

Ionosphere Modelling In India For Satellite Navigation Programme

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Indian Satellite Navigation Program

Consists of two Projects

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



GAGAN: Performance Objective

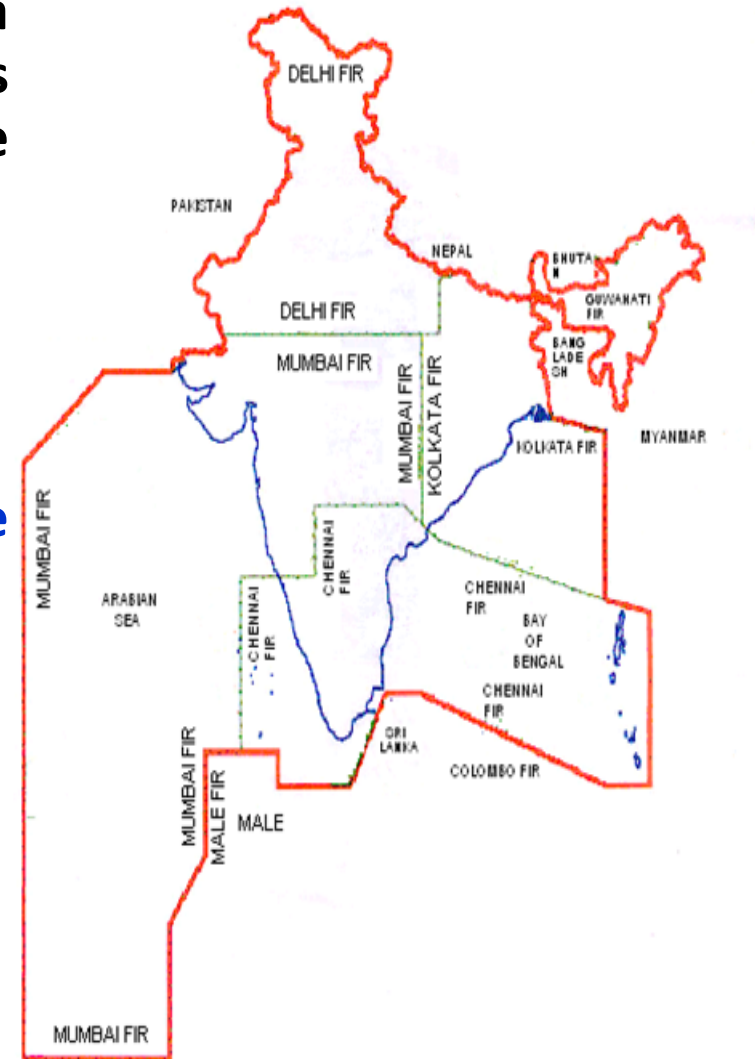
The objective of GAGAN-FOP is to realize a certified and operational SBAS for all phases of flight path **over the Indian FIR** to provide the air navigation services of

- ❖ RNP 0.1 en route navigation within Indian FIR
- ❖ APV-1/1.5 precision approach over the landmass of Indian FIR

Performance Requirements

Flight Phase	Accuracy	HAL	VAL
RNP 0.1	72 m (H)	185 m	N/A
APV 1.5	33.5 m (H) 9.8 m (V)	40 m	50 m

