NOAA
Spectrum Sharing

Radio Frequency Interference Monitoring System Project (RFIMS)

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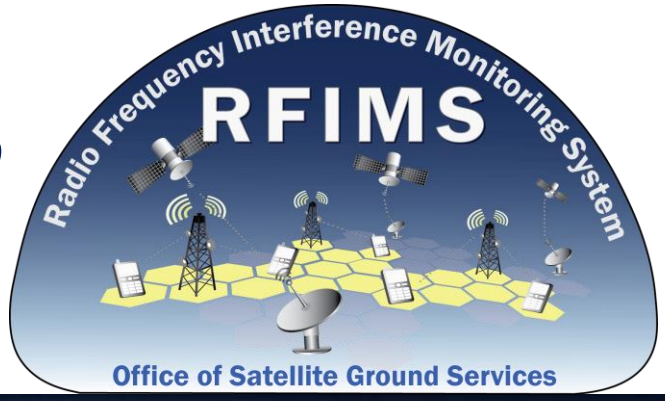
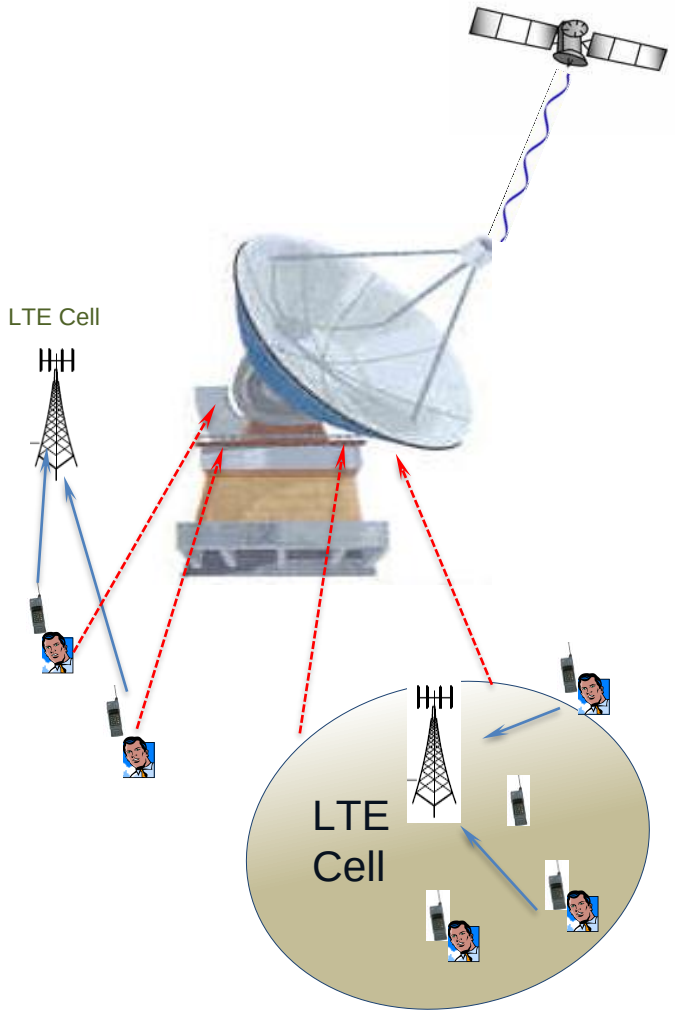
V1.0



