS over AeroMACS
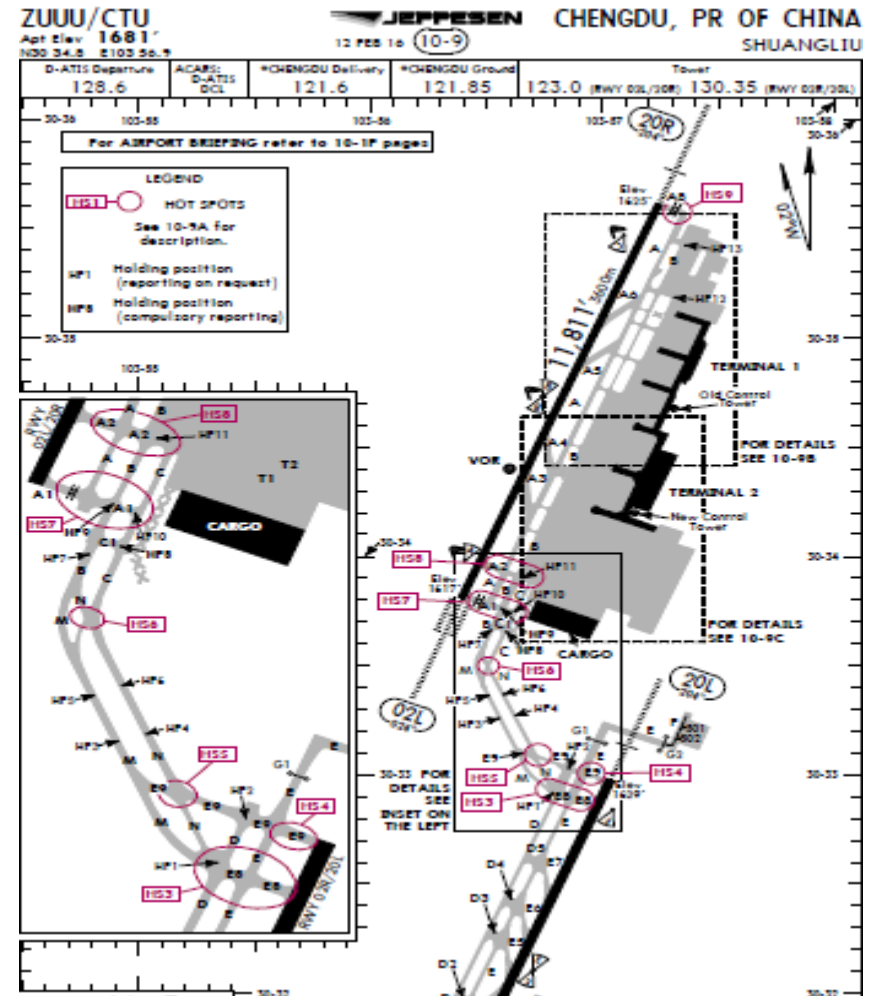
PEK - Beijing Airport D-Taxi

Air China, China Eastern Airline, Hainan Airline and Shandong Airline participated in the D-TAXI system cockpit trial in the period of departure and landing taxi stage via AeroMACS providing real-time guidance by the ATC control tower.

Honeywell Portable AeroMACS D-Taxi App
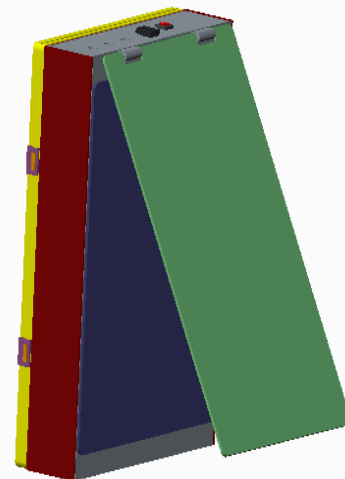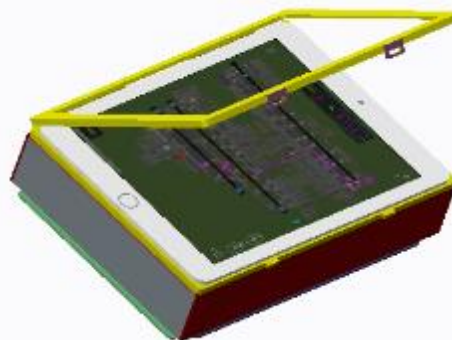
- D-Taxi Application is fully compliant with ATN-B2 message set RTCA SC-214/DO-350A EUROCAE ED-228A
- Supports IPS communications over AeroMACS
- Integrates multiple applications on the EFB/iPad: d-Taxi, A-SMGCS with moving map display, baggage handling and airline operations optimization, vehicle management, 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

