National Aeronautics and
Space Administration

NASA

# GPS/GNSS Search and Rescue (SAR) U.S. & Intl. Developments

Emerging Medium Earth Orbit (MEO) SAR Applications

Dr. Lisa Mazzuca
NASA SAR Mission Manager

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- Planned hosted payload onboard GPS-III (SV9 onward); DASS onboard GPS-IIFs (currently 14)

- Many SAR alerting benefits will be realized from a MEOSAR system, including:

    – Near instantaneous global coverage with accurate independent location capability

    – Robust beacon to satellite communication links, high levels of satellite redundancy and availability

    – Resilience against beacon to satellite obstructions

GPS Constellation

Downlink:
L–Band
1544
MHz for
OPS

RCC

SAR Aircraft

Uplink:
406 MHz
(C/S T.001 beacons)

    – Provision for additional (enhanced) SAR services

        • A Return Link Service (RLS) to the 406 MHz beacon

        • Second Generation Beacons – improved location accuracy
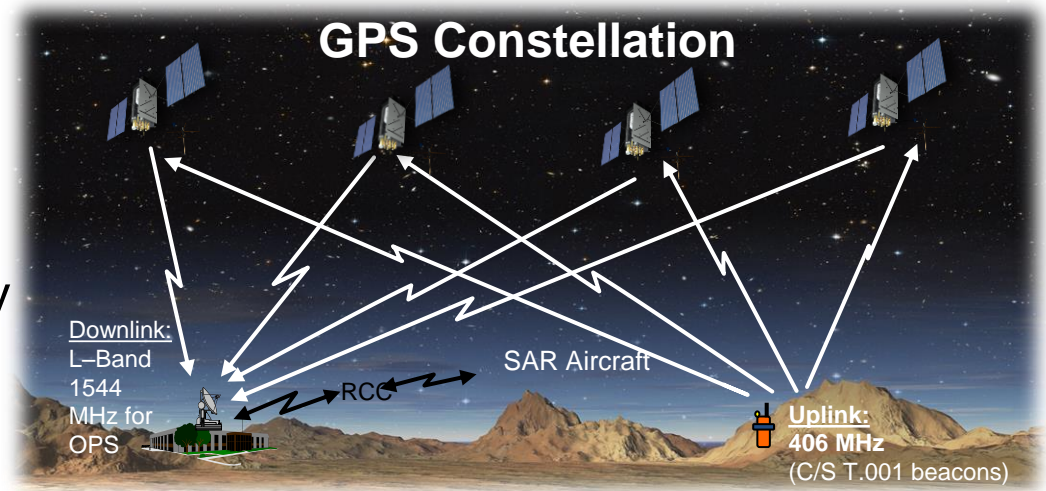
Return Link Service (RLS)

Cospas-Sarsat RLS

- The RLS protocol has been agreed to internationally and is now defined as a specific protocol within the Cospas-Sarsat Program
  - Type-1, called also automatic acknowledgment, where the RLM is sent automatically when the location of the alert has been confirmed

- The routing mechanism for the RLS implementation also defined
  - Planned to be tested during the Demonstration & Evaluation Phase

