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An Experimental Airport Surface Wireless Network

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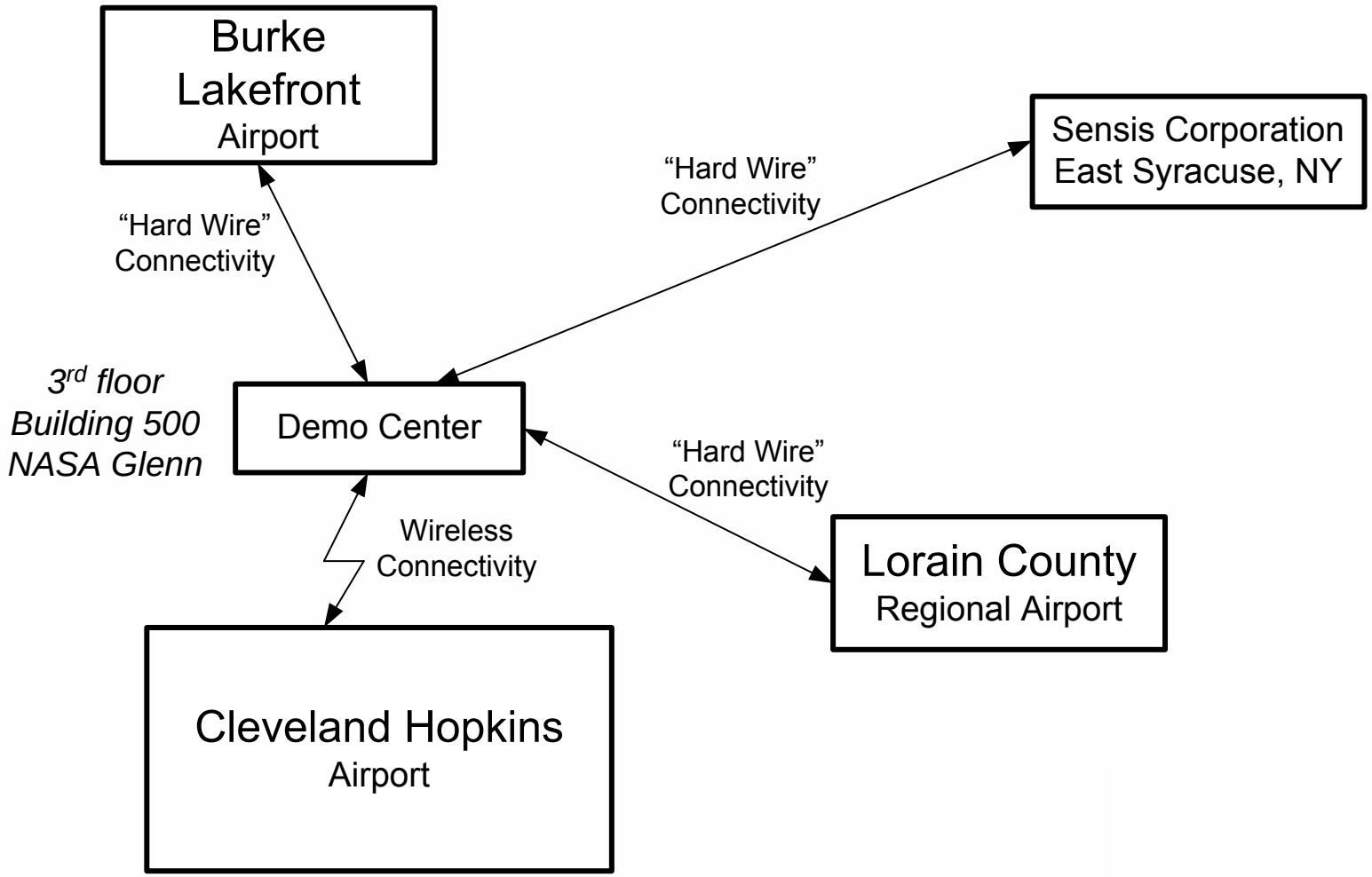
Detect the Difference

NGATS CNS Test Bed
3 Airports + NASA Demo Center + Sensis

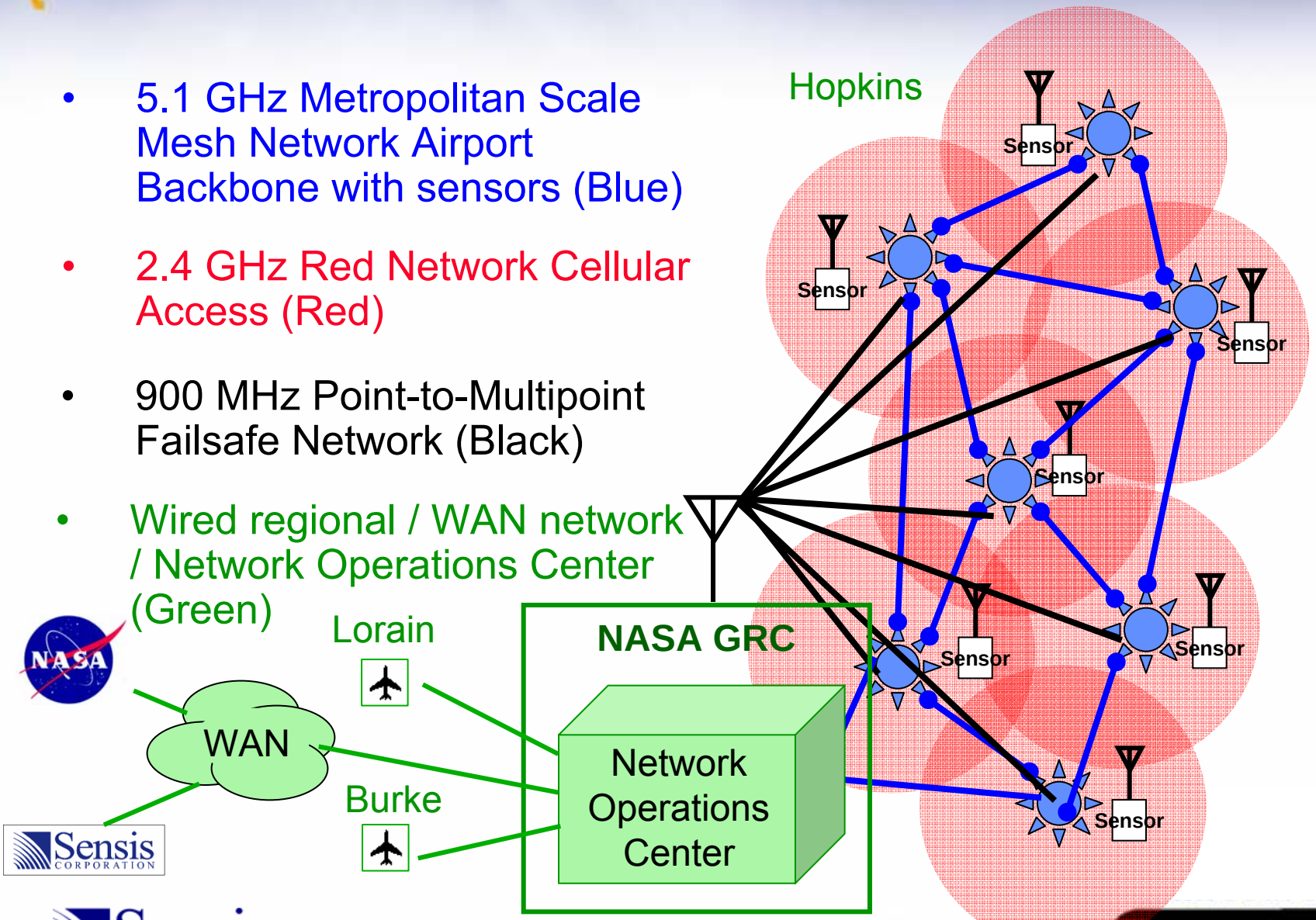


Motivation for NGATS Test Bed

- Validate NGATS concepts, technologies, policies and procedures in a real, operational environment
- Quantify stakeholder benefits to support business cases (e.g., ADS-B, SWIM/SDN investments)
- Build an early implementation for "host" airports, airlines and surrounding air transportation communities

