SARSAT Overview

SAR Controllers Training 2016
February 29 - March 3, 2016
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Direct Services Branch Chief/SARSAT Program Manager

Agenda

- Importance of SARSAT
- Cospas-Sarsat
- System Description
  - User Segment (Beacons)
  - Space Segment
  - Ground Segment
  - Search and Rescue (SAR) Segment
- U.S. SARSAT
- SARSAT Challenges

Importance of SARSAT

Benefits of SARSAT:

- Shorter searches
  - "Golden Hour", shorter response increases the likelihood of survival
  - Reduces risks to search teams
  - Reduces response costs
- Economic benefits
  - Creates jobs - 9 US Beacon manufacturers
  - Contributes to the economy - manufacturers produce thousands of distress beacons per year ~$437M invested in Beacons
- SARSAT Lives Saved
  - 2015 250 saves (138 at sea in 46 incidents, 21 aviation in 11 incidents, and 91 terrestrial in 65 incidents)
  - 2014 240 saves (112 at sea in 31 incidents, 15 aviation in 7 incidents, 113 terrestrial in 72 incidents)

SARSAT Rescues since 1982

World-wide: over *39,000 rescues*

United States: over *7,760 rescues*

October 22, 2010, Teen Sailor Abby Sunderland rescued via SARSAT

2014 Cost Benefit Analysis

- Total benefit lives and property (Based on Department of Transportation (DOT) June 13, 2014, value of a statistical life of $9.2M)
  - $1,263,477,920
- Total costs of federal rescue operations and SARSAT operation
  - $36,524,649 (State and local costs unknown)
- Net Benefit $1,226,953,271
- Cost benefit ratio 33.6 to 1.0

January 30, 2015, Crew of the *Rain Maker* with USCG Rescuers

May 22, 2015, USCG rescued two crew of sailing vessel *Boxer*

SARSAT Authorities

- International Cospas-Sarsat Programme Agreement
  - Intergovernmental agreement that assures the long term operation of the system on a non-discriminatory basis and supports ICAO and IMO, signed by Russia, France, Canada and United States
- Interagency Memorandum of Agreement for the United States Satellite-Aided Search and Rescue System
  - Interagency agreement addressing the management and operation of the U.S. Cospas-Sarsat System and the development and implementation of SAR/GPS
- National Regulations
  - Public Law 91-596, 106-181: Federal Aviation Act that requires general aviation (GA) aircraft to carry ELTs
  - Title 46 of the CFR 406 MHz EPIRBs, and Title 14, Subpart 91.207 deals with the carriage of 406 MHz ELTs.
  - The FCC authorizes the use of the 406 MHz frequency for EPIRBs CFR Title 47, Part 80, ELTs CFR Title 47, Part 87, and PLBs in CFR Title 47, Part 95.
  - State of Hawaii law requires all boats operating more than a mile off-shore to carry either an EPIRB or a Very High Frequency (VHF) radio.
- International Regulations
  - ICAO was founded through the Convention on International Civil Aviation signed on 7 December 1944. It is the United Nations Specialized Agency responsible for international civil aviation operations. ICAO requires the carriage of 406 MHz ELTs on certain international flights that fall under the ICAO Convention. Specifically, Annexes 6, 10, and 12 to the Convention on International Civil Aviation requires carriage and registration of 406 MHz emergency beacons. The United States is a Party to this Convention.
  - IMO is the United Nations' specialized agency responsible for improving maritime safety. IMO, through the Global Maritime Distress and Safety System (GMDSS), requires the carriage of EPIRBs for vessels that fall under the International Convention for the Safety of Life at Sea (SOLAS) Convention. Specifically, IMO resolutions A.662(16), A.694(17), A.696(17), A.810(19), and A.887(21) deal with carriage requirements, standards, type approval and registration of emergency beacons. The United States is a Party to the SOLAS Convention.
  - The International Telecommunication Union (ITU) has allocated the 406 MHz frequency band for the exclusive use of low-power, earth-to-space EPIRBs (International Radio Regulation No. 2997A)

Cospas-Sarsat Overview

- **COSPAS:** Cosmicheskaya Systyema Poiska Aariynyich Sudov (Russian) which translates loosely "Space System for the Search of Vessels in Distress"

- **SARSAT:** Search And Rescue Satellite Aided Tracking

Cospas-Sarsat provides, free-of-charge, distress alert and location information to search and rescue authorities anywhere in the world for maritime, aviation and land users in distress.

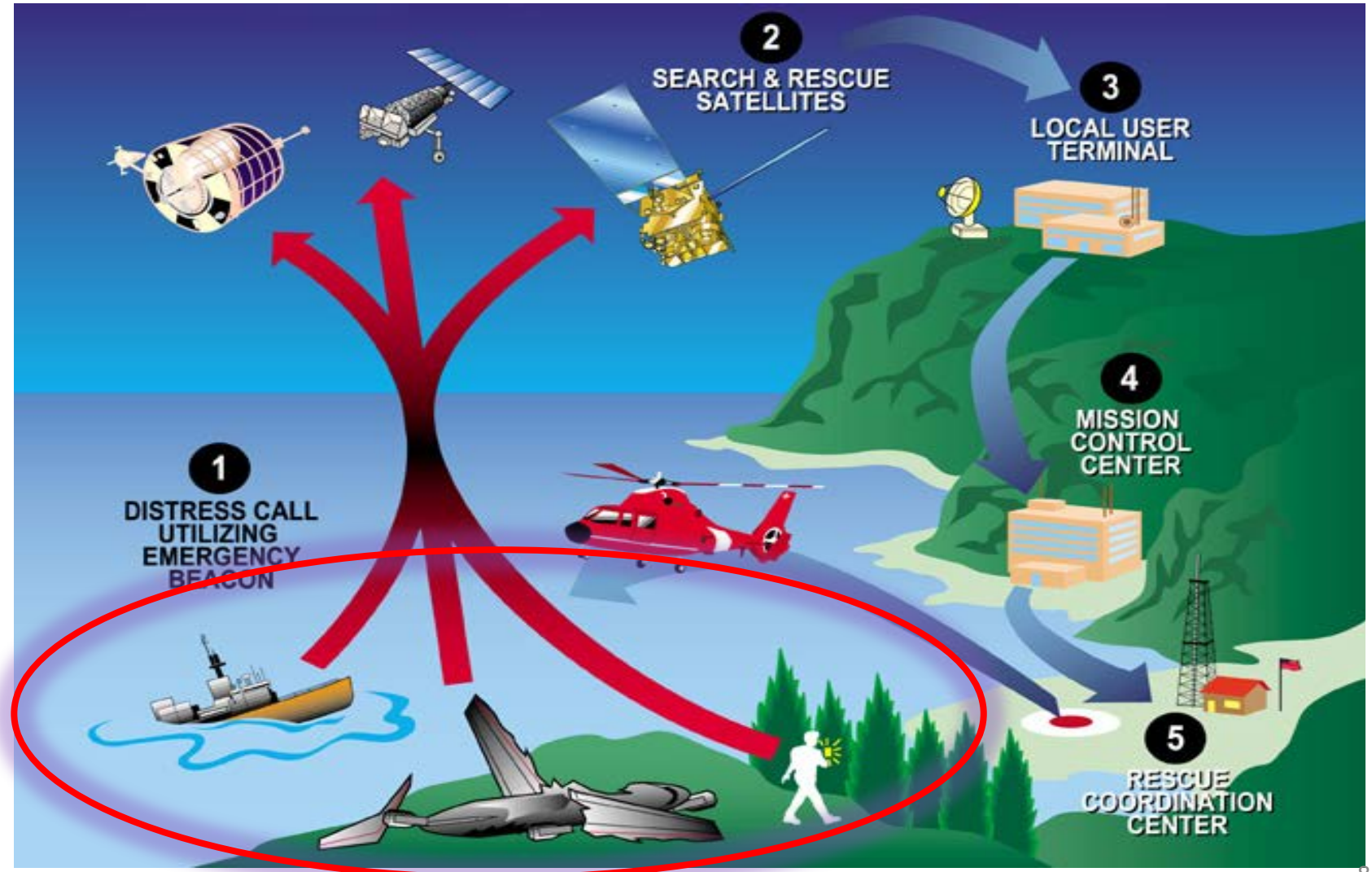
Cospas-Sarsat takes the "search" out of Search and Rescue

