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NASCTN – AWS-3 LTE Testing

The National Advance Spectrum & Communications Test Network

Mark Lofquist,
The MITRE Corporation
mlofquist@mitre.org

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<https://www.nist.gov/ctl/nasctn>



Bottom Line Up Front

Two ongoing NASCTN tests involving Advanced Wireless Services-3 (AWS-3) uplink emissions

1. Aggregate AWS-3 LTE Emissions Project
 - Sponsor Defense Information Systems Defense Spectrum (DISA DSO)
2. AWS-3 LTE Impacts on Aeronautical Mobile Telemetry (AMT)
 - Sponsor Edwards Air Force Base

1- Aggregate AWS-3 LTE Emissions Project

Objective

- Design, demonstrate, & validate a test methodology to measure LTE User Equipment (UE) emissions for use in aggregate interference calculations.
 - Collect measurements in a controlled laboratory setting
 - Rigorous uncertainty assessment and statistical analyses

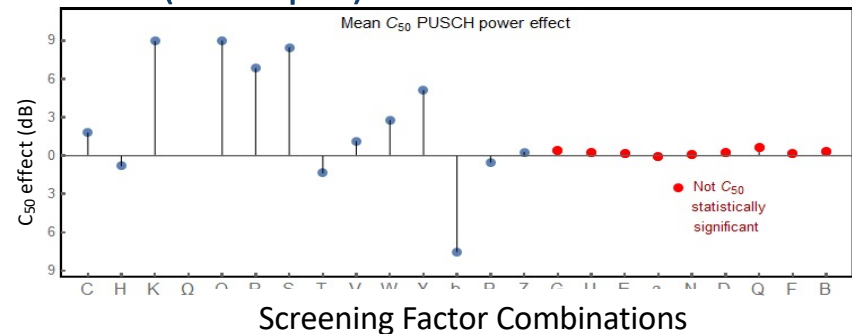
Test Detail

- Two test beds
- 28 total factors: 8 non-eNB, 20 eNB
- Experiment design:
 - 32 non-eNB configurations
 - 32 eNB configurations
 - Each UE measured twice
 - Combinatorics more than 200million trials -> DOE reduced to 5,504 trials

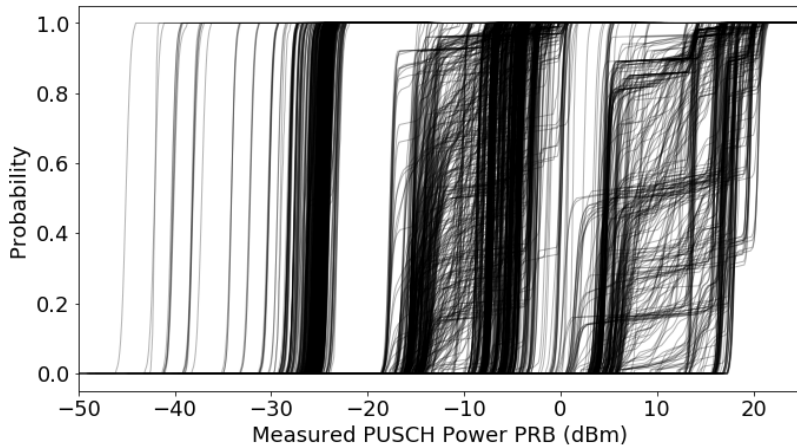
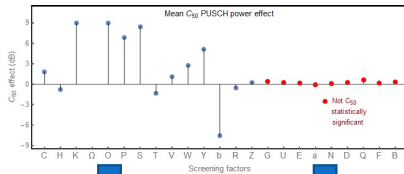
Status

- Factor Screening results analysis partially complete, report being drafted
- Identifying final test cases to execute before FY19 ends

Results (example)

