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Revision-0

Idaho National Laboratory Wireless Capabilities:
Expediting Wireless Research, Development, Demonstration, Evaluation, Testing, and Training

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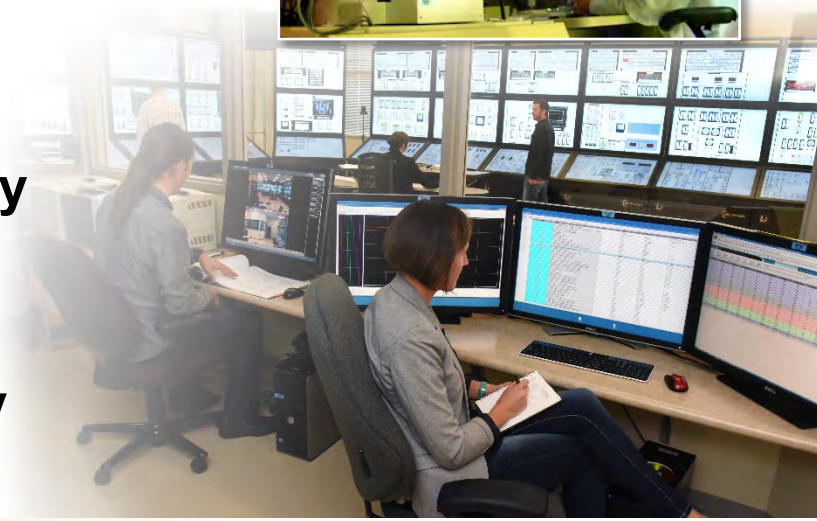
www.inl.gov

Idaho National Laboratory

INL's Position – Nationally

- A network of 17 DOE national labs
- The Nation's lead lab for Nuclear Energy research and development
- A major center for National Security and Clean Energy



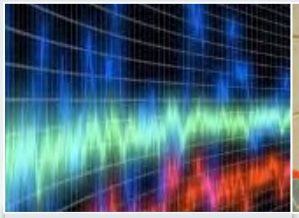
National Labs are "Capability Machines" that rely on unique capabilities

They innovate to solve multidisciplinary problems of national interest

They do what Universities and Industry can't, won't or shouldn't do

Research in the National Interest that Maintains U.S. Competitiveness & Security

Global Security Challenges



Wireless security and spectrum crunch

Nuclear nonproliferation safeguards and security

Enabling the warfighter, Intelligence Community and First Responders

Secure and resilient electric grid

Secure industrial control systems across critical infrastructure sectors

Global security against nuclear and radiological threats

INL is positioned to address the world's most challenging problems in:

Critical Infrastructure Protection and Resiliency, Nuclear/Radiological Security, Defense Systems

Unique National Security Infrastructure and Capabilities

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Electric Grid Test Bed

Commercial Feeds, Test Loops/Spurs

Water Security Test Bed

Municipal Water System

Radiological Ranges

First Responder Training

Specific Manufacturing

•00% Quality Product

Wireless Test Bed

Agile Spectrum

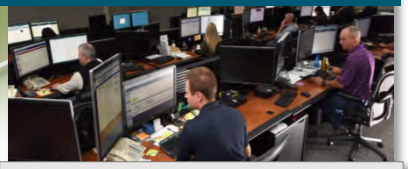
National Security Test Range

•~20k TNT, VA Center

Nuclear Materials R&D

Electro-refining, SNM for Test/R&D

Research and Education Campus



Controls & Energy Security Labs

- ✓ **Full-scale real-world testing and demonstrations for deployment** *(designed, built and operated by INL)*
- ✓ **Integrated testing across multidisciplinary areas** *(radiological, physical security, explosive, power, controls, cyber)*
- ✓ **Rapid development through model, test, validate, and refine** *(high fidelity, effects-based modeling, rapid testing and measurement)*
- ✓ **Access to the full range of support services** *(lineman, engineers, rad techs, fire fighters and security forces)*
- ✓ **Ability to develop prototypes, manufacturing process and resolve uncertainty**

•Innovation in nuclear, control systems, power grid, wireless and physical security

Enabling Successful Wireless Solution Development

Wireless R&D

- Develop solutions to national spectrum sharing and wireless communications security challenges

Modeling & Simulation

- Advanced software engineering, design, validation and testing of wireless technology and security solutions

Wireless Test Bed

- Test and validate full-scale deployment of wireless communications technology and security solutions
- INL Wireless Security Institute

