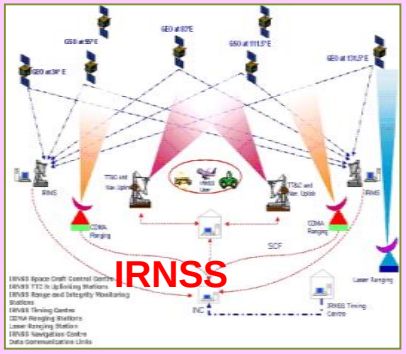
NavIC STATUS:
NAVIGATION WITH INDIAN CONSTELLATION



5 November, 2018

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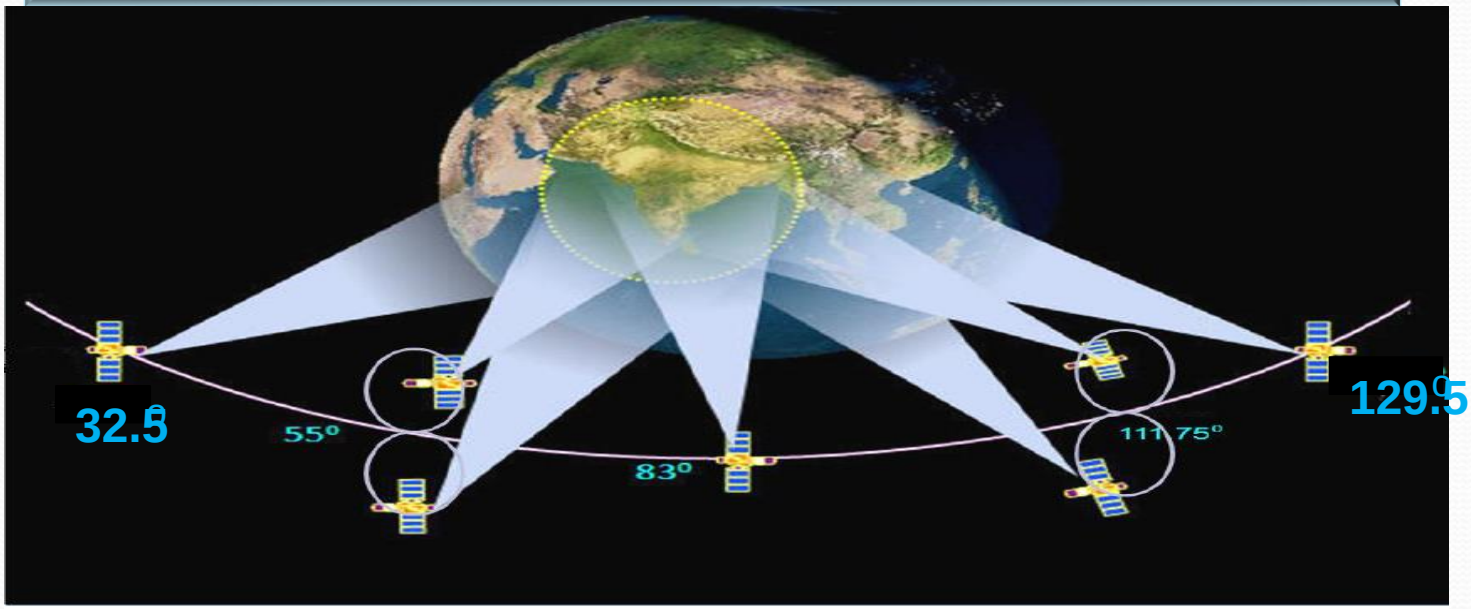
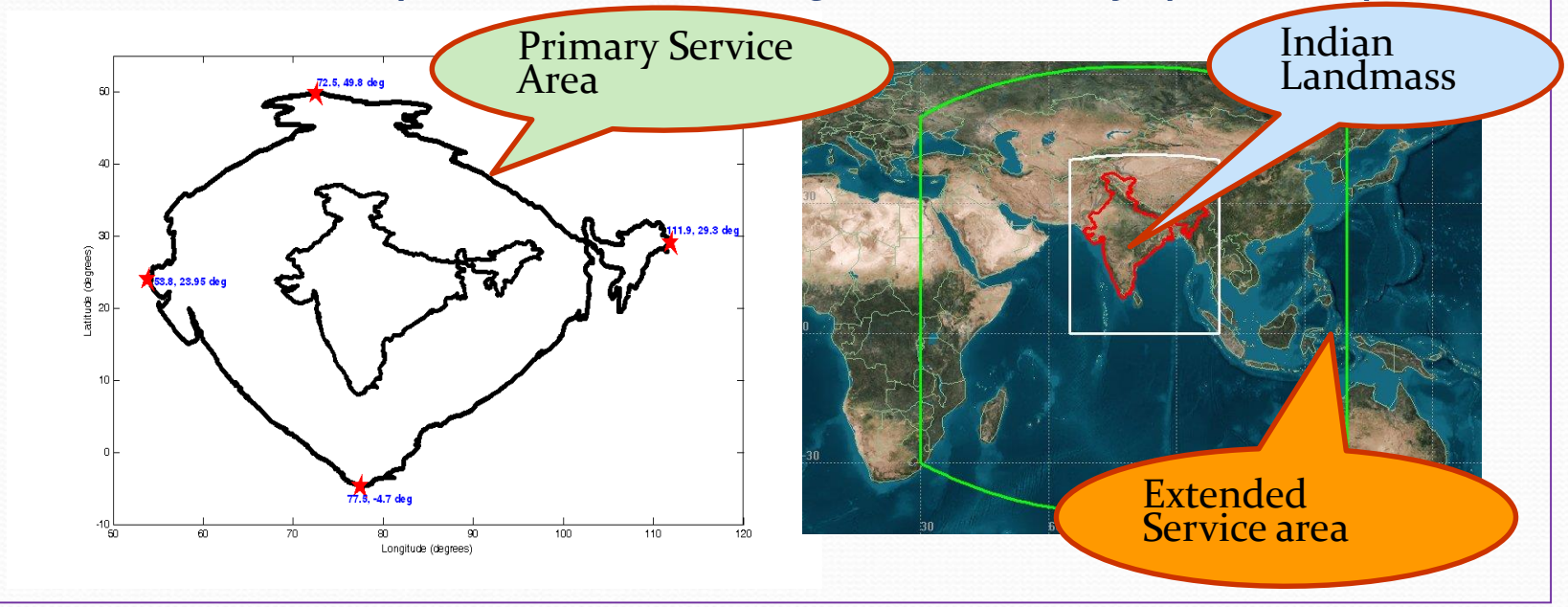
Navigation with Indian Constellation (NavIC)