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AeroMACS Validation

Civil Aviation Administration of China (CAAC) and Aviation Data Communication Corporation (ADCC) reported that modified procedures using AeroMACS **reduced the clearance delivery time by twenty minutes per flight**.

It substantially improved operating efficiency of the Tower Control as well as overall integrity of the clearances.
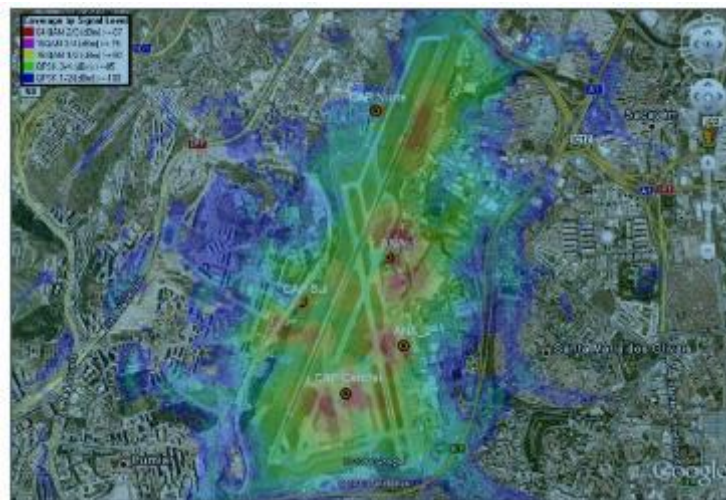
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Since it's deployment in 2012

- ## LVP (Low Visibility Message) panels installed in LIS's Airport around the airside using WIMAX connectivity

LIS - Lisbon

CCTV perimetric IP Cameras around the airside
Fire department and operational vehicles connectivity

What can we offer as an AeroMACS operator inside Lisbon's Airport?

- **Accelerate project implementations by deploying applications on any point of the airside**

- **Interconnect to external stakeholders like Ground Handling, ANSP, Airlines to permit collaboration**

- **Easily implement a network access point on request for a critical situation**

All of this in reduced budget, with much less equipment needs and easy to maintain network infrastructure

