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Dr. Lisa Mazzuca

MEOSAR: SPACE SEGMENT

BDS & Cospas-Sarsat: C-S JC-31 (Oct 2017)
China Working Papers

BDS 406 MHz MEOSAR REPEATER TECHNOLOGY STATUS (JC31-9/2)

<u>Executive Summary</u>
This document describes the Beidou 406 MHz MEOSAR repeater onboard BDS technology status including repeater configuration, modes of operation and performance characteristics

DEVELOPMENT PLAN FOR BDS MEOSAR PAYLOAD SYSTEM (JC31-9/3)

<u>Executive Summary</u>
This document presents the launch plan of BDS MEO satellites carrying MEOSAR payloads

BDS & Cospas-Sarsat

C-S JC-31 Splinter Group Considerations

Conclusions, Recommendations and Action Items:

1) The attached draft inserts to C/S R.012 be accepted by the TWG and offered to the Joint Committee for consideration and recommendation to CSC-59 for inclusion in R.012 should Council decide proceed with the integration of the SAR/Beidou system into the C/S MEOSAR System;

2) The TG consider the following action items to invite:

a. EC, China and other interested Space Segment providers to address the proposed Beidou downlink being at precisely the same frequency but opposite polarity as the Galileo downlink;

b. interested space segment providers, China and the Secretariat to further develop changes to C/S R.012 and other C/S documentation for CSC-59 and future meetings; and

c. Space Segment providers to start collaborating with China on coordination matters and to provide progress updates at CSC-59 and future meetings.

BDS & Cospas-Sarsat

C-S JC-31 General Comments

- Inclusion of the BDS MEOSAR Payload System into the Cospas-Sarsat constellation would require interactions at the programmatic and technical levels:

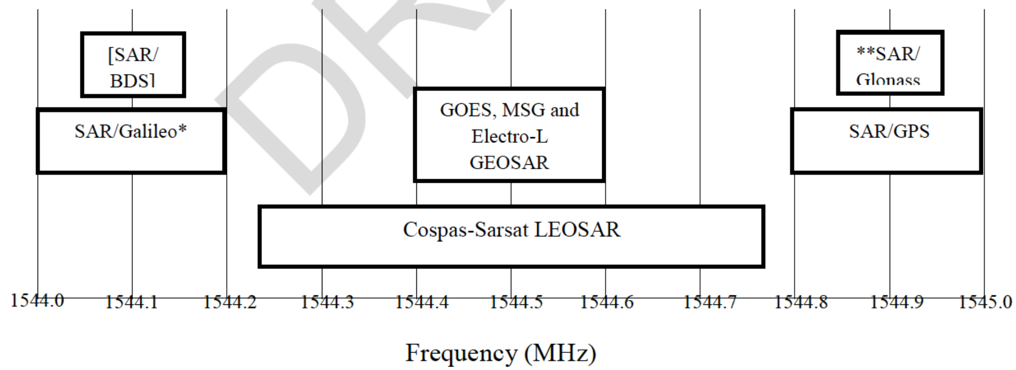
    - *Programmatic*: an instrument of cooperation would need to be agreed between China and the Cospas-Sarsat Council to lay a formal foundation document for the BDS space segment contribution

    - *Technical*: exchange of information would need to be organized between technical experts of China and other Space Segment providers to ensure that the BDS contribution is compatible and interoperable with Cospas-Sarsat and, in particular, does not present a radio-frequency interference risk to other Cospas-Sarsat space segments

- Amend terms of reference of the MEOSAR Space Segment Correspondence Working Group or to set up a dedicated Task Group to review the MEOSAR space segment interoperability parameters in order to adapt to the evolution of MEOSAR since the interoperability parameters were originally adopted in CS R.012 at JC-21/CSC-40 (2007)

MEOSAR: INTEROPERABILITY - DOWNLINKS

Figure 6.1: 1544 – 1545 MHz Band Plan



Notes: * SAR/Galileo will occupy approximately 100 kHz in the 1544.0 – 1544.2 MHz band.

** Exact Location of SAR/Glonass downlink has yet to be determined.

- This plan cannot be finalized until the protection requirements for the other users of the band have been established, the level of interference in the band from existing users has been quantified, and detailed analysis has been conducted to evaluate each proposed MEOSAR component against these criteria.
- **International agreement to operate systems in this band is achieved by completing the formal frequency coordination process with other administrations that have successfully notified their use of the band to the ITU.**

MEOSAR: INTEROPERABILITY - DOWNLINKS

Characteristics

SAR/Galileo Payload Downlink Characteristics	
Item	**Description**
Payload type	Direct frequency translation repeater
Downlink frequency*	Occupies 100 kHz from 1544.0 to 1544.2 MHz
Downlink EIRP	>16.8 dBW over the entire Earth coverage
Downlink polarisation	Left Hand Circular Polarisation (LHCP)
Bandwidth relayed	406.005 – 406.095 MHz (1 dB bandwidth)

SAR/Glonass Payload Downlink Characteristics	
Item	**Description**
Payload type	Direct frequency translation repeater
Downlink frequency**	Occupies approximately 100 kHz between 1544.8 and 1545.0 MHz
Downlink EIRP	19.0 dBW
Downlink polarisation	Left Hand Circular Polarisation (LHCP)
Bandwidth relayed	406.0 – 406.1 MHz, possibly reduced by small amount to accommodate MEOSAR Doppler shift

