DEFENSE INFORMATION SYSTEMS AGENCY
The IT Combat Support Agency

Current DoD Propagation Challenges

AWS-3 Perspective

Howard McDonald

Branch Chief DSO

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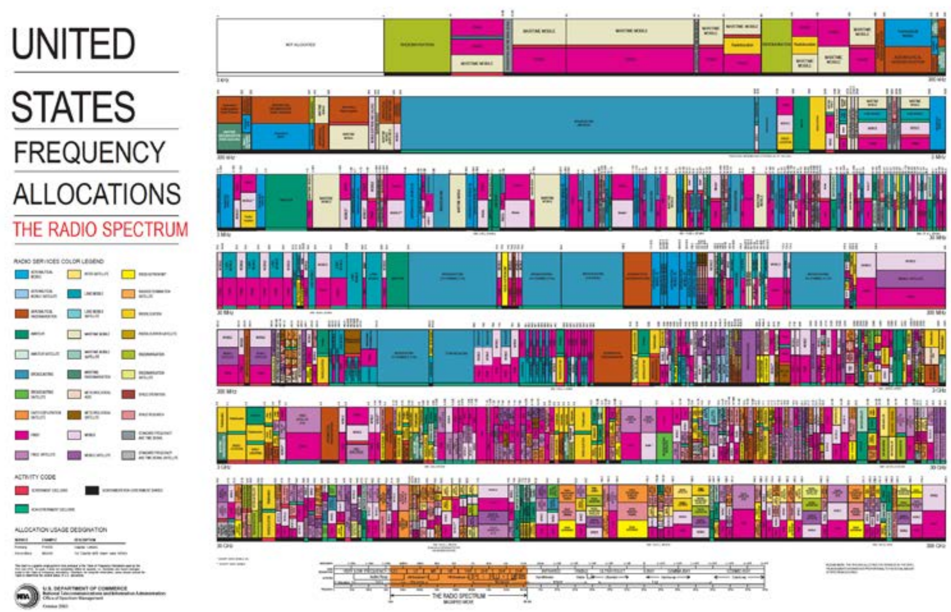
DISA

Advanced Wireless Services (AWS)

- **Advanced Wireless Services (AWS) is the collective term the FCC uses for innovative fixed and mobile terrestrial wireless services**
- **The FCC has designated several different AWS spectrum bands over the years**
  - **AWS-1: In 2002, the FCC released an Order that allocated 90 MHz of spectrum for AWS in the 1710-1755 and 2110-2155 MHz spectrum range**
  - **AWS at 1915-1920 MHz/1995-2000 MHz (“H Block”): In June 2013, the FCC released a Report and Order containing licensing, operating, technical, and competitive bidding rules for the H Block**
  - **AWS-3: Following a Notice of Proposed Rulemaking in July 2013, the Commission adopted a Report and Order in March 2014 with allocation, technical, and licensing rules for commercial use of the 1695-1710 MHz, 1755-1780 MHz and 2155-2180 MHz bands.**
  - **AWS-4: In 2012, the FCC released a Notice of Proposed Rulemaking that proposed to apply AWS service rules for spectrum in the 2000-2020 and 2180-2200 MHz spectrum range.**

