NextGen ATS Communication, Navigation, and Surveillance Test Bed

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NextGen Air Transportation System CNS Test Bed

- Partnership between Government and Industry
- Objectives
  - Engineering environment for evaluating candidate technologies & systems; Emphasis on communications, navigation, and surveillance
  - Identify and mitigate risk on new concepts and approaches
- Implementation began in 2006
- Major elements
  - 3 airports: Cleveland Hopkins, Burke Lakefront, Lorain County
  - Demonstration and Analysis Center at NASA Glenn
  - ARSR at Brecksville Ohio
  - Engineering Support Center at Sensis Corporation (Syracuse)

National Test Bed for Next Generation Air Transportation System

Lorain County Regional Airport (LPR)
- No Tower
- General Aviation Activity

NASA Glenn Research Center

Cleveland Hopkins International Airport (CLE)
- Continental Airline Hub
- Commercial Airline Activity

Downtown Cleveland

Burke Lakefront Airport (BKL)
- Contract Tower
- Business Jet Activity

Three Northeast Ohio Airports networked together with NASA Glenn Research Center

Test Bed Initial Focus

Prototype Applications

- **ASDE-X Generated Alerts to the Cockpit** (Larry Surace, Tuesday afternoon)
- **Remote Tower Services** (Dana Hall)
- **4-D Departure Flow Management** (Dana Hall)

