COSPAS-SARSAT SYSTEM OVERVIEW

UN/SOUTH AFRICA TRAINING COURSE ON SATELLITE AIDED SEARCH AND RESCUE
20 November 2006
Cape Town, South Africa
Mr. Daniel Karlson, U.S. Coast Guard

COSPAS-SARSAT:
What a curious name!

COSPAS = **Cosmicheskaya Systyema Poiska Aariynyich Sudov**

Which loosely translates into: "The Space System for the Search of Vessels in Distress"

SARSAT = **Search And Rescue Satellite Aided Tracking**

It's about saving lives…

The Cospas-Sarsat Program protects life and property by providing accurate, timely, and reliable distress alert and location information to search and rescue authorities.

In short, Cospas-Sarsat works to take the "search" out of Search & Rescue!

Cospas-Sarsat Program

- Services are provided world-wide and free of charge for the user in distress

- Alerts are provided using satellite and ground systems to detect, process, and relay the transmissions of emergency beacons operating on either 121.5/243 MHz or 406 MHz

Why a Space Based System?

Terrestrial System

- 121.5 MHz beacons developed in mid-1970's for aeronautical use
- Detection dependent on aircraft over-flight- no global monitoring
- Search area dependent on altitude of aircraft
- No location capability

Chance of survival in the event of a distress decreases significantly with time: "The Golden Hour"

Cost of rescue also increases significantly with increasing search area

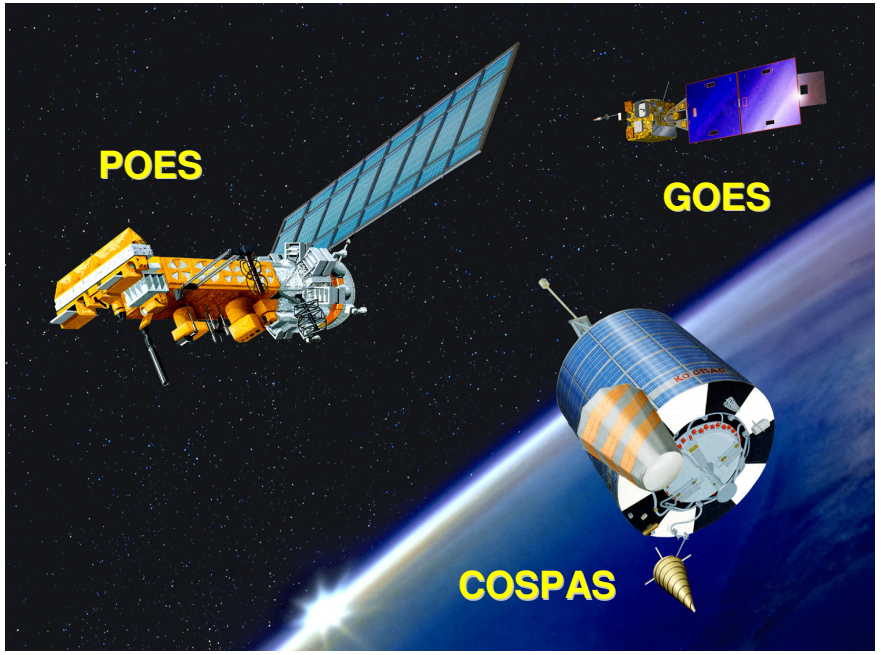
Why a Space Based System?

Space Based System

- Localized monitoring with Doppler location of

  121.5 MHz
- Global, near-instantaneous monitoring of 406 MHz
- Independent location capability
- Less delay = increased chance of survival:

  "The Golden Hour"

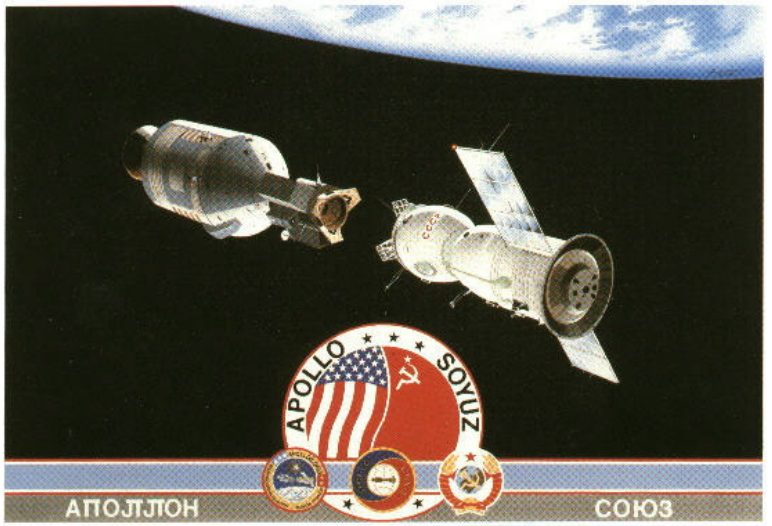


Cospas-Sarsat History

- First beacons were 121.5/243 MHz Emergency Locator Transmitters (ELTs) designed for military aircraft in the 1950's.
- U.S. Congress mandated ELTs on all U.S. aircraft after Boggs-Begich tragedy in SE Alaska in early 1970's. Canada follows suit.
- Problems soon emerge:
  - ✓ No identification of aircraft/beacon
  - ✓ Designed for audible detection by over-flying aircraft
  - ✓ No means of accurately locating ELTs

Cospas-Sarsat History International Cooperation

- 1978: Canada, France and the USA agree to co-operate on the development of the SARSAT low-altitude polar orbiting system to:
  - Locate existing 121.5 MHz beacons
  - Develop a new technology for improved performance = 406 MHz



- Russia declares its interest in co-operating with the objective of ensuring inter-operability of their COSPAS system with SARSAT.
- Cooperative venture: Governments were looking for additional cooperative efforts after success of Apollo-Soyuz and humanitarian nature of SAR was an easy fit…

Cospas-Sarsat History
The First Satellites

- **1982: First Cospas satellite**
  - **Cospas-1 (USSR) launched in June 1982.**
  - **First rescue in September 1982**
- **1983: Second Cospas and First Sarsat satellites**
  - **NOAA-8 satellite (USA) with Canadian (SARR) and French (SARP) instruments**
- **1985: System declared operational**
  - **406 MHz beacon technology arrives**

Toronto Globe and Mail, 17 Sept 1982

Satellite plays rescue role

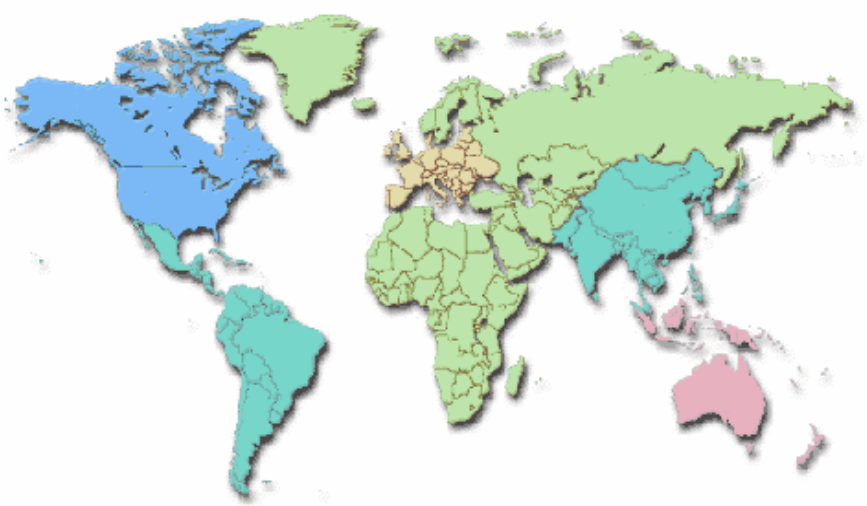
OTTAWA (CP) — Three Ontario men, whose light plane crashed in British Columbia last week, probably owe their lives to an orbiting Soviet satellite. In the first known rescue of its kind, the satellite picked up the automatic distress signal of the wrecked aircraft and pinpointed the site for Canadian search-and-rescue officials. Rescued and now recovering from cuts, bruises and broken ribs are pilot George Hammakerk and passengers John Englehorn and Gary Van Amelsvoort, all of Brampton. The satellite, launched June 20 by the Soviet Union, is the first link in what will eventually be an international search-and-rescue satellite system operated by the Soviets, Canada, the United States and France.

