Federal Aviation Administration

Aeronautical Mobile Airport Communications System (AeroMACS) for Access to SWIM

Presented to: Demonstration and Prototyping Information Exchange TIM6

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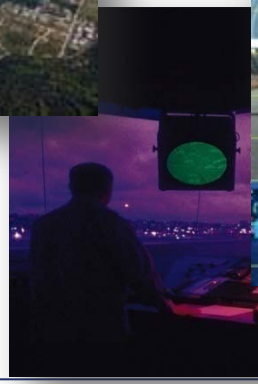
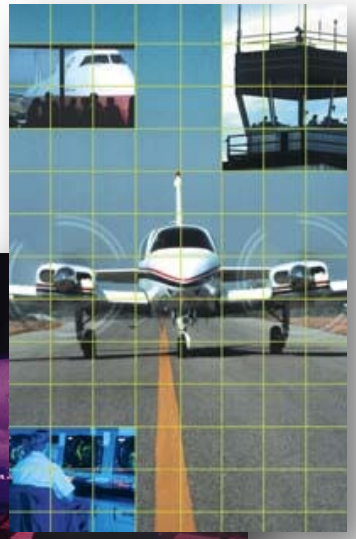
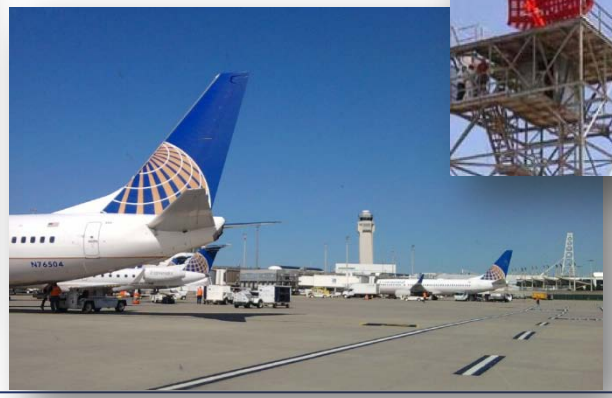
Aeronautical Mobile Airport Communications System (AeroMACS)

- Mobile and fixed broadband wireless networked communications for the highest concentration of users in the National Airspace System: Airports
  - Air traffic control, airline operations, airport operations, safety services, situational awareness







AeroMACS Description

- **Broadband wireless mobile communications technology in protected AM(R)S spectrum (5091-5150 MHz) for airport surface applications that involve safety and regularity of flight**

- **A physical and MAC layer standard based on the commercial WiMAX™ Forum profile of the IEEE 802.16-2009 standard**

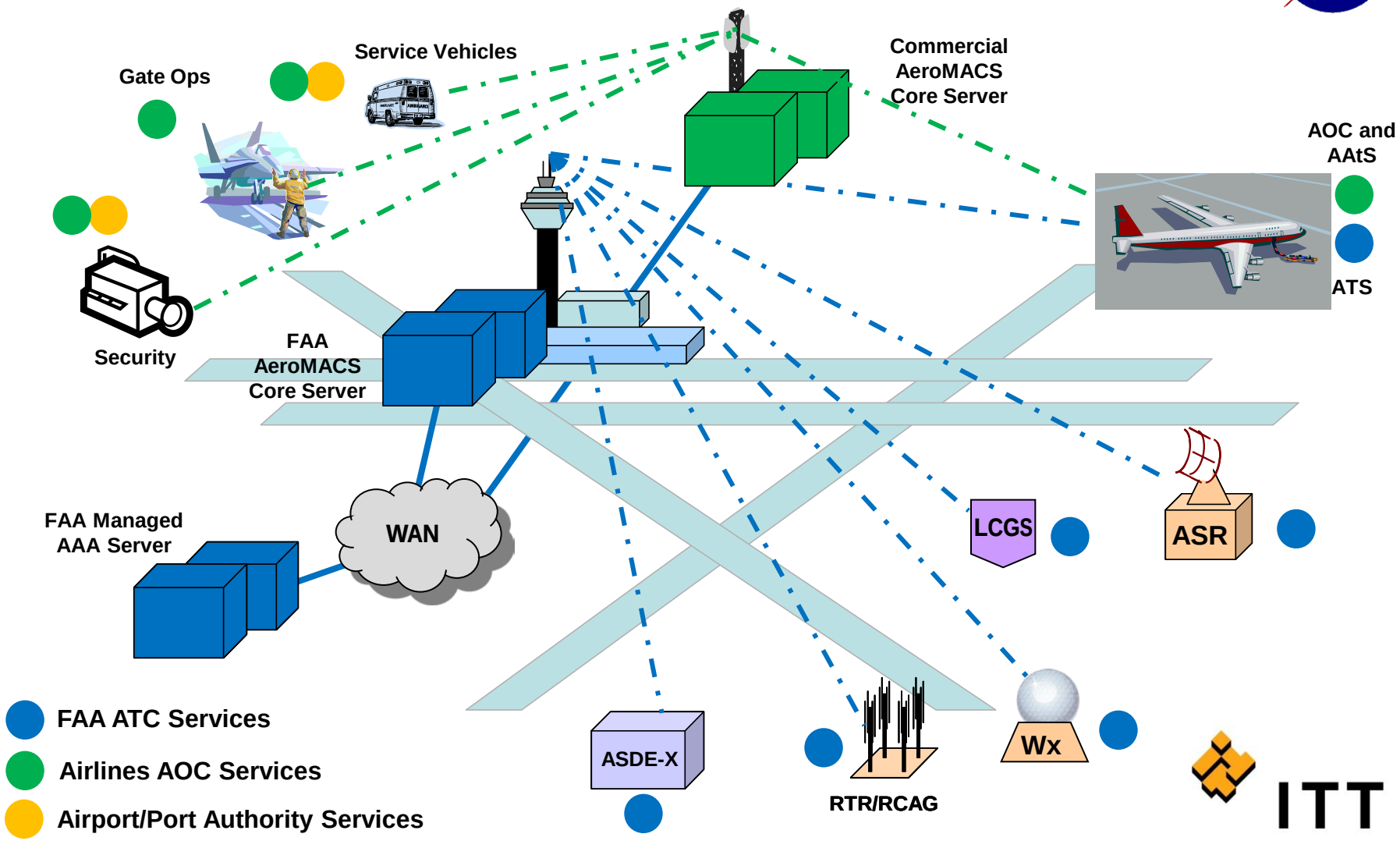
- **Commercially provided, high-rate IP network connectivity between base stations and mobile and stationary users (subscriber stations) on the airport surface**