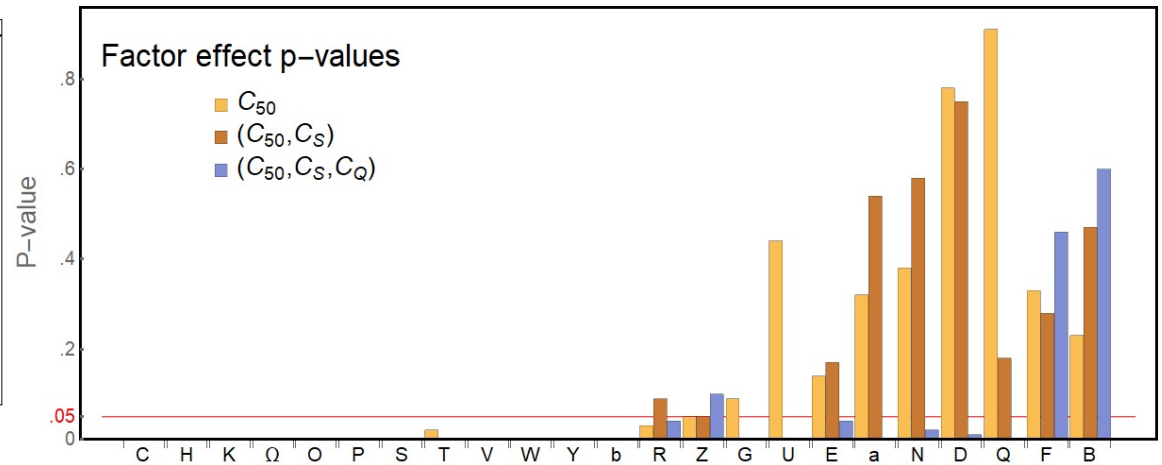


1- Results of Aggregate UE Test, continued



UE (e.g. smartphone) power cumulative distribution functions across all test cases
 PUSCH = Power uplink shared (data) channel

Statistical Insights



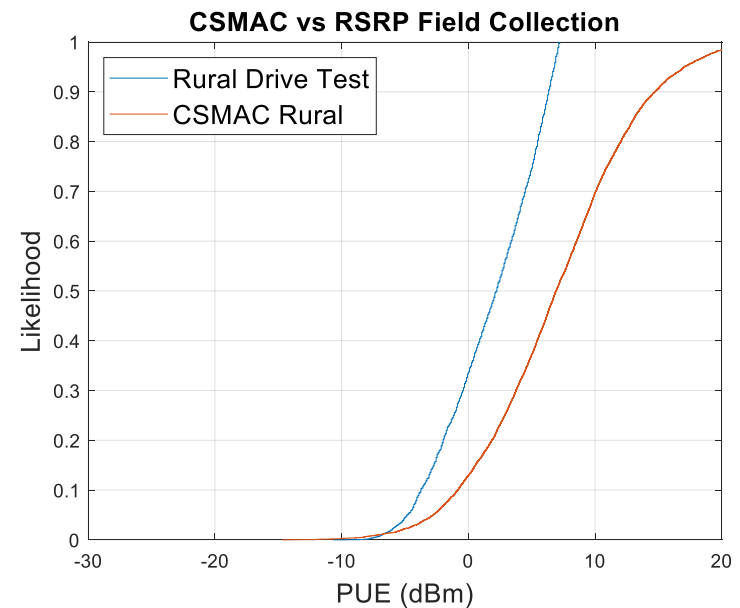
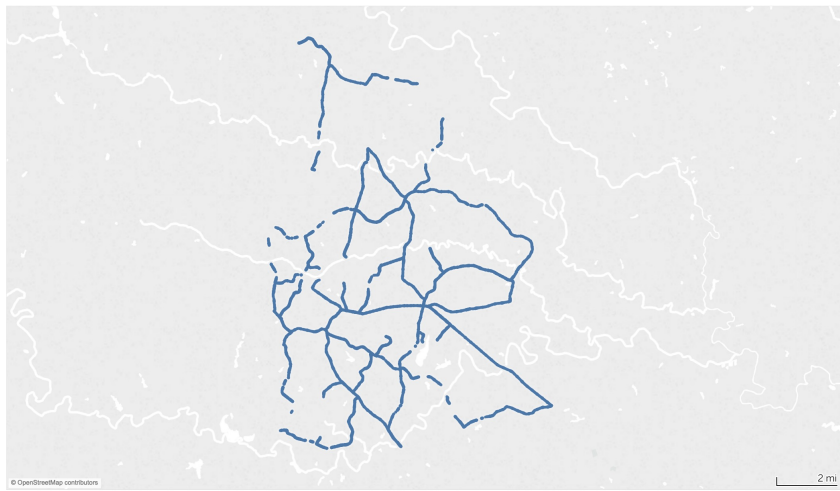
An analysis of the factors – their analysis of variance / **multivariate analysis of variance**, p-value = 0.95 % (ANOVA/MANOVA)