iono.
model

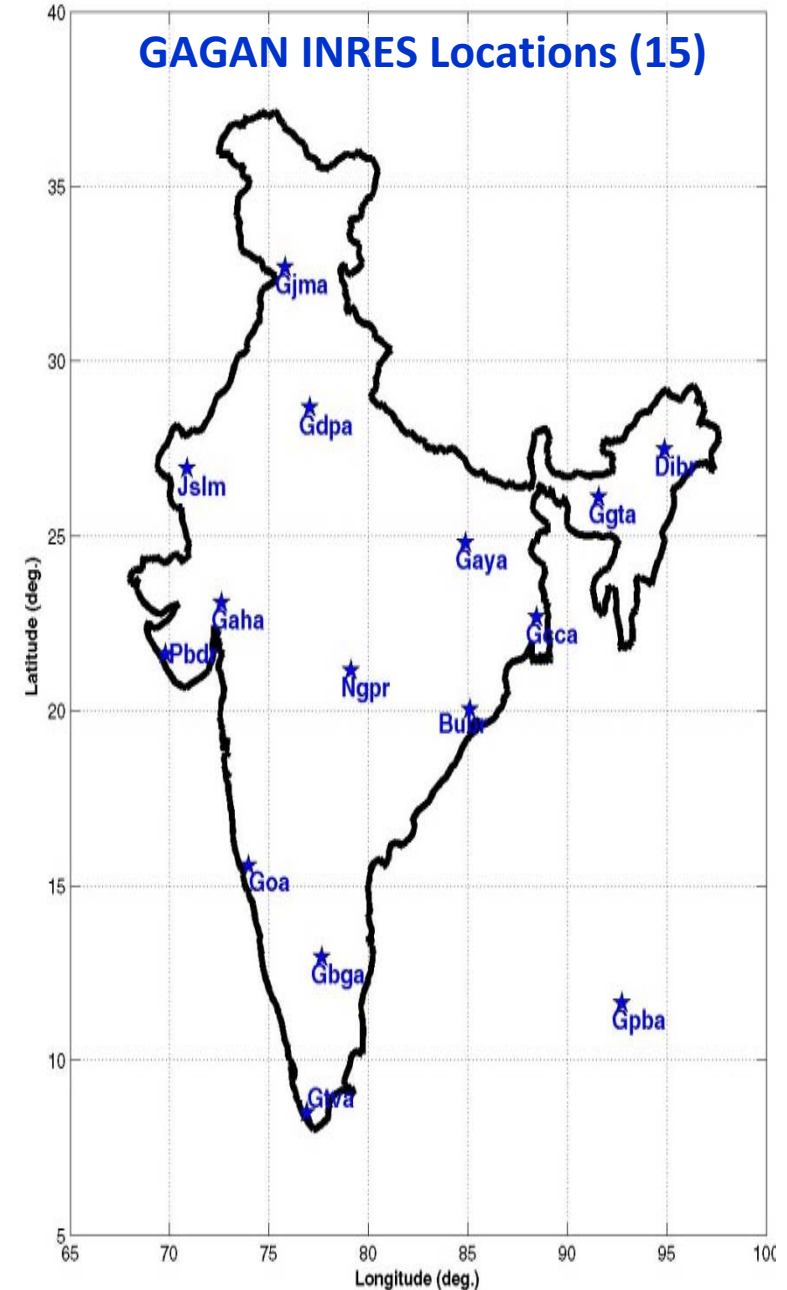




Grid Based Ionosphere Model For GAGAN

IGM-MLDF (ISRO GIVE Model- Multi Layer Data Fusion):