Cospas-Sarsat Summary

- 4 Parties to the Cospas-Sarsat Agreement
- 26 Ground Segment Providers
- 11 User States
- 2 Participating Organizations
- Space Segment
  - 5 Low Earth Orbit Search and Rescue Satellites
  - 6 Operational Geostationary Search and Rescue Satllites
- Ground Segment
  - 31 Mission Control Centers (MCCs)
  - 58 Low Earth Orbit Local User Terminals (LEOLUTs)
  - 22 Geostationary Local User Terminals (GEOLUTs)
- Over 1,200,000 Beacons

Cospas-Sarsat Participants

Cospas-Sarsat System Overview
User Segment



User Segment – Beacons

Activation:

- **Manual**
- **Automatic (Hydrostatic/G-Switch)**

Signal:

- **406 MHz (Digital)**
- **121.5 MHz (Analog) Homing**
- **Applications:**
- **Maritime - Emergency Position-Indicating Radio Beacon (EPIRB)**
- **Aviation - Emergency Locator Transmitter (ELT)**
- **Personal/Land - Personal Locator Beacon (PLB)**
- **Security – Ship Security Alerting System (SSAS)**

*** Most U.S. general aviation ELTs are still 121.5 MHz which are no longer monitored by Cospas-Sarsat**

United States User Segment

- **86,236* aviation users in U.S.**

  All types and uses of aircraft

- **213,059* maritime users in U.S.**

  Divided between commercial and recreational vessels

- **175,729* land-based users in U.S.**

  Recreational use plus some aviation and maritime use

- **Estimate of approximately 1,235,000 users worldwide in 2011 and 1,799,000 worldwide in 2016**

*** Registered U.S. beacons as of February 2016**

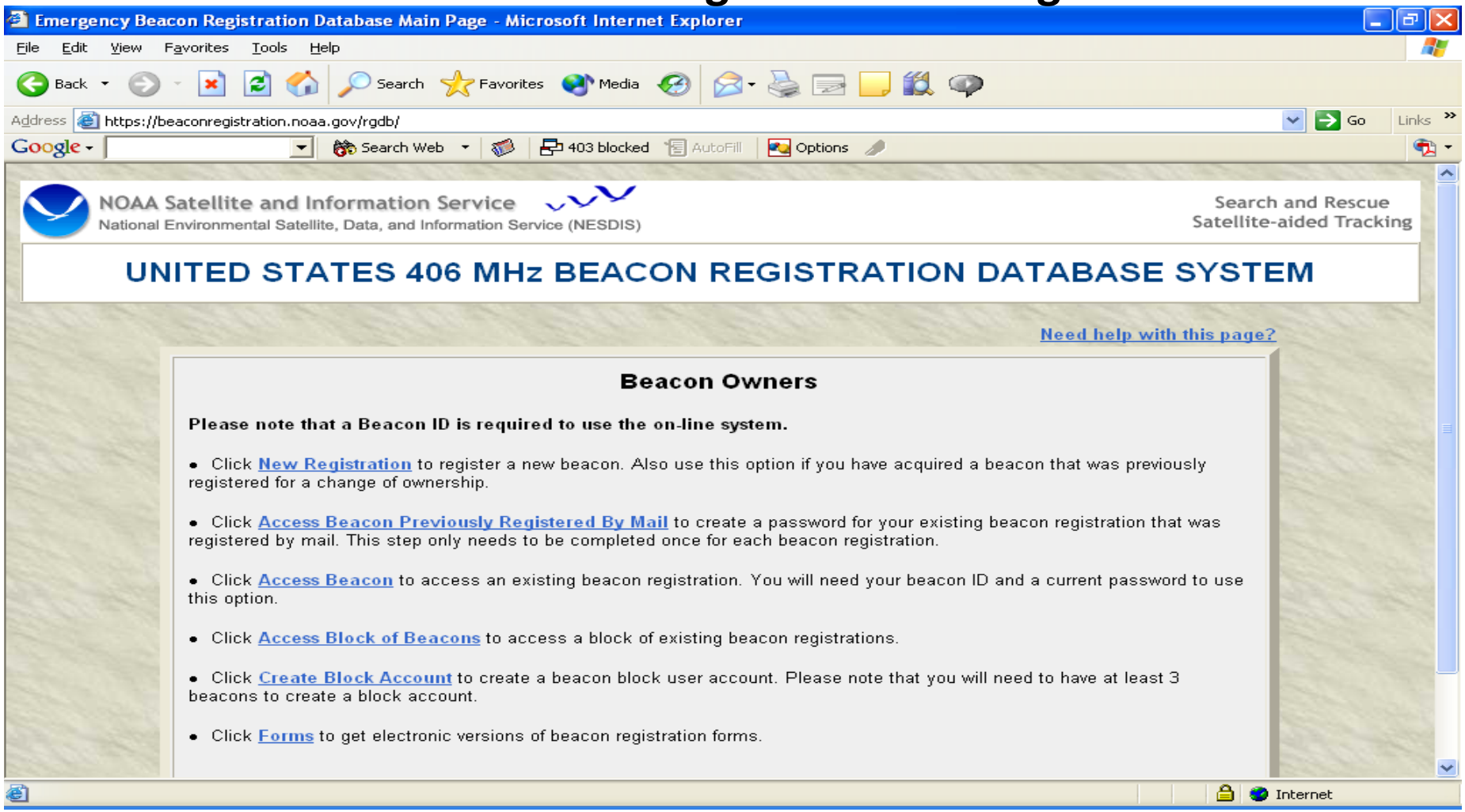
User Segment

Attributes of 406 MHz

- Every beacon has unique 15 digit hex identification
  - Unique ID allows registration with contact information
  - Non-Distress activations can be terminated with a phone call
  - Reduces stress on SAR assets
- Powerful 5 watt transmitter and digital signal increases accuracy of location by Doppler processing
- The system can discriminate between real beacon transmissions and non-beacon transmissions which reduces the resources spent on tracking interfering sources
- Global coverage provided by store and forward capability of Cospas-Sarsat LEOSAR satellites
- Increased system capacity due to short duration transmission, and spreading of frequency allocation

