NTIA/NIST Spectrum Monitoring Pilot Program

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Overview

- Program Goals & Major Tasks
- Deployment of RF Sensor Systems
- Measured Spectrum Occupancy Database (MSOD)
- RF Sensor Systems – Focus for presentation
  - Sensor System Architecture
  - COTS Sensor Classification
  - RF Performance Testing

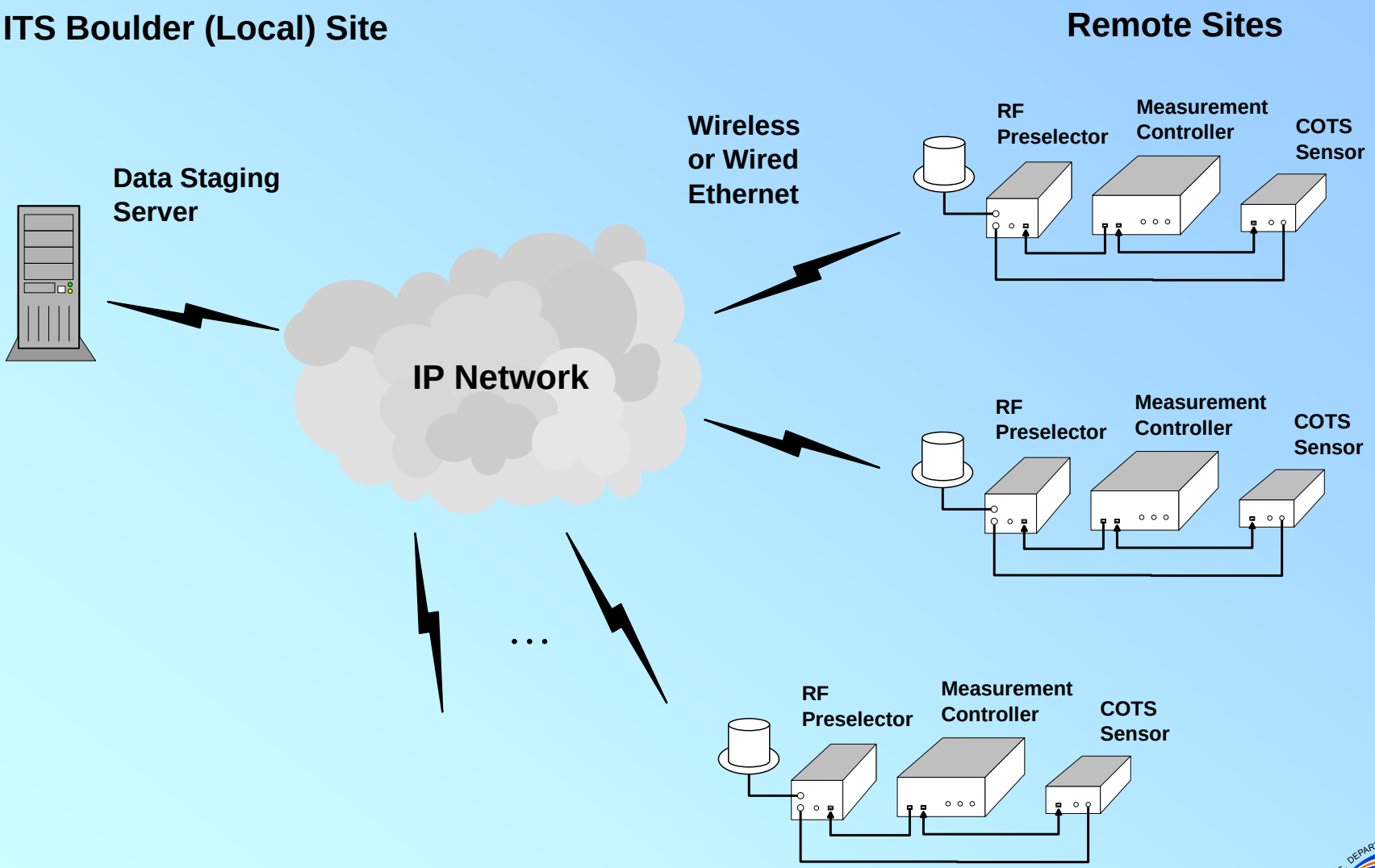
Program Goals

- Develop infrastructure
  - Acquire, amass spectrum data
- Data avail to spectrum community via web
- Establish, implement best practices spectrum data acquisition