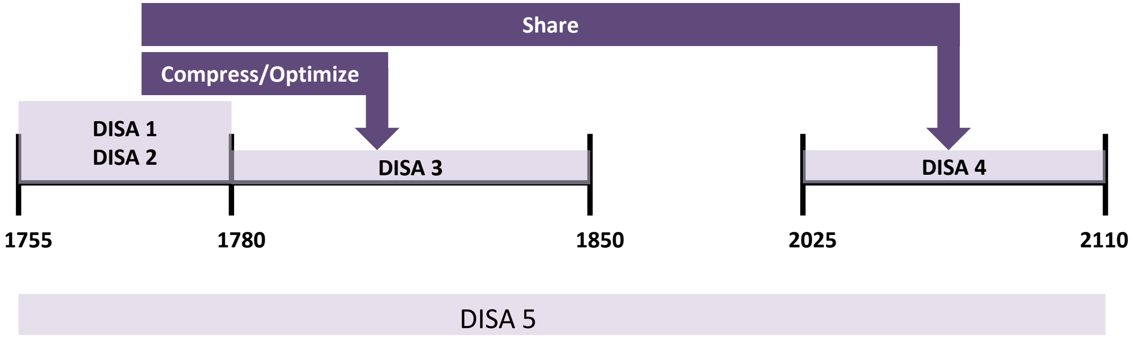


Federal Communications Commission

DISA Transition Plan for 1755-1780 MHz

- **DISA Transition Plan for 1755-1780 MHz – published July 9 2014**

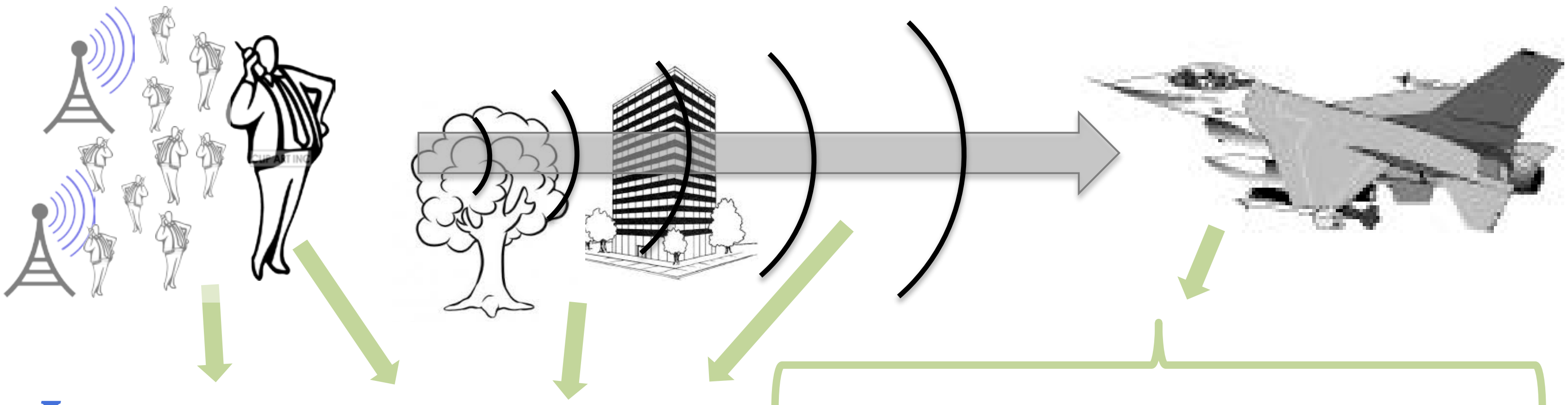
  - **DISA 1** - 1755-1780 MHz Band Portal (Early Entry Portal)
  - **DISA 2** - 1755-1780 MHz Band Portal (**NTIA Frequency Authorization Management Program (FAMP)** Portal)
  - **DISA 3** - 1780-1850 MHz Band Compression and Optimization Tool
  - **DISA 4** - 2025-2110 MHz Band Spectrum Management/Coordination System
  - **DISA 5 -** 1755-1780 MHz Band Spectrum Sharing Test & Demonstration (SST&D) Program



DISA

DoD AWS-3 Use Case

Calculating interference from a single <u>modeled</u> User Equipment (UE)