User Segment – Beacon Registration

www.beaconregistration.noaa.gov



Importance of Registration

Identification

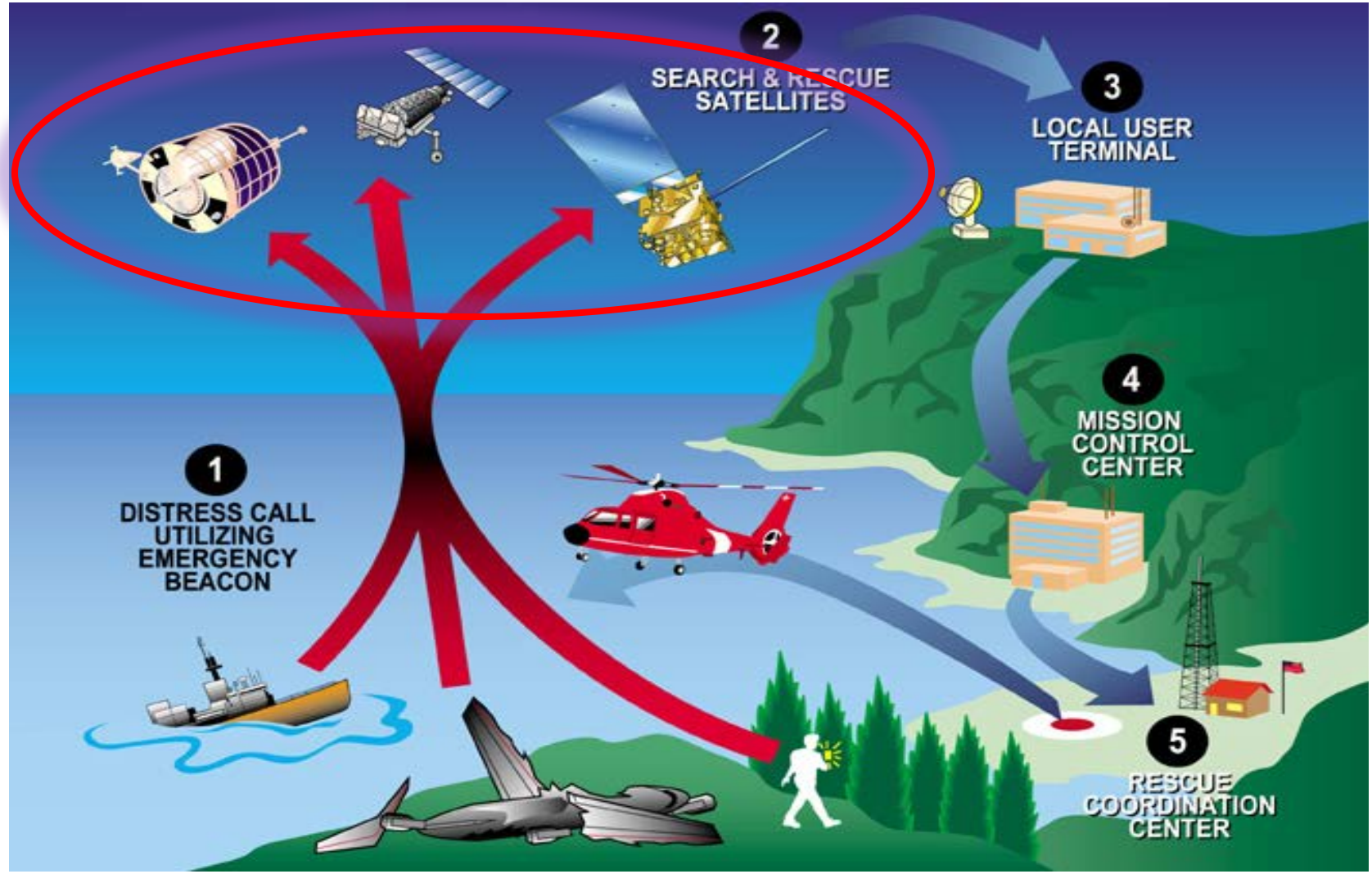
- Digital data transmitted by beacon provides nationality and type of beacon
- Tail number or other identifying information can be encoded into the beacon
- Registration Database provides additional information such as owner/operator, and can include specifics on aircraft or vessel
- In most cases, false alerts are resolved prior to launch of resources, saving taxpayer $$

Importance of Registration

Detection

- Near real-time detection of the 406 MHz transmission from an emergency beacon. Even if there is no LEO satellite in view to achieve Doppler for location, GEO satellites work to save lives in 4 ways:
  - Use of Registration Database to contact owner or emergency POC; this allows rescue forces to get more detailed information such as nature of emergency, severity of injuries, number of people involved, etc. and can help determine if alert is actual distress
  - GEOSAR satellites have continuous monitoring of over 1/3 the Earth's surface.
  - GEOSAR satellites have a 46-minute mean time "advantage" for first detection.

Cospas-Sarsat System Overview
Space Segment



Space Segment

Currently 2 Types of Satellites:

- **Low Earth Orbiting Search And Rescue (LEOSAR)- 5 on Orbit**

  Altitude: 500 miles in "Pole-Pole" orbit

  Performs Doppler locating function (primary means of locating…not GPS)

  Two instruments, Search and Rescue Repeater (SARR) and Search and Rescue Processor (SARP)

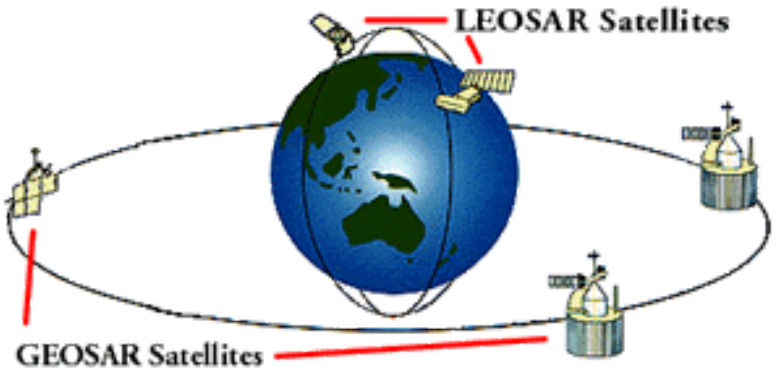
  SARP Stores & Forwards alerts continuously for 18 hours (originally 48 hours) which provides worldwide coverage and total system redundancy.