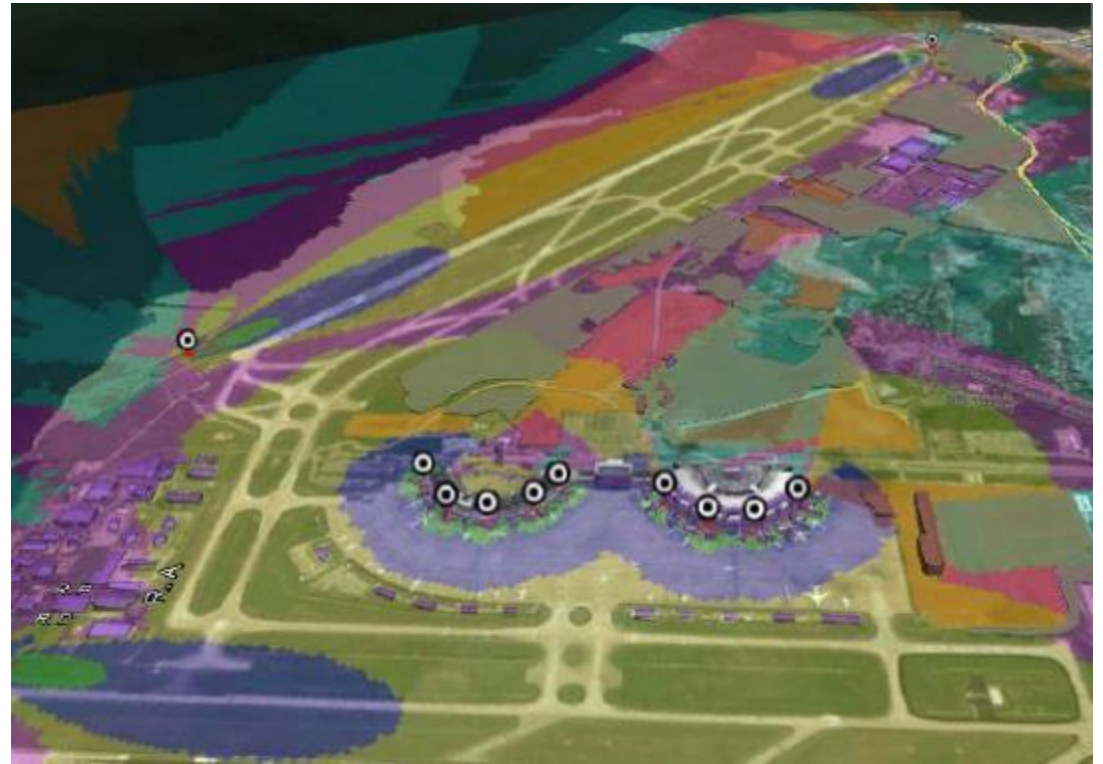# TLS - Toulouse

MXP - Malpensa
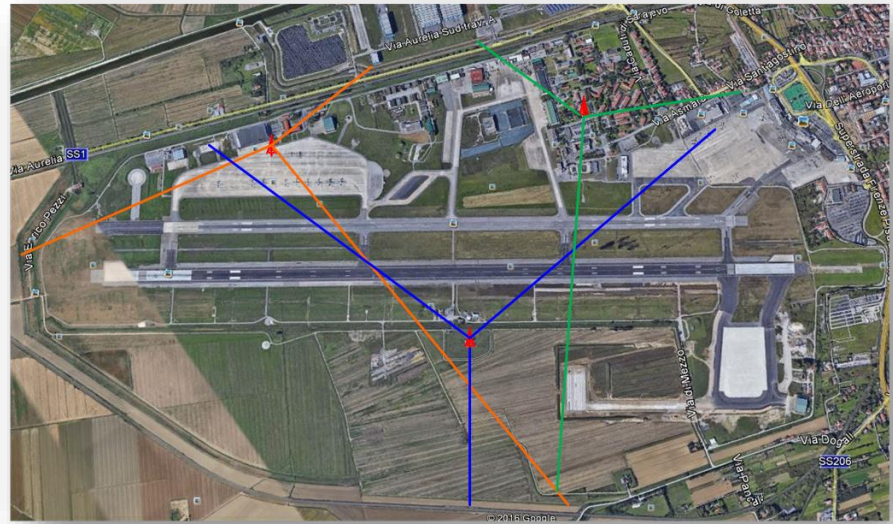
SDJ - Sendai

HND - Haneda
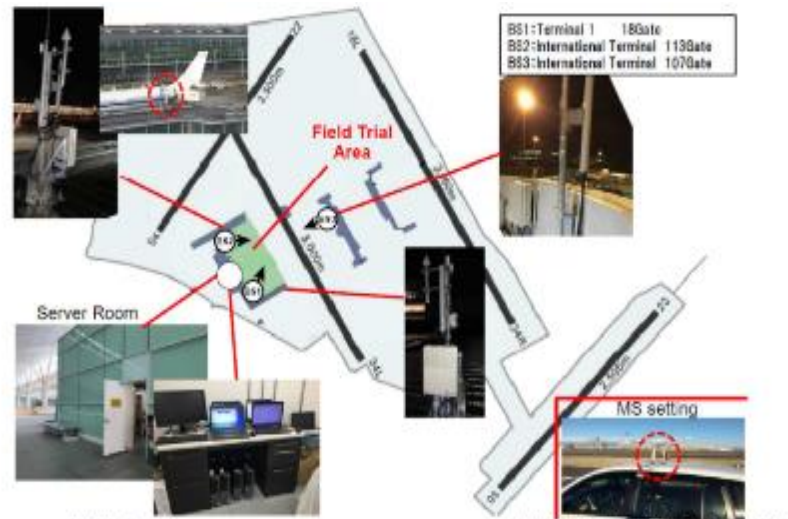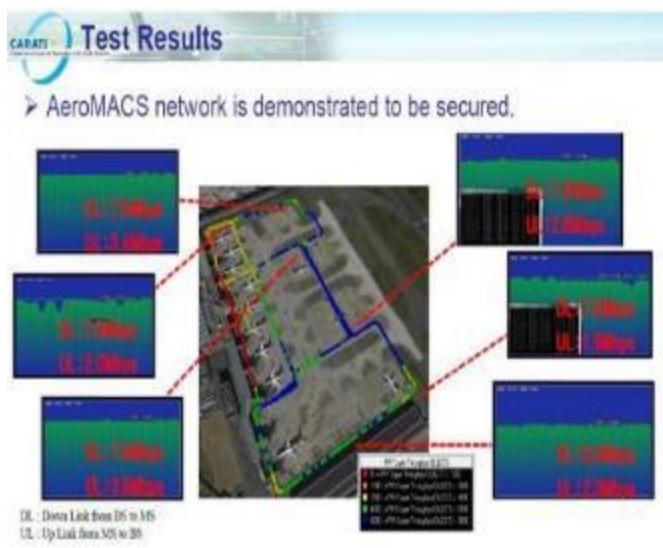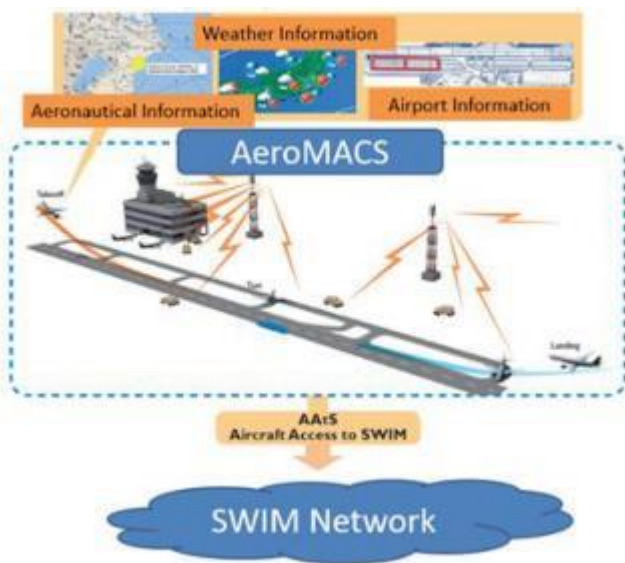
GIG - Galeao

- For the coverage two classes of services have been created:

# GIG - Galeao - Multilateration

- **Fixed service with CPE**
  - 4 CPE fixed at 10 meters
  - 2 CPEs installed at vehicles

- **Customer Requirements**