- **International interoperability through joint RTCA / EUROCAE standard AeroMACS profile and MOPS leading to ICAO ACP Working Group S standard**

AeroMACS Features

- **Quality of Service (QoS):**
  - throughput rate, packet error rate deleted, scheduling, time delay and jitter, resource management
- **Scalability:**
  - flexible bandwidth, channelization, enable growth on demand
- **Security:**
  - authentication, authorization, encryption, digital certificates
- **Privacy:**
  - support for private Virtual Local Area Networks (VLANs)
- **Commercial Leverage:**
  - Based on modern communications technologies and supports modern Internet-based network protocols
- **Lower Cost:**
  - Via commercial standards and components, WiMAX Forum™ industry capabilities, and reduced physical infrastructure

AeroMACS Notional Network



RTCA SC-223

- RTCA Program Management Council approved SC-223 in July 2009 for Airport Surface Wireless Communications standard development
  - Aeronautical Mobile Airport Communications System (AeroMACS) profile is based on IEEE 802.16-2009 standard
  - Co-Chairs: Honeywell/Aloke Roy and ITT/Ward Hall; Government Official; FAA/Brent Phillips; AeroMACS Profile Working Group Lead: Harris/Art Ahrens; User Services & Applications Survey (USAS) Co-Leads: Mosaic ATM/Chris Wargo and FAA/Rafael Apaza
  - Plenary meetings held on 3-4 November 2009, 26-27 January 2010, 17-18 April 2010, 15-16 June 2010 in DC, 17-18 August 2010 at NASA in Cleveland, 28-30 September 2010 as joint RTCA-223 and EUROCAE WG-82 at EUROCONTROL in Brussels; 16-17 November 2010 in DC
  - Final AeroMACS profile to be defined by December 2010
  - Minimum Operational Performance Standard (MOPS) by December 2011

Air Traffic Control/Air Traffic Management Examples*

Name	Mobile/Fixed	Description
Current ACARS		
OOOI	M	Provides time of out, off, on, in
Pre Departure Clearance	M	Departure clearance information
SC-214 CPDLC Services		
D-TAXI – Update Service	M	Update continuation to any previous delivered taxi route clearance
4DTRAD	M	Trajectory negotiation
D-TAXI Graphical Msg Service	M	Transmit a representation of the taxi route to aircraft for display
COCR Services		
D-SIG Surface information Guidance	M	Status of airport elements required for movement
OTHER		
D-LIGHTING	M	Active runway lighting systems from the cockpit

* **47 potential applications currently identified**

AIS & MET Examples*

Name	Mobile/Fixed	Description
Flight Deck		
D-AUS	M	Data link Aeronautical Update Services
D-OTIS	M	Airport/Runway configuration information
Convection products		
Convective SIGMET	M	In-flight aviation weather advisory
Forecast	M	Forecast meteorological information
AIS Baseline Synchronization Service		
FMS and GPS navigational databases	M	Data base uploads to aircraft avionics
Aerodrome Charts	M	Data base updates for EFB
Turbulence		
GTG	M	Graphical Turbulence Guidance data/map

