
UN/USA TRAINING COURSE ON
SATELLITE AIDED SEARCH AND RESCUE
19-23 JANUARY 2009
COSPAS-SARSAT
SPACE
SEGMENT

Introduction

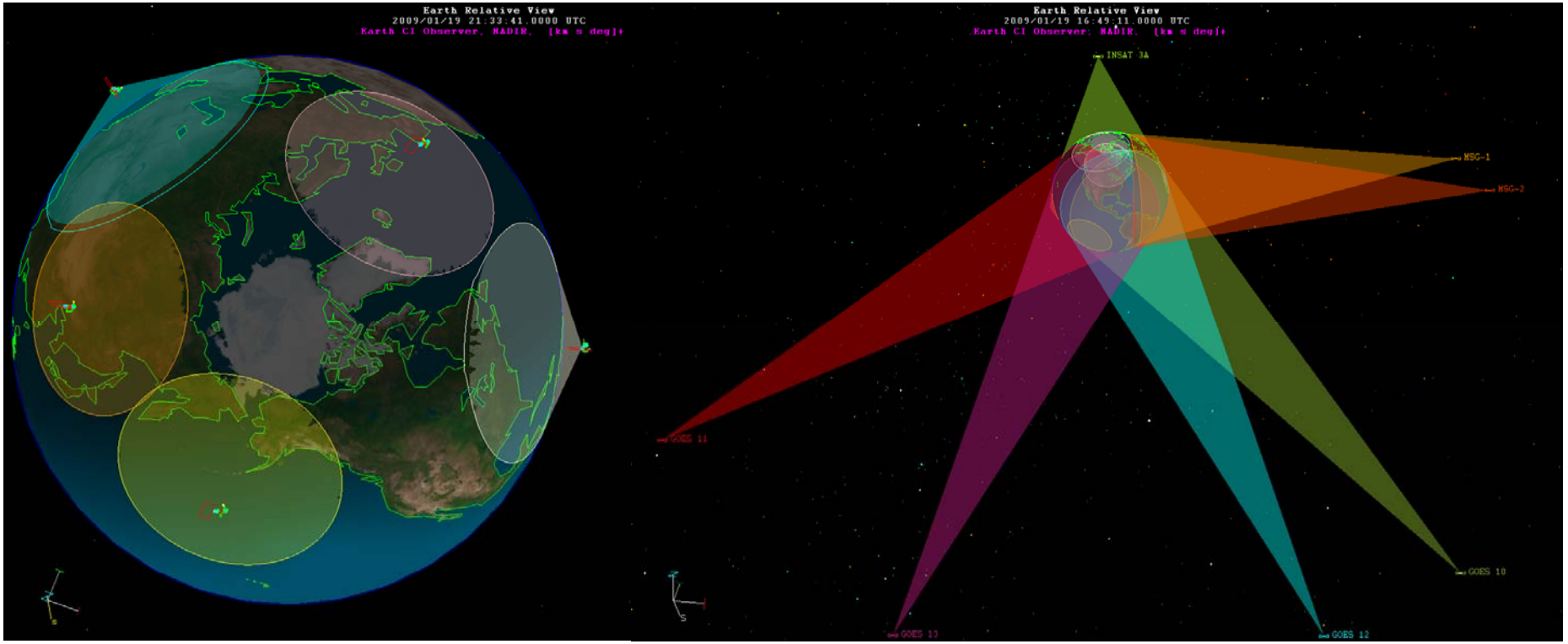
- Search and Rescue Satellite Aided Tracking (SARSAT) satellites
- Space segment assets and on-board instruments
- Advantages of each satellite system
- Satellite launch schedule
- Future satellite systems

Satellites Types

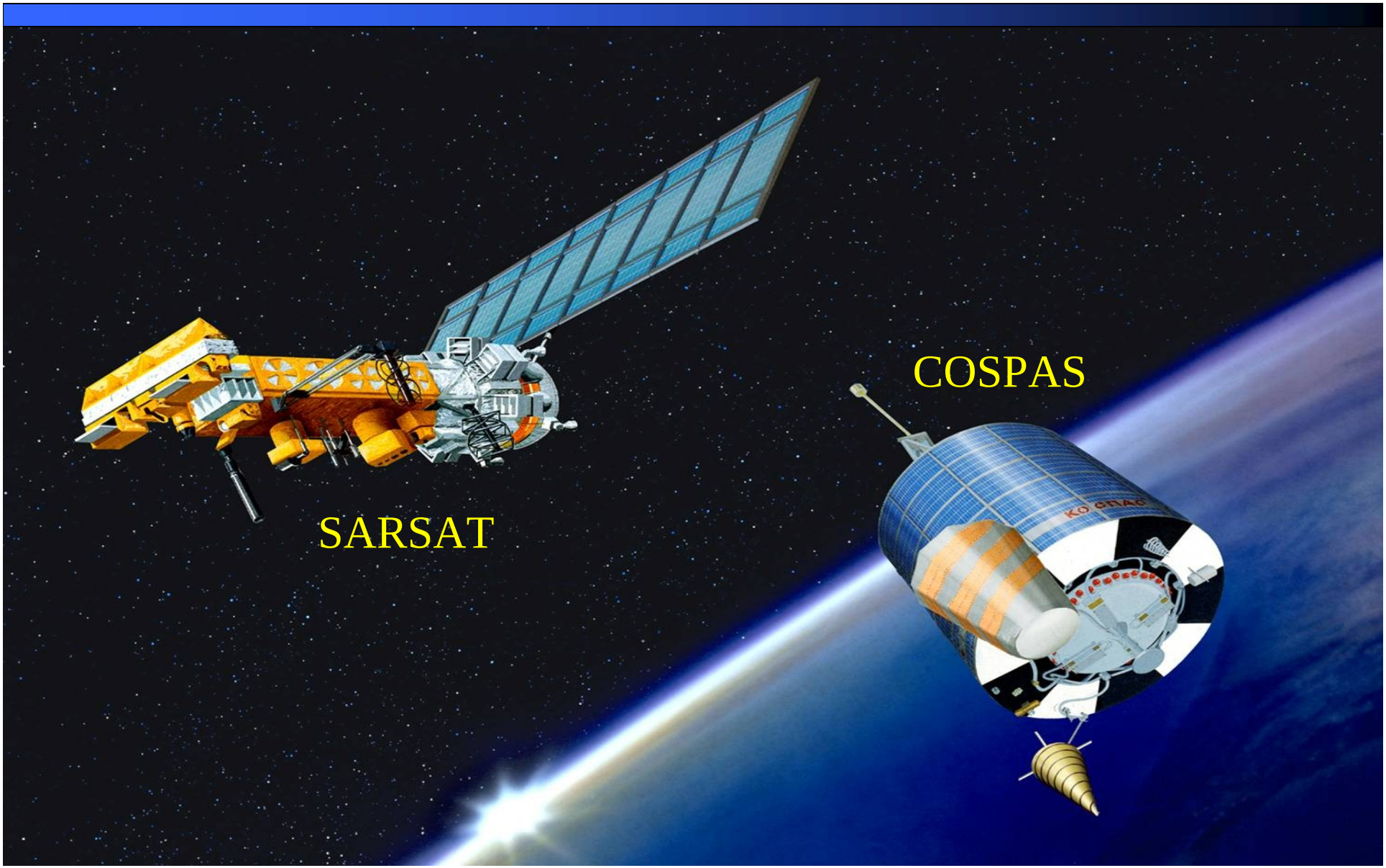
Two types of operational satellites:

Low-Earth orbiting (LEO) satellites orbiting at ~ 850 km

Geosynchronous Earth orbiting (GEO) satellites orbiting at ~ 35786 km

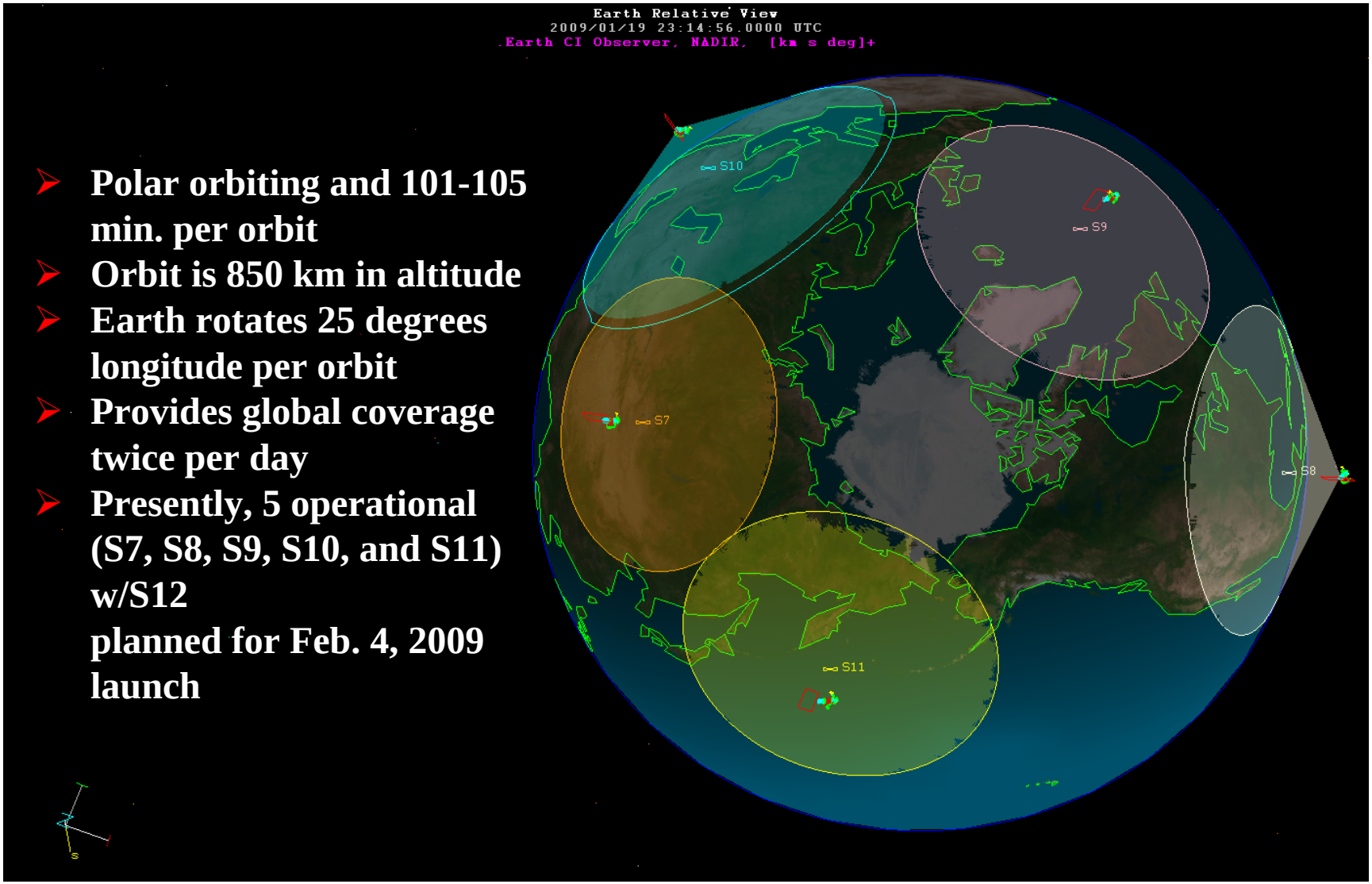


LEOSAR Satellites

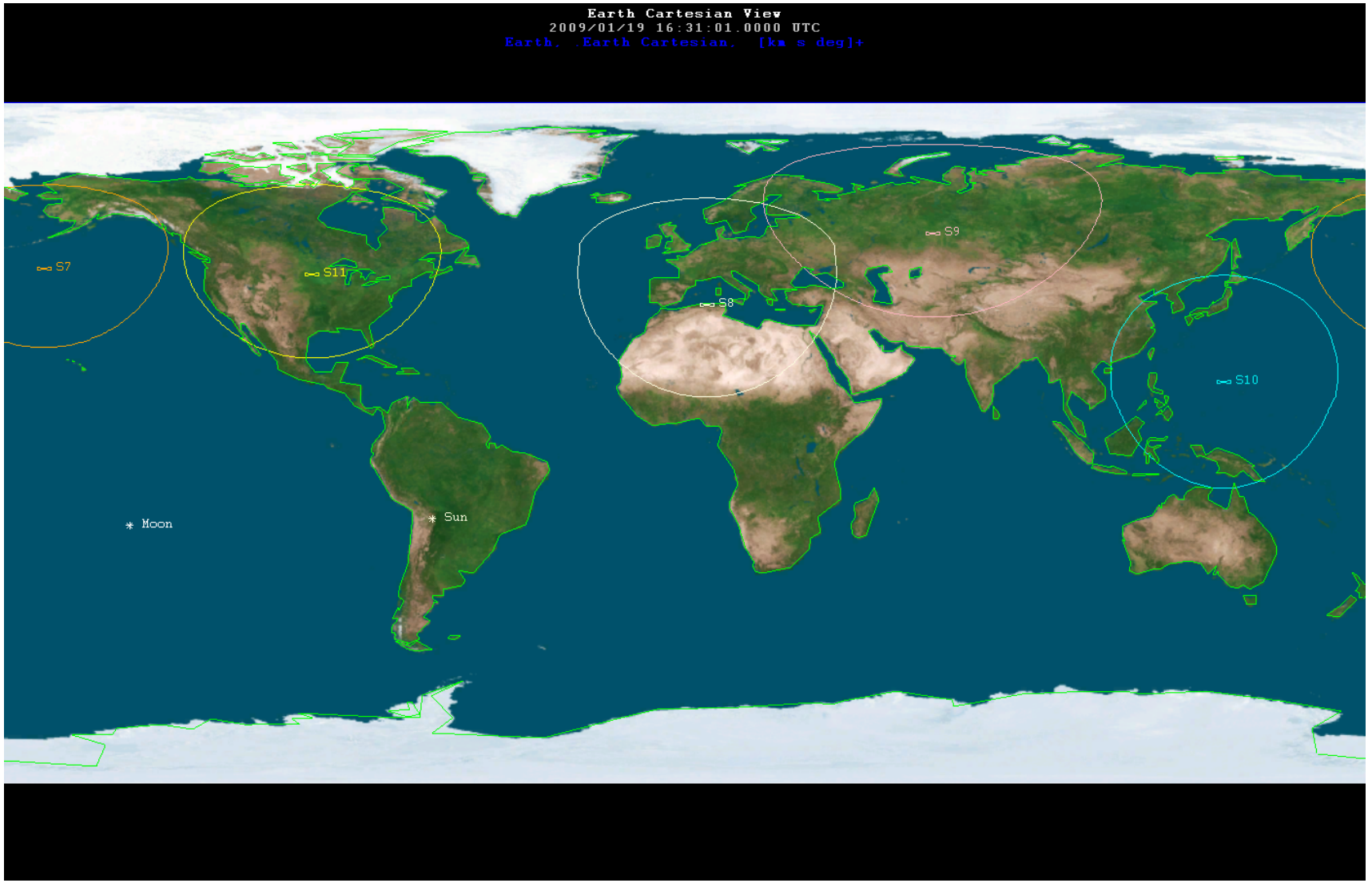


LEOSAR Satellites

- Polar orbiting and 101-105 min. per orbit
- Orbit is 850 km in altitude
- Earth rotates 25 degrees longitude per orbit
- Provides global coverage twice per day
- Presently, 5 operational (S7, S8, S9, S10, and S11) w/S12 planned for Feb. 4, 2009 launch

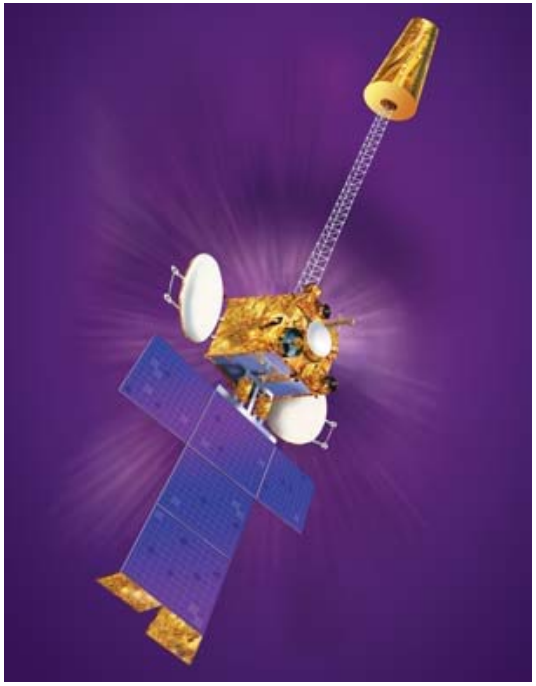


LEOSAR Coverage



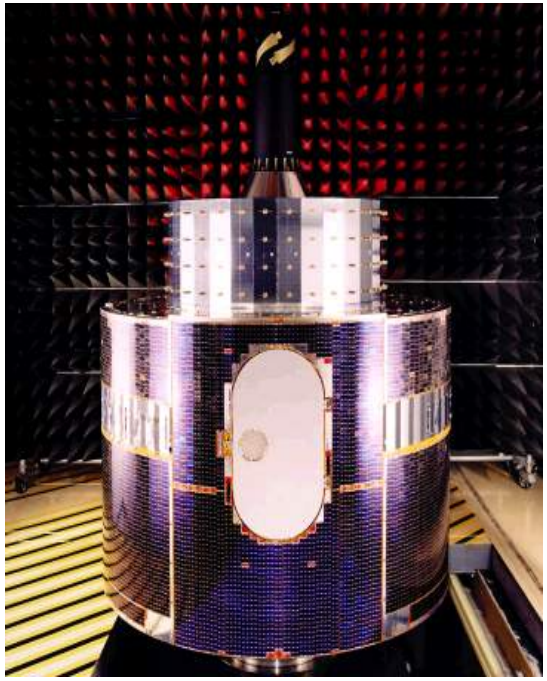
GEOSAR Satellites

Indian National Satellite (INSAT)