INL is Driven to Expeditiously Move Wireless Technology Solutions from Concept and Design through Validation and Deployment

INL Wireless Test Bed Mission

Provide wireless and telecommunications technical expertise, systems and environments to enable:

Testing and Demonstration of wireless systems and equipment

Development and Training of tactics, techniques and procedures

In a representative environment with tailored systems operating at real-world frequencies and power levels to make informed decisions

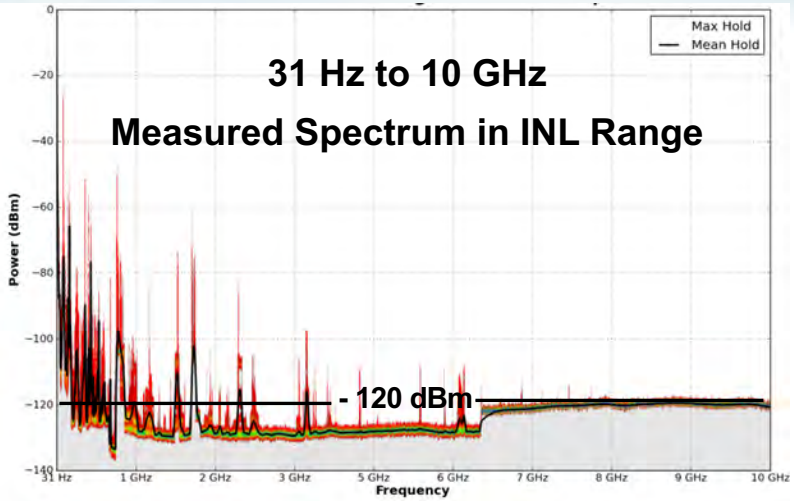
State-of-the-Art INL WTB Assets and Capabilities

Maximum Frequency Spectrum Available :

- Low RF noise: typically ≤ -120 dBm (over 10 kHz RBW)
  - No urban areas or military bases
- NTIA Experimental Radio Station
  - "Full" spectrum use (as outlined NTIA Redbook)
  - No harmful interference
  - Government test / experimental use only
    - Commercial customers apply for FCC TA/STA
- Local Spectrum Manager
  - Max Power/Frequencies case by case basis
  - Rapid approval (1 to 4 weeks) by INL Spectrum Manager
  - Remote Spectrum Monitoring

Full Scale Communications Test Networks (fixed & mobile) – International Frequencies

- LTE, UMTS & GSM Tier I Carrier Grade Networks
  - Handovers between networks
- LTE Tier III Network
- HF fixed and mobile radios / antennas
- ISBN Satellite system
- UAV and UGV test areas
- Mountain top line-of-site access



Instrumentation:

- RF waveform analyzers, generators
- Protocol analyzers
- Noise generators for controlled interference

Established Services & Processes:

- Spectrum approval & monitoring
- Safety, Medical, Fire, Security (physical)
- Resource management - personnel, networks, configuration control
- Secure, IP protected multi-user facility
- Broadband data access – entire INL Range
- Hardware prototyping, scientific labs
- Visitor – US citizen & foreign national

Comprehensive End-to-End Network & Engineering, Operations, Deployment & Testing Expertise

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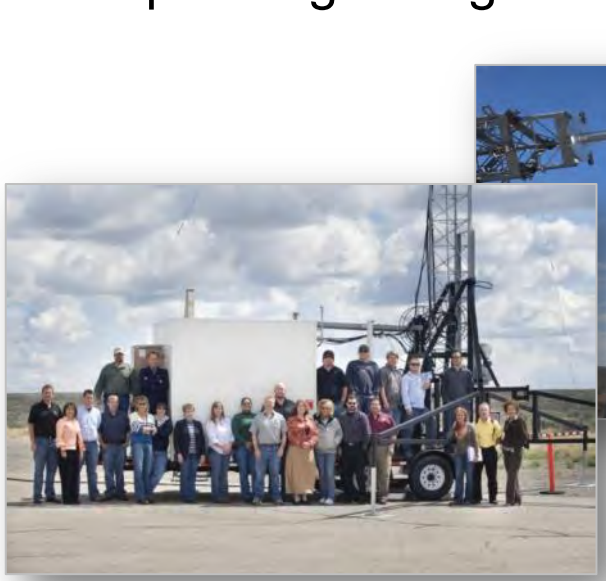
Our Communications Engineering Expertise Is Based on Industry Experience