- **Geostationary Orbiting Search And Rescue (GEOSAR)- 6 on Orbit**

  Altitude: 23,000 miles in fixed orbit

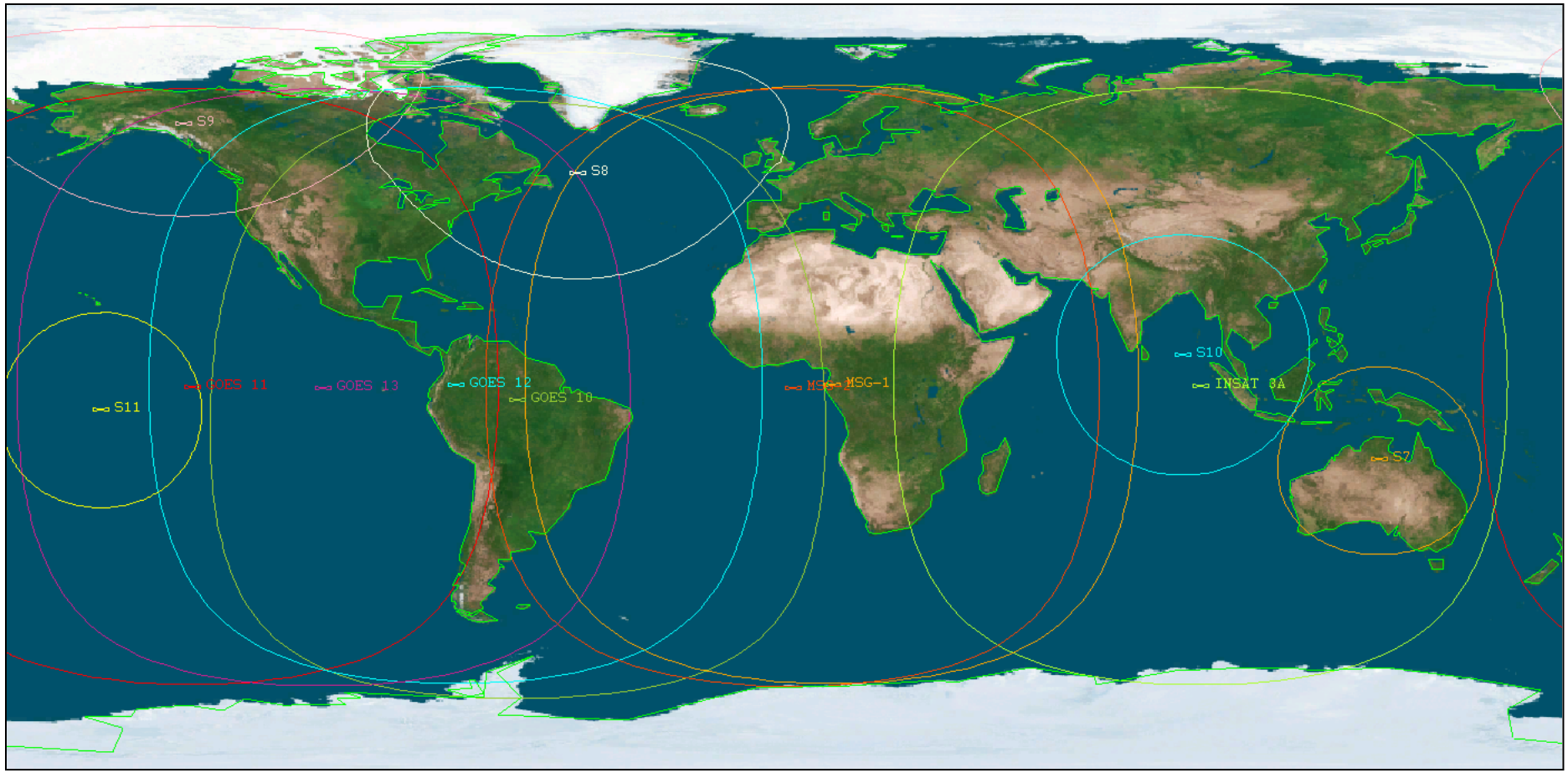
  Performs instantaneous alerting function. No locating capability unless beacon is equipped with GPS.