- Indian Regional Navigation Satellite System (IRNSS) is now called
  - NavIC (Navigation with Indian Constellation)
- NavIC/IRNSS consists of 7 Satellites
  - 4 Geo Synchronous Orbit (GSO) satellites at 55° E and 111.75° E at an inclination of 27°
  - 3 Geo Stationary Satellites (GEO) at 32.5° E, 83° E and 129.5° E at an inclination of 5°
- Transmits signals in L5 band (1176.45 MHz) and S band (2492.028 MHz)

NavIC Features

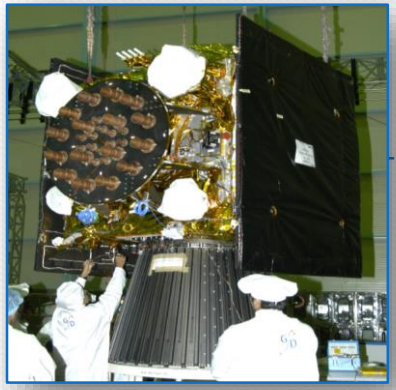
- Indigenous, Independent, Regional System
- Provide Navigation Services to
  - Indian Landmass extending 1500 Kms beyond the geopolitical boundary
    - 5° S to 50 ° N latitude ; 55° to 110 ° E longitude
- Extended Service, in future to a service area bounded by 30° S to 50 ° N latitude ; 40 ° to 140 ° E longitude
- All Weather 24/7 Operations with high availability (99.99%)



NavIC Status : Summary

Space Segment

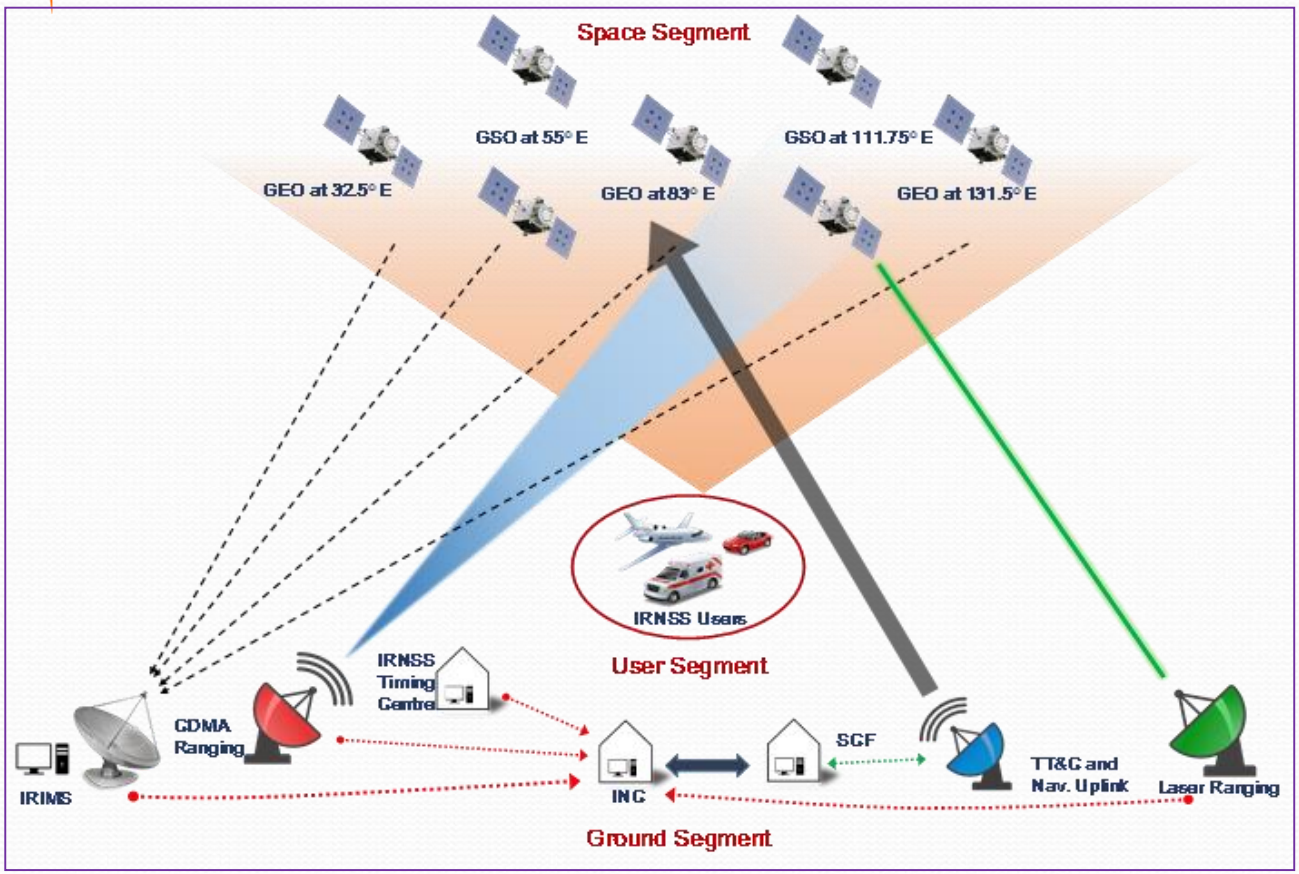
- Seven satellites are available and beaming signals in L5 and S band for Navigation service
- One additional satellite is available for “Messaging service”



Ground Segment

Navigation Control centres, Reference stations, IRNSS system Timing centres and Satellite control centres have been established and operational

