

Leveraging IEEE 802.16e in Airport Surface Communications Networks

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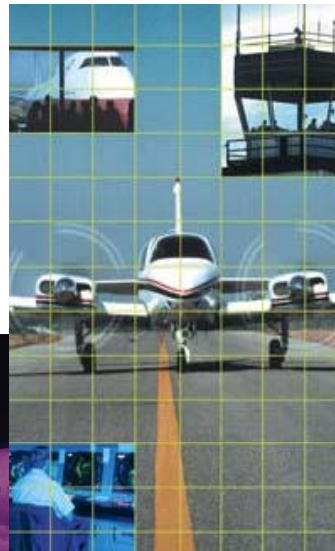
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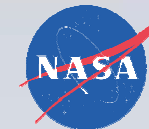
Briefing Outline

- Growing demand for airport surface communications
- ICAO endorsed basis for new standard
- New spectrum allocation for airport surface
- Potential applications for surface wireless network
- Comparison of WiFi and WiMAX features
- Deployment in NextGen CNS Test Bed

Airport Surface Communications

- Highest concentration of users in NAS
 - Air traffic control, airport operations, airline operations, safety
- Mobile and fixed assets
- Mobile access to SWIM





ICAO Endorsed Common FCS Technology Recommendations

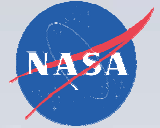
[ICAO ACP R1] Develop a new system based on the IEEE 802.16e standard operating in the C-band and supporting the airport surface environment.

United States		Common Shortlist		Europe	
Continental	B-AMC P34/TIA-902 LDL AMACS	B-AMC P34/TIA-902 LDL AMACS	Continental	Custom Satellite	
Oceanic/Remote	Inmarsat SBB Custom Satellite	Inmarsat SBB Custom Satellite	Oceanic/Remote		
Airport	IEEE 802.16e	IEEE 802.16e	Airport		



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C-band Datalink Recommendations

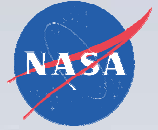
- Develop airport surface system based on IEEE 802.16e standard
 - [A1.1] Identify the portions of the IEEE standard best suited for airport surface wireless communications, identify and develop any missing functionality and propose an aviation specific standard to appropriate standardisation bodies;
 - [A1.2] Evaluate and validate the performance of the aviation specific standard to support wireless mobile communications networks operating in the relevant airport surface environments through trials and test bed development;
 - [A1.3] Propose a channelization methodology for allocation of safety and regularity of flight services in the band to accommodate a range of airport classes, configurations and operational requirements;
 - [A0.4] Complete business analysis in relation to the FCI components and implementation from the perspective of the ground infrastructure and the airlines.



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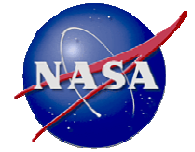
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2007 World Radiocommunications Conference Decision

- The WRC-07 approved adding an AM(R)S allocation for 5091-5150 MHz to the International Table of Frequency Allocations
 - Removed prior limitation in so-called MLS Extension Band for “support of navigation/surveillance functions”
 - AM(R)S designation for safety and regularity of flight applications
 - No interference allowed with other occupants in the band: non-GEO satellite feeder links and aeronautical telemetry
 - Protected allocation enables ICAO to develop international standards for airport mobile (i.e., wheels in contact) surface wireless communications networks that include fixed assets
 - Ideal for airport surface wireless network with short range (~10 km or less sector coverage) and high data throughput (10s of Mb/s)
- The WRC-11 will consider adding an AM(R)S allocation in the 5000-5030 MHz band



Potential Mobile Applications

- ATC Comm with any aircraft (A/C-to-fixed, A/C-to-A/C) anywhere
 - ATC comm with any vehicle in the airport movement area (runway and taxiways, but not ramp area where airlines control)
 - Tower datalink system (TDLS) for flight clearances
 - Loading FMS via CMU with 4D trajectories and modifications
 - Aeronautical information services updates and graphical weather
- AOC and non-ATS voice and data between airlines and pilot
 - Surface management, gate control, de-icing state
 - GPS and AIS updates (e.g., moving maps for taxi routes)
- Mobile SWIM
 - A/C access/send information (e.g., tactical Wx); Other vehicles RO
 - Fire, safety, snow removal, de-icing (in movement area)
 - Airport operations security; security video from cockpit and cabin
 - Hazards advisories and NOTAMS



Potential Fixed Applications

- Sensor data collection/dissemination for situational awareness
 - MLAT/ASDE-X
 - ADS-B
 - Airport Surface Radar (ASR) data
 - Network enabled Weather Data (ASOS, LLWAS, TDWR, ITWS, icing conditions)
- Cable/Telco replacement/augmentation
 - Backup/primary alternative to wired connections
 - Extend cable loop infrastructure to remote surface assets
 - Temporary connection of fixed assets during surface construction or service restoration

