SARSAT System Overview (including Space Segment)

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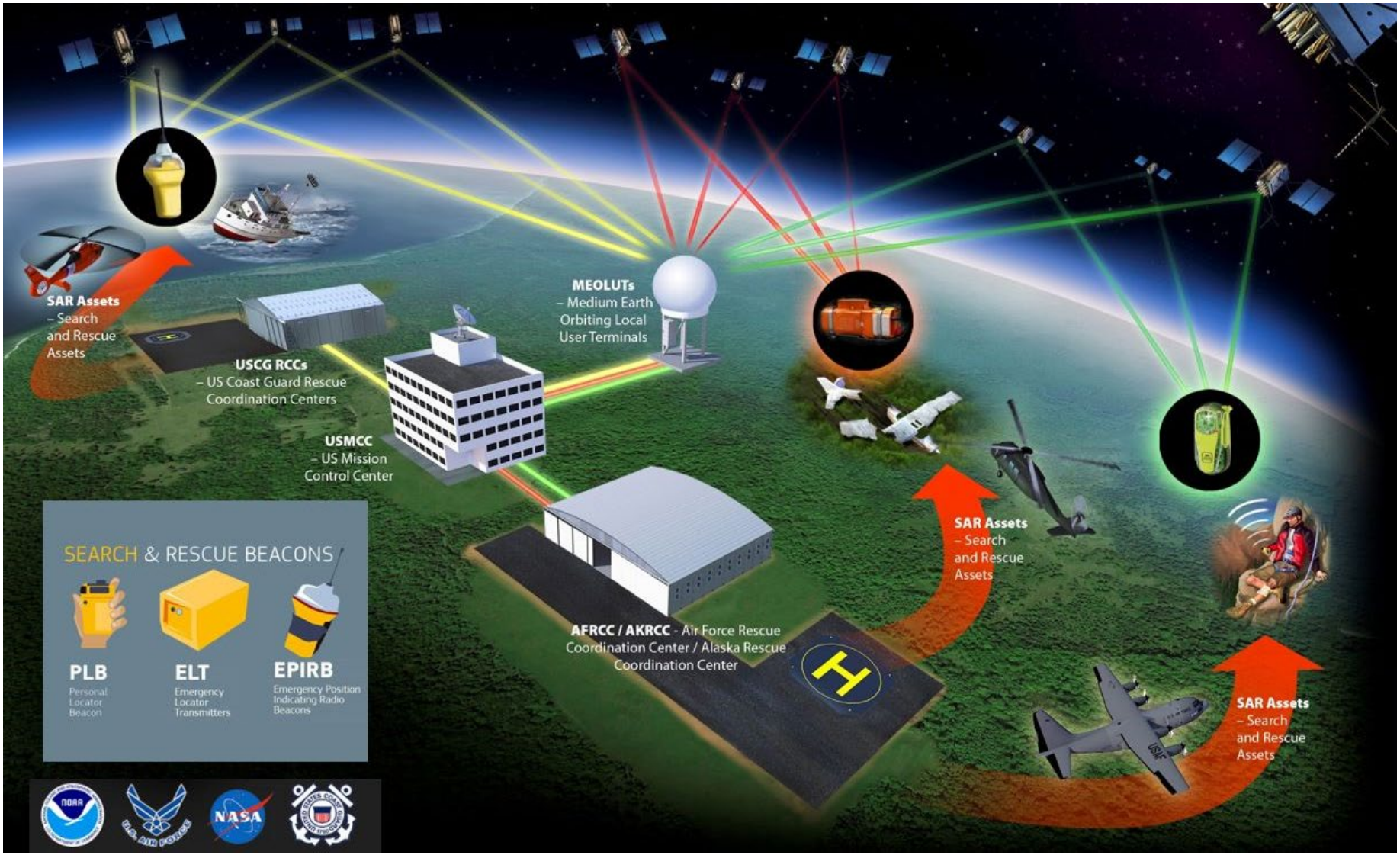
Introduction/Presentation Plan

- Provide an overview of the US operated Search and Rescue Satellite Aided Tracking (SARSAT) System
  - Space Segment description (US SARSAT controlled)
  - Ground Segment description (US SARSAT controlled)
  - Beacon Segment (User segment controlled, US SARSAT sets policy/type approval)

