Analysis on Passive Remote Sensing Frequency Disruptions

By Jamel Usen[1], Mohammad Koosha[1,2] and Dr. Nicholas Mastronarde[1,2]

[1]Department of Electrical Engineering, University at Buffalo

[2]Center for SMAP Research, University at Buffalo

Abstract

Passive remote sensing is imperative to modern society. For example, **NASA's Soil Moisture Active Passive (SMAP) satellite** [2][4] measures soil moisture, providing critical information for weather forecasting. At the same time, society is dependent on active wireless communications including 5G. However, as **active wireless systems** increase, there is a rise in **radio frequency interference (RFI)** at passive sensors, which can corrupt their scientific measurements. This report develops a **model and MATLAB-based software simulation** to assess the RFI that active wireless ground stations create at SMAP.

System Model

We model the RFI power that a single ground station creates at passive sensor.

Radio frequency interference (RFI) power [1][3]:

$$P_{RFI} = P_{TX} + G_{TX} - FSPL + G_{RX} \text{ dBW}$$

- P_{TX}: Ground station transmission power (dBW)
- G_{TX}: Ground station antenna gain (dB)
- $FSPL$: Free space path loss (dB)
- G_{RX}: Receiver antenna gain (dB)

Free space path loss [3]:

$$FSPL = 10\log_{10}\left(\frac{4\pi df}{c}\right)^2 \text{dB}$$

- d: Distance between transmitter and sensor (m) [1]
- f: Transmitter frequency (Hz)
- c: Speed of light in a vacuum (m/s)

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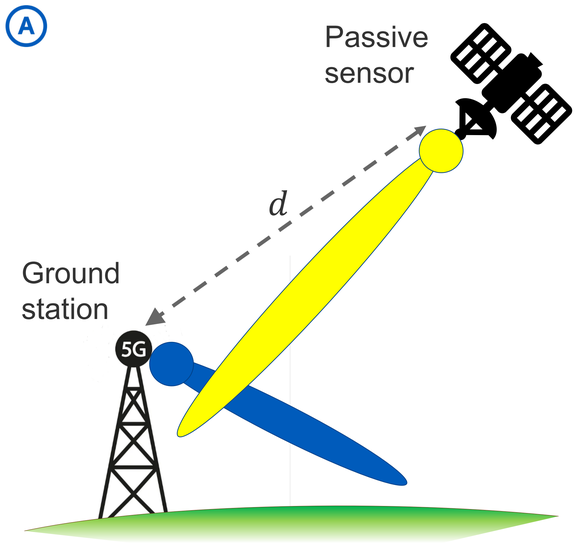

Figure 1 - System model diagram

Hypothesis

- Active wireless systems emit **radio frequency interference (RFI)** towards passive remote sensing systems.
- For a large portion of SMAP's orbit, this interference will be negligible.

Methods

Develop an RFI model between a ground station and satellite considering antenna gains and path loss in MATLAB

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Incorporate locations of ground station(s) and orbit of the satellite

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Create a visual of the scenario

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Plot the strength of RFI power at the passive sensing satellite over time

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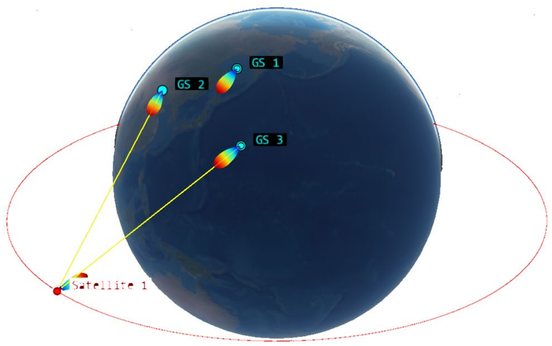

Figure 2 - MATLAB image of earth at 1:03:03 with three ground stations producing RFI at one remote sensor.

Results

Simulation-based measurements show the strength of RFI over 25 hours of the satellite's orbit.

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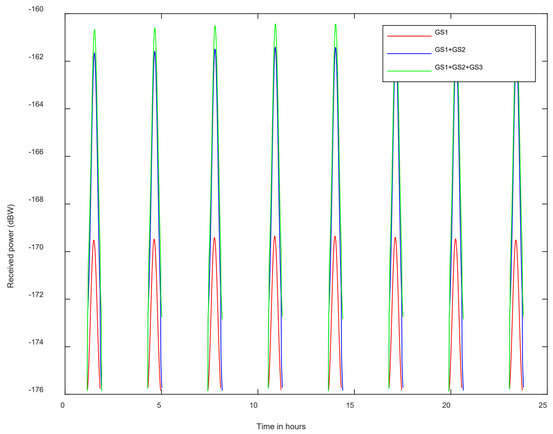

Figure 3 – RFI power over 25 hours from 1 to 3 ground stations

Conclusion

- **Active wireless systems** emit radio frequency interference that collides with **passive remote sensing systems**.
- This leads to the satellite being rendered useless and having data being considered false, meaning it won't be able to determine weather forecasting [4].
- **Future work** can leverage this model to help us find ways to reduce **RFI** and enable active and passive systems to coexist in the same frequency band.

References

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University at Buffalo The State University of New York

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Department of Electrical Engineering, The State University of New York at Buffalo

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