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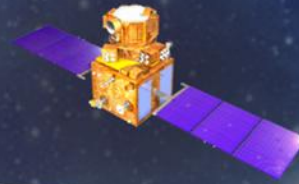
Overview of Indian Satellite Navigation Programme

N. Neelakantan
Director

Satellite Communication and Navigation Programme
Indian Space research Organization
India

The logo of the Indian Space Research Organisation (ISRO) is located in the top left corner. It features a stylized orange and blue arrow pointing upwards, with the text 'इसरो ISRO' in Hindi and English.

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GAGAN

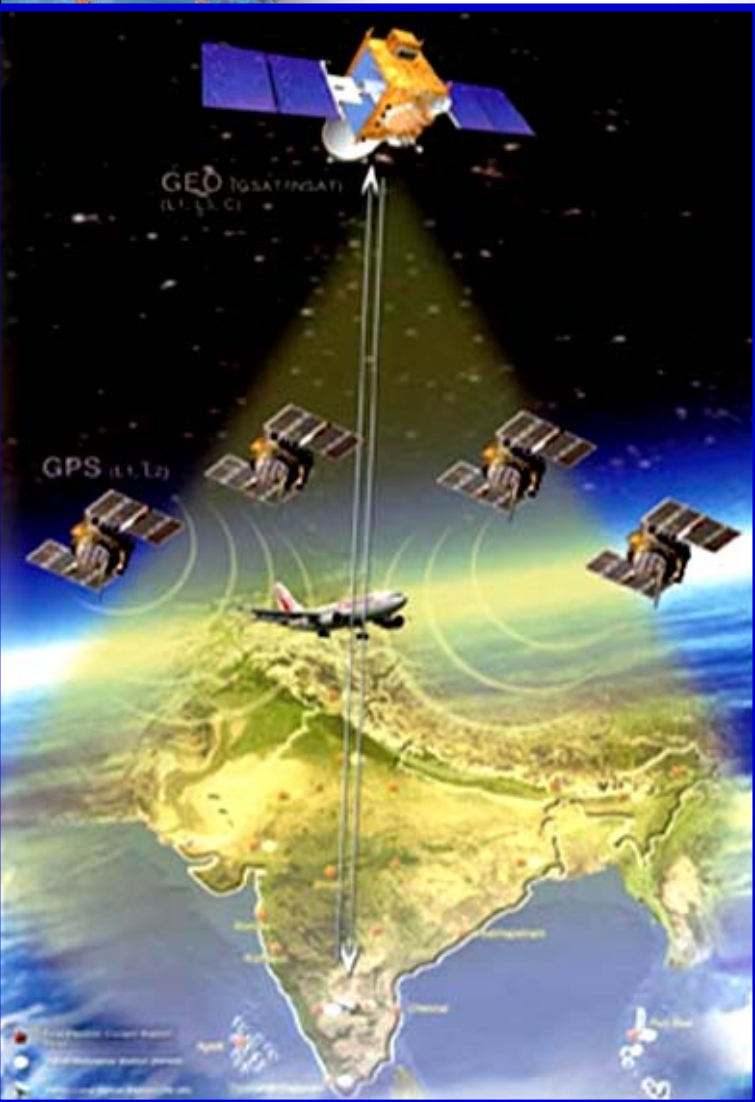
(GPS Aided Geo Augmented Navigation)

GAGAN

GPS Aided GEO Augmented Navigation

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1. GAGAN is a Satellite Based Augmentation System being implemented by India based on GPS
2. GAGAN jointly implemented by ISRO and Airports Authority of India (AAI)
3. GAGAN implementation in two phases
 - GAGAN – TDS (Tech. Demo System)
 - GAGAN – FOP (Final Operation Phase)

