Evaluating LTE Coverage and Quality from an Unmanned Aircraft System

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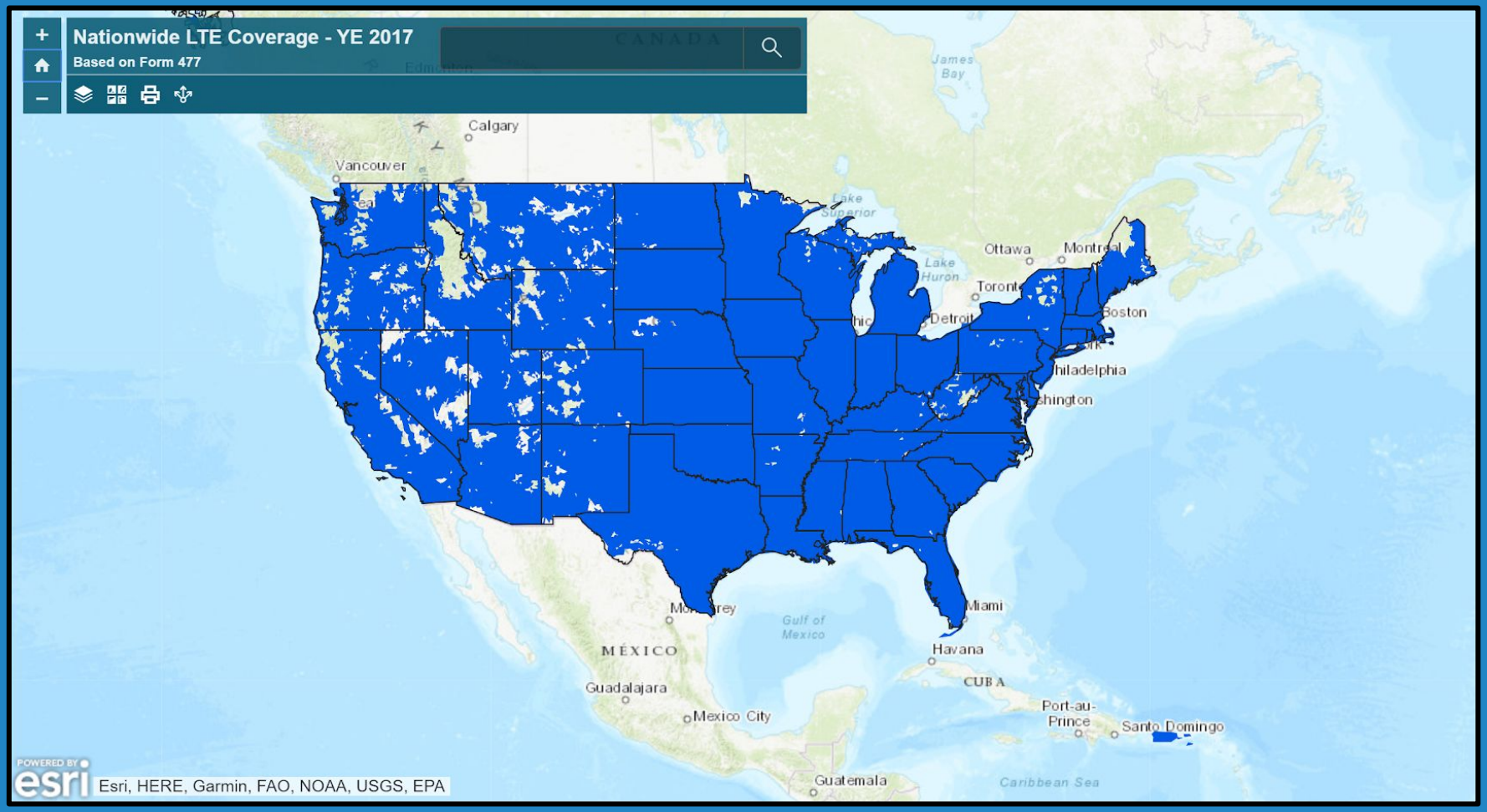
How do we effectively evaluate LTE cellular coverage?