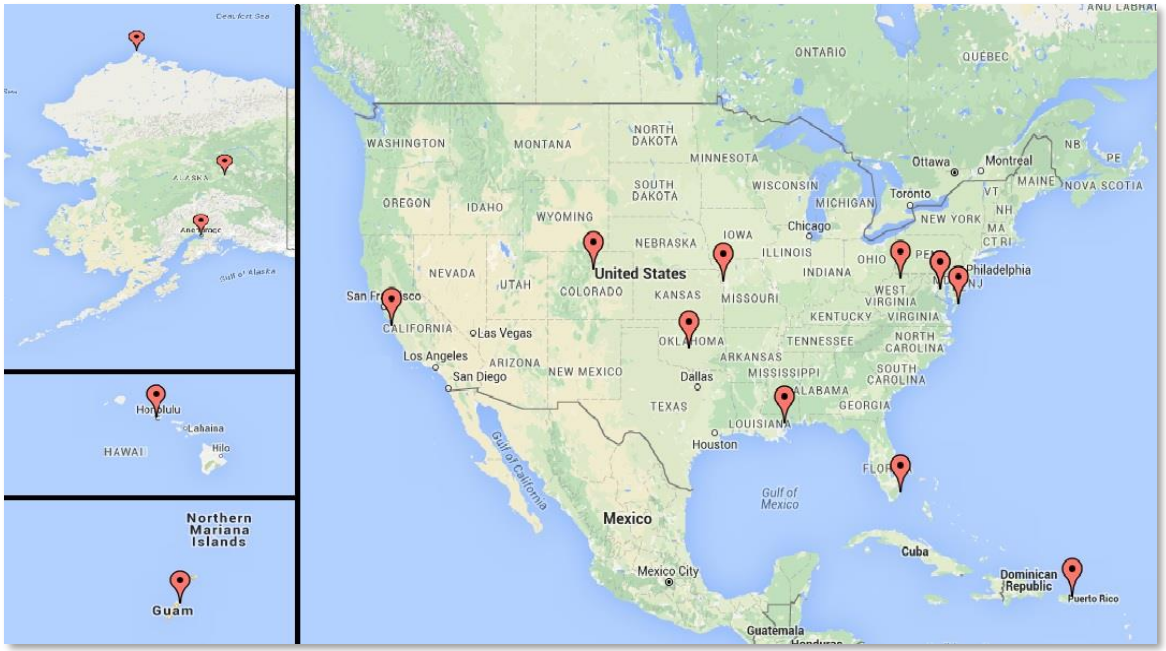
RFIMS background

- **NOAA downlinks meteorological data from their satellites in L-Band (1696-1710 MHz)**
- FCC **AWS-3 in Jan 2015** auctioned licenses to commercial LTE wireless carriers to operate their LTE *uplink* in the 1695-1710 MHz band – **necessitating real time spectrum sharing**.
- As a result of the auction, NOAA instituted the RFIMS project to design and deploy a **monitoring system for 17 NOAA ground stations** that allows sharing of the 1695 – 1710 MHz band with the commercial LTE wireless carriers while ensuring that interference is mitigated.
- The RFIMS' goal is to provide a near-real time monitoring, data collecting, and reporting methods to enhance radio capabilities to enhance RF protection of the ground segment.
- RFIMS treats spectrum sharing as a cooperative issue with the understanding that **NOAA has primacy** of the protected frequency band.
- In **cooperative spectrum sharing**, information is shared between the carriers and NOAA in real time. The shared information will enable the wireless carriers to **deconflict their operations** through active management, supervision, and management of signal power spectral densities to **<u>prevent interference</u>** to NOAA ground stations operations.