GAGAN

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OBJECTIVE

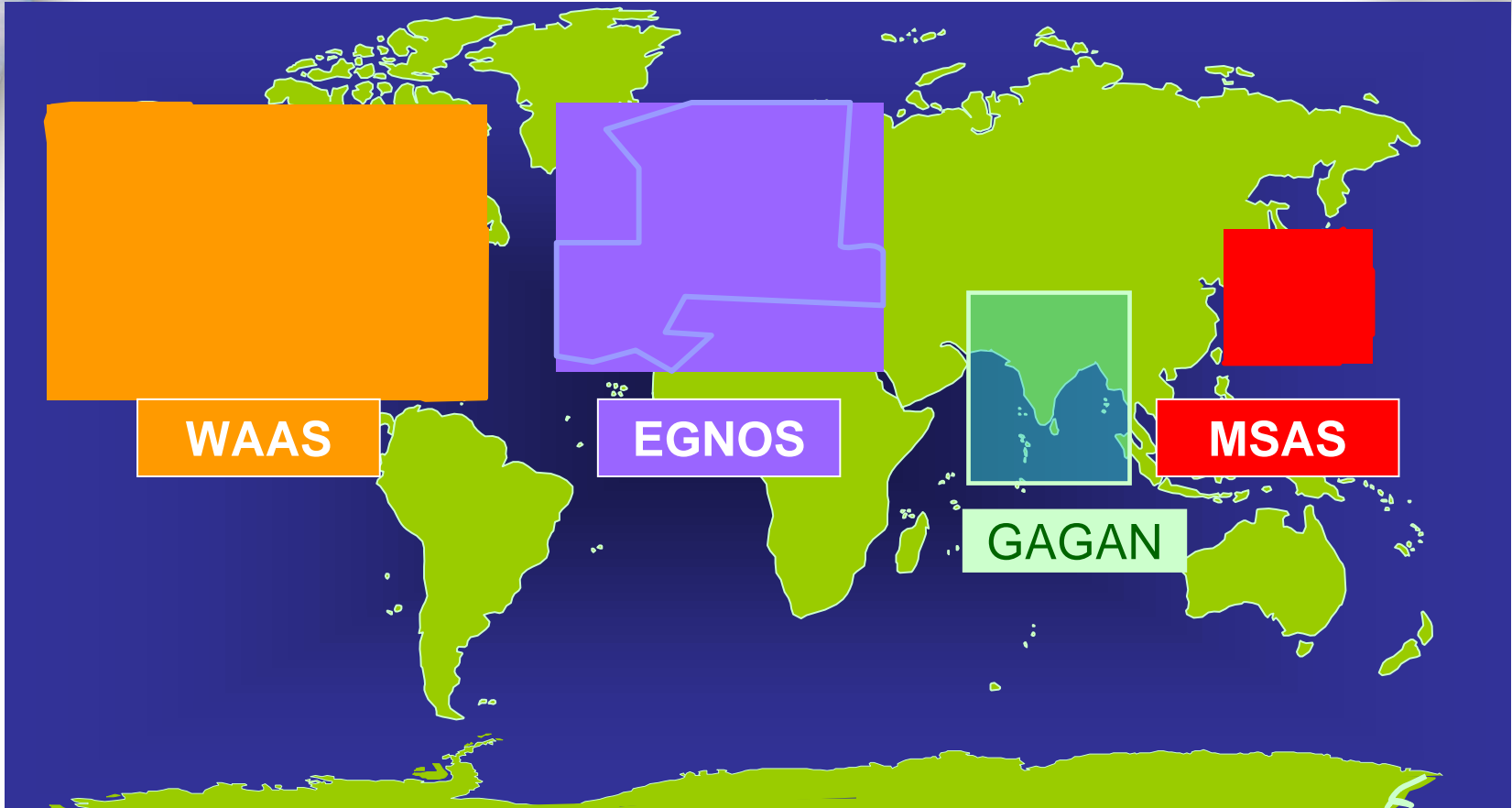
To provide Satellite-based Navigation services with accuracy and integrity required for civilian and aviation applications over Indian Air Space.

Better Air Traffic Management over Indian Airspace.

GPS Augmentation systems

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GAGAN CONFIGURATION

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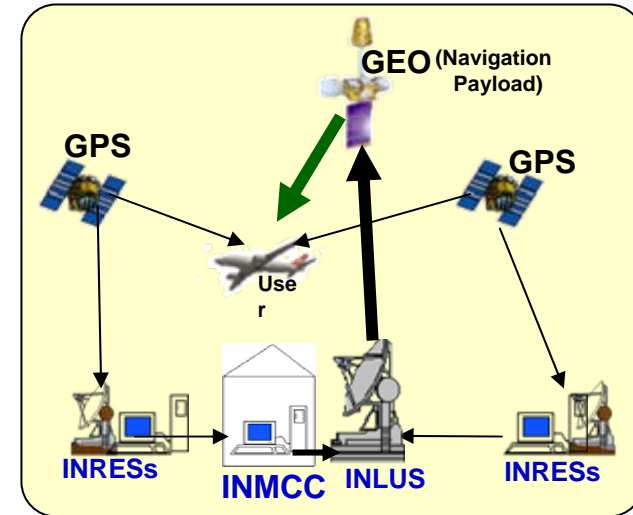
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SPACE SEGMENT Three GEO Satellites

- Two operational Navigation Payloads
- One in-orbit spare Navigation Payload

GROUND SEGMENT

- Indian Master Control Centre (INMCC)
- Indian Navigation Land Uplink Station (INLUS)
- Indian Reference Stations (INRES)
- Communication links



GAGAN NAVIGATION SIGNALS



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GAGAN Space Segment uses SBAS PRN codes 127 and 128 to transmit corrections and integrity parameters to SBAS receiver.

Signals Received by GAGAN Receiver

Signals	Frequency Band
1 MHz BPSK	L1 (1575.42 MHz)
10 MHz BPSK *	L5 (1176.45 MHz)