Federal Database - Mobile Operators Self Report



LTE Coverage Map, from FCC
based on December 2017 Data

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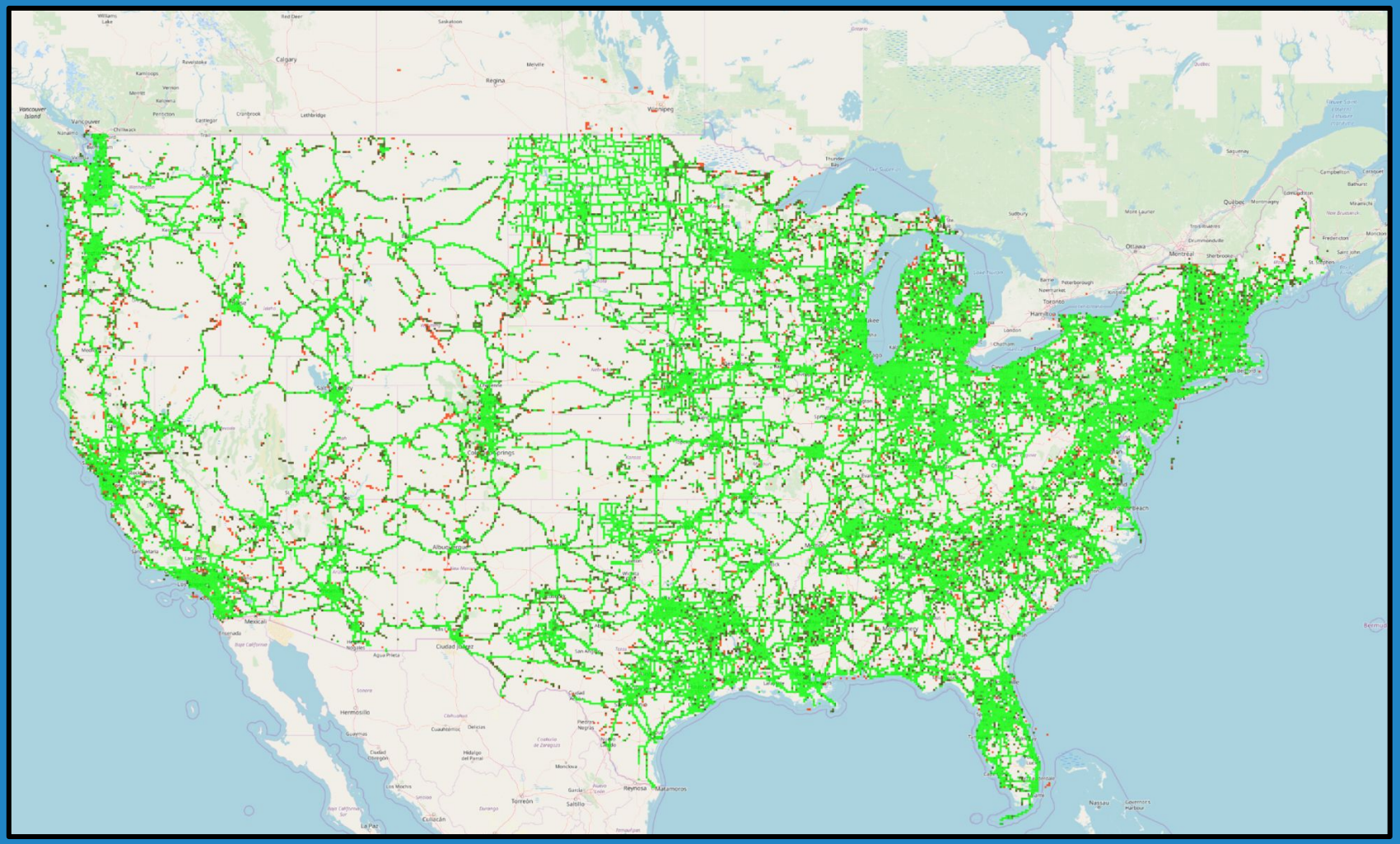
Crowdsourced Dataset