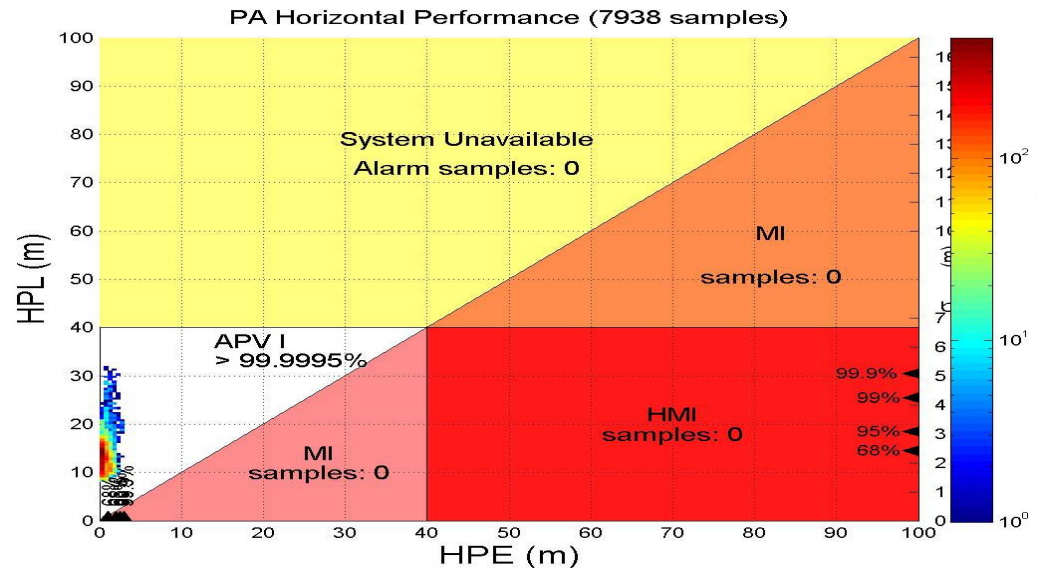
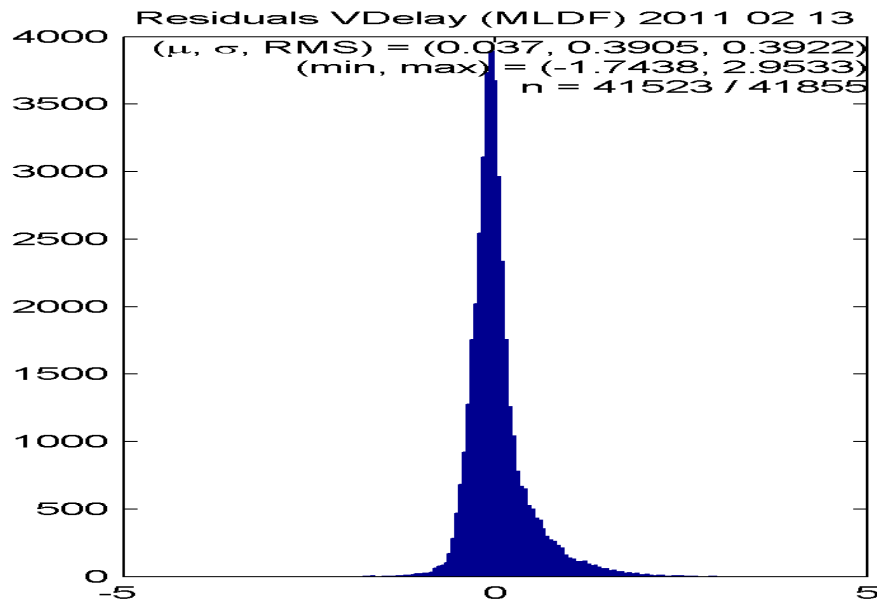
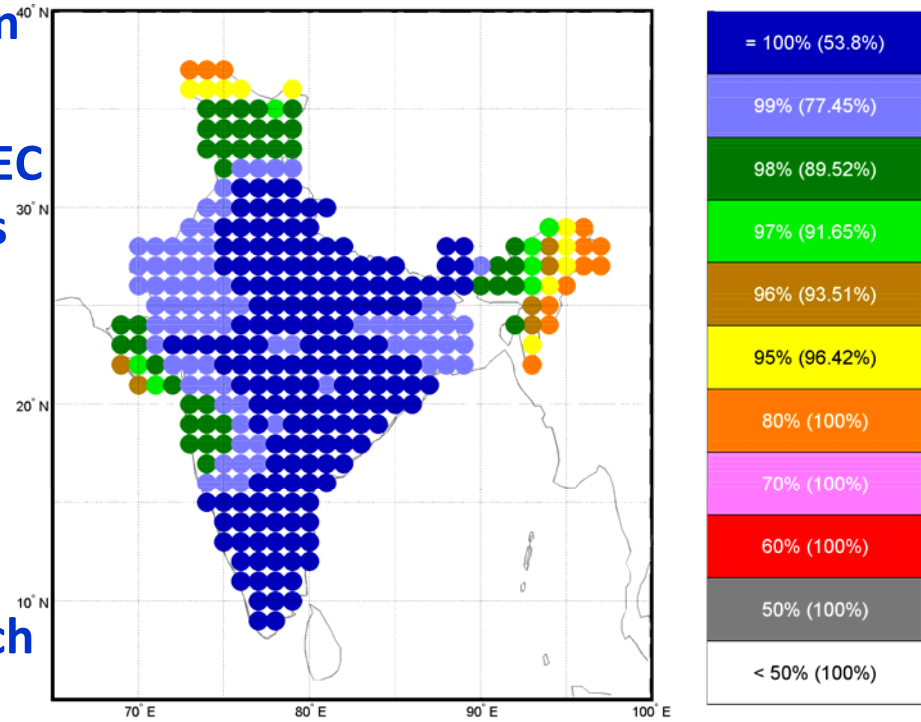
- New Multi layer Grid Based Model
- Uses Data Fusion Technique
- Provides GIVD, GIVE at 350 km (as per MOPS)
 - This model does not call for any change to the existing SBAS message structure
 - No change for the legacy users