SARSAT System Overview

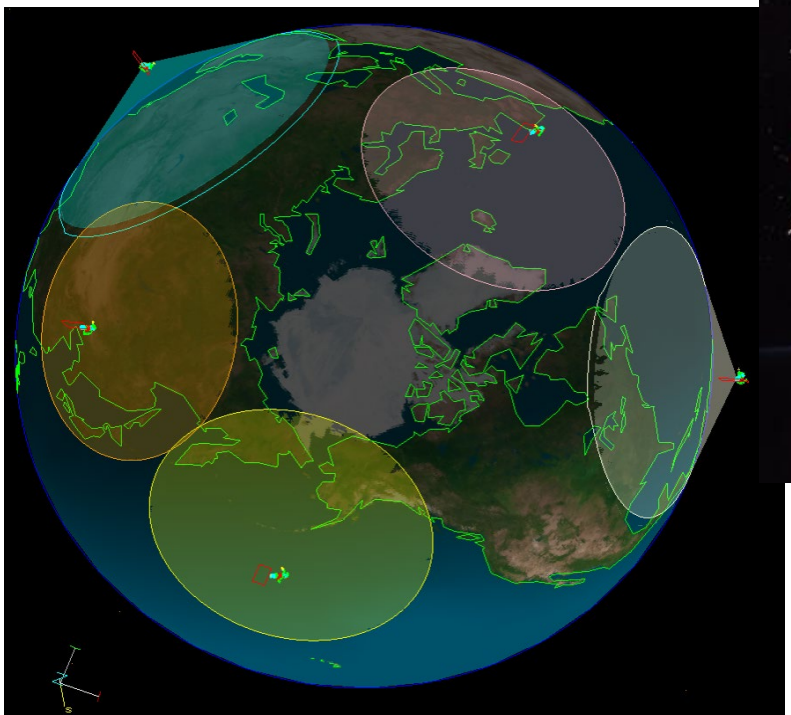


Satellite Types - LEO

There are 3 types of operational satellites with payloads used by SARSAT:

1. The US is currently operating 5 Low-Earth orbiting (LEO) satellites w SAR capabilities

Each satellite is orbiting at an altitude ~ 850 km has ~ 6% Instantaneous Field of View Coverage on the Earth & completes ~14 orbits/day, covering every location on the earth at least twice.