  - Wireless broadband network connectivity to Remote Sensor units deployed around perimeter of airport to locate airplanes while taxing to take off or after landing.

Enables airplanes location and visibility on the runways while taxing promoting the safety of passengers and regularity of flights.
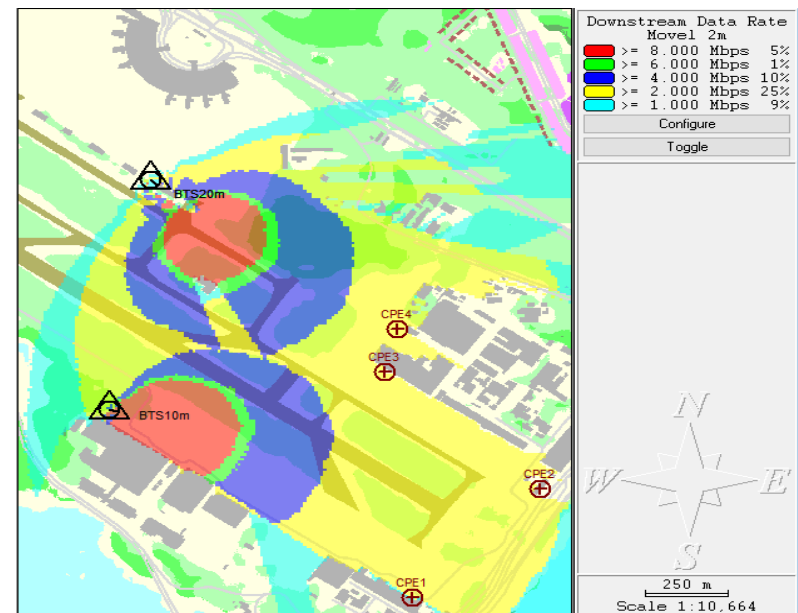
GIG - Galeao - Hydroplaning

- **Mobile service with antenna**
  - 1 BTS at 10 meters antenna
  - 1 BTS at 20 meters antenna

- **Customer Requirements:**
  - Private secured wireless network as a multi service platform for mobile communications.