  Coverage from 70N – 70S

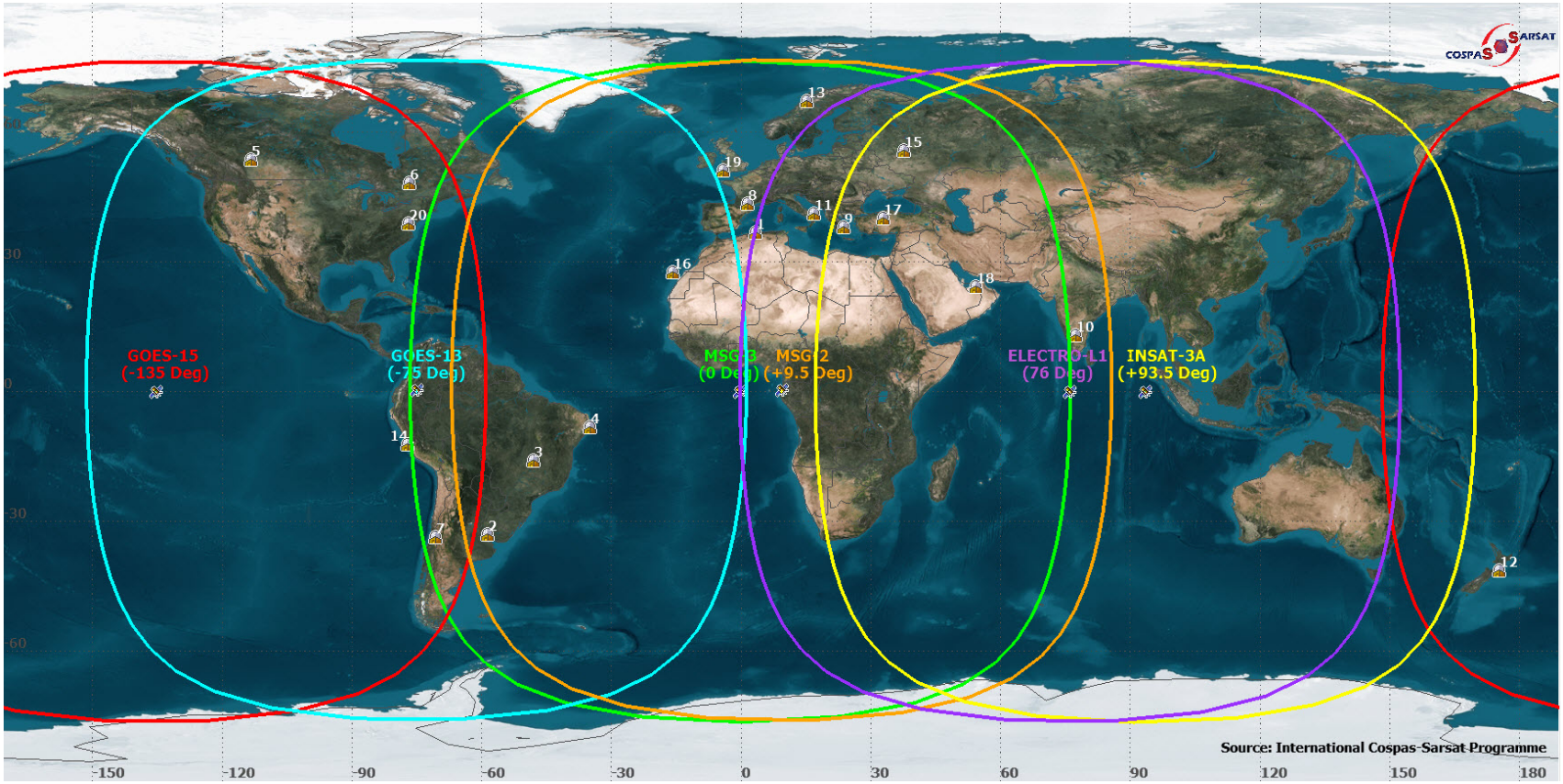


Space Segment

Typical Satellite Footprints

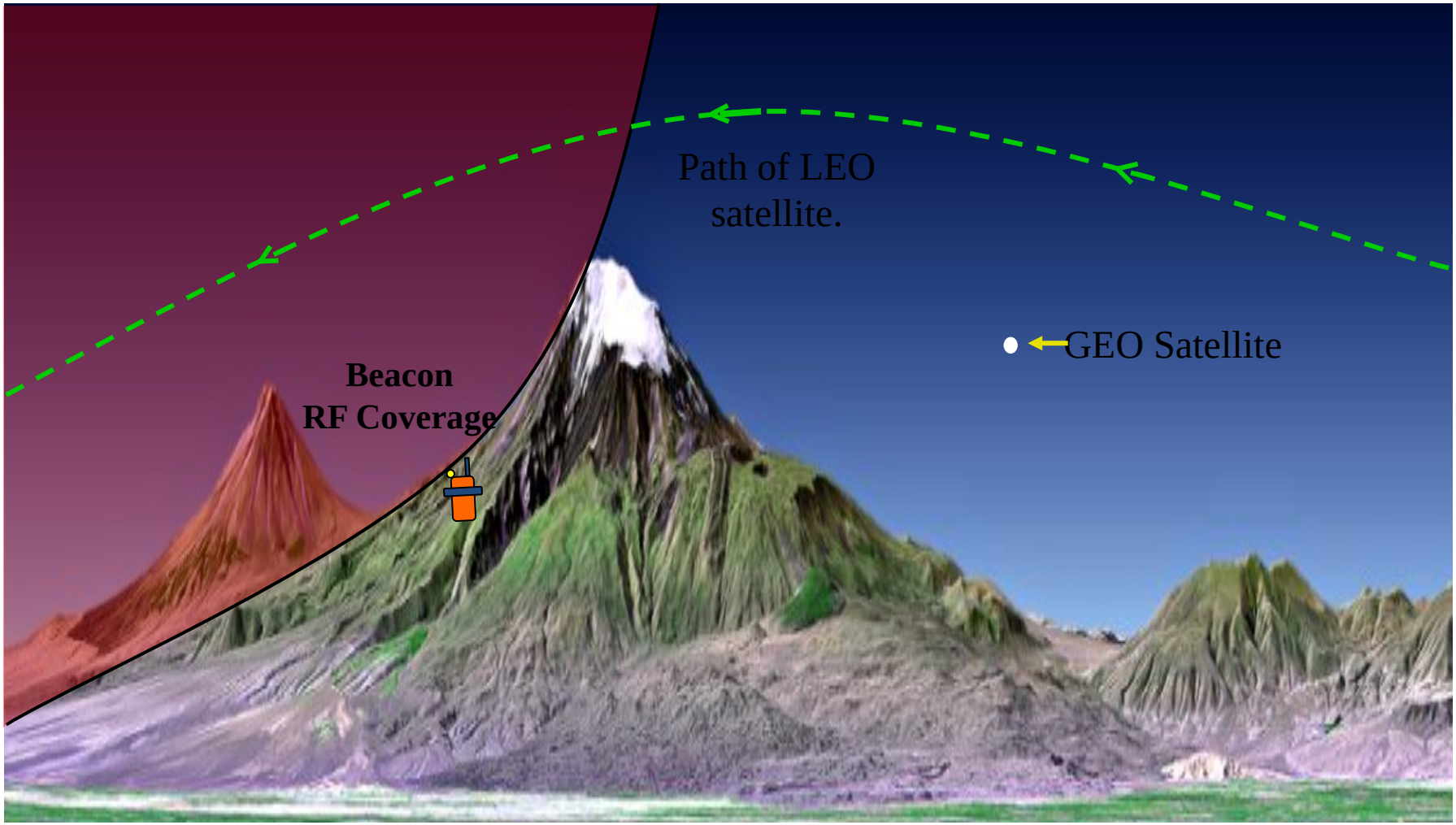


Space Segment
GEO Coverage

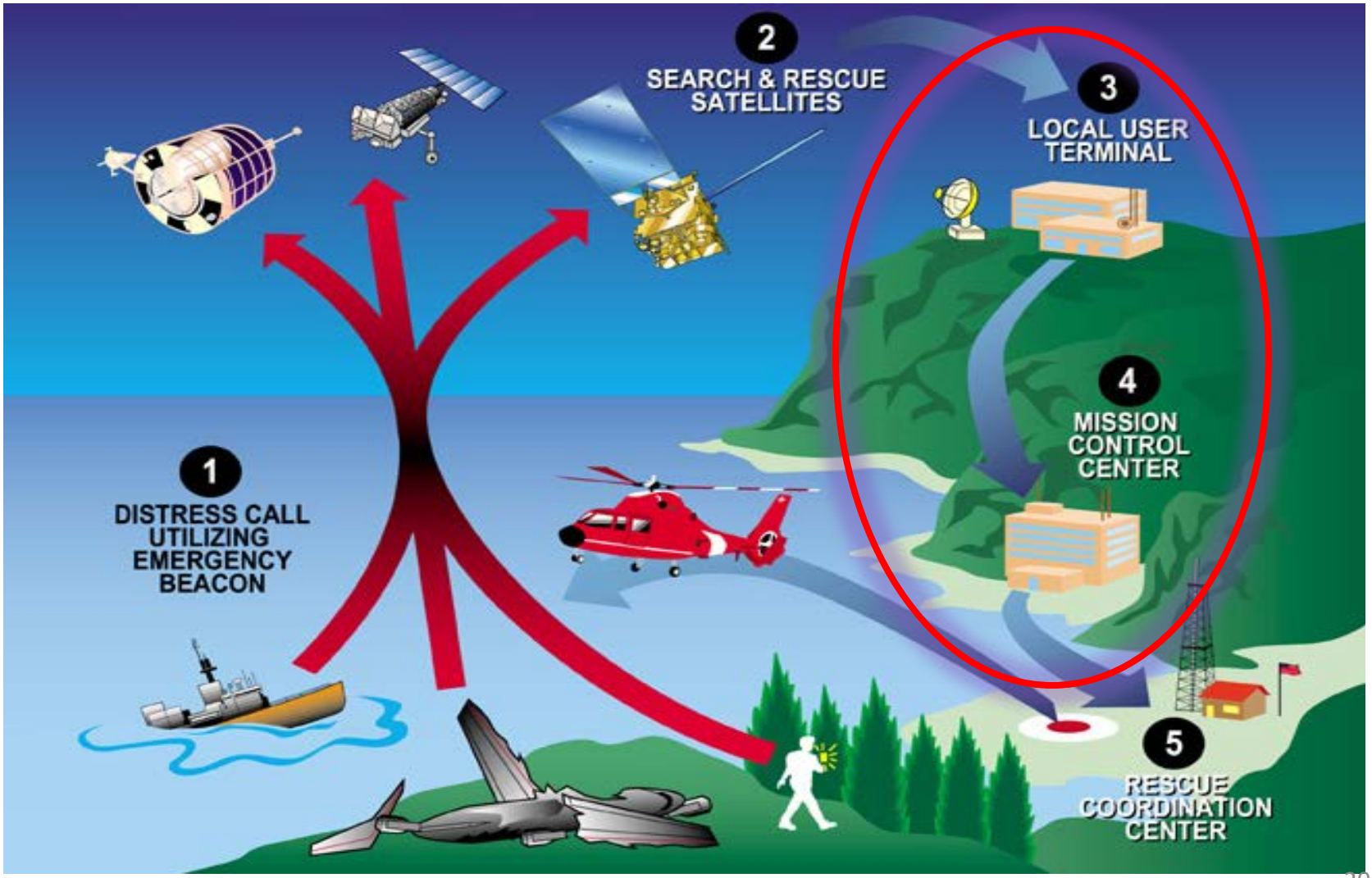


Space Segment

Field of View

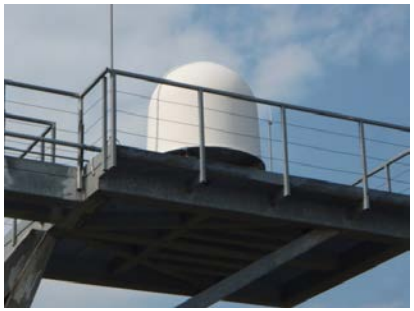


Cospas-Sarsat System Overview
Ground Segment

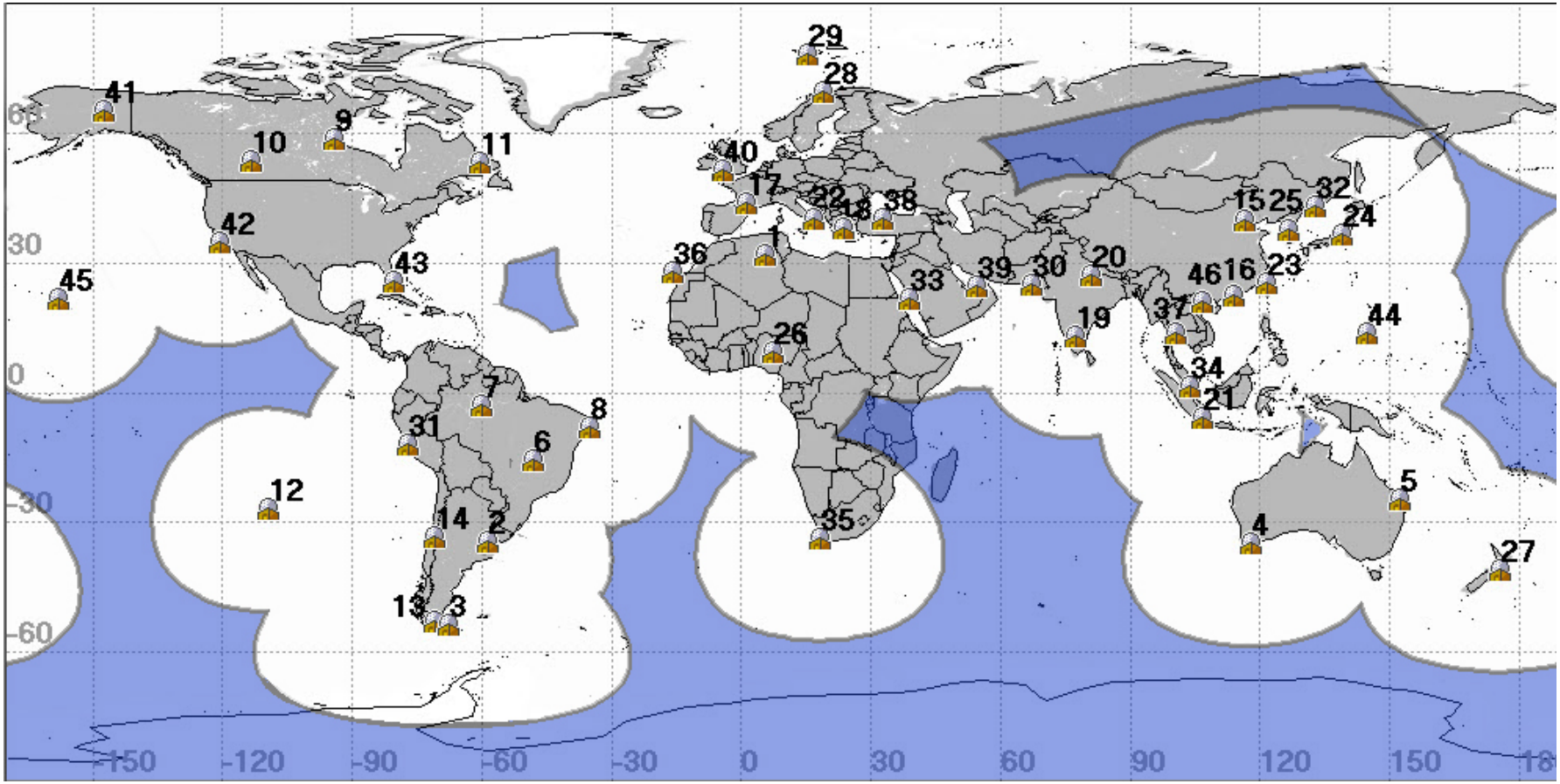


Ground Segment
LEOSAR Local User Terminals (LEOLUTs)

- Receive and process data from Low Earth Orbit (LEO) satellite search and rescue processors (SARP) and search and rescue repeaters (SARR)
- Combine LEO data with GEO data to improve Doppler processing
- Maintains accuracy by producing a correction of the satellite ephemeris each time a satellite signal is received
- Transmit collected data to the Mission Control Center



Cospas-Sarsat LEOSAR Local User Terminal Locations