Layered Network Architecture

- 5.1 GHz Metropolitan Scale Mesh Network Airport Backbone with sensors (Blue)
- 2.4 GHz Red Network Cellular Access (Red)
- 900 MHz Point-to-Multipoint Failsafe Network (Black)
- Wired regional / WAN network / Network Operations Center (Green)

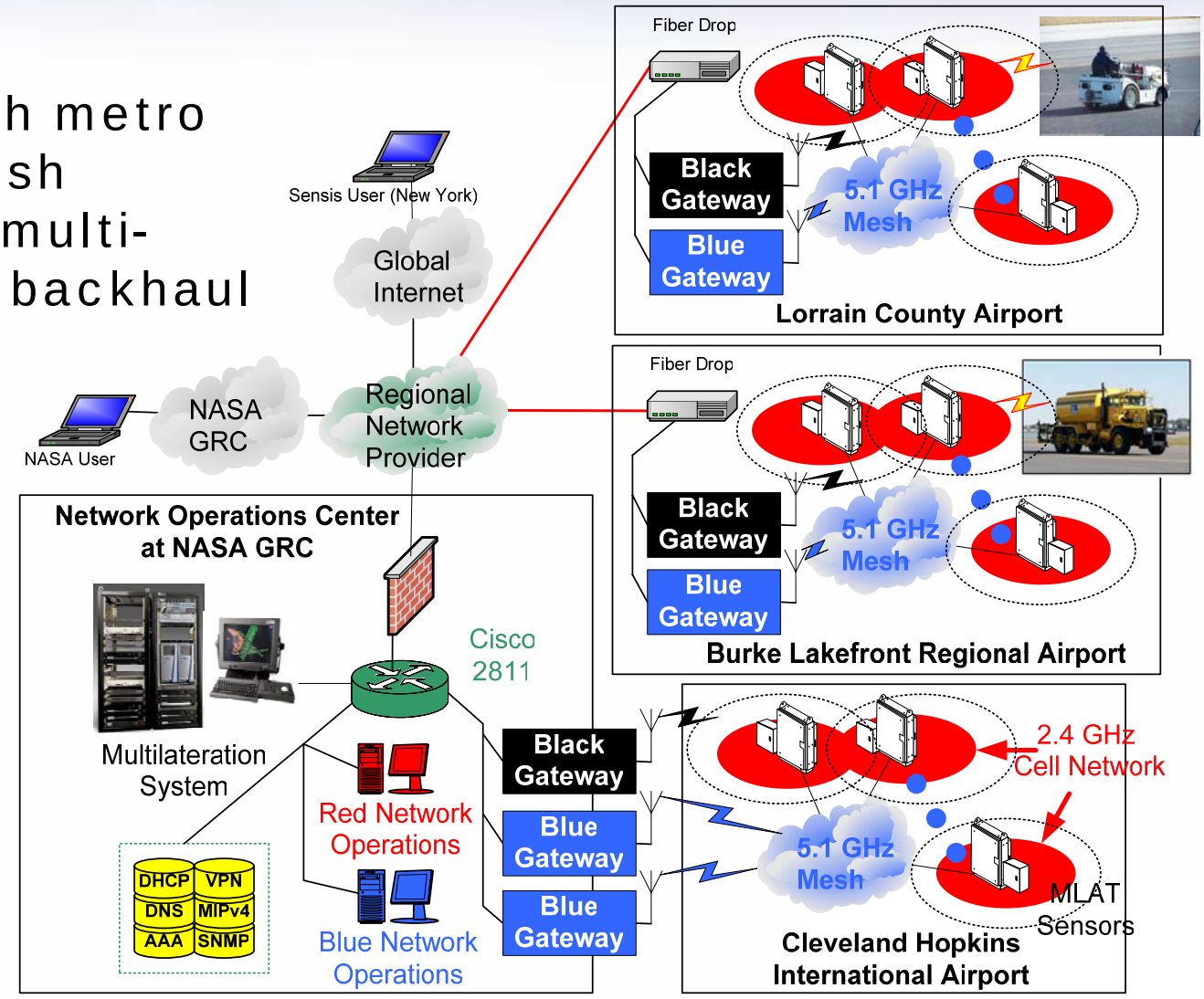


Testbed Communication Infrastructure

Three airports with metro scale wireless mesh infrastructure for multi-lateration system backhaul

Network Operations Center at NASA Glenn

Access network for mobile assets planned



Phase I Network Deployment

- **Install, configure and integrate wireless networks at each airport**
- **Configure and integrate intra-site wide area network**
- **Network experiments**
  - Link performance
  - Capacity
  - Latency
  - Mesh Failover
- **Integrate multilateration system sensors**

