NASA Beacon Dev/Enhancements Overview

SAR Controllers Workshop 2022
April 26 – 28, 2022

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Agenda

- NASA's Role in SAR
- Second-Gen Beacon Type Approval Process Progress
- Real-World Evaluation / SGB Testing
- NASA Support to Crewed Space Missions

NASA's Role In SAR

- Innovate and develop new technologies to improve search and rescue hardware for national/international use in emergencies
  - Emergency beacons for use in distress
  - Ground stations that monitor and distribute data to rescue forces
  - Space payloads that detect the emergency signal and relay to Earth
- Technical arm for United States satellite-aided SAR Program (SARSAT)
- Represent USA on international level (COSPAS-SARSAT Program) with partner agencies (NOAA, USAF, USCG)
  - 42+ countries work together to obtain full Earth coverage of beacon detections and rescues
- Internal to NASA, the SAR Office supports NASA human spaceflight missions with technical expertise in SAR systems and future development

Second-Generation Beacon Type Approval Progress

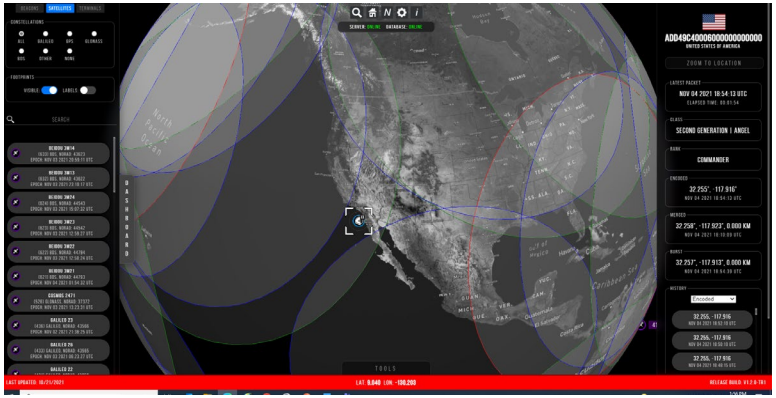
- NASA has led technical progress in qualification of domestic (US) 2nd-Gen Beacon (SGB) test facility – the US Army's Electronics Proving Ground (EPG)
- The first cohort of SGBs will be granted Type Approvals in Q3 2022, beginning initial entry for DoD/NASA use followed by commercial on-ramping
- SGB-based ELT(DTs) currently in development, about to enter Type Approval Certification (TAC) processes after NASA ANGEL and other beacons nearing TAC completion
- Approval of domestic and international SGB test facilities was a critical step in entering SGBs into service

Why Does this Matter to SAR Controllers?

SGBs are now entering into service with NASA and DoD users, within specific use parameters, but are now part of the SAR ecosystem

Real-World Evaluation / Testing of SGBs

- NASA performed open ocean testing with ANGEL SGBs and NASA recovery forces in October / November 2021 to evaluate use for Artemis moon missions
- Real-world testing validated beacon performance through Cospas-Sarsat system and ground station mutual viewability for NASA-specific mission support
- 4 SGBs tested in conjunction with single FGB representative of Orion landing configuration in an emergency



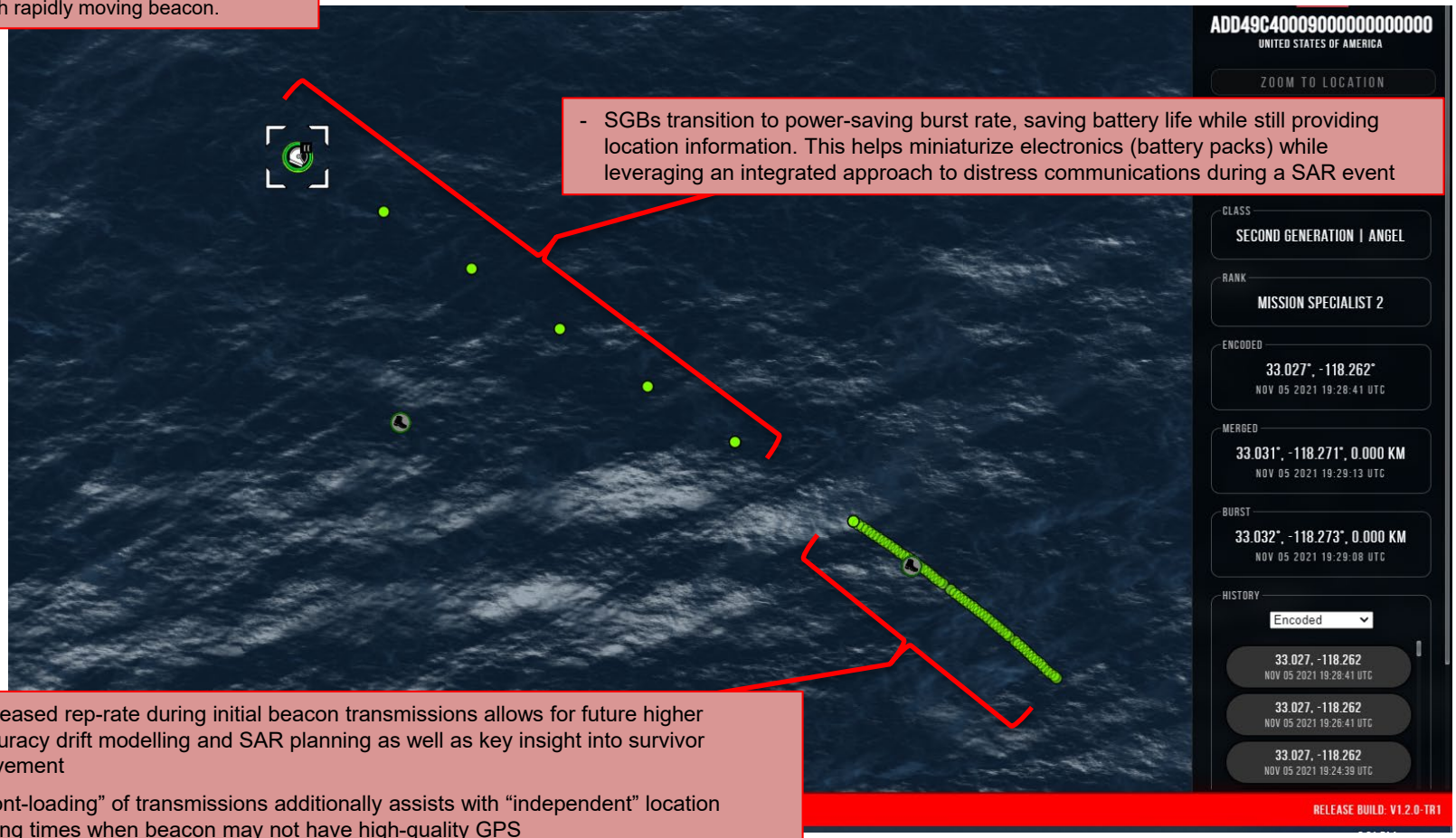
Why Does this Matter to SAR Controllers?