RUGGEDCOM WIN5151

Service Vehicles
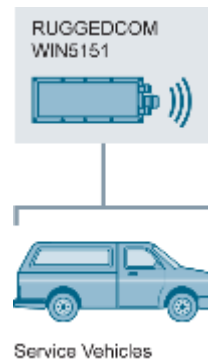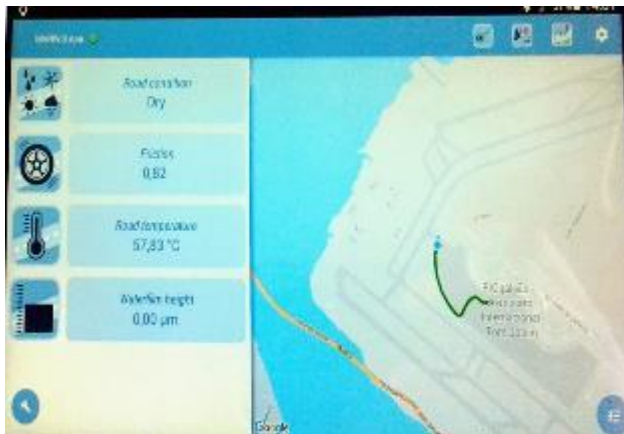
AeroMACS Aircraft Tests

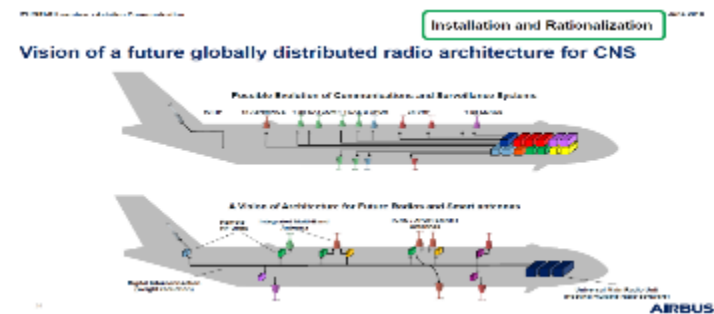Existing VHF antenna replaced by AeroMACS Sensor Systems

Validation tests conducted using a Boeing 737-700 aircraft.