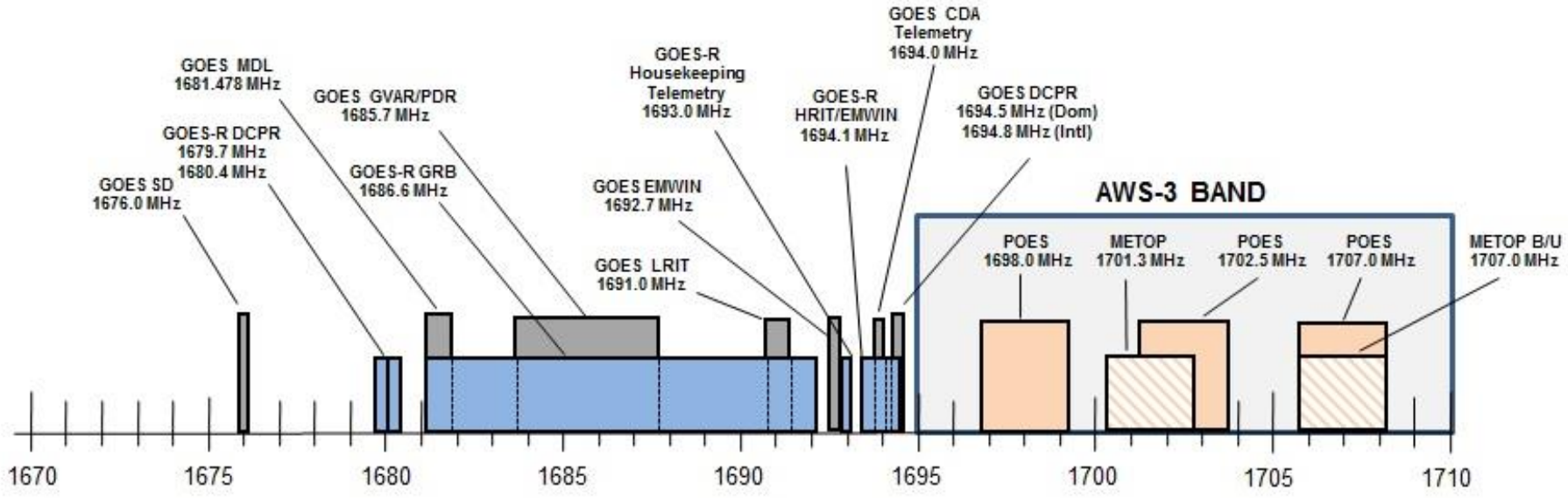
Ground stations and protection zones

- The FCC adopted new rules that will allow commercial entities to **share** the 1695-1710 MHz band with federal agencies conditioned on **Protection Zones** around federal agency facilities.
- These Protection Zones are based on the NTIA interference analysis and interference protection criteria (IPC), including aggregate Interference Power Spectral Density (IPSD) limits.
- Per these rules, protection zones are defined for each of the ground location.
- **NOAA** operates **17 ground stations** that have protection zones around them



NOAA L-Band Downlink Frequencies

In this band, NOAA operates its polar satellites downlink reception and in the adjacent lower band NOAA also operates its geosynchronous weather satellites downlink reception.



Note: GOES-R to launch Oct 2016

RFIMS Data Collection Objectives

- **The purpose of monitoring UE interference is to characterize it in ways that will facilitate real-time interference mitigation by the UE operators, who exercise control over the UE emissions, through a cooperative mechanism between NOAA and carriers.**

- **In order to achieve this, the monitoring system must operate continuously at each of the identified NOAA earth stations and collect data.**

- **The data collection should enable three functionalities:**
- **Detect**: *Detect* “events” in which the interference level lies at or above a prescribed protection threshold power level (TBD), during NOAA’s earth station downlink reception.
- **Classify**: Classify the nature of unacceptable RF interference. Where “classify” is the *discrimination* between interference types i.e.: LTE uplink, background impulsive noise, out of band emission from other RF sources, etc.
- **Identify**: Identify the source of unacceptable interference; that is, for interference generated by LTE UEs, *positively identify the wireless carrier responsible* for the interference and preferably the geographical location of the harmful interference.

