GPS-AIDED GEO AUGMENTED NAVIGATION SYSTEM (GAGAN) AND INDIAN REGIONAL NAVIGATION SATELLITE SYSTEM (IRNSS)

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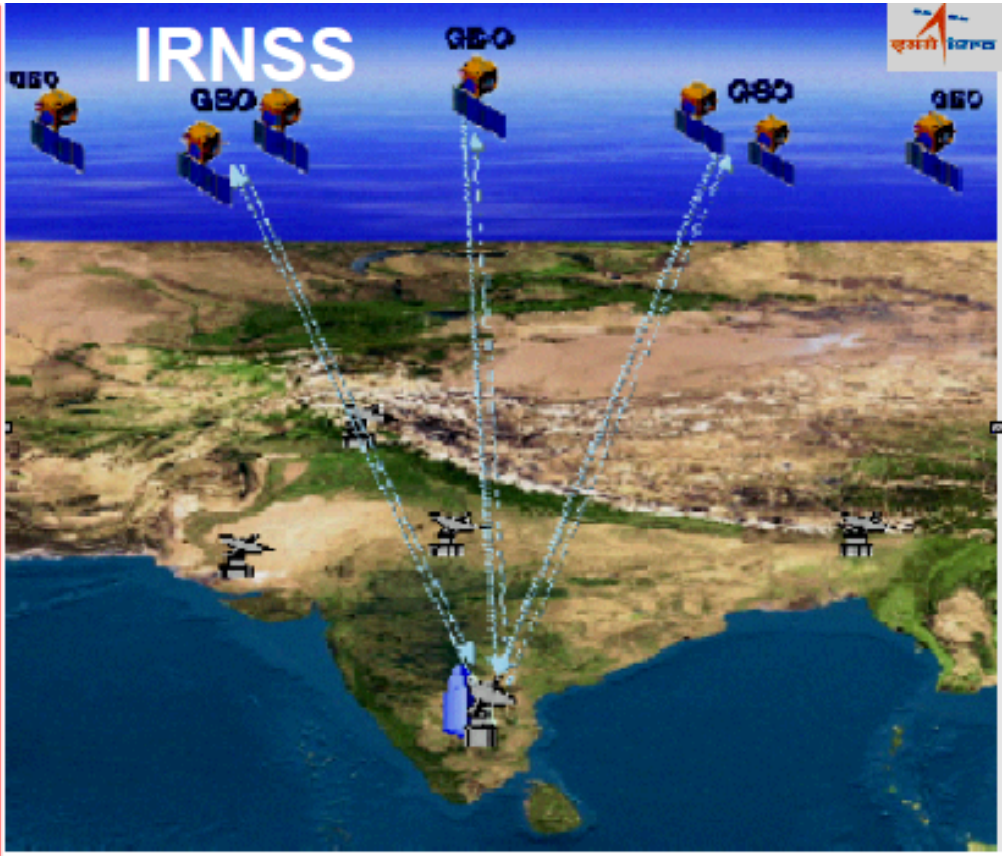
INDIAN SATELLITE NAVIGATION PROGRAM



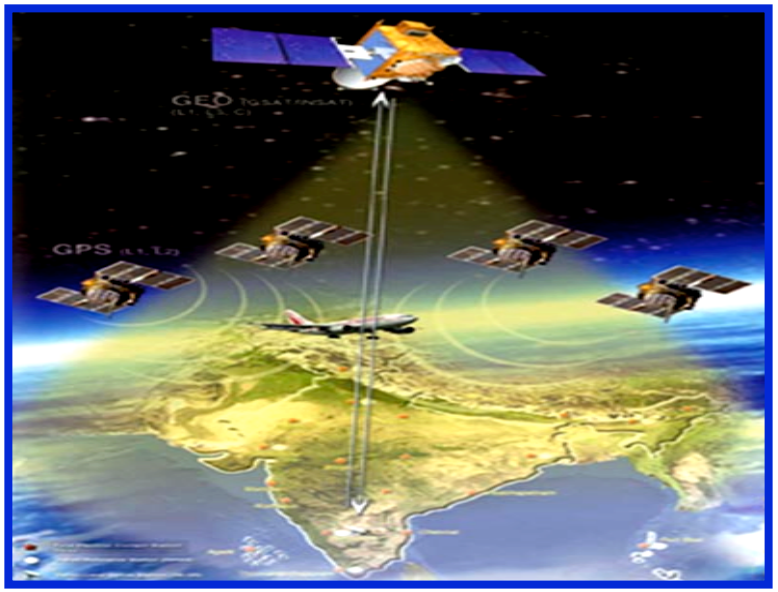
GAGAN
(GPS Aided GEO Augmented Navigation)