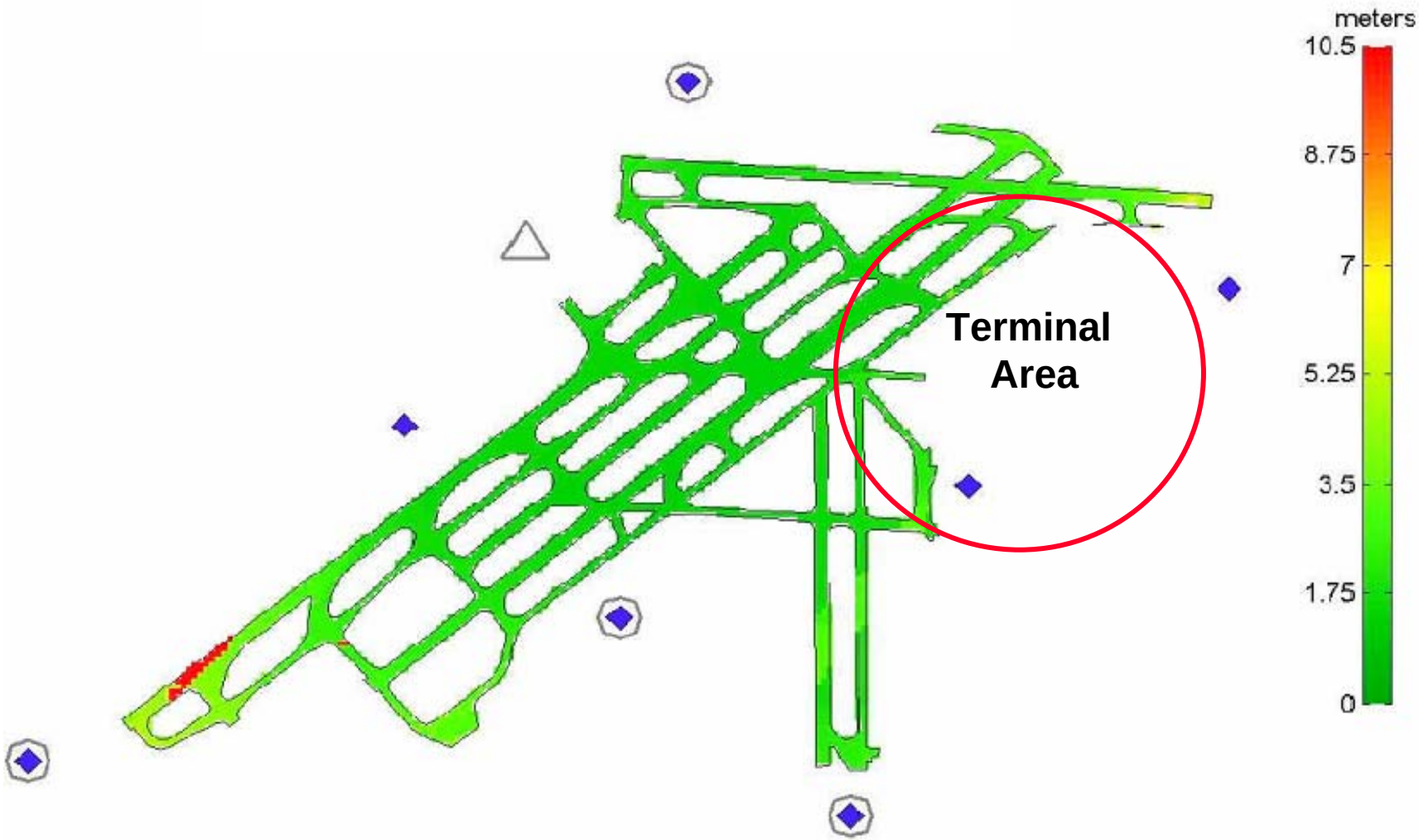
Establish Infrastructure

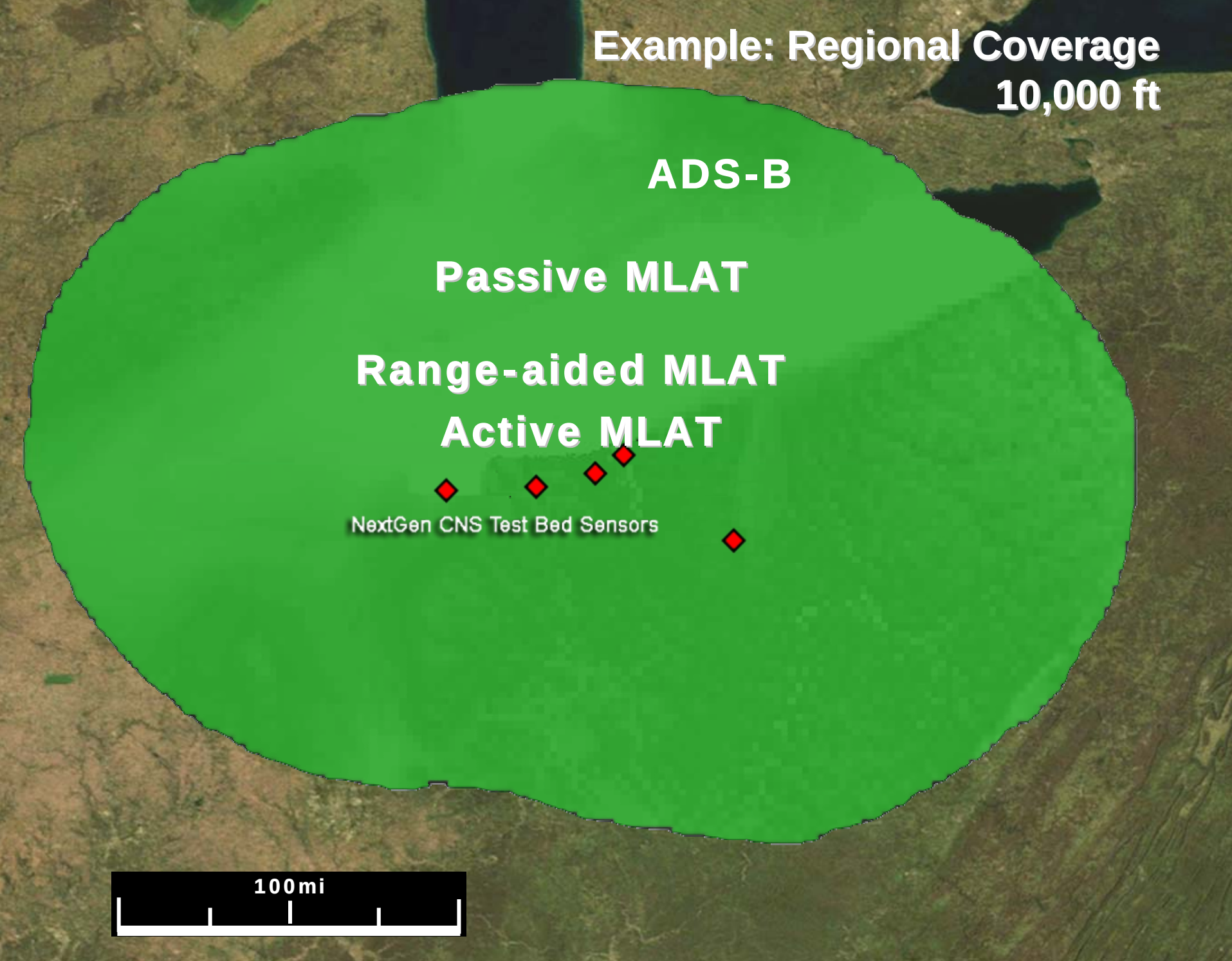
- **Information Sharing & Data Management** (Dana Hall)
- **Airport Surface Wireless Communications** (Jim Budinger)
- **Advanced Integrated Surveillance** (Dana Hall)