USA-CANADA-FRANCE-CCCP
SARSAT
КОСПАС

PRESS ACCOUNT OF FIRST SUCCESSFUL APPLICATION OF COSPAS-SARSAT SYSTEM, 10 SEPTEMBER, 1982

International Organization

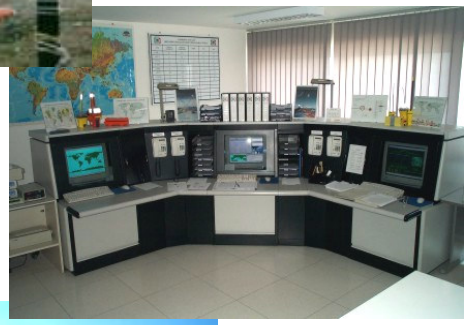
- **Initially developed under interagency Memorandum of Understanding signed in 1979 (USSR, USA, Canada, France)**
- **System declared operational in 1985**
- **406 MHz beacons accepted by IMO for GMDSS in 1988**
- **International Cospas-Sarsat Programme Agreement (ICSPA) formally signed on July 1, 1988 among the governments of Canada, France, the former U.S.S.R and the United States**
- **ICSPA ensures continuity of the space system and availability to all States on a non-discriminatory basis**



Principles of Participation

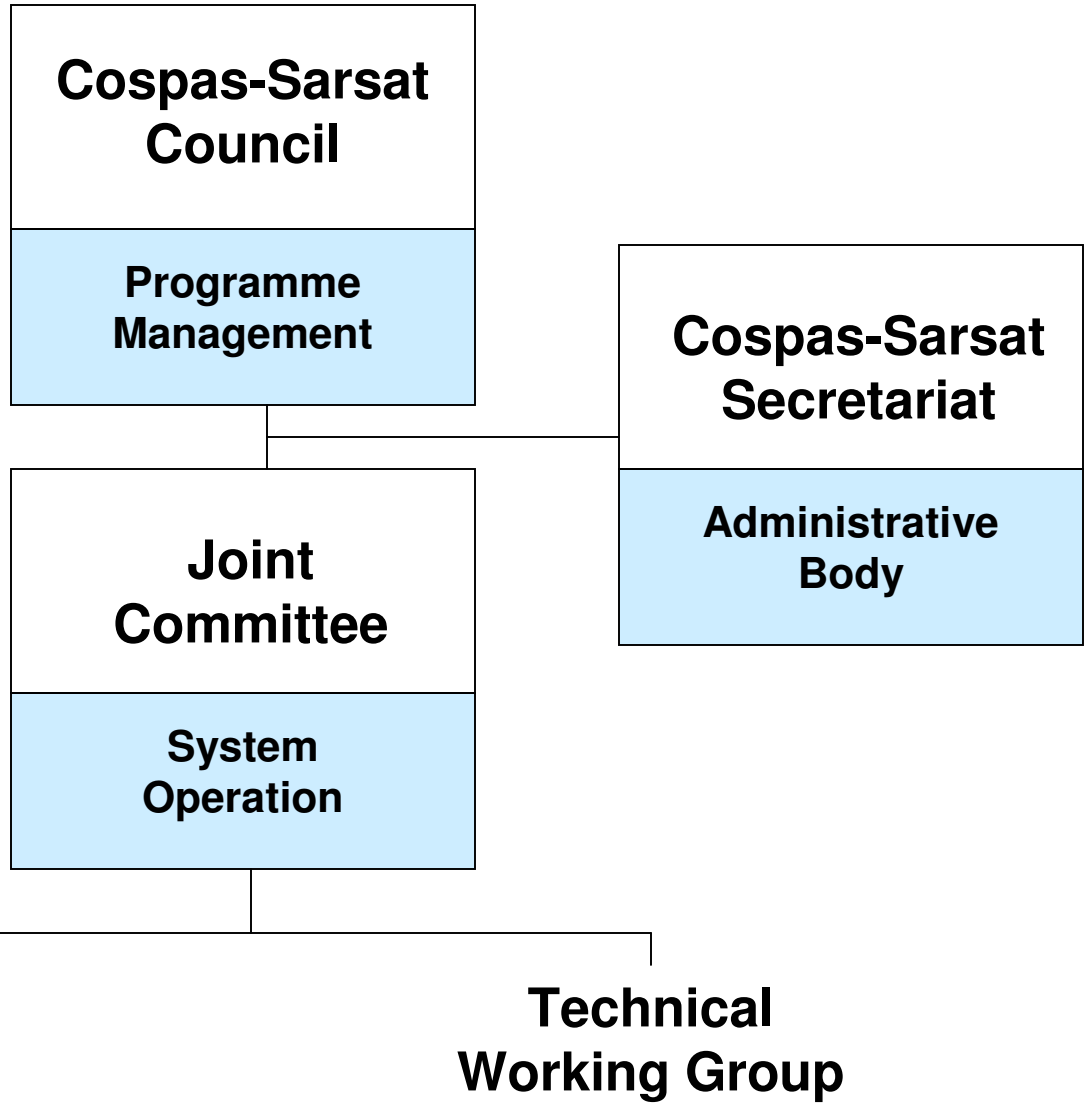
All nations, including those not formally associated with Cospas-Sarsat should:

- **– Designate a SAR Point of Contact (SPOC) to receive alerts from Cospas-Sarsat MCC**
- **– Decide on 406 MHz beacon coding and national beacon approval requirements**
- **– Ensure that 406MHz beacons authorised for use have received a Cospas-Sarsat Type-Approval Certificate**
- **– Establish a 406MHz beacon register as required by ICAO and IMO or utilize the IBRD**



Cospas-Sarsat Organization

Cospas-Sarsat Secretariat
Montreal, Quebec



Benefits of Membership

- **Association with Program allows States to contribute to the system and participate in management of Cospas-Sarsat**

- **Goals include supporting the SAR objectives of ICAO and IMO – C/S maintains a close partnership with these U.N. agencies and the ITU…and OOSA too!**

IMO

ICAO • OACI • ИКАО

ITU

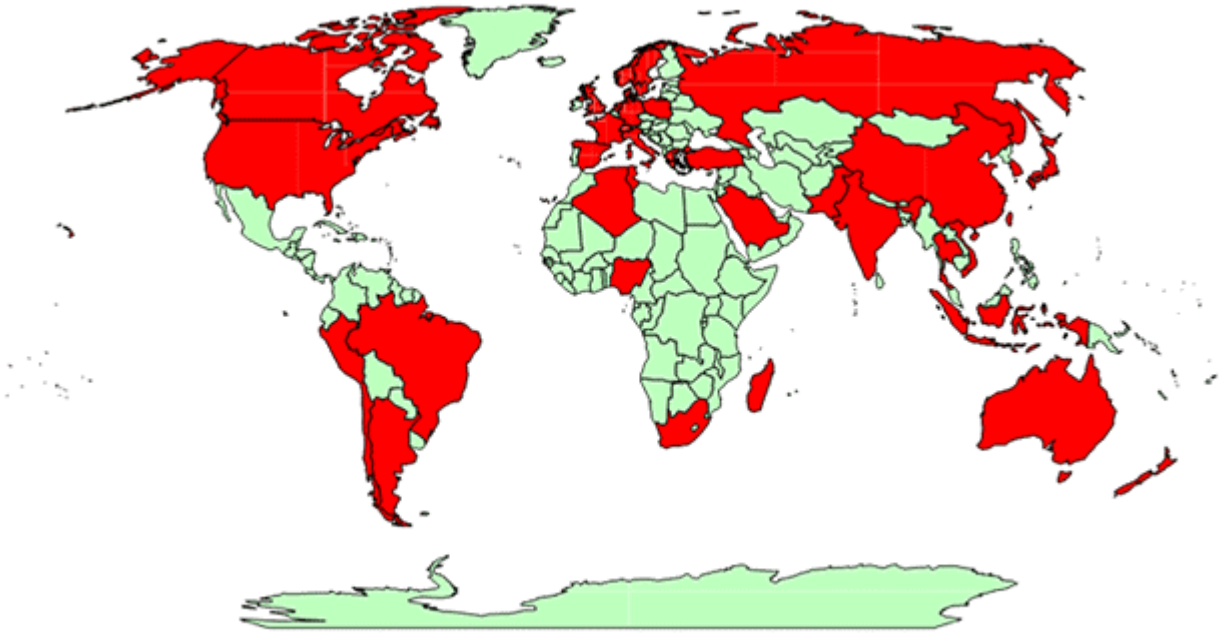
Participating States

Algeria
Argentina
Australia
Brazil
Canada
Chile
China (P.R. of)
Cyprus*
Denmark
France
Finland*
Germany
Greece
India
Indonesia
Italy
Japan
Korea (Rep. of)
Madagascar
Netherlands (The)
New Zealand
Nigeria
Norway
Pakistan
Peru
Poland
Russia
Saudi Arabia
Singapore
South Africa
Spain
Sweden
Switzerland
Thailand
Turkey
Tunisia
United Kingdom
USA
Venezuela*
Vietnam