OBJECTIVES

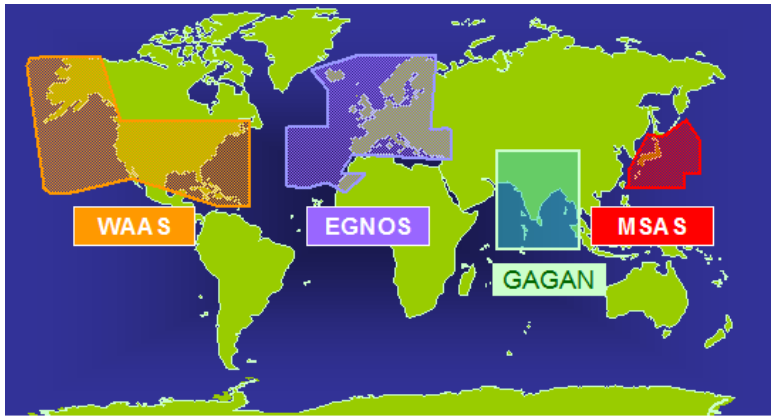
- *To provide Satellite-based Navigation services with accuracy and integrity required for civil aviation applications over Indian Air Space.*

- *Better Air Traffic Management over Indian Airspace.*

GAGAN
(GPS Aided GEO Augmented Navigation)