IGM-MLDF: Preliminary Results

- Joint activity between ISRO and Raytheon
- Algorithm evaluated using the measurement based model data (ISRO-TEC data) for selected nominal & stormy days over 2004-07
- Algorithm is under evaluation with high quality live data collected over 15 INRES locations
- The live data (supertruth) contains measurements from 2/3 INREEs from each of the INRES



GAGAN TEC Data

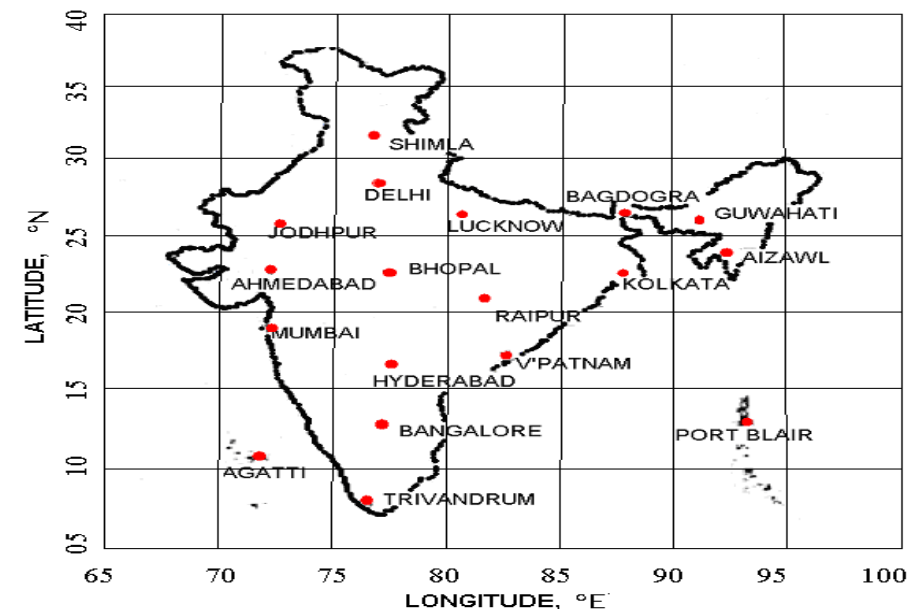
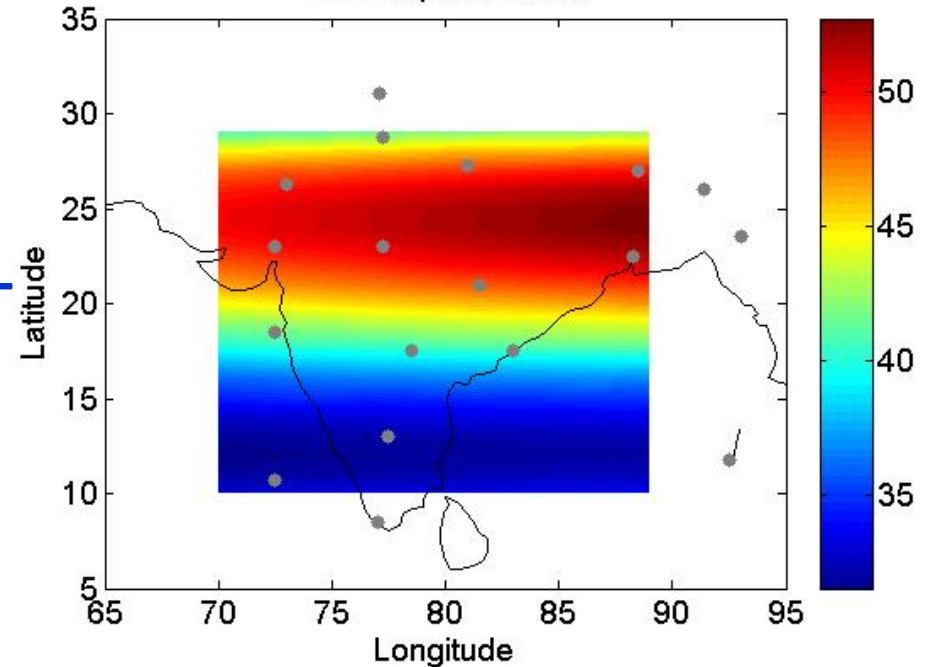
Measurement Based Ionosphere Model - ISRO TEC Model