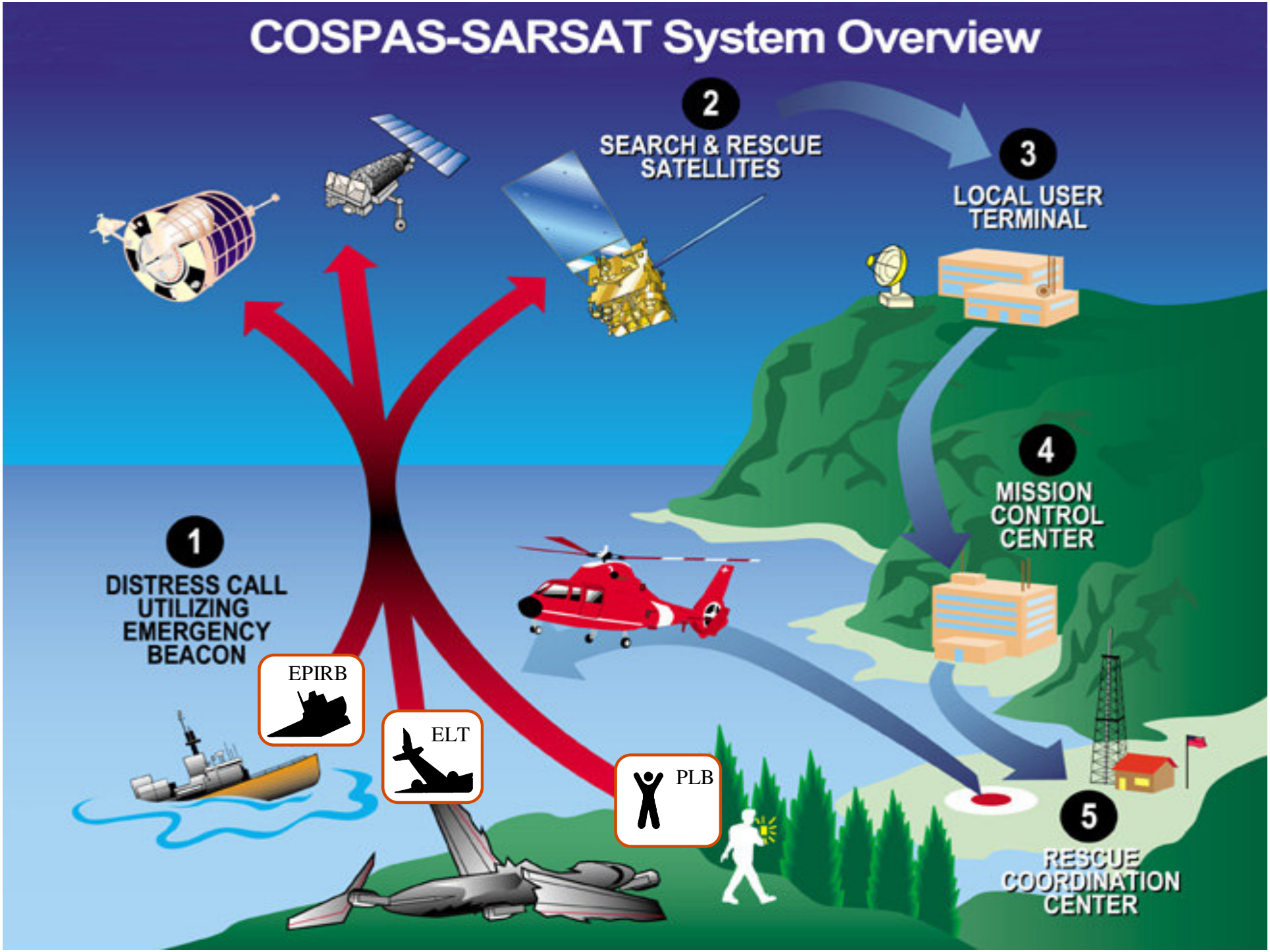
Participating Organizations

The International Telecommunication Development Corporation (ITDC) - Taiwan
The Marine Department of Hong Kong, China

Cospas-Sarsat Participants



- **40 countries and 2 organisations participate (October 2006)**
- **26 Ground Segment Providers operate ground receiving stations (Local User Terminals (LUTs)) and Mission Control Centres (MCCs) for the worldwide distribution of distress alerts**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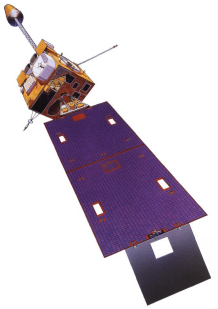
Elements of the C-S System

- Users
- Beacons
- Space Segment
  - LEOSAR
  - GEOSAR
- Ground Segment
  - Local User Terminal
  - Mission Control Center
  - Rescue Coordination Centres & SPOCs



Emergency Beacons

- **Two types: 121.5/243 MHz and 406 MHz**
- **Four applications:**
  - **Emergency Position Indication Radio Beacons (EPIRB)** ***for Maritime Uses***
  - **Emergency Locator Transmitters (ELT)** ***for Aviation Uses***
  - **Personal Locator Beacons (PLB)** ***for Remote Area Personal Use***
  - **Ship Security Alerting System (SSAS)** ***for Shipboard Terrorism/Piracy Alerting (covert)***

Emergency Beacons

EPIRBs

ELTs

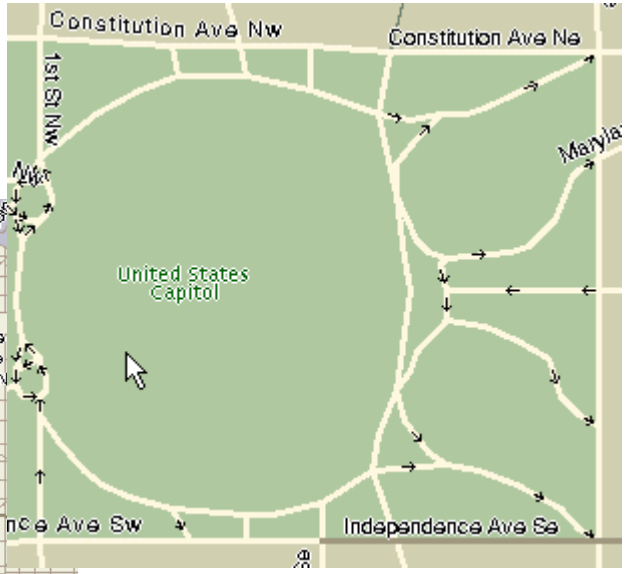
PLBs

SSAS

Emergency Beacons

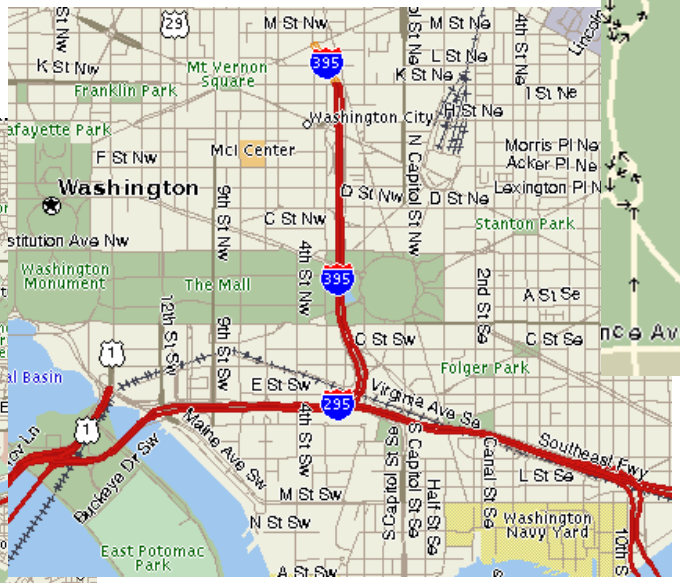
Comparison of 121.5 MHz vs 406 MHz

406 MHz with GPS



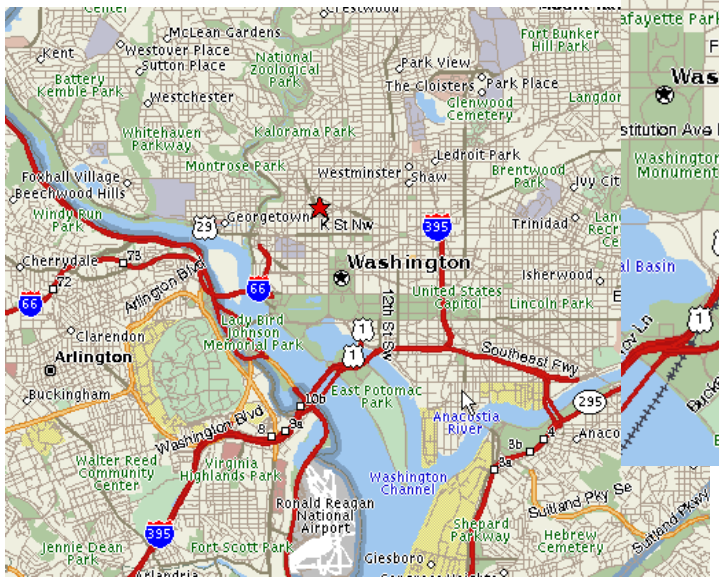
Search Time = Minimal

406 MHz



Search Time = 2 - 3 hours

121.5 MHz



Search Time = 12+ hours

Switch to 406 !