NavIC Space Segment



- All Seven Satellites are successfully realized in orbit
  - IRNSS-1A (1July 2013) IRNSS-1B (4 Apr. 2014)
  - IRNSS-1C (10 Nov. 2014) IRNSS-1D (28 March 2015)
  - IRNSS-1E (20 Jan. 2016) IRNSS-1F (10 March 2016)
  - IRNSS-1G (28 April 2016) IRNSS-1I (12 April 2018)

NavIC Ground Control Segment

IRNSS CDMA Ranging Stations (IRCDR) Blr., Jodhpur, Bhopal, NE

ISRO Navigation Centre (INC), Bylalu/Lucknow

IRNSS Range & Integrity Monitoring Stations (IRIMS) :15/17

IRNSS Network Timing Facility (IRNWT),Bylalu

IRNSS Data Commn. Network (IRDCN), Bylalu

IRNSS Spacecraft Control Facility (IRSCF), Hassan

NavIC Signals, Services & Acccuracy

- **NavIC/IRNSS User Segment:**
- Standard Positioning Service (SPS) for civilian users
- Restricted Services (RS) for authorized users
- Single Frequency Users (L5/S band)
  - Grid based Ionosphere related corrections
- Dual Frequency Users (L5 & S band)

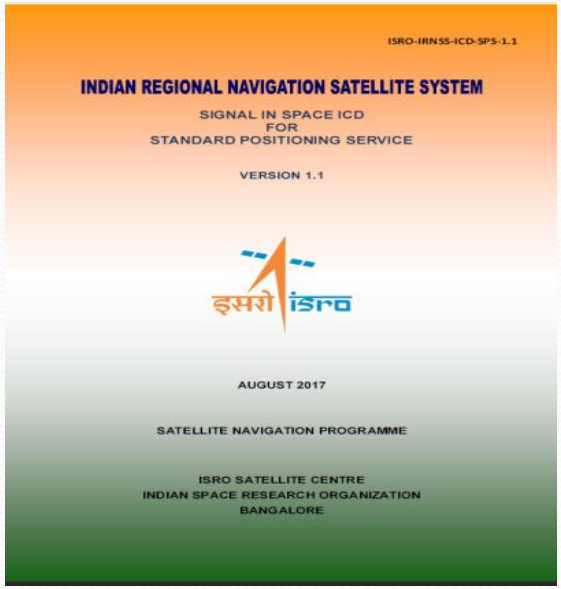
Service Type	Signal	Frequency	Accuracy
Standard Positioning Services (SPS)	**BPSK (1)**	**L5 (1176.45 MHz) S (2492.028 MHz)**	**Single Frequency < 20 meters < 100 nsec.**
Restricted Positioning Services (RS)	**BOC (5,2)**	**L5 (1176.45 MHz) S (2492.028 MHz)**	**Dual Frequency < 10 meters #15 nsec.**

NavIC: Published Documents

Information on signal structure and algorithms for user receiver dev

- Signal-in-space (SIS) Interface Control Document (ICD) provides required interface definitions like PRN codes, data structures, data contents, user algorithms etc.
- SIS ICD for Standard Positioning Service SPS (version 1.1) has been released August 2017
- SIS ICD for Message service has been released June 2018
- The NMEA 0183 standard for IRNSS / NavIC has been defined with new identifier 'GI' and incorporated. Enables ease of interface between NavIC receivers and commercial equipments. To be published

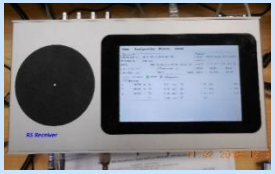
www.isro.gov.in/irnss-programme



NavIC RECEIVERS

NavIC Receiver Variants

RS Receiver



Position & Messaging Rx

NavIC RX for Launchers

NAVIC Antenna

19 Channel FPGA Rx for Coastal Surveillance & Vehicle tracking

Asic based Receivers

5 Nov., 2018

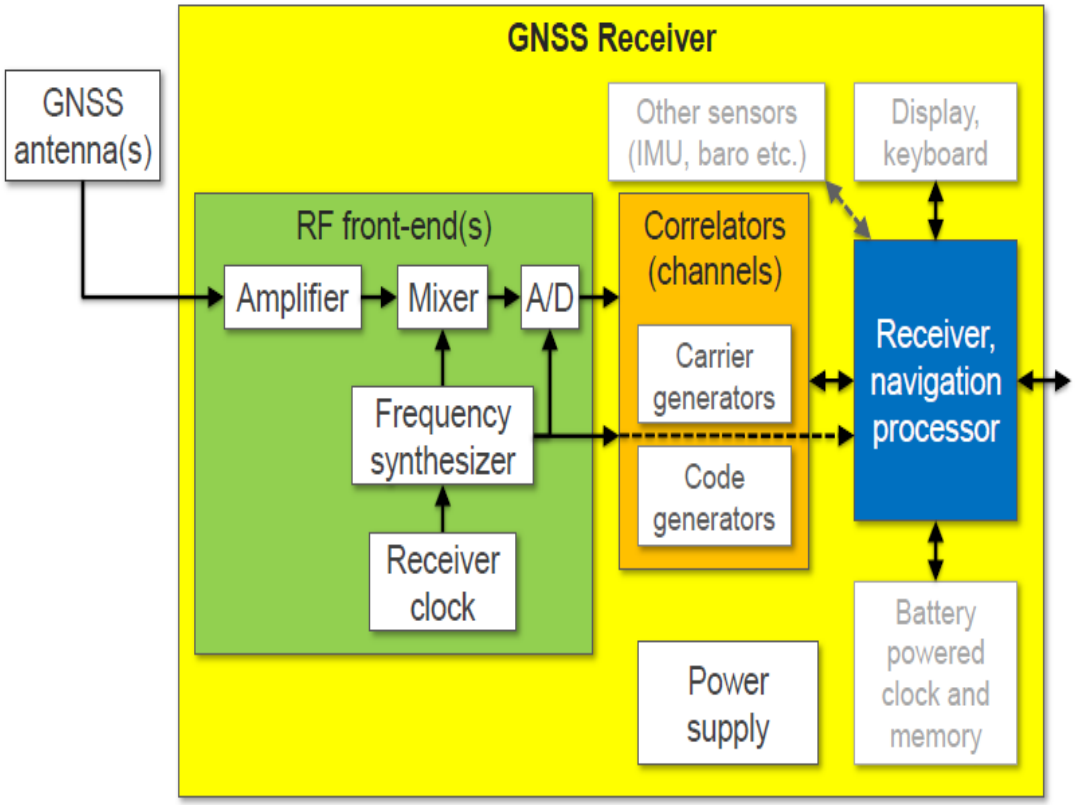
NavIC Chipsets

Chipset Developments

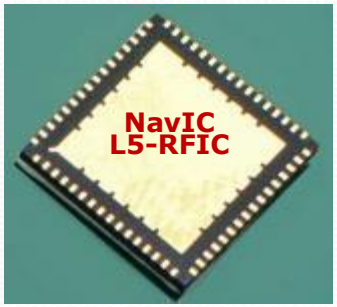
- RF Front End Chip: L1/L5/S-band
- Digital ASIC- BB Processing Chip
- Mixed Signal : Single chip SoC