Advanced Integrated Surveillance

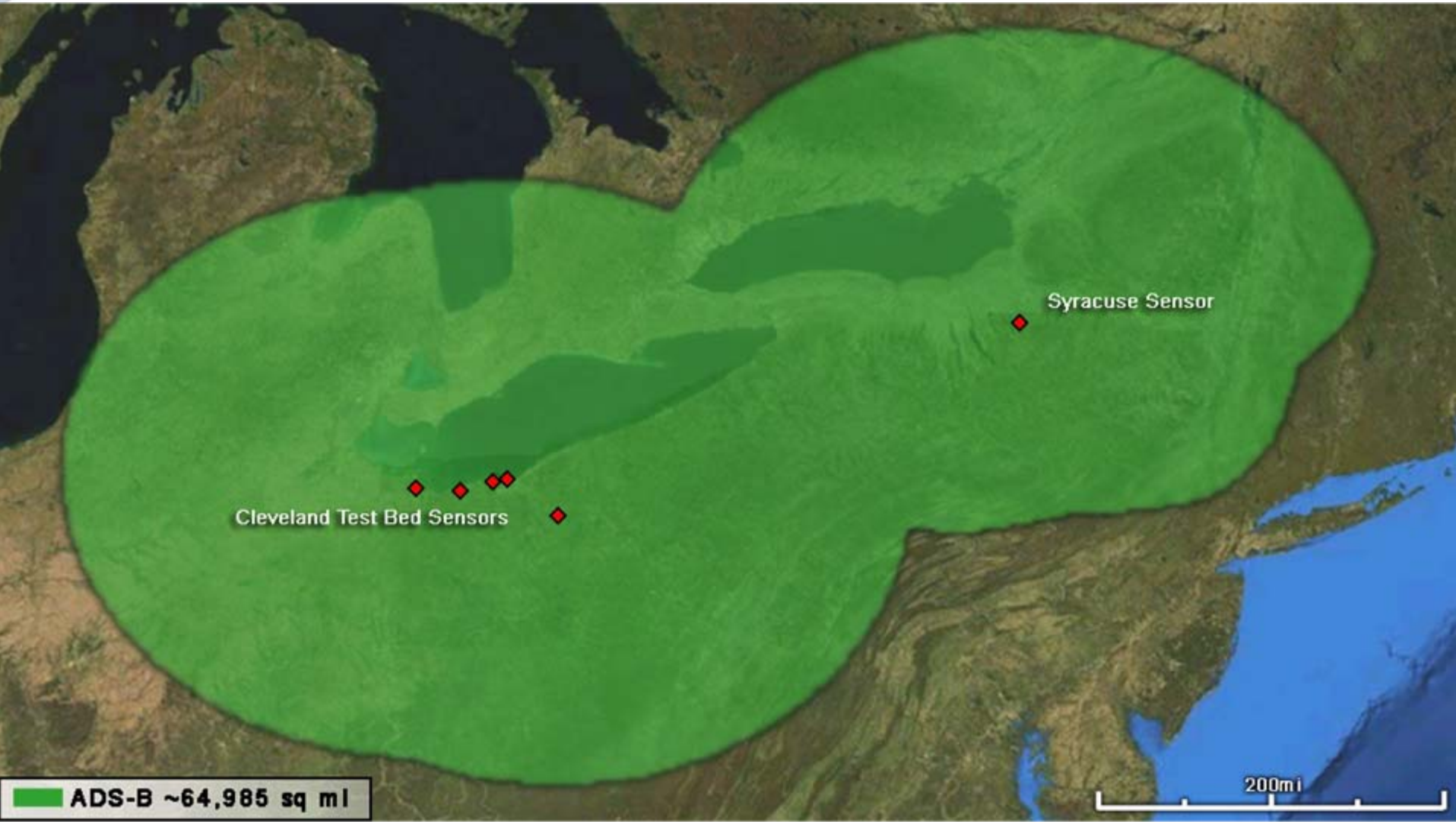
- Latest generation ADS-B/Multilateration ground stations implemented at:
  - Hopkins (8 sensors)
  - Burke Lakefront (5 sensors)
  - Lorain County (4 sensors)
- Awaiting FAA ok to add in:
  - Long range radar at Brecksville Ohio (60 miles south of Cleveland)
  - ASR-9 at Hopkins
  - Flight plan data from STARS (terminal airspace) and HADDS (enroute airspace)
- Installing additional Mlat sensor 50 mi southeast of Cleveland
- Will add sensors at Hopkins for gate/ramp/non-movement coverage
- **Result:** Unique gate-to-gate airspace and airport surface surveillance technologies engineering test bed. Can explore system-level:
  - Reliability and back-ups
  - Coverage performance
  - Efficiency and effectiveness vs cost

Example: Surface Coverage (Mlat only) Cleveland Hopkins International




Example: Regional Coverage
10,000 ft
ADS-B
Passive MLAT
Range-aided MLAT
Active MLAT
NextGen CNS Test Bed Sensors
100mi

Example: ADS-B Regional Coverage Coupling a Ground Station at Syracuse with a Ground Station at the Test Bed 30,000 ft