*****Remember This Date*****

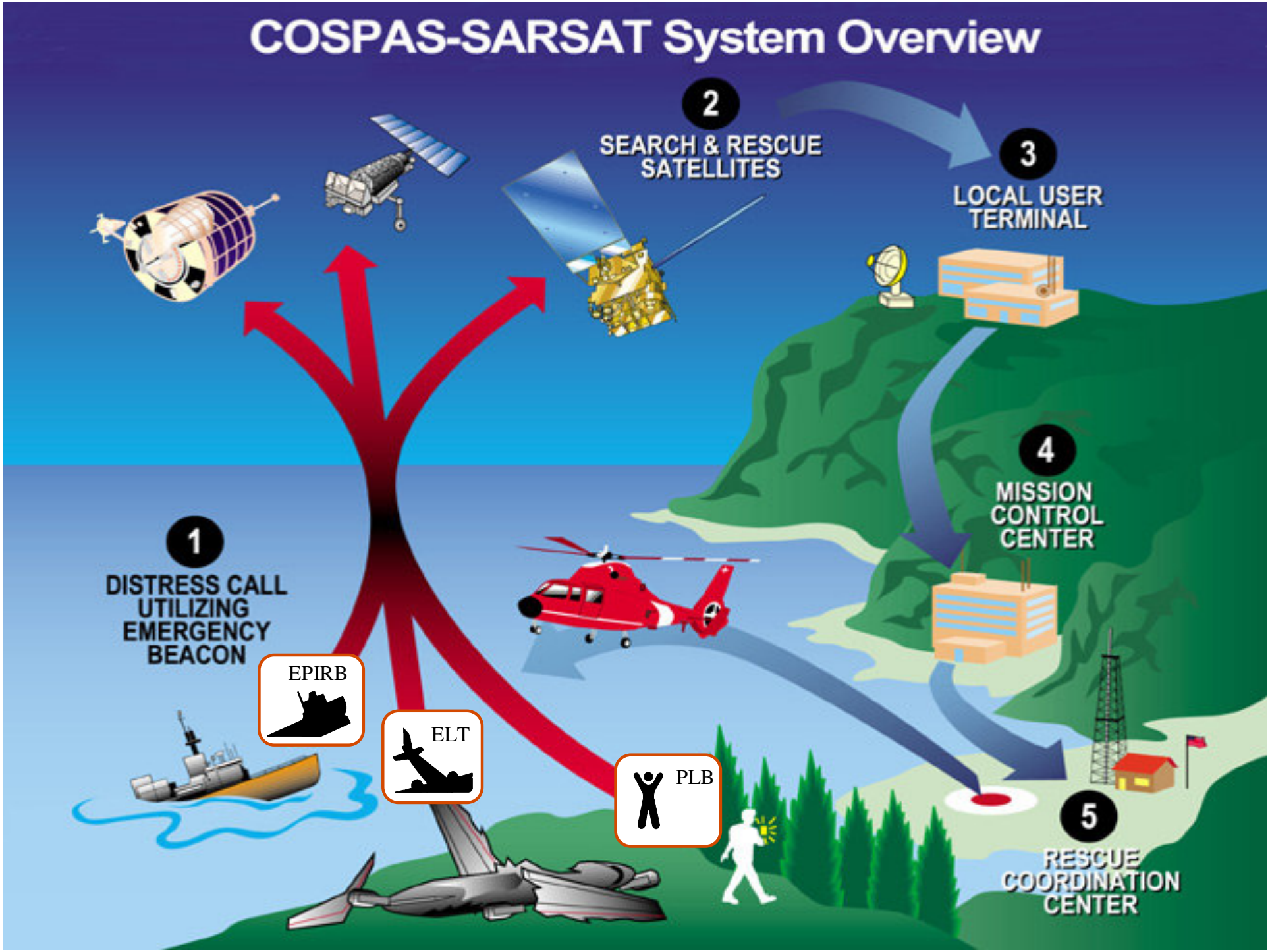
Beginning on 1 February 2009 the Cospas-Sarsat satellite system will no longer detect the 121.5 or 243 MHz frequencies

Reasons:

- ✓ **Coverage – Global vs Local**
- ✓ **False Alerts**
- ✓ **Identification**
- ✓ **Accuracy**

Beacon Growth = More Users

Year	2010		2015	
Frequency / Beacons	406 MHz	121.5 MHz	406 MHz	121.5 MHz
ELTs	159,890	132,631	235,506	73,014
EPIRBs	448,956	33,292	604,643	2,950
PLBs	101,779	5,330	152,295	725
Total	710,625	171,253	992,444	76,689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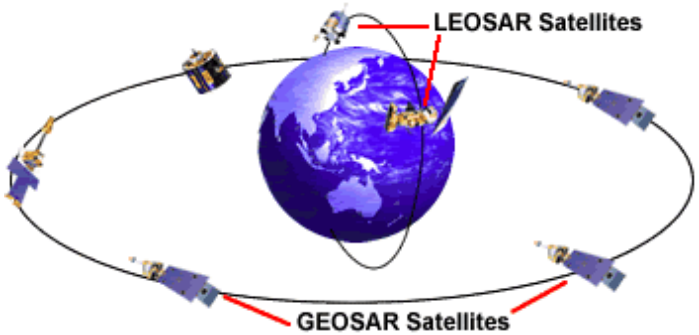
Space Segment



2 Types of Satellites:

- **Low Earth Orbiting Search And Rescue (LEOSAR)**

  (7) Satellites in Orbit:

  - **COSPAS 9**
  - **SARSAT 6, 7, 8, 9, 10** ***(Operated by NOAA)***
  - **METOP** ***(Operated by EUMETSAT – just launched & now going thru checkout)***

- **Geostationary Orbiting Search And Rescue (GEOSAR)**

  (5) Satellites in Orbit:

  - **GOES East & West** ***(Operated by NOAA)***
  - **GOES 9 (160-deg East)** ***(New Zealand GEOLUT)***
  - **INSAT** ***(Operated by India)***
  - **MSG** ***(Operated by European Space Agency)***

Space Segment

2 Types of Satellites:

- ***Low Earth Orbiting Search And Rescue (LEOSAR)***

  - Altitude: 500 miles in "Pole-Pole" orbit

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

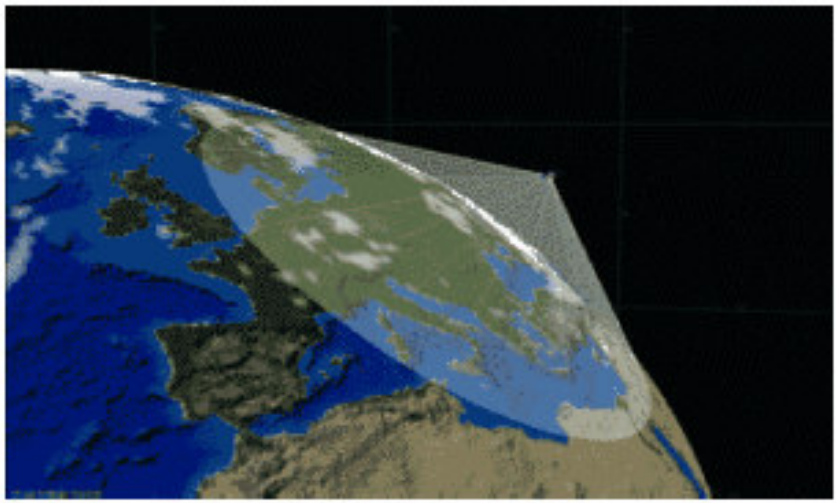
  - Stores & Forwards alerts continuously for 48 hours (provides worldwide coverage and total system redundancy)

- ***Geostationary Orbiting Search And Rescue (GEOSAR)***

  - Altitude: 23,000 miles in fixed orbit

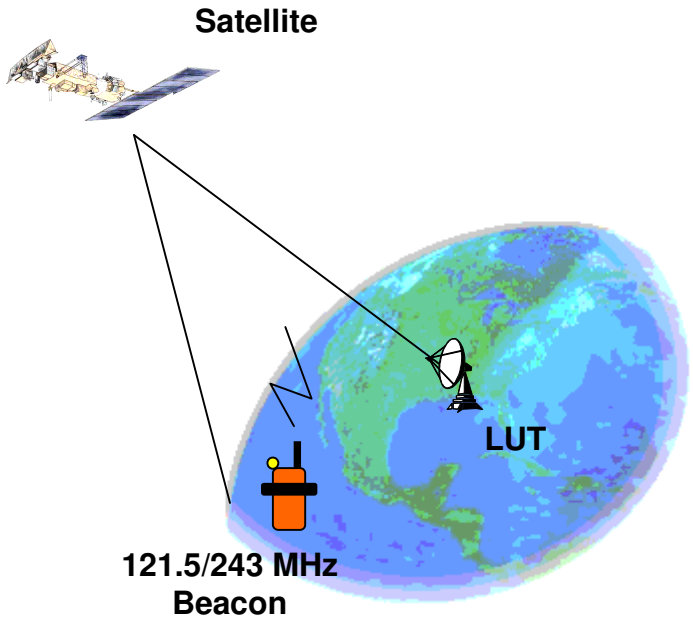
  - Performs instantaneous alerting function. No locating capability unless beacon is equipped with GPS.