NavIC-Only

NavIC+GAGAN/GPS : 2 Types



BROADCOM chip



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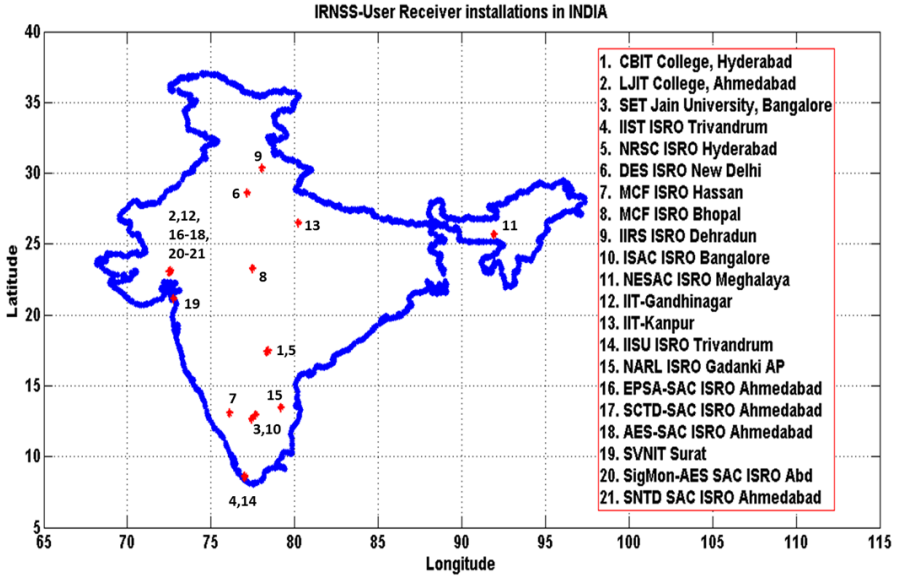
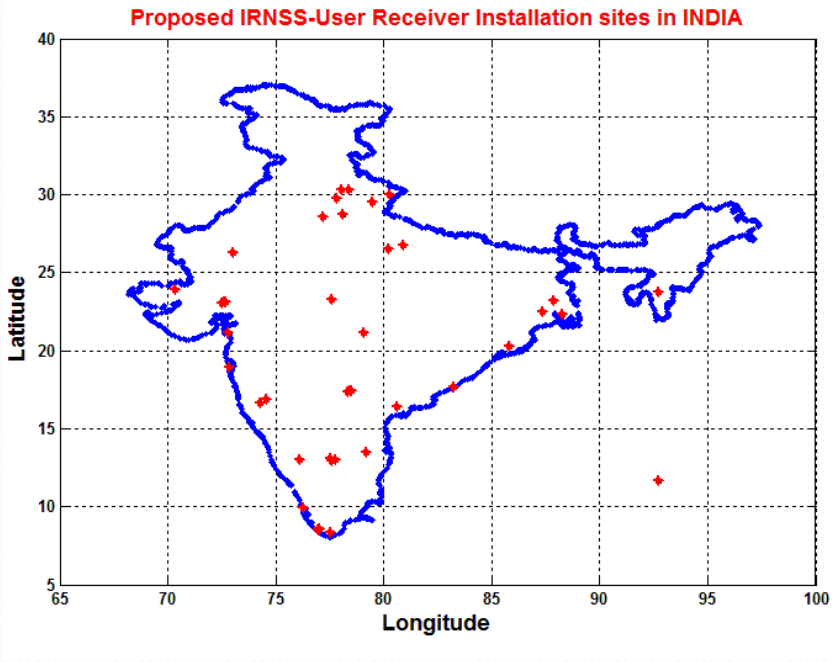
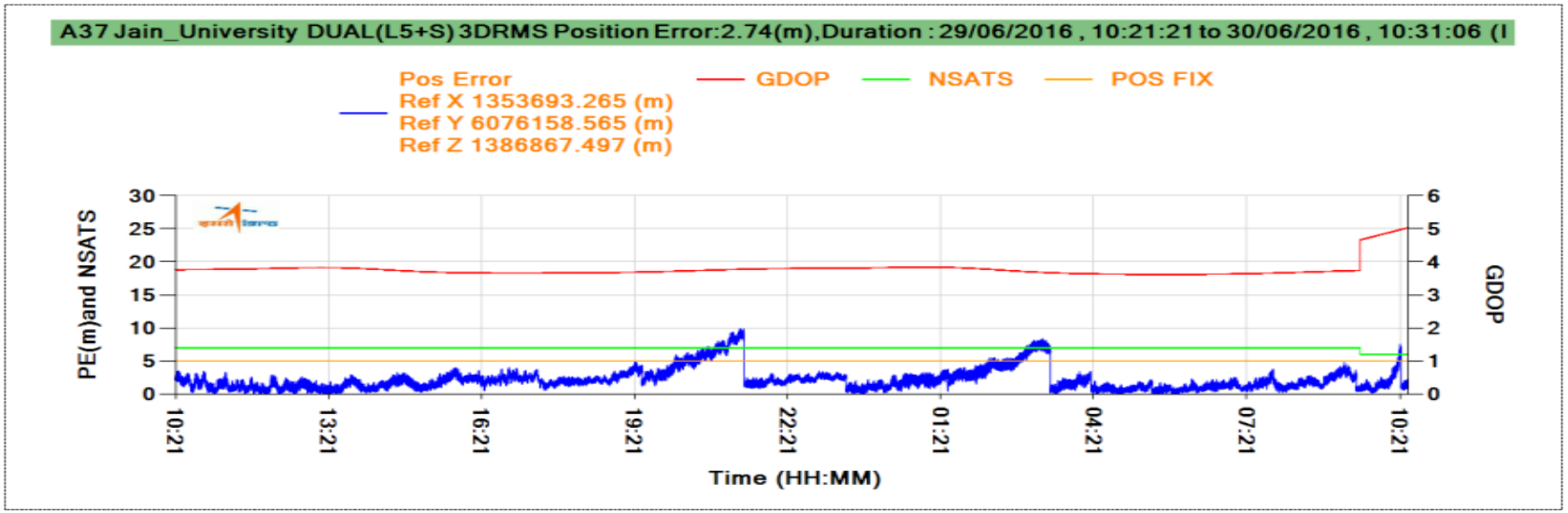
NavIC Receivers : Field Trials & Deployments