LTE Coverage Map of Verizon, from Cellmapper based on November 2019 Data

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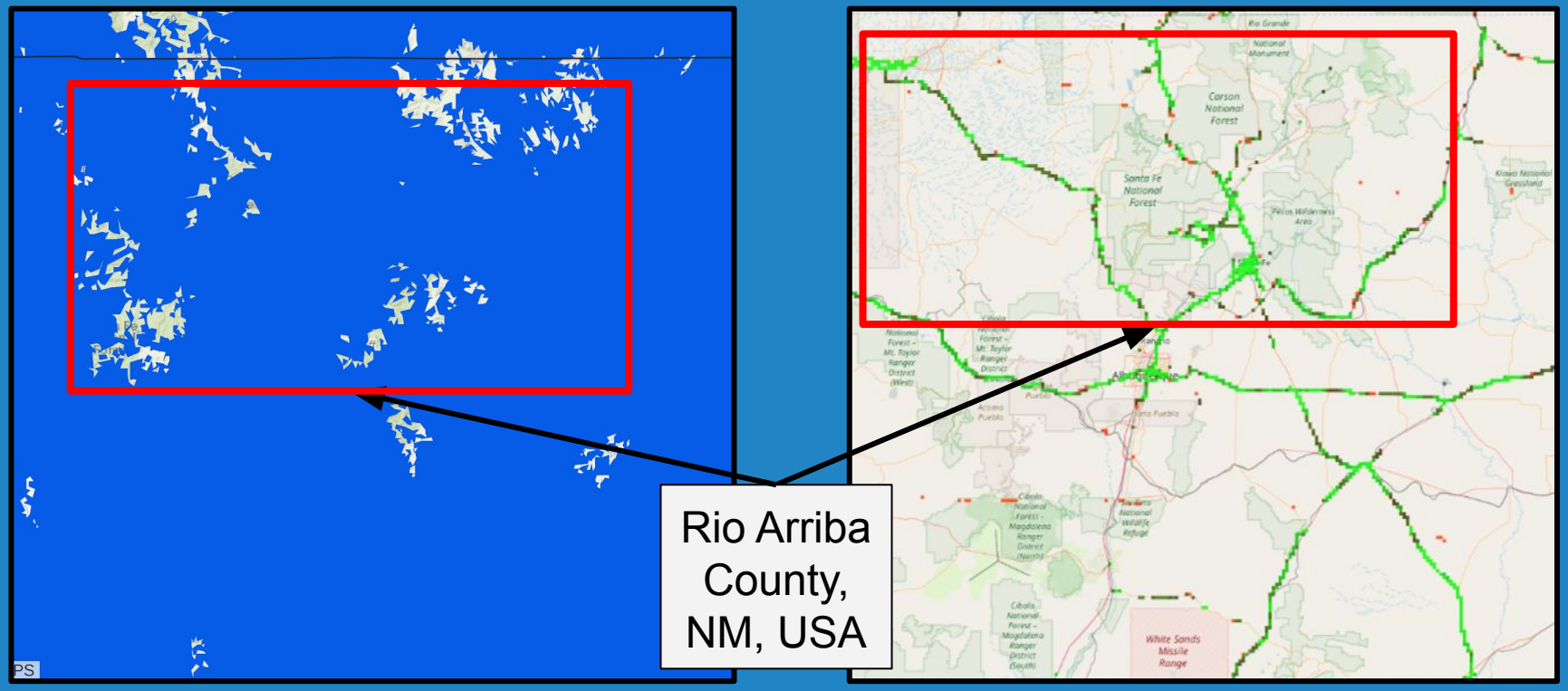


LTE Coverage Map rom FCC
based on December 2017 Data

LTE Coverage Map of Verizon, from Cellmapper
based on November 2019 Data

Common Methods of LTE Coverage Reporting:

FCC Self-Reporting

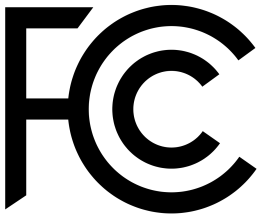
- Mobile providers report coverage.
- Coverage is binary
- Methodology is proprietary to each mobile operator