*** When GPS L5Civil is available**

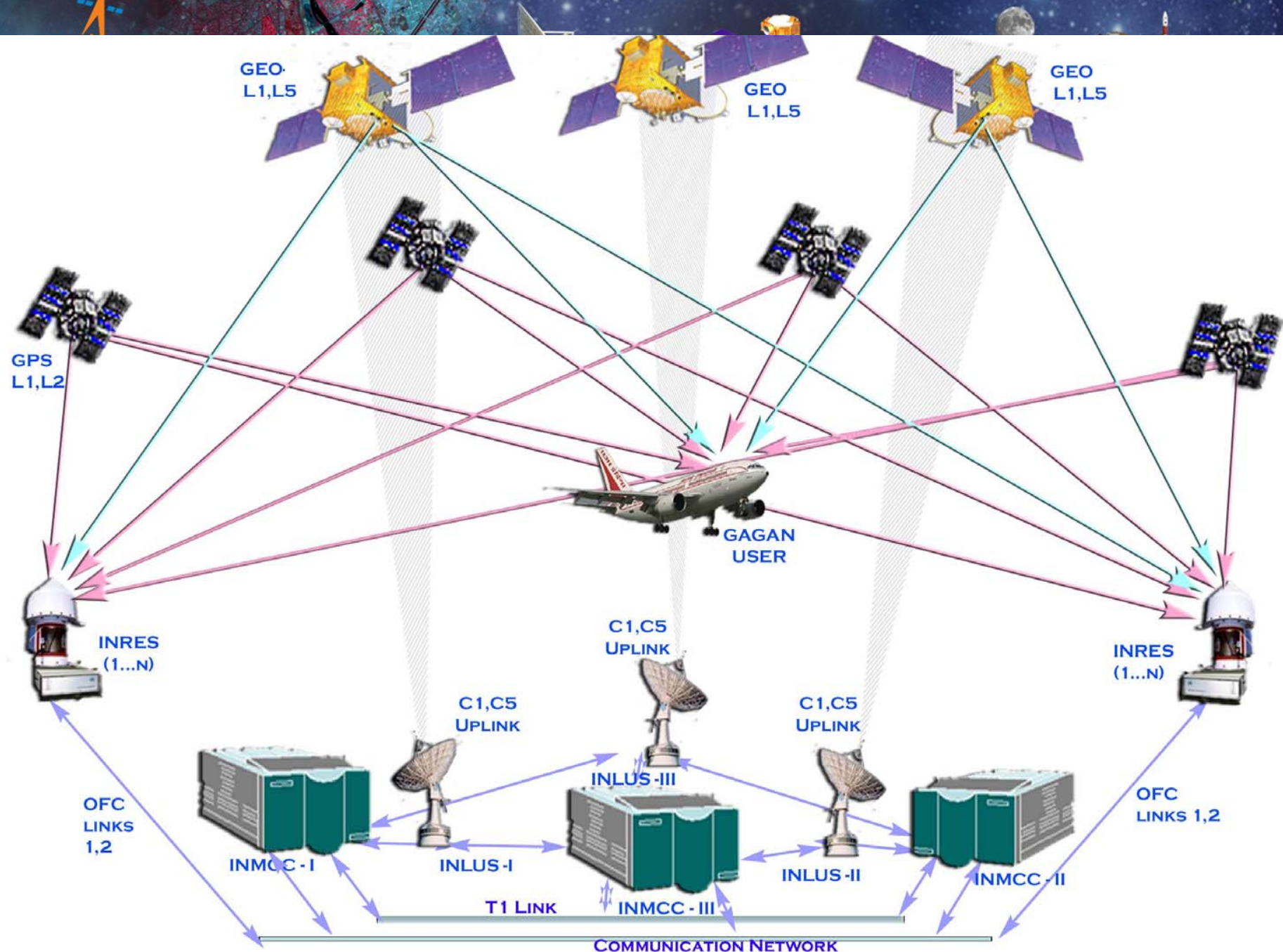
GAGAN PAYLOAD CHARACTERISTICS

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Sl. No.	System characteristics	L1 Freq. (1575.42 MHz)	L5 Freq. (1176.45 MHz)
1.	Transmit EIRP (EOC)	30.2 dBW	29.2 dBW
2.	Receive G/T	-2 dB/deg.K	-2 dB/deg.K
3.	Bandwidth	20 MHz	24 MHz
4.	Footprint	Global	Global
5.	Feeder Link frequency	C-band	C-band
6.	Transmit polarisation	RHCP	RHCP
7.	Type of Antenna	Helix	Helix
8.	Antenna Gain	15.8 dB	15.8 dB
9.	RF Power rating	40W	40W
10.	Total Payload weight	50 Kg	
11.	Power D C	240W	