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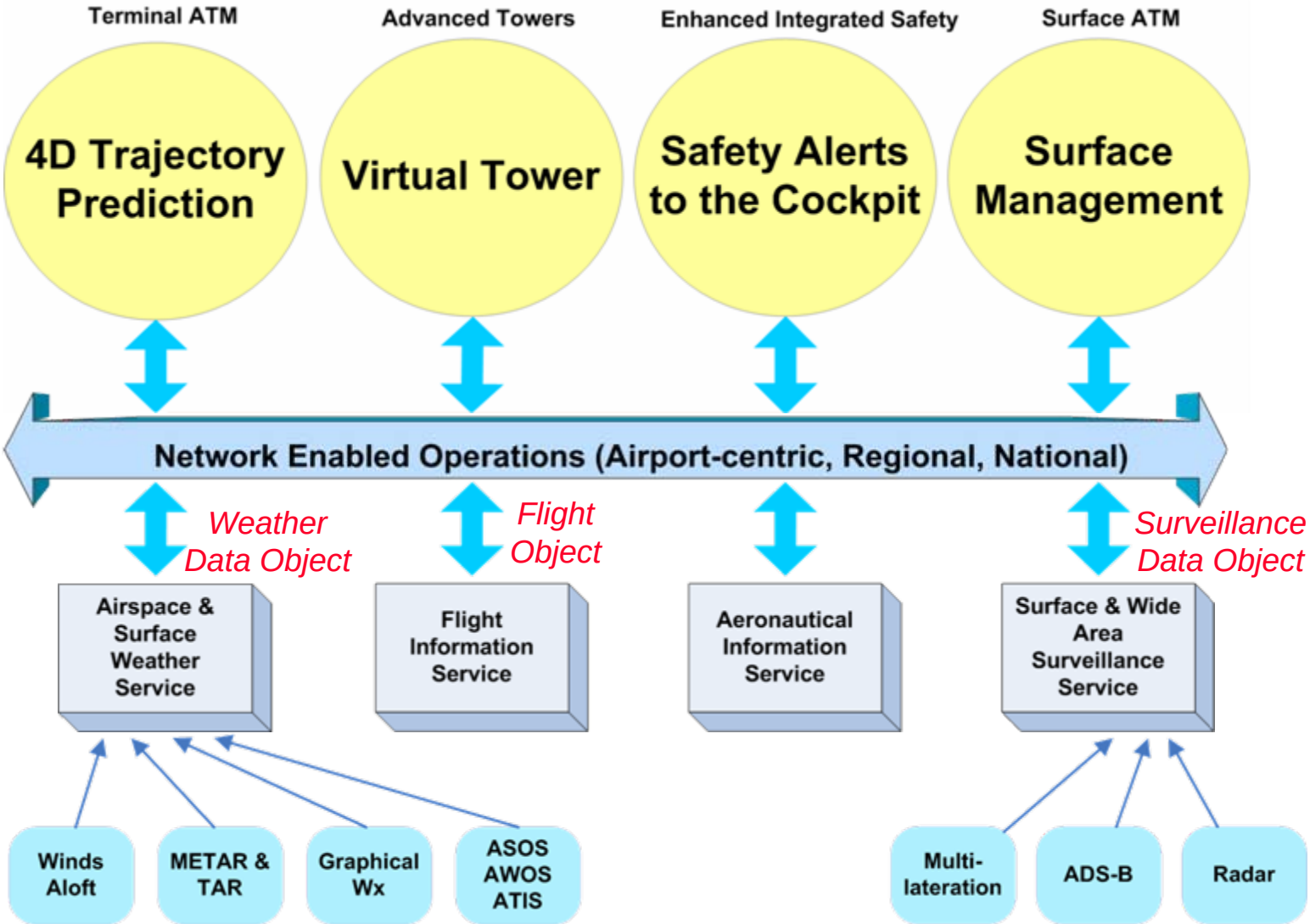
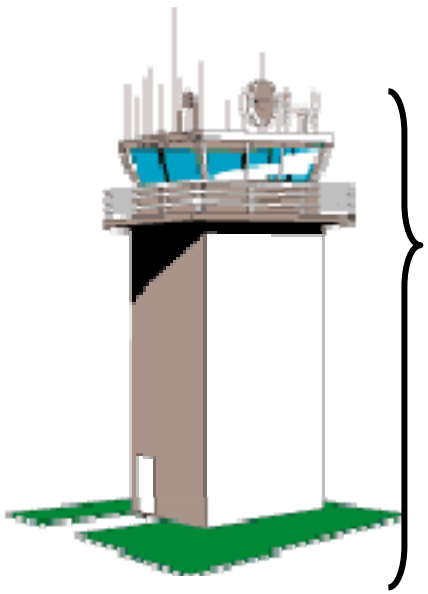
Information Sharing and Data Management

Concept: NAS-wide availability of ATM data when needed, where needed, with appropriate security



Remote Tower Services
“Systems View”