1- Follow-on work – Identified Research

Currently two draft papers

1. **Investigations and Analyses of LTE Network Cell Tower Deployments and Impact on Path Loss Calculations** (status: published in May '19)
2. **A Priori Estimation of UE Uplink Power Distributions** (status: currently being drafted)

Other research opportunities identified



2 - AWS-3 LTE Impacts on AMT

Objectives

- Effects on AMT from a set of waveforms
- Develop a Library LTE waveforms for current and future testing (captured from laboratory and in situ settings)
- In situ captures using AMT infrastructure

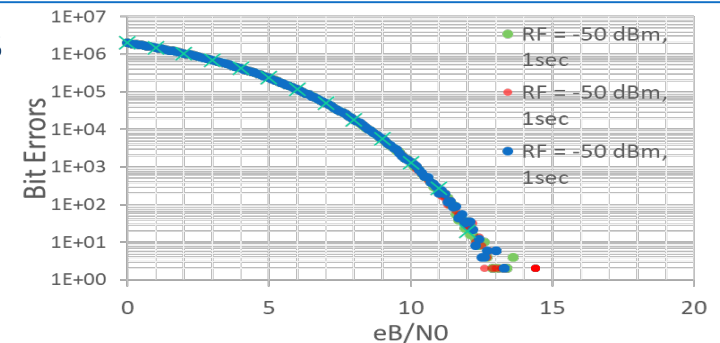
Status

- Kick-off 3/26/2019
- Team TRMC, NIST, DoD CIO, NASA, NTIA ITS, MITRE Bedford LTE Lab
 - In situ measurement plan drafted
 - Site visits schedule
 - RF Test Set #1 assembled, automation continues

Test Detail

- Sensitivity analysis – AMT Key Performance Indicator (KPI) response to various synthesized waveforms
- In situ LTE emissions using AMT RX
- Susceptibility analysis – with LTE injected to emulate “near” and “far” proximity

Results



2 – Test Detail of AWS-3 LTE Impacts on AMT, continued

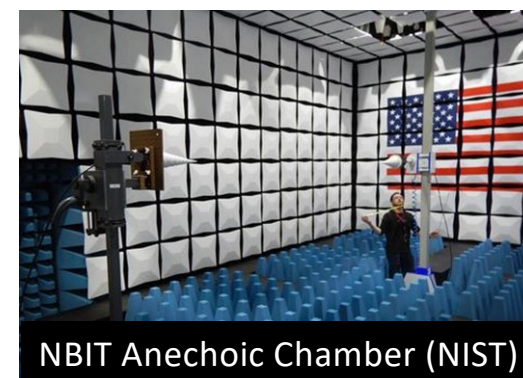
Test Scenarios require both controlled and in situ waveform captures

- **Controlled captures**

- Anechoic chamber measurements of UE emissions from 2 COTS UEs attached to an eNB

- **In situ captures**

- OTA captures using **AMT infrastructure** at two test ranges
 - Edwards AFB (EAFB), with antenna pointed at population centers 20, 30, 40 km distance
 - NASA Langley Science Center (larger population center & complex RF environment)



NBIT Anechoic Chamber (NIST)



