Recent Advancement in Space Technology and Satellites for Disaster Management Application in SAARC Region

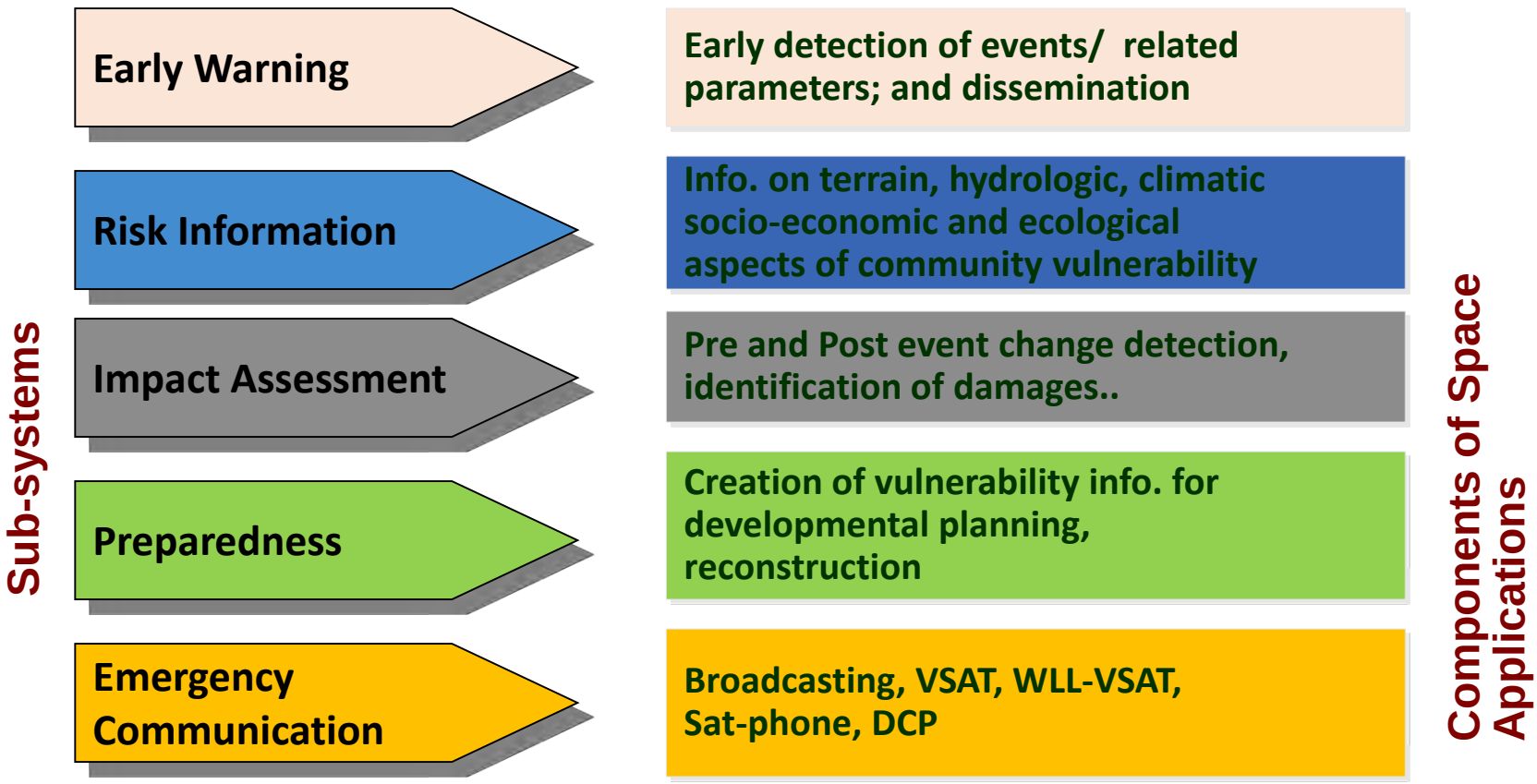
D K Singh, SAC/ISRO

Role of Space Technology

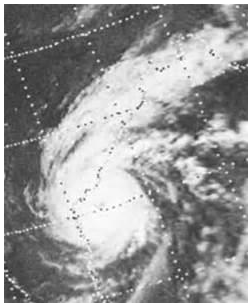
All components of space technology (Earth Observation, Satellite Communication and Satellite Navigation) play an important role in disaster management.