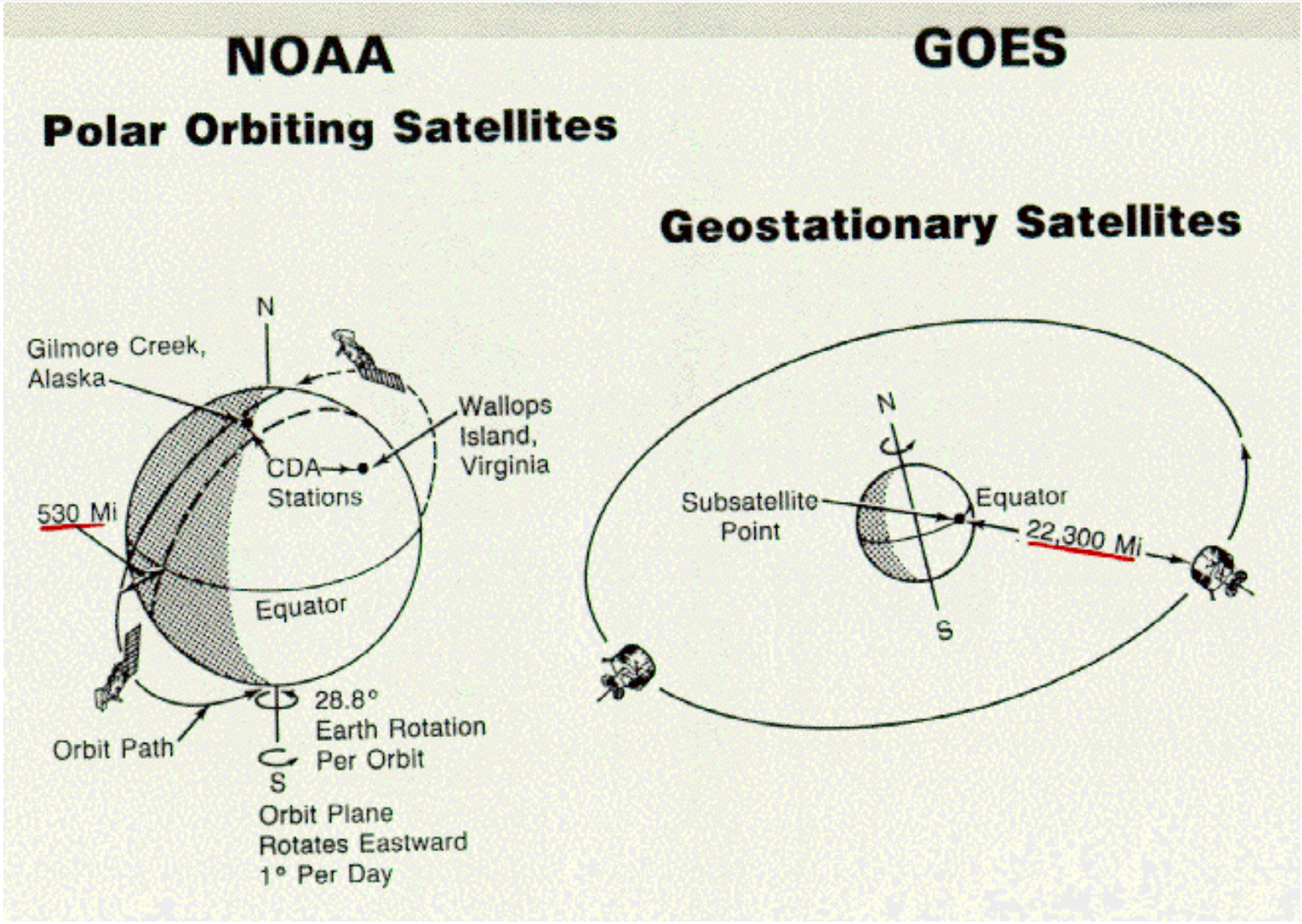
Backup Slides

Orbitology

NOAA uses two different orbits to provide satellite weather data

- GOES is in a Geostationary (GEO) Orbit, ~35,000 km altitude
  - "Parked" in a particular location over the equator
  - Large footprint/field of view
  - Orbital period is 24 hours, stays over the same location as the earth rotates
  - Data is collected 24/7 since satellite is always in view
- POES and METOP are in Low Earth Orbit (LEO) Orbit, ~500 km
  - Satellites in highly inclined LEO orbits fly over the earth's poles ("polar" orbit)
  - Smaller footprint/field of view
  - Orbit is inclined, which allows the satellite to pass over different locations as the earth rotates
  - Orbital period is about 102 mins, so the satellite circles the earth ~14 times/day
  - Typical visibility over a ground station is 12-15 minutes