Traditional Control Tower

Existing Tower Systems

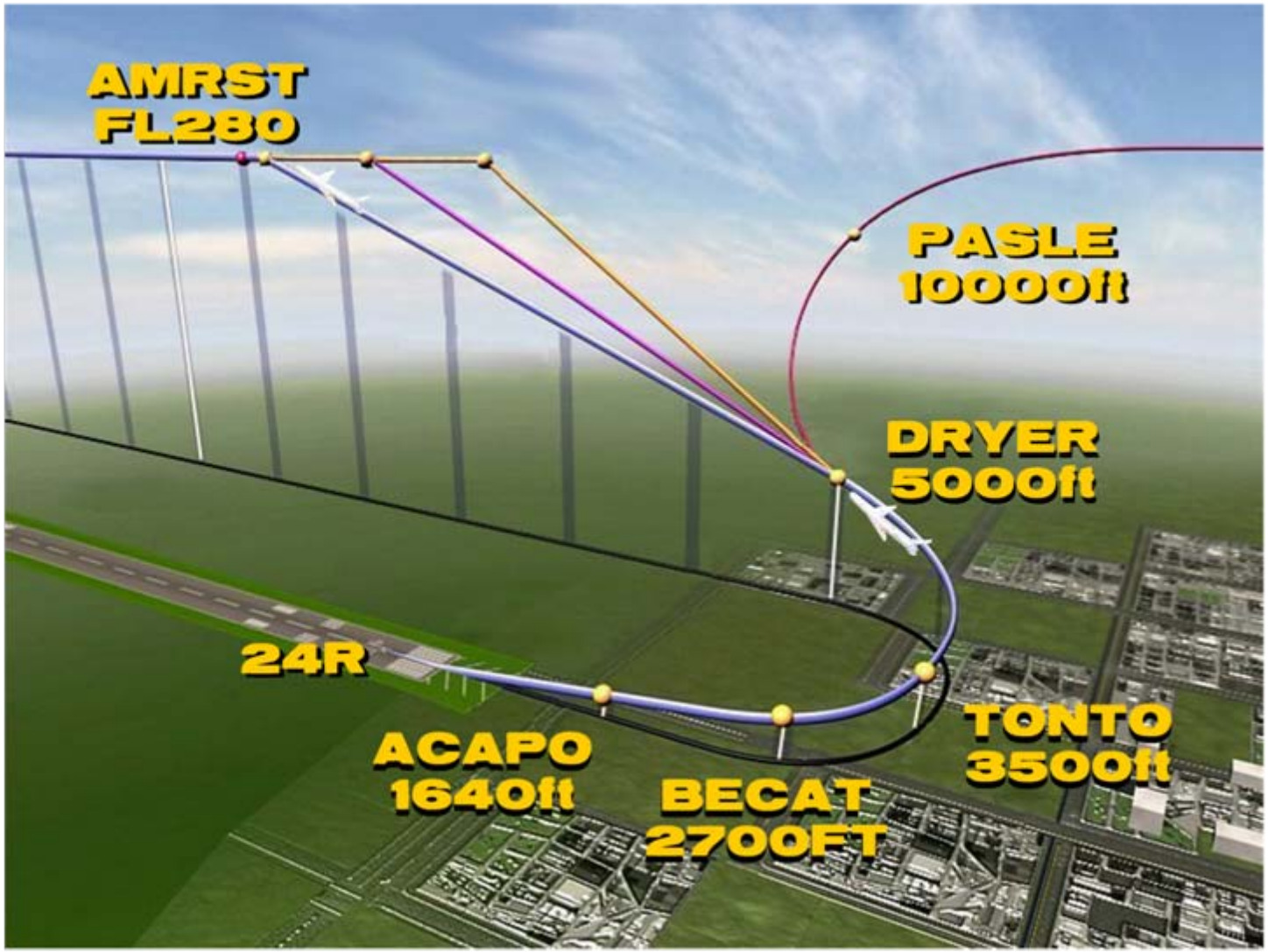
+ New Capabilities

Remote Tower Controller

Remote Tower Services Prototype Console (Demo and Analysis Center)