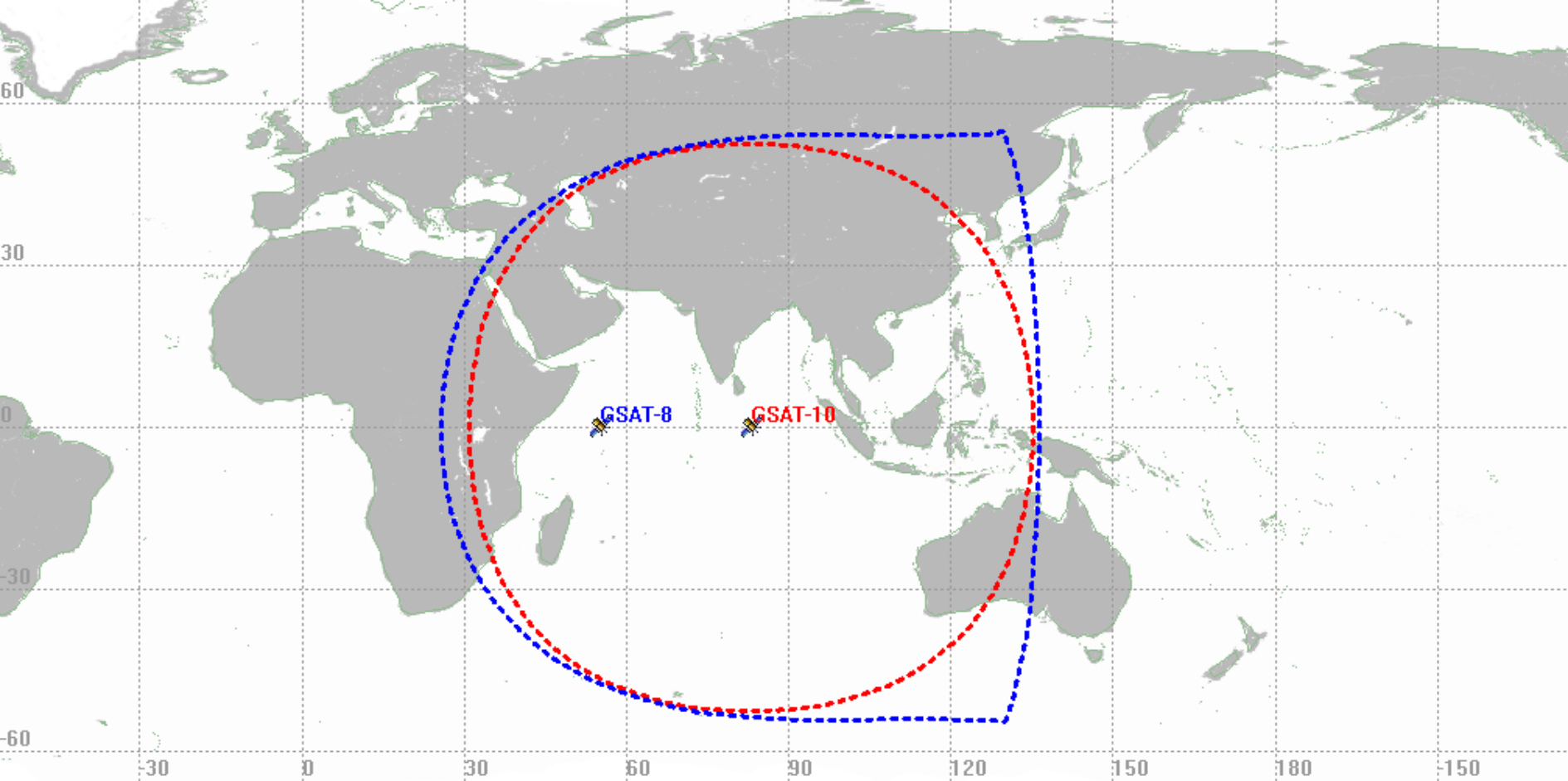
GAGAN CONFIGURATION



GAGAN COVERAGE FROM 55 & 83 Deg.E



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GAGAN INTENDED SERVICES

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- High position accuracies with integrity (APV-1.5 or better) over Indian geographical area.
- 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.



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IRNSS

(Indian Regional Navigation Satellite System)

IRNSS

Indian Regional Navigation Satellite System

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- IRNSS is an independent regional navigation system
- 7 satellite constellation and corresponding ground segment.
- Coverage area is about 1500 km beyond Indian territory.

