Mapping Radio Frequency Infrastructure from Space:

Case Study to Developing a National RF Map

Individual Studies
GEOG 596A
Project Proposal
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Project Overview

The radio frequency (RF) spectrum is ubiquitous worldwide due to its widespread use in cellular communication towers, wireless networks, radio transmitters, and other devices and infrastructure. However, traditional methods of mapping the RF spectrum are either highly inefficient, involving physical surveys of terrestrial locations, or rely on the accuracy of crowd-sourced data to generate RF Signal Propagation, Loss, and Terrain analysis tool (SPLAT) coverage maps.

Understanding the RF spectrum is crucial for creating efficient and effective communication infrastructure, mitigating signal interference, identifying coverage gaps, and making informed decisions about communication network strategies. Furthermore, it can provide insights into the temporal aspects of human geography, impacts on infrastructure after a disaster, possible conflicts or nefarious actions, and assist in researching the environmental or health impacts of RF transmitters.

The advancement of commercial space RF sensors by companies such as Hawkeye 360, Maxar – RF Solutions (previously known as Aurora Insight), KLEOS, PredaSAR, and others will revolutionize communication infrastructure. These sensors can collect accurate and actionable RF spectrum data over a wide area of coverage with high fidelity and incredible speed. As a result, they will offer valuable insights into the RF spectrum landscape.

To improve our understanding of the RF spectrum landscape, I'm submitting a project proposal and case study exploring the feasibility of creating a National RF Spectrum Map using advanced commercial space RF sensors. The research would involve a market assessment and selection of current commercial space RF sensor providers, identifying 2-3 sample sites to test and develop a standardized process generating an RF Spectrum Map and determine the requirements for implementing a national collection strategy and implementation of a National RF Spectrum Map in the United States.

Objectives

A. Identify a commercial space RF sensor provider to assist in the development of a National RF Spectrum Map.

1. Develop collection requirements needed for developing a RF Spectrum Map

2. Feasibility study of current commercial space RF sensor providers, that meet the collection requirements

3. Submit collection requirements for tasking of 2-3 sample sites

4. Receive collections for 2-3 sites for post-processing

B. Develop a standardized process to generating a RF Spectrum Map.

1. Generate a heatmap of RF Spectrum across the sample sites

2. Develop a 24-hour approximate average RF spectrum across the sample sites

3. Compare traditional RF Signal Propagation, Loss, and Terrain analysis tool (SPLAT) coverage maps to Space collected RF Spectrum Map

Objectives Cont.

C. Develop a report and recommendation on implementing a collection strategy and process to supporting a National RF Spectrum Map Initiative.

1. Collection strategy recommendation

2. Identify storage requirements

3. Identify processing requirements

4. Generate a post-processing standardization procedure

5. Recommend web-hosting services

6. Generate an estimated timeline of National RF Spectrum Map completion

Methods

Feasibility study on leveraging commercial space RF sensors in developing a RF Spectrum Map Assessment will be based on 3 primary factors: Spectrum Range, Maturity of Constellation, Access to sample data.

1. Spectrum range between 225 MHz – 7.125 GHz (Federal Government Spectrum Use Reports – National Telecommunications and Information Administration-US Department of Commerce)

2. Operational constellation of satellites currently in orbit

3. Must have access to sample data (requested through established government process or directly with the vendor)

Develop RF Spectrum heatmaps of sample sites.

1. Leverage the Institute for Telecommunication Sciences- Propagation Modeling Website (PMW) to model the propagation of RF using any of the following propagation models: TIREM 3.15, Longley-Rice 1.22, COST 231 Extended Okumura-Hata, Undisturbed Field/Mobile-to-Mobile, Low Frequency/Medium Frequency (LF/MF), ICEWave, and ITURHFProp.

This step will produce a shapefile output

2. Preform Raster calculations provided by the PMW output
   - Sum of total number of RF transmitters within a given resolution
   - Sum of RF power within a given resolution

3. Preform calculations to determine 24hr average

Methods Cont.

Develop a report and recommendation on implementing a collection strategy and process to supporting a National RF Spectrum Map Initiative.

1. Determine a collection strategy
2. Identify storage requirements
3. Identify processing requirements
4. Generate a post-processing standardization procedure
5. Recommend web-hosting services
6. Generate an estimated timeline of National RF Spectrum Map completion

Products

The following products are intended to be produced from the research and efforts into the development of a RF Spectrum Map produced by commercial space RF sensor providers.

- Feasibility study on leveraging commercial space RF sensors in developing a RF Spectrum Map
- Develop RF Spectrum heatmaps of sample sites
- Develop a report and recommendation on implementing a collection strategy and process to supporting a National RF Spectrum Map Initiative

Timeline

The following timeline has been developed to support the research and efforts into the development of a RF Spectrum Map produced by commercial space RF sensor providers.

- **Phase 1** – Identify a provider
- **Phase 2** – Submit collection requirements for tasking for 2-3 sites (Est. 2-4weeks)
- **Phase 3** – Develop a post-processing standardization procedure (Est. 1-3weeks)
- **Phase 4** – Develop a report and recommendation on implementing a collection strategy and process to supporting a National RF Spectrum Map Initiative (Est. 2-4weeks)
- **Phase 5** – Present Research Findings

Timeline Cont.

- Start Phase 1 Fall 2022
- Complete Phase 1 by end of March 2023
- Start Phase 2 upon completion of Phase 1
- Start Phase 3 upon receipt of sample data
- Start Phase 4 upon completion of Phase 3
- Complete Phase 5 upon completion of Phase 4

Milestones

The following are milestones within the research and efforts into the development of a RF Spectrum Map produced by commercial space RF sensor providers.

- Identify if it's possible with the current providers constellations
- Create a collection plan or identify a previous collection sample
- Develop a standardized RF Spectrum Map process
- Develop a national collection strategy and implementation estimate

Procurement of Products or Services

The following are products and services identify as being key to supporting the research and efforts into the development of a RF Spectrum Map produced by commercial space RF sensor providers.

- Commercial space RF sensors provider's capability and limitations.
- Sample dataset provided by the identified commercial space RF sensors provider
- Access to the PMW
- ESRI license

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