EAFB in situ capture

Range of expected powers
Using free space path loss
(FSPL)

$$FSPL_1^*(20km) = -160 \text{ dB}$$

$$FSPL_2^*(40km) = -167 \text{ dB}$$

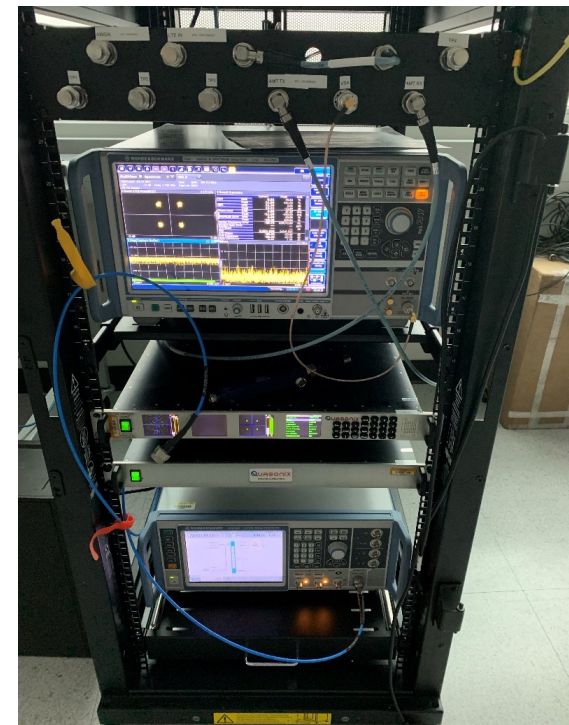
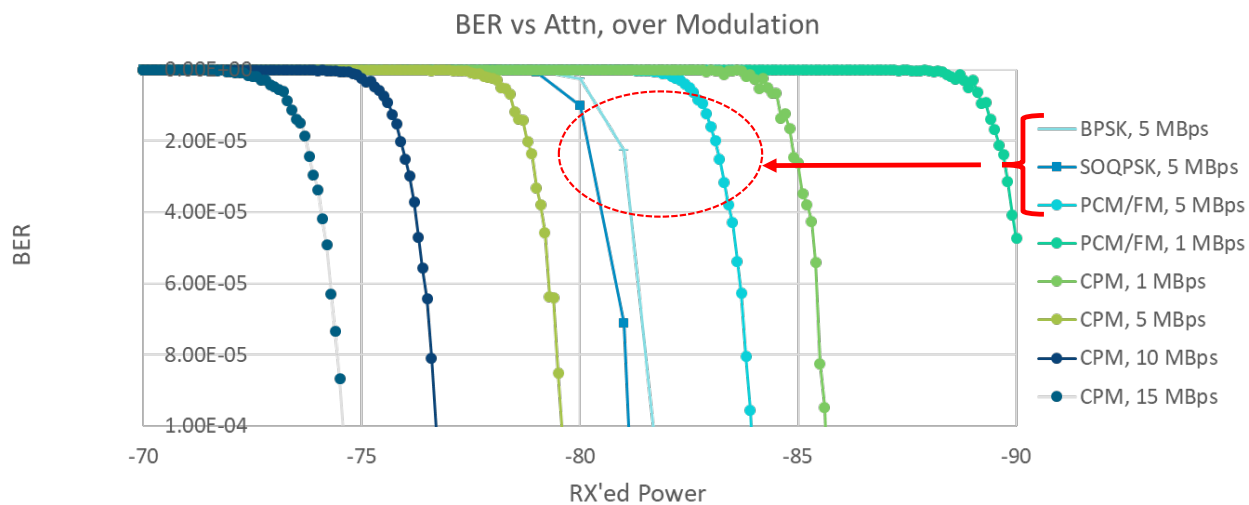
$$P_{RX1} = 23 \text{ dBm} - FSPL_1 = -137 \text{ dBm}$$