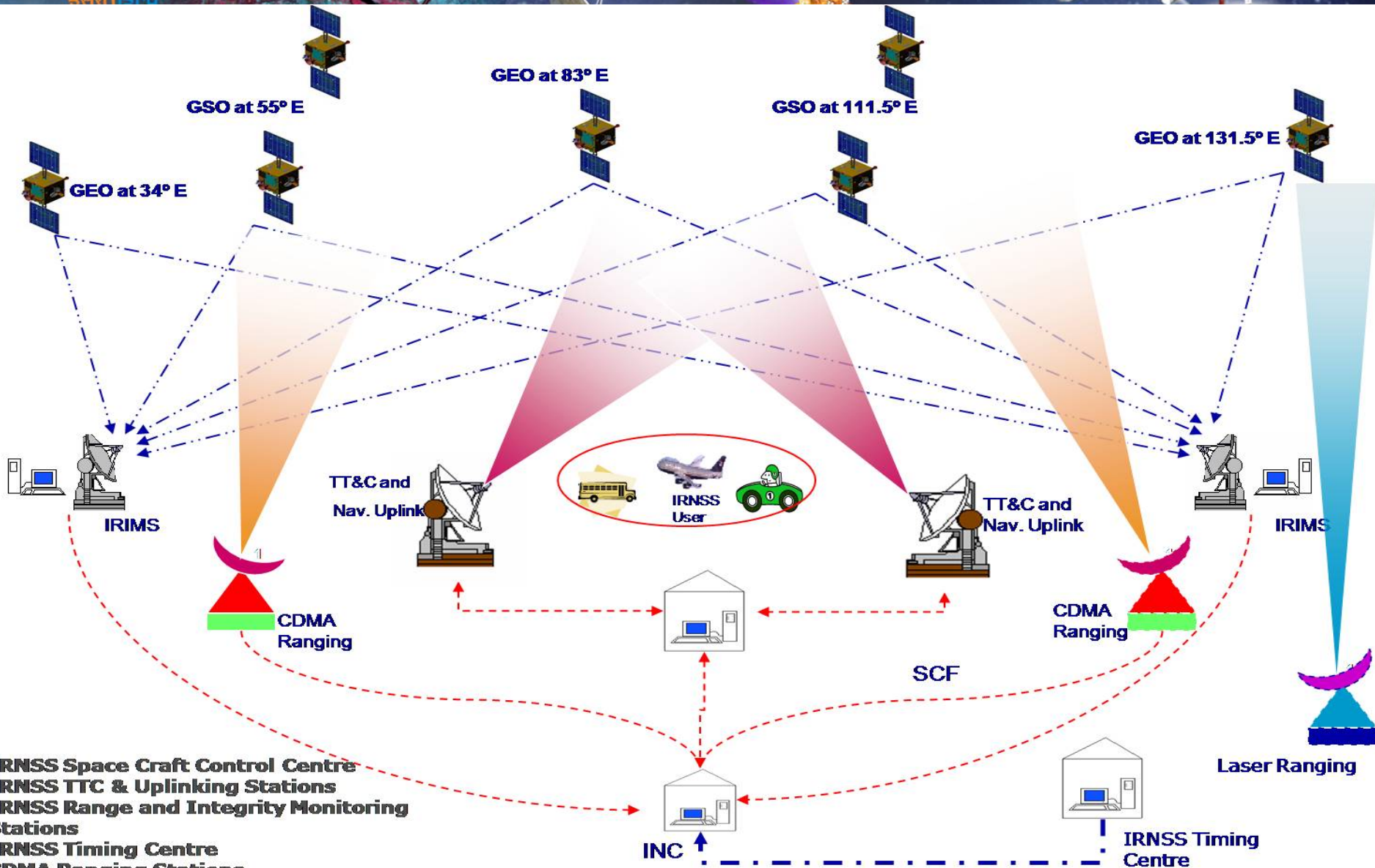
IRNSS

Indian Regional Navigation Satellite System

OBJECTIVES

- Reliable Position, Navigation and Timing services over India and its immediate neighborhood.
- To provide fairly good accuracy to the user.
- The constellation is seen by user all the time.
- Integrity and ionospheric correction messages to user.

IRNSS CONFIGURATION



IRNSS Space Craft Control Centre
IRNSS TTC & Uplinking Stations
IRNSS Range and Integrity Monitoring Stations
IRNSS Timing Centre
CDMA Ranging Stations
Laser Ranging Station
IRNSS Navigation Centre
Data Communication Links

IRNSS SPACE SEGMENT

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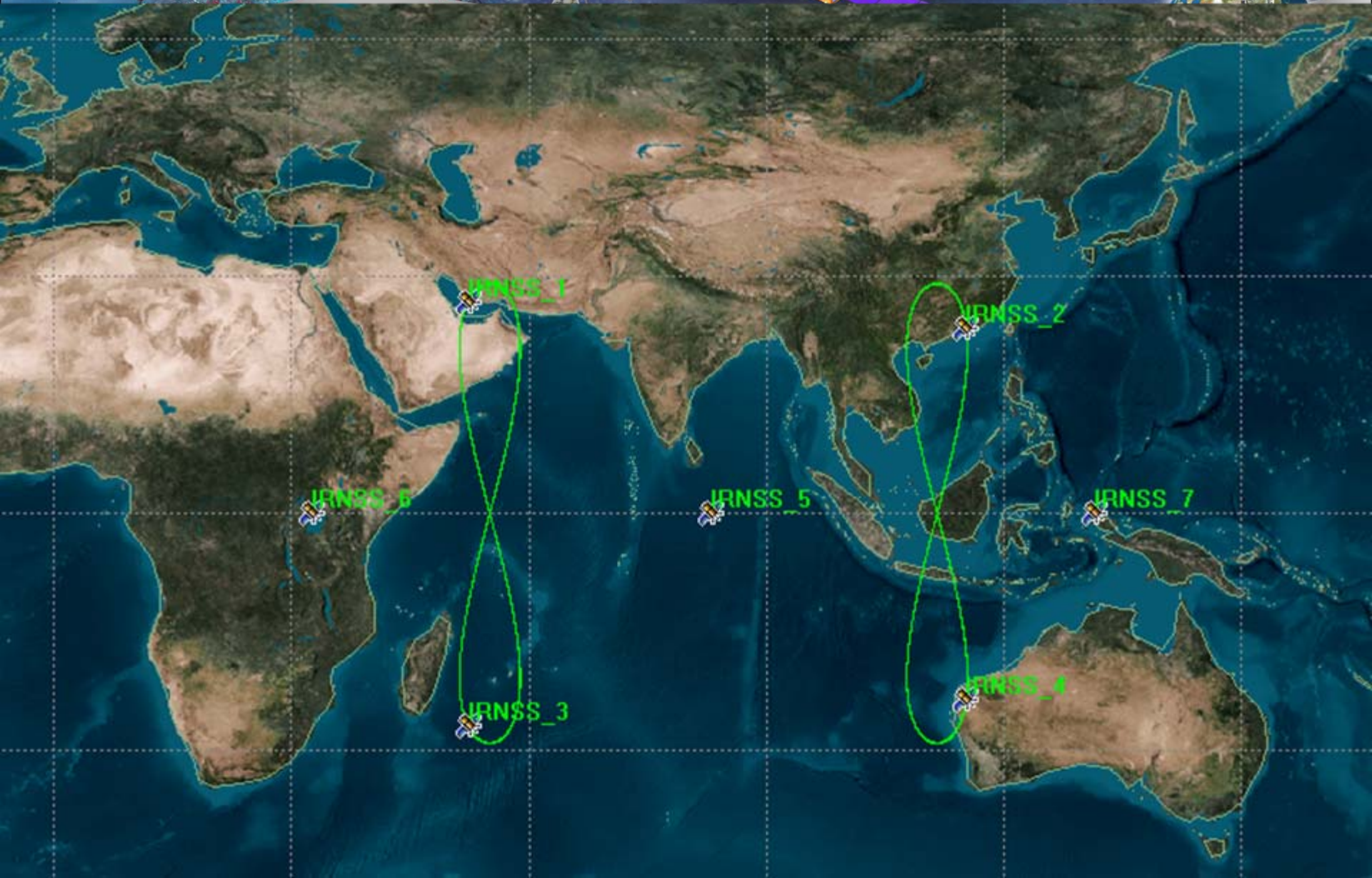
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- ✚ 3 GSO satellites at 34° , 83° , and 131.5° East.
- ✚ 4 Inclined GSO satellites at 29° inclination with Longitude crossing at 55° and 111.5° .
- ✚ To be launched indigenously on the proven Indian PSLV.
- ✚ First satellite launch by second half of 2011.
- ✚ Full constellation completion by mid 2014.
- ✚ In Phase#2, the space segment is proposed to be augmented with 4 more satellites to make 11 satellite constellation with better coverage and accuracy.