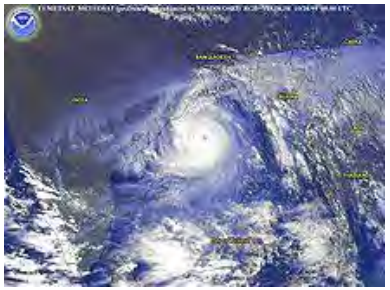
- **Earth observation** is used in all phases of disaster management: Early warning, Preparedness, Monitoring, Response, Recovery and Mitigation.
- **Satellite Communications** provide the critical path for relief in emergency and disaster situations, in-situ observation network, transfer of data & products in near real-time to decision makers/ managers.
- **Satellite Navigation** provides the crucial location information required either directly for relief operation or for proper utilization of remote sensing data in disaster management.

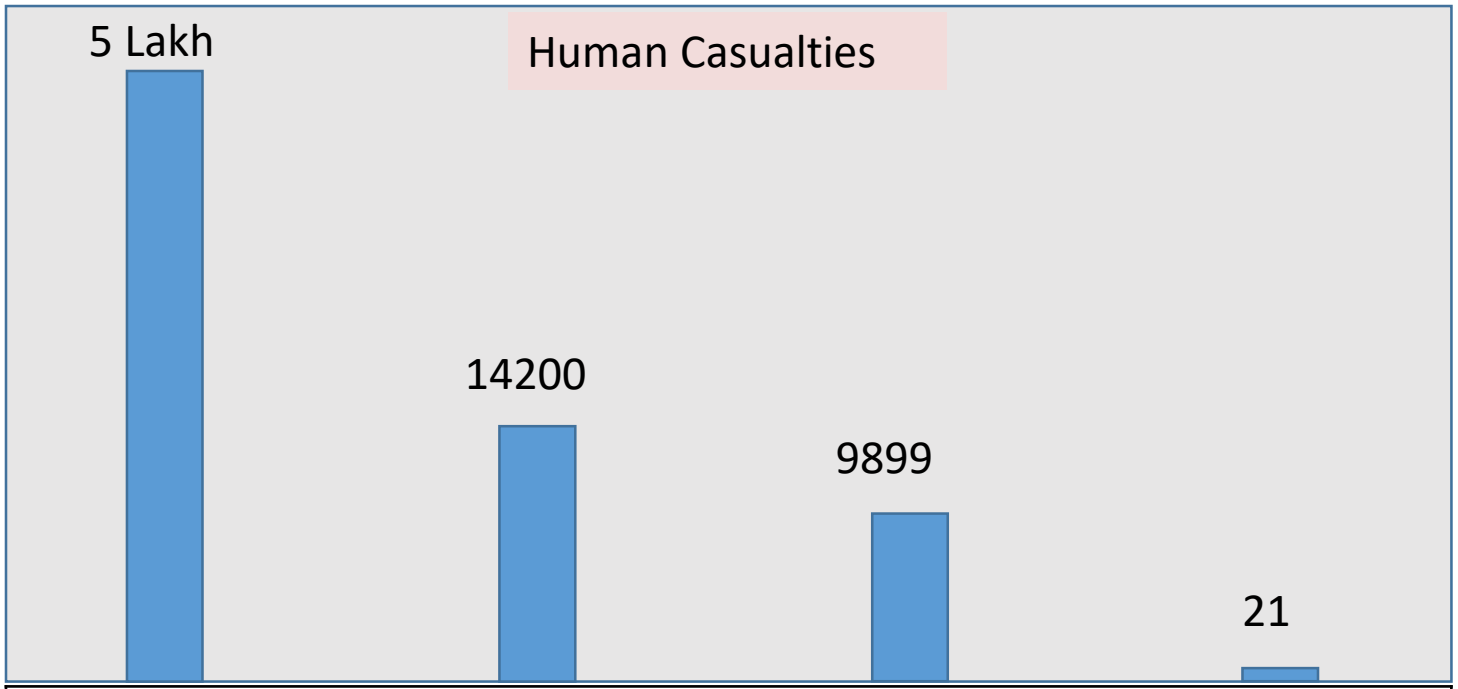
Operationally Demonstrated Role of Space Technology



Saving Human Life from 'Space'







1970	1977	1999	2013
Cyclone Bhola	Andhra Cyclone	Odisha Cyclone	Cyclone Phailin

Earth Observation : Eye in Space

- The Early warning and post disaster damage assessment is key to minimize the impact of disaster.
- The Space based observations have been playing key role in this domain
- The space borne instruments operating from microwave to optical wavelengths proved these observations.
- The GEO and LEO satellites carry these instruments.
- GEO provide coarse resolution observation on 24x7 basis
- LEO can provide fine resolution observation when ever it passes over region of interest.