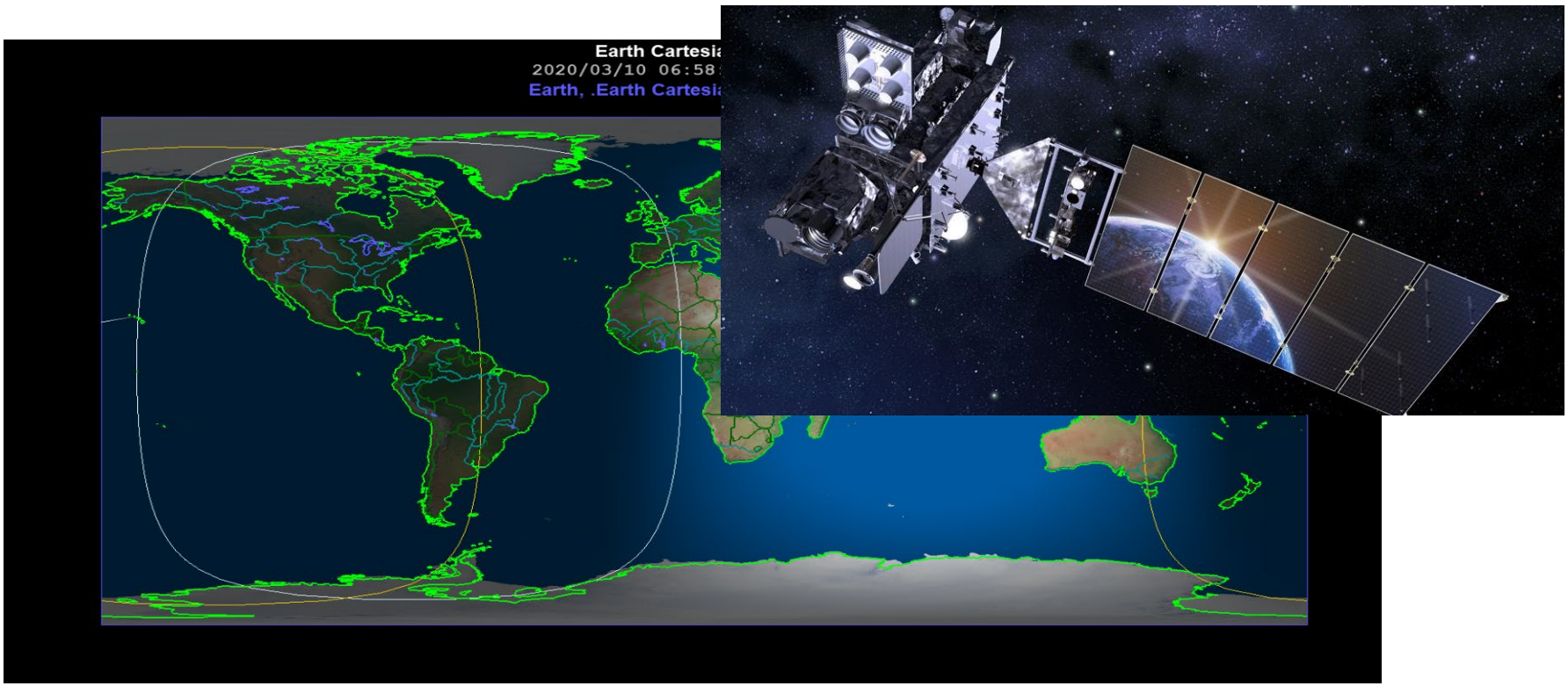
LEOSAR Space Segment Status

- LEOSAR Space Segment
  - SARSAT-13 aka Metop-B (launched SEP 12) 5 yr design, 5 years beyond its design life, and in a similar orbit plane to SARSAT-11. Has an orbit adjust capability
  - SARSAT-7 aka NOAA-15 (launched in MAY 98) 2 yr design, 24 yrs on orbit, 22 yrs beyond its design life (currently disabled due to conflict/interference with SARSAT-10)
  - SARSAT-10 aka NOAA-18 (launched MAY 05) 2 yr design, 15 yrs in orbit, 10 yrs beyond its design life, CURRENTLY not an operational asset as it interferes with
  - SARSAT-11 aka Metop-A (launched SEP 06) 5 yr design, 14 yrs in orbit, 9 yrs beyond its design life. Has orbit adjust capability- **DEACTIVATED NOV 11, 2021 at 1111Z**
  - SARSAT-12 aka NOAA-19 (launched FEB 09) 2 yr design, 11 yrs in orbit, 9 yrs beyond its design life

Satellite Types - GEO

2. **The US currently operates 2 Geosynchronous Earth orbiting (GEO) satellites which have a SAR capability**

Each satellite is orbiting at an altitude ~ 36000 km & has ~ 40% Instantaneous Field of View Coverage on the Earth & completes ~1 orbits/day.



GEO Space Segment status

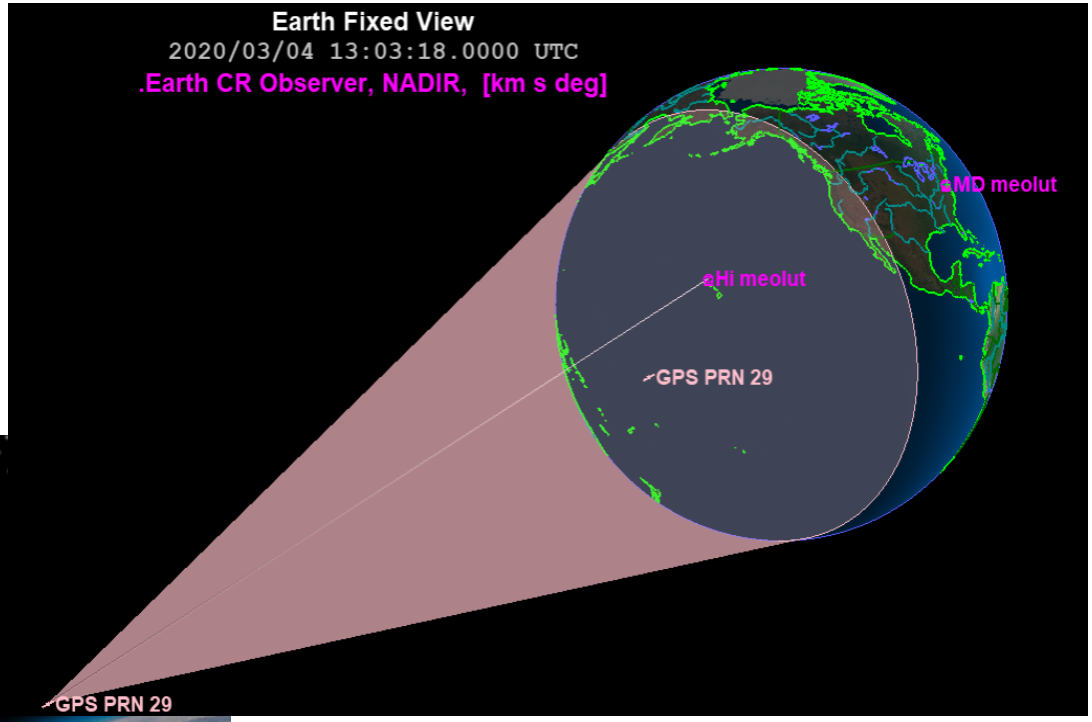
- GEOSAR Space Segment operated by the US
  - GOES-16, (launched NOV 16), 10 yrs design life, 6 yrs on orbit
  - GOES-17, (launched MAR 18), 10 yr design life. 4 years on orbit, faulty instruments (NOT SARSAT), will be replaced by GOES-18 in late 2022