Route options, weather information and other data transmitted by NASA to FAA Bombardier Global 5000.
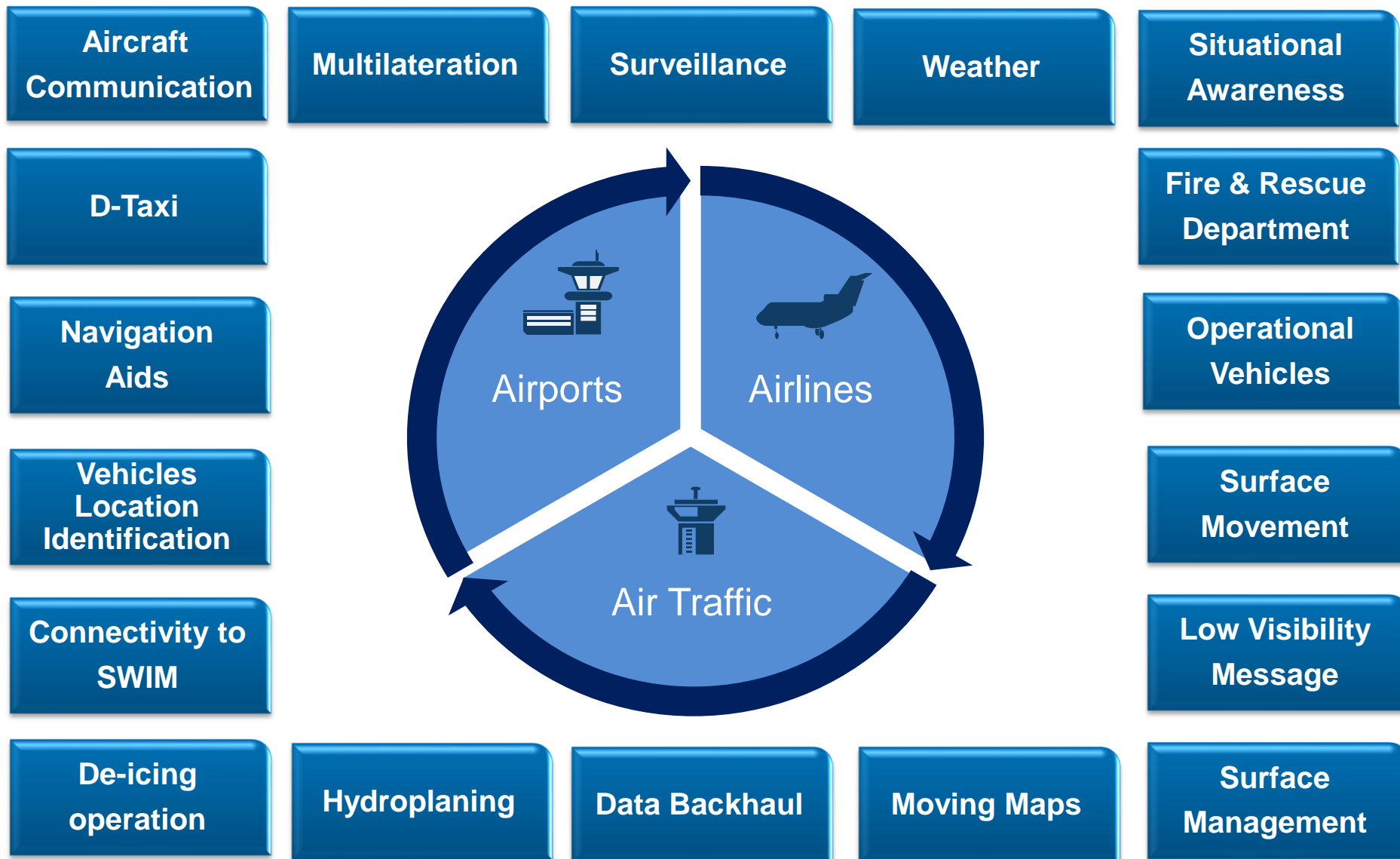
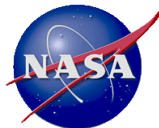AeroMACS and Telemetry tests at Embraer facility.

Airbus aircraft installation and rational.

AeroMACS Current Implementations

Aircraft Communication

Multilateration

Surveillance

Weather

Situational Awareness

D-Taxi

Fire & Rescue Department

Navigation Aids

Operational Vehicles

Vehicles Location Identification

Surface Movement

Connectivity to SWIM

Low Visibility Message

De-icing operation

Hydroplaning

Data Backhaul

Moving Maps

Surface Management

Airports

Airlines

Air Traffic

AeroMACS

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AeroMACS Global Contributors

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**.

- The WiMAX Forum with the collaboration of its member companies, industry leaders, experts, technology providers, **EUROCONTROL**, **FAA** and **ICAO** has been producing important work to increase awareness and advance AeroMACS as the standardized and secure broadband connectivity for the 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. **We're Here to Help!**

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.

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AeroMACS – What Is Next?

According studies and analysis, AeroMACS has been identified as a strong candidate to be used as an aviation standard for the Unmanned Aircraft Vehicles (UAV).

It has been recognized that AeroMACS can be an essential technology paving the way to fully integrate UAV into airspace operations providing a safe and efficient environment.

Gracias! Obrigada! Thank You!

Alessandra Rocha

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Back-up Slides

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 <u>potentially competitive</u> 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

5091 5095 5100 5105 5110 5115 5120 5125 5130 5135 5140 5145 5150

BW = 5 MHz

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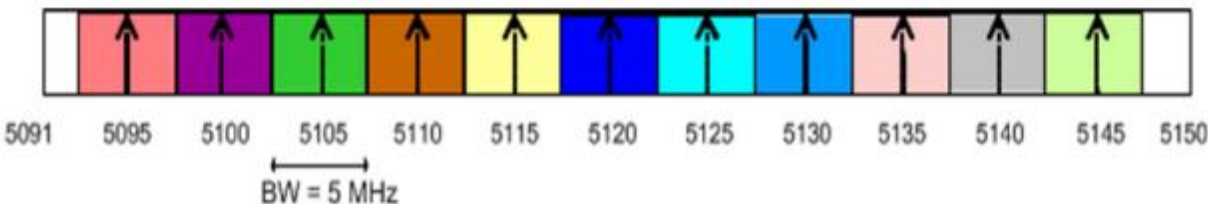
AeroMACS Features

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

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

Supports Air Traffic Control, Airline Operation and Airport communications using single technology.