  - Coverage from 70N – 70S

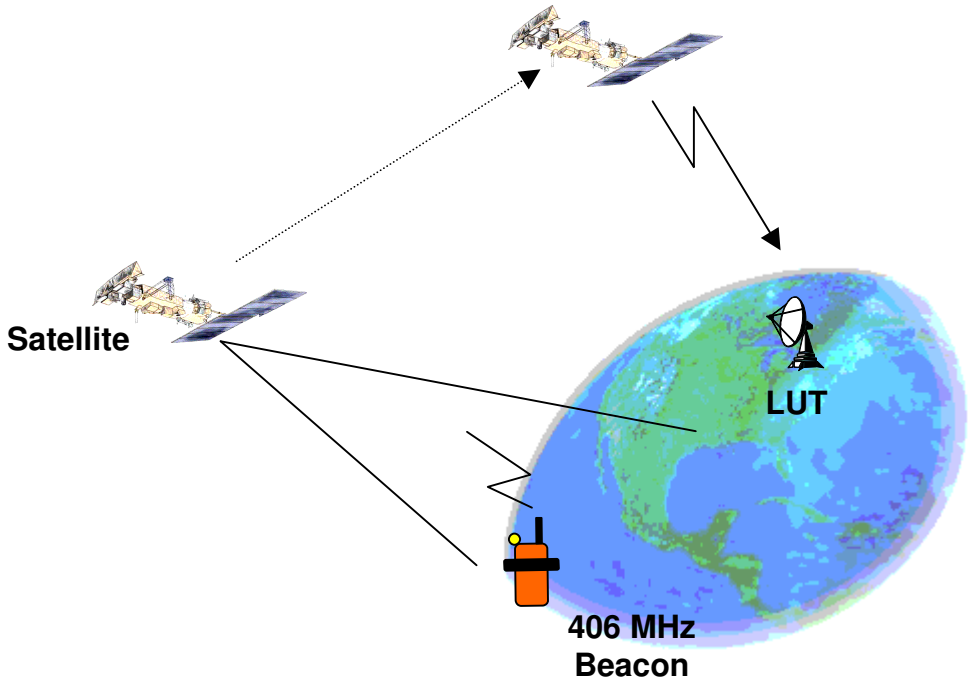


LEOSAR Instantaneous View of the Earth, a Circle of about 3000 km Radius

LEOSAR



406 MHz beacon detections can be stored on board the satellite and re-broadcast later

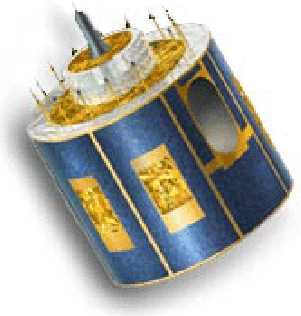


Detection of a 121.5/243 MHz beacon requires mutual visibility between beacon, satellite and ground station (LUT)

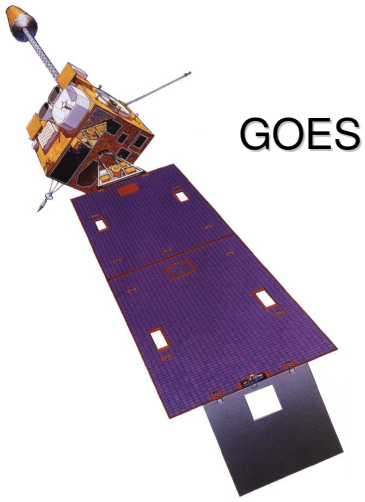
From LEO to GEO…

- **1995 406 MHz beacon message modified to include location from navigation device**
- **1998 Council accepts 406 MHz GEOSAR enhancement to the LEOSAR system**

INSAT



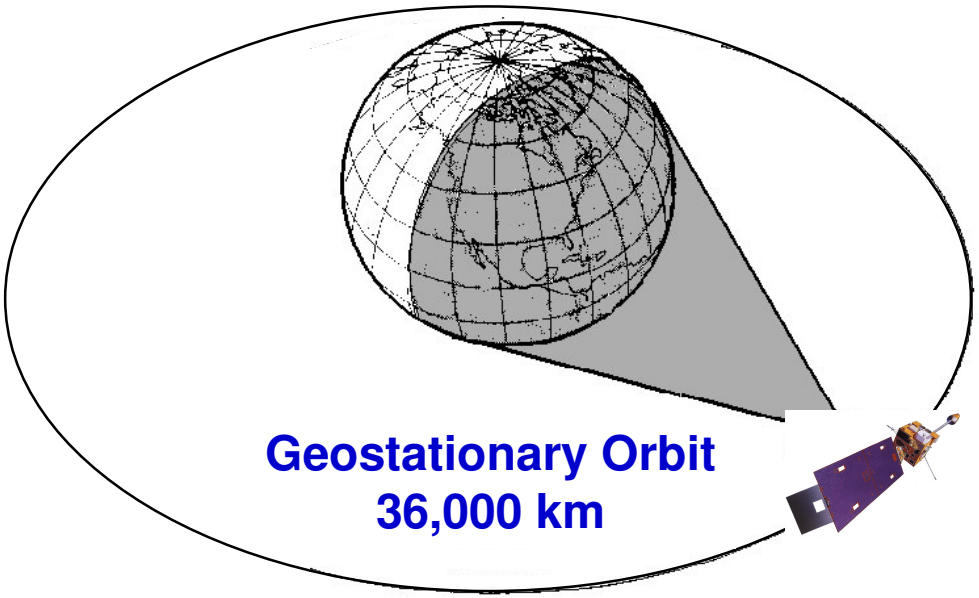
MSG



GOES

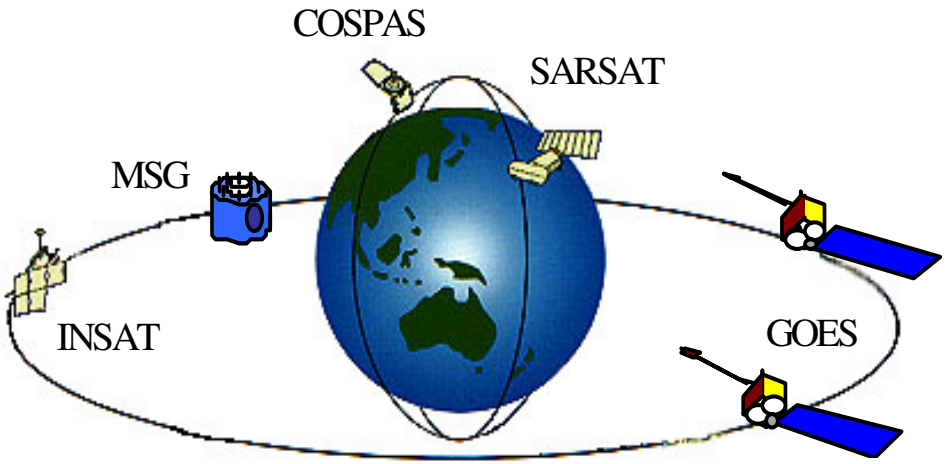
GEOSAR

- GEOLUTs detect transmissions from 406 MHz beacons relayed by high altitude geostationary satellites
- Continuous coverage between 70N and 70 S
- Position information must be acquired from GNSS and encoded in beacon message



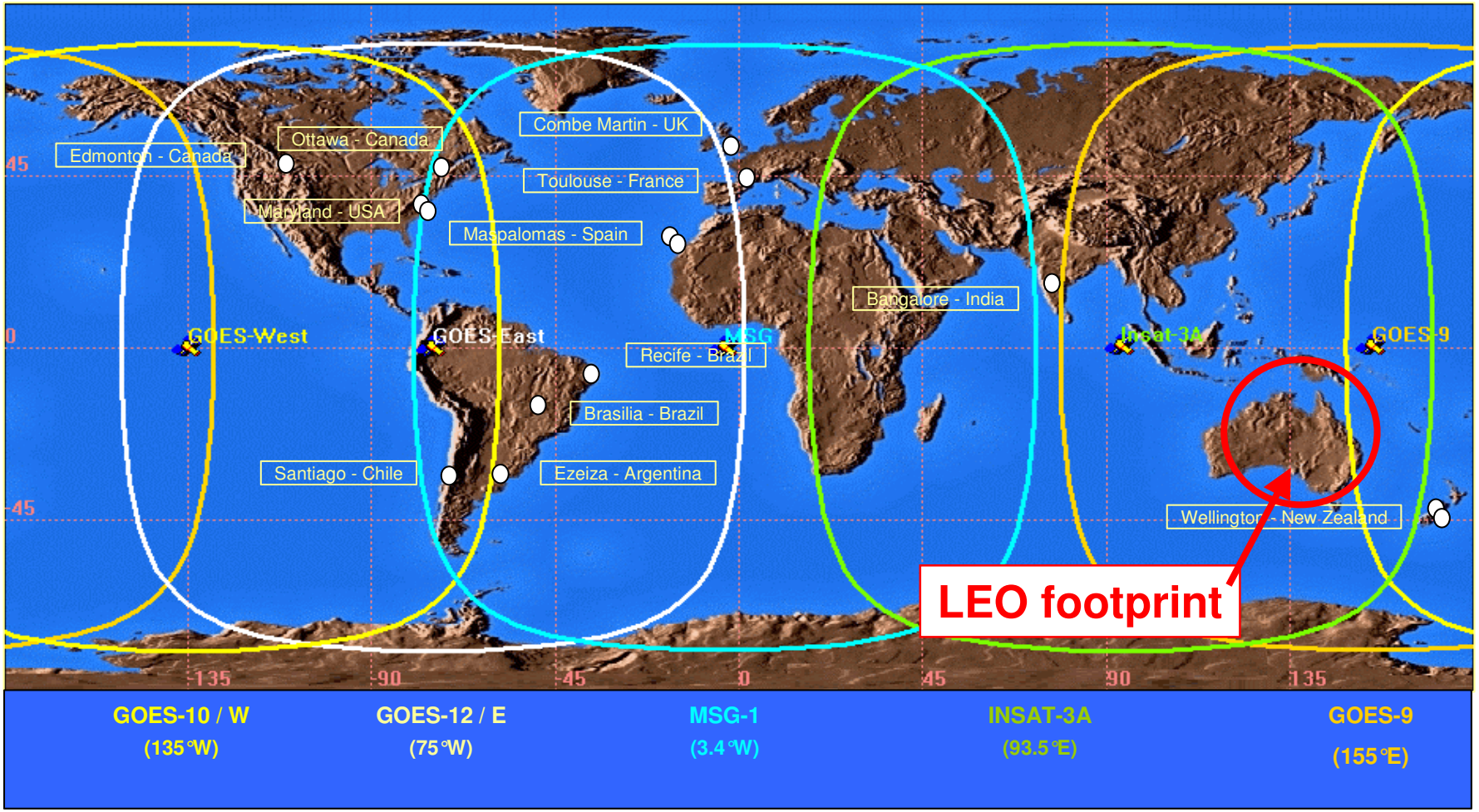
Cospas-Sarsat Today: Combined LEO/GEO System