- Other GEOSAR assets (foreign partners,needs review)
  - Electro-1, (launched JAN 11), 10 yr design, 9 yrs on orbit
  - INSAT-3A, (launched APR 03), 12 yr design, 17 years on orbit, 5 yrs beyond design life
    - MSG 3, (launched JUL 12), 7 yr design, 8 yrs on orbit
    - Luch 5A, (launched DEC 11), 10 yr design, 9 yrs on orbit

Satellite Types - MEO

3. **The US currently is operating 19 Medium Earth Orbiting (MEO) satellites (DASS)**

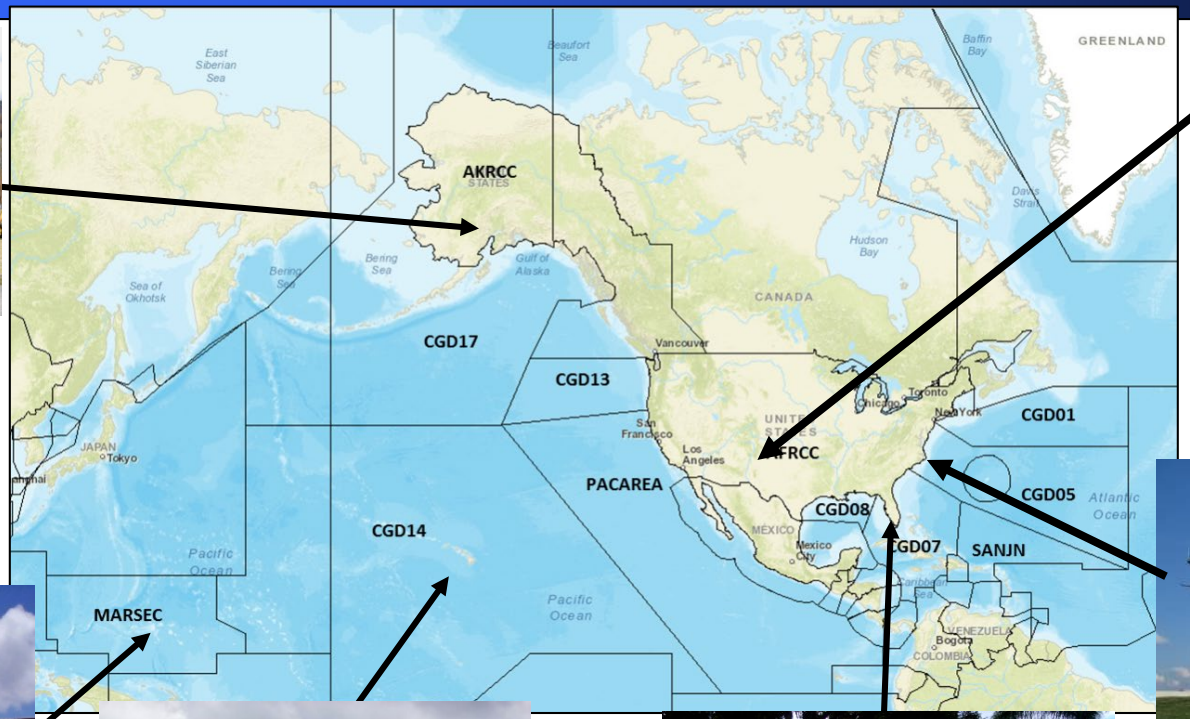
Each **satellite is orbiting at an altitude ~ 20000 km & has ~ 33% Instantaneous Field of View Coverage on the Earth & completes ~2 orbits/day. Constellation size ensures that ALL areas of the earth are covered in real-time!**



There are now 23 Galileo w an L-band SARR payload (all in use by US). Between US and Galileo, 42 satellites!

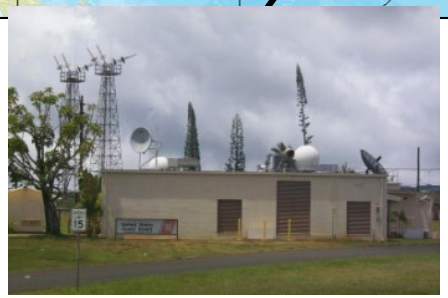
US SARSAT Ground Segment

Alaska
NOAA Fairbanks, Alaska Command and Data Acquisition Station (FCDA)
2 LEOLUTs replaced by 2 LEO/MEOLUTs in 2019



New Mexico
SUSA MEOLUT
2 phased array's under development

Guam
Andersen AFB
2 LEOLUTs replaced by 2 LEO/MEOLUTs in 2019



Hawaii
2 LEOLUTs replaced by 2 LEO/MEOLUTs in 2019
&
6 antenna MEOLUT

Miami
2 LEOLUTs replaced by 2 LEO/MEOLUTs in 2019
&
6 antenna MEOLUT

Maryland
US Mission Control Center
Maryland has 2 GEOLUTs & 1 test GEOLUT
&
1 Test LEOLUT
1 Test LEO/MEOLUT