Transmissions of beacons activated in the blue areas are stored when they are received by the satellite and later transmitted to a LEOLUT when the satellite passes near that ground station.

U.S. SARSAT Ground Segment

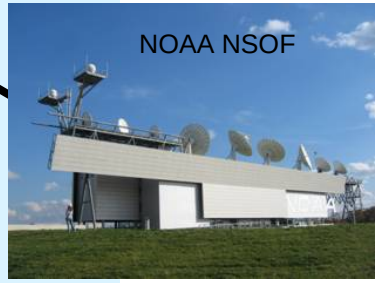
Alaska
NOAA FCDA
2 LEOLUTs

Guam
Andersen AFB
2 LEOLUTs

Hawaii

California
Vandenberg AFB

Maryland*

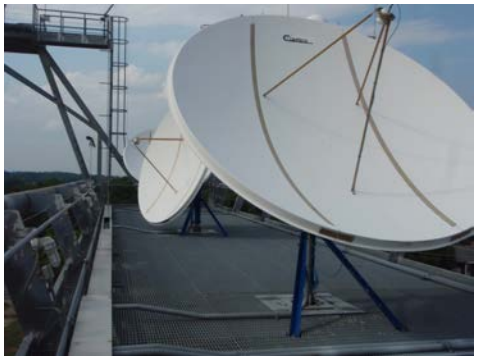


***Maryland has 3 GEOLUTs**
&
1 LEOLUT
US Mission Control
Center

Miami
USCG COMMSTA Miami
2 LEOLUTs
6 antenna MEOLUT

Ground Segment
GEOSAR Local User Terminals (GEOLUTs)

- Receive and process data from Geostationary Earth Orbit (GEO) satellite search and rescue repeaters (SARR)
- Provides beacon location information to MCC when it is included in the digital message of a 406 MHz beacon if the beacon has external or internal navigation device
- Transmit collected data to the Mission Control Center