Mesh Network QoS

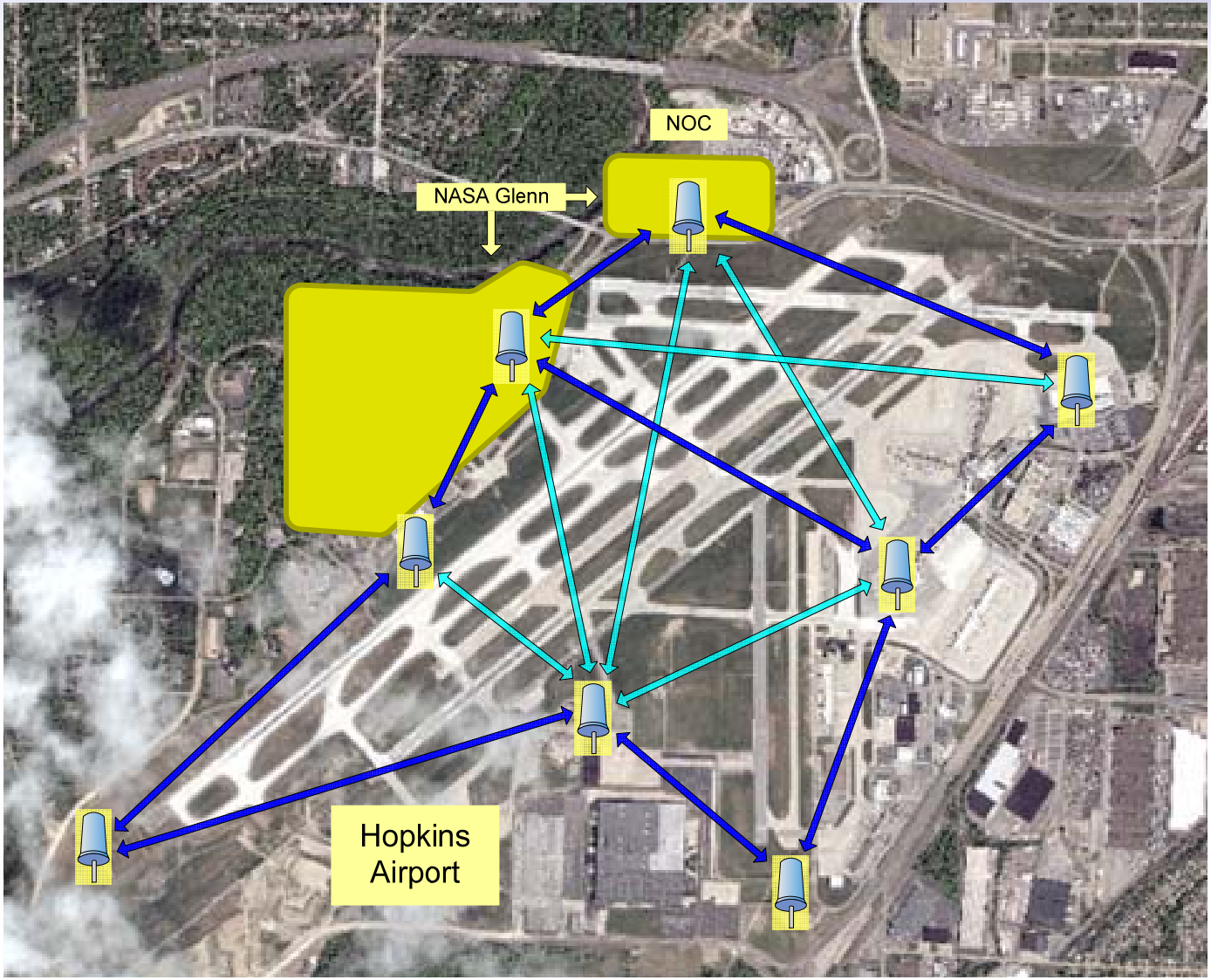
- **Subscriber Rate Control** - Operator can define maximum upstream and downstream data rates per subscriber. Rate control implemented at the network ingress points.
- **Packet Prioritization** - Operator may prioritize individual subscriber packets based on a range of parameters. This classification is completed at the ingress points and the packets are marked as having a high or low priority. Prioritization is then maintained by any intermediary mesh nodes.
- **QoS Granularity** – IP Type-of-service (TOS) field, Source / Destination IP Address, Source/Destination IP Port, Protocol Type, IEEE 802.1p

Network Security Elements

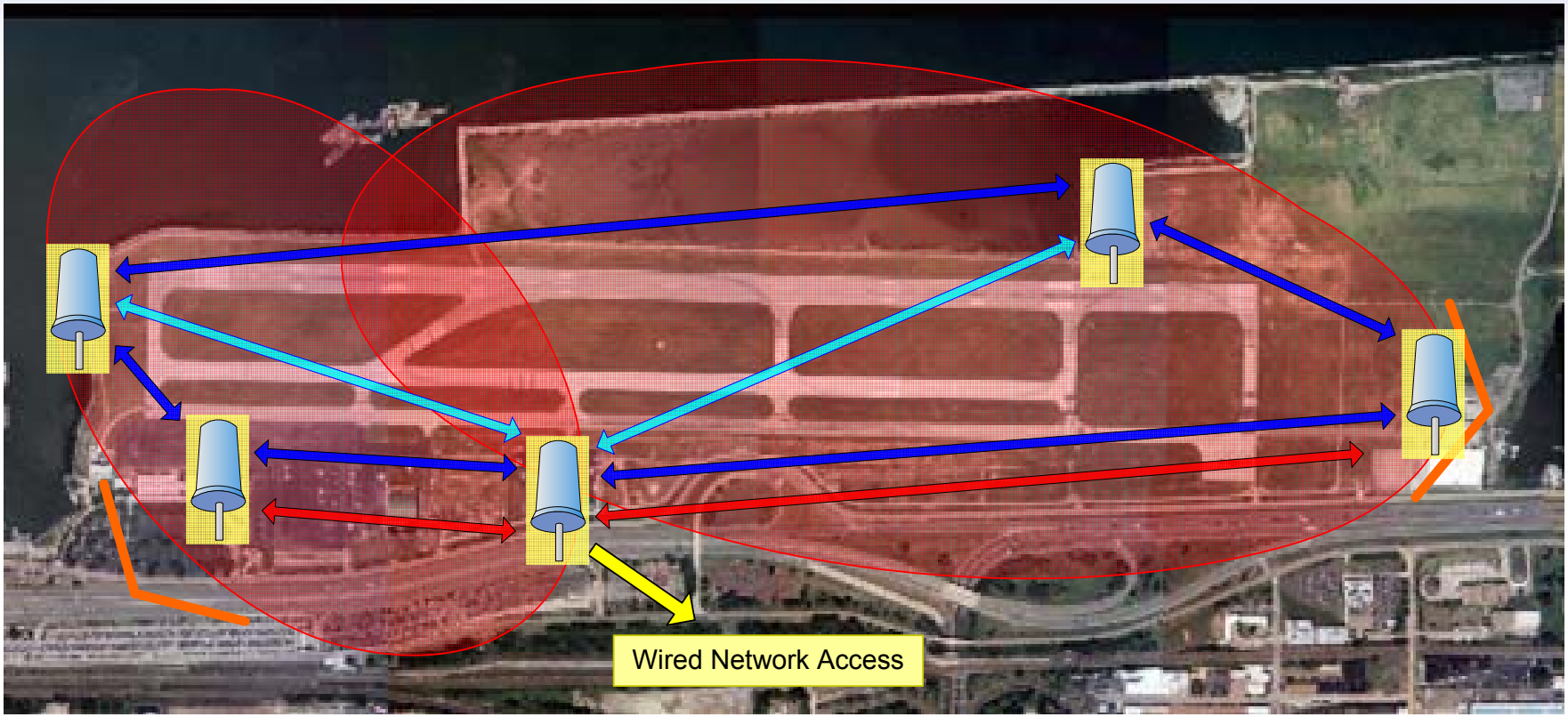
- **Blue Network uses negotiated session key between mesh nodes with AES-128-bit block cipher. Manufacturer installed MD-5 based certificates.**
- **Red Network implements WPA-2 level security based RADIUS AAA, 802.1x EAP security.**
- **Black network uses shared key 256-bit AES block cipher.**
- **WAN implements firewall with X.509 digital certificate based Cisco VPN client access.**

Cleveland Hopkins Airport Network

- Airport surface
- NASA Glenn campus
- Network Operations Center
- Mesh network
- Primary link paths
- Network gateways