Ground Segment

United States Mission Control Center (USMCC)

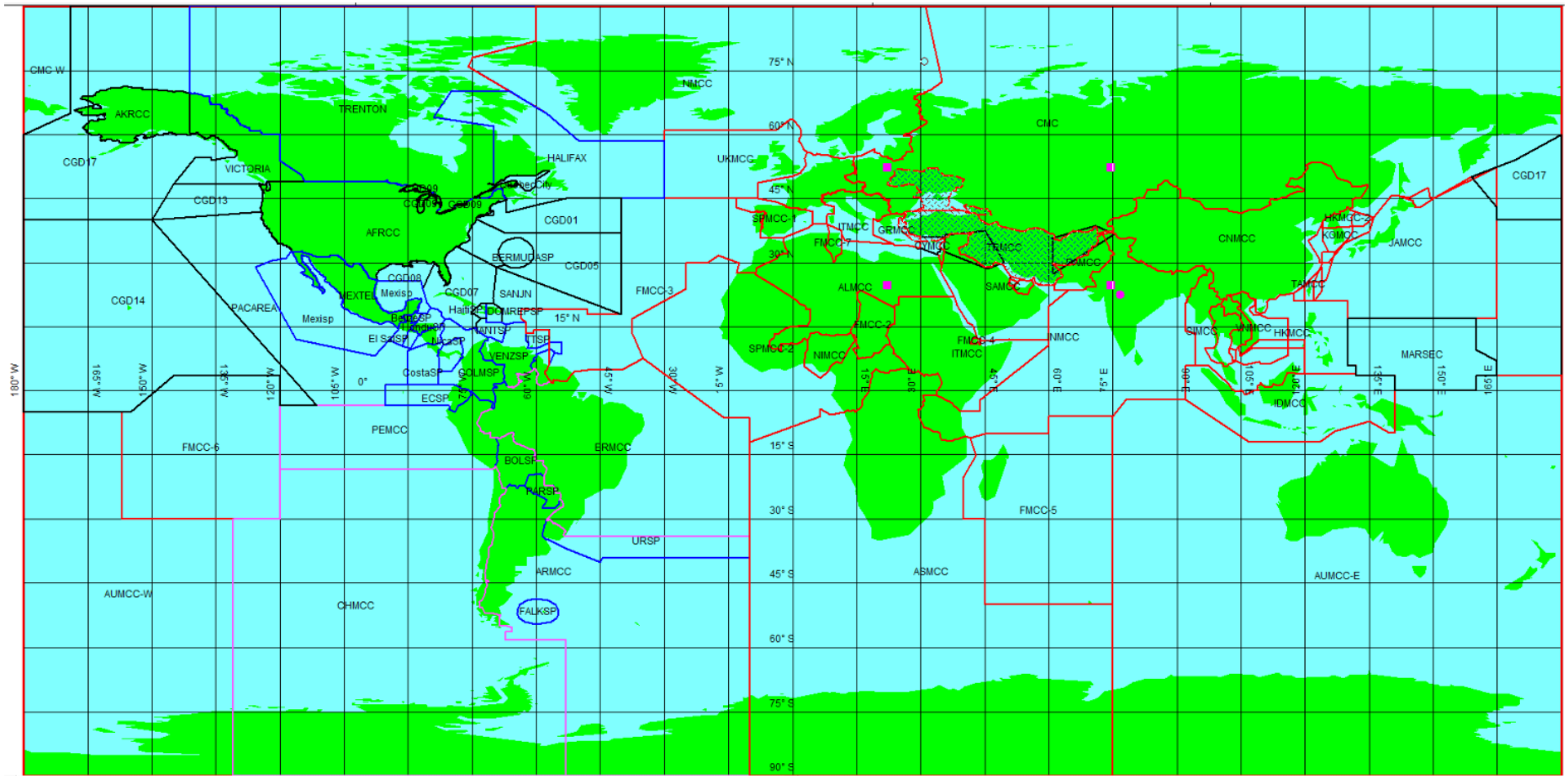
- Receives alerts from national LUTs and foreign MCCs
- Validates, matches, and merges alerts to improve location accuracy and determine the correct destination
- Correlates with NOAA registration database and append info to alert

Ground Segment

United States Mission Control Center (USMCC)