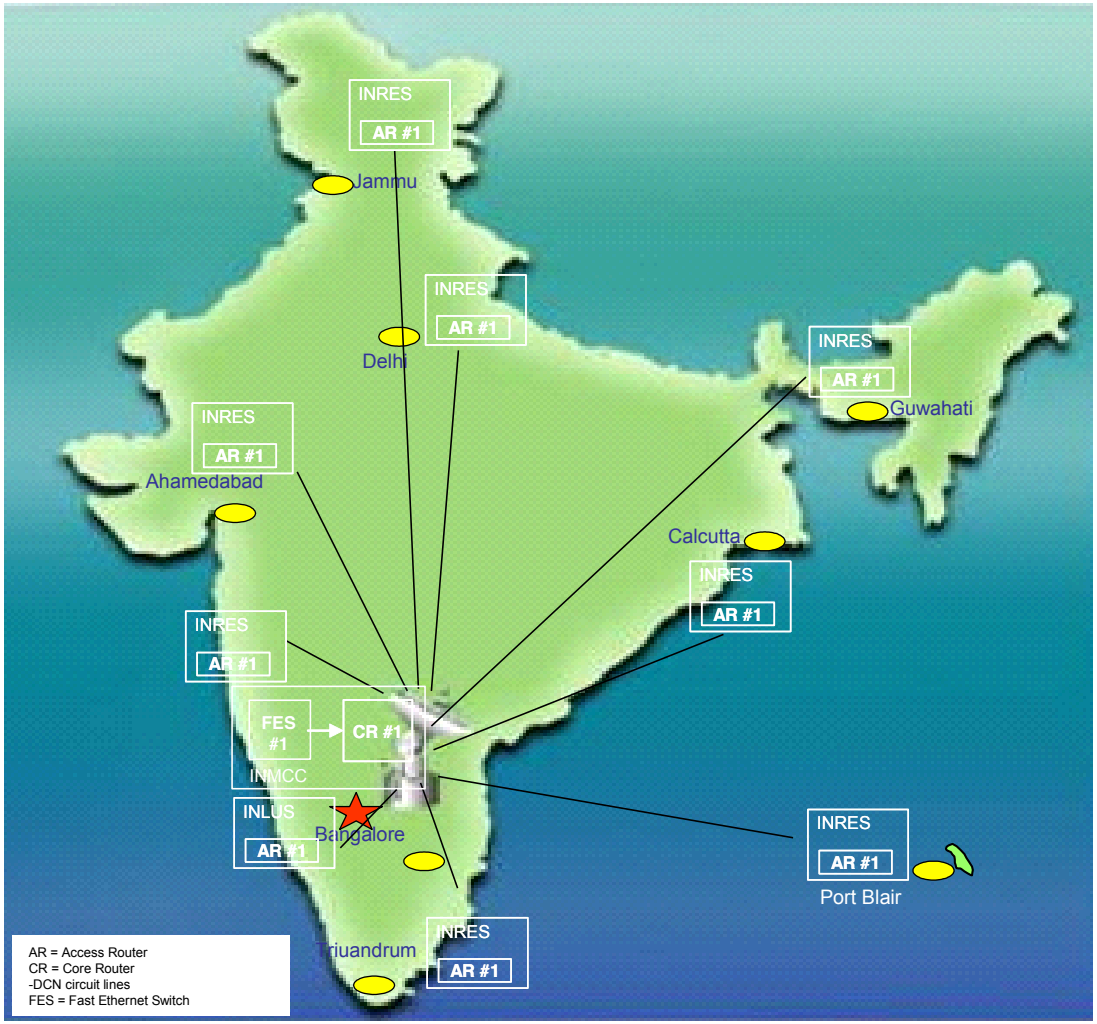


- *GAGAN is a Satellite Based Augmentation System being implemented by India based on GPS*
- *GAGAN jointly implemented by ISRO and Airports Authority of India (AAI)*
- *Compatible and Interoperable with other SBAS*



- *Provides Seamless navigation*
- *GAGAN implementation in two phases:*
  - *GAGAN – TDS (Technology Demonstration System)*
  - *GAGAN – FOP (Final Operation Phase)*

GAGAN Configuration in TDS



Ground Segment

- *8 INRES: 2 INREEs*
- *1 INMCC*
- *1 INLUS*
- *1 ring of OFC (7 INRES)*
- *1 VSAT link (GPB)*

Space Segment

- *INMARSAT-4F1*

GAGAN Signal-In-Space Verified and validated through flight-trail from Hyderabad to Bangalore.

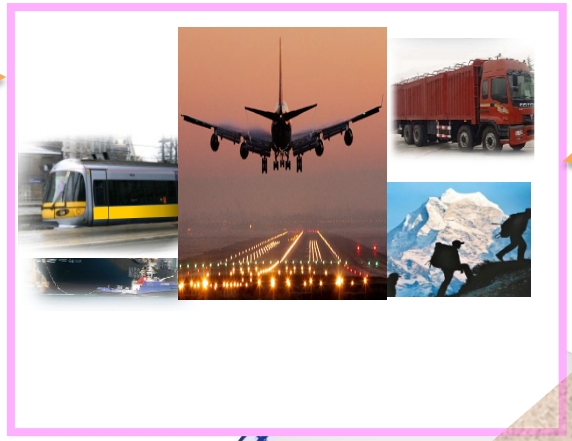
On-board GAGAN Receiver position compared with DGPS position to demonstrate SBAS capability.