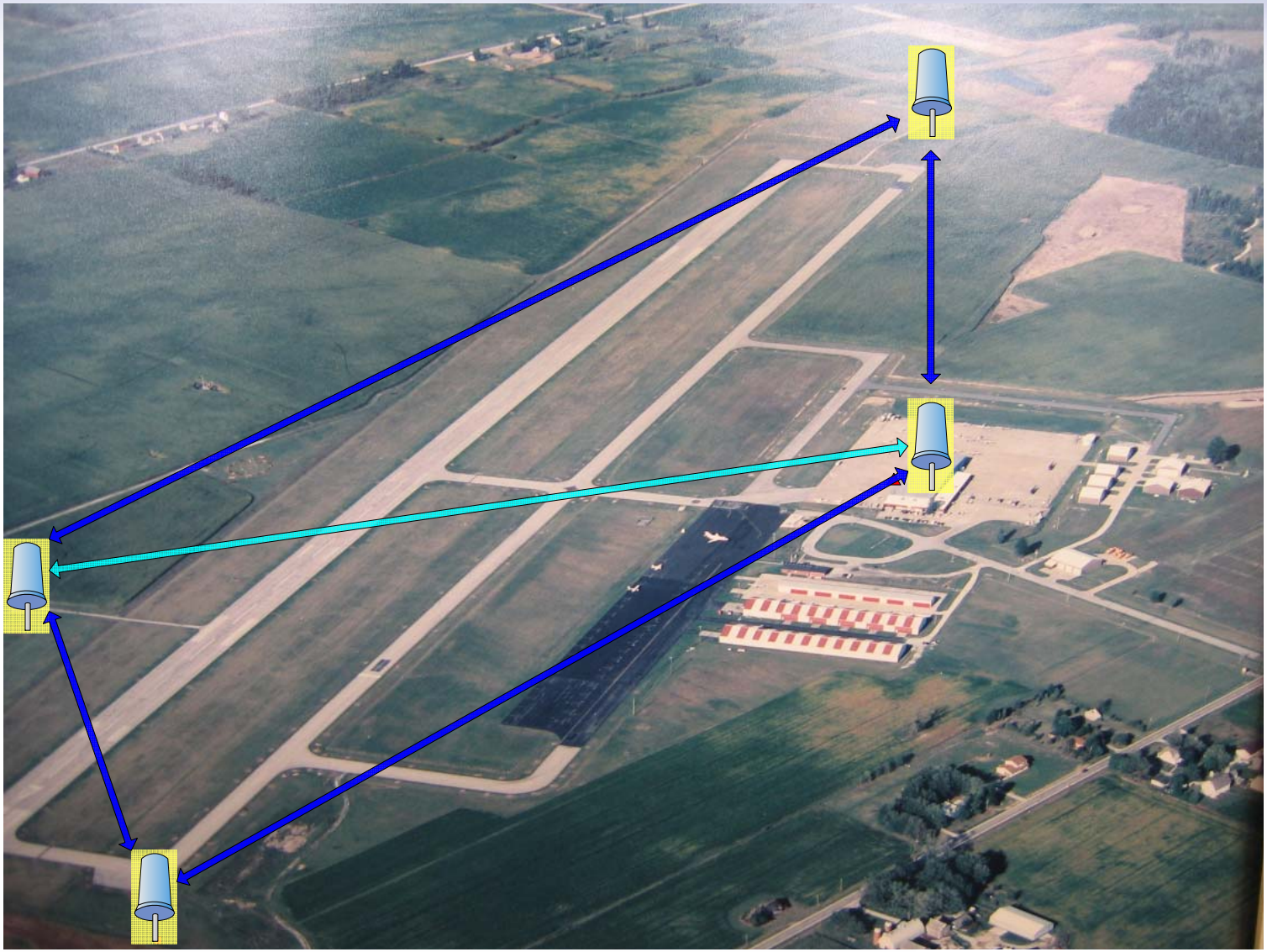
Burke Lakefront Airport Network



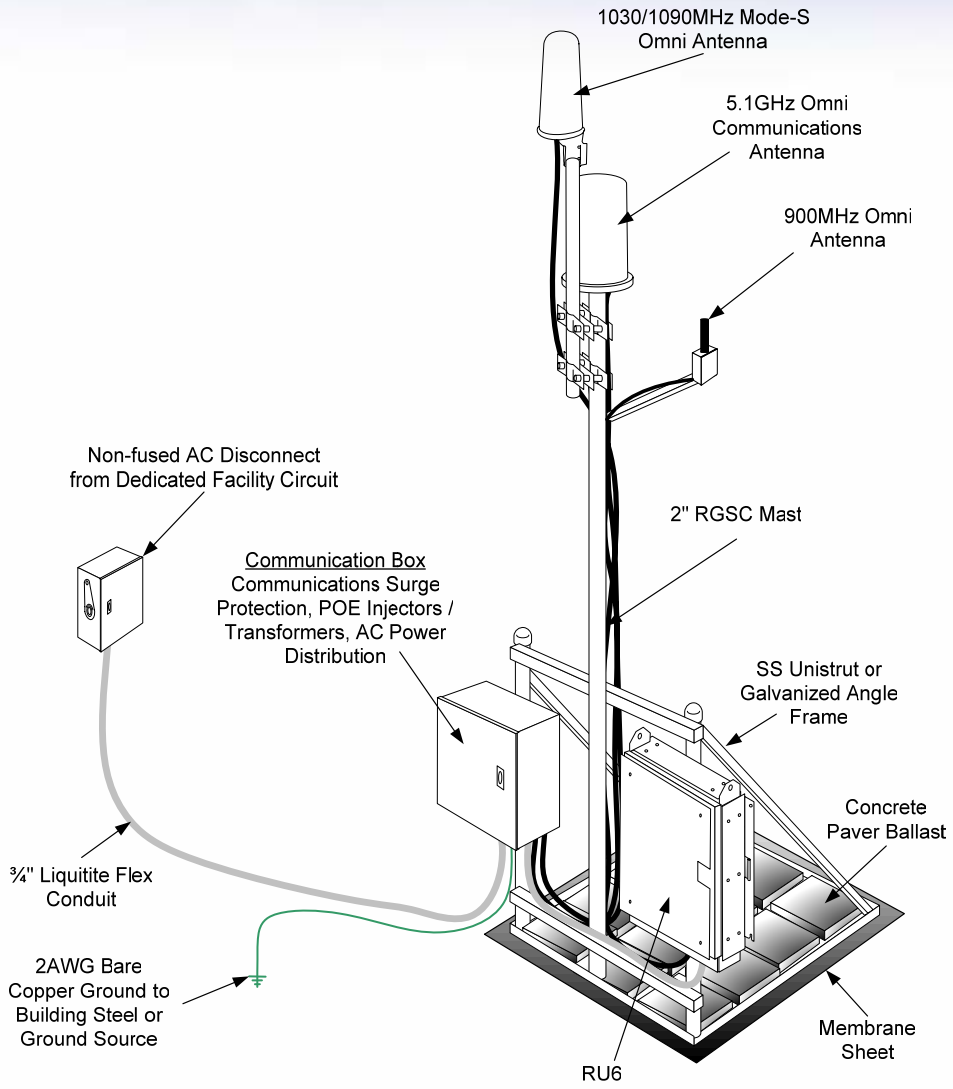
- Blue backbone linking surface surveillance sensors.
- Wired network access.
- Red mobile access network.
- Red network backhaul.