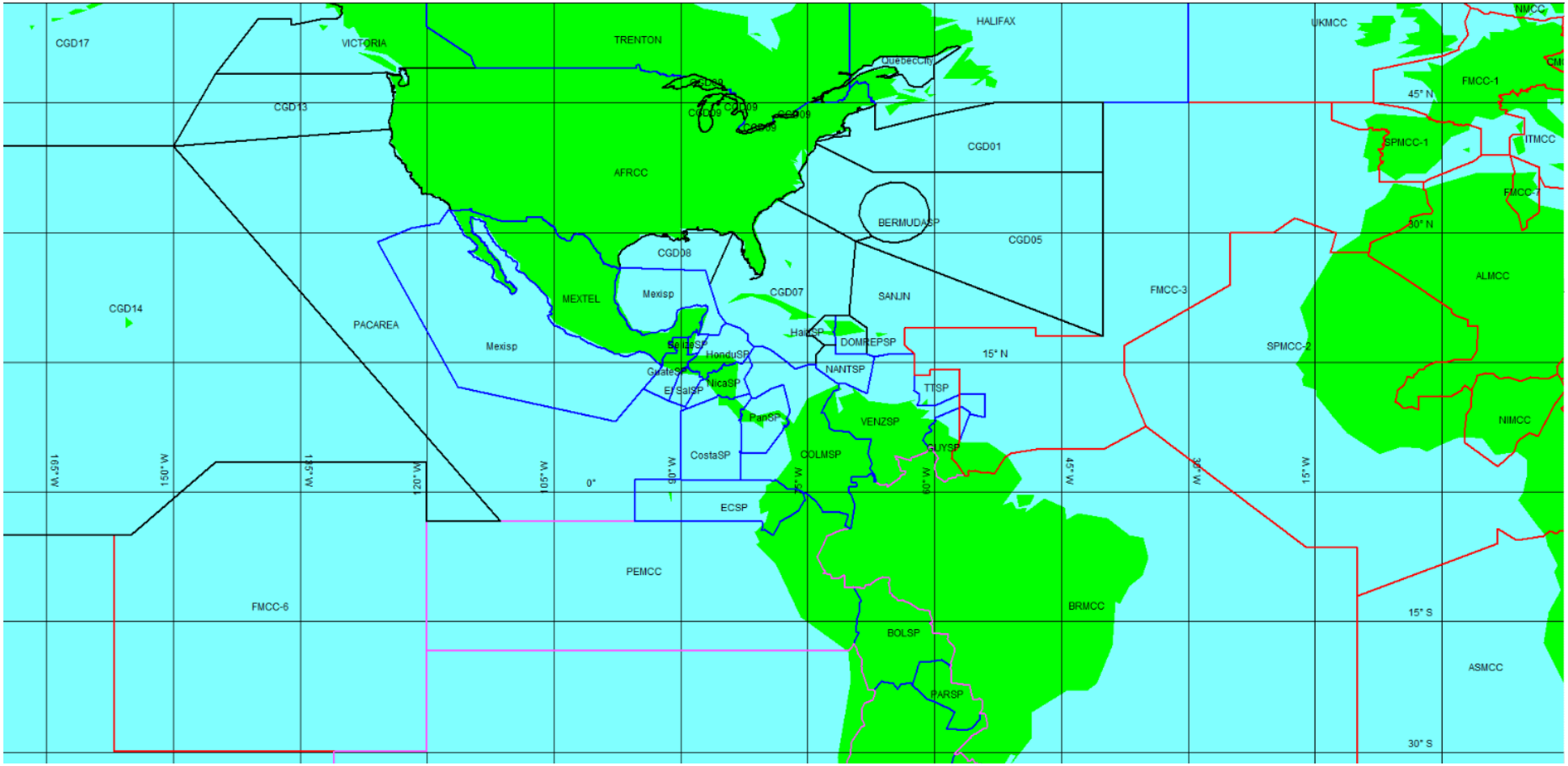
- Filters redundant data
- Performs system support and monitoring functions
- Alert data received by the MCC is archived for access at a later time if required
- A record is created when sites close (beacon stops transmitting) in the Incident History Database (IHDB)
- The IHBD is populated by Search and Rescue Personnel and maintained by the USMCC to provide the history of why each SARSAT alert was received by USMCC
- The IHDB records tell the story of how each SARSAT alert case was handled, who handled it, and the accuracy of the information in the Registration Database

USMCC Global GEOSORT



USMCC GEOSORT aligned with IMO Boundaries

USMCC SPOC SRR GEOSORT



Closer view of SPOC SRR distribution

COSPAS-SARSAT Beacons

Activation:

- Manual
- Automatic (Hydrostatic/G-Switch)

Signal:

- 406 MHz (Digital)
- 121.5 MHz (Analog) Homing

Applications:

- Aviation - Emergency Locator Transmitter (ELT)*
- Maritime - Emergency Position-Indicating Radio Beacon (EPIRB)
- Personal/Land - Personal Locator Beacon (PLB)
- Security - Ship Security Alert System (SSAS)