* **96 potential applications currently identified**

Airline – Cargo Operations Examples*

Name	Mobile/Fixed	Description
Ground Operations & Services		
Fueling	M	Coordination of fueling operations.
De-Icing	M	Coordination of De-Ice operations
Maintenance Information		
FOQA	M	Offload of flight operational quality assurance data
Aircraft Maintenance	M	Unscheduled maintenance coordination
Aircraft & Company Operations		
Flight Operations Manuals	M	Updates to documents (EFB)
Weight & Balance	M	Information for pilot takeoff settings

* **123 potential applications currently identified**

Airport Operations Examples*

Name	Mobile/Fixed	Description
FAR 139 Safety Self Inspection		
Navigational Aids System Maintenance	M	Reporting status of airport runway/taxiway lights, monitor repair status.
Signage	M	Issue manage and verify time critical airfield inspection defects
RFID-Real time reporting		
Parking Decal Monitoring	M	Monitor compliance
Asset Inventory	M	Read utility meters, and fixed assets
Public Safety		
Police & SWAT	M	Live wireless video feed to EOC and chief office for recording purposes.
Fire	M	Stream video feeds during fire events.

*** 33 potential applications currently identified**

FAA Airport Infrastructure Examples*

Name	Mobile/Fixed	Description
Airport Surface Infrastructure		
Airport Surface Detection (ASDE-X)	F	Surface Movement Data
Airport Surveillance Radar	F	Short Range Radar Data
Far Field Monitor (FFM)	F	ILS monitoring system Data
Glide Slope	F	Instrument Landing System Data
Remote Maintenance & Monitoring (RMM)	F	Electronic Equipment Performance Data
Medium Intensity Approach Lighting System	F	System control Data
Runway Visual Range (RVR)	F	Visibility Data
Remote Transmitter Receiver	F	Pilot Controller voice communications

* **33 potential applications currently identified**

NASA-CLE CNS Test Bed Partners

FAA ATO-P NextGen and Operations Planning

Sensis

Rockwell Collins

GE Aviation

LOCKHEED MARTIN

CLEVELAND AIRPORT SYSTEM

FREQUENTIS

LCRA

WSI

Continental Airlines

BARCO

ITT

Honeywell

AeroMACS Sponsor & Partners

FAA ATO-P/Systems Engineering; ATO-P/R&T Development; ATO-W/Spectrum	Washington DC	Research Sponsor, Collaborator, and Customer
Sensis Corporation	East Syracuse NY	>$5M in Earmarks and cost sharing on NextGen CNS Test Bed
ITT Corporation	Herndon VA, Ft. Wayne IN	$2.8M in cost sharing on AeroMACS research and prototype
Cleveland Airport System	Cleveland OH	Access to airport facilities and testing support
Ohio University	Athens OH	World class C-band channel models for Line Of Site (LOS) and Non-LOS
Continental Airlines	Houston TX, Cleveland OH	Applications and interest in deploying AeroMACS at hubs for all integrated ground ops
Air Force Institute of Technology	Dayton OH	Experiments to exploit security vulnerabilities of wireless waveforms
Mentor Radio	Cleveland OH	Aeronautical Radio equipment supplier located at CLE planning to develop AeroMACS equipment
Harris Corporation	Melbourne FL	Plans to leverage FAA and State of Florida funds to establish similar AeroMACS test bed
EUROCONTROL, EUROCAE, ICAO	Europe	Action Plan 17 and 30 for Research Collaboration, Harmonized International Standards; Software radio
Japan Civil Aviation Bureau Japan Radio Air Navigation Systems Association, Electronic Navigation Research Institute	Japan	Desire to collaborate on similar AeroMACS and FCI test beds