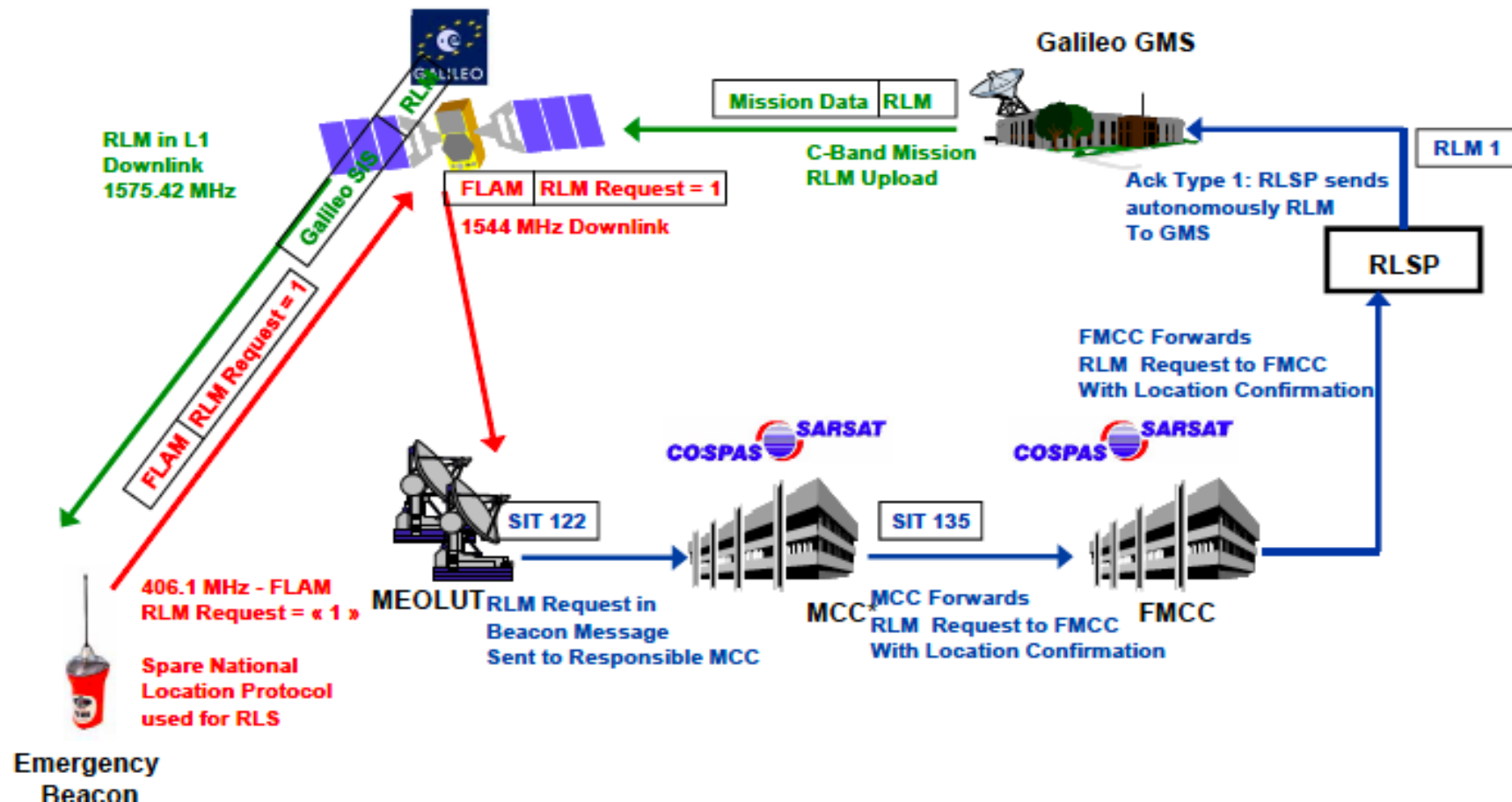- Delivery of Type-1 RLM (80 bits) takes 8s (20 bits per half-frame)
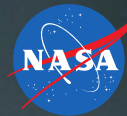
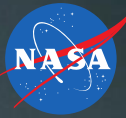Return Link Acknowledgment Service End-to-End Loop (RLM Type-1)

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

RLS and the USA

- GPS has the capability to implement RLS but not currently in the concept of operations

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

- Upon detection of an RLS enable beacon, the US must contact the French Mission Control Center (FMCC)
  - Impacts interoperability and response time to SAR incident