- Technical experts in wireless communications
  - Cellular, VHF, UHF, HF, IP
  - Design, Implementation, Programming, Operations
- Expertise from major wireless and telecommunication companies
  - AT&T, T-Mobile, Nokia, Lockheed Martin, Boeing, Motorola, Hughes, L-3 Com, EG&G, Nextel, and Radix
- Experience in designing, installing, configuring, maintaining and operating next generation wireless communications systems



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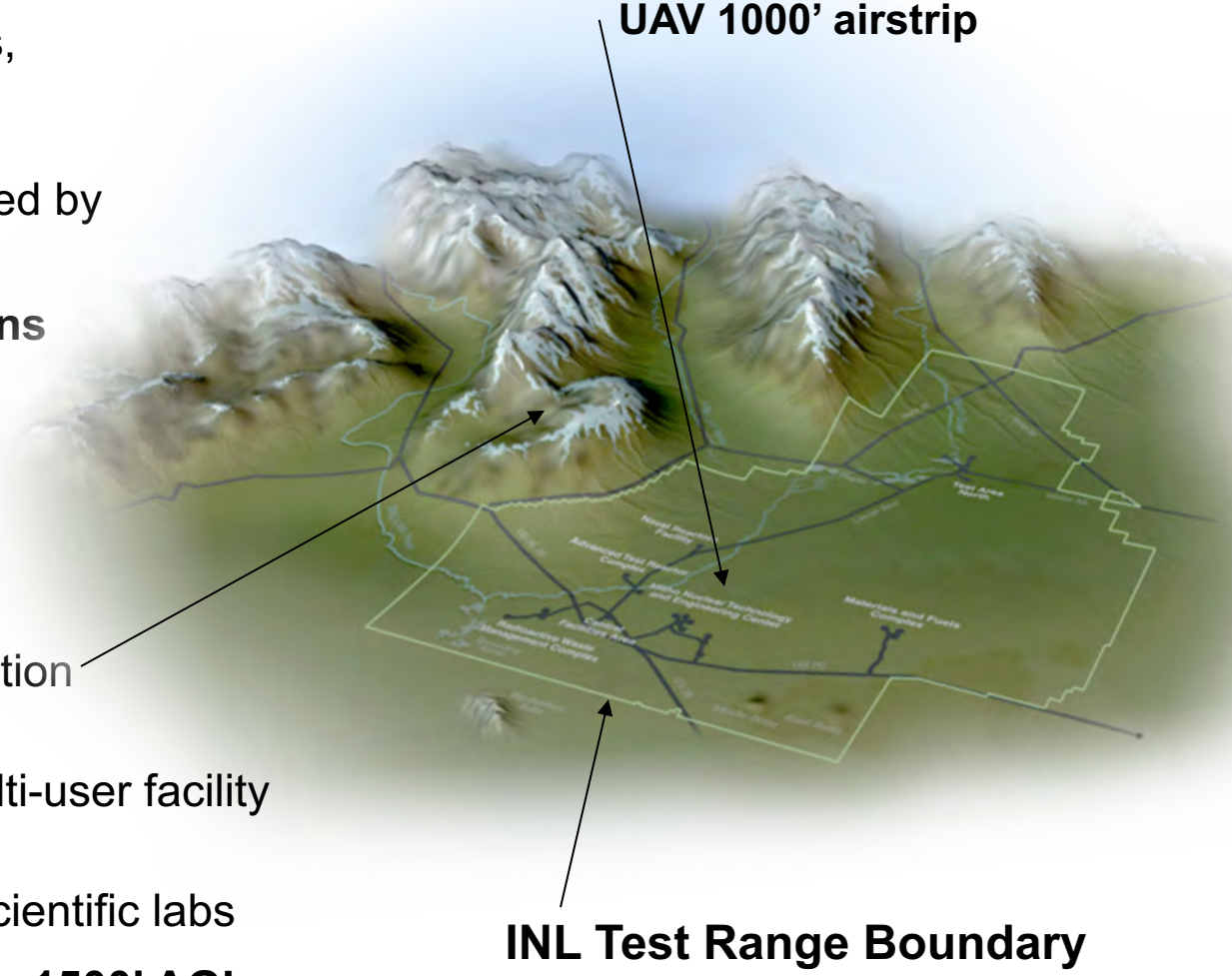
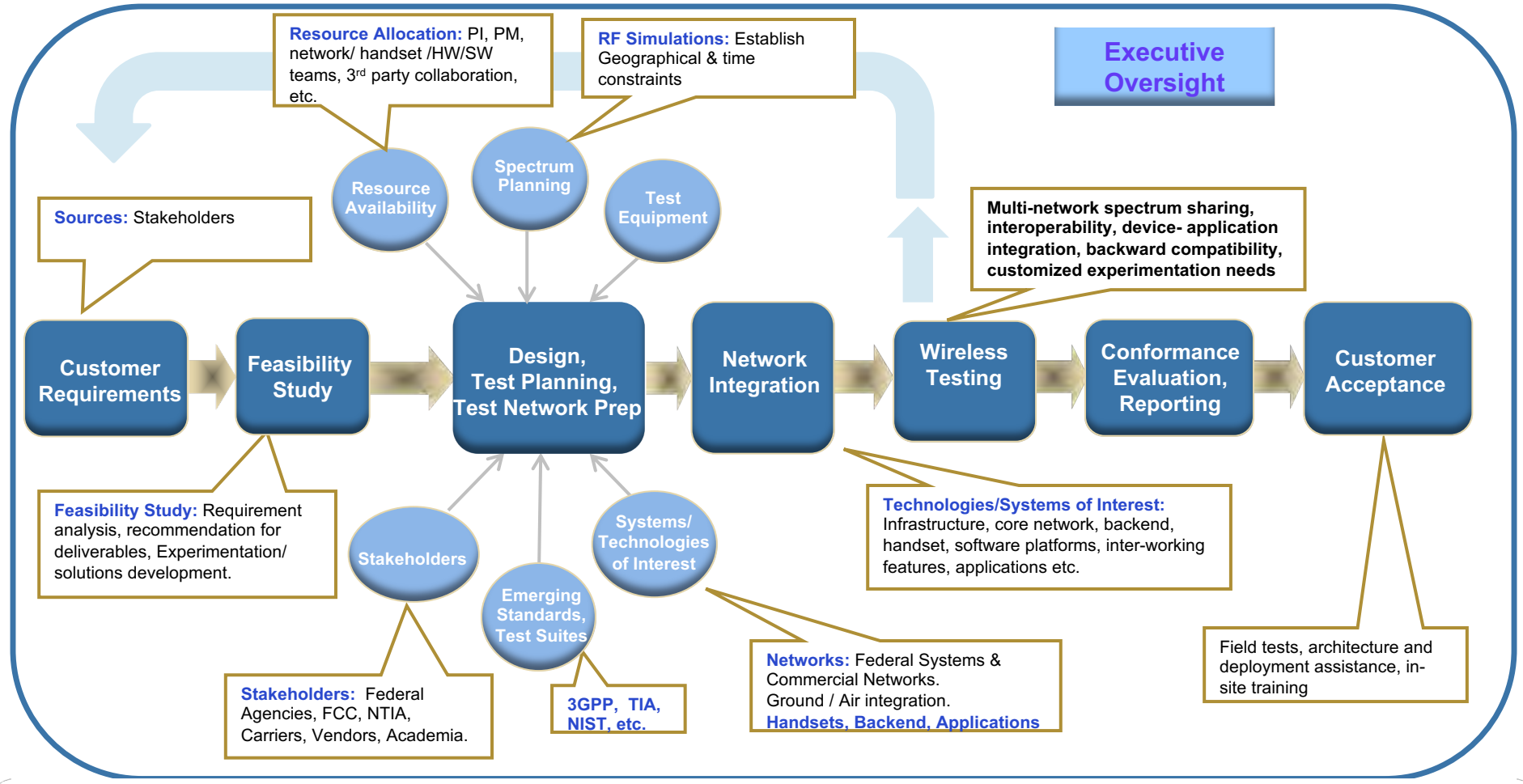
INL's 890 Square Miles Provides Diverse Opportunities

- **Isolated test range**
  - No nearby military bases, international airports or urban areas
  - Natural RF shield provided by caldera landscape
- **Multiple facilities and terrains**
  - 3 fixed cell sites
  - Numerous test areas
  - Rolling high desert with surrounding mountains
  - 5000' average elevation
  - Radio site at 8628' elevation
  - Controlled access
  - Secure, IP protected multi-user facility
  - Broadband data access
  - Hardware prototyping, scientific labs
- **Unrestricted airspace above 1500' AGL**