NavIC: Performance Observations

Rx Location	IRNSS L5 + GPS 3D RMS PE (m)	IRNSS DF 3D RMS PE (m)	IRNSS L5 only 3D RMS PE (m)	IRNSS S only 3D RMS PE (m)
East India (West Bengal)	1.87	3.97	5.73	3.37
South East (Hyderabad)	1.41	2.72	2.74	2.28
South (Bangalore)	1.44	2.74	2.62	1.88
West (Ahmedabad)	2.04	3.30	3.44	2.35
North (Delhi)	1.74	4.09	4.36	4.08



Position Error with Dual Frequency Receiver (L5 and S band)

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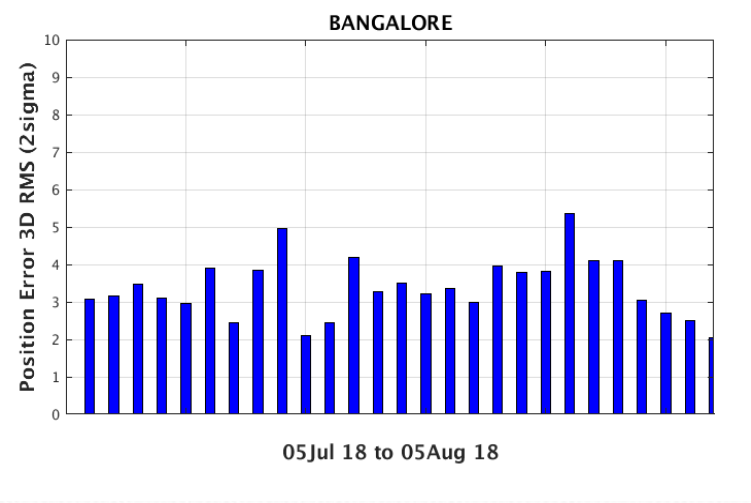
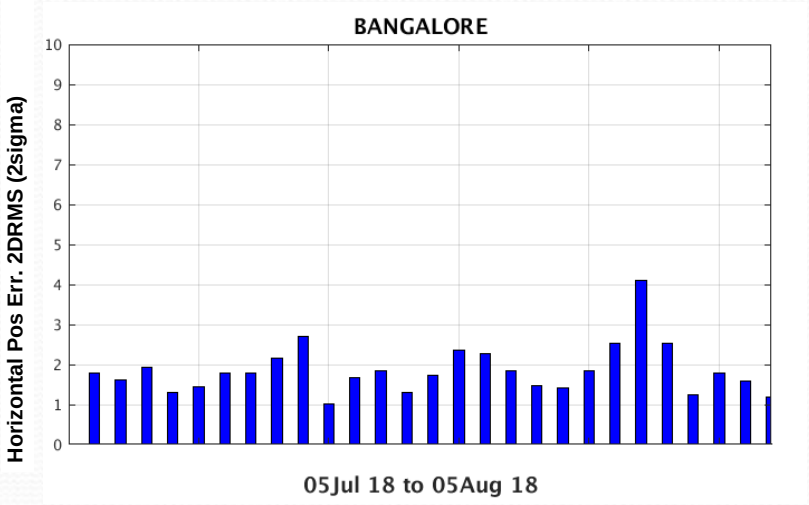
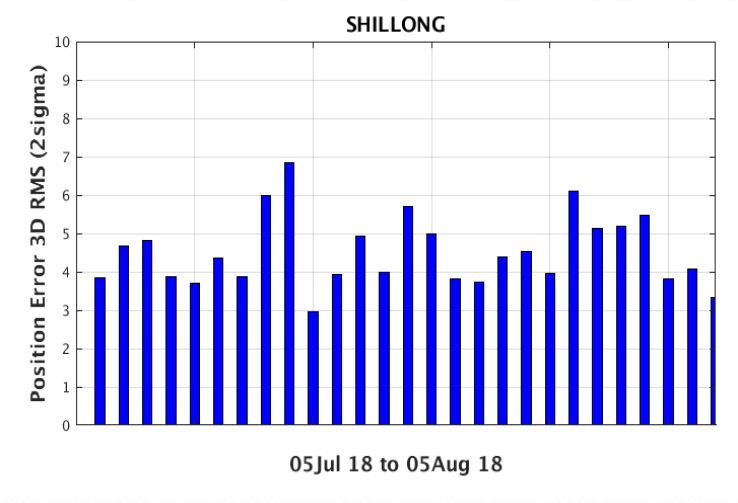
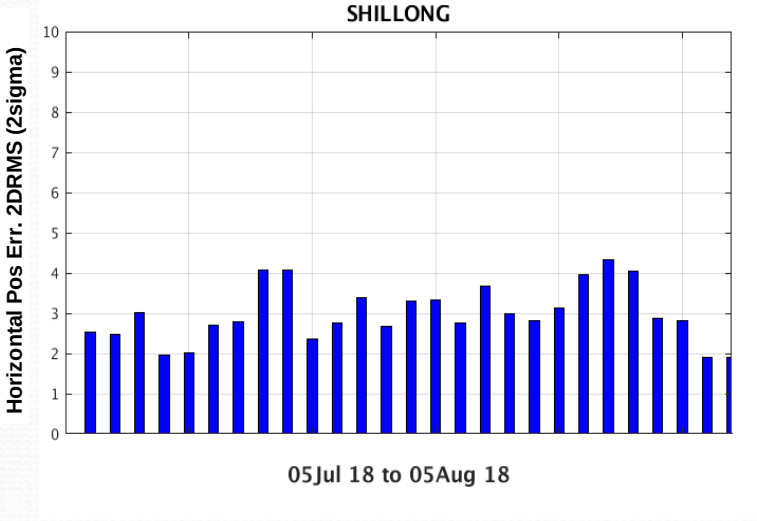
NavIC: Performance Observations