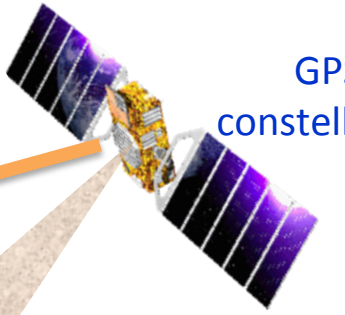
GAGAN Operational System

3 GEO Satellites

3 Uplink stations

2 Control Centres





GPS constellation

15 Reference Stations

4 Data communication networks

GAGAN – Intended Services

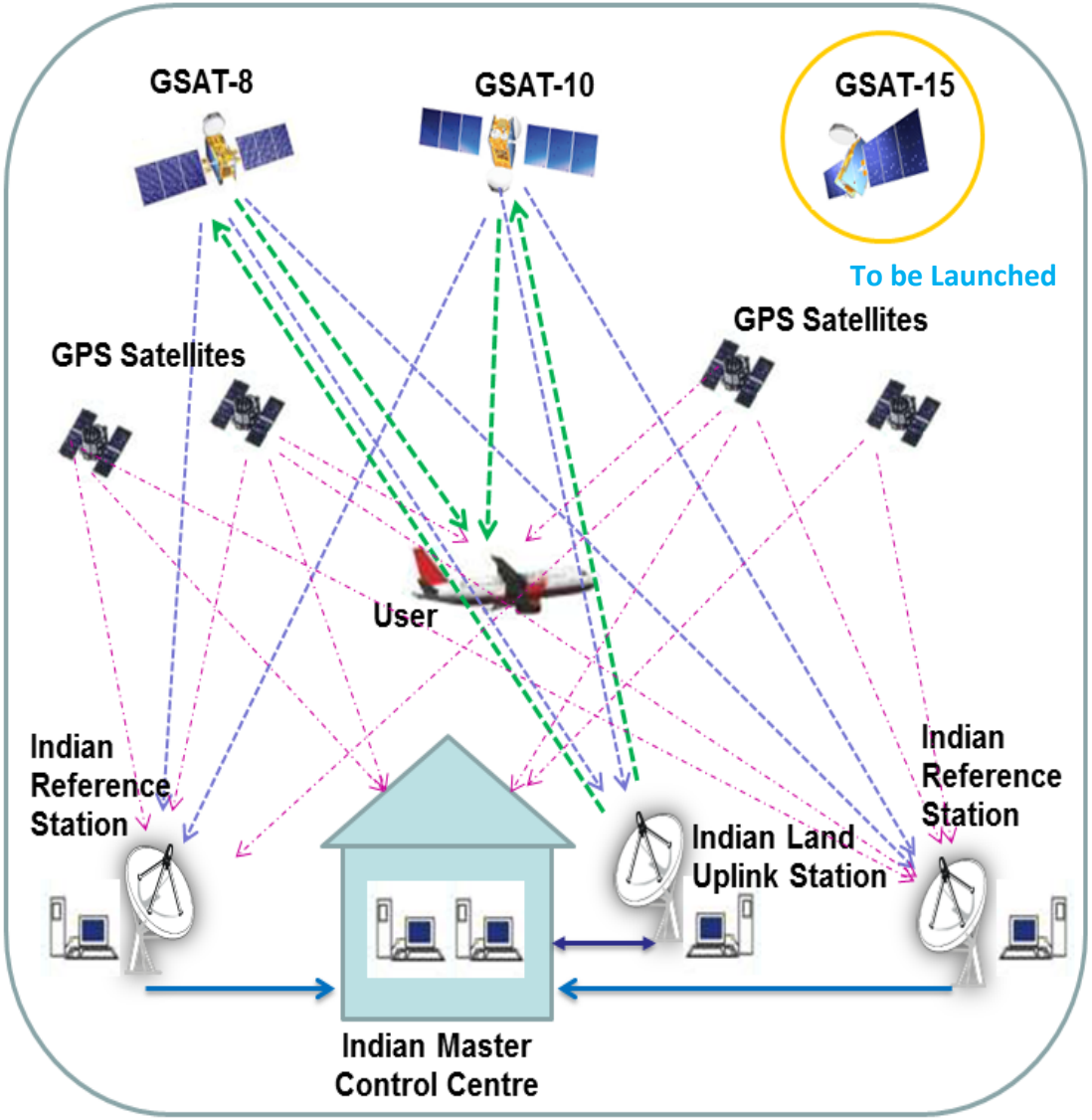
- *High position accuracies with integrity (APV- 1/1.5 and RNP 0.1) over a wide geographical area such as the Indian Airspace.*

- *These position accuracies to be simultaneously made available to all airports and air fields in Indian FIR, enabling satellite based landing of aircraft fitted with SBAS receivers.*

- *To provide fuel efficient air corridors.*

- *Better upper Air-space management over India.*

GAGAN – Current Status



- *The GAGAN Signal-in-Space is available through GSAT-8 and GSAT-10*
- **GAGAN System certified by DGCA (Director General of Civil Aviation) on 30th December 2013 for En-route RNP 0.1 (Required Navigation Performance – 0.1 Nautical Mile) level operation**
- ***The certification process for APV-1/1.5 by DGCA is under progress***