- Based on real data from GAGAN TEC stations combined with Physics-based Semi-empirical Model
- Provides TEC Map over Indian region

Activities include:

- Data Collection and Archival
- Model Comparison and Validation
- Testing New Algorithms

TEC Map over India





Depletion Studies

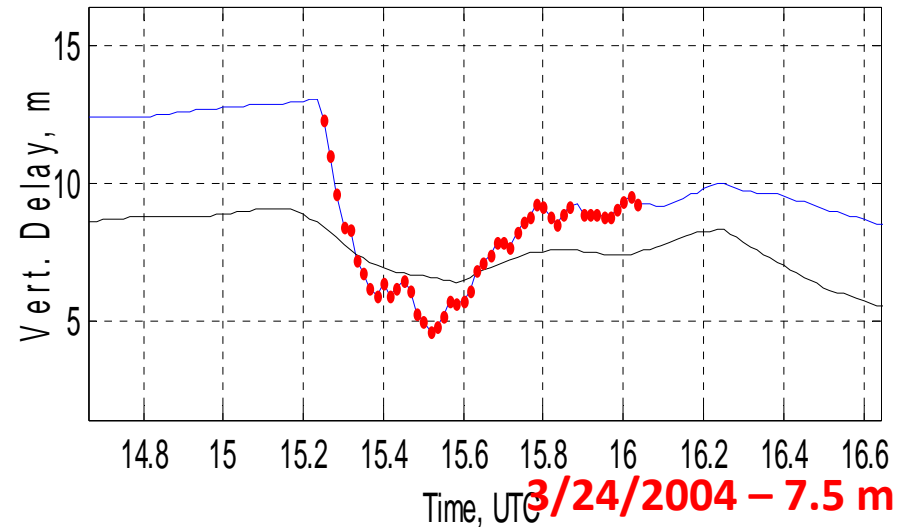
- **Depletion:**

- Post sunset events
- Local phenomena (i.e., Depletion observed by an user may/may not be observed by any of the INRES)
- User protection against depletion: Mitigated through the ground model