Major Program Tasks

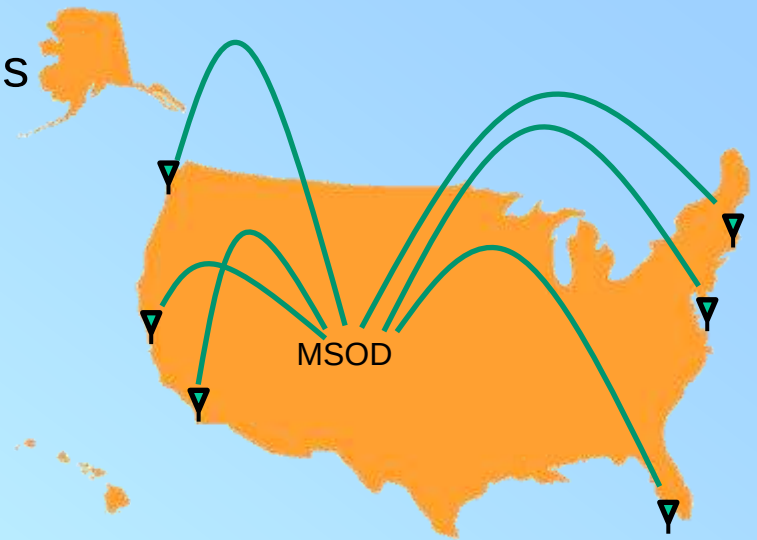
- Design, develop, deploy sensor systems to collect spectrum usage data
- Develop sensor system network
  - Spectrum data acquired by network of RF sensor systems
- Develop MSOD
- RF Performance testing of COTS sensors
  - Goal: build cost/capability/performance matrix

Sensor System Network



RF Sensor System Deployment