***Most US general aviation ELTs are still 121.5 MHz, which are no longer monitored by Cospas-Sarsat**

SARSAT Beacon Totals

- More than **784,499** U.S. beacons in the NOAA Registration Database as of 21 April 2022:
  - **139,433 ELTs**
  - **288,270 EPIRBs**
  - **320,531 PLBs**
  - **65 SSAS**
  - **118,986** DoD devices registered in JSETS
- Estimated worldwide beacon population in 2021: **~1,900,000**

SARSAT Rescues

As of Apr 22, 2022 needs updating

107 Rescues in the United States during Calendar Year 2022

Rescues at sea: 75 people rescued in 20 incidents

Aviation rescues: 12 people rescued in 7 incidents

Terrestrial rescues: 20 people rescued in 15 incidents

Number rescued world-wide since 1982: over *48,000*

Number rescued in United States since 1982: *9,830*

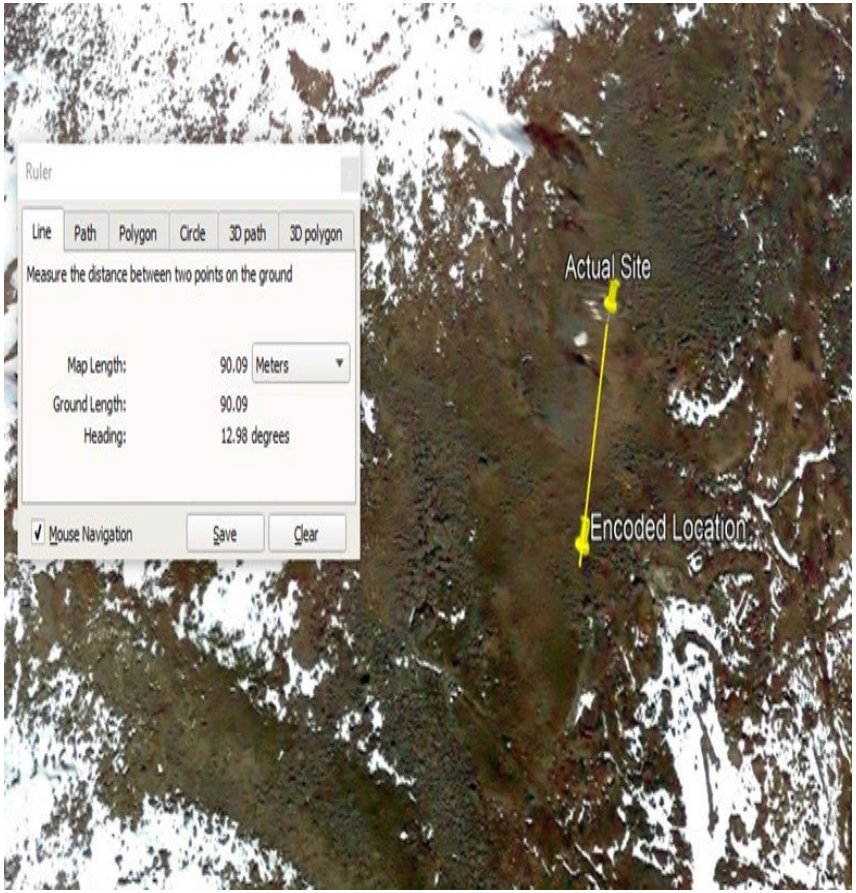
SARSAT SAVE - CASE STUDY

Background

- A mountain/rock climber was saved by their PLB after a rock-climbing fall at Hatcher Pass, Alaska. The individual is an experienced climber, and a member of the Anchorage Mountaineering Club.
- The fall occurred on the second pitch of the climb, with the climber fell to a small grassy wet ledge suffering broken C1 vertebrae.
- The PLB was in pack at mountain base – climbing partner repelled down to retrieve the beacon and activated it at the incident location. The injured climber had told the other climbers in their party that they had a PLB, but did not discuss how to activate or on proper placement.
- The fall happened at approximately 3pm on July 14, 2020 and the climber indicated that the PLB was activated around 3:30pm. The climber said that after the rescue the pararescue first responder told them that they had been notified of the activation around 6pm (nearly 3 hours after activation) The climber was transported to a hospital via rescue helicopter at approximately 9:30pm.
- Beacon was properly registered. Registration was up to date, and beacon had a current battery
- The climber contacted NOAA and was asking why there was a long delay in receiving the signal especially since they had to stay still with a neck injury for several hours.
- NOAA verified that neither Cospas-Sarsat nor the USMCC received any alerts prior to 6:11PM, nearly 3 hours after the PLB was turned on. Incident location was visible to MEO and LEO but only one LEO satellite detected the beacon
- PLB was sent to manufacturer who conducted forensic examination of the beacon.

