Concept of Operations

GPS III Satellites

Activated 406 Emergency Locator Transmitter (ELT)

Local User Terminal

SAR Response

Mission Control Center

US Coast Guard Rescue Coordination Center

US Air Force Rescue Coordination Center

Activated 406 Emergency Position Indicating Radio Beacon (EPIRB)

SAR Response

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 faster alert notices and thus more lives saved.

SAR/GPS

Search and Rescue-Global Positioning Satellite System

Global Search and Rescue System

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

"...assess the utility and feasibility of hosting secondary payloads on Global Positioning System satellites, including, but not limited to those intended to enhance global search and rescue capabilities for all users..."

National Security Presidential Directive-39 (08 DEC. 04)











Background

Since its inception in 1982, SARSAT (Search and Rescue Satellite-Aided Tracking System) has provided critical emergency distress alert and location information to U.S. search and rescue (SAR) services. For over 30 years SARSAT has been credited with assisting in the rescue of thousands of people in the United States and around the world. As part of the international COSPAS-SARSAT program, SARSAT provides a humanitarian life saving service to individuals in distress that transcends national boarders. Operated and managed by the National Oceanic and Atmospheric Administration (NOAA), the U.S. Air Force (USAF), the U.S. Coast Guard (USCG) and the National Aeronautics and Space Administration (NASA), SARSAT's mission is to:

Protect life and property by providing timely, accurate and reliable distress alerts to search and rescue services world wide, in an effective and efficient manner.

SARSAT uses satellites to detect and locate emergency beacons carried by mariners, aviators and land-based users. After calculations by a Local User Terminal (LUT) and geo-sorted at the Mission Control Center, the distress alerts are then relayed to either Air Force or Coast Guard Rescue Coordination Centers, or to search and rescue services in other countries, to coordinate the rescue. SARSAT has become an extremely successful, worldwide distress alerting system that currently supports more than 500,000 beacon owners in the United States and more than a million users globally. Both of these numbers will continue to grow.

Although originally created as a civilian SAR system, SARSAT also supports the United States military in both combat and peacetime situations to meet personnel recovery objectives. Not only does the military operate aircraft with Emergency Locator Transmitters (ELTs) and ships with Emergency Position Indicating Radio Beacons (EPIRBs), but also Personal Locator Beacons (PLBs) have found their way to the warfighter. Emergency beacons are currently being used for distress situations both in and out of combat; in all aspects of air, land and sea operations.

The Current System

SARSAT currently consists of two different satellite constellations. Together they support a global distress alerting capability.

Low earth-orbiting (LEO) satellites orbit at an altitude of 550 miles and circle the Earth every 100 minutes. Onboard receivers, provided by Canada and France, detect signals from activated distress beacons as the satellites pass overhead. The satellites relay the distress information to ground stations that, using Doppler technology, are able to process the information and calculate a beacon location.

Unfortunately, the LEO satellite constellation does have systemic limitations that include:

- A limited number of satellites. A single failure can cause an unacceptable gap in coverage.
- Delays in confirmation of location. Leo satellites require at least two satellite passes to resolve ambiguity in Doppler location.
- Long time interval between satellite passes. This time interval delays the calculation of the distress beacon's position and the search and rescue service's response to the distress.
- A single satellite failure would result in a significant degradation in service.

Geostationary (GEO) satellites operate in a synchronized orbit 22,320 miles above the equator. This gives each satellite a fixed view of approximately one third of the planet ranging from 70 degrees north to 70 degrees south. Because GEO satellite coverage is constant, distress alerts are relayed almost instantaneously to ground stations. Although successful over the years, the GEO satellite constellation also has systemic limitations:

- Unable to provide location information through Doppler processing.
- With only a limited number of GEO satellites, if one satellite fails, SARSAT would be unable to provide real time coverage to a significant portion of the world.
- Because GEO satellites are in synchronized orbit, they are subject to terrain masking by terrestrial features that can prevent distress beacon visibility.

What is SAR/GPS?

The Search and Rescue - Global Positioning Satellite System SAR/GPS is a viable next generation replacement to the current SARSAT system that will utilize SAR payloads on future GPS III satellites. These satellites will operate in a Medium-altitude Earth Orbit (MEO) at approximately 12,500 miles. A full constellation will consist of at least 24 satellites equipped with Canadian supplied search and rescue repeater payloads. The GPS constellation arrangement will be such that no less than four (SAR/GPS)-equipped satellites will be visible from anywhere on Earth at any time. Reverse triangulation calculations, using frequency difference of arrival (FDOA) and time difference of arrival (TDOA) algorithms, will allow for near instantaneous global detection and position fixes after one beacon burst (a Cospas-Sarsat beacon transmits a short digital message, often referred to as a beacon burst, every 50 seconds).

What are the benefits?

SAR/GPS is being designed to provide the following benefits:

- Quicker alerting –This will significantly reduce the time required for detection of a beacon to within three minutes and provide a location estimate of the beacon position within 5 minutes of beacon activitation, resulting in more lives saved.
- More accurate positions – The error in locating a distress beacon will be reduced from an average of 3.1 km to 1.7 km. Accurate position information will result in reduced search times, quicker rescue, and fewer resources expended.
- Less costly – By operating just two satellite constellations (MEO and GEO), life-cycle costs to build and operate the system are expected to be more than 2.5 million dollars *less* than the current system.
- Free from terrain masking – Because GPS satellites will be in non-synchronous orbit in relation to the Earth, satellite beacon detection will occur from continually changing angles. As a result, terrain masking will be significantly reduced.

SAR/GPS is also executable in terms of the infrastructure required to transition the project into operation. The current SARSAT Mission Control Center (MCC) network and associated communication links, along with modified data distribution plans, will be used to deliver SAR/GPS distress alerts to the SAR community. Furthermore, a management structure and international agreements are already in place to accommodate the introduction and near term operation of SAR/GPS. SAR/GPS is a low-risk program from a technical perspective. The user segment (i.e., emergency beacons) has already been in existence for more than 20 years and will be fully compatible with SAR/GPS. In addition, the SAR repeaters to be provided by Canada are based on proven technology already in operation for more than 25 years.

Lastly, there are no other public or private organizations that are currently capable of relaying distress alerts more effectively, more efficiently, or at lower cost.

The Bottom Line..:

SAR/GPS will provide an enhanced distress alerting capability characterized by:

- Near instantaneous global detection for emergency beacons.
- Improved location accuracy.
- High levels of space and ground segment redundancy and availability.
- Robust beacon to satellite communication links and
- Multiple and continuously changing beacon/satellite links, thereby providing flexibility against beacon to satellite obstructions, and resilience to interference.

SAR/GPS is executable, will improve overall performance, does not duplicate any other system in the public or private sector and is consistent with the goals and objectives of the U.S. government. With decreased detection times and increased accuracy, SAR/GPS will not only equate to reduced costs, but most importantly, result in more lives saved.

For more information on COSPAS-SARSAT, please visit the following sites:

NOAA - SARSAT Program
www.sarsat.noaa.gov

United States Air Force Rescue Coordination Center
http://www.1af.acc.af.mil/units/afrcc/

United States Coast Guard Office of Search and Rescue
http://www.uscg.mil/hq/cg5/c534/

NASA Search and Rescue Mission Office
http://searchandrescue.gsfc.nasa.gov

International Cospas-Sarsat Program
www.cospas-sarsat.org