Study on Feasibility of Incorporating SBAS Payload in NavIC Satellite

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Introduction

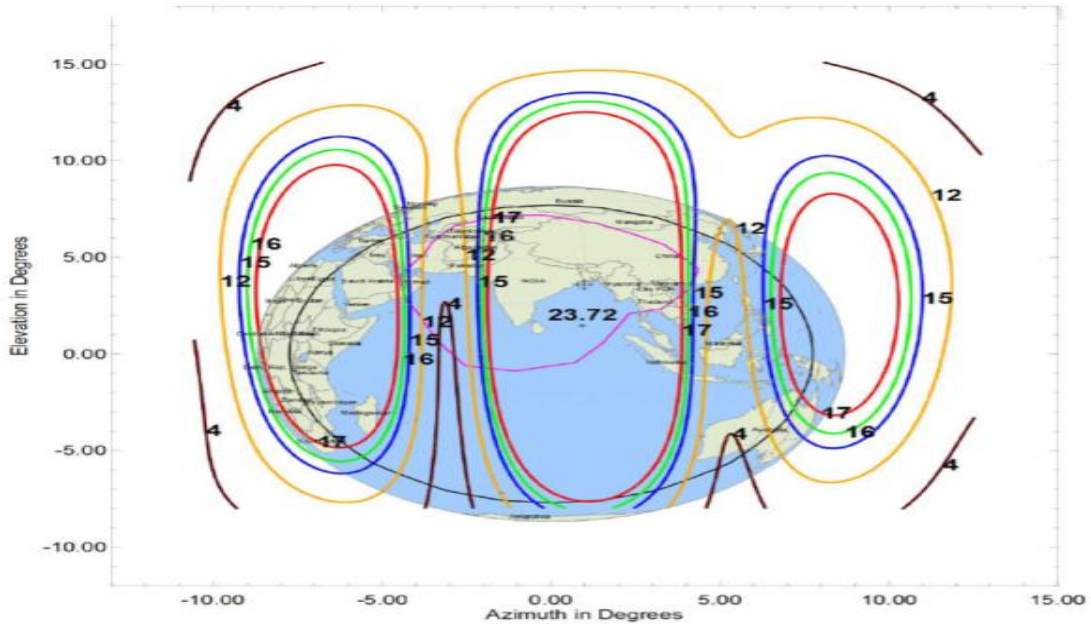
- Space Based Augmentation Systems (SBAS) conventionally augments a stand-alone navigation system operating in MEO constellation using signals from Geostationary orbits.
- NavIC is a stand-alone navigation system with its space segment designed as a combination of GSO and IGSO satellites. This presents an opportunity to consider the incorporation of SBAS payload in a common space platform along with NavIC.
- Different aspects were considered for studying the feasibility of incorporating SBAS payload on-board NavIC satellites including multiple signal broadcast in the same frequency, signal interference, doppler collision and thermal management of atomic clocks.