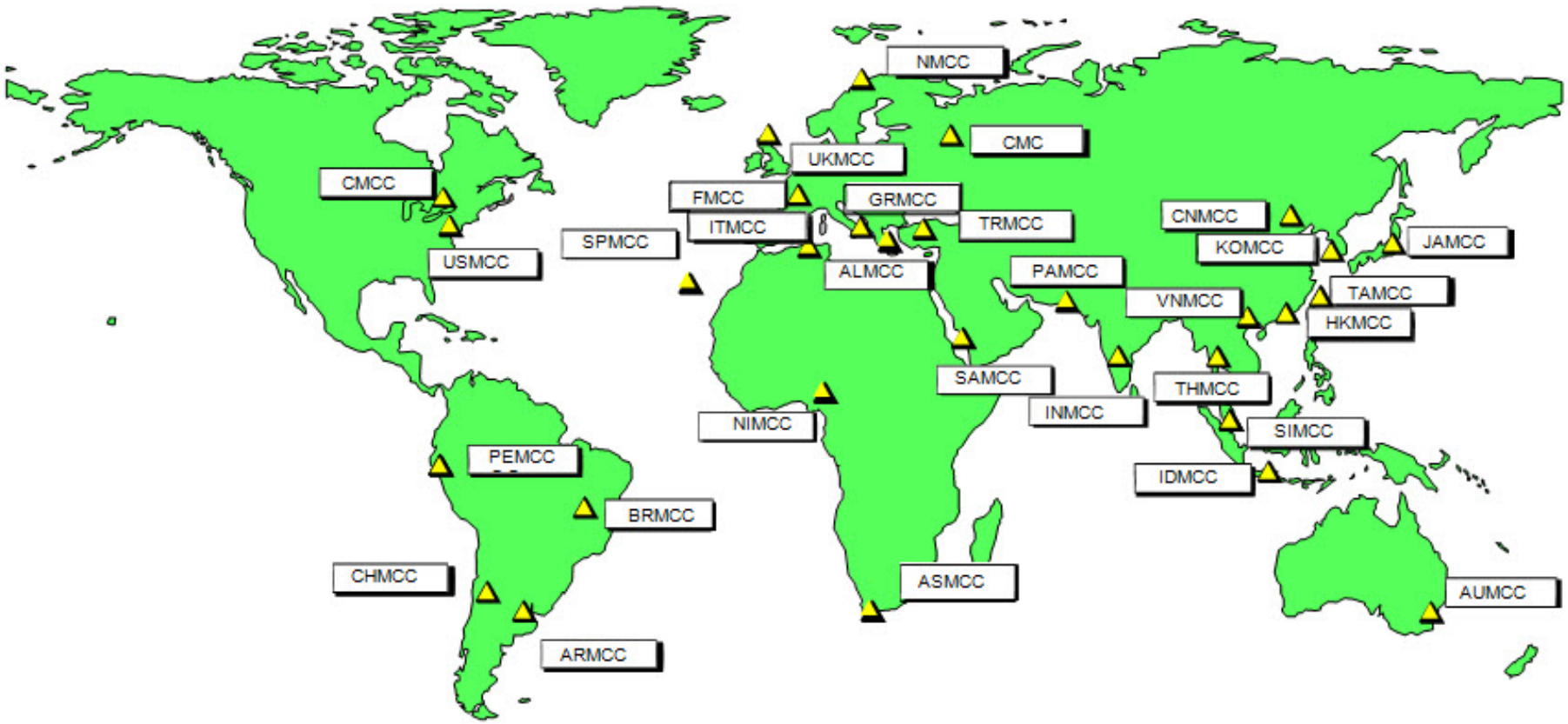


Ground Segment

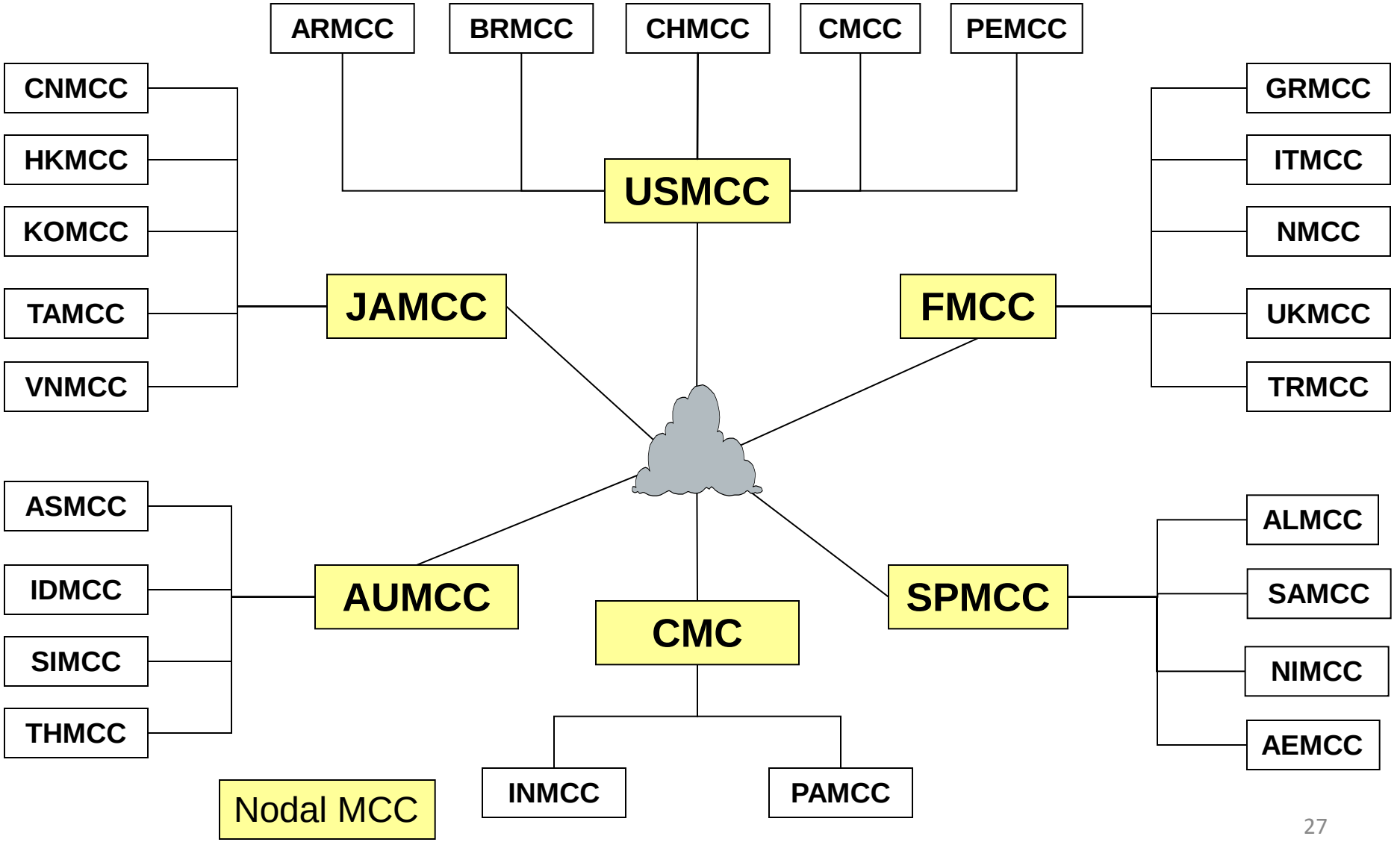
Mission Control Centers (MCCs)

- Receive alerts from national LUTs and foreign MCCs
- Validate, match, and merge alerts to improve location accuracy and determine the correct destination
- Correlate with registration database and append info to alert
- Geographically sort and then transmit alerts to appropriate Rescue Coordination Centers (RCCs) and SAR Points of Contact (SPOC)
- Filter redundant data
- Perform System support and monitoring functions