Geosynchronous Operational and Environmental Satellite (GOES)

Meteosat Second Generation (MSG)

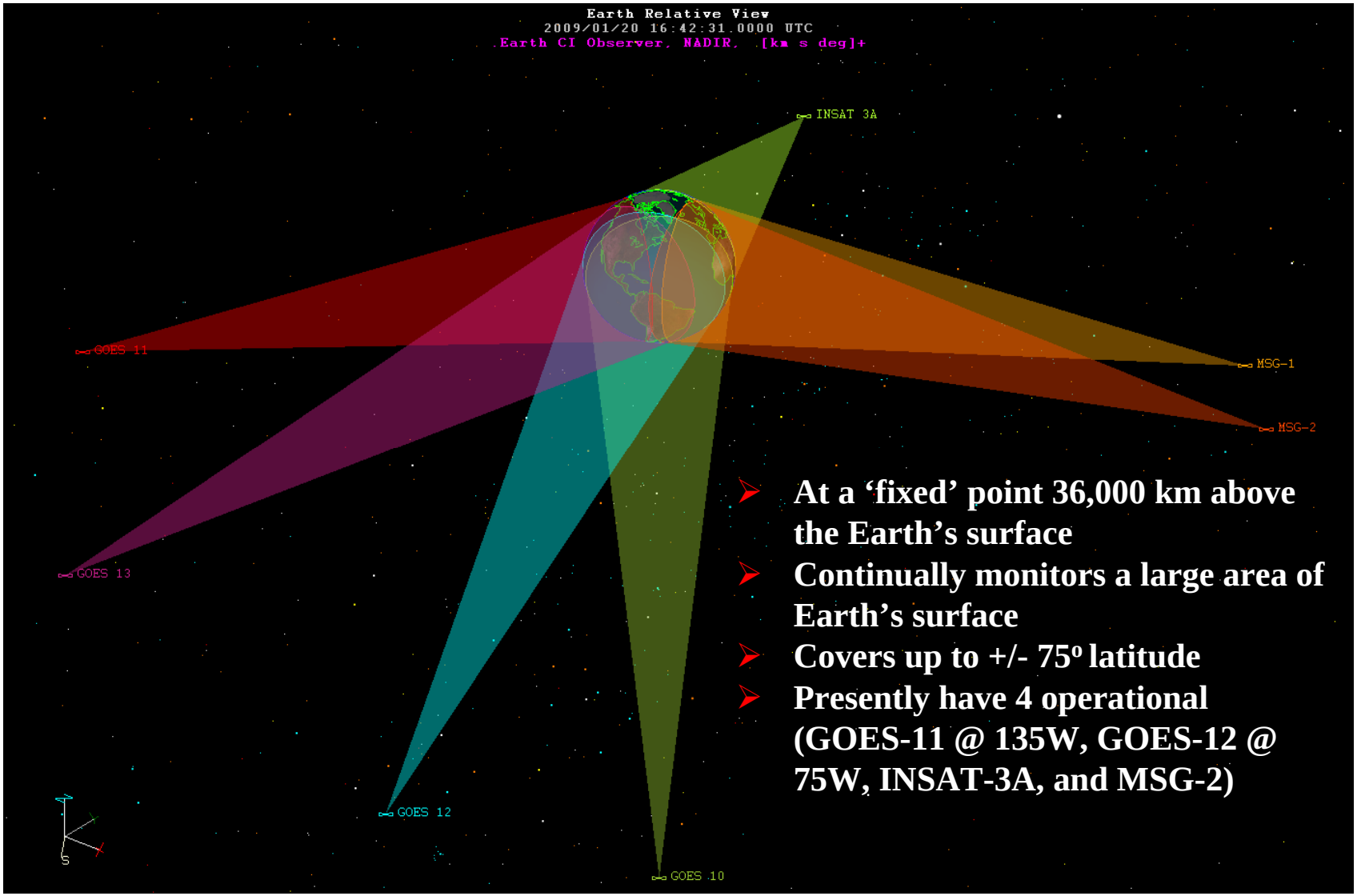


GEO Satellite and SAR Instrument

MSG Satellite

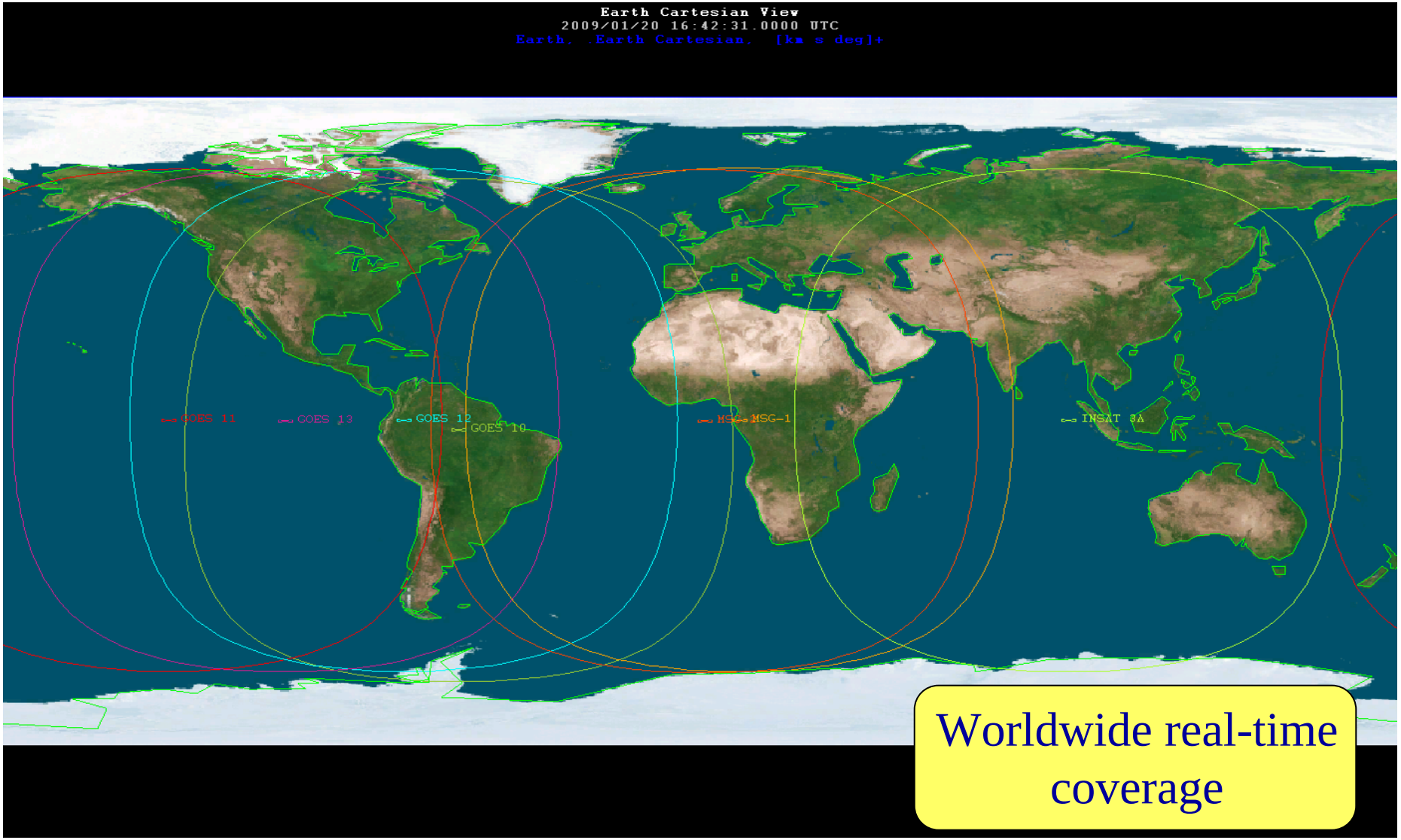
SAR Instrument

GEOSAR Satellites



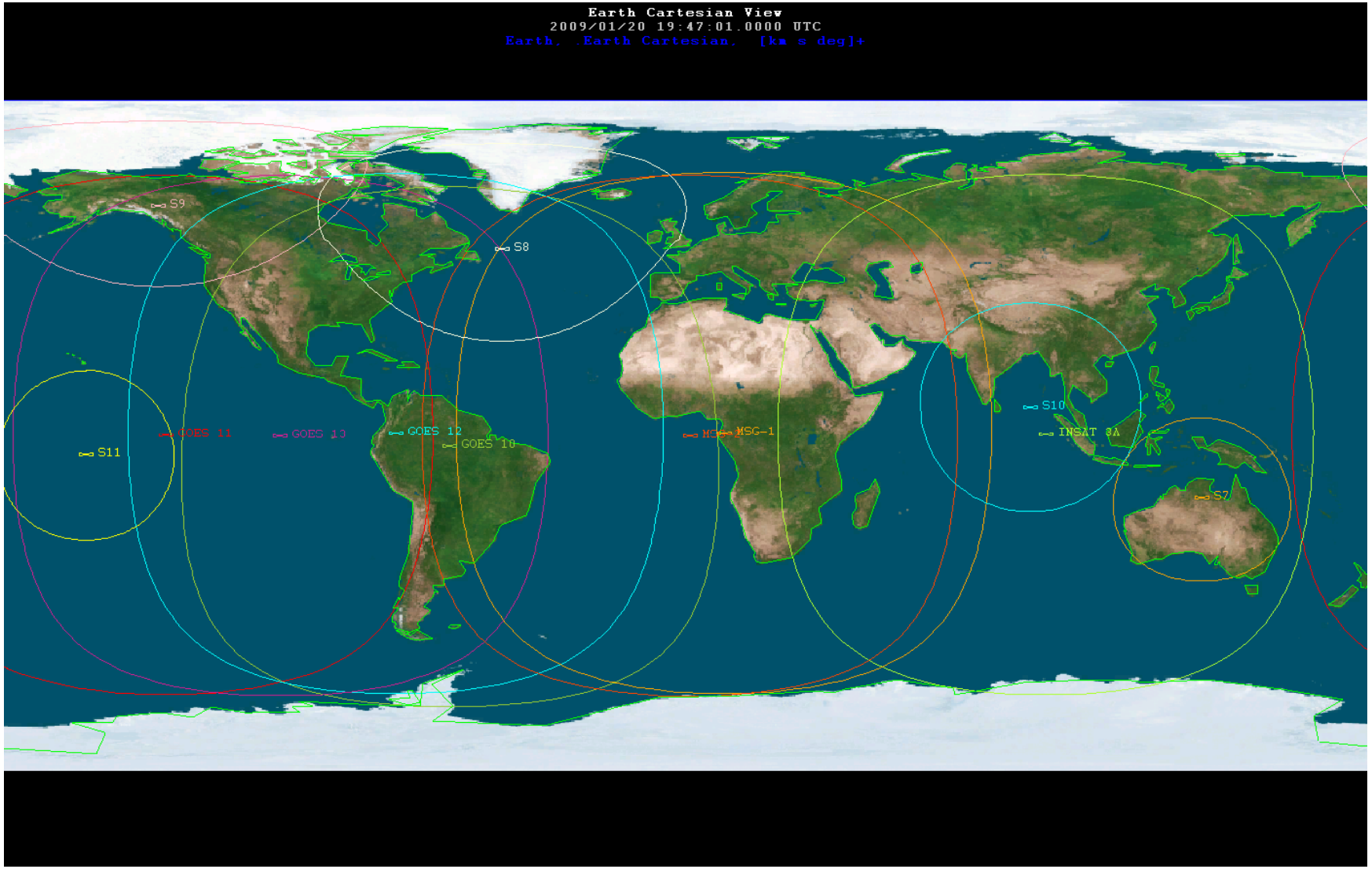
- At a ‘fixed’ point 36,000 km above the Earth’s surface
- Continually monitors a large area of Earth’s surface
- Covers up to +/- 75º latitude
- Presently have 4 operational (GOES-11 @ 135W, GOES-12 @ 75W, INSAT-3A, and MSG-2)

GEOSAR Coverage



Worldwide real-time coverage

Advantages of a combined LEOSAR/GEOSAR System



Advantages of LEOSAR System over the GEOSAR System

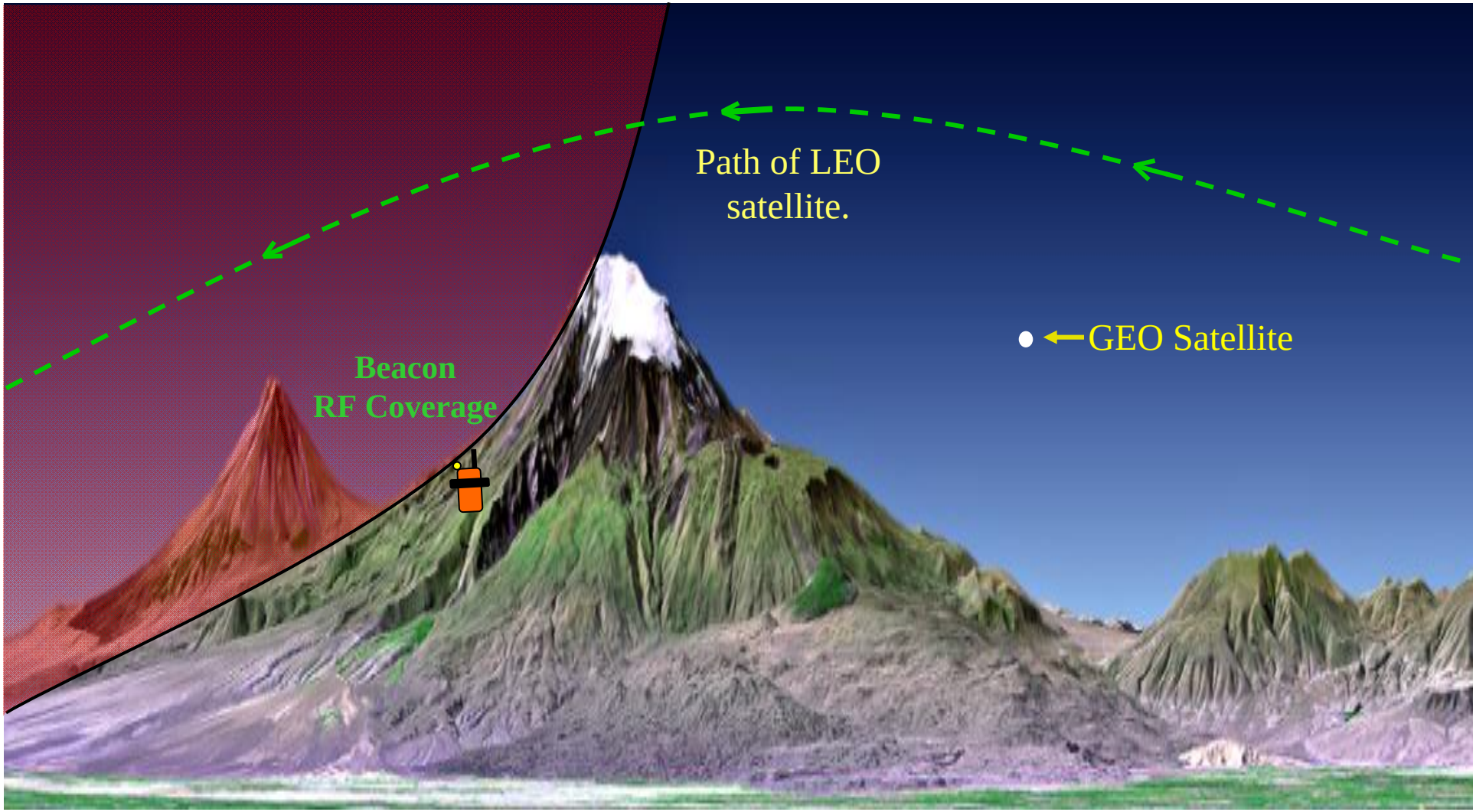
- **Locates beacons using Doppler shift processing. GEOSAR system does not have Doppler capability.**
- **Detects and locates 121.5 MHz signals. ****after Feb. 1, 2009 N/A***
- **Locates 406 MHz beacons. GEOSAR system only detects 406 MHz beacons.**
- **Provides global coverage for 406 MHz. GEOSAR system does not cover the polar areas.**
- **Provides improved detection probability for obstructed beacons.**
- **Receives higher power levels from beacons, which increases the probability for beacon detection.**

Advantages of GEOSAR System over the LEOSAR System

For 406 MHz beacons only:

- **Near instantaneous detection.**
- **Near instantaneous location determintation for beacons with GPS capacity**
- **Continuous monitoring of ~1/3 of Earth's surface**
- **Has a 46 minute mean time 'advantage' for first detection**

