Trusted Spectrum Testing

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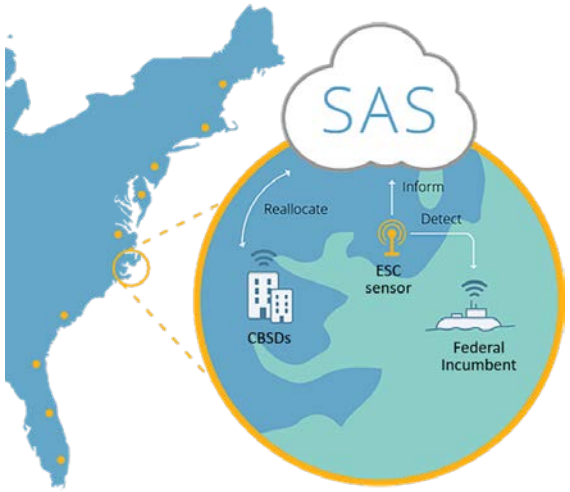
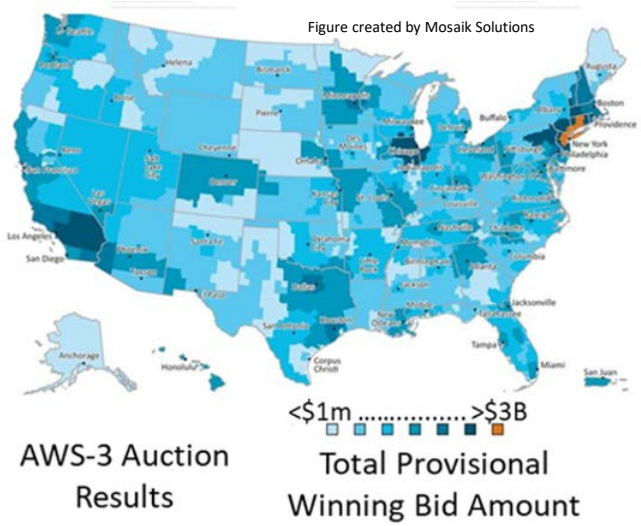
Growing Need for Trusted Spectrum Testing NIST

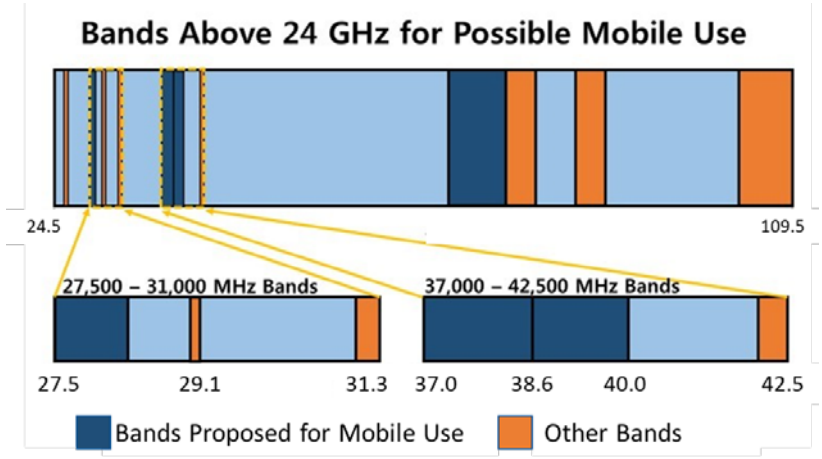
The Federal government is required to operate in a compressed spectrum ranges due to FCC auctions. This presents a risk that a variety of commercial and federal operators will harmfully interfere with each other.