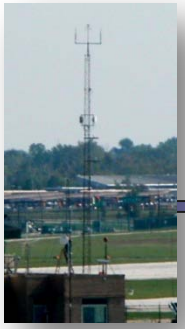
Major Milestones

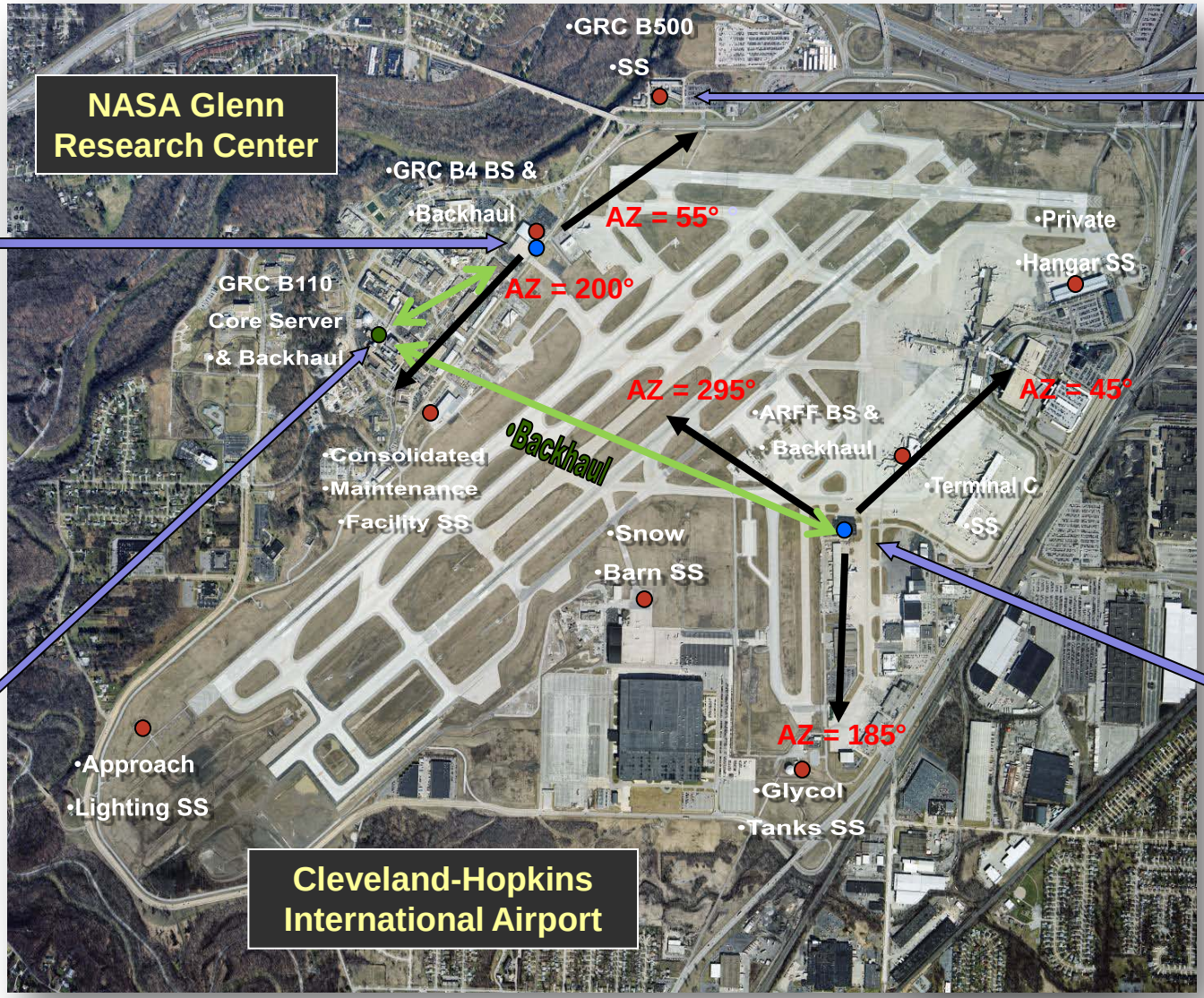
- **FY09**
  - Concepts of use, preliminary requirements, and architecture
  - Prototype AeroMACS network in the NASA-CLE CNS Test Bed
  - Initial identification of potential security vulnerabilities
  - Recommended channelization methodology and channel plan

- **FY10**
  - Draft AeroMACS Profile in joint RTCA SC-223/EUROCAE WG-82
  - Globalstar interference modeling and simulation

- **FY11**
  - Assess technical issues to support Final AeroMACS Profile and Minimum Operational Performance Standards (MOPS)
  - Enhance AeroMACS propagation and interference modeling
  - Investigate network capabilities for AeroMACS to support AOC applications and Airborne Access to SWIM (AAtS)

