NTIA Spectrum Monitoring

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Outline

- Motivation
- Boulder Wireless Test City (BWTC)
- Heterogeneous, distributed, persistent monitoring
- Conclusion
ITS History in Spectrum Measurement and Monitoring

Commerce and NTIA systems since 1927:
(Clockwise from low-left)
- Radio measurement car, 1927
- RSMS-1, 1980
- RSMS-3, Angel Island
- RSMS-1
- RSMS-4
- NTIA suitcase system, Fort Irwin, 2000
Motivation

- Increasing demand for finite spectrum
- Congestion and dynamic usage of spectrum may lead to unintended interference/degradation
- Jamming and intentional interference has become cheaper and easier
- Wireless security lags behind cybersecurity
- Traditional monitoring approaches are not standardized and do not scale to the current and future challenges
- Value in persistent sensing
- Real-world wireless test environments are needed to develop advanced wireless technologies
Future of Spectrum Monitoring

- Monitoring paradigm shift
- Real-world development/test
- Distributed, persistent, and automated spectrum monitoring
  - Heterogeneous sensors
  - Standardized and open source software
  - Common metadata
  - Automation for security and scalability
Boulder Wireless Test City

- Distributed sensors throughout Boulder and ITS Table Mountain Field Site and Radio Quiet Zone
- Variety of propagation environments
- Diverse spectrum activity
- Ongoing Cooperative agreement with CU to deploy RF sensors throughout campus
- Actively working additional deployments and fiber access with Boulder Research and Administrative Network (BRAN)
- Spectrum Occupancy and Characterization Sensing (SCOS) software
Heterogeneous Sensing

- Customize to mission
- Reduce cost to scale when necessary
- COTS components
- Interchangeable components + repeatable, automated, rigorous process to go from lab to field

Greyhound sensor (~$5k)

Basset hound sensor (~$25k)
Application Programming Interface (API) establishes universal language to interact with heterogeneous sensors

- Currently supports 2 commercial SDRs
- **Open sourced** to allow additional integrations
- Discoverable sensing Actions
  - Edge processing
  - Research transition path
- Onboard scheduler
SCOS Manager

- Centralized command and control for large networks of distributed sensors
  - Manage sensor schedules
  - Search and download archived RF data
  - Analytics and visualization
- Analytics API supports third party integrations
- Secure data service from sensors - NTIA website available for authorized Federal users in 2021 Q1
Interoperability and Reusability

- Break down silos by encouraging interoperability and reusability
  - IEEE 802.15.22.3 standardization
  - Open source common metadata

- 9 SigMF Extensions in sigmf-ns-ntia in public GitHub repo
  - `ntia-core` adds generally useful metadata fields
  - `ntia-sensor` defines hardware components and settings
  - `ntia-algorithm` describes the measurement performed (detectors, algorithms, etc)
  - `ntia-calibration` provides information about calibration factors applied to the data
  - `ntia-emitter` gives information about the emitter being measured
  - `ntia-location` gives information about the types of coordinate systems used in the metadata.
  - `ntia-environment` gives information about the environment around a sensor or emitter
  - `ntia-waveform` provides metadata to describe measured or transmitted waveforms
  - `ntia-scos` provides metadata for the NTIA Spectrum Characterization and Occupancy Sensing (SCOS) implementation
Scalability and Security

● Automation
  ▪ Automated provisioning and maintenance
  ▪ Foreman – Operating System (OS) deployment and status/monitoring
  ▪ Puppet – dev/test/prod environments support technology evolution and experimentation
  ▪ Automated software updates

● Confidentiality & Integrity
  ▪ NIST Special Publication 800-53 security controls
  ▪ Ansible automated security hardening of edge devices
  ▪ Calibration and sensor definition files characterize every sensor
  ▪ Provide metadata with every acquisition
  ▪ Lab verification and configuration management of sensing actions
Conclusion:
Local Research National Impact

- Edge processing
- Coordinated sensing
- Characterize RF environment
  - Broadband survey
  - Band occupancy measurements
  - Noise floor measurements
  - Spectrum map
- Propagation model development & validation
- Compliance and usage validation
- Enforcement methods
  - Anomaly/Interference detection
  - Classification
  - Geolocation
  - Reporting, Notification, and Mitigation

Partnering with industry, academia, and other Federal agencies in the development of advanced spectrum monitoring technologies
References

- [NTA Spectrum Monitoring Website](#)
- Boulware, [sigmf-ns-ntia](#), NTIA Github, 03/20.
- [IEEE 802.15.22](#)