Citizens Broadband Radio Service
CBRS (3.5GHz)
Navy Radars



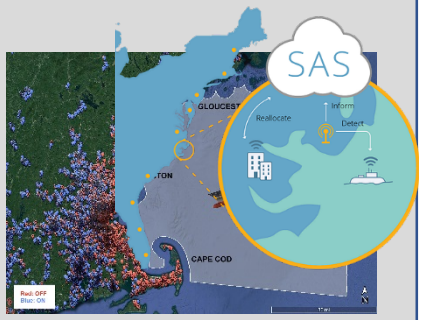
Advanced Wireless Services
AWS-3 (LTE)
DoD test ranges



Spectrum Frontiers (24&28GHz)
NASA/NOAA Weather
and remote sensing

NIST's Efforts Related to Trusted Spectrum Testing

NASCTN



CBRS and SAS

Core Challenges

Coexistence Metrics

Coexistence metrics and testing methods for wireless systems in shared-spectrum environments

Spectrum Management

Impartial trusted source for test methods to evaluate effectiveness of centralized spectrum-management approaches

Waveform Metrology & Calibration

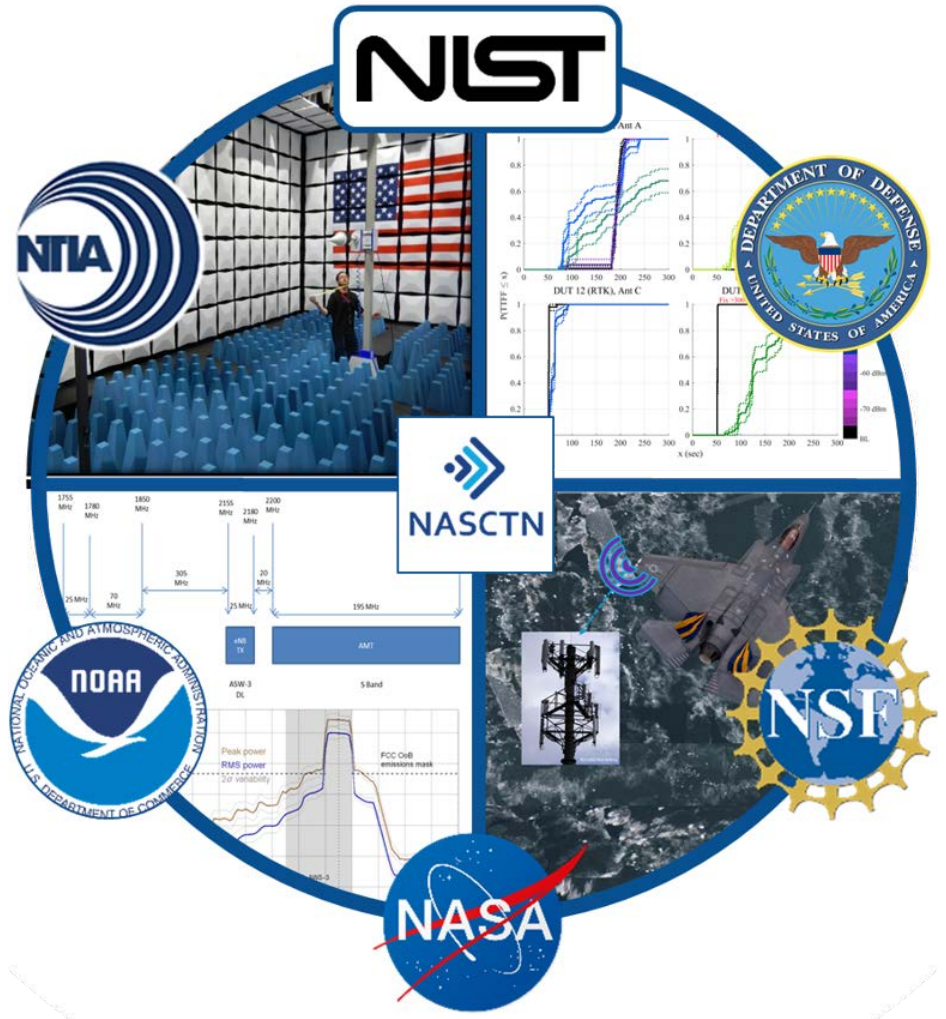
Traceable and rigorous test methods for OTA testing of wireless systems. Quantify RF environments, spectrum usage and wireless system behavior

Over the Air (OTA) Testing

CBRS WInnForum Standards™

Standards Development

National Advanced Spectrum and Communications Test Network (NASCTN)



Established in 2015 by NIST, the U.S. DoD, and NTIA. In 2018, added NOAA, NSF, and NASA.