Crowdsourced

- Collected from UEs
- Data sparse
  - Transit corridors
  - Urban centers

Measurement Campaign

- Limited Scope
- Costly
  - Manpower
  - Equipment



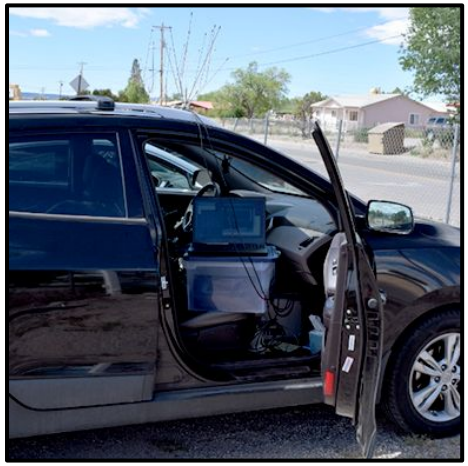
Properties of Desired Methodology

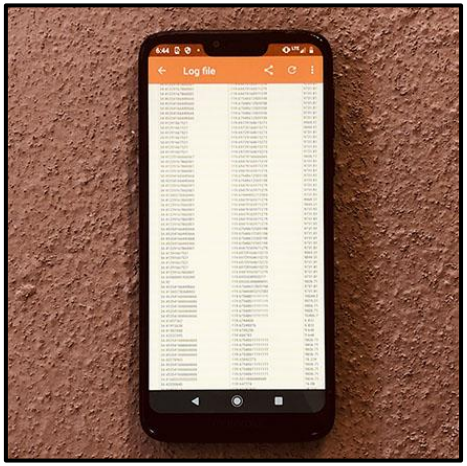
- Applicable to vulnerable communities
- Independent of mobile operators
- Limit cost/manpower

We investigate:

- Leverage low cost SDRs for RSRP measurement
- Mounting SDR on an Unmanned Aircraft System
- Comparing to ground and UE approaches

Methods





Ground-Driven:

- Keysight N9340b Spectrum Analyzer
- USRP B200
- RTL-SDR RTL2832U

Aerial:

- DJI Matrice 100
- RTL-SDR RTL2832U
- Raspberry Pi 2B+

Longitudinal:

- RTL-SDR RTL2832U
- Raspberry Pi 3B+
- 2 Days continuous monitoring

UEs:

- 4x Android Motorola G7 Power
- Sprint, Verizon, T-Mobile, AT&T
- App: Network Monitor

Data Collection

Rio Arriba County, NM

5 Days, May 2019

Networks: Sprint, Verizon, T-Mobile, AT&T

SDRs: Monitoring 20 of 22 LTE
Frequencies detected in area

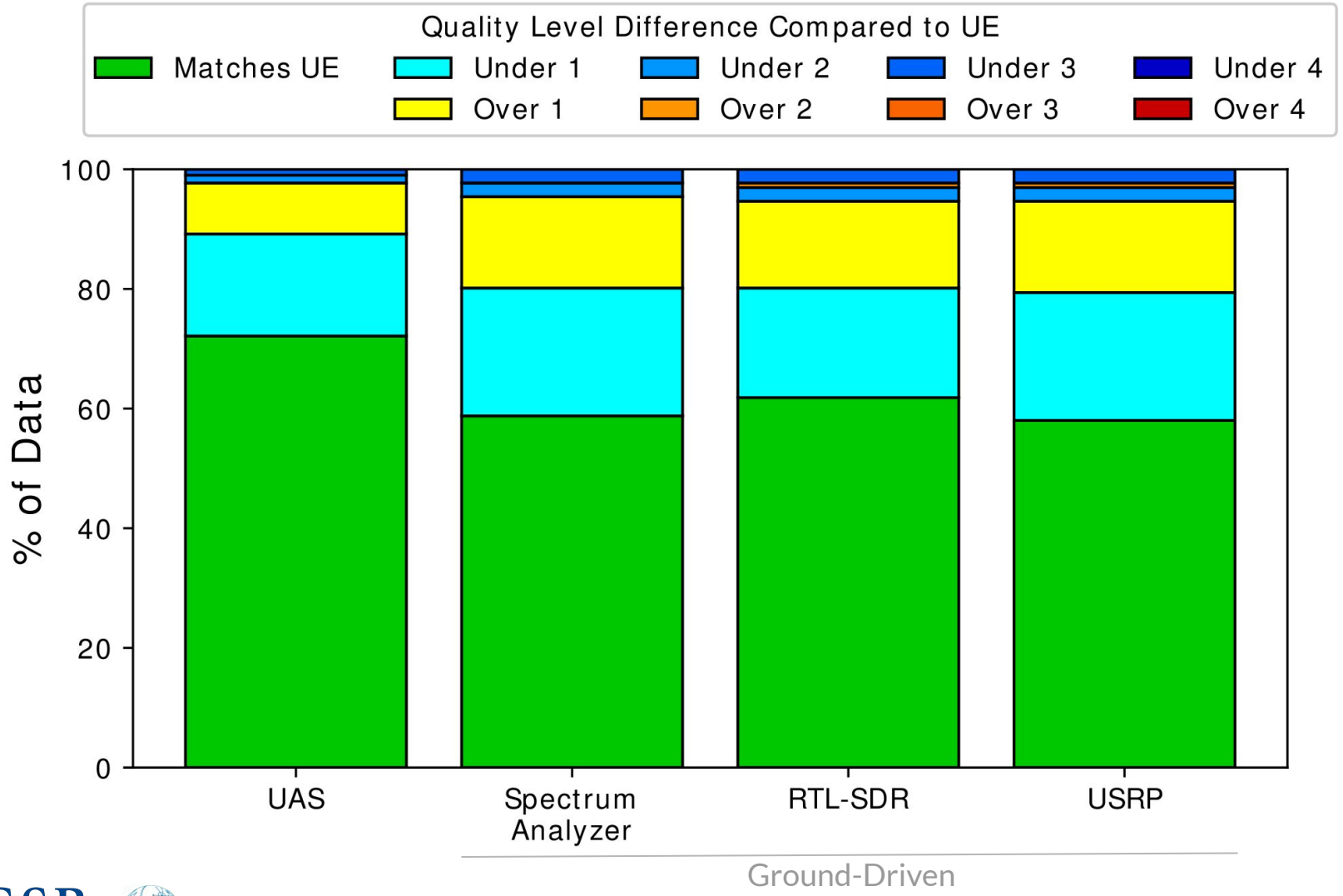
Area: 2,637 unique 110m^2 geographic bins.