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

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Over 330 AeroMACS Applications

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

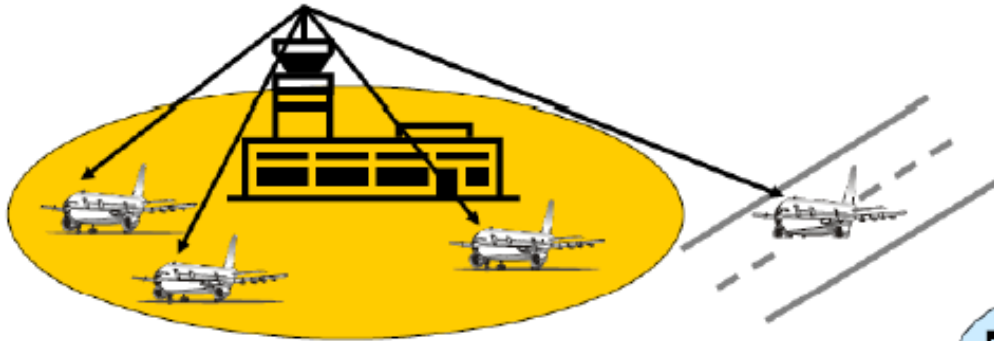Support airport operations and any applications mandated by regulators

Suppliers

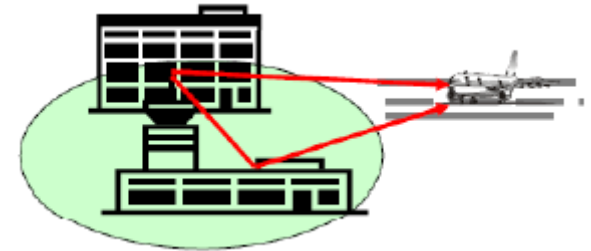Provide equipment, services, network applications and management tools

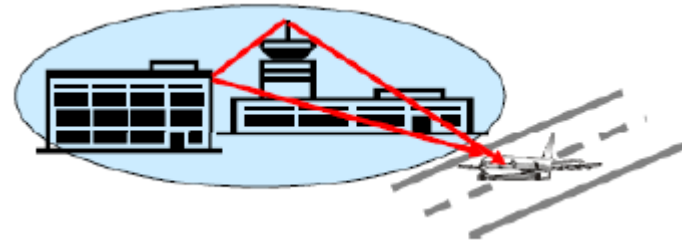**Synergy to share the network infrastructure and its benefits**

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AeroMACS Basic Scenarios

Transmission from control tower to aircrafts
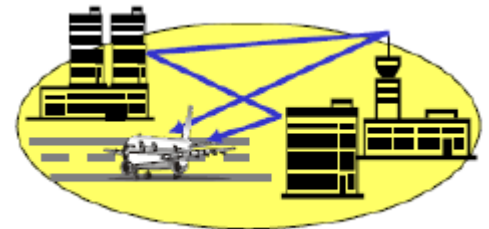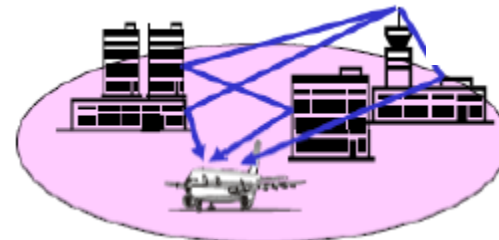
Runway