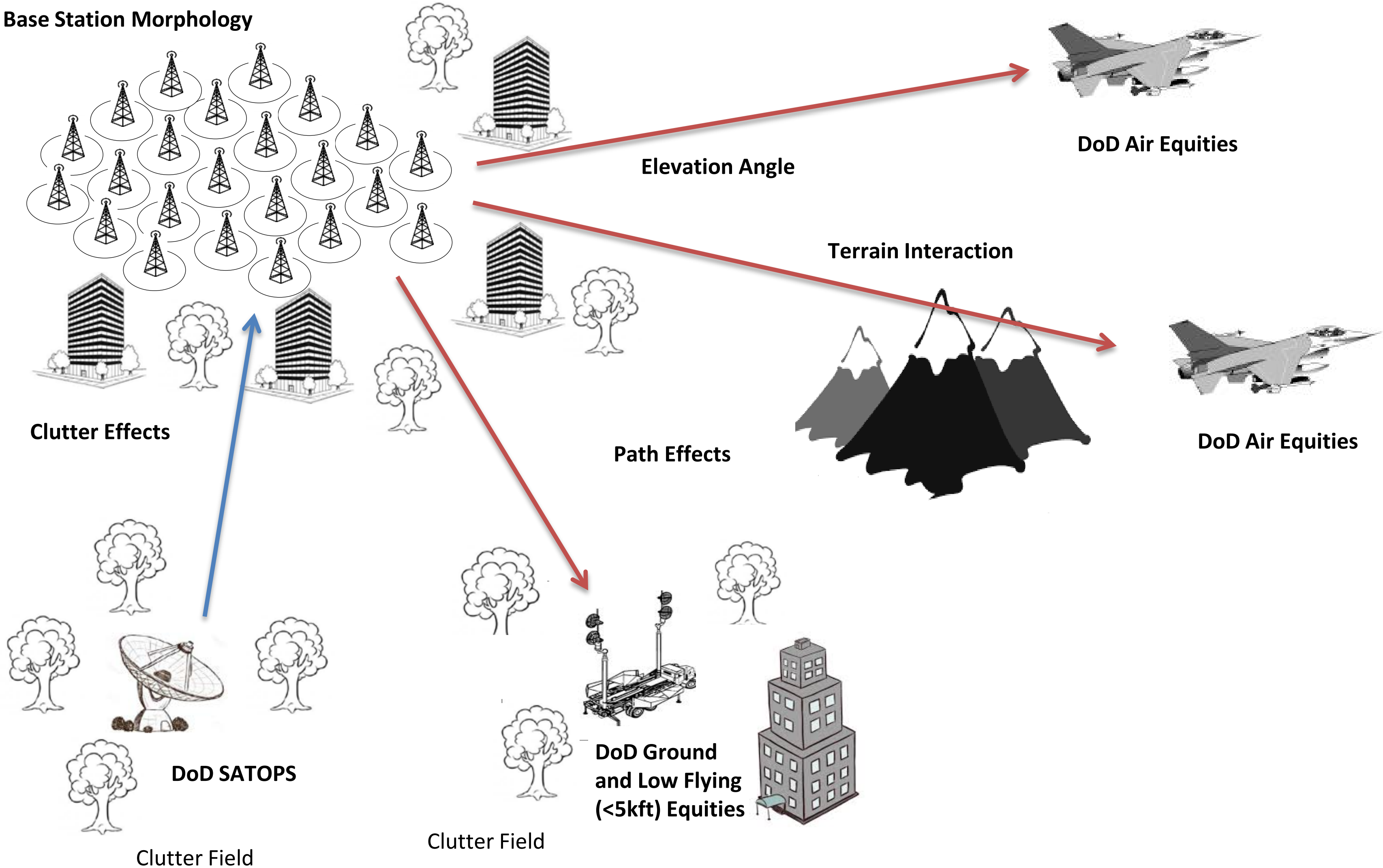


$$I_k = NL + EIRP - L_{Cl} - L_p - FDR(\Delta f) + G_r(\theta, \phi) - L_{pol} - L_s$$

- I_k = predicted interfering signal level in the DoD receiver from a single modeled UE, dBm
- NL = Network Loading Factor, dB *(Factor to account for below full capacity LTE system traffic)*
- EIRP = modeled UE transmitter effective isotropic radiated power, dBm
- L_{Cl} = clutter loss between a modeled UE and a DoD receiver, dB
- L_p = interference path propagation loss between a modeled UE and a DoD receiver, dB
- $FDR(\Delta f)$ = Frequency Dependent Rejection, dB *(Amount of UE power rejected by receiver selectivity)*
- $G_r(\theta, \phi)$ = DoD receiver antenna gain in the direction of the interferer transmitter, dBi
- L_{pol} = DoD receiver antenna polarization mismatch loss, dB
- L_s = DoD incumbent receiver system loss, dB

Notes: Blue indicates items currently modeled as a random variable. Other parameters such as L_p may be modeled as a random variable in the future. Capital = dB (or dBm); Lower Case = Power (i.e., mW)