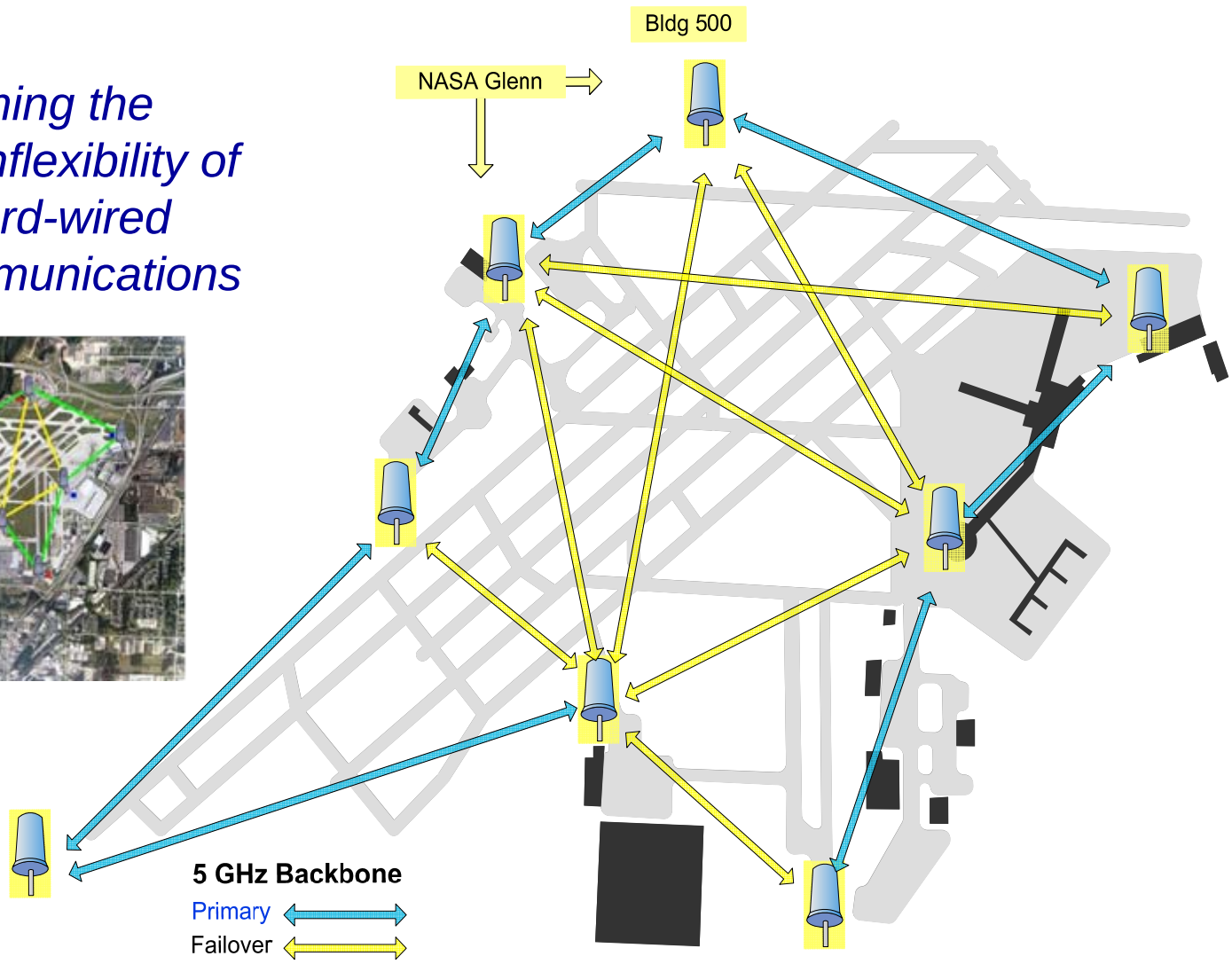
Example Application: Improved Tools for 4-D Departures

- Collaborating with Continental Airlines and GE Aviation Systems (Smiths)
- **Objective:** Develop tools that improve efficiency from gate to enroute merge



Surface Wireless Mesh Networks

Overcoming the expense & inflexibility of buried hard-wired surface communications



Why Airport Surface Wireless Communications?

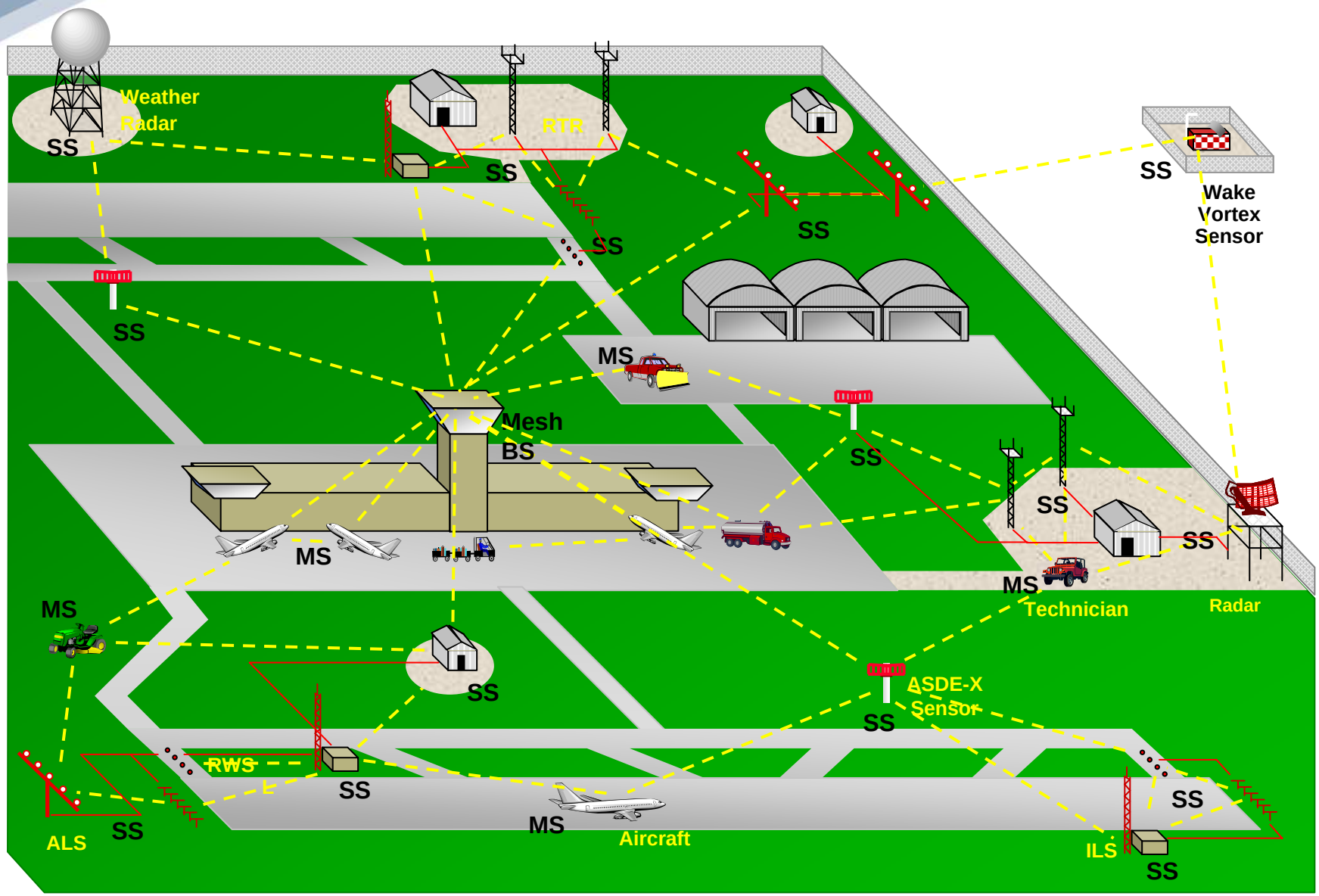
- Existing airport communications infrastructure lacks flexibility and underground cabling is expensive to deploy and maintain
  - Aging, costly, vulnerable
  - Cabling infrastructure not at all airports
  - Limited integration & network connectivity