- **Observations:**

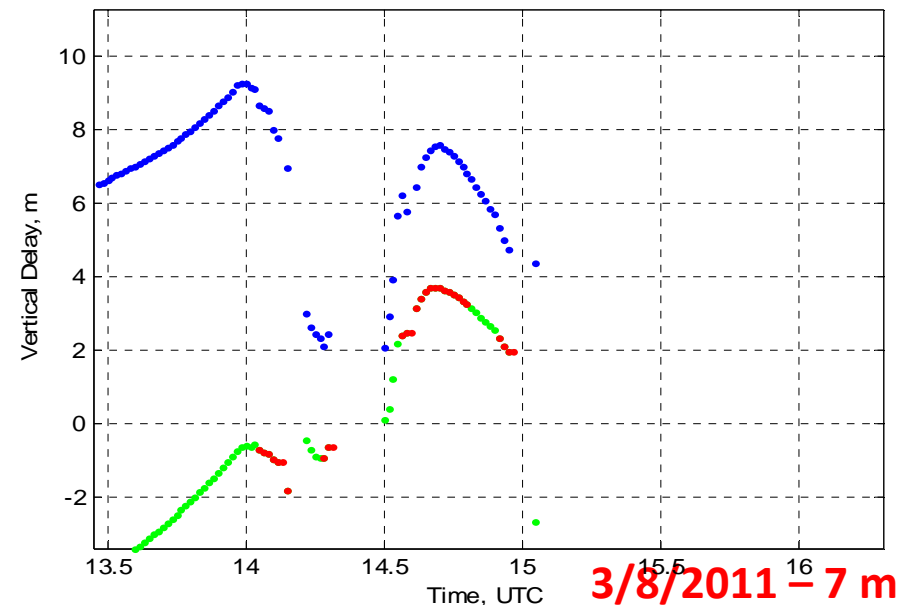
- Indicates that the depletion with >0.5 m magnitude occur during 5:30 p.m. – 3:30 a.m. local time.
- Maximum observed depth: 7 - 7.5 m

GAGAN TEC Data Mumbai 25



GAGAN INRES Data

Vert Delay from L1-L2. Rec. 3. PRN 32





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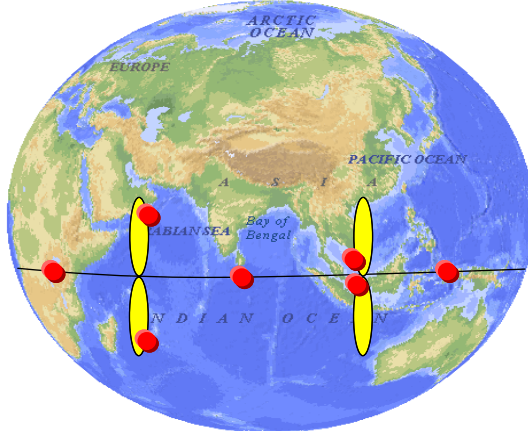
IRNSS: INDIAN REGIONAL NAVIGATION SATELLITE SYSTEM

- Refers to an independent Indian Regional Navigation Satellite System providing navigation services over Indian Region.