IRNSS SPACE SEGMENT

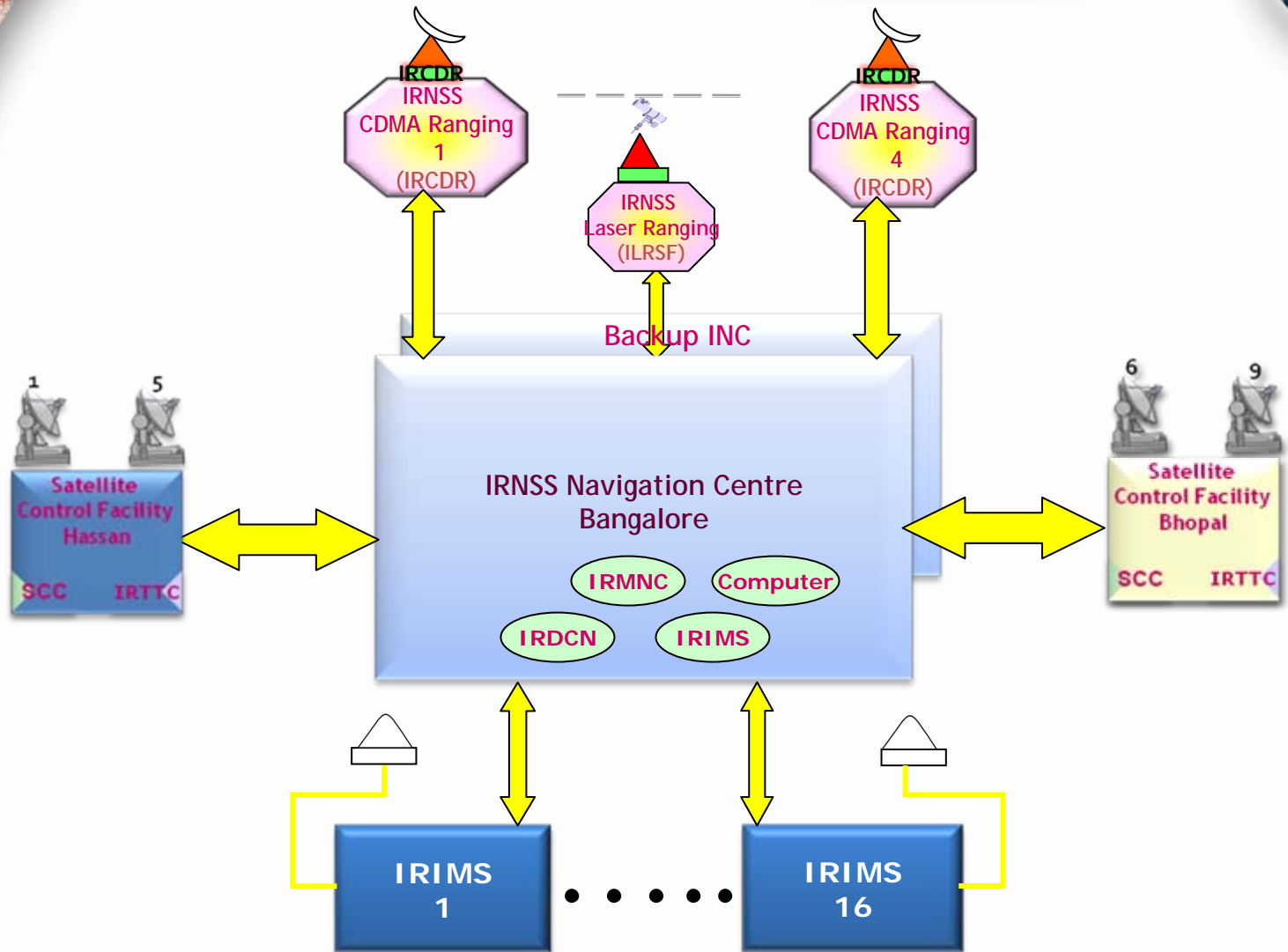
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IRNSS- GROUND SEGMENT Architecture



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IRNSS- GROUND SEGMENT Architecture