Doppler collision

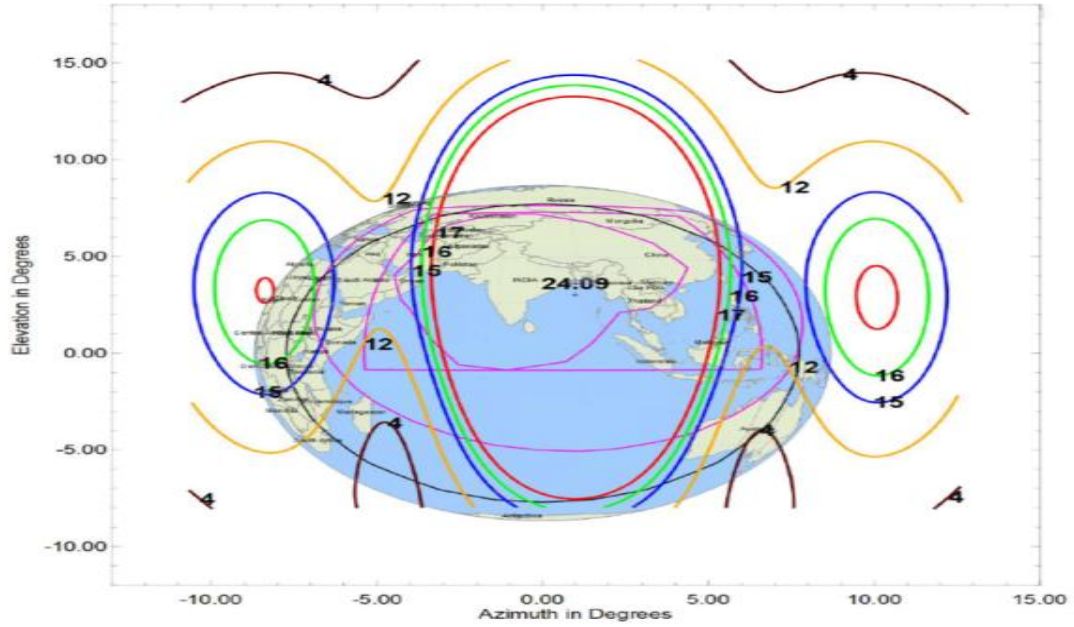
- SBAS payload placed in NavIC satellite may cause Doppler collision effect as they operate in same centre frequency from same platform.
  - Same geometric Doppler.
  - Due to slow varying relative frequency difference among GAGAN and NavIC carriers, the Doppler Collision can manifest for longer durations.
- This can be avoided by coherent on-board signal generation of NavIC and GAGAN signals, while carefully selecting the PRN codes to minimize the cross correlation effect.

Antenna Beam interference

Simultaneous transmission from both antennas (SBAS and GNSS) shall form an array configuration. Depending on the input power & phase, the combined radiation pattern shall be different from the expected radiation pattern. There could be possibility of nulls in required service area. This could be resolved by generating SBAS signal onboard and transmission of NavIC & SBAS from same antenna.



L1 Band



L5 Band

Thermal management of atomic clock

- NavIC satellite houses Atomic Frequency Standard (RAFS) for the generation of stable reference and the RAFS are sensitive to the temperature variations. To maintain the RAFS temperature within the performance window NavIC satellites undergo flipping along YAW axis to avoid the effect of sun incidence.
- If the SBAS payload is placed in NavIC satellite with YAW flipping then it will lead to following challenges,
  - ✓ The SBAS ground uplink and onboard receiver polarization is Linear Vertical (LV), Due to YAW flipping the polarization mismatch will occur and SBAS signal uplink may fail.
  - ✓ The SBAS payload and NavIC satellites are having a separate fixed beam pointing, in case of YAW flipping it won't be possible to maintain the beam pointing for both the services.
- An alternate approach of RAFS thermal management without yaw flipping is considered to solve the issues of polarization mismatch and satellite downlink antenna beam pointing. This requires increase in radiator area and consequently satellite real estate.

Signal interference

- **Signal interference between L1 and L5 signals of NavIC and SBAS**
  - ✓ The NavIC signals are broadcasted using L5, L1 and S frequency bands and SBAS signals are broadcasted using L5 and L1 frequency bands. When both the signals are hosted on the same platform them the signals shall potentially interfere with each other.
  - ✓ The simulation has shown that for the high gain antenna at SBAS ground stations the estimated degradation are very high in L1 and L5 frequency bands. However the ground stations are equipped to handle this much of degradation as sufficient margins are available.
- **Signal interference between uplink signals to the satellite**
  - ✓ NavIC satellites uses two way CDMA ranging payload for the validation of one way ranging. The SBAS C-band uplink frequency is overlapping with NavIC CDMA ranging frequencies. This will cause interference to each other if both the payloads are hosted on the same satellite platform.
  - ✓ However, this uplink signal interference issue can be resolved by suitably choosing the transmitter and receiver polarization.

Advantage of Incorporating SBAS Payload in NavIC Satellite

- Platform utilisation
  - Cost/ manpower advantage
- Sharing of Orbital slot
  - Advantage in coordination
- Independent Nav satellite configuration
- Increase in number of SBAS signals

Thanks You