Bin by Signal Quality

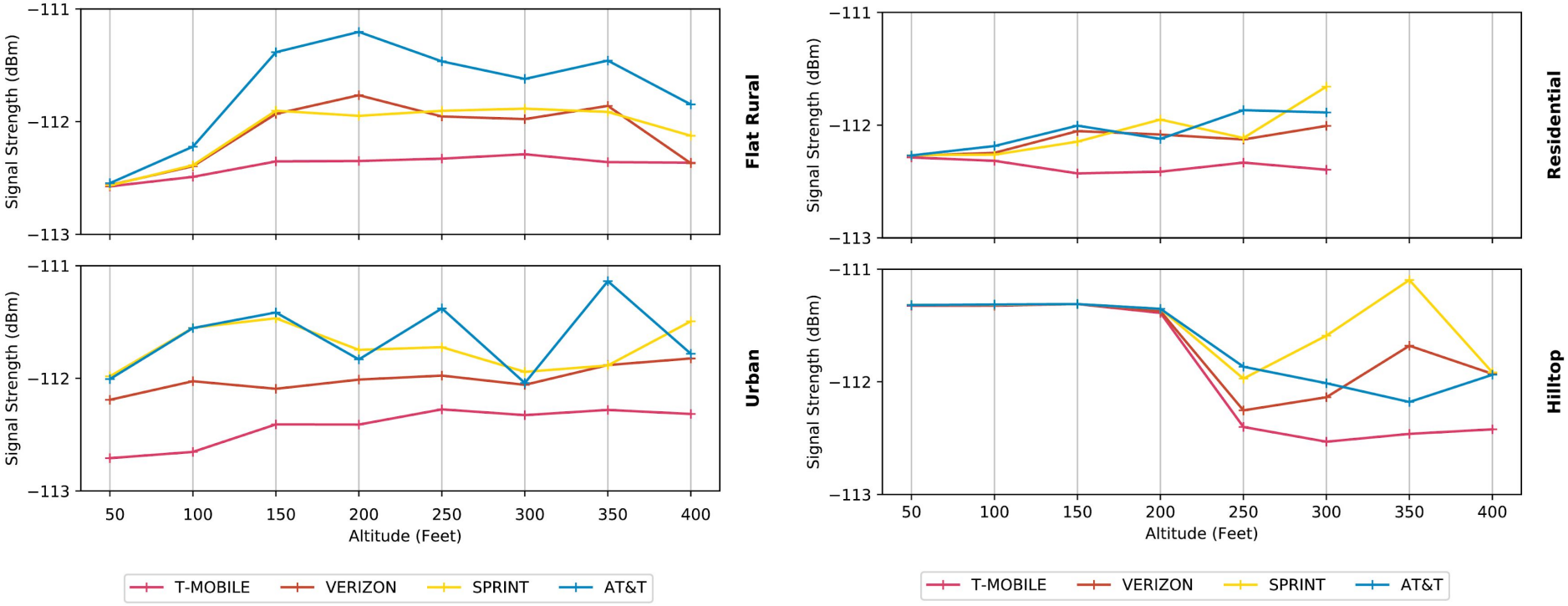
Quality	Range
Bad	< -120 dBm
Poor	-120 to -111 dBm
Fair	-111 to -105 dBm
Good	-105 to -90 dBm
Excellent	> -90 dBm