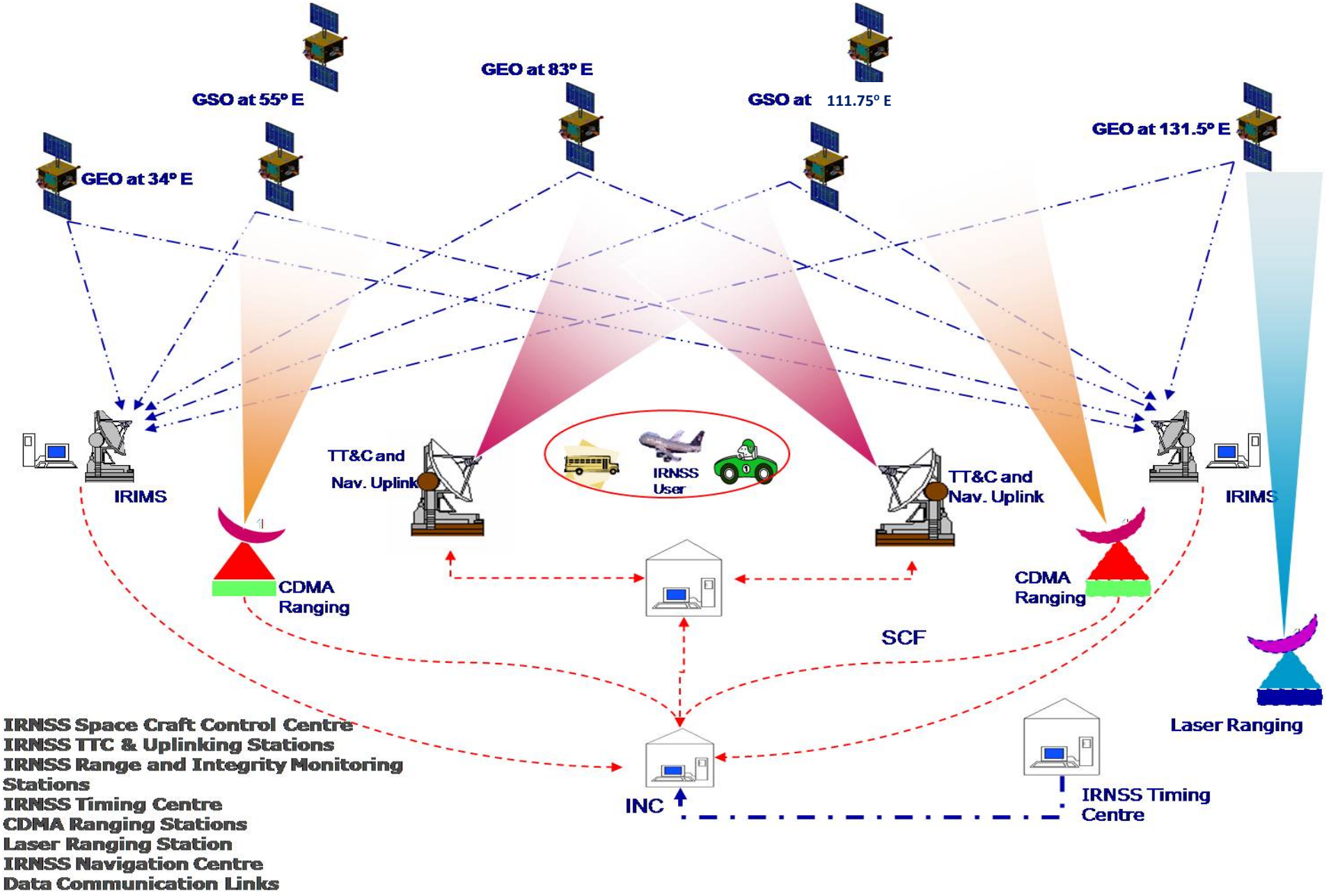
Indian Regional Navigation Satellite System (IRNSS)

- *IRNSS is an independent regional navigation system.*
- *7 satellite constellation and ground segment.*
- *Coverage area is about 1500 km beyond Indian territory.*
- *Estimated horizontal position accuracy of 20m in over India and adjoining areas.*