Organizes a national network of federal, academic, and commercial test facilities

Provides trusted spectrum testing, modeling, and analysis to develop and deploy spectrum-sharing technologies and inform future spectrum policy and regulations.

NASCTN MISSION

To provide, through its members, **robust test processes** and **validated measurement data** necessary to develop, evaluate and deploy spectrum sharing technologies that can **increase access to the spectrum** by both federal agencies and non-federal spectrum users.

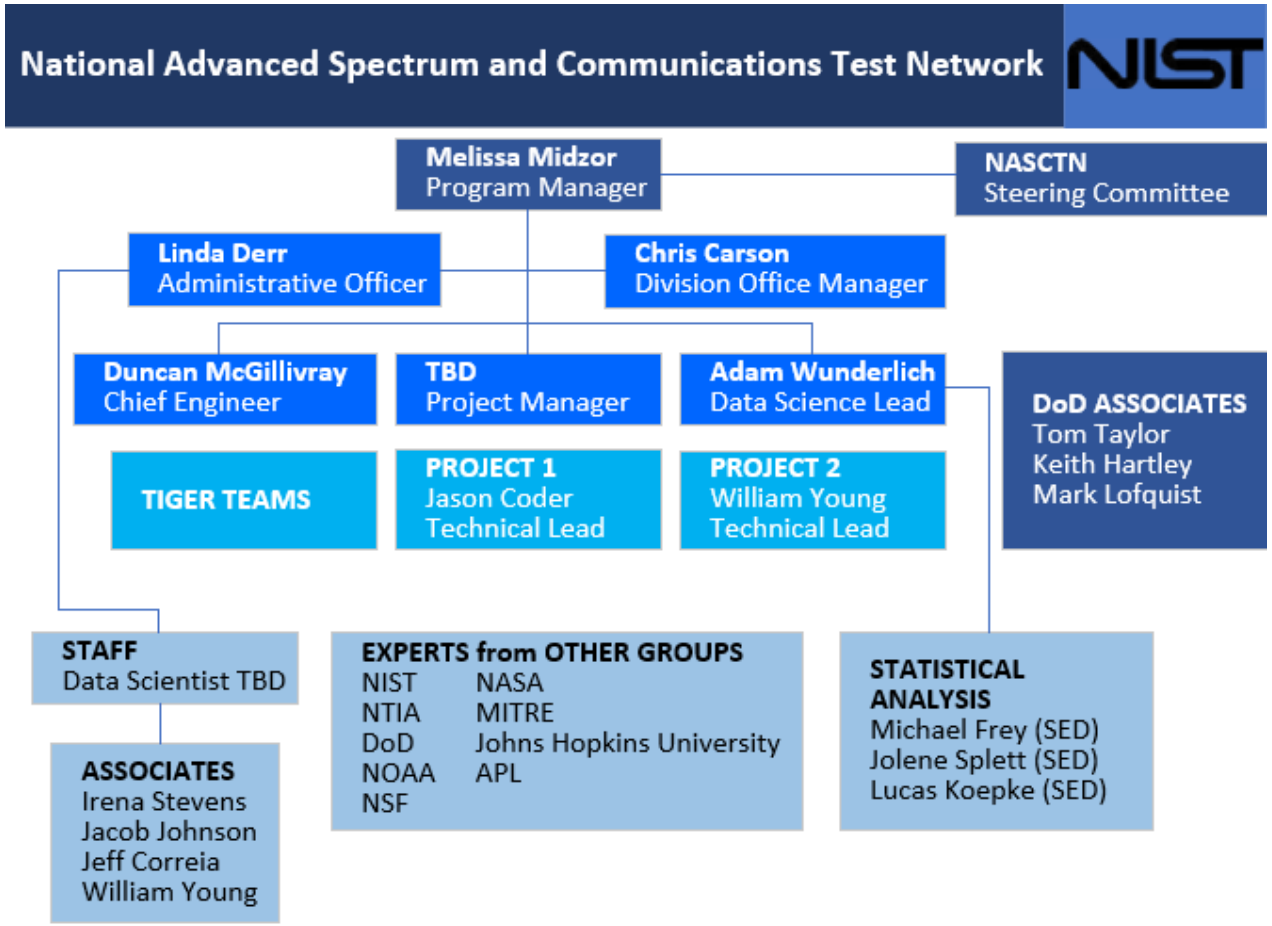
Develop scientifically rigorous test plans and new methodologies with independent experts