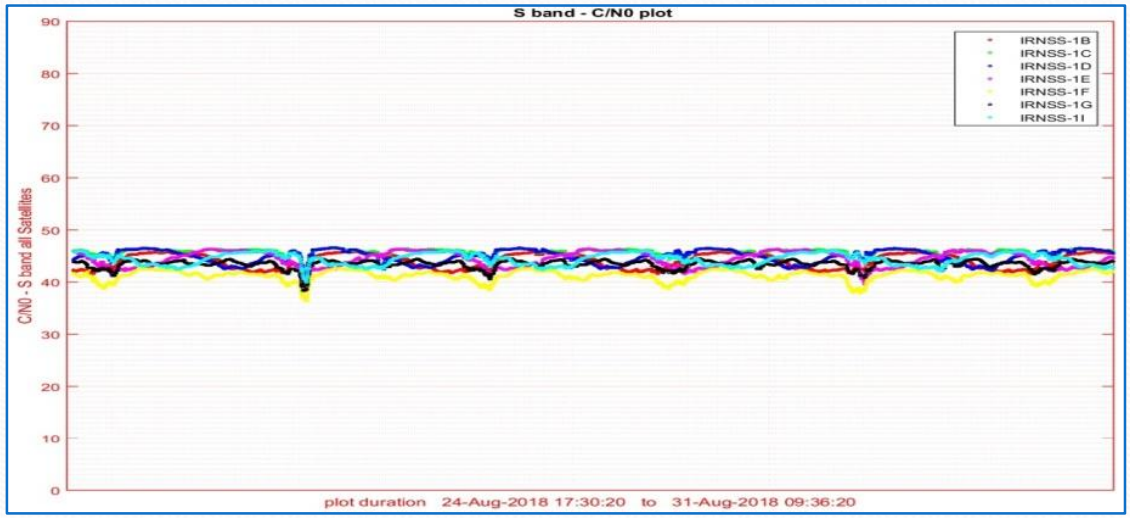


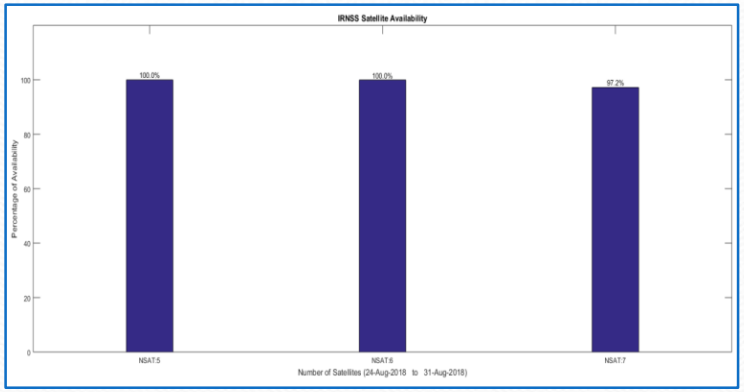


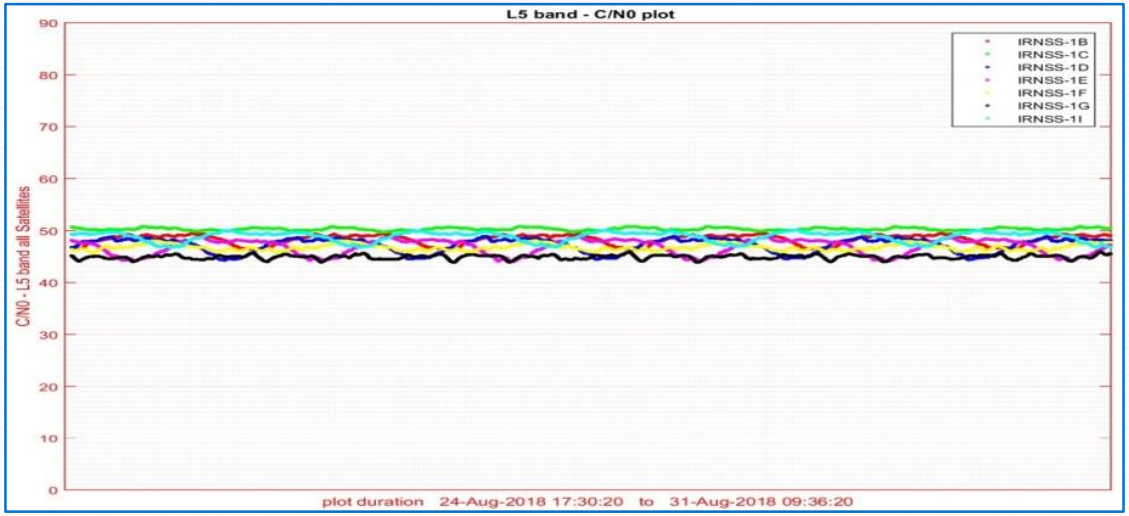




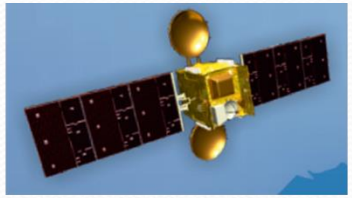
NavIC: Performance Observations







NavIC Positioning and Messaging Apps



NAVIC Satellite

VSAT Network

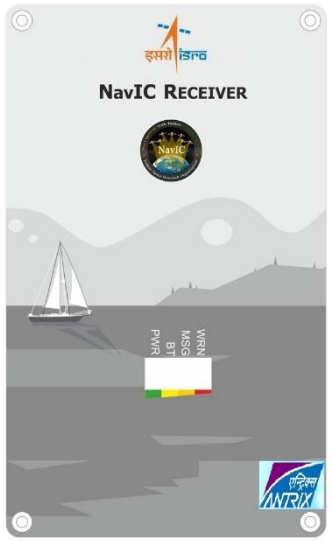
Indian Meteorological Department

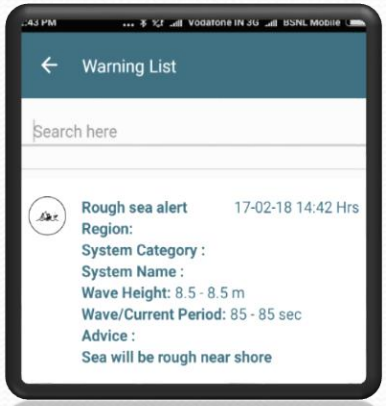
Disaster Management Authority

IRNSS Navigation Centre

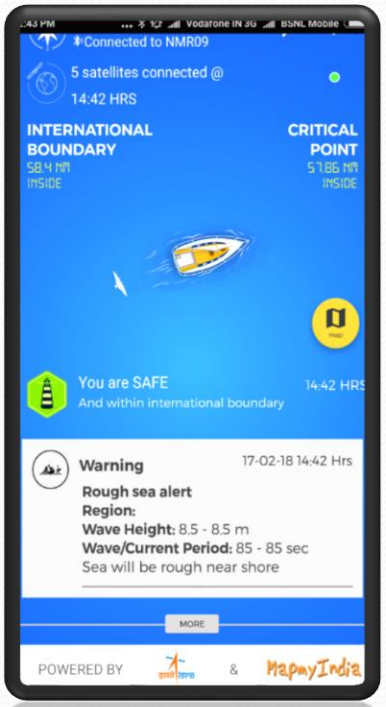
IRNSS T T and C

Internet / Fibre Optic





Mrs J. Mercykutty Amma, Minister, Fisheries & Harbour Engineering, Kerala State Government, observing NavIC Messaging Receiver



NavIC Messaging Receiver