- Network of six 3.5 GHz sensor systems
  - Maritime radar monitoring
  - Along East and West coasts
- Sensor system deployment status
  - Current: Virginia Beach
  - FY15: San Diego, San Francisco, Florida Keys
  - FY16: Astoria, Cape Cod



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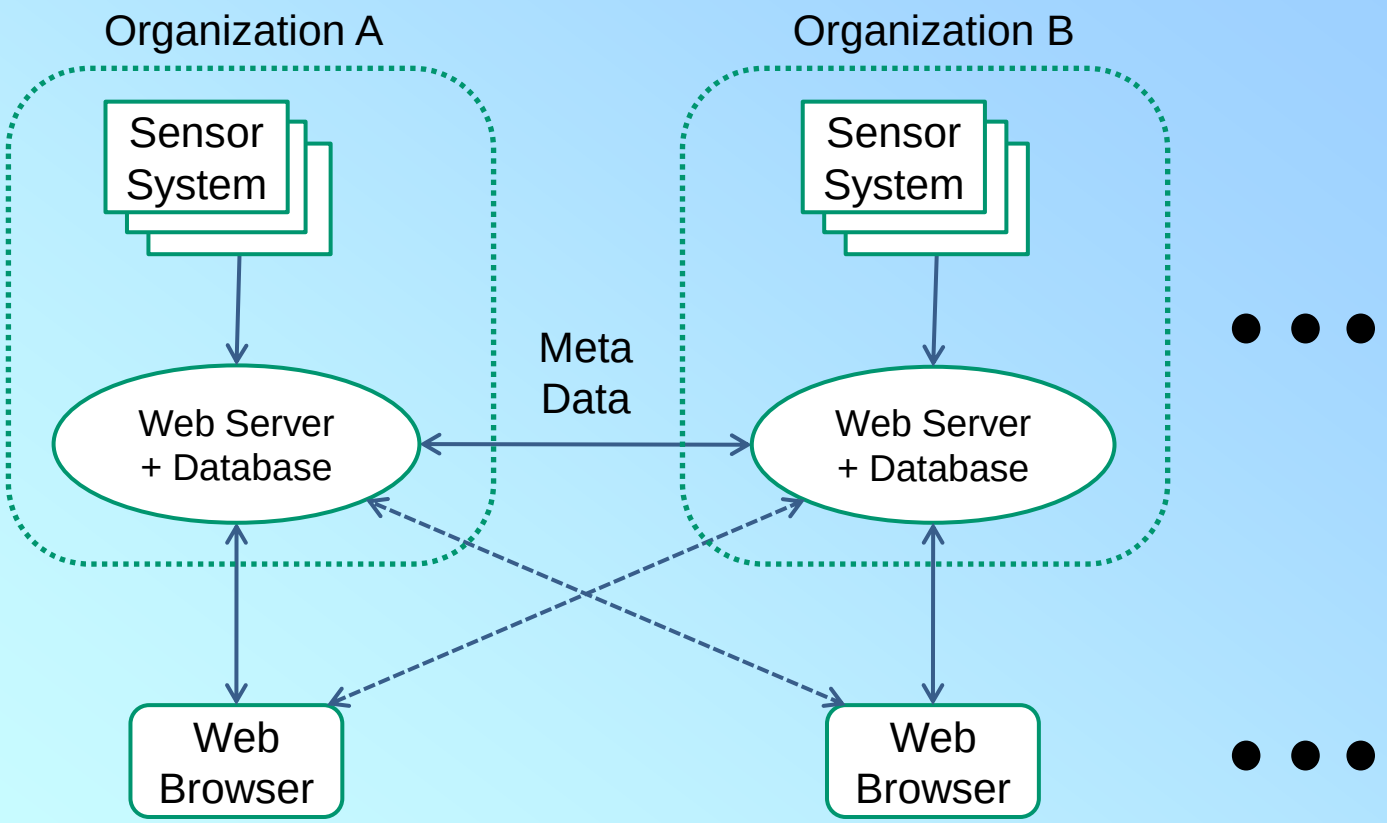
RF Sensor System Deployment