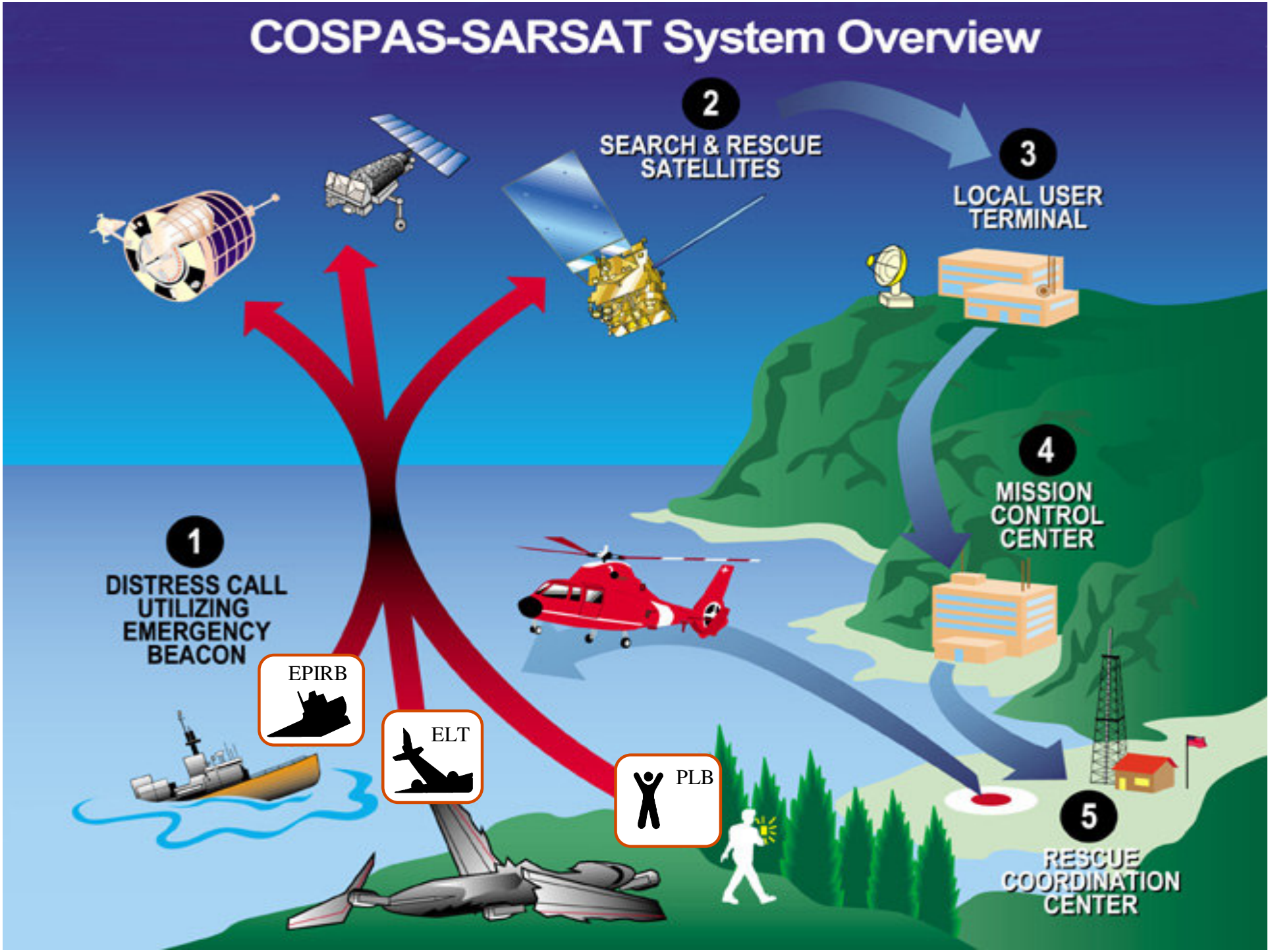
- At 406 MHz, the Cospas-Sarsat system combines the benefits of its LEO and GEO components:
  - Global LEOSAR coverage
  - Real-time GEOSAR alerting
  - Independent LEOSAR Doppler positioning capability



  - Highly accurate GNSS positioning (in equipped beacons)
  - High probability of LEO detection even when GEO blocked
  - High system capacity

Typical Satellite Footprints

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LEOLUTS and GEOLUTS

(Cospas-Sarsat Ground Stations)

LEOSAR Local User Terminals

(LEOLUT)

- **Track COSPAS and SARSAT satellites**
- **Recover beacon signals**
- **Perform error checking**
- **Perform Doppler locating on beacons:**

  - Appox. 2 mile accuracy on first-pass for 406 MHz

  - ½mile accuracy on composite solution) for 406 MHz

- **Sends alerts to Mission Control Center**

LEOLUTS and GEOLUTS

(Cospas-Sarsat Ground Stations)

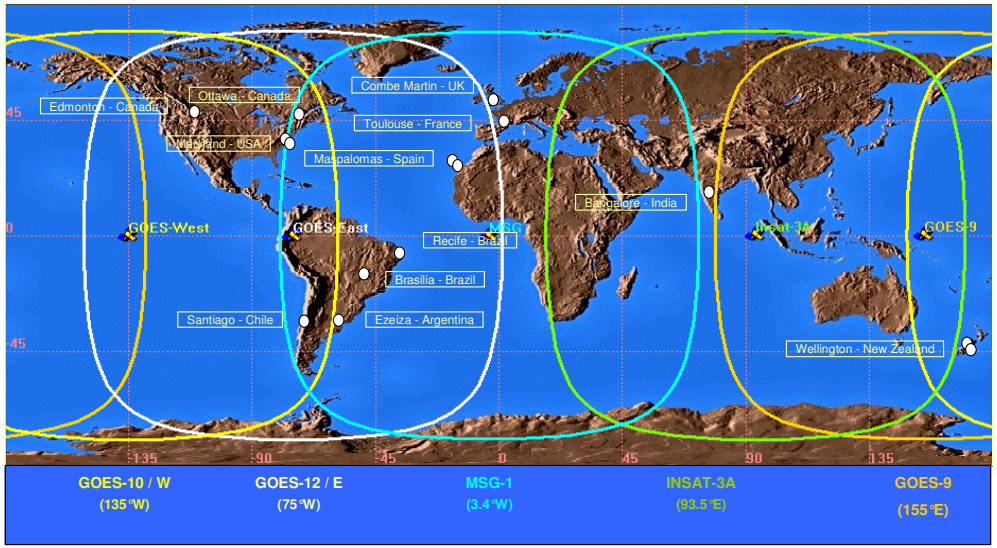
GEOSAR Local User Terminals (GEOLUT)