Lorain County Airport

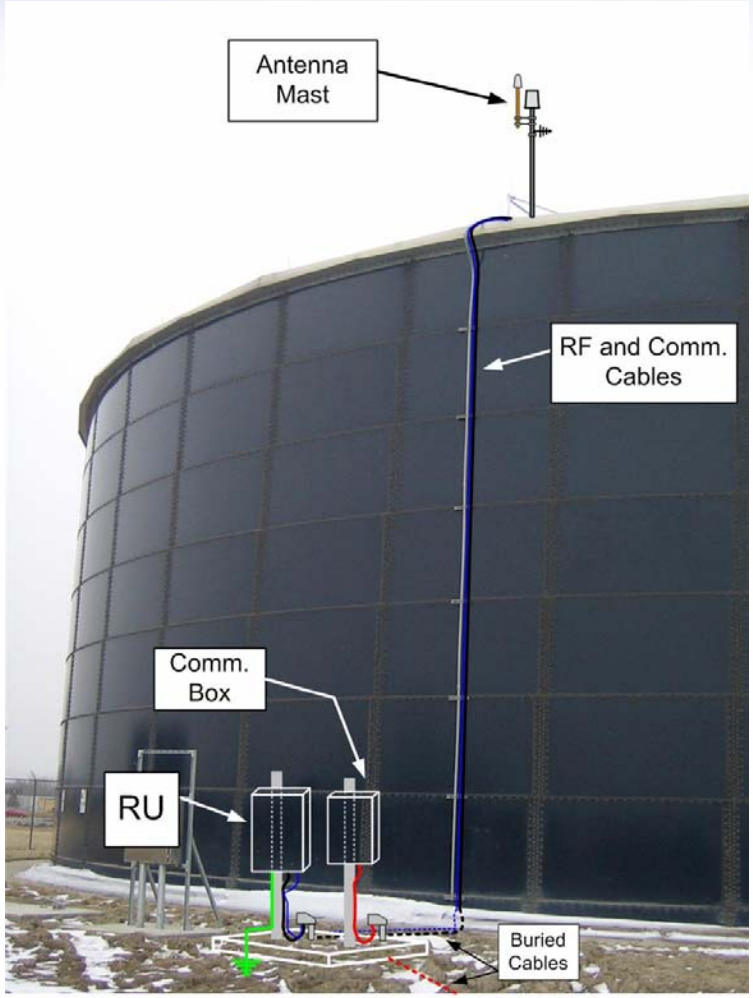
- Four Nodes
- Small Aircraft
- Surface Surveillance
- Runway Occupancy Lighting