- GPS Modifications
  - Need authority to use bits (estimate 80 bits for Type-1 message);
  - 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
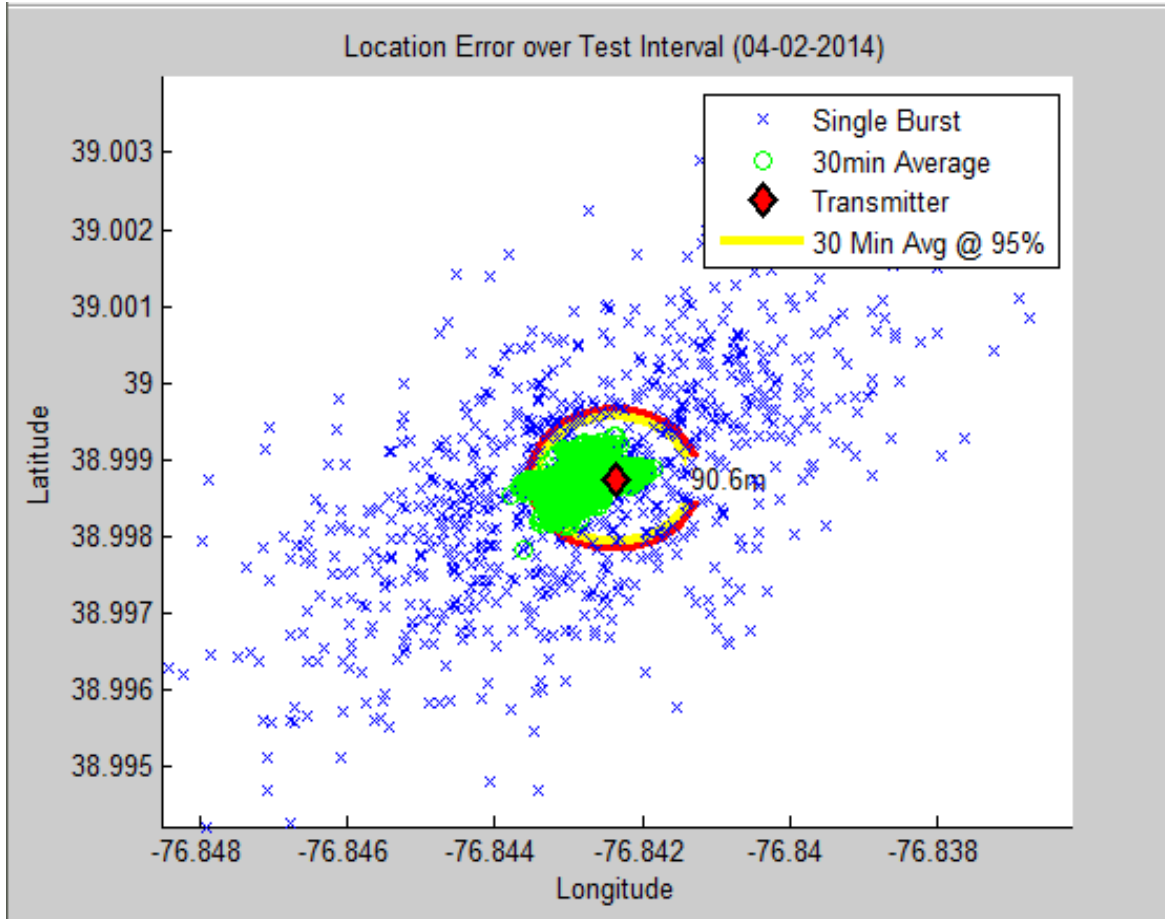
Second Generation Beacons (SGB)

USA Goals

- Capitalize on MEOSAR space segment and improve system performance to meet or exceed C/S requirements, including:

  - Detection probability, location accuracy and system capacity

  - Modernize beacon signal for MEOSAR system

  - Relax beacon requirements to reduce cost and complexity

  - Collaborate with manufacturers to obtain the most competitive end product

Spread Spectrum Type
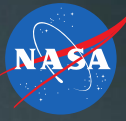
- USA SGB uses Direct Sequence Spread Spectrum (DSSS) Code Division Multiple Access (CDMA)

- Industry standard basis for major performance improvements in detection, location and capacity

- Easy to implement – code applied to digital data in software

- Relaxes beacon requirements

  - Oscillator frequency stability of 5-10 ppmillion – orders of magnitude improvement over current 1-2 pp_billion_

  - All beacons transmit at same center frequency

    - never have to change oscillator

    - different codes applied in software.

SGB locations over 2-day duration

Location Error over Test Interval (04-02-2014)

Legend:
- × Single Burst
- ○ 30min Average
- ◆ Transmitter
- ▬ 30 Min Avg @ 95%

90.6m

- NASA prototype beacon signal transmitted over 48hr period (1 burst every 50 sec) through DASS;
- Locations collected at NASA MEO ground station

Location accuracy meets C/S SGB requirements for location accuracy:
→ shows that at least 95% of the results of the 30 minute average are within the 100m (red) circle
→ order of magnitude improvement from first generation beacons