Event Timeline

Date/Time (Alaska UTC-8)	Alert	Source	Position
July 14, 2020 ~3pm	Time of Accident	Survivor Interview	
July 14, 2020 ~3:30pm	PLB Turned On	Survivor Interview	
July 14, 2020, 4:59 PM	Actual Position	GPS tag from iPhone Photo	61° 49' 31.03" N, 149° 14' 34.57" W
July 14, 2020, 6:11 PM	406 BEACON LOCATED FIRST ALERT (POSITION UNCONFIRMED)	LEO S12 Encoded	61 45.00N 149 15.00W
July 14, 2020, 7:51 PM	CONFIRMED POSITION (Composite?)	LEO S12	61 46.6N 149 15.2W
July 14, 2020, 7:51 PM	POSITION CONFIRMED FROM THE FOLLOWING NEW INFORMATION	LEO Doppler A	61 49.3N 149 16.4W
July 14, 2020, 7:51 PM		LEO Encoded	61 49.47N 149 14.60W



The reported carrier power (reported by the SARP) values were -117.43 and -139.45 dBm.

The -139dBm signal is close to the normal values

Incident Assessment

- Incident pictures captured the survivor providing a view of the PLB deployment (The GPS location was embedded in the photos on the phone).
- The PLB was upside down with the antenna bent.
- Antenna was laying on the ground – unable to verify for how long.
- Significant terrain masking due to the incident location (high mountains and rock face).

PLB Assessment

- The original test data from the PLB factory birth record (2017) was within specification and passed all tests
- The PLB was labeled correctly with a current and correct UIN.
- The returned unit had a pronounced antenna kink consistent with the picture of the PLB position at the accident site
  - The PLB battery measured the correct voltage
  - The unit did not pass self-test
  - The unit did not pass GNSS self-test
  - Battery was changed and self-test still failed
  - Subsequent circuit inspection reveals a damaged power amplifier
  - Replacement of the power amplifier resulted in a fully functional unit *sans* the antenna.

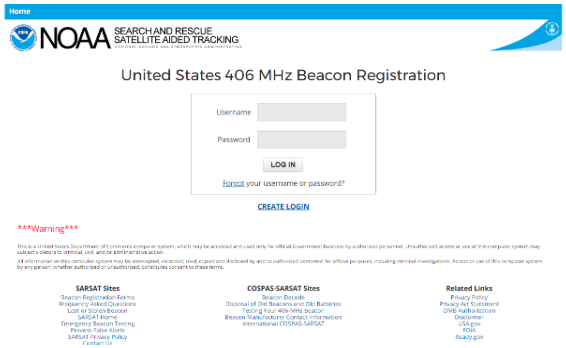
Event Takeaways

- The C/S system works even under very challenging conditions
- Encoded location works!
- The position and conditions of the distress beacon can dramatically affect the signals to the satellites
- The time to understand how the beacon functions is before the distress situation happens not during
- GOOD NEWS! - Climber is well on their way to a full recovery and has been provided a brand-new PLB.

Importance of Registration

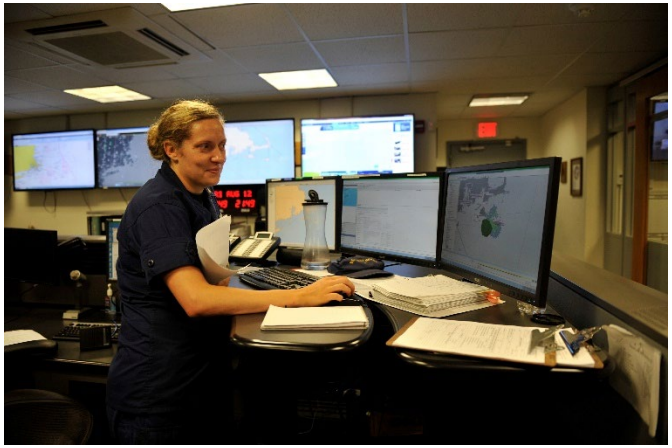
Register online at beaconregistration.noaa.gov

- Digital data transmitted by beacon provides nationality and type of beacon and aids in tracking.
- Emergency contact information and home port are listed in registration
- Tail number and identifying information can be encoded into the beacon
- Registration can include information about the owner/operator, specifics on aircraft or vessel, capability of the beacon and/or medical concerns of the owner. This information allows for a more coordinated, timely and prepared search and rescue response by SAR authorities.
- Often, false alerts are resolved prior to dispatching limited search and rescue resources, protecting those valuable resources for actual cases, saving tax dollars, and protecting search and rescue crews.



Importance of Registration

- Digital data transmitted by beacon provides nationality and type of beacon
- Emergency contact information and home port are listed in registration
- Tail number or other identifying information can be encoded into the beacon
- Registration Database provides additional information about the owner/operator, and can include specifics on aircraft or vessel
- In most cases, false alerts are resolved prior to launching SAR resources, saving taxpayer $$



Questions?

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