Access to key test facilities, and commercial and federal equipment and capabilities

Provide validated data and models for use within the spectrum sharing community

Operates as a trusted agent and protect proprietary, sensitive, and classified information

Unique structure for flexible, adaptable teams



Core Group (Hosted at NIST)
Overall programmatic direction and coordination across partners, ensures technical quality, enables rapid start up

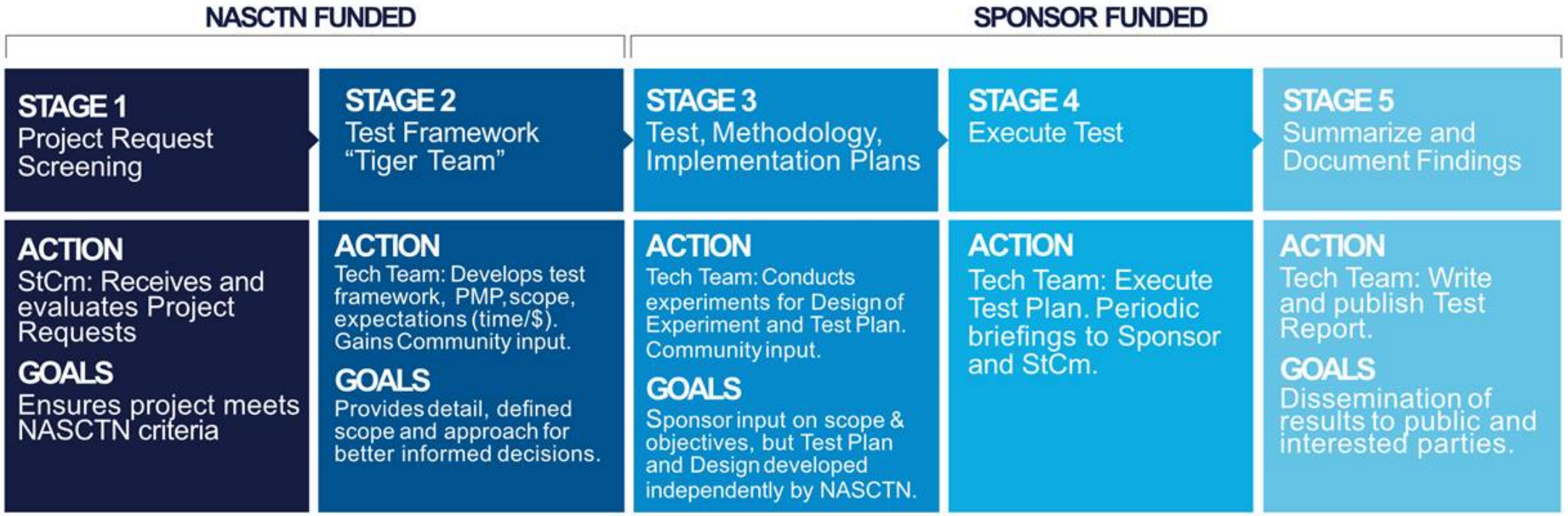
Subject Matter Experts (NIST, Other)
Each project employs personnel based on test requirements from NIST, NASCTN members, FFRDCs, CCS

Steering Committee
Provides guidance, outreach, approval of projects, and governance for NASCTN activities.