Taxi

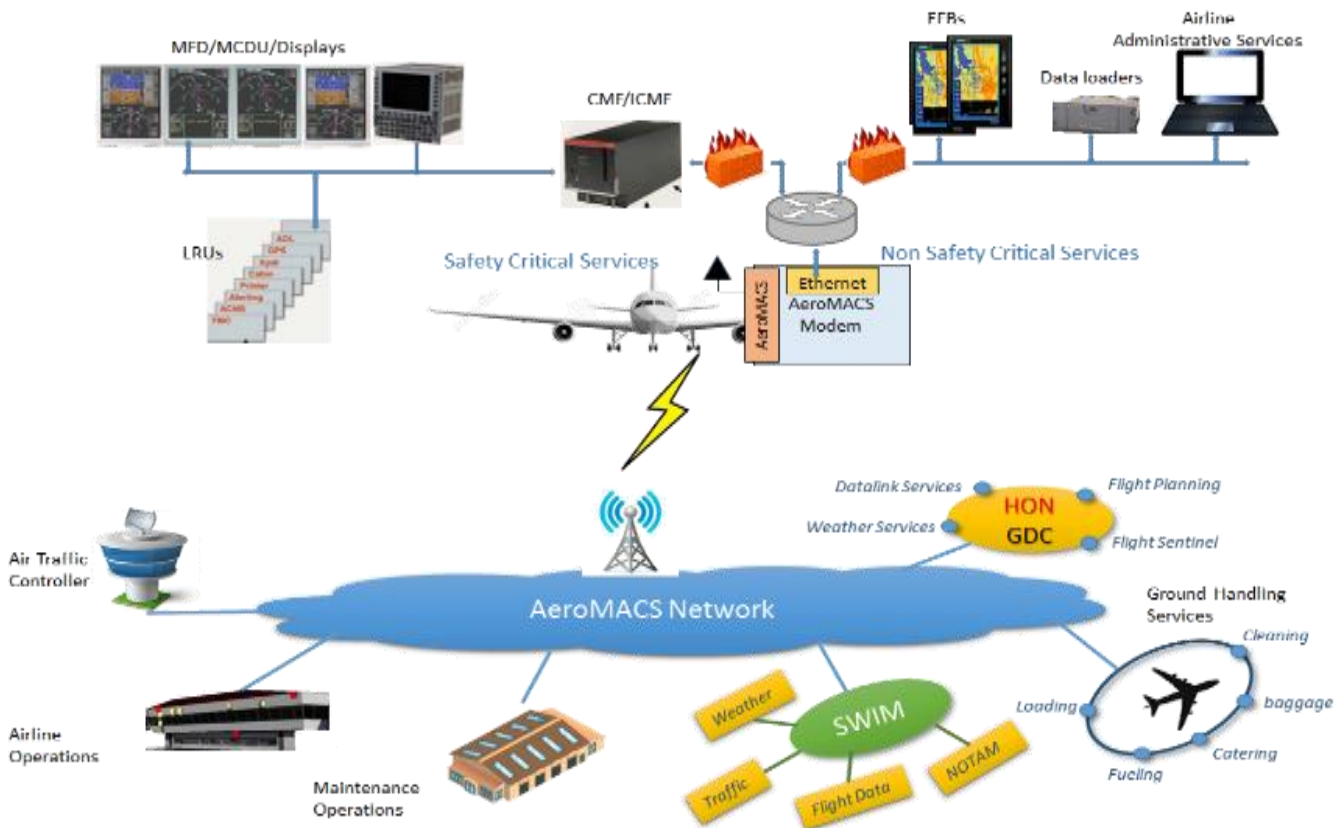**Transmission from aircrafts to control tower**
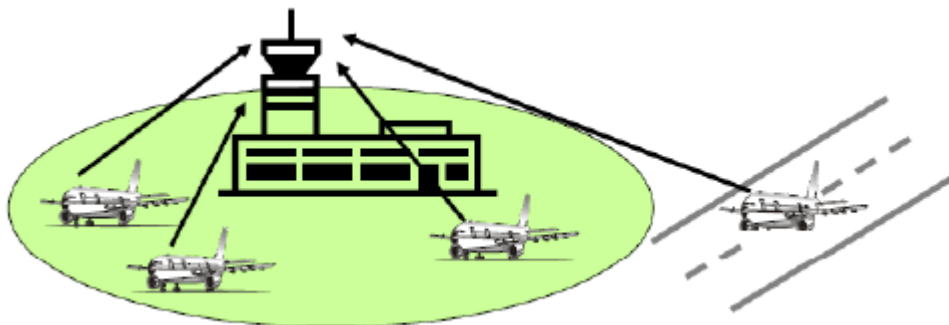
Apron

Parking

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