DASS Payload Downlink Characteristics	
Item	**Description**
Payload type	Direct frequency translation repeater
Downlink frequency	Occupies 200 kHz from 1544.8 to 1545.0 MHz
Downlink EIRP	17.5 dBW
Downlink polarisation	Right Hand Circular Polarisation (RHCP)
Bandwidth relayed	406.0 – 406.1 MHz, possibly reduced by small amount to accommodate MEOSAR Doppler shift

SAR/BDS Payload Downlink Characteristics	
Item	**Description**
Payload type	Direct frequency translation repeater
Downlink frequency	Occupies approximately 100 kHz from [1544.0 to 1544.2 MHz]
Downlink EIRP	18.3 dBW
Downlink polarisation	[Right Hand Circular Polarisation (RHCP)]
Bandwidth relayed	406.01 – 406.09 MHz (1 dB bandwidth)

MEOSAR: INTEROPERABILITY - DOWNLINKS

- Concern from many JC participants that some frequency separation in addition to polarity separation on the downlink is necessary and the suggestion that for frequency separation to be effective at all it would need to be at least 100 kHz

- Frequencies E1, E2, E5B and E6 overlap with Galileo frequencies. What has been done to ensure that multi-constellation GNSS receivers will not be impacted by the overlap within E1 and E2 bands. Will GNSS receivers have to have different channels for the E1 and E2 from Galileo and E1 and E2 from BDS?

- The specification of axial ratio for both Galileo and BDS is insufficient to determine the amount of cross polarization. i.e. the amount of Galileo downlink energy a MEOLUT configured for BDS will receive and vice versa. In order to determine the cross polarization, one needs the angle difference between the major axis of the Galileo elliptical antenna pattern and the major axis of the BDS elliptical antenna pattern- with each angle referend to the same point i.e. x axis for example. Will China provide this information?

Mitigation Strategy & Current Implementation

A. Significant analysis performed in early 1990's by NASA
   1. Using opposite polarization gives some separation in signal strength (6 -7 dBM) so ideally pick the satellite with strongest signal
   2. NASA performed many simulations with up to 90 spacecraft in orbit and noted possibility of beam collision very low
   3. Major source of differentiation is a tracking plan that avoids spacecraft beam conjunctions
      - Want orbital diversity - better geometry (DOP) yields better solutions
      - Cospas-Sarsat doesn't primarily use time or frequency differences to choose spacecraft to track

B. Each C-S MEOLUT uses a spacecraft tracking schedule to avoid multiple beams close by -> have control over the situation

C. Discussions will continue to revive the analysis and review

Questions for Further Consideration

1. Will China provide a website where status and precision orbital vectors for each satellite in the BDS would be available to MEOLUT operators, just like GPS and Galileo do?
2. Will China be providing the following to T.016 “Description of the 406 MHz Payloads Used in the Cospas-Sarsat MEOSAR System”?
   - Receive and transmit antenna patterns?
   - Filter settings as per T.016 Table B.4?
   - The types of orbital data per Annex C?
3. Are the variations of Earth noise taken into account when computing system noise temperature and if so, are there different temperatures for satellites in view of China and those in view of the Pacific Ocean or the USA?
4. Will the satellites handle both First Generation Beacons (FGBs) and Second Generation Beacons (SGBs)?
5. Can China provide more info on the role of the 3 GEO and 3 IGSO satellites in relation to the 24 MEO satellites? Will they be part of the C-S GEOSAR?
6. Is China considering enabling Return Link Service for C-S beacons?

MEOSAR SPACE SEGMENT: Return Link Service (RLS)

Ground System Status

- RLS rescheduled to begin testing by the end of 2017 (MEOSAR D&E test O-5 “SAR/Galileo Return Link Service (RLS)”) and to become operational by the end of 2018 (per the TG-1/2017 Report) - designed to evaluate the SAR/Galileo RLS in respect of data volume, the effectiveness of data distribution procedures and the timely delivery of return link messages
- The JC noted from discussion of document JC-31/2/44-Rev.1 that
  a. Information provided by RTCM that at least four manufacturers were developing RLS-capable beacons with type-approval planned in 2018;
  b. The view of the EC that it was important to understand what ground segment coverage would be available when the RLS was declared operational at the end of 2018;
  c. LUT upgrades were required to properly process RLS-capable beacons, and MCCs needed to be upgraded in order to not filter out messages from this beacon type; and
  d. MCCs that intended to participate in test O-5 needed to be upgraded to process RLS-capable beacons in order to conduct test O-5 of the MEOSAR D&E; however, all MCCs would need to implement the agreed critical changes by December 2018.

MEOSAR: RETURN LINK SERVICE (RLS)

From JC-31…

- C-S has begun to develop necessary amendments to document C/S G.005 “Cospas-Sarsat Guidelines on 406 MHz Beacon Coding, Registration and Type Approval” to introduce RLS protocol beacons.
  - JC-31/5/5 AND JC-31/5/6-CORR.1
  - Limitations on beacon coding: issues are particularly relevant to countries that do not permit the use of beacons coded with serial numbers or that place certain restrictions on the use of some types of beacon – pertains only to FGBs
  - Any coding changes require changes to the ground system
- **The JC noted general agreement to invite Participants to urgently review the information on RLS Protocol Beacons in sub-sections 1 and 2 of their own Administration’s beacon-regulation pages**
- **At this time, the program would not consider further development of:**
  - **A combined GNSS and RLS test capability, and**
  - **Proposals for modifying the Galileo SAR Short and/or Long RLM to accommodate an RLM Homing Service**