NASCTN Framework

NASCTN projects follow an open, transparent and comprehensive process for developing scientifically based test plans, facilitating access to member test ranges and laboratories, protecting controlled information, and validating test results before findings are reported.

The five-stage Framework serves as a common architecture across NASCTN's diverse spectrum sharing projects.



Projects and Research

LTE Sharing

AWS-3: Aggregate Emissions (DoD DISO)

Co-Channel interference (Navy)

3.5 GHz Sharing

- Citizens Broadband Radio Service (CBRS)
- Detection of RF waveforms

Adjacent Band LTE

GPS (Ligado Networks, LLC)

AWS-3 LTE Out Of Band Emissions (Edwards Air Force Base)

AWS-3 LTE Impacts on AMT (Edwards Air Force Base)

Impacts between Federal and Commercial Systems

Detection and Standards in Shared Spectrum environment

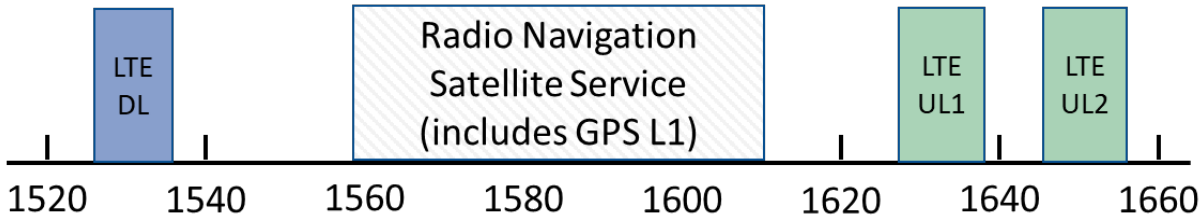
LTE impacts on Federal Systems

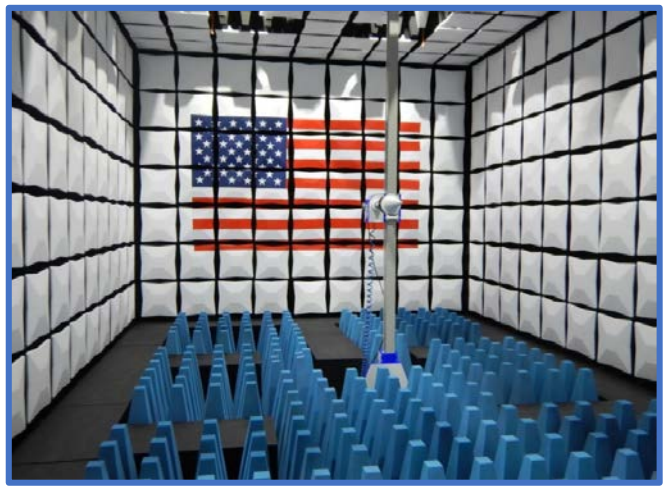
Projects: Outcomes and Impacts

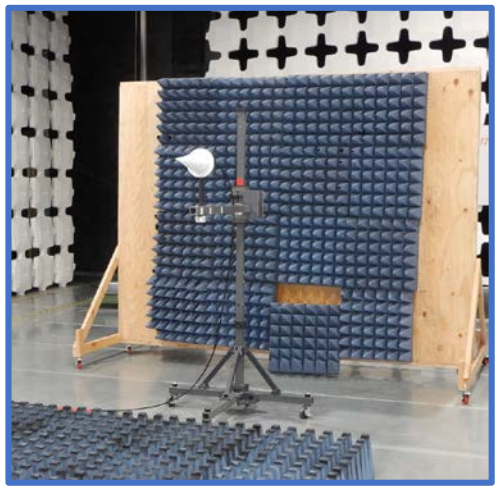
Since NASCTN was founded in 2015, has pursued 6 key spectrum sharing projects that brought together Commercial and Federal agencies. These include:

- **LTE Impacts on GPS L1** : Accepted as a neutral body and provided key data for LTE and GPS policy discussions. *(DoC Gold Medal)*
- **Aggregate AWS-3 LTE Emissions Project** : Informs interference models used by DoD for expedited and expanded entry of commercial deployments into the 1755-1780 MHz band. New metrology characterizes cumulative and complex interactions for cell phone emissions.
- **AWS-3 LTE Impacts on AMT**: Expands interference test methodology (beyond IRIG), and creates a public catalog of LTE waveforms for future interference testing for DoD test ranges to mitigate impact from future cellular equipment deployments.
- **Radar Waveforms in 3.5Ghz Band**: Collection of high resolution data. Machine Learning applied to IQ data and spectrographs provide methodology for occupancy rates, to inform commercial investments and risks.
- **AWS-3 LTE Out-of-Band Emissions:** Precise measurements for potential inference mitigation on DoD Range AMT systems.
- **Co-Channel Interference with LTE**: Test methodology for co-channel interference between advanced waveforms and LTE uplink traffic. Diverse KPIs to evaluate system response. *(Ex: hopping techniques degraded LTE performance despite high throughput.)*

LTE Impacts on GPS L1
(Adjacent Band LTE)







2011 - FCC grants conditional waiver to Ligado to deploy terrestrial LTE network adjacent to GPS L1 band

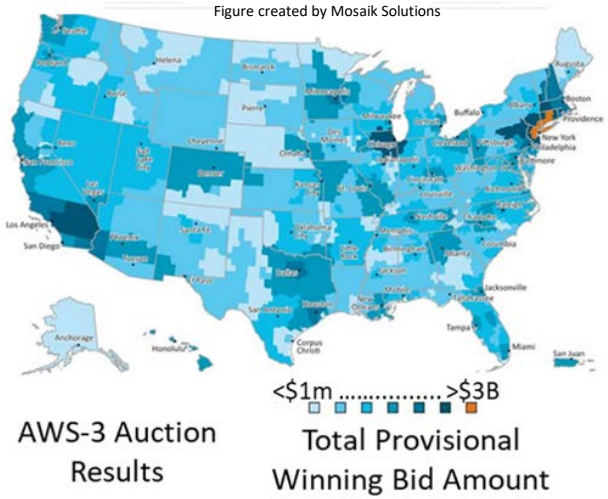
FCC suspends waiver due to potential interference. Extremely controversial, misinformation (multiple measurements).

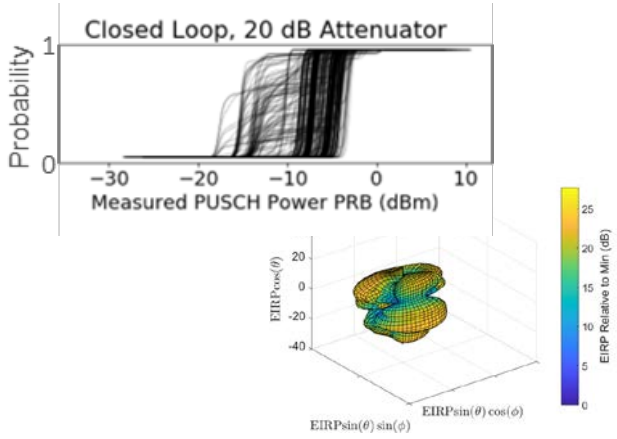
A trusted neutral party was required to investigate and measure effects of LTE signals on GPS receivers → NASCTN founded

Provided independent test methodology and data directly to regulators and stakeholder community.