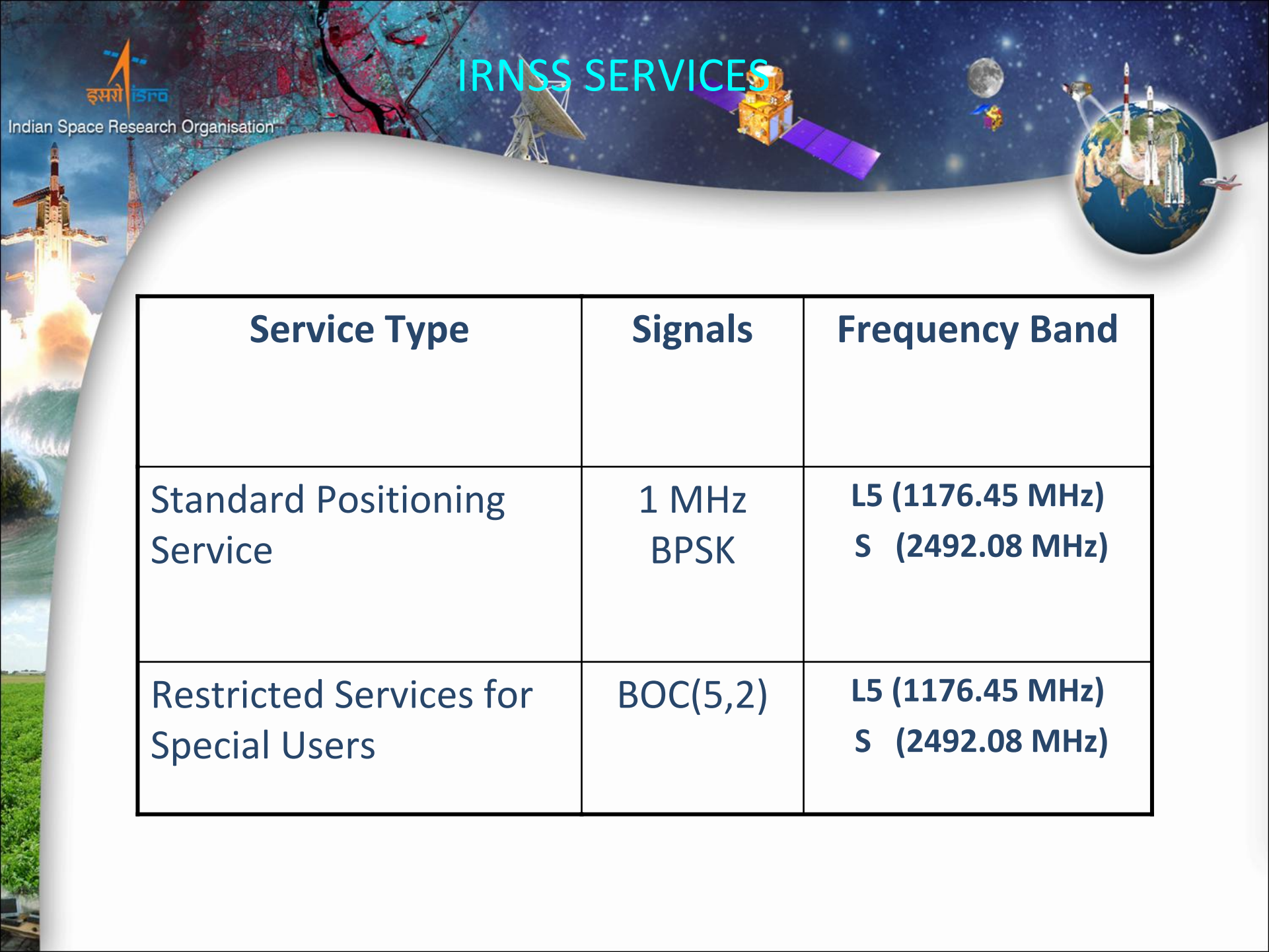
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- **IRNSS Navigation Control Facility (IRNCF)**
 - IRNSS Navigation Centre (INC) - 2 Nos**
 - IRNSS Network Time (IRNWT) - 2 Nos**
 - IRNSS CDMA Ranging Stations (IRCDR) - 4 Nos**
 - IRNSS Laser Ranging Service (ILRS)**
 - IRNSS Range and Integrity Monitoring Stations - 16 Nos**
 - IRNSS Data Communication Network (IRDCN)**

- **IRNSS Satellite Control Facility (IRSCF)**
 - IRNSS TTC & Land Uplink Stations (INLUS) - 9 Nos**
 - IRNSS Satellite Control Centre (IRSCC) - 2 Nos**

IRNSS SERVICES



Service Type	Signals	Frequency Band
Standard Positioning Service	1 MHz BPSK	L5 (1176.45 MHz) S (2492.08 MHz)
Restricted Services for Special Users	BOC(5,2)	L5 (1176.45 MHz) S (2492.08 MHz)

IRNSS NAVIGATION SIGNALS

	SPS	RS
L5 (1176.45 MHz)	BPSK	BOC (5,2)
S band (2492.028 MHz)	BPSK	BOC(5,2)