Propagation-Related Focus



Propagation Refinement Roadmap

<table>
<tr><th rowspan="2">Version</th><th colspan="2">Basic Propagation Model</th><th colspan="3">Clutter Effects</th></tr>
<tr><th>Type</th><th>Propagation Model</th><th>Morphology</th><th>Path Type</th><th>Equivalent Clutter (EC) (dB)</th></tr>
<tr><td>IOC (V1)</td><td>Air
Ground</td><td>P.528
TIREM</td><td>Urban
Urban
Rural
Rural</td><td>Air
Ground
Air
Ground</td><td>1.32 dB
16.05 dB
0 dB
4.08 dB</td></tr>
<tr><td>V2</td><td>Air with Terrain</td><td>TIREM</td><td>Urban
Rural</td><td>Air
Air</td><td>2.83 dB
1.56 dB</td></tr>
<tr><td>V(X)</td><td>Air
Ground</td><td>IF-77
TIREM</td><td>Dense Urban
Urban
Suburban
Sub. Forested
Rural
Rural Forested
Barren</td><td>Ground
Air (w elevation angle)</td><td>Elevation Angle Dependent

WORK IN PROGRESS</td></tr>
<tr><td>V(X+1)</td><td colspan="5">Propagation Models – Inclusion of 2D/3D higher fidelity models, Incorporation of measured data
Clutter Morphologies – More/Better -> Site specific modeling
Clutter Distributions – More/Better Models, Incorporation of more measured data, near-field (multipath) vs far-field effects (atmospheric)
Data – Improved national DBs with terrain, foliage, and man-made structures
Integrated Propagation Modeling replacing separate Atmospheric/Terrain plus Endpoint Clutter</td></tr>
</table>

Resources Being Used to Refine Propagation Modeling

- **Propagation/Clutter Models**
  - TIREM
  - SEM
  - IF-77
  - ITU P.528-3
  - ITM
  - APM
  - TEMPER
  - Wireless Insite
  - eHata
  - ITU P.452
  - ITU P.2108

- **Measurement Data Sets**
  - (SEE NEXT SLIDE)
  - Propagation Measurement Retrieval System (PMRS)
  - ITS R4, Environment - From within a woods. Dates1966,1967 – Reference McQuate, P. L., J. M. Harman, and M. E. McClanahan (1971)

- **Geospatial Data Sets**
  - DTED
  - SRTM
  - USGS DEM
  - LIDAR
  - NLCD
  - Census Data
  - Forestry Data

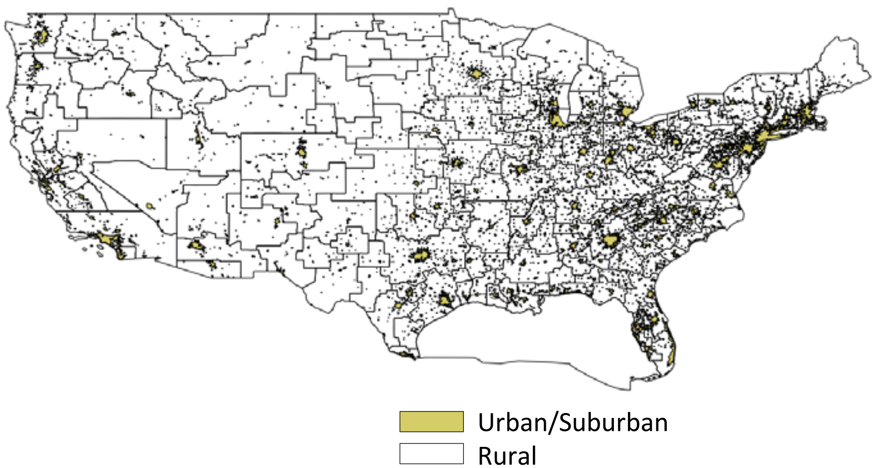
SST&D Measurements

- **Ground-to-Ground Drive Test**
  - San Diego, CA
  - Los Angeles, CA
  - Phoenix, AZ
  - Salt Lake City, UT
  - Denver, CO
  - Washington DC
  - Chapel Hill, NC
- **Fixed Point-to-Point Long Term**
  - Stockbridge, NY
- **Ground-to-Air Aerostat Drive Test**
  - Washington DC
  - Baltimore, MD
  - Ft Myer, FL
- **Ground-to-Air Drone Test**
  - Blossom Point, MD
- **Ground-to-Air GPS**
  - Blacksburg, VA
- **Ground-to-Air Fixed Wing Aircraft**
  - Easton, MD
- **Ground-to-Air Urban Drive Tests**
  - Chicago, IL

Clutter Loss Modeling Refinement Challenge (Example)