NASA-CLE AeroMACS Network Layout





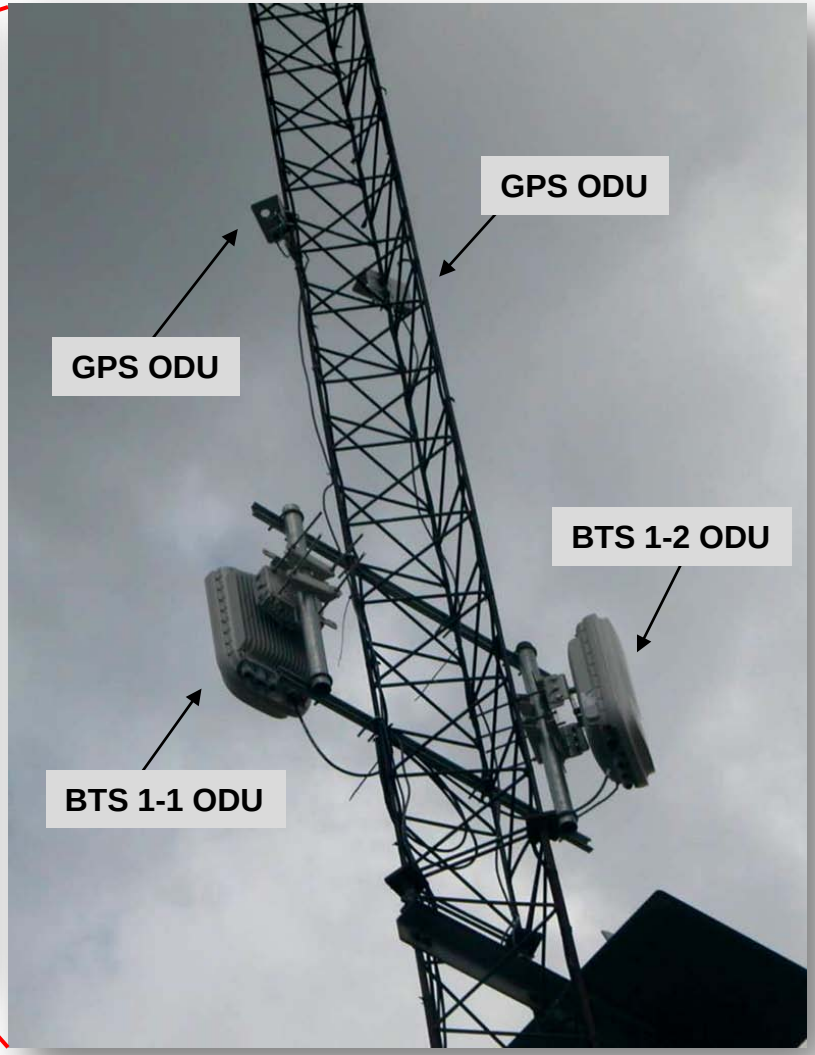
Subscriber Stations

Base Stations

Core Server

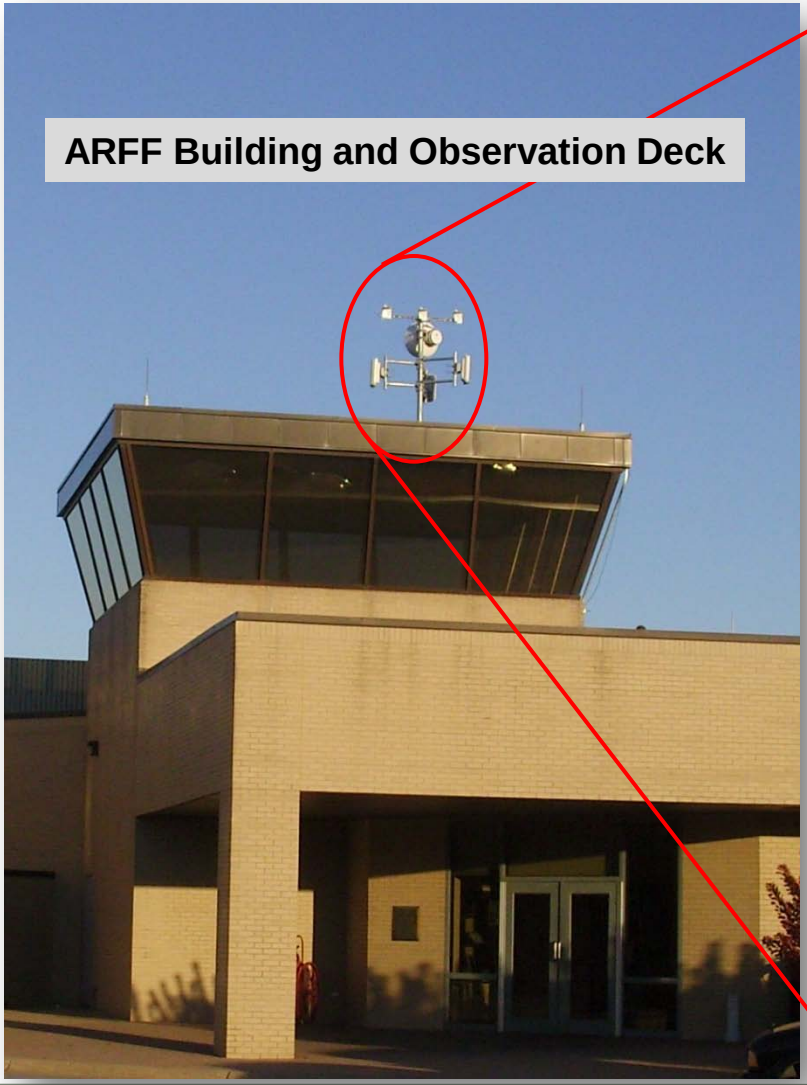
Two-Sector AeroMACS Base Station

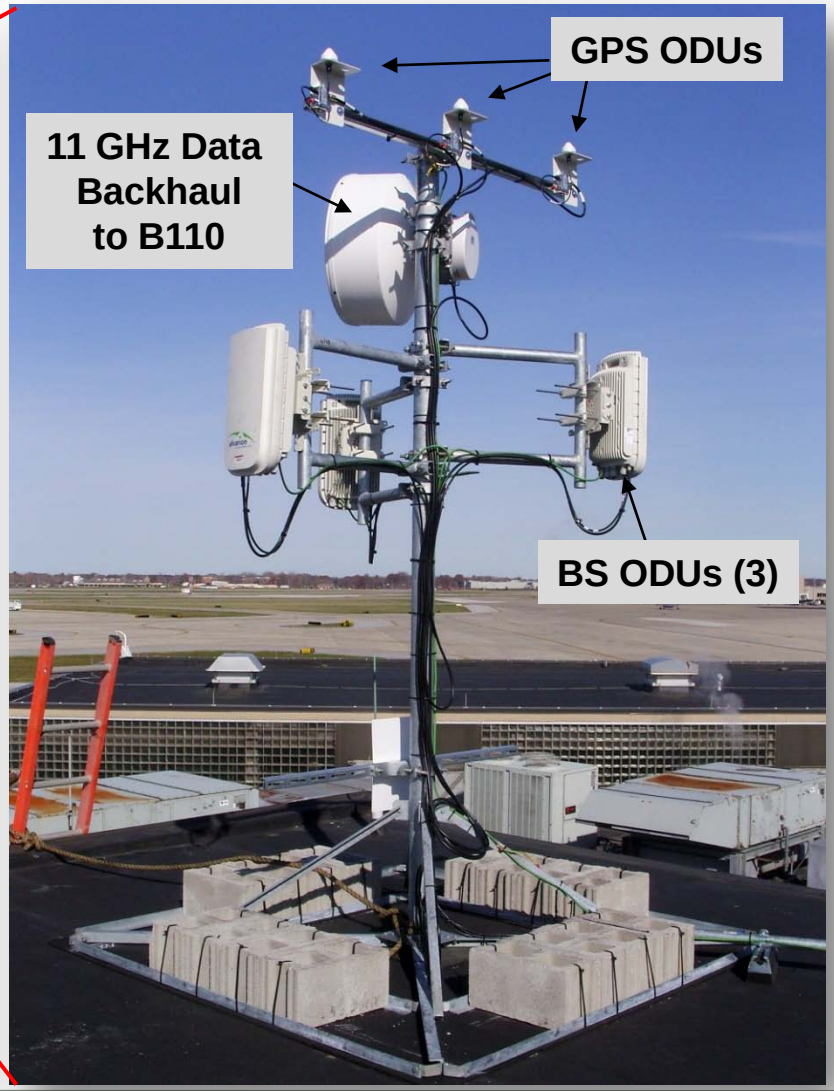
Located at NASA Glenn Hangar Building 4



Three-Sector AeroMACS Base Station

Located at CLE Aircraft Rescue and Firefighting (ARFF) Building





AeroMACS Fixed Subscriber Station

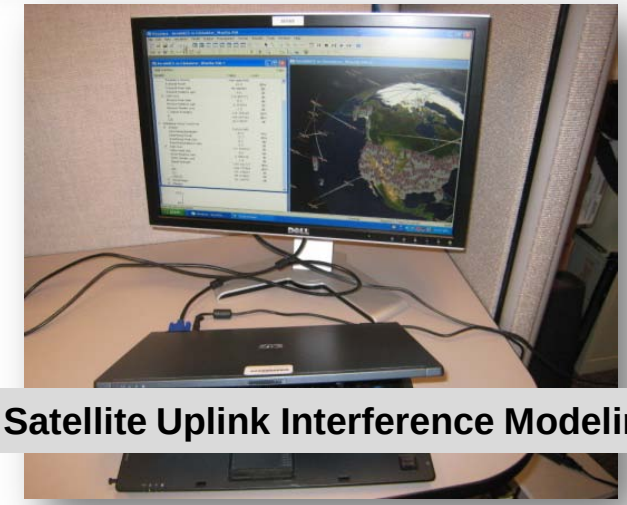
Located on Sensis MLAT Equipment at GRC Building 500

CNS Test Bed Control & Displays
Building 110 Room 310

Line-of-Site Microwave Links

Control Room

Multilateration (MLAT) Surveillance Display



Satellite Uplink Interference Modeling

Surveillance & Comm Equipment

NASA GRC Building 110 Room 310

Sensis Multilateration (MLAT) Surveillance Data Processors

ITT AeroMACS Network and Subscriber Management Equipment

Airport Surface Research &Demos

Aeronautical Research Vehicle (ARV)