2017 DoC Gold Metal

Aggregate AWS-3 LTE Emissions
(LTE Sharing)





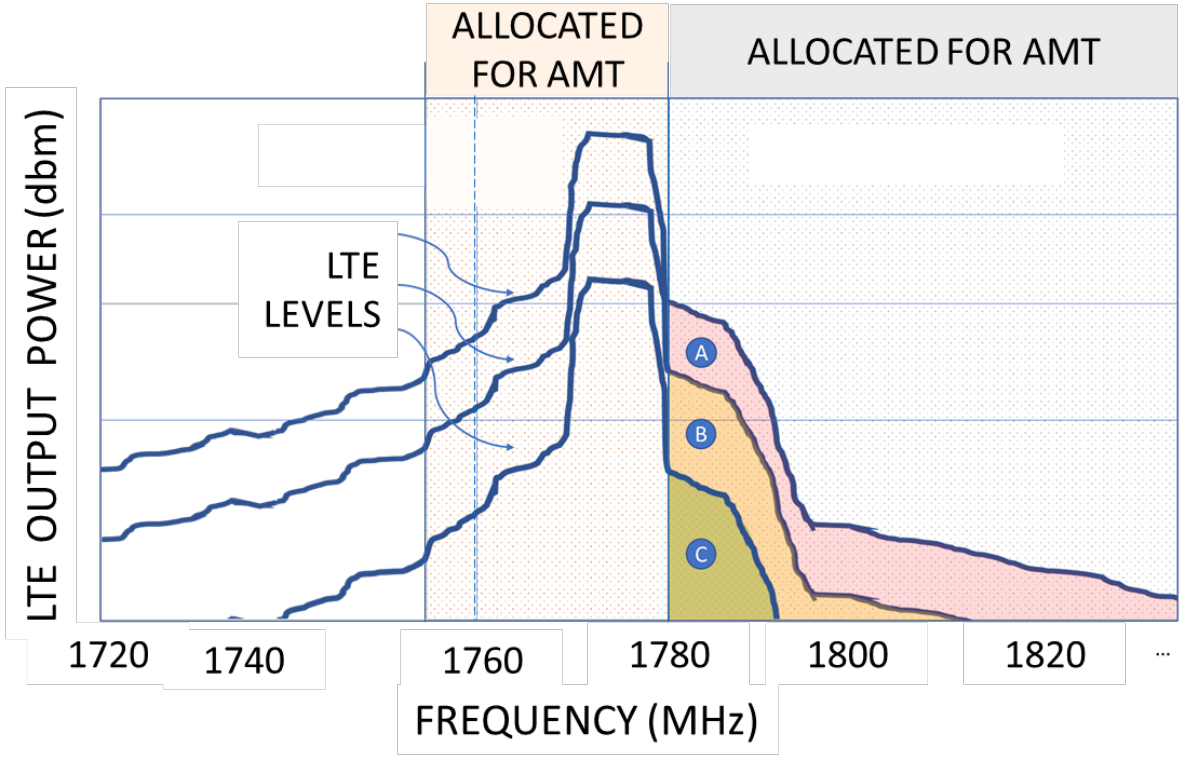
AWS-3 spectrum auction: $41.3B , must deploy within 5 years or lose license (2020)

Coordination for early entry relies on agreed upon Interference Model

Trusted rigorous measurement data required to support proposed changes to Interference Model.
→ support DoD FY19 LTE Network Emission Model recommendations

New metrology required to characterize cumulative and complex interactions for cell phone emissions.

AWS-3 LTE Impact on AMT (Adjacent Band LTE)



AWS-3 auction led to compressed operations of DoD range Aeronautical Mobile Telemetry (AMT) systems.

AMT infrastructure remains unchanged, and current Inter Range Instrumentation Group (IRIG) Protocols for mitigating interference do not include new waveforms such as LTE.

Project will develop

- New coexistence metrics and compatible methodologies for multiple waveforms
- A curated set of LTE waveforms for future testing of multiple range environments.

Targeting Future Challenges

Develop Metrology and Curated data sets

- ML Training and evaluation
- RF interference and sensing testing (“impact”)
- 5G, Optical networks

Machine Learning / AI

Pro-Active Measurements

- Key measurements in advance of spectrum auctions
- Early identification of issues and risks
- Improve investments

Future Auctions

Developing new Statistical Analysis

- Large # variables, complex interactions, distributed responses
- LTE, 5G and beyond, DoD mission testing

Data Science

QUESTIONS?