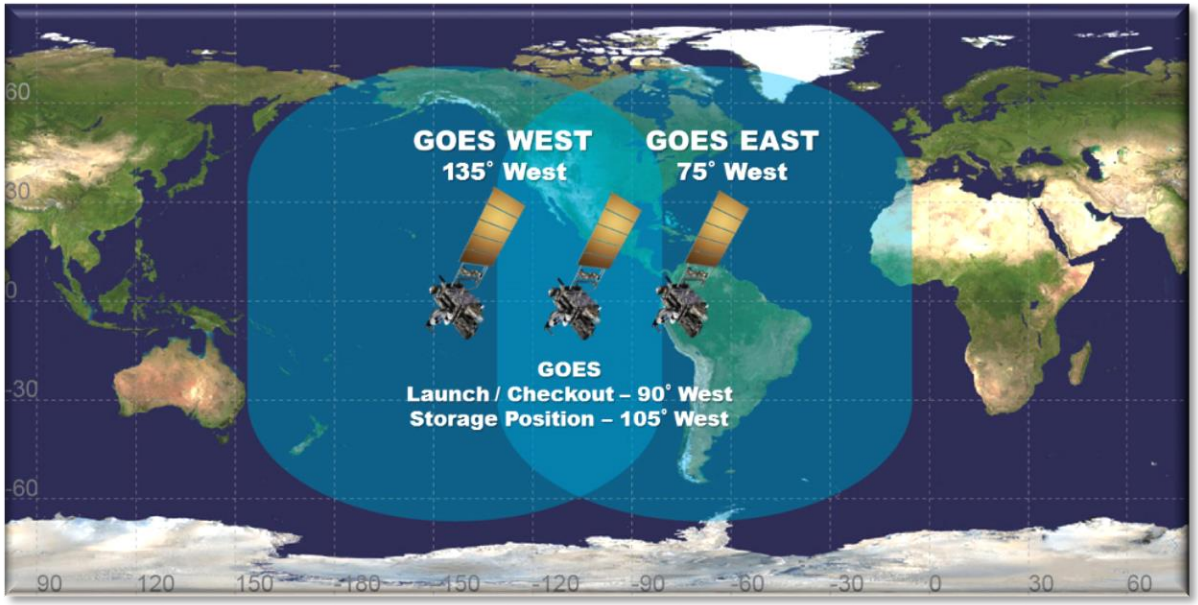
Orbitology


NOAA
GOES
Polar Orbiting Satellites
Geostationary Satellites
N
Gilmore Creek,
Alaska
Wallops
Island,
Virginia
CDA
Stations
530 Mi
Equator
28.8°
Earth Rotation
Per Orbit
Orbit Path
S
Orbit Plane
Rotates Eastward
1° Per Day
N
Subsatellite
Point
Equator
22,300 Mi
S

GEO Satellite Constellation

Current Satellites:

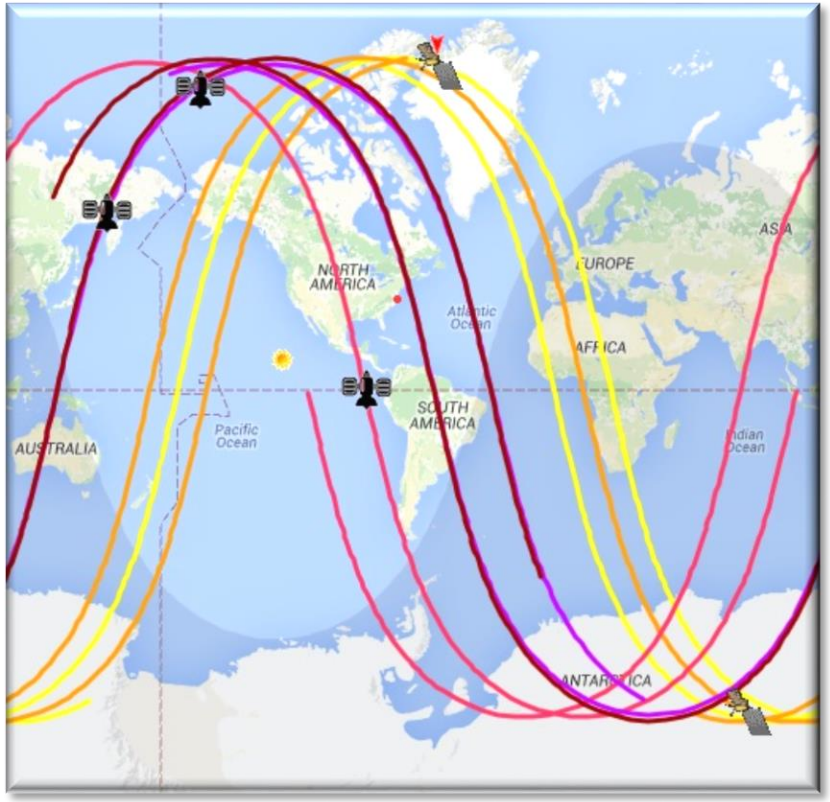
- GOES-East - 75^{0}W Longitude
- GOES-West - 135^{0}W
- GOES-Spare - 105^{0}W