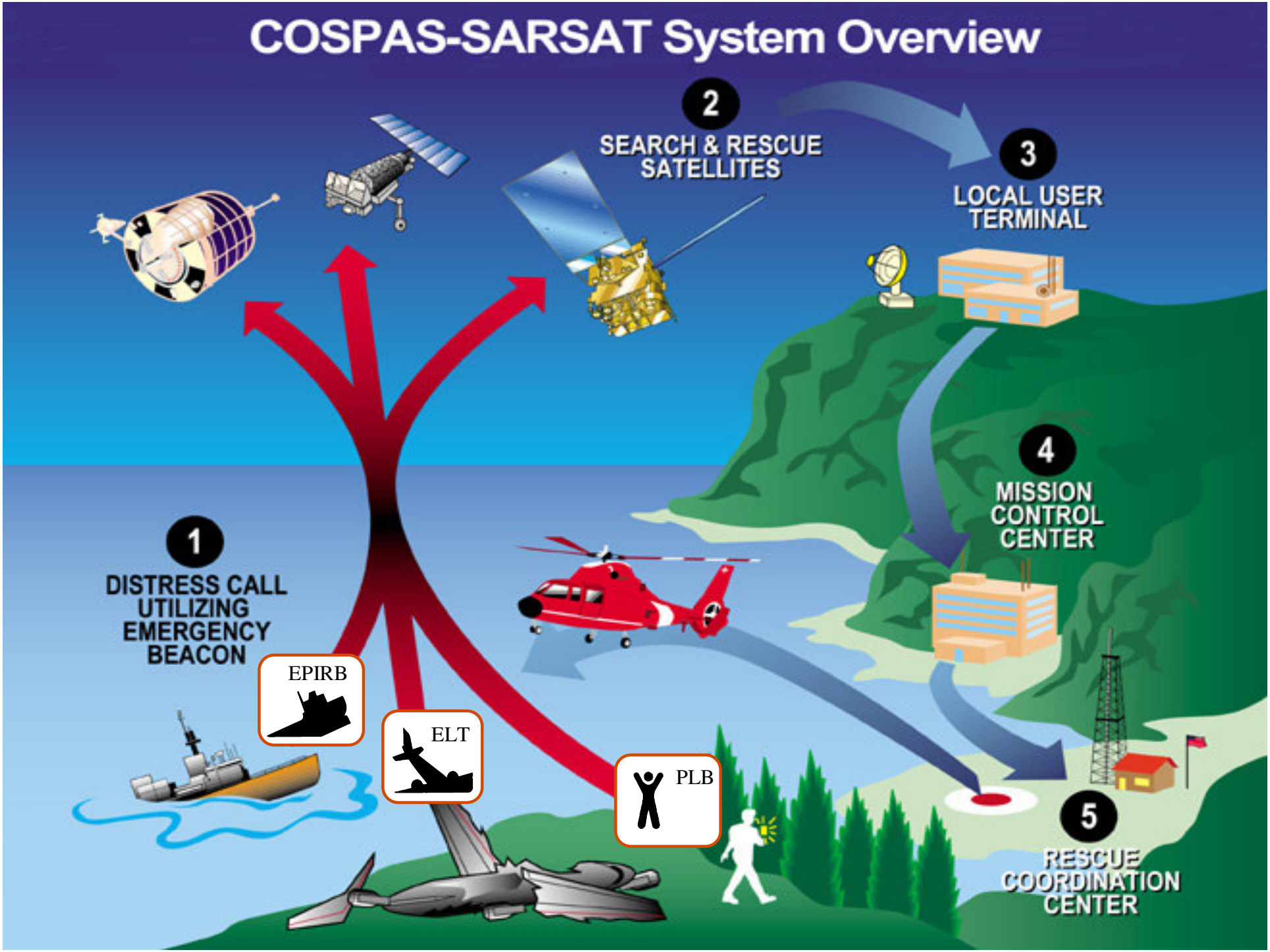
- **Track GOES, MSG and INSAT satellites**
- **Recover beacon signals (within seconds of beacon activation)**
- **Recover encoded position from GPS-equipped beacons**
  - ***Appox 100 meter accuracy***
- **Perform error checking**
- **Sends alerts to Mission Control Center**

LEOLUTS and GEOLUTS

46 LEOLUTs track the Cospas-Sarsat polar-orbiting satellites

15 GEOLUTs track the geostationary satellites

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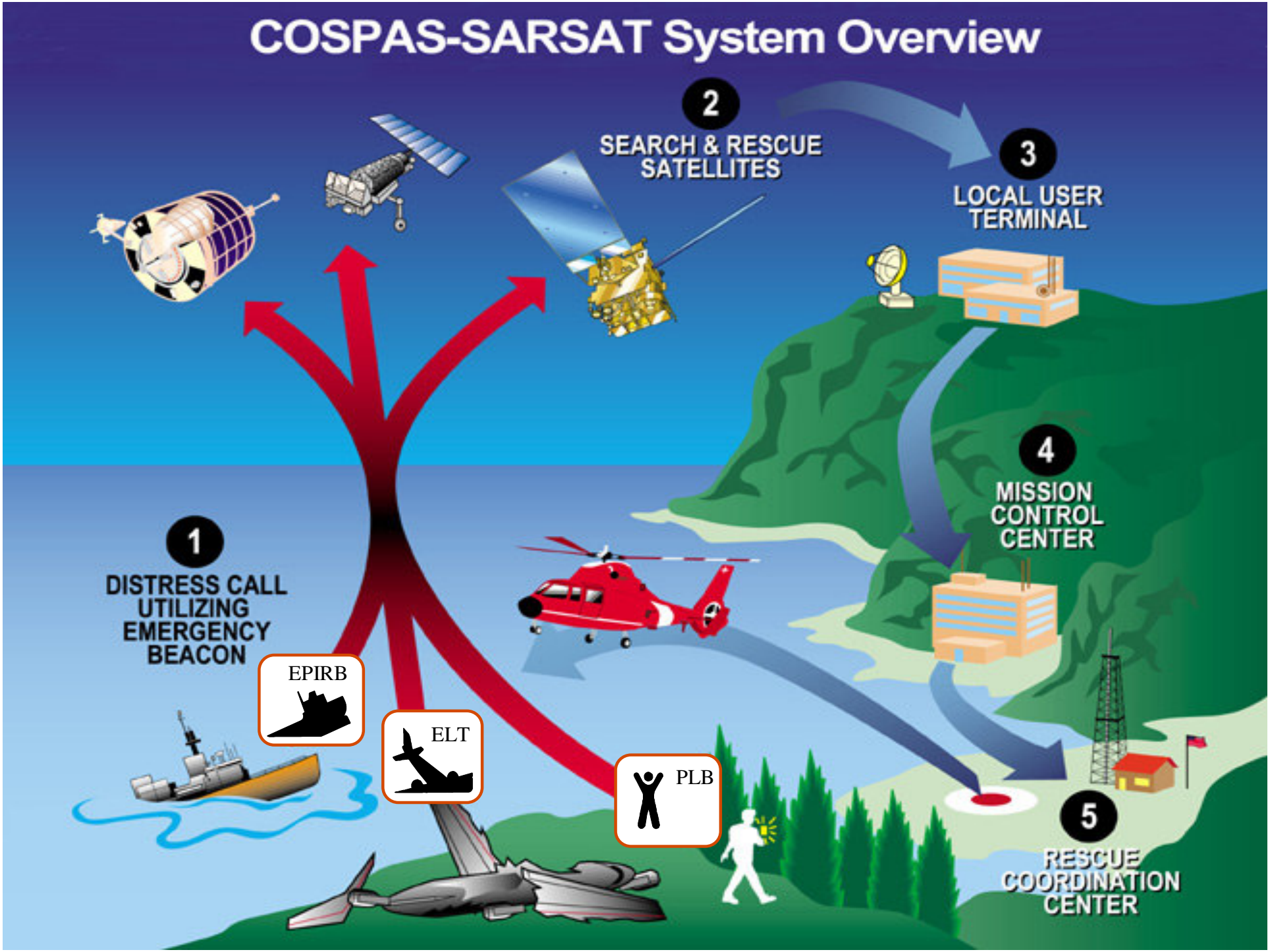
Mission Control Centres (MCCs)

- **Receive alerts from national LUTs and foreign MCCs.**
- **Validate, match and merge alerts to improve location accuracy and determine the correct destination.**
- **Query 406 MHz Registration Database and transmit registration info with distress alert.**
- **Transmit alerts to Rescue Coordination Centers (RCCs) and SAR Points of Contact (SPOC) and filter redundant data.**
- **Most MCC functions are handled automatically…no manual intervention = efficiency!**

USMCC

Suitland, Maryland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Rescue Coordination Centres (RCCs)