IRNSS ELEMENTS

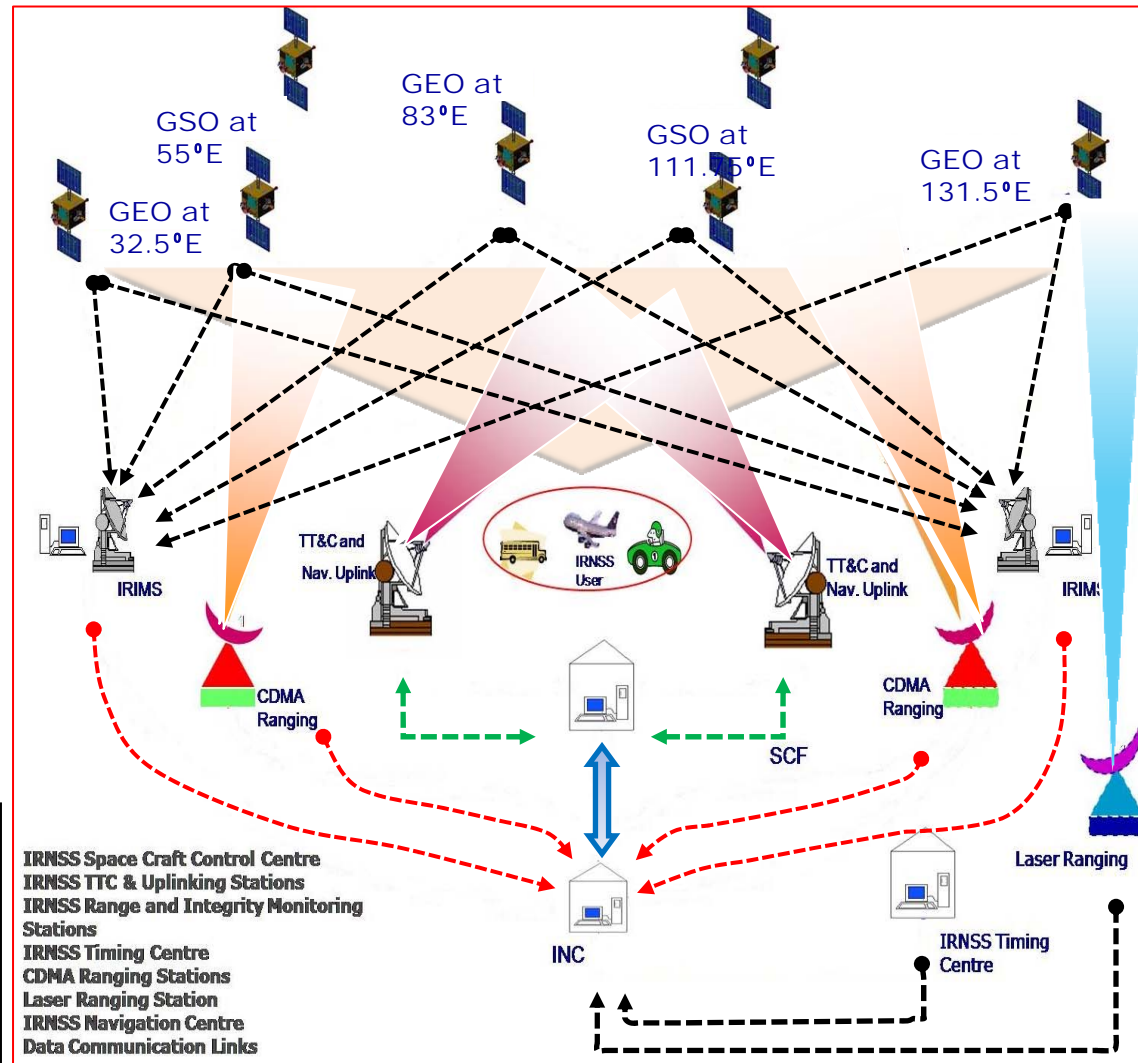
- Space Segment
- Ground Segment
- User Segment

SPACE SEGMENT



IRNSS SERVICES

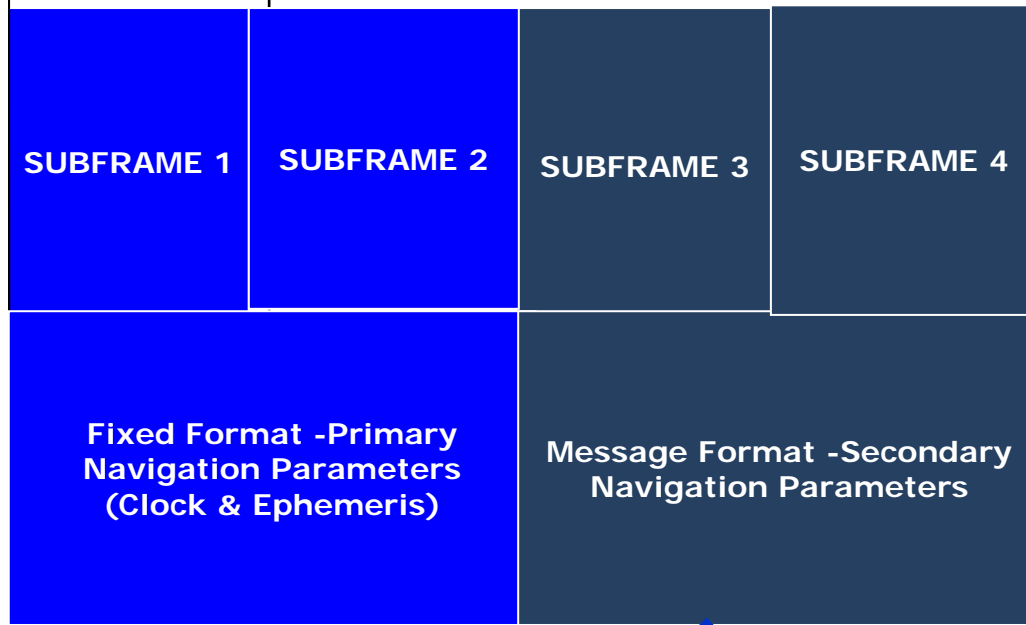
Service Type	Freq. Band
Standard Positioning Service	L5(1176.45Mhz) S(2492.028hz)
Restricted Services for Special Users	L5 S