Thirteen Earth Observation Satellites in Orbit

LAND & WATER

RESOURCESAT-2

RISAT-1

HIGH RESOLUTION

CARTOSAT-2 Series

RISAT

CARTOSAT-1

OCEAN

OCEANSAT-2

SARAL

SCATSAT-1

WEATHER; CLIMATE

INSAT-3A

KALPANA

MEGHA-TROPIQUES

INSAT-3D, 3DR

1 KM ⟵ **IMAGING CAPABILITY** ⟶ 0.8 M

Synoptic Coverage

Frequent Revisit

Stereo

Time & Weather Independent

Satellites Communication : Vital Link

- The natural disasters occur suddenly and with minimal or no warnings.
- The success of effective relief operations and the delivery of appropriate aid depend on accurate and timely assessment of the situation on the ground.
- The value of such assessment always depends upon reliable information, which can be speedily communicated from the affected area to the nodal agency.
- Satellites offer a reliable way of ensuring that autonomous communications are established from the outset anywhere in the world irrespective of conditions on the ground
- Satellites are the only wireless communications infrastructure that is not susceptible to damage from disasters

Fifteen Communication Satellites in Orbit

GSAT-8
GSAT-16
55^0 E

INSAT-3C
INSAT-4CR
GSAT-7
GSAT-14
GSAT-18
74^0 E

INSAT-4A
GSAT-10
GSAT-12
GSAT-MSS
83^0 E

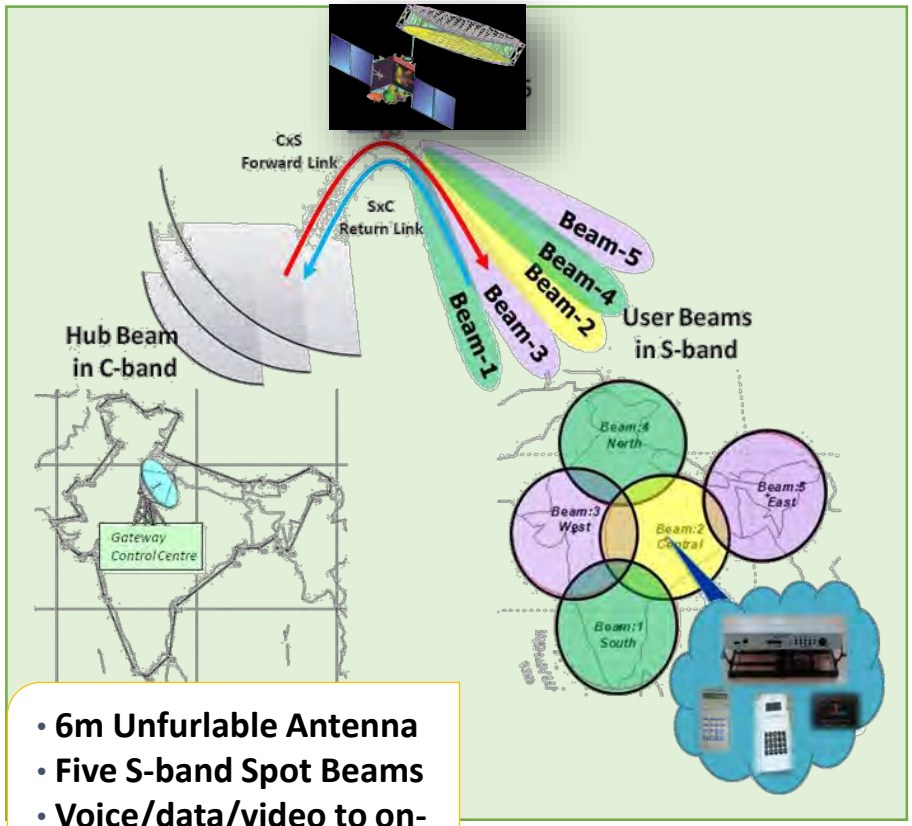
INSAT-3A
INSAT-4B
GSAT-15
93.5^0 E

GSAT-9

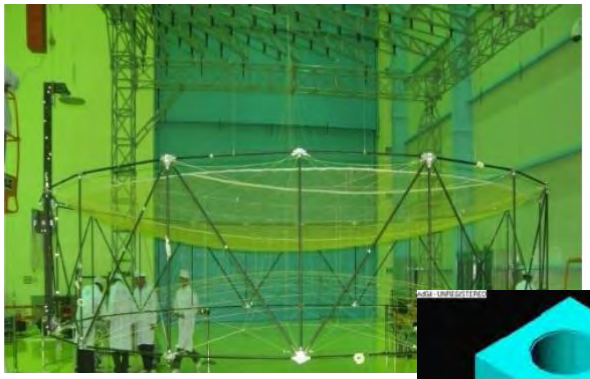
Telecommunication	~2.50 Lakh VSATs
Television and DTH services	100% National Coverage and > 4.2 Crores DTH Subscriptions , ~800 Channels
News gathering	On-spot; Real-time news coverage
Radio-networking	415 AIR Stations
Mobile services	Emergency communication link
Search and Rescue services	13,800 Indian Beacons from Maritime and Aviation Agencies
MET DATA dissemination service	~1900 AWS and ~1200 Rain Gauge Stations ; 40 Dissemination Stations
Tele-education	83 Networks covering 26 States & 5 UTs
Tele-medicine	60 Specialty Hospitals; 300 Remote Hospitals; 16 Mobile Vans

Satellites for Mobile Satellite Communication Services

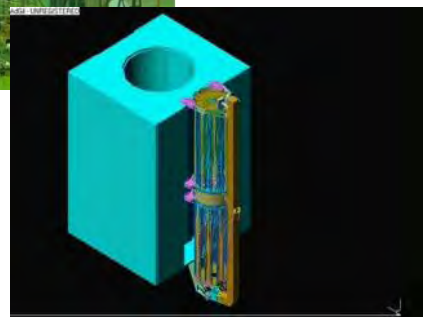
MSS Satellite: (Multibeam)



- 6m Unfurlable Antenna
- Five S-band Spot Beams
- Voice/data/video to on-the-move Terminals



