FOUNDRY

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Model Standardization: Propagation Case Study

Introduction and Background

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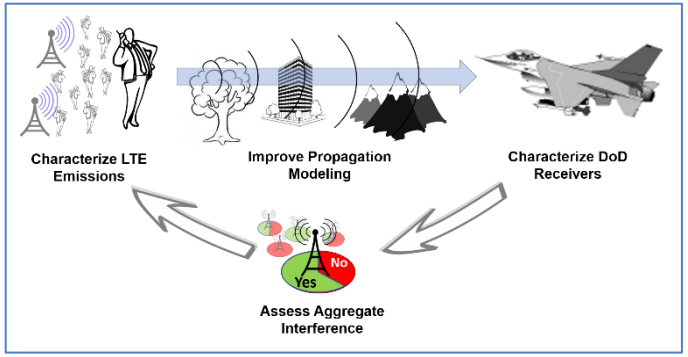
Background

- **Began working DoD Spectrum Management in 2007**
  - SPECTRUM XXI – Operational Planning and Spectrum Management Tool
  - GEMSIS - Global Electromagnetic Spectrum Information System
  - Advanced Spectrum Concepts – e.g., Dynamic Spectrum Access (DSA)

- **IEEE DySPAN-SC since 2012**
  - P1900.5 Chair since 2019 – DSA Policy Language and Architectures
  - Focused on support for Cognitive Networks, Dynamic Policy Management, Policy Languages, Spectrum Consumption Modeling

- **AWS-3 Spectrum Sharing Test and Demonstration (SSTD) since 2015**
  - Chief Engineer
  - Focused on LTE 4G/5G Characterization, Propagation Modeling, DoD Receiver Characterization, and Aggregate Interference Assessments



SSTD Propagation Modeling Timeline and Key Items

2013

CSMAC developed sharing plans for the AWS-3 bands

2014

FCC Report and Order adopted rules governing AWS-3 bands

"We expect a good faith effort … to facilitate commercial use of the band"

2015

FCC completed AWS-3 Auction - $44.9B

SSTD establishes Improved Propagation WG

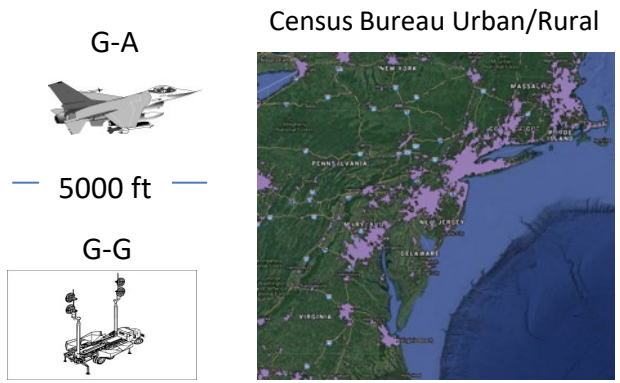
Begins efforts to standardize increasingly realistic propagation models for use in AWS-3 spectrum sharing assessments

SSTD facilitates stakeholder acceptance of IOC AWS-3 propagation models

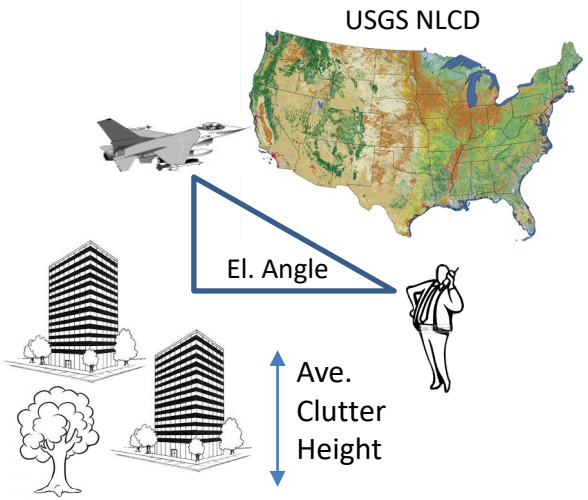
DoD opens the AWS-3 Coordination Portal

SSTD facilitates annual stakeholder acceptance of improved propagation models

- **Propagation Measured Data**
  - **Drive Tests – Multi-day propagation measurement events in 14 different locations across the US**
  - **FAA ADS-B - 2 years of nearly all aircraft to over 700 FAA ground stations across the entire US**
- **Clutter/Building Exit Loss Differential Measurement Techniques**
  - **GPS BCLM**
  - **ADS-B**
- **Application of Machine Learning to Category and Predictive Clutter Models**



IOC – 4 Clutter Categories



FY21 – 117 Clutter Categories

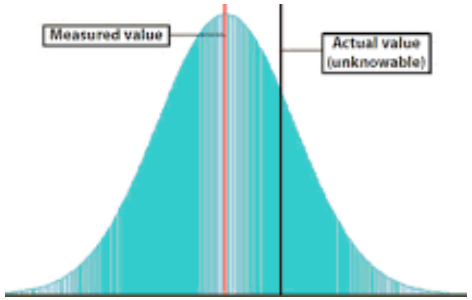
Propagation Modeling Perspective

- **"All models are wrong, some are useful" – George Box and Howard McDonald (DSO)**
  - **It is important to be realistic about the achievable "truth" of your effort, also**

    Since all models are wrong the scientist must be alert to what is importantly wrong. It is inappropriate to be concerned about mice when there are tigers abroad - George Box

0.1 dB vs 10 dB

- **"Propagation loss is a highly variable phenomenon" – Paul McKenna (ITS)**
  - **It is important to model it that way or use a <u>proper</u> equivalent value**
  - **Location, situation, and time all contribute to variability**
  - **Even the same measurement, day to day is often up to +/- 7 dB different**

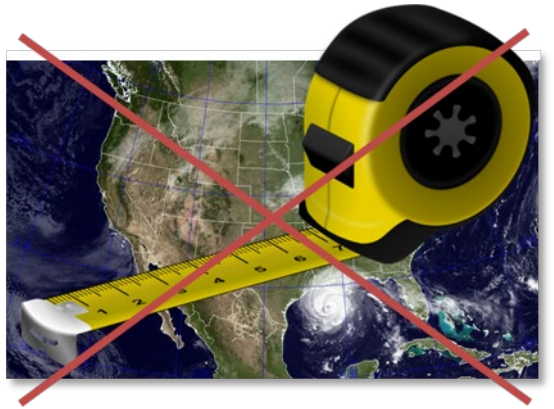


- **"There is <u>not</u> one model to rule them all" – Chris Anderson (USNA)**
  - **Different situations may require different models (e.g.; 2D vs 3D)**
  - **Different applications may require different models (e.g.; link performance vs interference protection)**

The Model!

Propagation Model Standardization Perspective

- **You can't measure the world, but a model untethered from data is hard to trust**
  - **Make/acquire as much measurement data as you can**
  - **Find meaningful ways to leverage it**
    - SSTD validates path loss techniques against measurements and then uses those techniques to generate category-based area models



- **There is safety in numbers**
  - **Aggregation can be your friend if you don't need each instance to be "good"**
  - **Site-general models (category/class) can be useful, but you sacrifice fidelity**

- **Propagation model standardization is better as an inclusive iterative process rather than a "Big Bang" event**
  - **A fait accompli result can be hard to agree on and endorse**
  - **Inviting all stakeholders to view and participate in the sausage-making can ease/speed the path to acceptance**
  - **Incremental improvements provide opportunities to:**
    - Codify any existing agreements among stakeholders
    - Address one or a few challenges at a time
    - Modify data collection and tactics as the problem statement evolves

Forging the Future of Spectrum