- Current NAS modernization and anticipated “NextGen” Air Traffic System increase demands for CNS information sharing stakeholders
  - ASDE-X sensors, runway incursion prevention, weather & wake sensors…
  - Controllers, pilots, airlines, ramp, de-icing, service & emergency dispatch…

- Wireless mobile airport surface communications network benefits:
  - Reliable, secure integration of voice/video/data at all airport locations
  - Enables “SWIM” networked integration of data sources and users
  - Allows flexible, expandable, affordable deployment at all airports
  - Reduces VHF spectrum congestion

Cable Cuts During Runway Refurbishment

Surface Mesh Network Concept

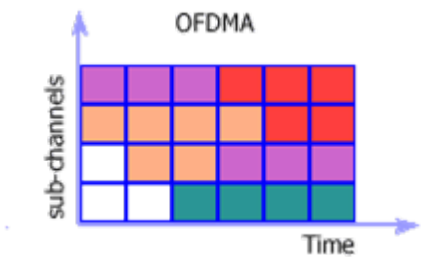


R&D Plan for Airport Surface Mobile Wireless Communications

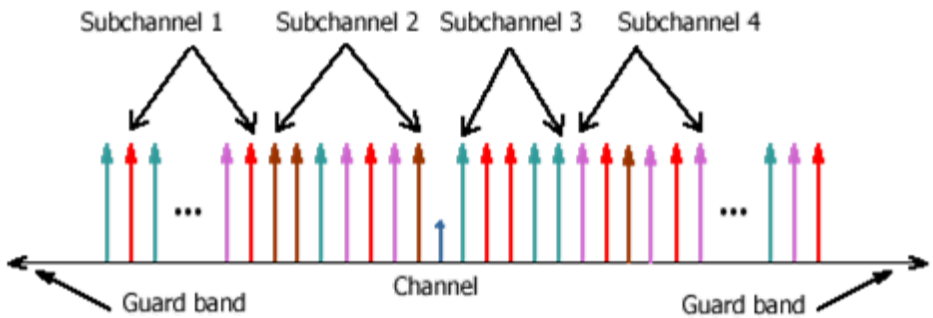
- **Goal:** Evaluate and recommend best options for 802.16e-based mobile communications in 5.1 GHz for airport surface applications
- **Research Approach:**
  - Evaluation of COTS product options
    - Verify capabilities for required capacity, latency, availability
    - Assess tradeoffs among modulation, coding, protocols options
    - Analyze enhanced performance capabilities
    - Recommend “aviation profile” from 802.16e standard for airport surface
  - Assess and recommend 5.1 GHz channelization standard
    - Partitions for safety and regularity of flight and advisory services
    - Structure adaptable across range of airport sizes and applications
    - Enable mobile extensions of SWIM capabilities among all airport users and stakeholders in SWIM Segment 2 timeframe
    - Advocate positions in WiMAX, RTCA, FAA and ICAO forums
  - Assess and complement field trials by Eurocontrol

IEEE Standard Proposed as Basis for Airport Surface System

- IEEE 802.16e has been identified by the U.S. (FAA & NASA) and Eurocontrol for safety critical airport surface mobile datalinks
  - Open standard; emerging capabilities; multiple commercial sources
    - Supports data rates to 50 Mb/s and mobility to 120 km/h within 3 mile radius
  - Compatible operation within desired band
    - 5091-5150 MHz (MLS Extension band) is within 2-6 GHz spectrum
  - Efficient access technique mitigates multi-path interference
    - Scalable OFDMA reduces ISI an allows flexible efficient allocation of spectrum
  - Adaptable link performance for various airport conditions
    - 64-QAM for best conditions, 16-QAM or QPSK for nominal, BPSK for severe