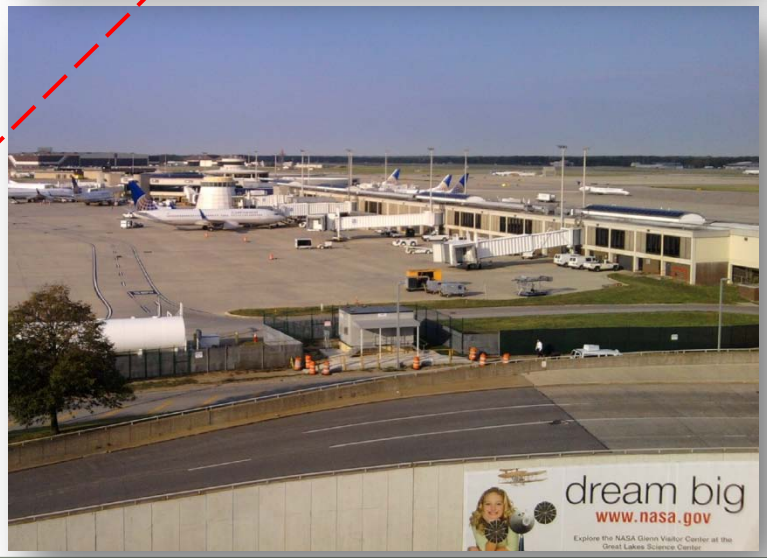
Sensor Systems MLS
5 GHZ Antenna

Sensis Mode S Vehicle
Locator 24-bit ICAO address

Viking S3-B

- FY10 Research
  - Network performance, mobile sector handoffs, blockage/ outage recovery, signal propagation
  - QoS data prioritization, data throughput, channelization
  - Security with authentication and encryption
  - Globalstar interference modeling
- FY10 Demos
  - Communication of MLAT surveillance data via AeroMACS
  - Emulate loading graphical weather products into cockpit
  - Establish Mobile AeroMACS Initial Operational Capability

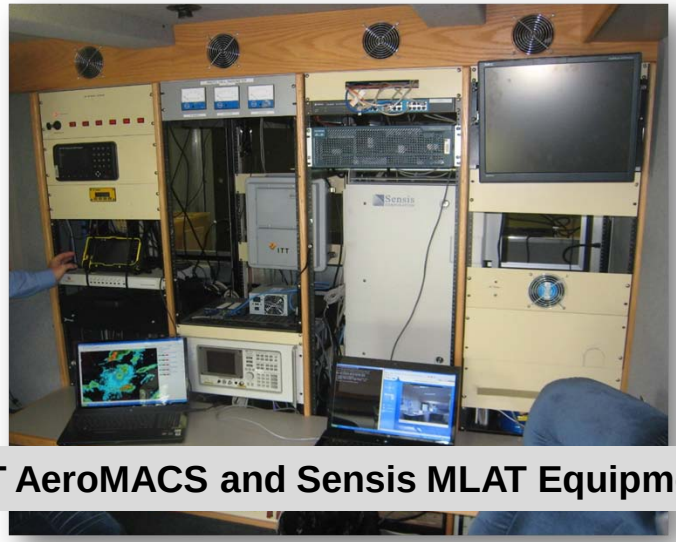
C-band Propagation Modeling



Aeronautical Research Vehicle

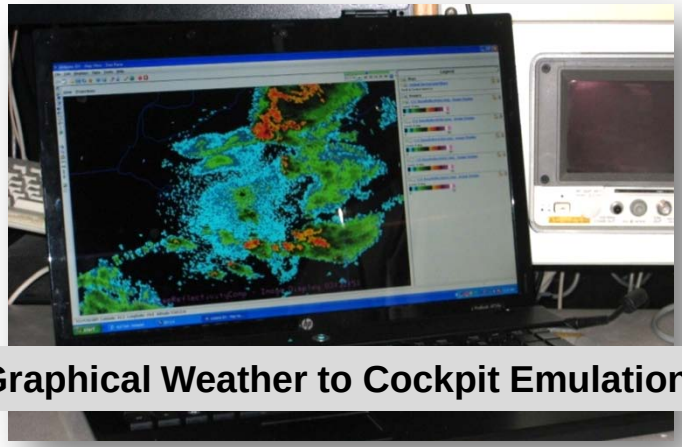
Equipped for Mobile AeroMACS Testing

Aeronautical Research Vehicle (ARV)