- Currently developing prototype sensor system
  - LTE monitoring in 1695 – 1710 MHz & adjacent bands
- Possible deployment: NOAA Meteorological Satellite Earth Stations
- Deployment planned FY16

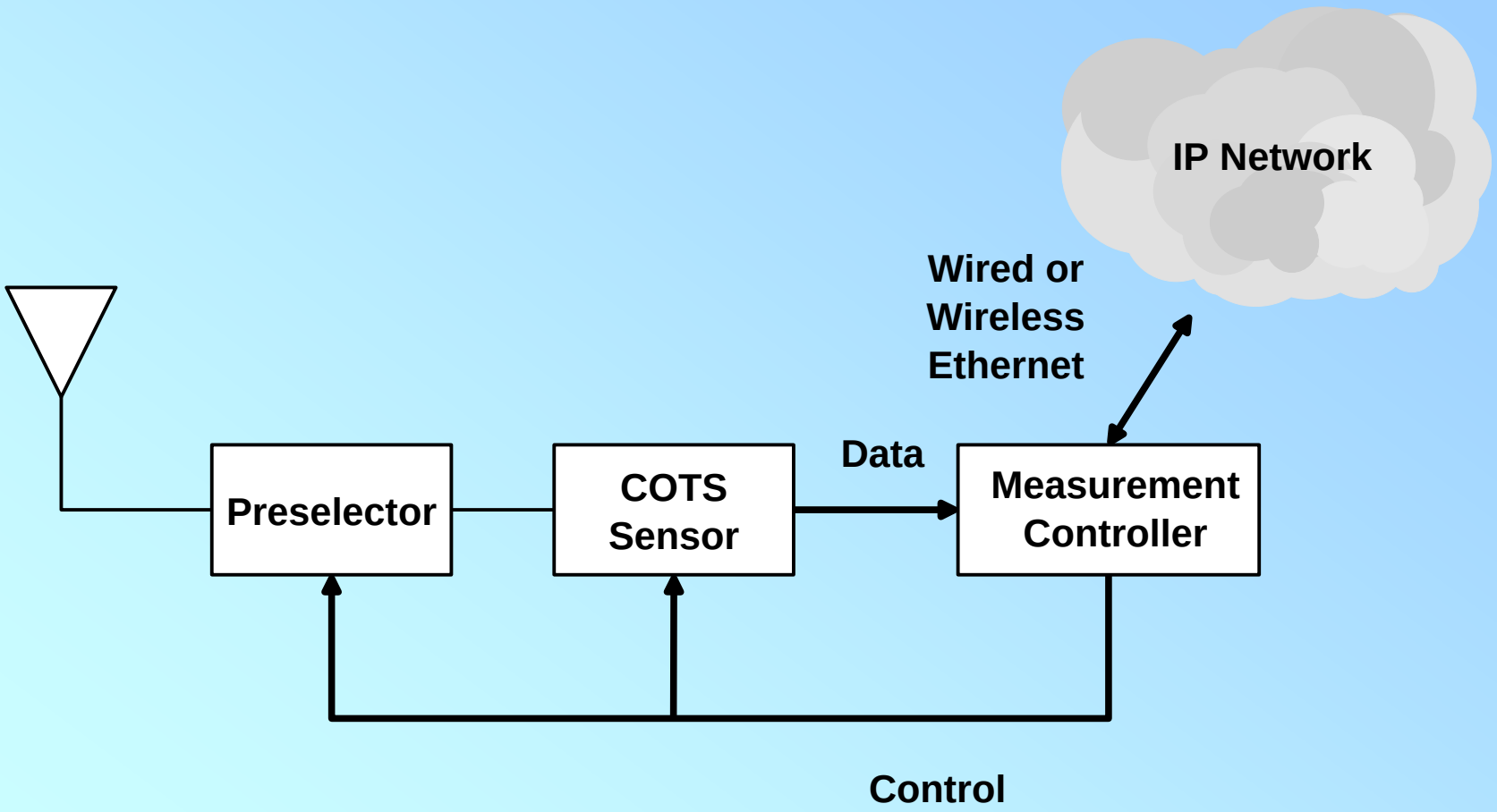
Measured Spectrum Occupancy Database



Measured Spectrum Occupancy Database

- Standardized data transfer specification
  - Based on Java Script Object Notation JSON
  - Flexible – allows different types of data
- Provides threshold-based band occupancy statistics & amplitude vs. freq. data
- Test environment for authorized users
  - Planned Jan 2016

General Sensor System Architecture



COTS Sensor Classification

- Classify sensors into 5 tiers
- Differentiated by capability, intended purpose, loosely by cost

High Tier	**General purpose lab equipment** **Spectrum, vector signal, real-time analyzers** **Use superhet front-end arch** **Cost: ~ $25,000 or more**
Mid Tier	**DFT-based sensors** **Unattended RF data collection & outdoor use** **Use superhet RF front-end arch** **Cost: ~ $15,000 - $20,000**

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COTS Sensor Classification

Low Tier	**Designed as general experimental SDR receivers** **Can configure to operate like mid-tier sensors** **Not for outdoor use** **Use direct conversion front-end for cost savings** **Cost: ~ $1000 - $5000**
Very Low Tier	**Reduced cost versions of low-tier sensors** **Geared toward hobbyist** **Single IC RF front-ends** **Cost: a few hundred dollars**
Extremely Low Tier	**DVB-T television USB stick receiver** **Can be modified to be SDR receiver** **Cost: ~ $20**

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RF Performance Testing

- Two types COTS sensor tests
- Fundamental RF performance tests
  - Example: DANL, Signal Overload, TOI Tests
- Detection of simulated real world signals
  - Example: Compare band occupancy for simulated SPN-43 radar emissions
- Motivation for testing

