Overview

- Cospas-Sarsat System
  - Current operational infrastructure
  - Near-future: GNSS-enabled SAR (MEOSAR)
- MEOSAR implementation timeline
- SAR using
  - GPS
  - Galileo
  - GLONASS
- MEOSAR and Return Link Service (RLS)
Cospas-Sarsat (C-S) Program uses dedicated Search and Rescue (SAR) payloads onboard satellites to relay beacons signals to ground stations

C-S system consists of three segments:

- **User Segment** – the emergency beacon transmitters
  - Marine: EPIRB (Emergency Position Indicating Radio Beacon)
  - Aviation: ELT (Emergency Locating Transmitter)
  - Land: PLB (Personal Locating Beacon)

- **Space Segment**
  - LEOSAR: Low-Earth Orbit - Provides for beacon location using Doppler processing; uses Store & Forward instrument to provide global coverage
  - GEOSAR: Geosynchronous Orbit Performs instantaneous alerting function; no locating capability unless beacon is equipped with GNSS receiver.
  - MEOSAR*: Mid-Earth Orbit (GNSS)

- **Ground Segment** – Local User Terminals (LUTs)

* MEO is not yet operational – early operational capability Dec 2015
MEOSAR Concept of Operations

Concept of Operations

Activated 406 Emergency Locator Transmitter (ELT)

GPS III Satellites

Local User Terminal

Mission Control Center

US Coast Guard Rescue Coordination Center

Activated 406 Emergency Position Indicating Radio Beacon (EPIRB)

SAR Response

US Air Force Rescue Coordination Center

System Overview Diagram

The fully operational MEOSAR constellation SAR/GPS will provide worldwide coverage with the ability to detect and locate emergency distress beacons accurately in as little as one beacon burst.

With a footprint over seven times larger than a LEO Satellite, the MEOSAR constellation allows for real-time alerting worldwide without the need to store information in the satellite to relay at a later time. This capability equates to fewer alert notices and thus more lives saved.

SAR/GPS
Search and Rescue:
Global Positioning Satellite System
Global Search and Rescue System

NASCAR
National Search and Rescue
And
SAR
Search and Rescue

...则 aware the utility and viability of hosting secondary payloads on Global Positioning System satellites, including, but not limited to...
Next generation of satellite-aided SAR

• Based on the use of SAR Repeaters carried on board Global Navigation Satellite System (GNSS) satellites
• GNSS constellations consist of 24 (or more) satellites Mid Earth Orbit (GPS, Galileo, GLONASS)
• Provides
  – Multiple satellites in view of the beacon anywhere in the world at all times
  – Advanced location process using time and frequency measurements of beacon signal to triangulate its location
  – Near instantaneous beacon detection and location, globally, at all times
  – Mitigates terrain blockage due to multiple look angles from multiple moving satellites
  – Robust space segment, well maintained and highly redundant
  – Simple space segment repeater allows for development of higher performance beacon signal
MEOSAR Location Processing

- Like “reverse” GPS
  - Ground Station position is known exactly
  - Positions and velocities of satellites are known (very small error)

- To calculate location of distress beacon, triangulate using time and frequency measurements of beacon signal through at least 3 different MEOSAR satellites
• U.S. SAR Operational Space Segment
  – In 2009 USAF approved request from U.S. civil SAR community to host SAR repeaters on 24 GPS-III satellites
  – Repeater payload will be provided by Canadian government built to C-S specifications including interoperability with Galileo and GLONASS
  – Development underway with first operational payload planned to launch on board GPS III SV-9
• SAR/GPS PDR – held November 20, 2013
Galileo and SAR

• Galileo – launch of full constellation of a minimum of 24 satellites has begun
  – SAR payloads on Satellites 419 and 420 launched in October 2012 are fully compliant to the C-S technical specifications and commissioned.
  – Two more satellites launched in 2014 but in unintentional eccentric orbit
    • Small (not quantified) performance impact to SAR but fully functional

• Planning to use Return Link Service (RLS)
  – Protocol is now defined as a specific protocol within the C-S Program (use at national level); inclusion of a RLS Functionality on maritime beacons has been accepted by IMO
  – Type-1, called also automatic acknowledgment, where return link message sent automatically when location of alert has been confirmed

• Routing mechanism for RLS implementation also defined
  – Return Link Message to the beacon is carried on the L1 navigation signal.
  – Planned to be tested during the Demonstration & Evaluation Phase
Message sent by the distress beacon (specific RLS protocol on the 406 MHz uplink signal) to the RLS Provider (RLSP) to indicate it has a Return Link capability.
• One Glonass-K1 satellite, launched on 26 February 2011, was successfully tested and is now available for MEOSAR D&E testing.
• Russia plans to launch 5 more Glonass-K1 satellites between 2015 and 2018.
• Planning to implement RLS after 2018
• GPS has the capability to implement RLS but not currently in the concept of operations (i.e., SAR/GPS not fully interoperable with other GNSS)

• A US registered beacon must use the Galileo space and ground control segments to take advantage of the capability

• Upon detection of an RLS enabled beacon, the US Mission Control Center (USMCC) must forward beacon message to French MCC
  – Bit embedded in beacon message indicating RLS beacon
  – Impacts interoperability and response time to SAR incident

• US Coast Guard endorses RLS for use in SAR cases

• GPS Modifications
  – Need authority to use bits (estimate 80 bits for Type-1 message and beacon ID);
  – SAR downlink needs to go from USMCC to GPS control center, which then sends command to GPS to insert the message into the PNT downlink
• SAR payloads onboard GNSS (i.e., MEOSAR) will significantly increase SAR capabilities and interoperability

• Provides single burst location identification and enhanced second generation beacons

• Allows for use of RLS
  – Type-1 protocol adopted by C-S and will be implemented
  – Further use of RLS being considered by ESA for Aviation remote in-flight beacon activation
    • Requires further investigation on reliability