IRNSS - Objectives

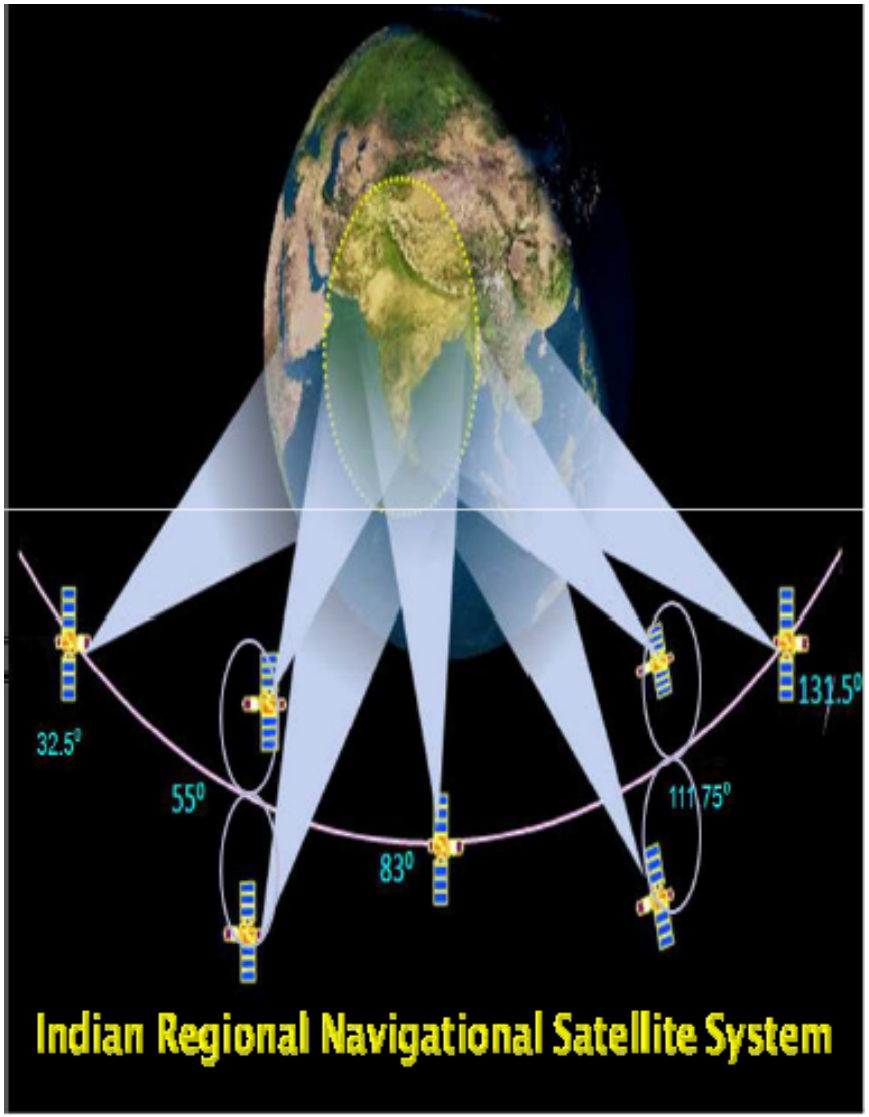
- *Reliable Position, Navigation and Timing services over India and its neighbourhood*
- *To provide 20m accuracy to the user in the Indian Subcontinent*
- *Entire constellation is visible to the user in the service area at all time.*
- *Grid based Ionospheric correction messages to single frequency user.*

IRNSS CONFIGURATION



IRNSS SPACE SEGMENT

- *Consists of 7 Satellites, 3 in Geo-Stationary orbit at 32.5°, 83° and 131.5° East.*
- *4 Satellites in GEO Synchronous orbit at inclination of 29° with Longitude crossing at 55° and 111.75° East.*
- *IRNSS Satellites are to be launched by the Indian launcher PSLV.*
- *The first Satellite launched on 1st July 2013. The second satellite launched on 4th April 2014, the third satellite launched on 16th October 2014*
- *The full constellation will be realized by the end of 2015.*



IRNSS Ground Systems

IRNSS CDMA Ranging Stations (IRCDR)

ISRO Navigation Centre (INC)

IRNSS Range & Integrity Monitoring Stations (IRIMS)

IRNSS Network Timing Facility (IRNWT)

IRNSS Data Communication Network (IRDCN)

IRNSS Spacecraft Control Facility (IRSCF)

IRNSS Ground Systems

- *CDMA ranging from all four IRCDR stations and one way ranging from twelve IRIMS stations being carried out for orbit determination*
- *IRNWT is maintained well within 15ns with respect to UTC*
- *Laser ranging has been successfully carried out from ILRS stations. ISRO acknowledges the laser ranging support provided by these stations with thanks and appreciation.*
- *Navigation signal performance is being monitored.*

IRNSS USER SEGMENT

- *The user segment consists of IRNSS receivers operating in*
  - *Single Frequency (L5 or S band)*
  - *Dual Frequency (L5 and S band)*
- *Single frequency and dual frequency receivers shall receive both SPS and RS signals. SPS is for civilian users. RS signal is meant for authorised users.*

IRNSS SIGNALS

- *IRNSS signals are transmitted using the following frequencies and modulations.*

  L5 : 1176.45 MHz
  S : 2492.028 MHz

- *Modulation schemes:*

  BPSK(1) and BOC (5,2)

IRNSS SIS ICD available for Download at http://irnss.isro.gov.in

Thank you for your Attention