Benefit of having both systems, beacon detection with obstruction



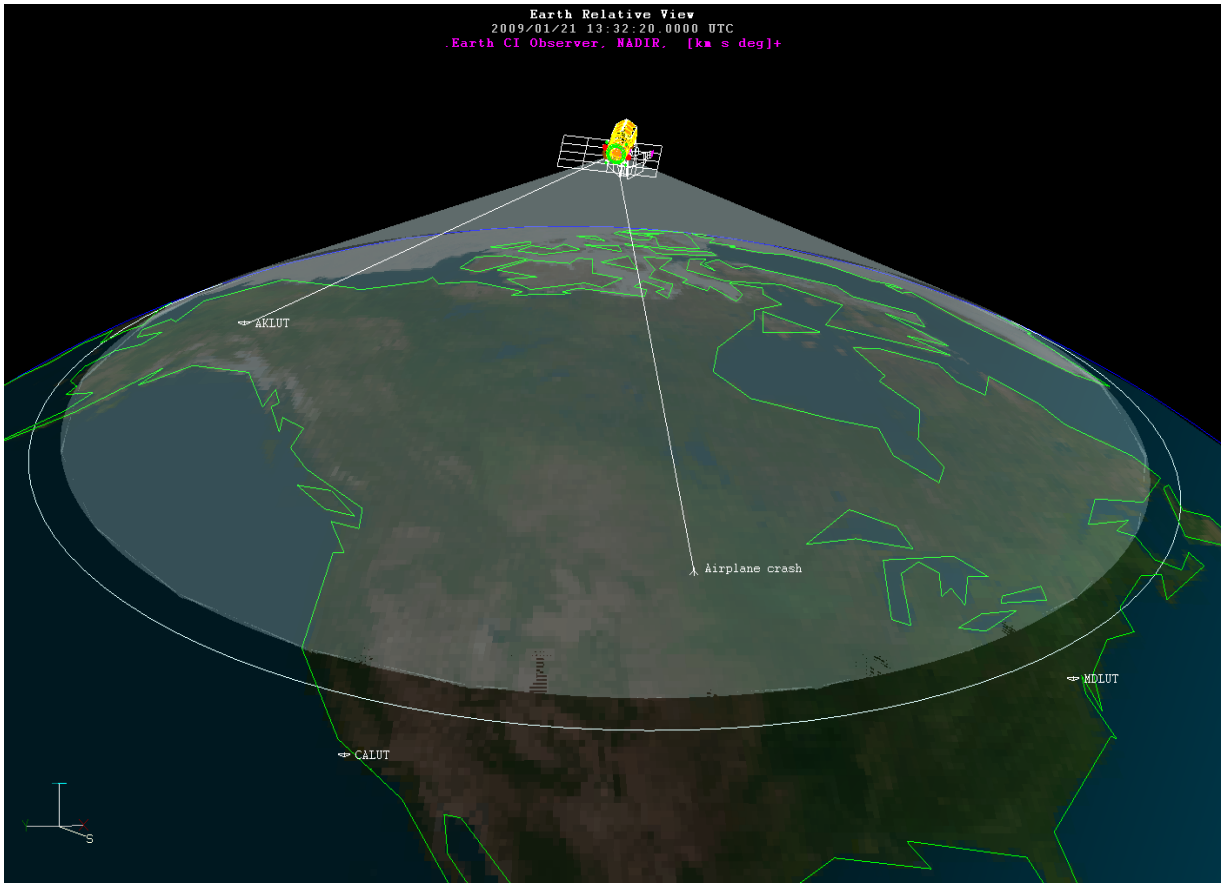
Space Segment Providers and On-Board Instruments

- **LEO Space Segment and Instrument Providers**
  - **SARSAT**
    - **Canada – Search & Rescue Repeater (SARR)**
    - **France – Search & Rescue Processor (SARP)**
    - **U.S. – Satellites**
    - **Europe (Eumetsat) – Satellites**
- **GEO Space Segment and Instrument Providers**
  - **U.S. – GOES (East and West) – Repeater (SARR)**
  - **India – INSAT-3A – Repeater – Repeater (SARR)**
  - **Europe (Eumetsat) – MSG – Repeater (SARR)**

Search and Rescue Repeater (SARR)

LEO "BENT PIPE"

- **LEOSAR**
  - **Receives at 121.5, 243, and 406 MHz frequency, then transmits a multiplexed downlink signal at 1544.5 MHz (RCP).**
  - **No on-board position processing is performed.**
- **GEOSAR**
  - **Receives only at 406 MHz and re-transmits at 1544.5 MHz (LCP).**
  - **No on-board processing is performed.**



Search and Rescue Processor (SARP) w/On-Board Memory

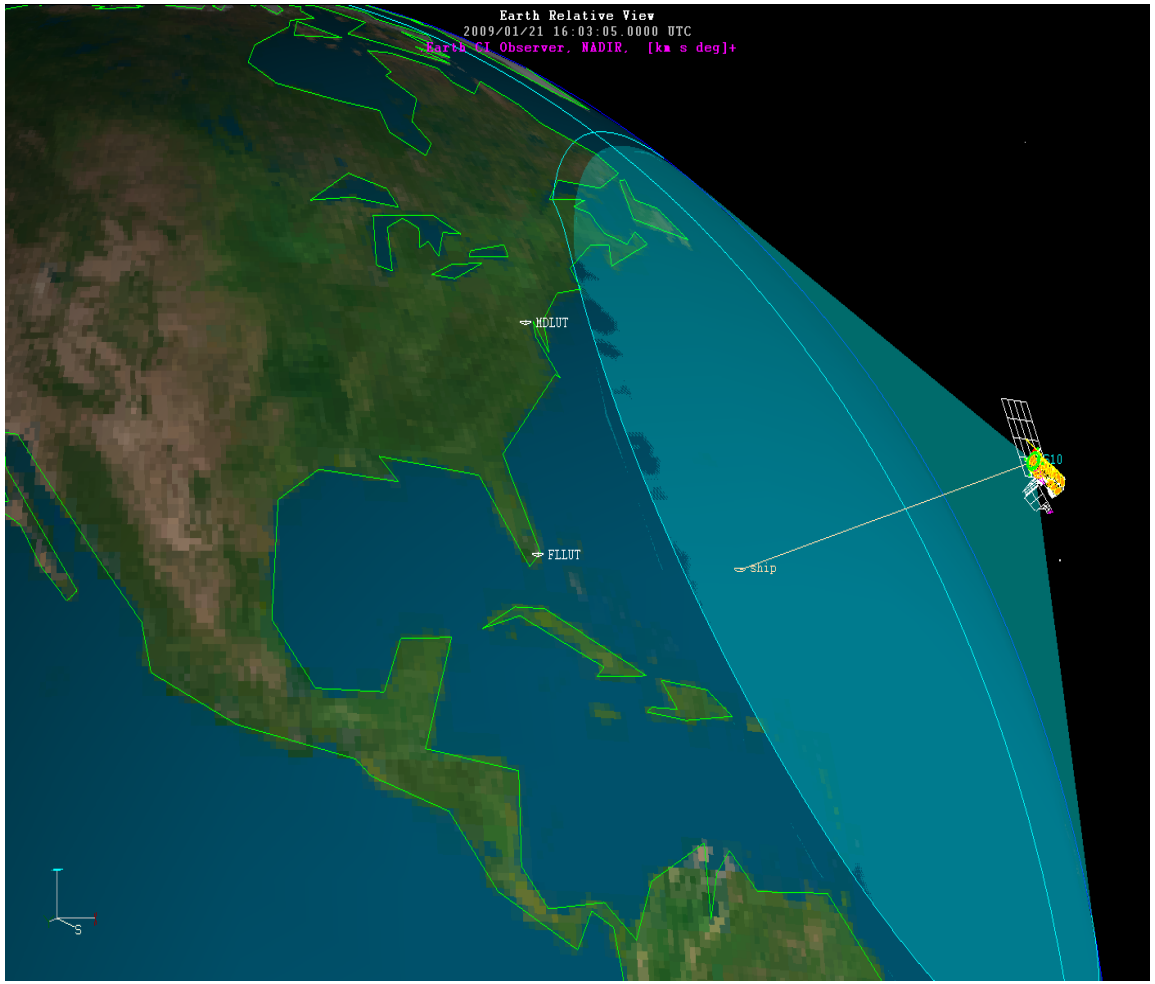
SARP

- Only on-board the LEO Satellites
- Digitally extracts the beacon ID
- Measures the signal's carrier frequency and time tags the measurement
- Immediately puts the received 406 MHz beacon uplink message into the continuous 2.4 kbps memory data stream transmission