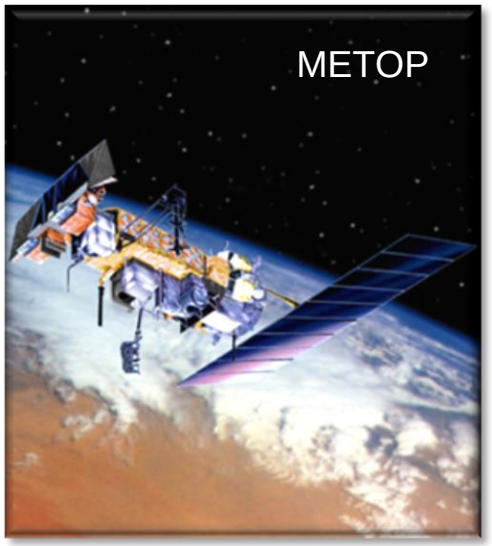


Polar (LEO) Satellite Constellation

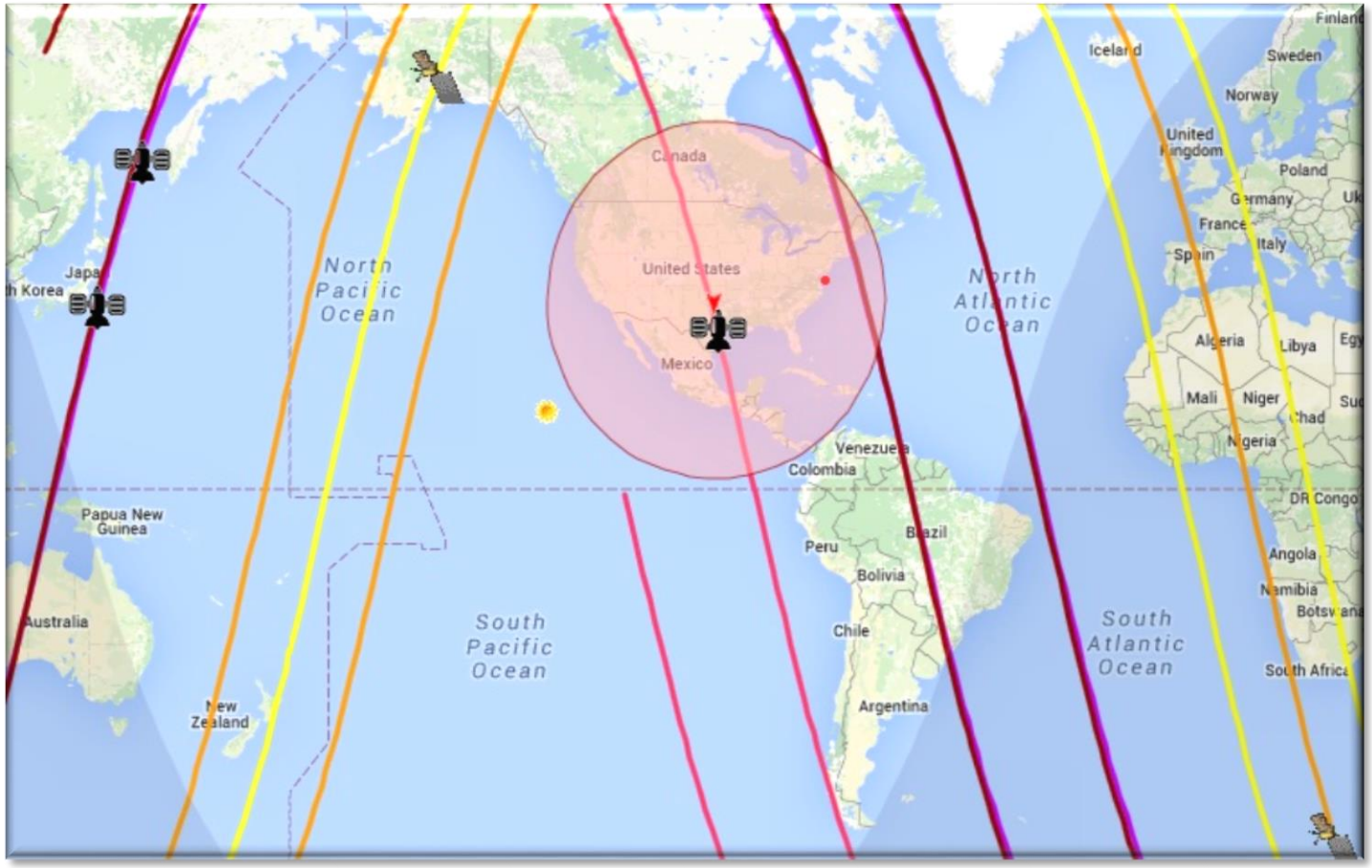
Satellites:

- POES-15, POES-18, POES-19
- METOP-A, METOP-B





POES Field of View



http://www.n2yo.com

Tracking Polar Satellites