AS IS

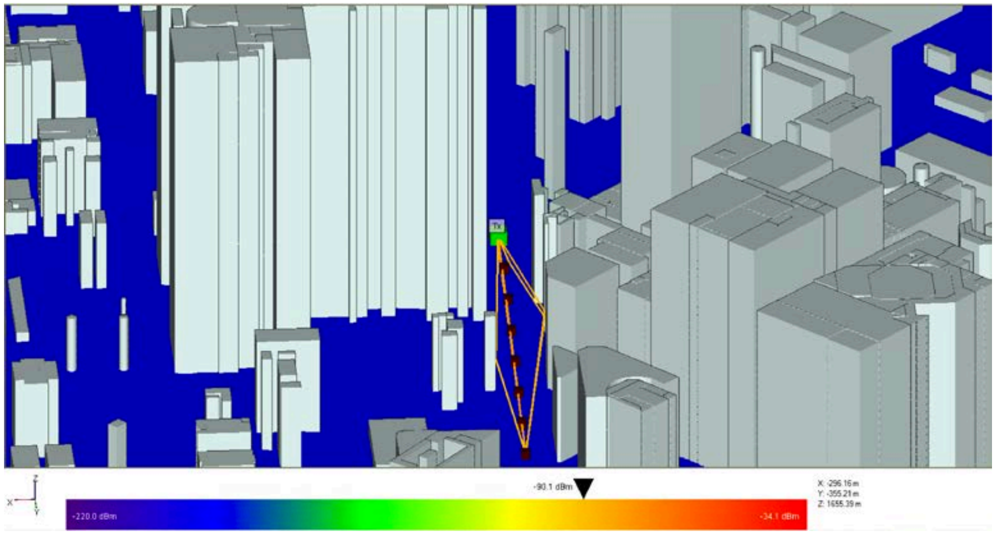
Census database is used to determine which of 4 clutter loss models to use (G-G or A-G)

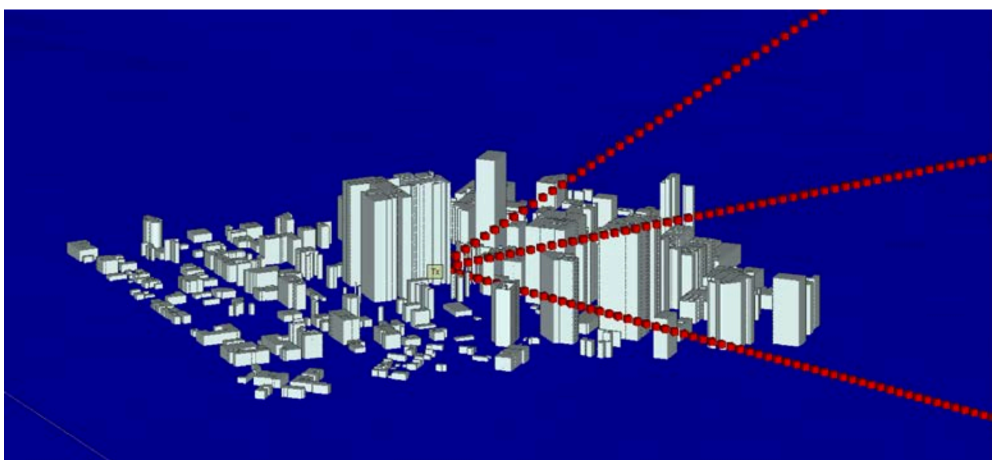


TO BE

LULC database used to determine clutter loss as a function of elevation angle

Near/Far Clutter Measurement Challenge (Example)





Clutter measurement campaigns have been focused on site-specific clutter phenomena

- Localized multipath phenomena significantly influences measurement data

The AWS-3 Use Case involves consideration of interactions between 1000’s of emitters (located in dense clutter environments) and DoD assets located significant distances away fro the emitters

Concepts being explored to measure the effects of clutter within the AWS-3 Use Case

Ongoing Activities – Next Steps

- **Estimating Measurement Uncertainty and Using Best Practices**

  "Measure it with a micrometer"

- **Assessing Propagation Variability (time, season, local conditions, etc)**

  "some are useful"

- **Mapping Near Measurements to Far Modeling**

  "mark it with a chalk"

- **Improved Categories**

  "mark it with a chalk"

- **Dependency on Elevation Angle**

  "mark it with a chalk"

- **Integrate into Early Entry Coordination Processes**
  - **"chop it with an axe"**

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