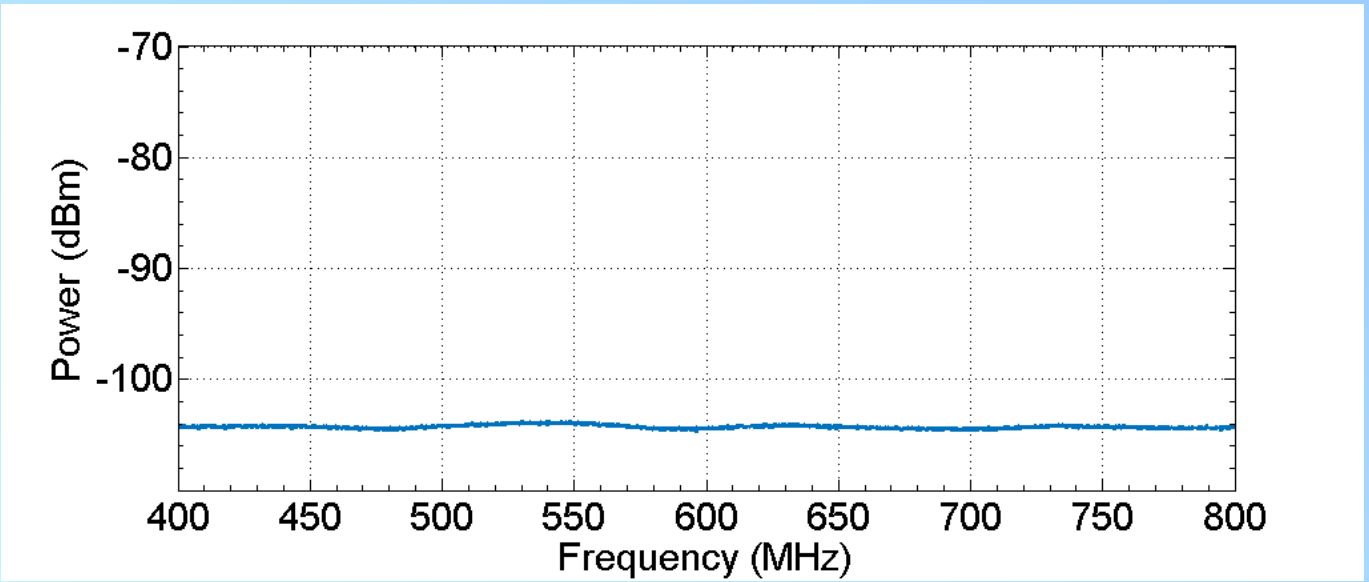
RF Performance Testing

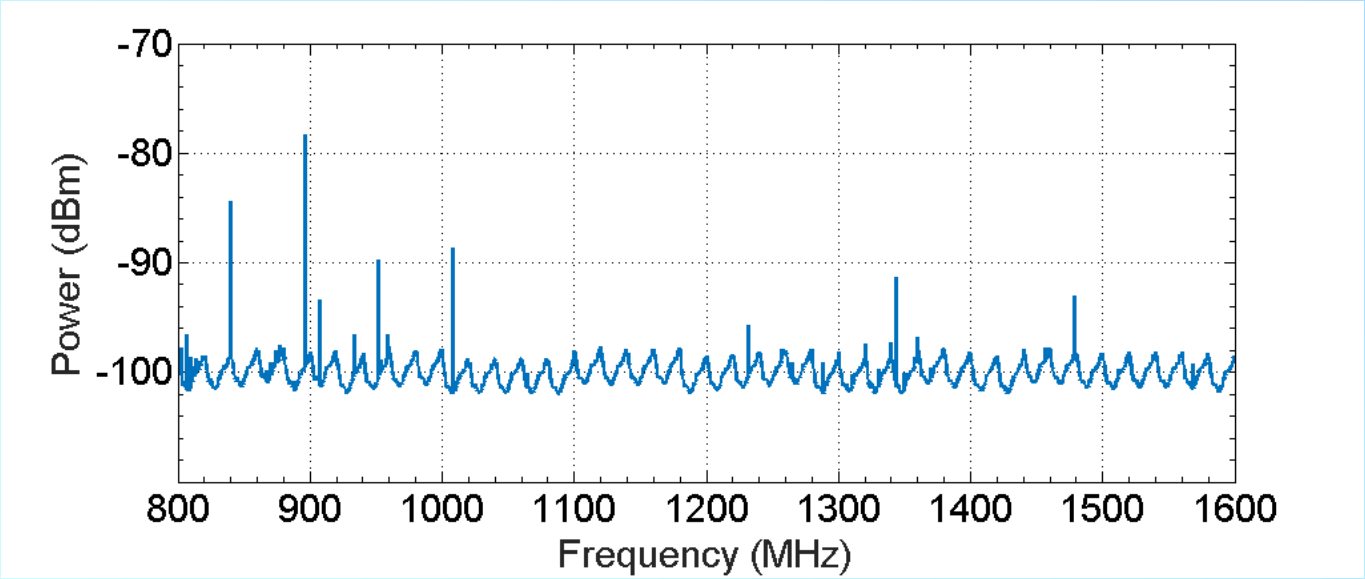
- Increasing number of spectrum monitoring efforts – wide variety sensors
- Measured spectrum data integrity crucial
  - Spurious responses or intermod generated must not be mistaken real signals
- Comparing specs between mfr. difficult
  - Use different parameters to specify sensors
  - Even with same parameters, conditions likely different