End-to-End WTB Test & Experimentation Process



INL has well defined and established flexible Experimentation Research Processes, critical to successful wireless experimentation and innovation

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Isolated, Reconfigurable, Multidisciplinary, High-Fidelity Environment

INL Range

Idaho Falls

Monitoring Equipment

Mobile Platforms

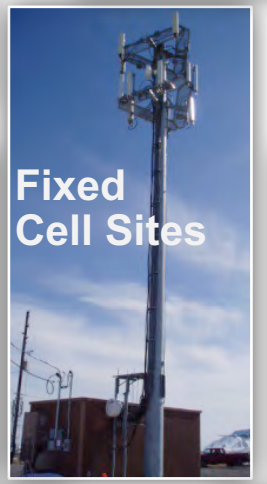
Multiple Test Sites

PSTN Simulator

Call Generator

Cellular Network Operations Centers

Fixed Cell Sites



Cell Switch Center

Power Grid Labs

Cellular NOC

Cyber & SCADA Labs

WTB History

- May 2003 through September 2019
  - 108 customers, 835 Tests, 6256 Test days
  - 5 to 275 participants per test
  - Duration – 1 to 12 weeks
  - Costs – $125K to $1.2M per test
- Customers typically test with the WTB two to four times through development and prototype and then multiple times for TTP development and training

Upon finishing WTB test activities, majority of customers state:

That is **not what we expected** from our system(s).

Need to **rethink entire approach**.

*This is the **most accommodating, technically knowledgeable staff** at any test range that I have tested with.*

Experience was Priceless.

*That is **not what happened in the lab**.*

*That is **not what the RF simulation results predicted**.*

WTB provides technical expertise and platforms for Real World Data to make informed decision regarding Wireless Systems, Devices Technologies and TTPs

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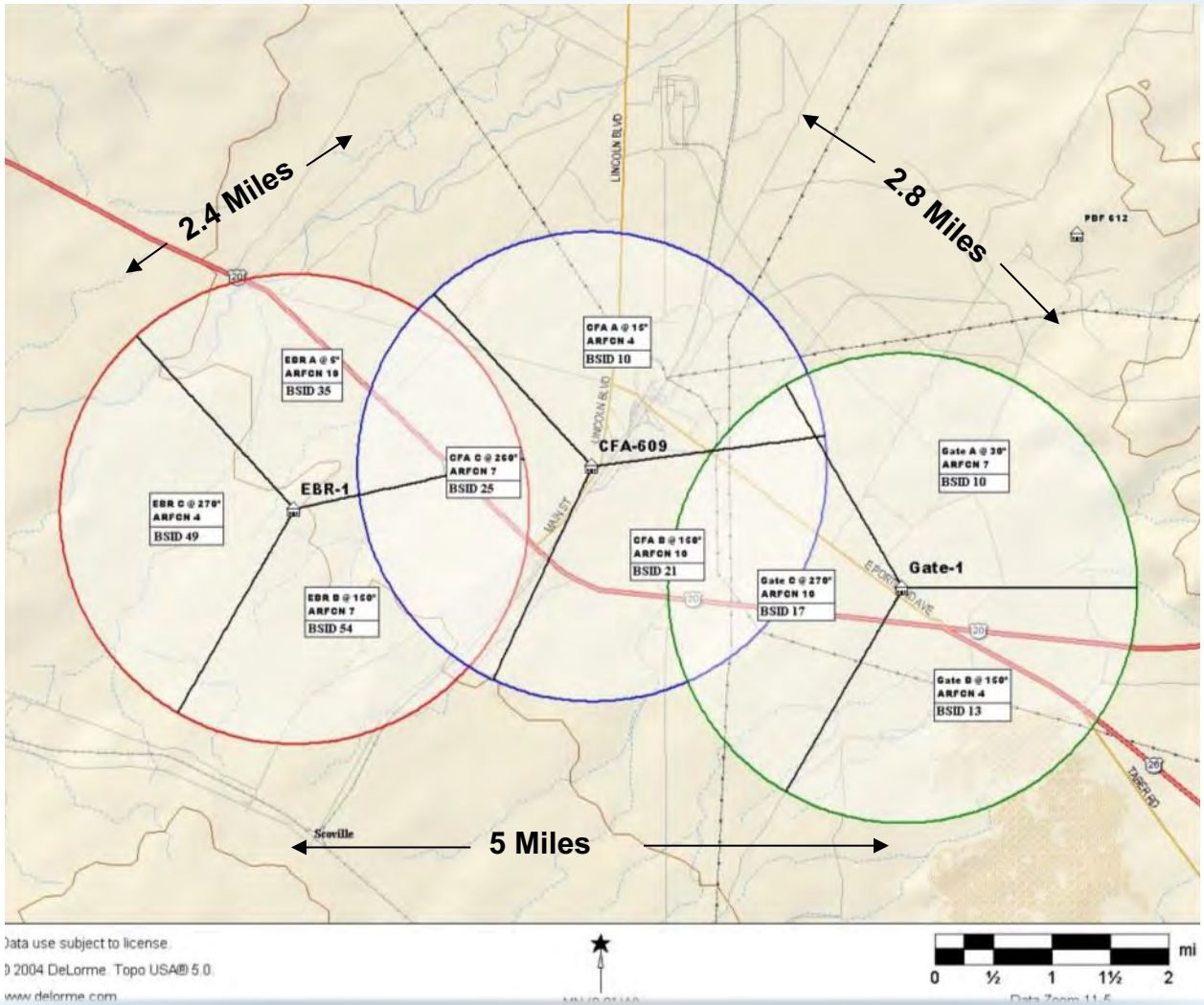
WTB Cellular Configurations