Sub-channelization in WiMAX
Users transmit in the same time slot over several sub-channels



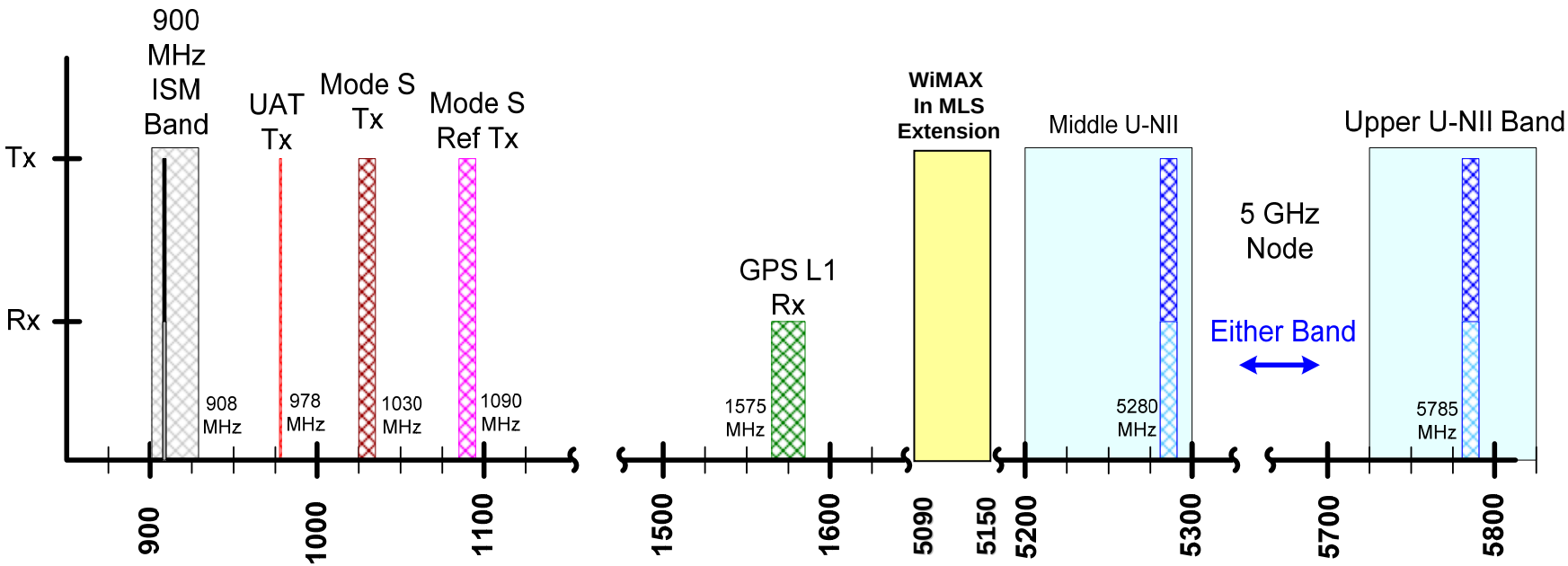
OFDMA symbol structure in WiMAX
Sub-carriers of the same color represent a sub-channel

Proposed Spectrum

- Current international allocation of 5091-5150 MHz for radio-navigation: microwave landing system and fixed satellite service (FSS) feeder links
  - Co-primary allocation limits applications to short-range transmissions to prevent interference into FSS uplinks – ideal for airport surface applications
- Upcoming World Radiocommunications Conference (WRC-07 October/November 2007) will consider changes in international allocations
  - Allocations sought for aeronautical mobile route (R) service [AM(R)S] in parts of bands between 108MHz and 6GHz for safety and regularity of flight
- The International Civil Aviation Organization (United Nations), U.S. and others support adding an AM(R)S allocation for 5091-5150 MHz
  - Protected AM(R)S allocation enables international standardization of safety critical airport mobile surface wireless communications networks that include fixed assets

NextGen CNS Test Bed Spectrum Plan

- 900 MHz unlicensed Tx/Rx for administration network
- 978 MHz licensed Tx for UAT ADS-B broadcast transmissions
- 1030 MHz licensed Tx for Mode S interrogation transmitter
- 1575 MHz GPS receiver
- 5 GHz bands for airport surface wireless backbone networks
  - 802.11a in unlicensed U-NII bands (5280 or 5785 MHz) for non safety-critical comms
  - ***Experiment with 802.16e in licensed band (5091-5150 MHz) for safety-critical data***



Surveillance & Communications Infrastructure Status

- MLAT surveillance installed at 3 airports
- Flexibility via wireless connectivity
  - 17 remote units to central processor
  - Via 802.11 in unlicensed band for initial installation and testing
  - Via 802.16e in licensed 5.1 GHz band for next phase of research
- Remote access established
  - For monitoring, reconfiguration, and control of network experiments
- Modifications to GRC's "THEVAN" are underway to enable emulation of:
  - Transportable assets
  - Mobile users