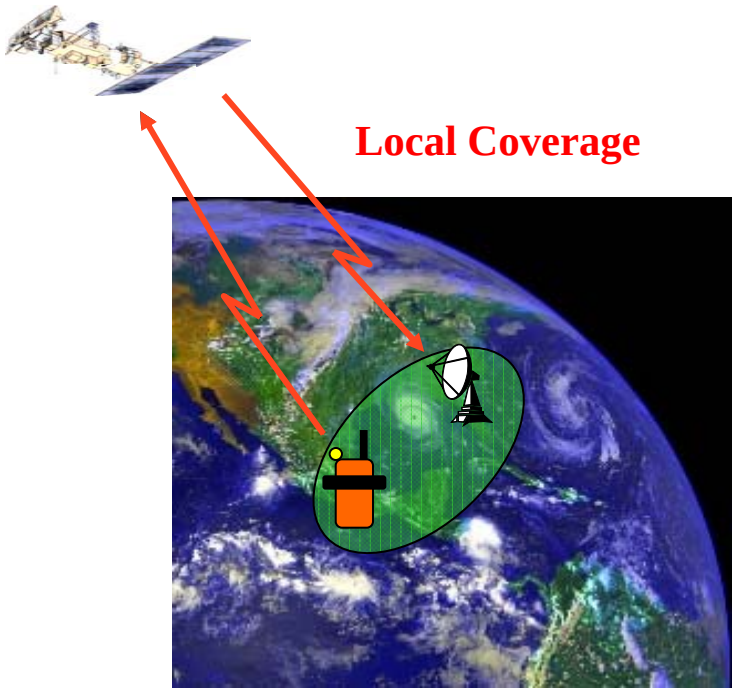
On-Board Memory

- Stores all of the received and previously processed data
- Is completely transmitted (about every 3 minutes) on a continual basis
- Once memory is completely filled, oldest data is purged as new is entered

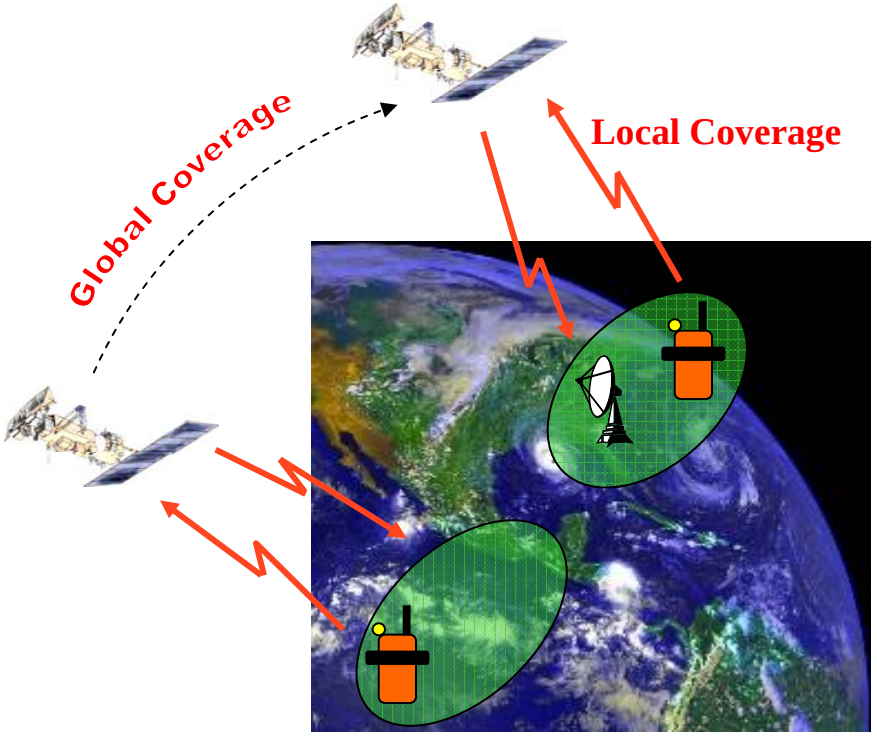
406 MHz Beacon SAR Processor



LEO Local and Global Coverage

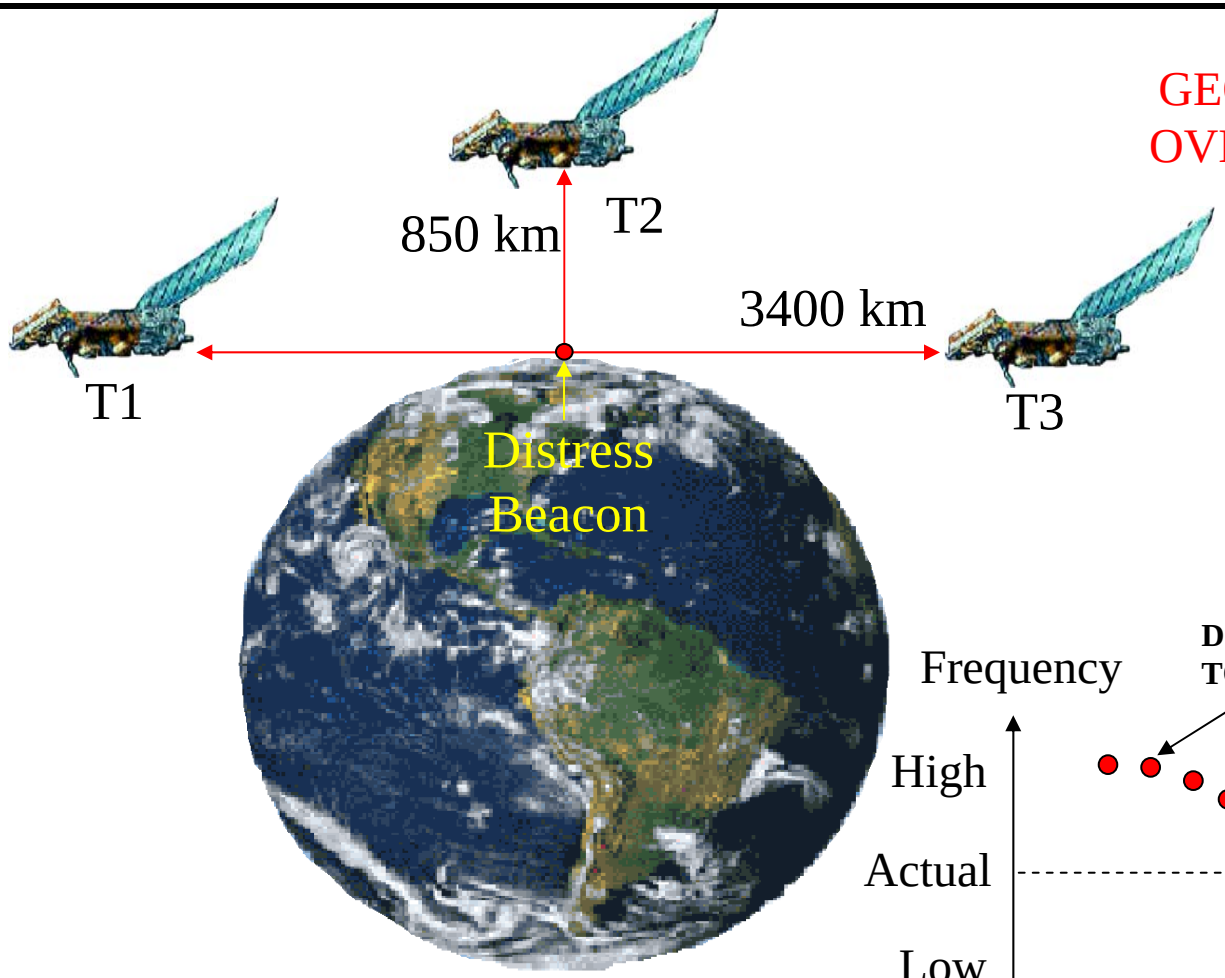


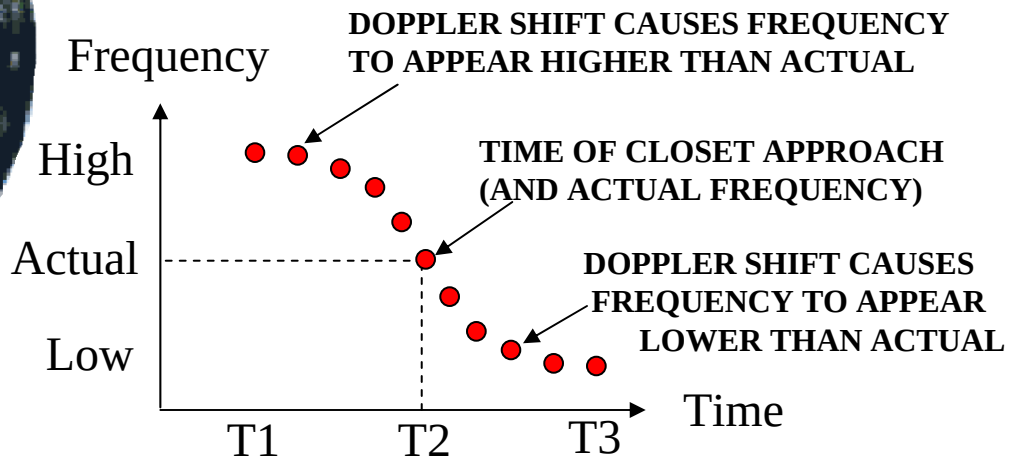
406 MHz beacon detections can be detected immediately if mutual visibility is available or stored on board the satellite for re-broadcast later if no mutual visibility exists between satellite and LUT