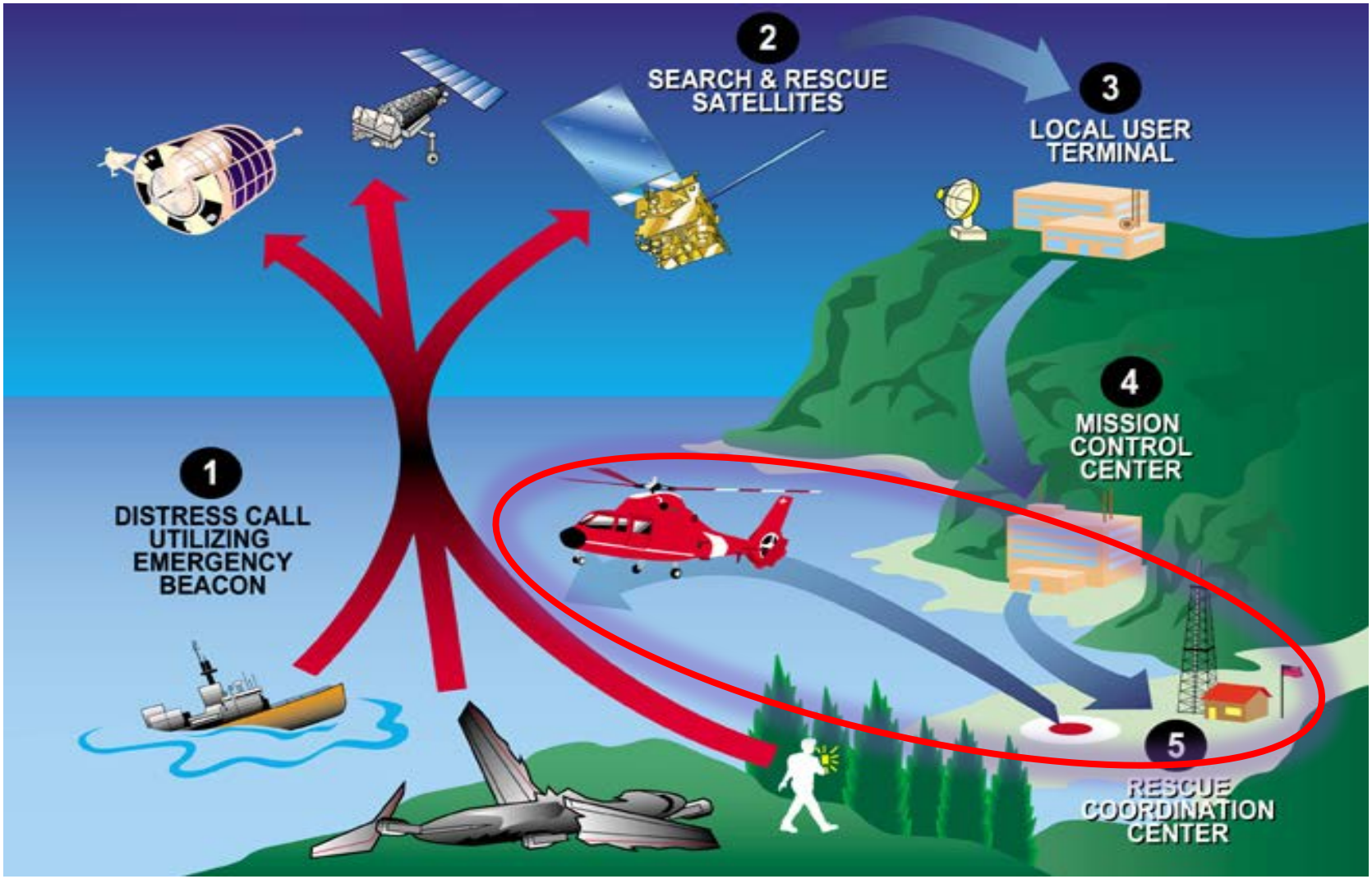
Cospas-Sarsat Mission Control Centers



MCC to MCC Data Distribution



Cospas-Sarsat System Overview
Search and Rescue Segment

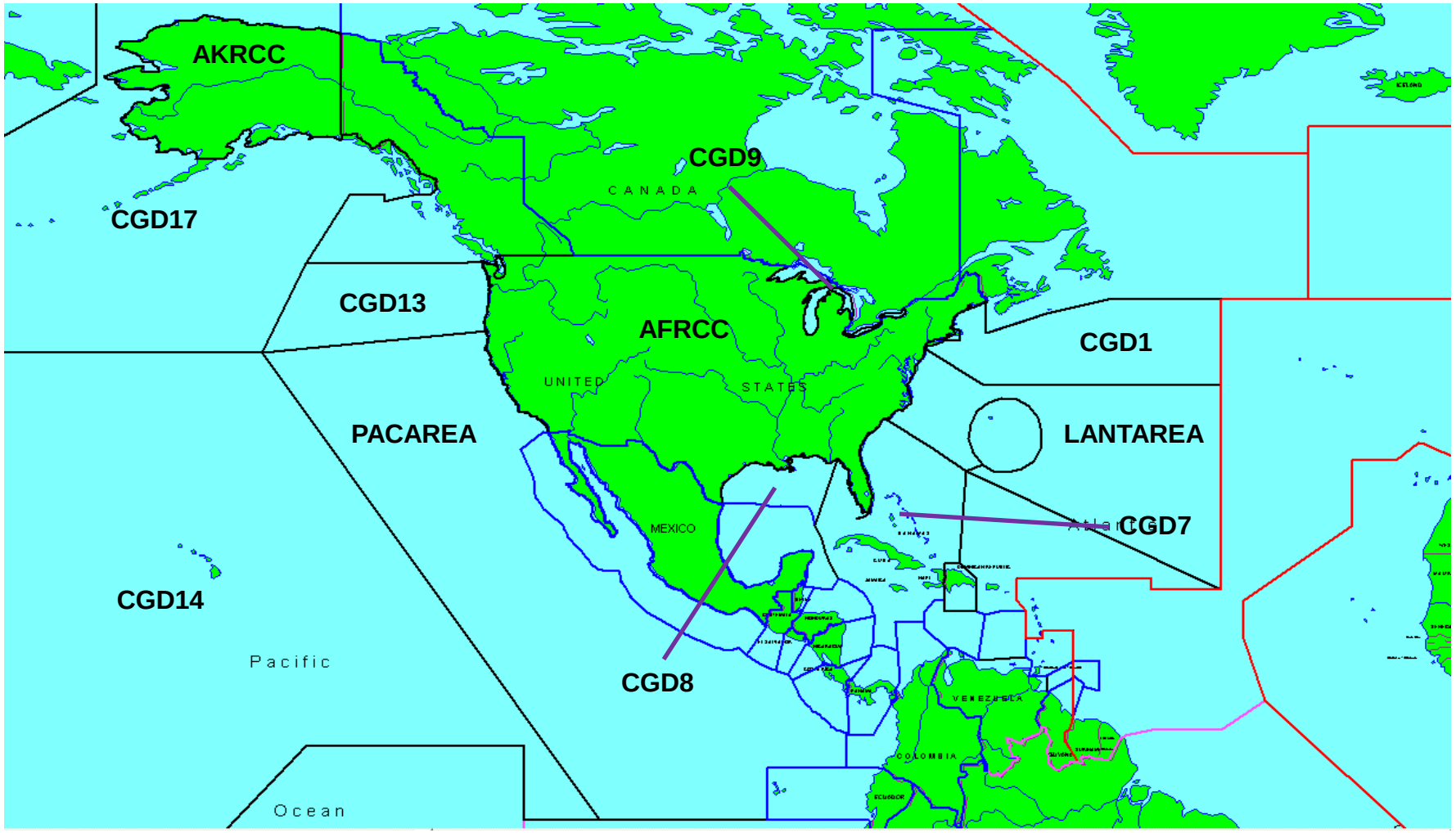


Rescue Coordination Centers

- Receive SARSAT Distress Alerts from MCCs
- Coordinate the Rescue Response

Rescue Coordination Centers

U.S. Rescue Coordination Center Coverage Areas



Cospas-Sarsat Results

Cospas-Sarsat Results

Number rescued world-wide since 1982: over *39,000+*

Number rescued in United States since 1982: over *7,760*

U.S. SARSAT Rescues

CY 2015 – 250 Rescues in 122 Events

Rescues at sea:	**138** people rescued in **46** incidents
Aviation rescues:	**21** people rescued in **11** incidents
Terrestrial rescues:	**91** people rescued in **65** incidents

SARSAT Challenges

- MEOSAR early operations with Distress Alerting Satellite System (DASS)
- USMCC recode
- RGDB recode
- Transition to new satellites (GOES-R and MEOSAR – SAR/GPS, Galileo, GLONASS)
  - Aging LEO Satellites
    - Cooperative Data and Rescue Services (CDARS) – NOAA's next polar satellite planned for Q1 FY2021 (December 2020)

Questions?