- Bluetooth connectivity to user Mobile Cellphone
- Potential Fishing Zone (PFZ) Advisory and Alerts (Cyclone, High Wave) messages in local language on Mobile cellphone
- Message generation by Govt. agencies

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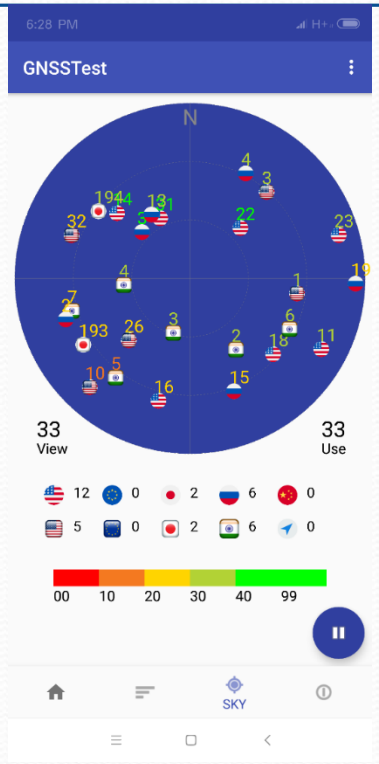
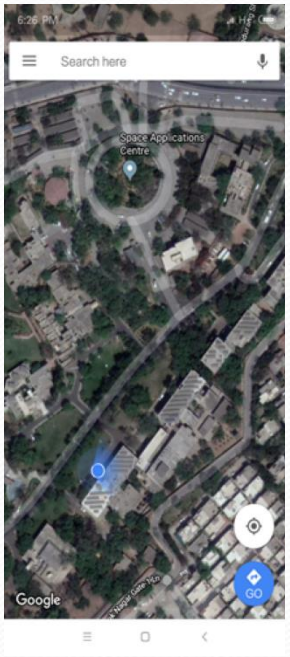
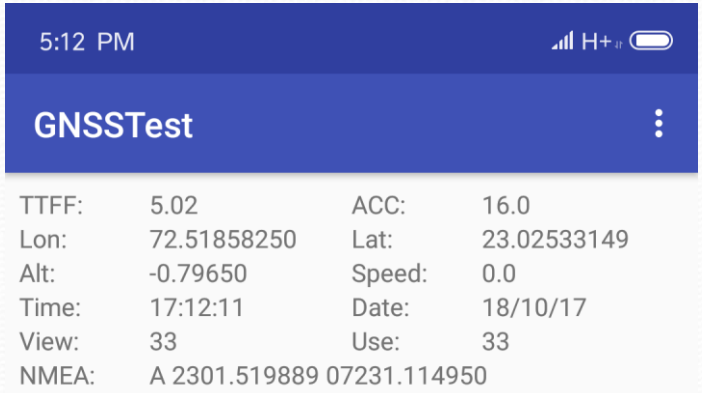
NavIC in Mobile Phone

Xaiomi MI 8: first Cell phone with Dual Freq. L1/L5 Rx chip

- **BROADCOM** launched Dual Frequency L1/L5 GNSS Receiver chip with Integrated Sensor Hub
- Supports Navigation using
  - GPS L1 C/A, L5
  - GLONASS L1
  - BeiDou (BDS) B1
  - QZSS L, L5
  - Galileo E1, E5a
  - IRNSS L5