Detection of a 121.5/243 MHz beacon *required* mutual visibility between beacon, satellite and ground station (LUT). Being phased out 2/1/09

Determining Beacon Locations From LEO Doppler Data





Resolving Ambiguity

Two Pass Solution for a Beacon Located in Brazil

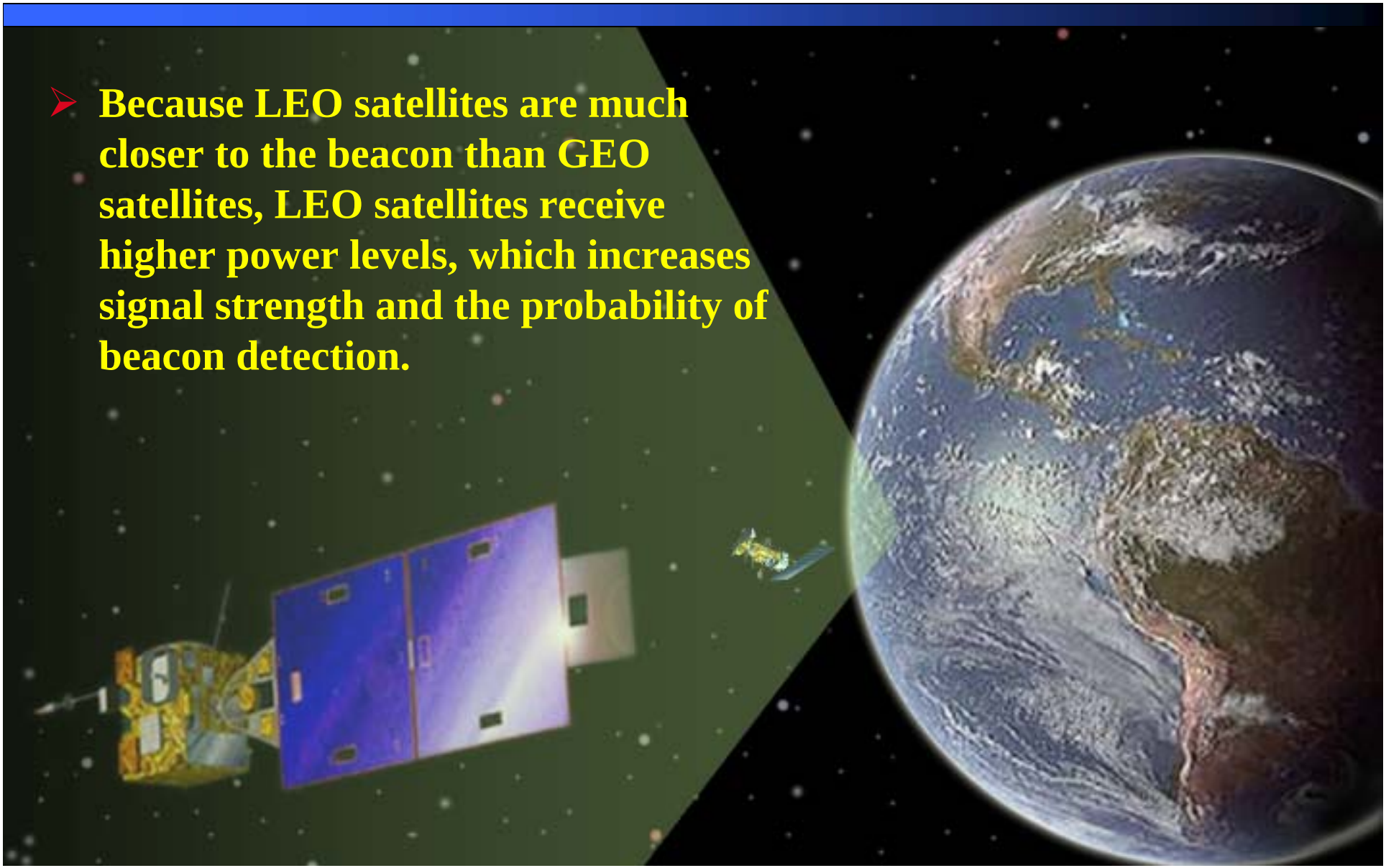
LEGEND: 1 2 ground tracks of successive spacecraft orbits

1A, 1B Real and Image solutions from pass 1

2A, 2B Real and Image solutions from pass 2

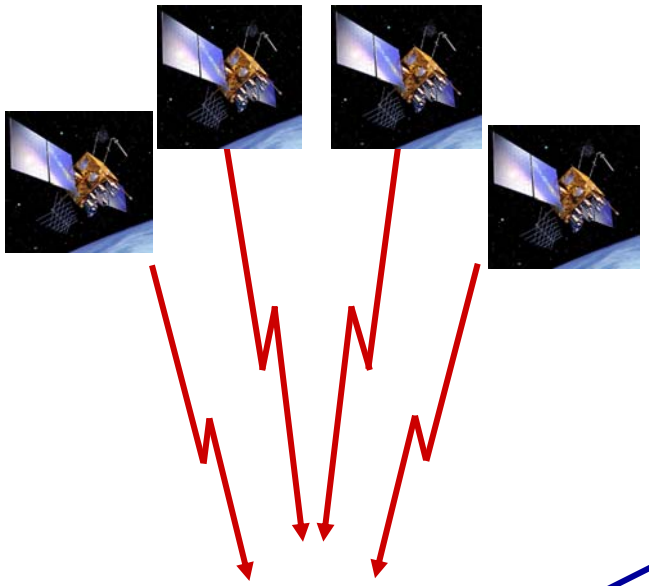
Beacon Power Levels with Distance

- **Because LEO satellites are much closer to the beacon than GEO satellites, LEO satellites receive higher power levels, which increases signal strength and the probability of beacon detection.**

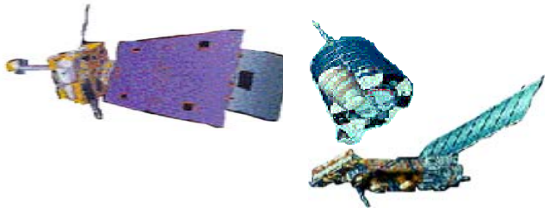


Use of GPS in Location Protocol Beacons

4 GPS Satellites



406 MHz Message with Embedded GPS location

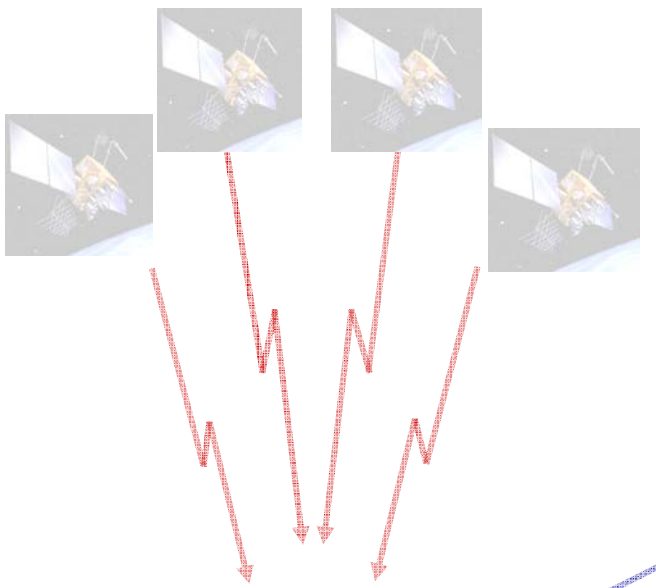


C/S Satellites

LUT

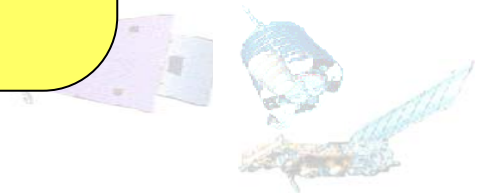
>15% of beacons are Location Protocol

Use of GPS in Location Protocol Beacons



GPS Satellites

- 24-satellite constellation
- 4 satellites in view at all times
- Minimum of 3 satellites needed to compute locations. Additional satellites improve accuracy.
- Transmit time and orbital data