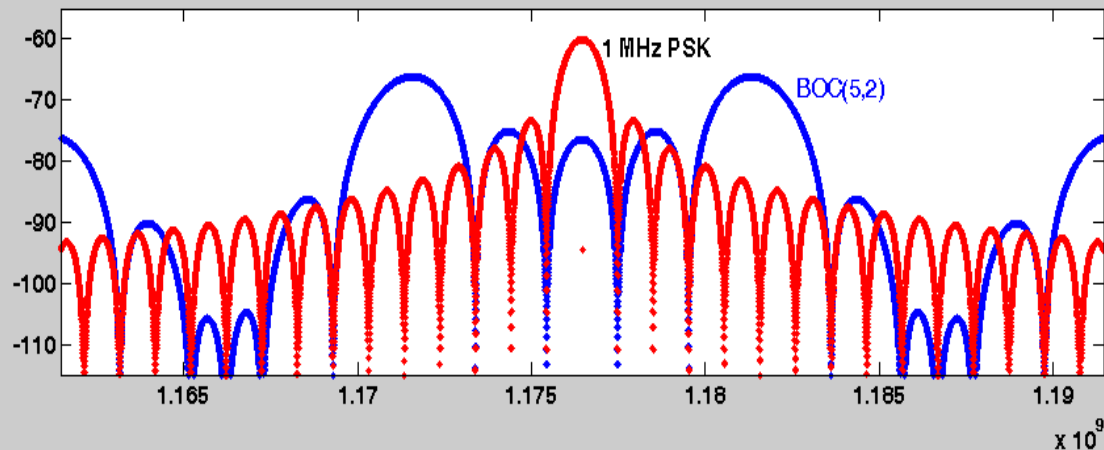
CDMA Ranging Frequencies

- Uplink : 6712 .0MHz (B.W 24MHz)
- Downlink : 3412 .0 MHz (B.W 24MHz)

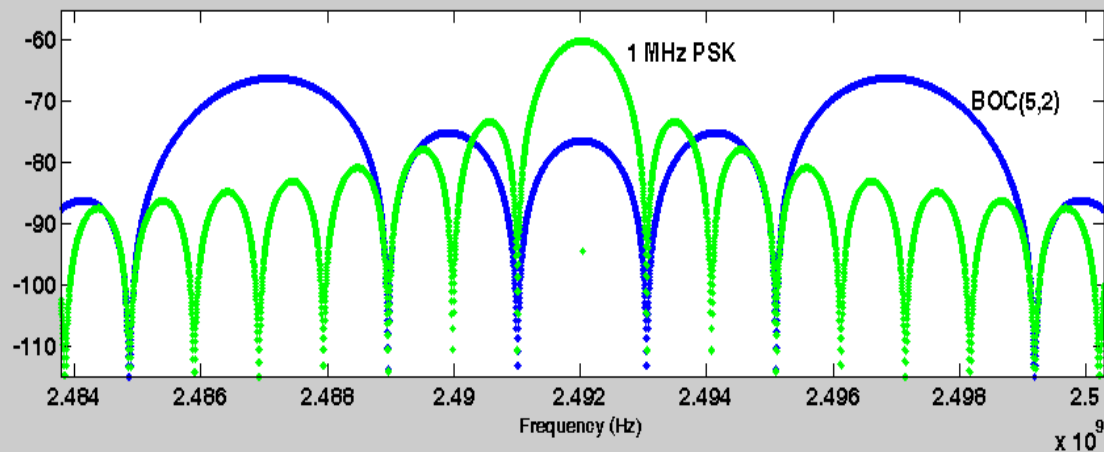
IRNSS NAVIGATION SIGNALS



IRNSS Signals (PSD in dBW) in L5 - Band: 1.023 PSK and BOC(5,2)



IRNSS Signals (PSD in dBW) in S - Band: 1.023 PSK and BOC(5,2)





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THANK YOU

GNSS- Aviation Alert Limits



Service	HAL	VAL	Decision Ht.
RNP 0.1	0.2 nm	None	None
LP	40 m	Barometer	250 ft.
APV 1.5	40 m	50 m	250 ft.
LPV 200*	40 m	35 m	200 ft.
CAT-I	40 m	10-15 m	200 ft.

GNSS- Aviation Operational Performance Requirements

	<i>Accuracy</i>	<i>Integrity</i>	<i>Time-to-Alert</i>	<i>Continuity</i>	<i>Availability</i>
En route	3.7 km (H)	1-10⁻⁷ per hr	5 min	1-10⁻⁴/hr to 1-10⁻⁸/hr	0.99 to 0.99999
Terminal	0.74 km (H)	1-10⁻⁷ per hr	15 sec	1-10⁻⁴/hr to 1-10⁻⁸/hr	0.999 to 0.99999
Initial & Int Approach, NPA, Departure	220 m (H)	1-10⁻⁷ per hr	10 sec	1-10⁻⁴/hr to 1-10⁻⁸/hr	0.99 to 0.99999
APV-I	220 m (H) 20 m (V)	1-2x10⁻⁷ per approach	10 sec	1-8x10⁻⁶/hr in any 15 sec	0.99 to 0.99999
APV-II	16 m (H) 8 m (V)	1-2x10⁻⁷ per approach	6 sec	1-8x10⁻⁶/hr in any 15 sec	0.99 to 0.99999
CAT I	16 m (H) 6-4 m (V)	1-2x10⁻⁷ per approach	6 sec	1-8x10⁻⁶/hr in any 15 sec	0.99 to 0.99999

IRNSS NAVIGATION FRAME STRUCTURE



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SUBFRAME 1	Fixed Format-- Ephemeris and clock parameters
SUBFRAME 2	Fixed Format-- Ephemeris parameters
SUBFRAME 3	Message Format-- Secondary parameters
SUBFRAME 4	Message Format-- Secondary parameters

Format
SUBFRAME 1 & 2

TLM	TOW	DATA	CRC	TAIL
8	22	232	24	6

Format
SUBFRAME 3 & 4

TLM	TOW	MSG ID	DATA	CRC	TAIL
8	22	6	226	24	6

FRAME STRUCTURE AFTER FEC

2400 bits @50bps

SUBFRAME 1	SUBFRAME 2	SUBFRAME 3	SUBFRAME 4
600 Symbols	600 Symbols	600 Symbols	600 Symbols

Structure for Master Frame

600 Symbols	
Sync Code	Subframe
16 Bits	584 symbols

IRNSS Subframe Structure