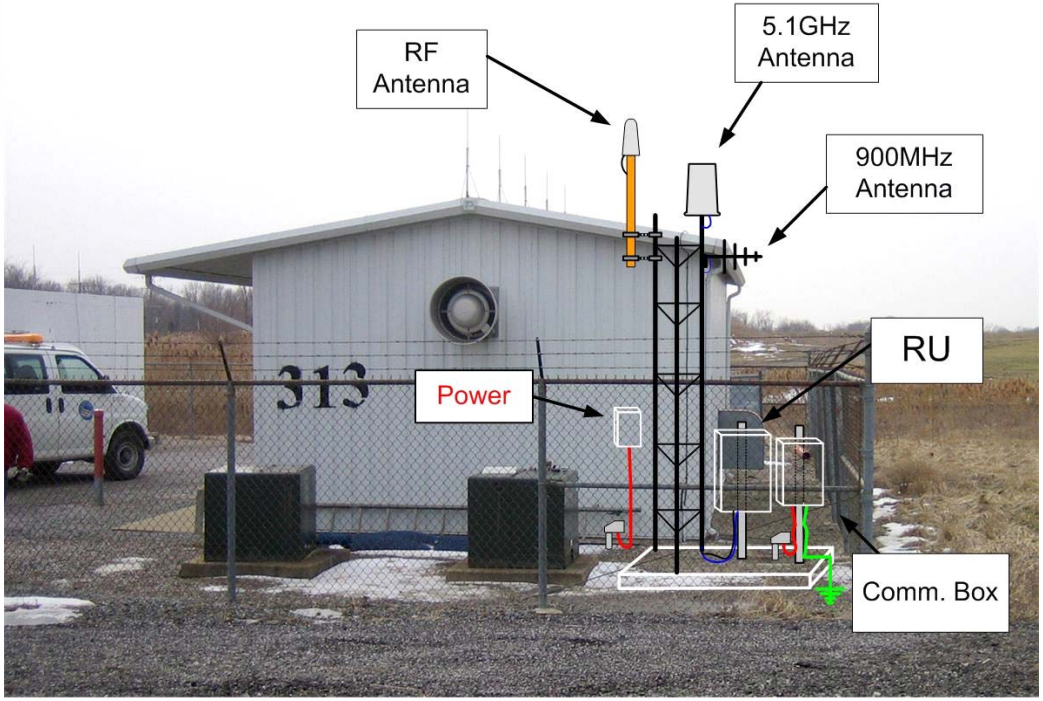
Site Hardware Configuration



Representative Exterior Installations

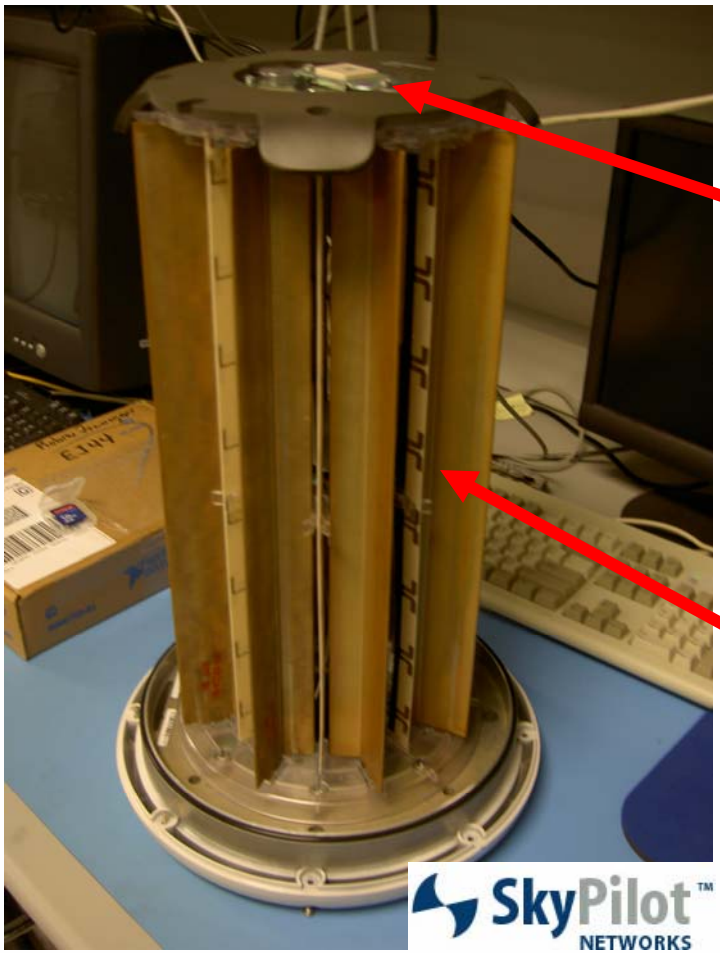


Glycol Tank



6th Right ALSF

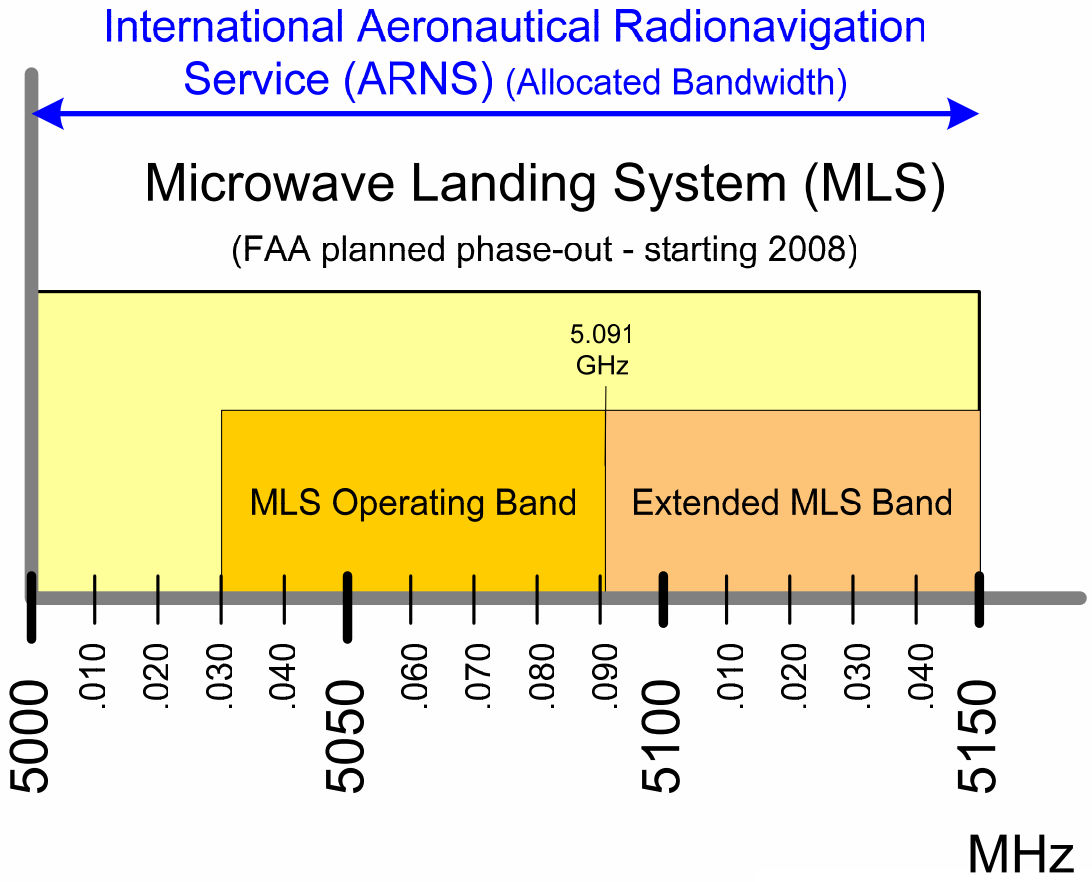
SkyPilot™ Mesh Node Details



- Shown without radome at left.
- GPS synchronized switched beam layer two mesh approach.
- Design mitigates mesh self interference (hidden node / exposed node problems) which are common in 1st Generation Mesh products.
- 18 dBi gain in direction of synchronized XMIT.
- 4.9 GHz – 5.8 GHz operation.

MLS Spectrum

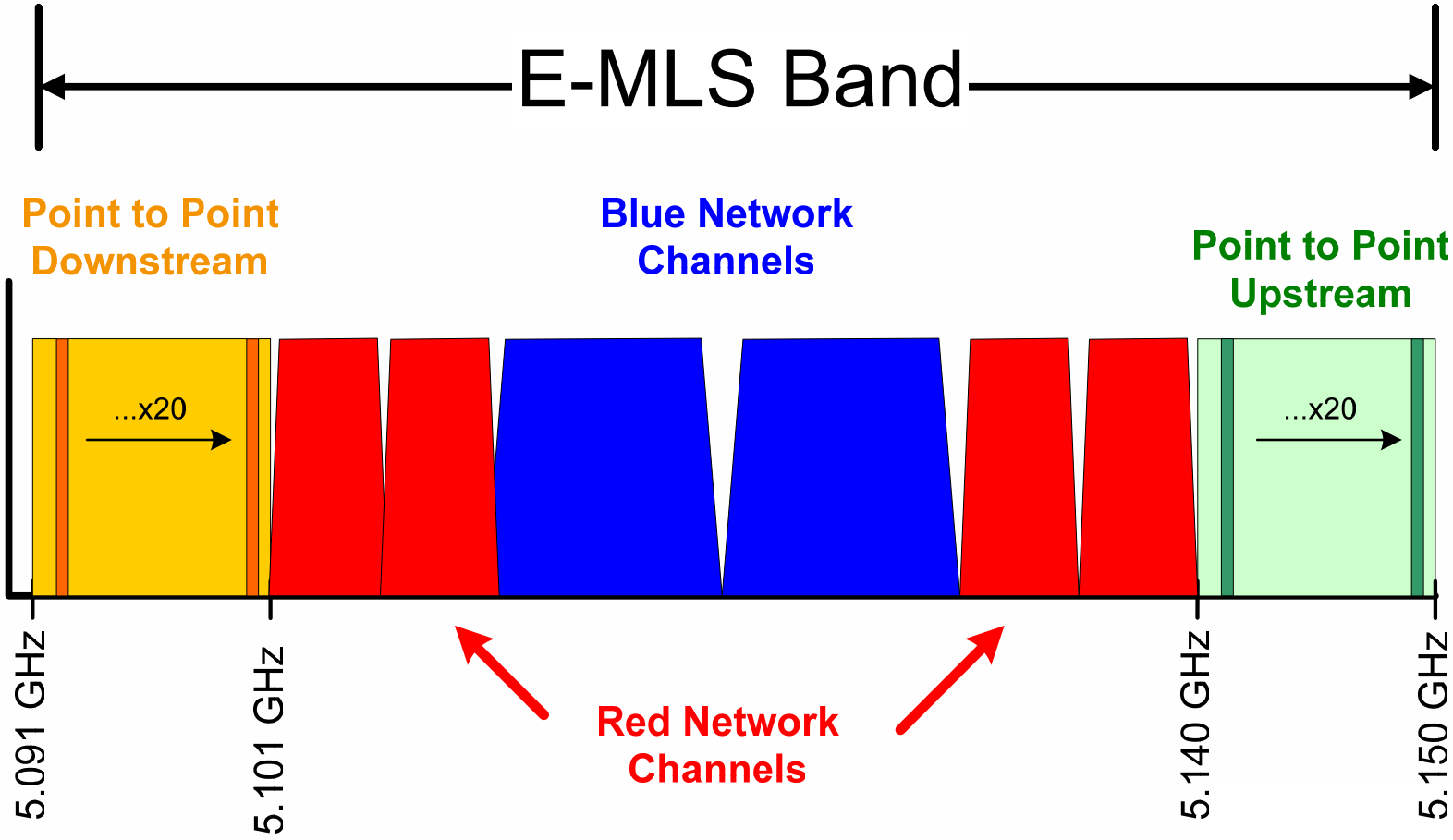
- Only a few active MLS systems in the US.
- Only a few satellite ground stations active in Extended MLS band.
- Testbed objective is to use Extended MLS band for wireless network to evaluate performance in a surface network.
- Strengthens FAA position to retain band allocation.