$$P_{RX2} = 23 \text{ dBm} - FSPL_2 = -144 \text{ dBm}$$

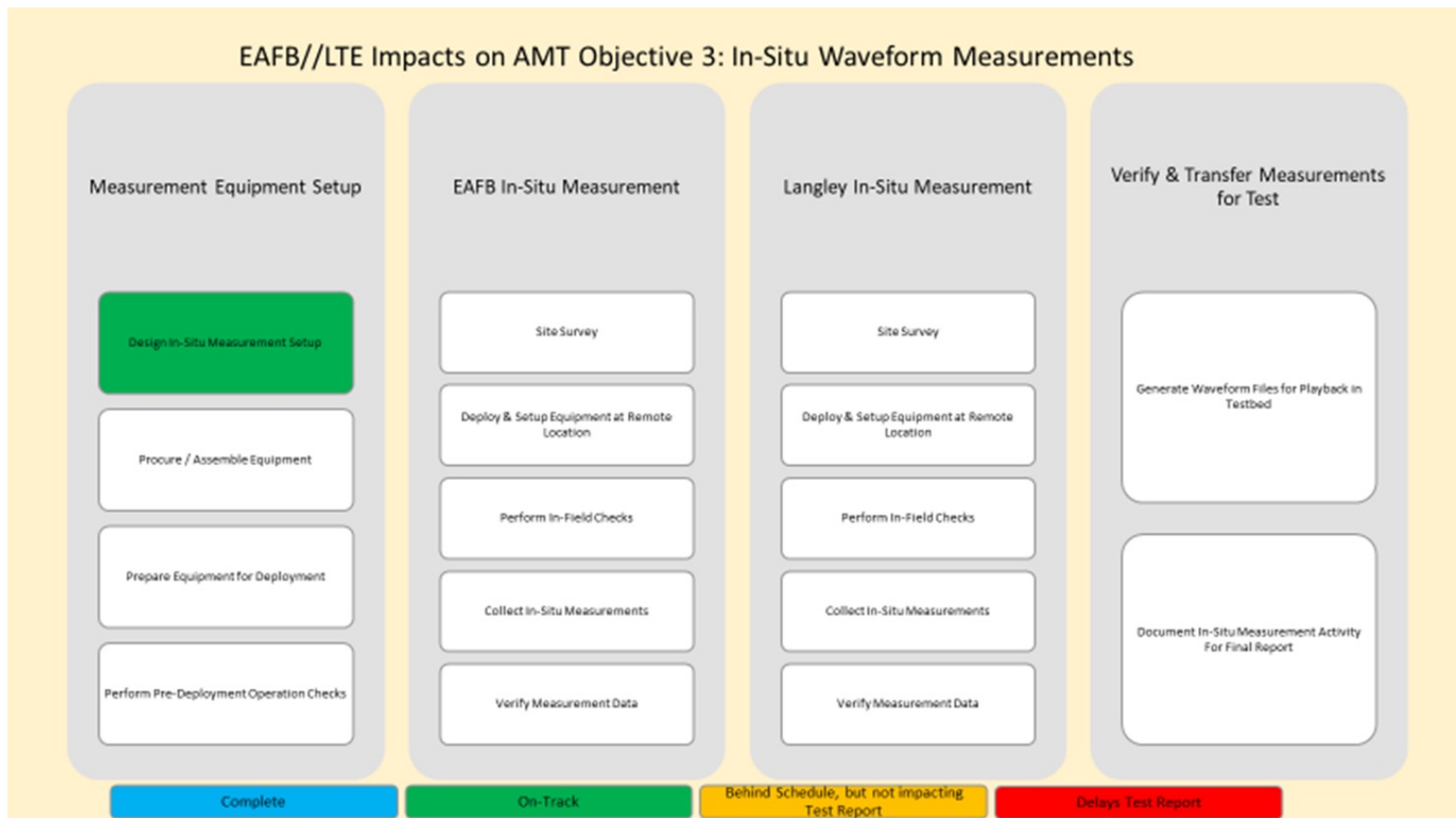
$$*FSPL = 20 \log_{10}(d) + 20 \log_{10}(f) + 20 \log_{10}\left(\frac{4\pi}{c}\right) - G_{Tx} - G_{Rx}$$

2 - Results of AWS-3 LTE Impacts on AMT, continued

- Early measurements for determining level setting and test bed SNR. “Finding the knees”



1 – In Situ Waveform Measurements Sub-Schedule



Questions?

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