IRNSS Configuration

Ionosphere Corrections In IRNSS

IRNSS Data Structure



1200 bits



- 1. Co-efficient based (4α & 4β) Iono. Corrections
- 2. Grid Based Iono. Corrections (on L5)

IRIMS STATIONS



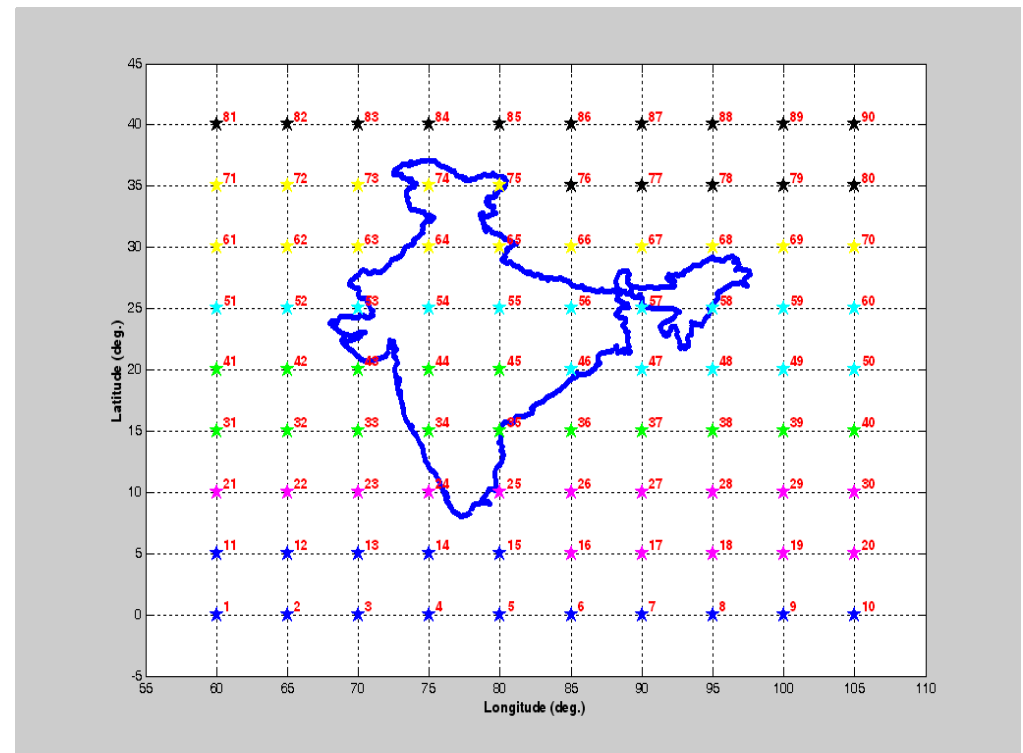


Ionosphere Corrections for IRNSS

- Region Specific co-efficient based model
- Model developed based on
 - GAGAN TEC data
 - GAGAN INRES data

Grid Based Corrections

- IGM-MLDF model for single frequency
- Service Area: Indian Land Mass
- Total Number of IGPs
 - 90 (Subdivided into 6 Regions)
- Message Content
 - No. of Regions Serviced
 - Region ID
 - GIVD, GIVE





THANK YOU