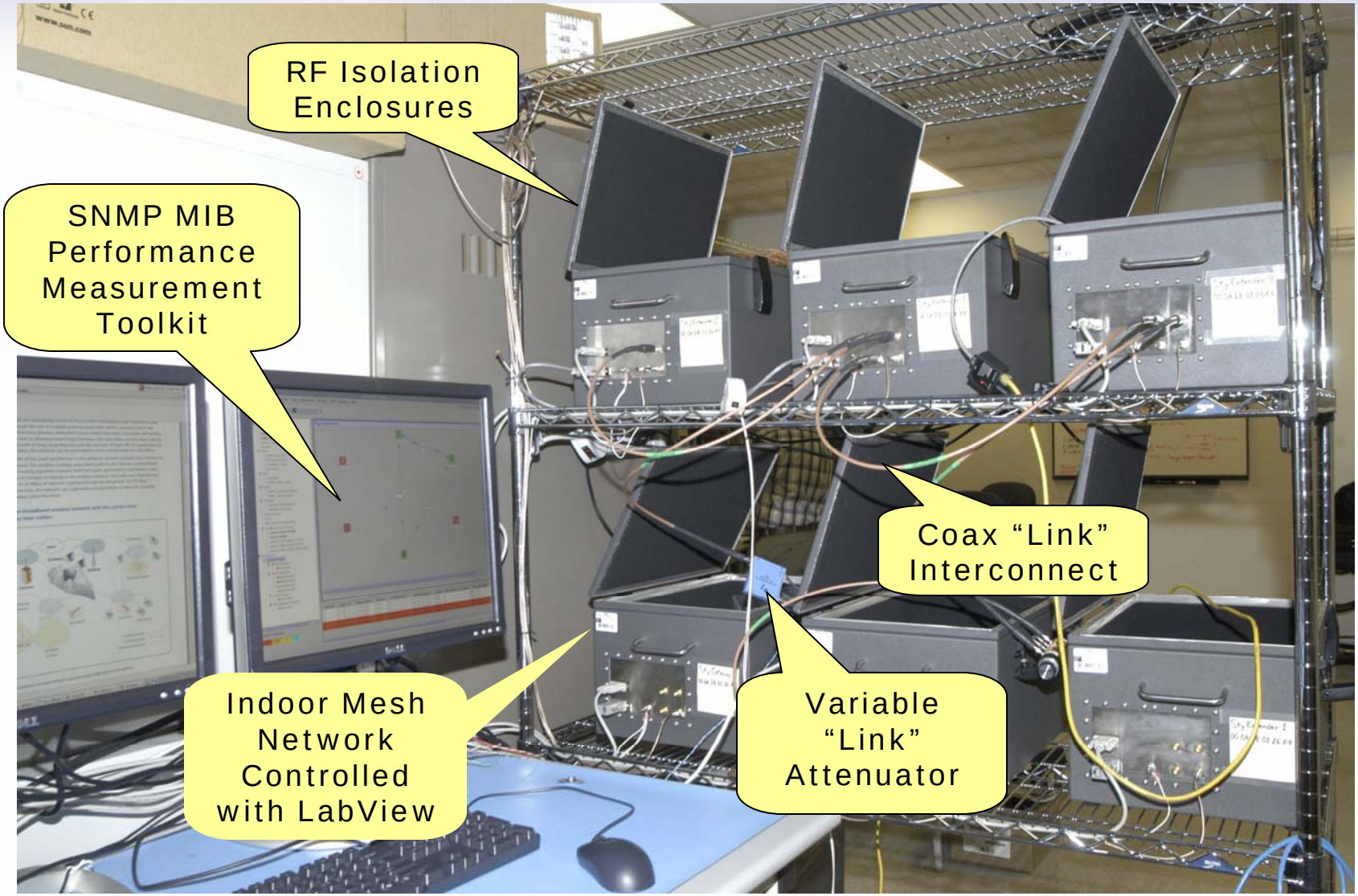
Proposed Extended MLS Band Applications

- **Narrowband, Full Duplex point to point links for remote ASDE-X surveillance sensors.**
  - Hardware currently available.
- **Airport Surface wireless network**
  - Part of NGATS Testbed.
- **Air to Ground communications link**
  - FAA experiments planned for this summer.