ITT AeroMACS and Sensis MLAT Equipment

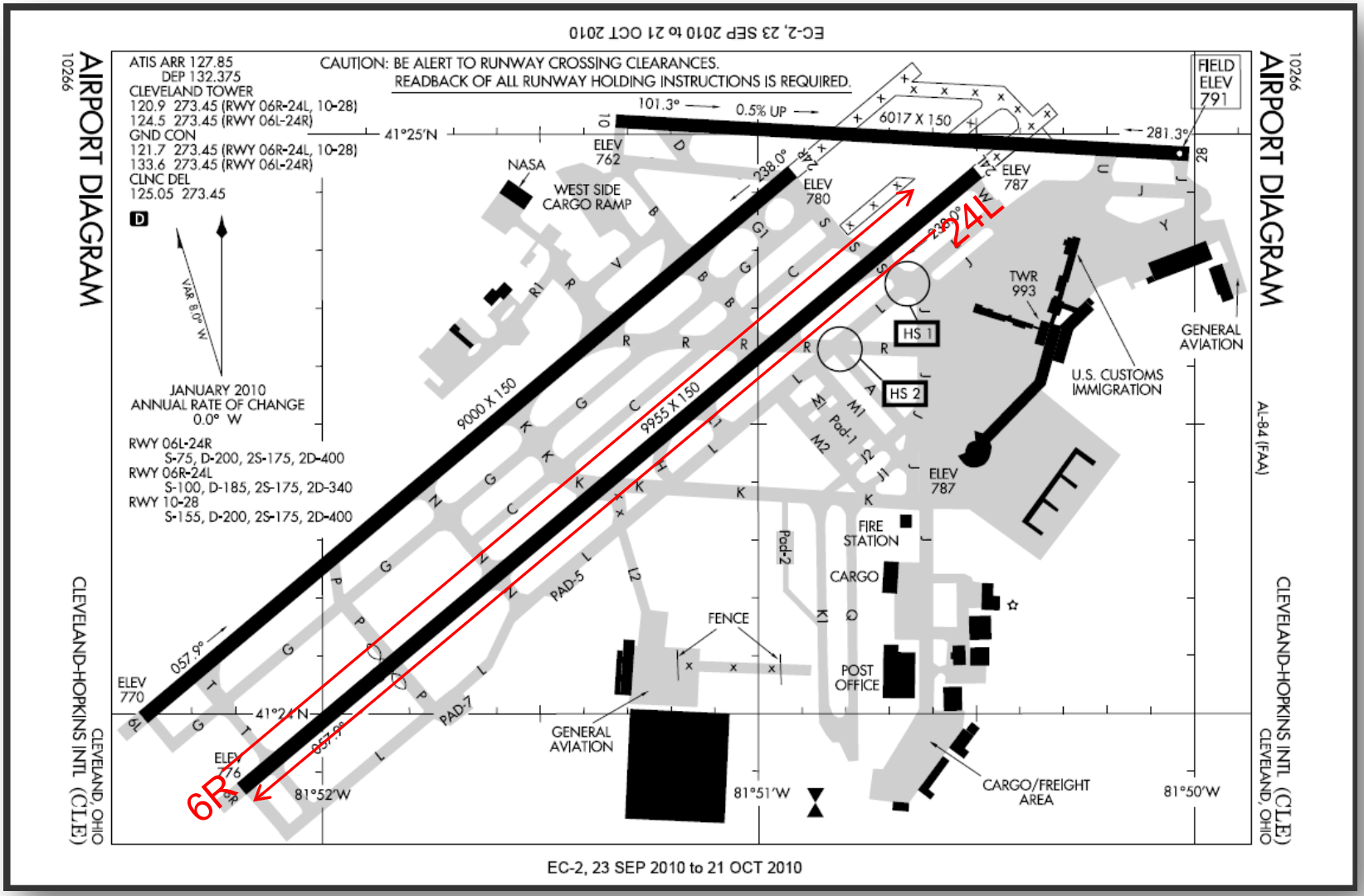
Multiple Input Multiple Output (MIMO) Antennas



Graphical Weather to Cockpit Emulation

CLE Airport Diagram

First AeroMACS Mobility Testing – 12 Oct 2010



First AeroMACS Surface Mobility Testing

CLE Runway 24L SW Traverse at 40 knots – 12 Oct 2010

First AeroMACS Surface Mobility Testing

CLE Runway 6R NE Traverse at 40 knots – 12 Oct 2010

Future Plans (FY12)

- **Verify ATS and AOC Applications & NextGen surface scenarios**
  - 4D TBO negotiations; loading 4D flight plans into FMS; monitoring 4D movement compliance and provision of corrective action; delivery of AIM and MET data to cockpit via Aircraft Access to SWIM (AAtS) prototype
- **Support harmonization on parallel research via pending AP-30**
  - Multilink (integration of A/G datalinks across flight domains); Software reconfigurable radios over multiple flight domains; COCR messages; ConUse; Support preparation for ANC-12 in 2012
- **Support Newly Announced ICAO Working Group (S) – Surface:**
  - Develop SARPS and Guidance Material for the Airport Surface Datalink once the industry groups (RTCA/EUROCAE) finish development of some basic technical standards [Ref: http://www.icao.int/anb/panels/ac]
- **Conduct AeroMACS investment analyses**
  - Business case, security, safety, and certification analyses to support FAA investment decisions and impact on Data Comm, ASDE-X, FTI

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