RF Performance Testing

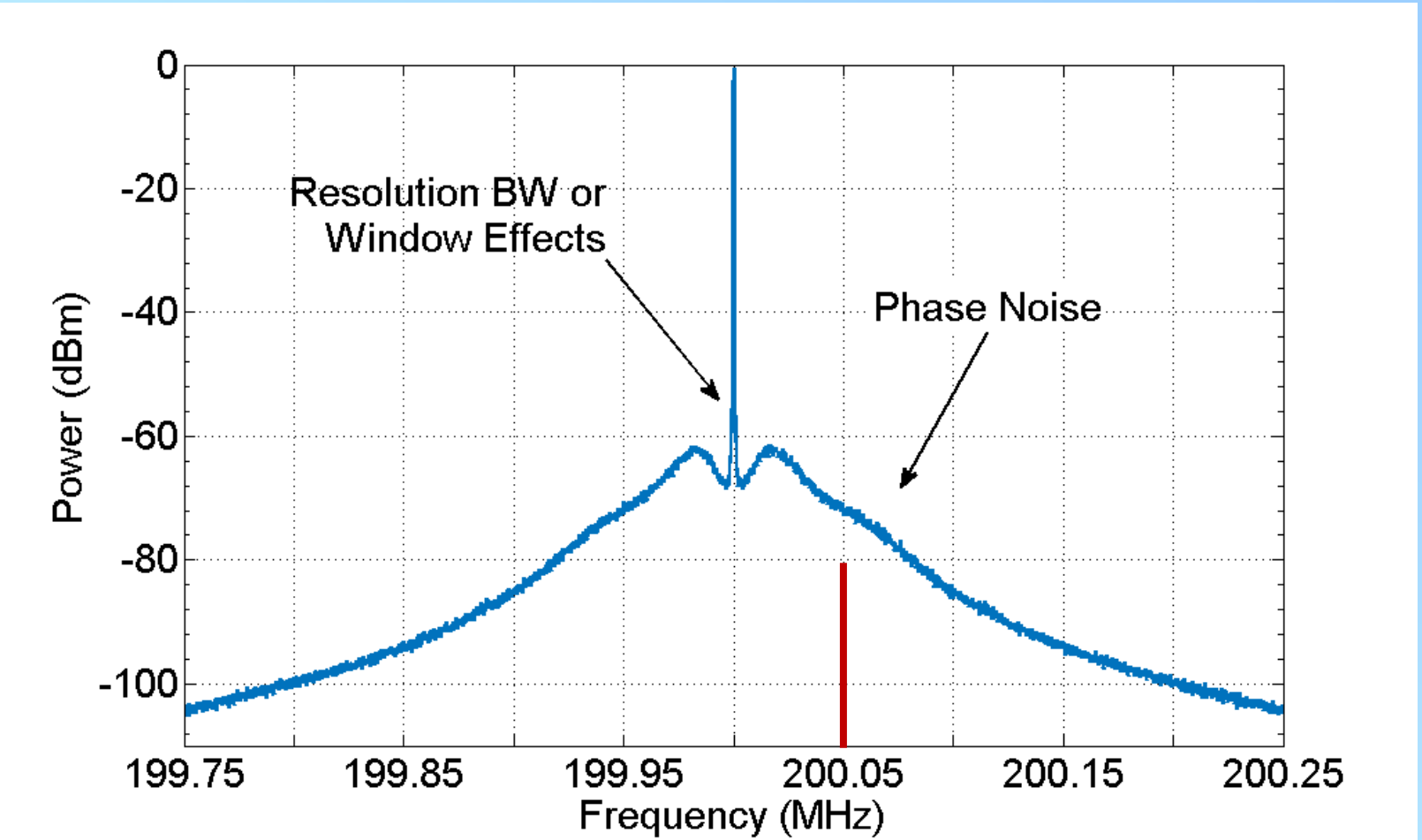
- Reduction in sensor cost
  - Desirable/necessary new paradigm spectrum monitoring
    - Continuous, long-term spectrum monitoring
    - Many locations simultaneously
- Performance testing important
  - Is lower-tier/cost sensor suitable for given monitoring scenario?
- Examples

DANL Test Examples – High & Mid -Tier





Phase Noise Test Example



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Conclusions

- Deploying network of six 3.5 GHz sensor systems
- Developing prototype LTE sensor system
- MSOD test environment planned - Jan 2016
- Developing comprehensive RF perf. test plan
- Beginning to implement tests in laboratory
- RF performance of sensors important
  - Integrity of spectrum data crucial
- Clearly see signals that are actually present
- Must not count sensor artifacts as signals!