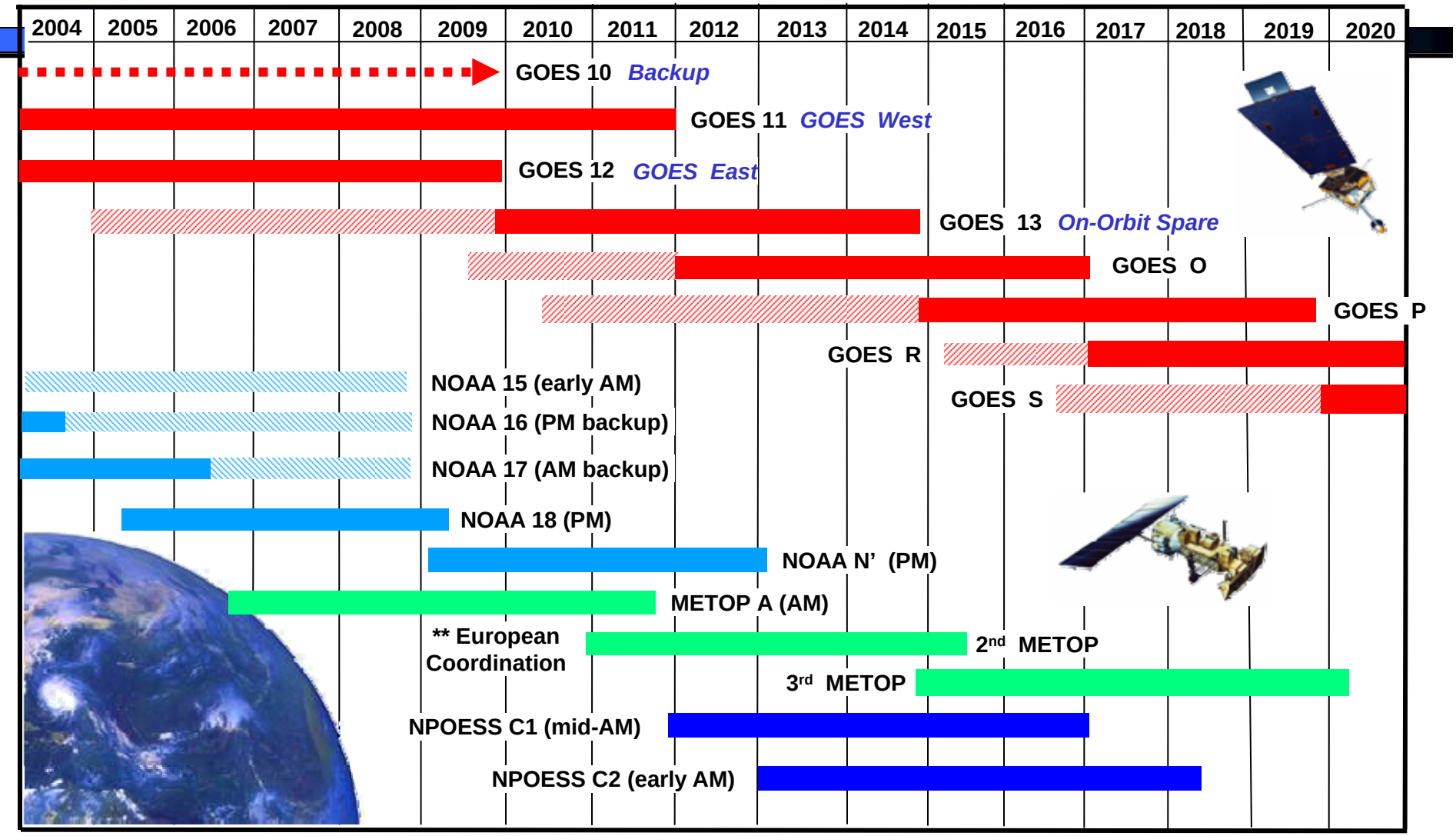
406 MHz Message with Embedded GPS location

LUT

406 MHz Beacon with GPS Receiver

- Uses satellite-beacon time difference to calculate distance from each GPS satellite
- Uses GPS satellite orbital data and distance from beacon to calculate beacon location.
- Encodes location in 406 MHz message.

NOAA Plans for Continuity of Operational Satellite Programs NOAA Satellite Launches* Scheduled to Maintain Data Continuity (Calendar Years)



* Actual launch dates are determined by the failure of on-orbit assets

** Assumes METOP will provide the morning orbit and NOAA-N' will provide afternoon orbit instruments

Satellite is operational beyond design life

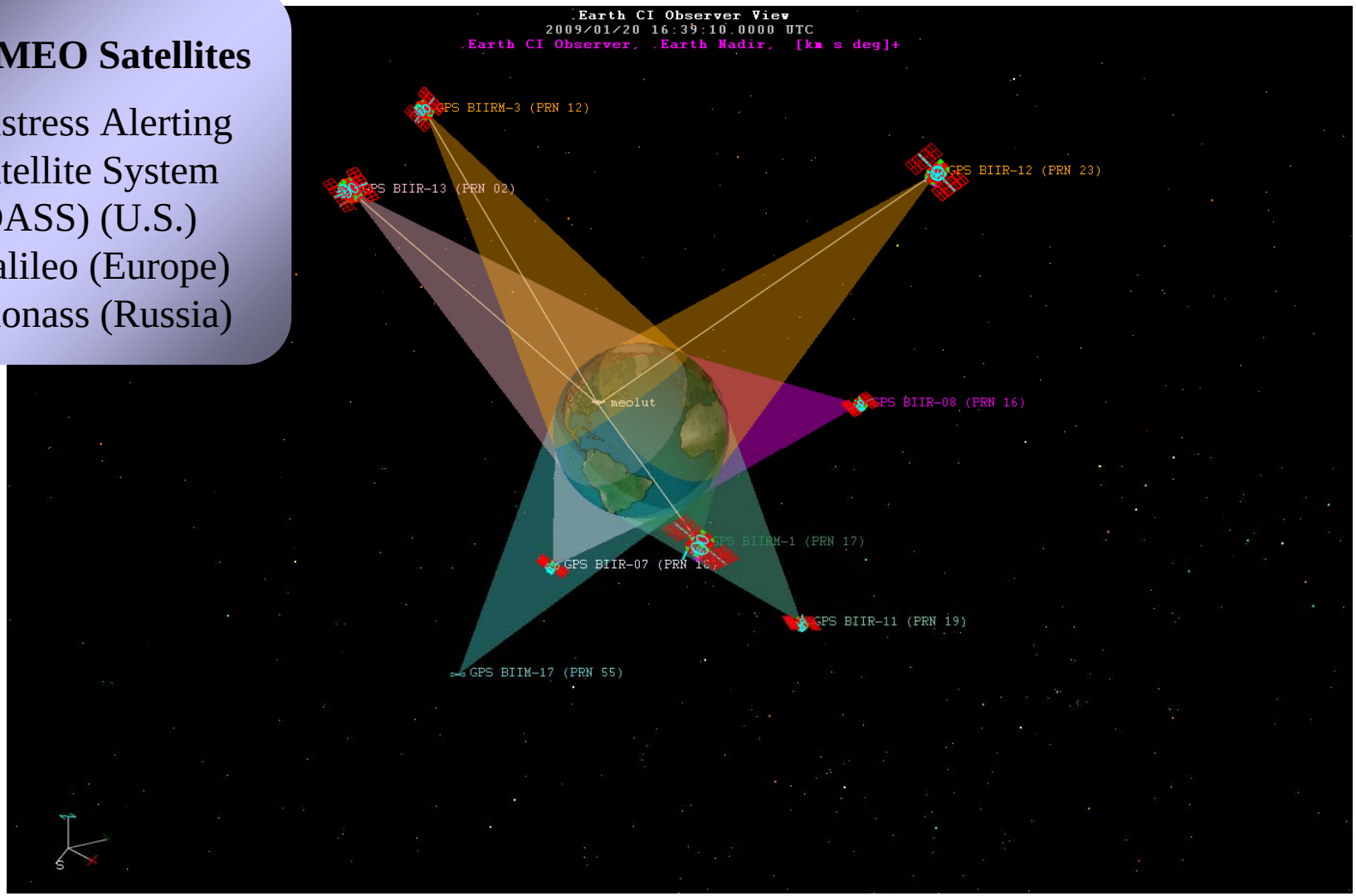
On-orbit GOES storage

Extended operation

Future Cospas-Sarsat Satellite Constellations-MEOSAR

C/S MEO Satellites

- Distress Alerting Satellite System (DASS) (U.S.)
- Galileo (Europe)
- Glonass (Russia)



Questions? My contact information is below, thank you.

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