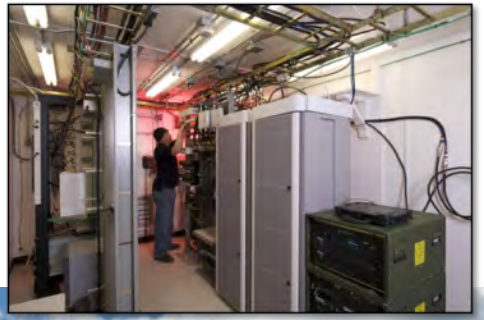
Flexible & Reconfigurable

Cellular Core:

- Handovers
- Alarms

RAN:

- Frequencies
- Power
- Antenna downtilt



Ability to reconfigure to resemble wireless environment of a metropolis one minute and a rural area the next

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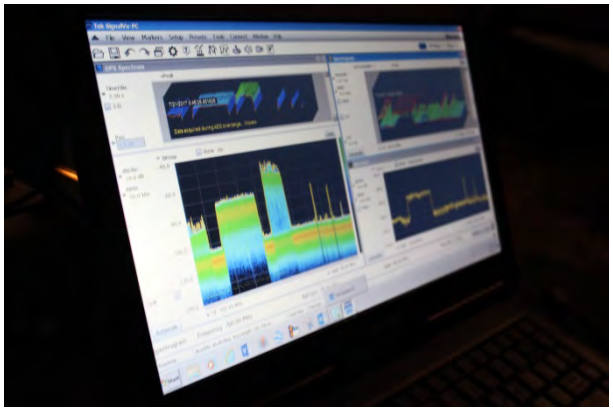
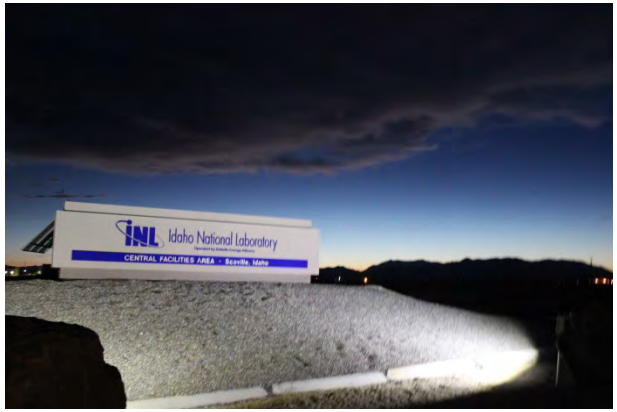
DHS JamX 2017 Campaign

- "Did we improve from lessons learned in JamX 2016?"
  - JamX 17 Results:
    - Many successes and improvement: Evaluated 8 new technologies
    - Evaluated Tactics and Techniques to overcome
    - Outcome: DHS report





Help first responders across the country build more resilient communication networks and prepare them to recognize, respond to, report and resolve RF interference incidents when they occur.

INL WTB EMP Testing

- EMP Impacts on cellular systems
  - EMP Commission, Telcordia
  - Support EMP Commission

EMP Sensors

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