Extended MLS Channel Plan Concept



Lab Test Configuration

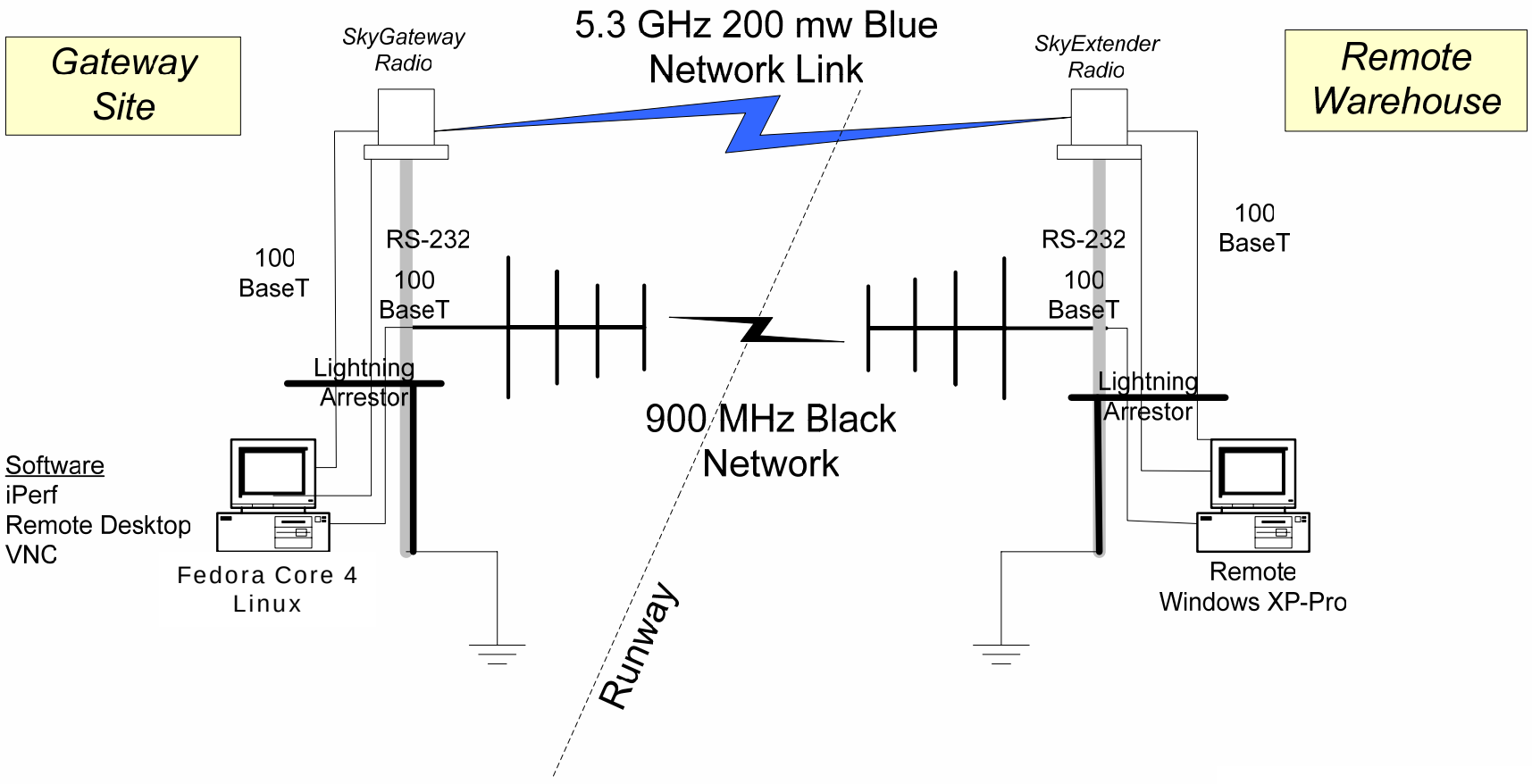


Network Lab Testing

- **Self-forming Self Healing mesh observed in lab.**
  - 5 minute transition time
  - Reduced by an order of magnitude with next firmware revision (30 seconds)
- **Measured latency**
  - 8 mSec per hop.
- **Link capacity**
  - 5 Mb/sec, bi-directional UDP traffic
  - 10 Mb/sec unidirectional UDP traffic

Syracuse Hancock Airport Test Links and Location

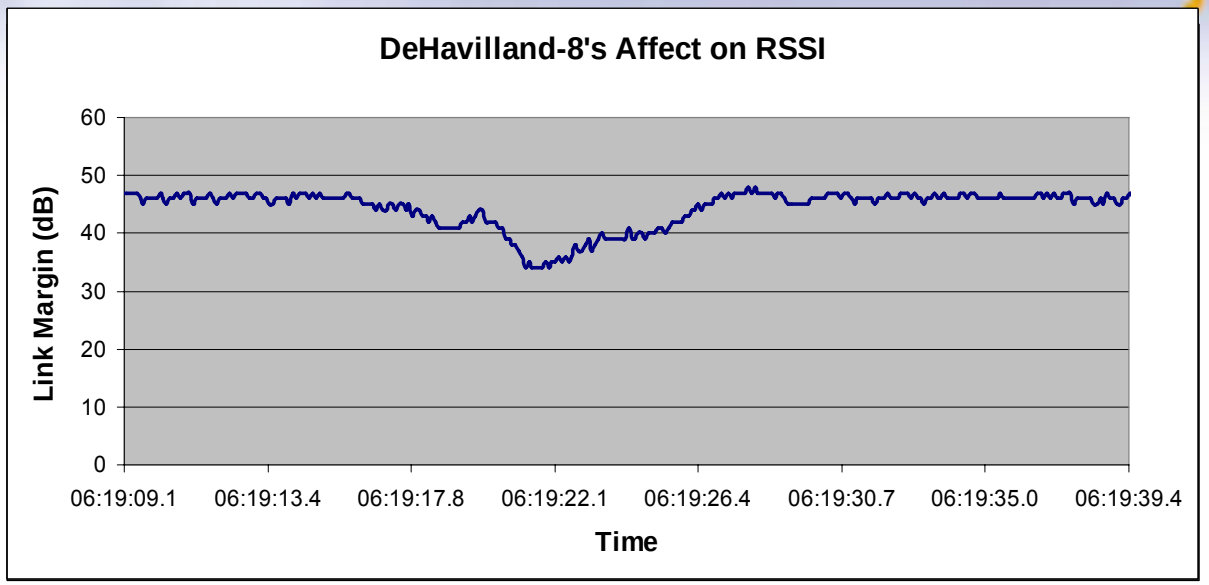
Outdoor Test Configuration

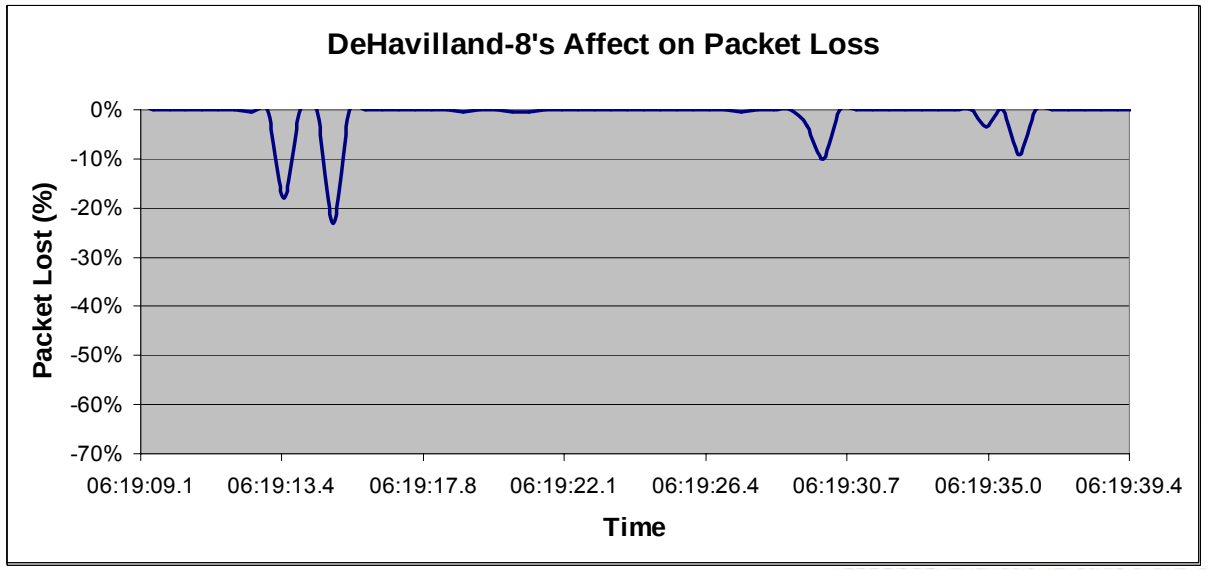


Propagation & Link Performance Tests

- √ **Tested variety of antenna heights**
- √ **Tested Propagation & link performance with moving aircraft & vehicle obstructions**
- √ **Tested outdoor deployment infrastructure**
- √ **Test 900 MHz remote network administration link concept**

Aircraft Link Obstruction Behavior





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Test bed Wireless Network → Summary

- **Objectives:**
  - Validate surface wireless network architecture in an operational environment
    - Network performance experiments
    - Provide infrastructure for NGATS technologies
- **Accomplishments:**
  - Architecture
  - Network Design
  - Component Selection
  - Lab based network testbed
  - Preliminary link testing

Test bed Wireless Network → Summary

- **Next Steps:**
  - Network deployment & integration at 3 Cleveland area airports (Hopkins, Burke Lakefront, Lorrain)
  - Performance & operational experiments
  - Open platform for NGATS experiments

Questions

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