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

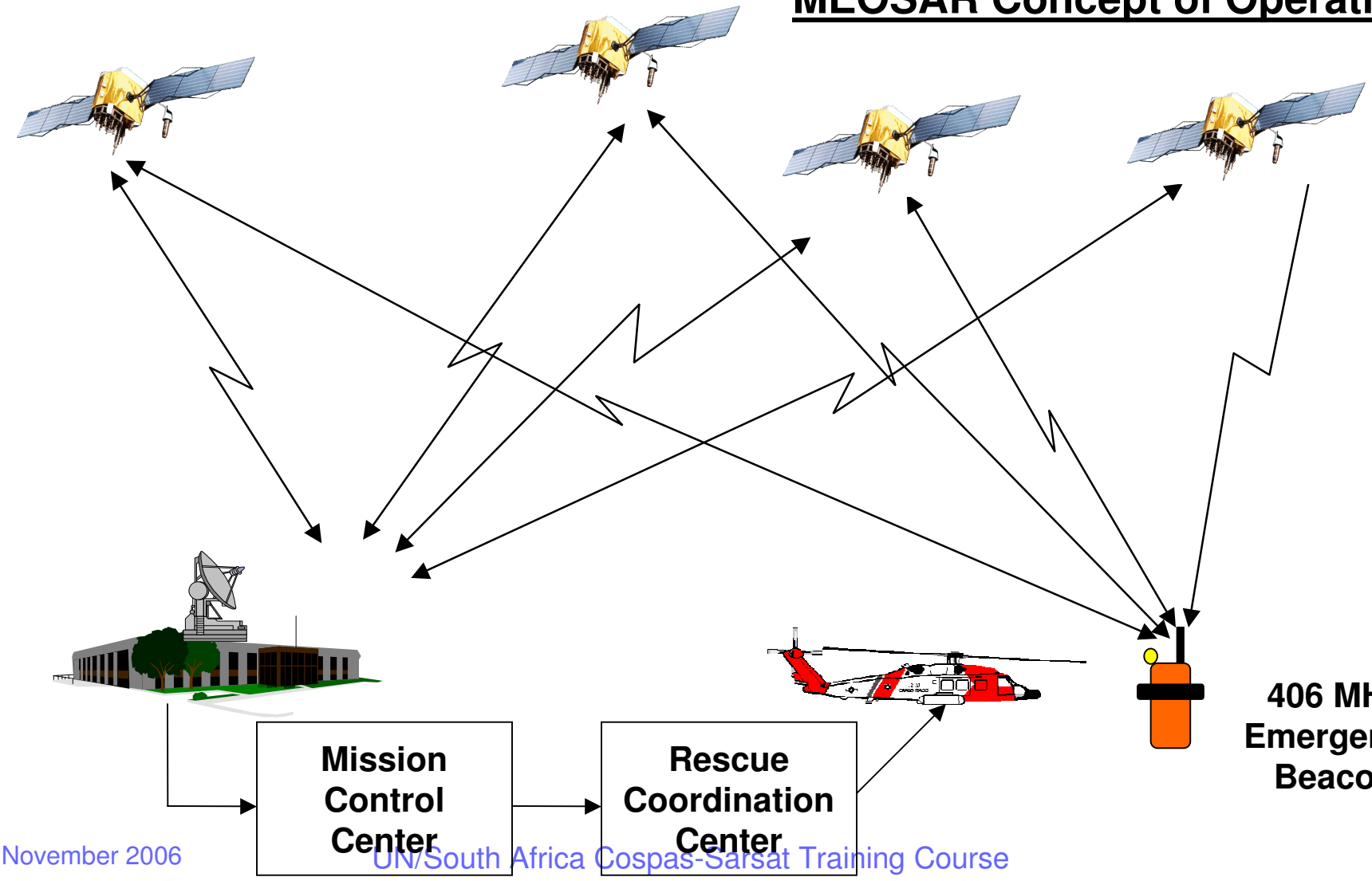
Cospas-Sarsat of Tomorrow: MEOSAR

Russia (GLONASS), USA (GPS) and ESA/EC (Galileo) working to include 406 MHz repeater instruments on future medium Earth altitude orbiting (MEO) satellite constellations

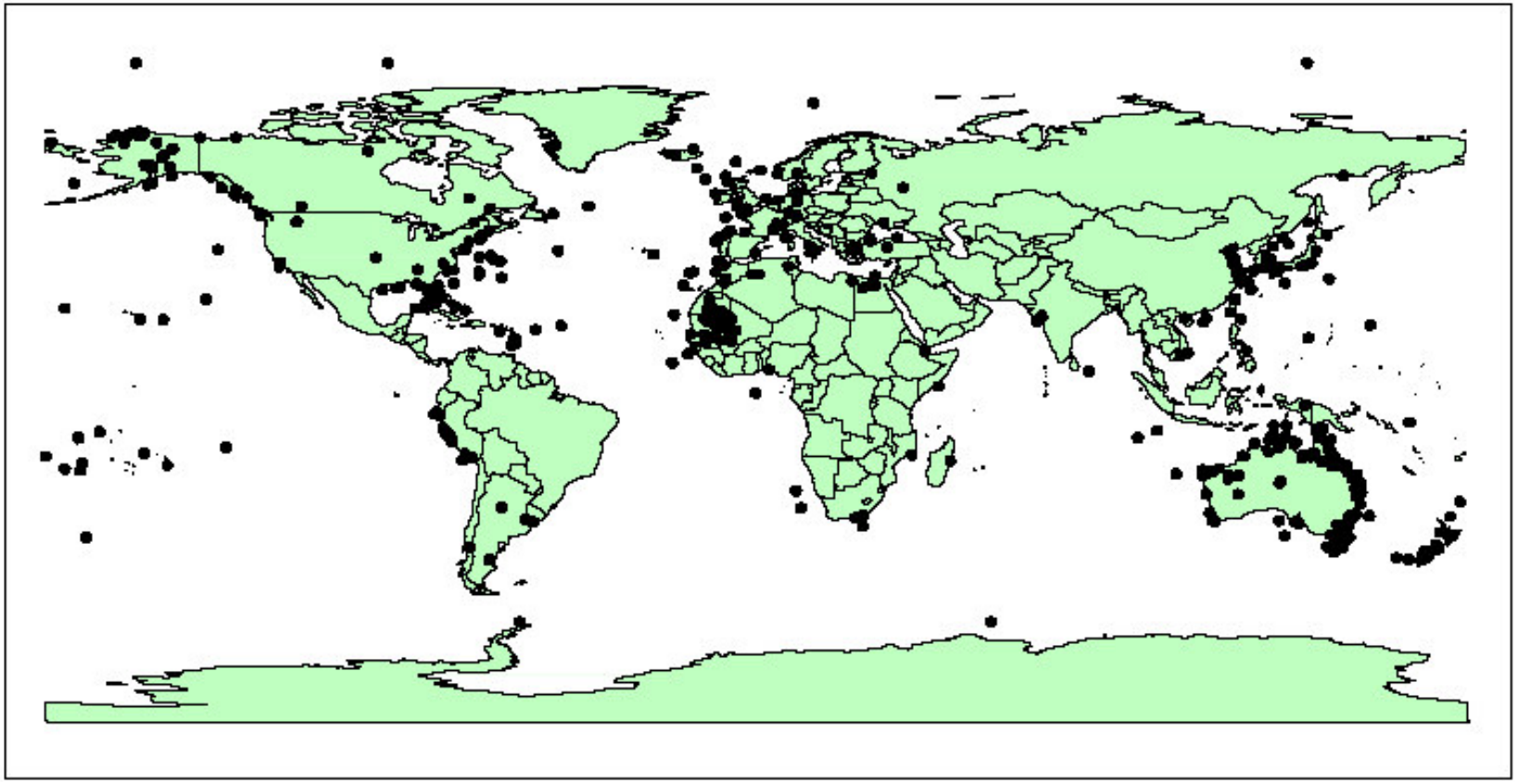
- **Constellations will be fully compatible**
- **Coordinating with C-S on specifications and compatibility**
- **Global detection + location:**
  - **Beacon without embedded GPS - greater than Cospas-Sarsat accuracy with 3 bursts or less**
  - **Self-locating beacons - GPS accuracy after single beacon burst**
- **Operational alerts could be available in System from 2012 (five DASS test satellites currently in orbit)**

Cospas-Sarsat of Tomorrow: MEOSAR

MEOSAR Concept of Operations



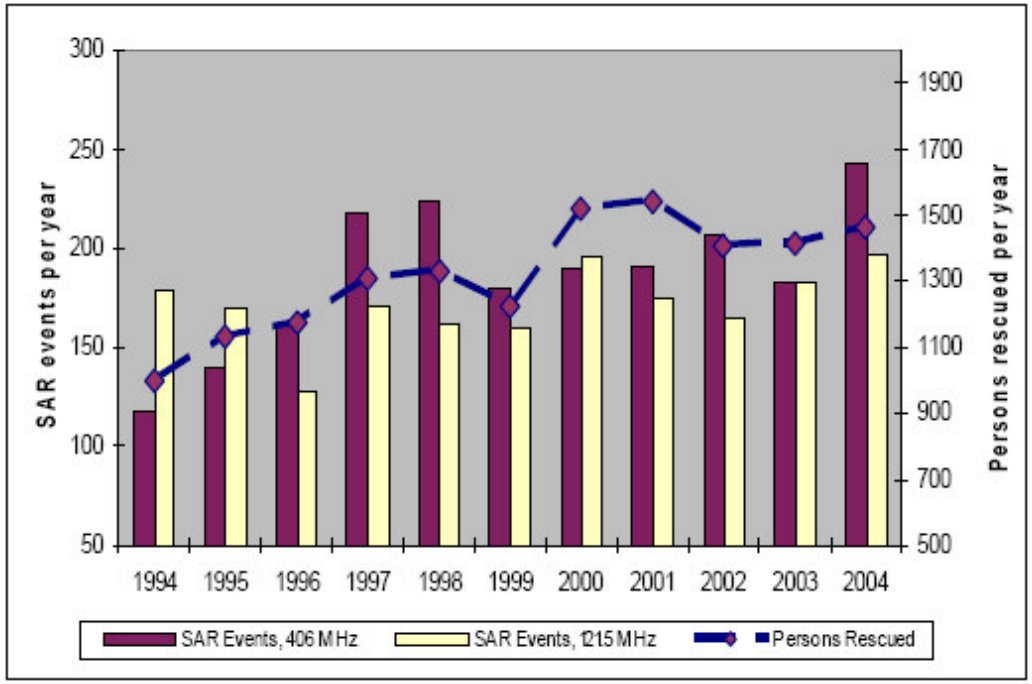
Cospas-Sarsat Saves Lives…



SAR Events Assisted by Cospas-Sarsat in 2005:

435 with 1,666 lives saved!

Cospas-Sarsat Saves Lives…



Since inception (1982) over 20,000 persons rescued in about 5,700 SAR events…

…or, on average four lives saved per day in at least one SAR incident per day.

Cospas-Sarsat saves lives…

15 January 2006: American Fire Rowing

- Two young women competing in the Woodvale TransAtlantic Rowing Race.
- Had completed over 1,600 miles when they encountered a heavy storm about 1,300 miles east of Puerto Rico. Boat flips.
- Escaped cabin, liferaft carried away. Activated EPIRB and rode out storm on top of hull.
- RCC Norfolk receives alert from USMCC at 18:06Z. AMVER system used to locate M/V Olympic Faith appox 200nm away. EGC issued. Two-masted, tall-ship S/V Stavros Niarchos responds with 10-hour ETA.
- C-130 dispatched from AIRSTA Clearwater, FL and on-scene in 3 hours. Drops liferaft and additional survival equipment. Remains on-scene (swap with another C-130) until S/V arrived and rescued the two women some 16 hours after boat overturned.

2 LIVES SAVED!

For More Info, Please Contact:

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