Note:
No set standards

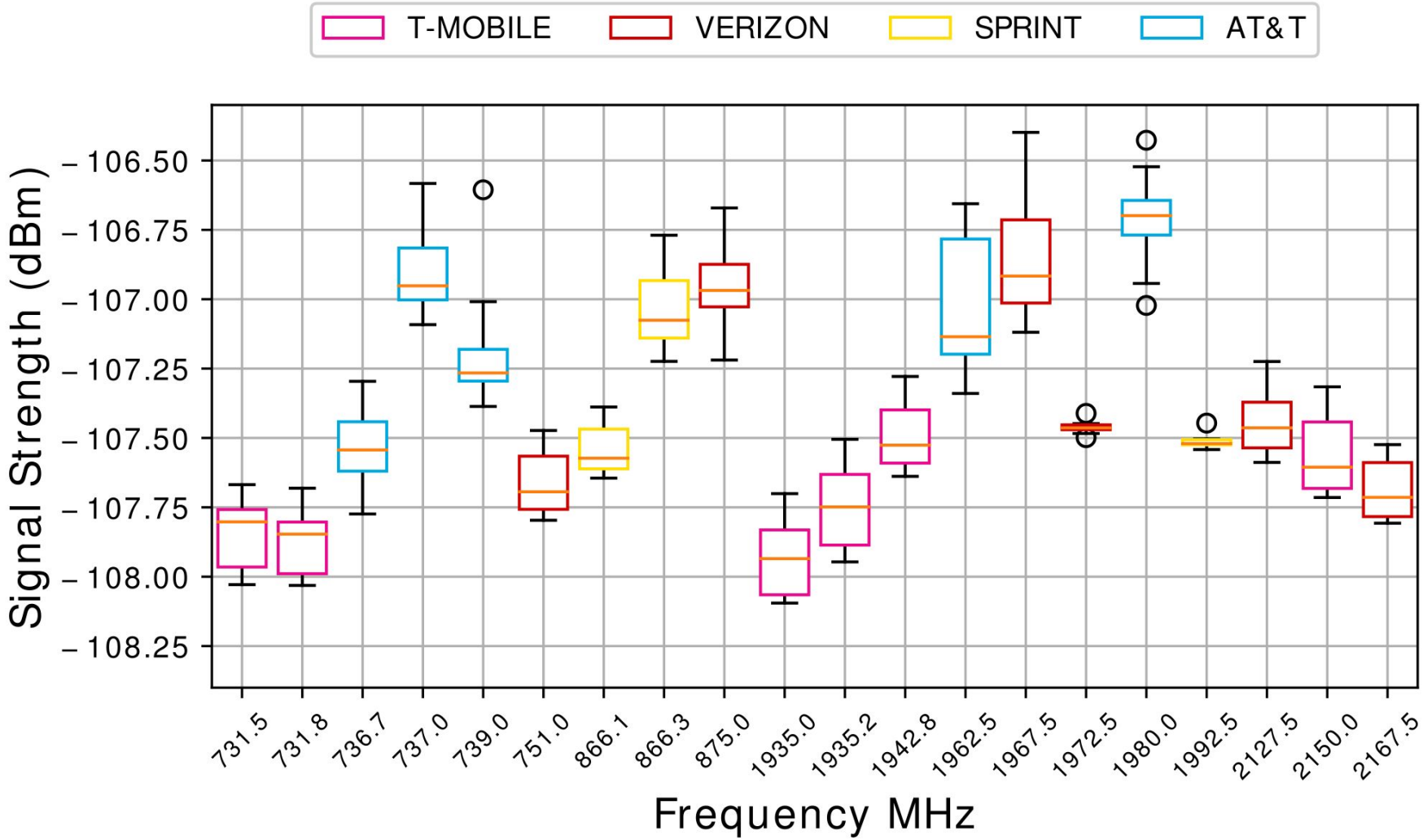
Accuracy (Compared to UE)



UAS - RSRP by Altitude



RSRP Variation by Frequency (over 2 days)



Conclusions

- RTL-SDR on UAS can be a low cost method of coverage mapping
- Passive method does not require network SIM
- Does not correlate perfectly with UEs, but provides 72% accuracy in same quality level and 98% accuracy within 1 quality level
- Altitude does impact signal reception

Our Team

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Questions?

For offline questions please contact me:

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