Regulatory Lab Perspective on Iterative Regulatory Improvement

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Receiver Performance and IPC Testing

- ITS Receiver Performance Testing
  - Field measurements using actual system antennas and hardware in real-world propagation geometries to assess how in- and adjacent-band signals affect receiver performance
  - Laboratory measurements to assess receiver front end, end-user experience, and interference protection criteria (IPC) under controlled signal conditions
  - Simulation based on communications and radar models and assumptions are performed to validate and generalize results
- This work is mostly reactive today
- A long-term **commitment to systematic testing and modeling receiver performance in interfering environments** would help move feasibility studies move away from worst-case analysis. Testing should begin at an early stage of receiver development.

Antenna Characterization

- ITS Antennas Characterization and Modeling
  - Field measurements performed with mounted antennas at Table Mountain turntable
  - Anechoic chamber measurements performed at NIST facilities
  - Antenna models used in analyses are static and assume no environmental interaction
  - New planned R&D initiative to characterize active antennas
- A long-term commitment **to systematically characterize advanced antennas in real-world spectrum sharing scenarios** would help make antenna models more accurate for feasibility analyses
- More generally, modern active antennas are dynamic and algorithm based. Advanced active antennas should be evaluated and regulations adapted to proven mitigation techniques.

Propagation applied to Modern Use Cases

- ITS Propagation Modeling and Measurements
  - Propagation models are developed from first principles, simplifying assumptions, and field measurements
  - Field measurements are designed to fill-in gaps and address inaccuracies. This is a large measurement challenge.
  - Model standardization at ITU-R SG3
  - New mid-band propagation measurements will expand propagation measurements 4×
- Propagation models can be mistakenly used outside their intended scope and inherent set of assumptions resulting in inaccurate predictions
- A long-term commitment **to systematic improvement and validation of propagation models applied to specific priority scenarios** is needed to improve accuracies and reduce margins where practical

System Deployment Models

- ITS System Deployment Models
  - Obstacles to acquiring accurate and granular data on government and industry system deployments exist
  - Measurements are performed, but results are extremely limited in scope
  - Aggregate models and simulations based on population and random laydowns. Power levels are modeled at the authorized emission level and/or system emulation assumptions
- Data is limited in its applicability and results have limited validation
- A long-term **commitment to model and validate network densities, improved data on government system operating ranges, and power levels** is needed to enable risk-informed interference analyses

NTIA Spectrum Management R&D Program

- Quick Reaction technical support
- One-and-done regulatory process falls into Quick-Reaction style of work
- Planned R&D
  - Interference modeling and analysis
  - Propagation modeling, measurements, standardization, and software
  - Antenna characterization, measurements, and modeling
  - Spectrum quantification, characterization, and validation
- The NTIA Planned Spectrum Management R&D program could be expanded to support an iterative regulatory process, engage with stakeholders, negotiate priorities, and create a pipeline for new science, data, and technologies to be tested, better understood, and used by the regulator