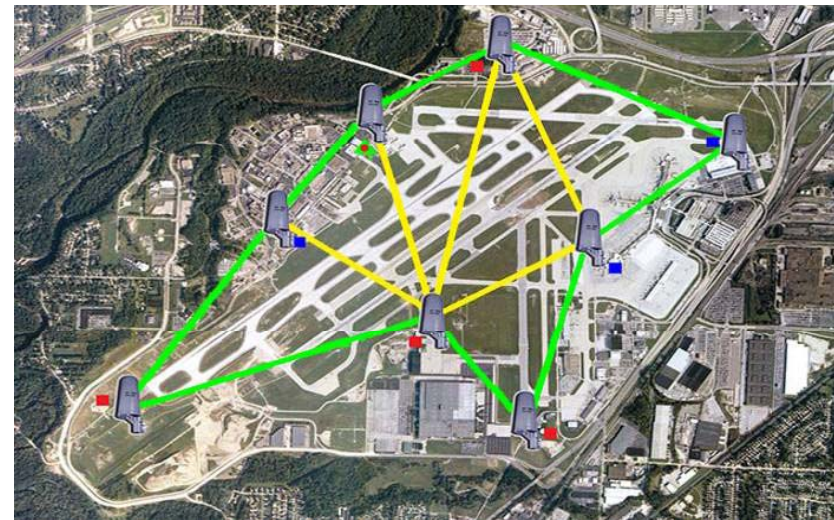


IEEE 802.16e Basis for New Standard

- 802.16e standard provides many features and modes that are applicable to ATS & AOC communications
 - Applicable modes include
 - Metropolitan-area network, supporting both point-to-multipoint and mesh topologies
 - Backhaul connections (dedicated point-to-point links) could replace conventional telecommunications functions
 - Applicable 802.16e features include
 - Designed for mobility (through 120 km/hr)
 - Line of sight communications link distance of up to ~12 km
 - Air interface supports non-line of sight communications
 - Provides robust and guaranteed end-to-end Quality of Service (QoS) with data service prioritization
 - Secure, high speed data transfer of > 5 Mbps

NextGen CNS Test Bed

- Located across three airports in the greater Cleveland, OH area and centered at Cleveland Hopkins International Airport and NASA Glenn Research Center
- Development and and evaluation of Air Traffic Control technologies and procedures for surface and wide area operations
- An eight node IEEE 802.11a based wireless mesh network on the airport surface for backhaul of airport surface surveillance data



Lessons Learned

- Currently deployed network
 - Pros
 - 5 GHz spectrum in the airport surface environment can support sustained wireless communications
 - Quality of Service and system capacity supported a latency and jitter sensitive application
 - Cons
 - Line of sight occlusion and asset mobility degraded network performance
 - Mesh failover was not instantaneous
 - Introduction of new infrastructure into airport surface environment was procedurally intensive
 - Scalability of a LAN solution can be difficult

- There is value in a robust, scalable network that can be leveraged by multiple stakeholders on the airport surface



Surface Wireless Network Technologies

	IEEE 802.11a	IEEE 802.16e
Frequency Spectrum	Middle U-NII (5250-5350 MHz)	MLS Extension (5091-5150 MHz)
Modulation	OFDM	OFDMA
Link Obstruction Tolerance	Line of Sight	Non-Line of Sight (MIMO)
Security	Optional WEP, WPA, WPA2	Inherent AES
Mobility	Limited	Up to 120 km/h
Operational Use	Fixed and Transportable Assets	Mobile, Fixed, and Transportable Assets

Moving Forward

- ITT Corporation is in the process of installing 802.16e mobile and fixed wireless communications network at the Test Bed
- Design, develop, and integrate NextGen wireless surface applications for mobile and fixed assets
- Modifications planned for GRC's "THEVAN" and potential use of S-3 or T-34 for emulation of transportable assets and mobile users to enable first phases of application development and validation

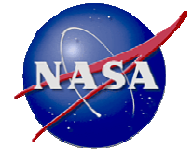


Participation or Endorsement (as of Q3FY2009)



The central image is an aerial view of the Glenn Research Center, featuring a large white dome and various industrial buildings. Surrounding this central image are logos for several partner organizations:

- Sensis** (top center)
- FAA TECHNOLOGY DEVELOPMENT OFFICE** (top left)
- Rockwell Collins** (left side)
- LOCKHEED MARTIN** (left side)
- FREQUENTIS** (left side)
- NASA** (bottom left, with text: National Aeronautics and Space Administration Glenn Research Center)
- Continental Airlines** (bottom center)
- Honeywell** (bottom center)
- WSP** (bottom left)
- GE Aviation** (right side)
- CLEVELAND AIRPORT SYSTEM** (right side)
- LCRA** (right side)
- BARCO** (bottom right)
- ITT** (bottom right)



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- <http://nextgentestbed.com/>
- <http://acast.grc.nasa.gov/main/projects/nextgen-cns-test-bed/>