SAR Controllers may respond to mixed ecosystem of SGB and FGB beacons in the foreseeable future. NASA use of SGB/FGB combinations exemplifies the type of SAR case where varied types may be used, and field testing shows full compatibility

SGB Testing Example -

The Power of SGB Transmission Scheduling for SAR Response

Data from November 2021 testing in Pacific Ocean with rapidly moving beacon.



- SGBs transition to power-saving burst rate, saving battery life while still providing location information. This helps miniaturize electronics (battery packs) while leveraging an integrated approach to distress communications during a SAR event

- Increased rep-rate during initial beacon transmissions allows for future higher accuracy drift modelling and SAR planning as well as key insight into survivor movement
- “Front-loading” of transmissions additionally assists with “independent” location during times when beacon may not have high-quality GPS

SARSAT Support to Crewed Space Missions

- Commercial spaceflight sector is booming, with plans for orbital and suborbital crewed missions, some carrying SARSAT beacons
- NASA working directly with SpaceX and Boeing under their Commercial Crew Program (CCP) contracts with NASA to ensure vehicle beacons meet SARSAT Letter of Compatibility standards
- Purely private missions will need to meet Type Approval standards for use, owing to international nature of spaceflight landing zones and private versus government use
- NASA chairing National Search & Rescue Committee (NSARC) Space Working Group with US SARSAT partners to provide US SAR program position statements on beacon carriage requirements and SAR coordination specific to the Crewed Space Mission use-case

Why Does this Matter to SAR Controllers?

SAR Controllers are the first line of response to highly dynamic spaceflight landing SAR events, and US SARSAT program is working to ensure that legacy interfaces are maintained in this new spaceflight era to ensure crew safety

Future Capabilities - LunaSAR

- NASA developing concept for lunar search and rescue system for NASA's return to the moon, based off of the best practices seen today on Earth
- LunaSAR designed for the Artemis IV-V+ timeframe, when excursions begin occurring beyond immediate walk-back distances and risks increase for potential incapacitation, injury, or suit failure
- Reduced gravity (Moon or Mars) evacuation of incapacitated crewmember through level (or low-angle undulating) and/or rough terrain with obstacles not trafficable by rover requires the use of transport system for as few as one rescuer crewmember to move an incapacitated crew member to a rover (at which time, haul systems and ingress methods can be used)
- Need for external assistance among varied users drives:
  - Need for accurate survivor location data regardless of nav architecture
  - Need for assured communications with specific distress-related messaging
  - Need for a common bi-directional messaging architecture separate from a commercial-vendor specific RF link

Future Capabilities - LunaSAR

Adapting and Expanding Current SAR Capabilities to Cislunar Space

Lunar Search & Rescue (LunaSAR)
ALL INFORMATION AND IMAGES NOTIONAL

Search and Rescue
Terrestrial

Current Capability

- Dedicated 406 MHz distress for location
- Independent of GNSS/PNT system
- Unencrypted waveform
- Return link acknowledgement
- National use special allocation
- ELT-DT (automatic distress tracking and triggering)

Search and Rescue
NASA-Specific

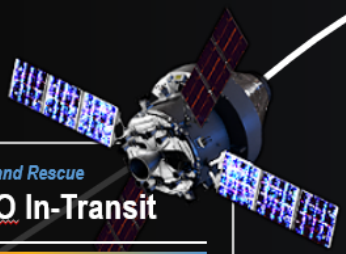
Current Capability

Prototype Waveform with:
- Return link messaging
- Relay customized data (e.g. biomedical, environmental)

Search and Rescue
xGEO In-Transit

Enabling Capability

All terrestrial and lunar surface capabilities plus:
- Crew capsule location
- Other hardware asset location
- Remote activation and deactivation of ELT(s)



Search and Rescue
Lunar Surface

Enabling Capability

All terrestrial capabilities plus:
- Resilient waveform (encrypted)
- Point-to-point local homing
- SWaP considerations with a new waveform

Capabilities enabled via standardized communication and physical interfaces