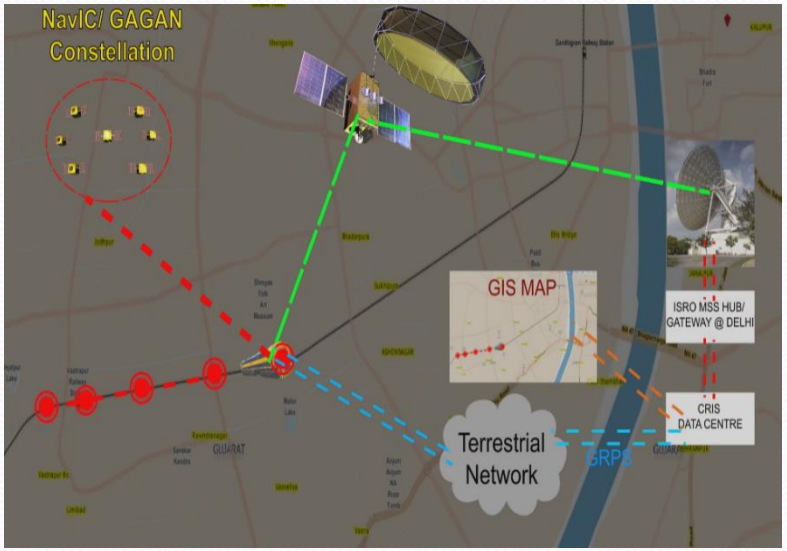




NavCom Applications for Indian Railways

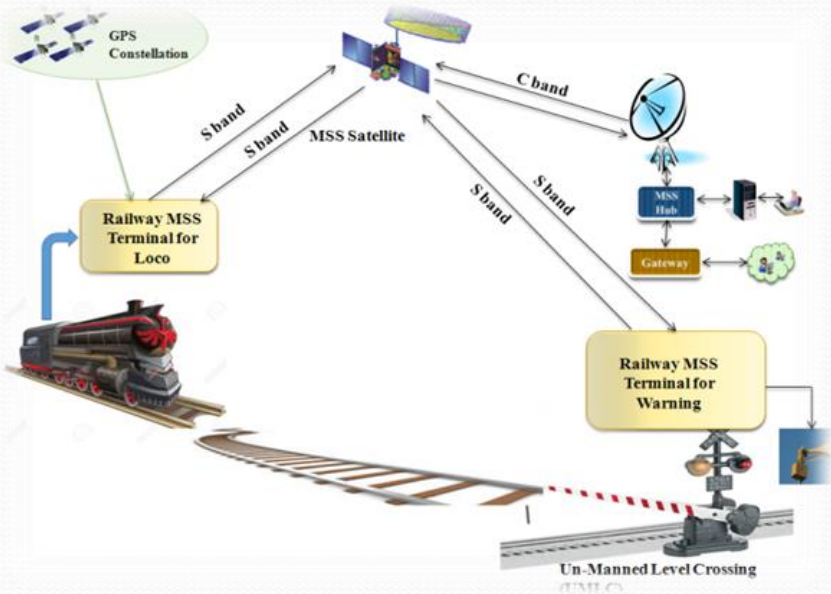
Salient Feature of RTIS Network:

- ✓ Near Real-Time Train Tracking (less than 1 sec delay)
- ✓ Hybrid Network with GPRS connectivity (dual-SIM) to improve availability of network
- ✓ Reporting of events like Arrival, Departure, Run Through etc in real-time.
- ✓ SOS Feature to avoid follow on accidents & warning
- ✓ Navigational aid to loco-pilot
- ✓ Emergency Broadcast & Remote Health Monitoring
- ✓ Six(6) locomotives fitted with MSS terminals tested in pilot project during July-Sept., 2017 on New Delhi- Guwahati and New Delhi-Mumbai Rajdhani Train Routes.



Salient Feature of UMLC Warning Network:

- ✓ Automatic Warning at UMLC & in Locomotive when train is 1-2Kms (programmable) away from UMLC
- ✓ Emergency small message communication to and from locomotive to control centre
- ✓ SOS Feature to avoid follow on accidents & warning
- ✓ Navigational aid to loco-pilot
- ✓ Emergency Broadcast to all
- ✓ Emergency voice communication may be added
- ✓ Remote Health Monitoring of UMLC Equipment
- ✓ Installed at Five (5) UMLC gates identified in East Central Railways (Hajipur Zone) & Field trials completed.



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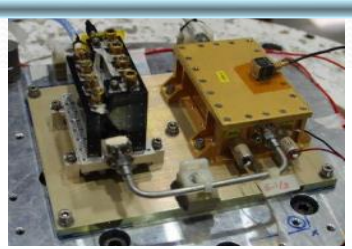
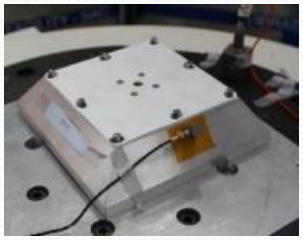
NavIC for Time and Frequency Synchronisation

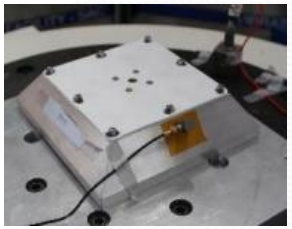
- Timing Receiver: 1 PPS, 1/5/10 MHz Clock IRIG-B Std.
- Satellite Launch and Tracking Networks
  - SDSC-SHAR, Shri Harikota, ISTRAC, MCF-HASSAN
- National Power Grids

NavIC Receivers Onboard ISRO Launchers





NavIC
L1+L5
Antenna



NavIC
L1+L5
Antenna

Ruggedized NavIC Receivers

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NavIC: Near Future Activities

- Continuity of service and Sustainability
- Indigenous Atomic Clock Development
- L1 signal for “Standard Position Service”
  - MBoC (6,1,1/11) Modulation
- Traceability of IRNSS/NavIC time to IST
- Continuous monitoring / evaluation / analysis
- Completion of IMO Certification Process for Maritime Service

CONCLUDING REMARKS

- ISRO's SatNav Programme
  - Better Governance & Development
  - Vigilant Eyes in the Sky
  - Serving Nation's interests: Civilian, Science, Strategic

ACKNOWLEDGEMENTS

- ISRO Delegation & Other Colleagues
- ICG-13 Organisers : CHINA, ICG Secretariat-Vienna
- All ICG-13 Participants

תודה
Dankie
Gracias
Спасибо
شكراً
Merci
Takk
Köszönjük
Terima kasih
Grazie
Dziękujemy
Dėkojame
Ďakujeme
Vielen Dank
Paldies
Kiitos
Täname teid
谢谢
Thank You
Tak
感謝您
Obrigado
Teşekkür Ederiz
감사합니다
Σας
धन्यवाद
ขอบคุณ
Bedankt
Děkujeme vám
ありがとうございます
Tack

Questions ?

The future depends on what we do in the present.

- Mahatma Gandhi