6m Unfurlable Antenna

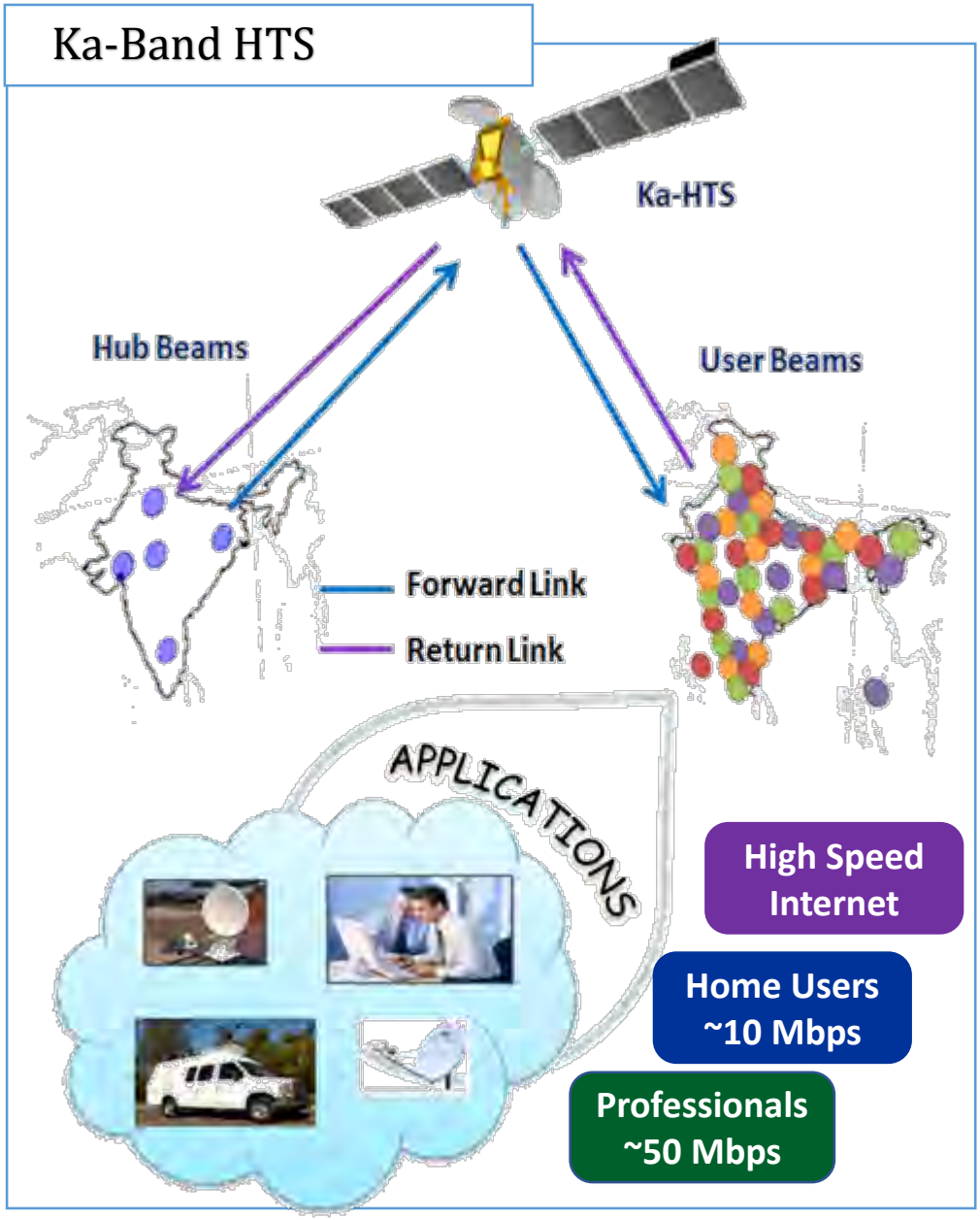


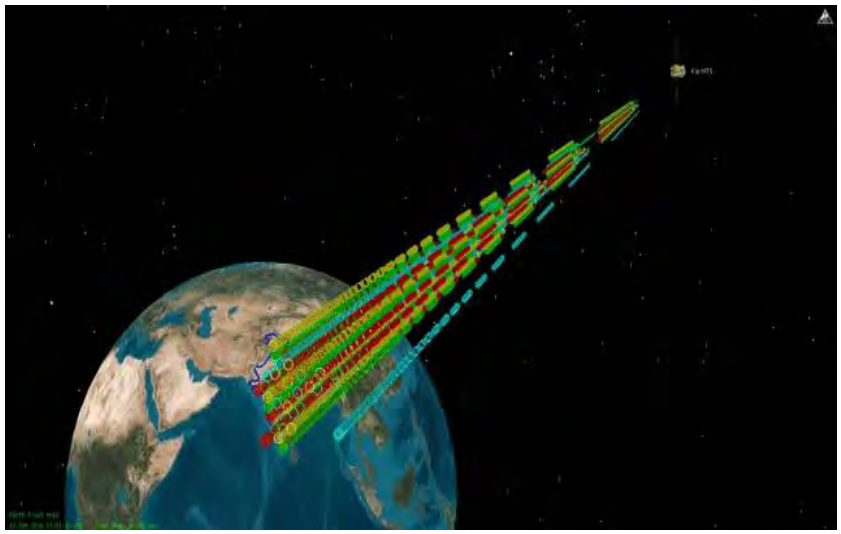
Future MSS Satellite

- 12m Unfurlable Antenna, High EIRP, G/T
- 40 Beams over Indian Region
- Spectrum Channelization & Routing
- ON-BOARD BEAMFORMING
- Voice/Data to handheld mobile terminals

Next Gen Communication Satellite: High Throughput Satellites

Ka-Band HTS





- First Indian Ka-Band HTS
- > 80 Gbps Throughput over India
- 40 user Beams, 5 Hub Stations
- 0.4 deg Spot Beams *(~200 km dia)*
- 500 MHz Band-with per beam
- Coverage:

✓ *~80% Population*

✓ *All Major Cities*

(including proposed Indian Smart Cities)

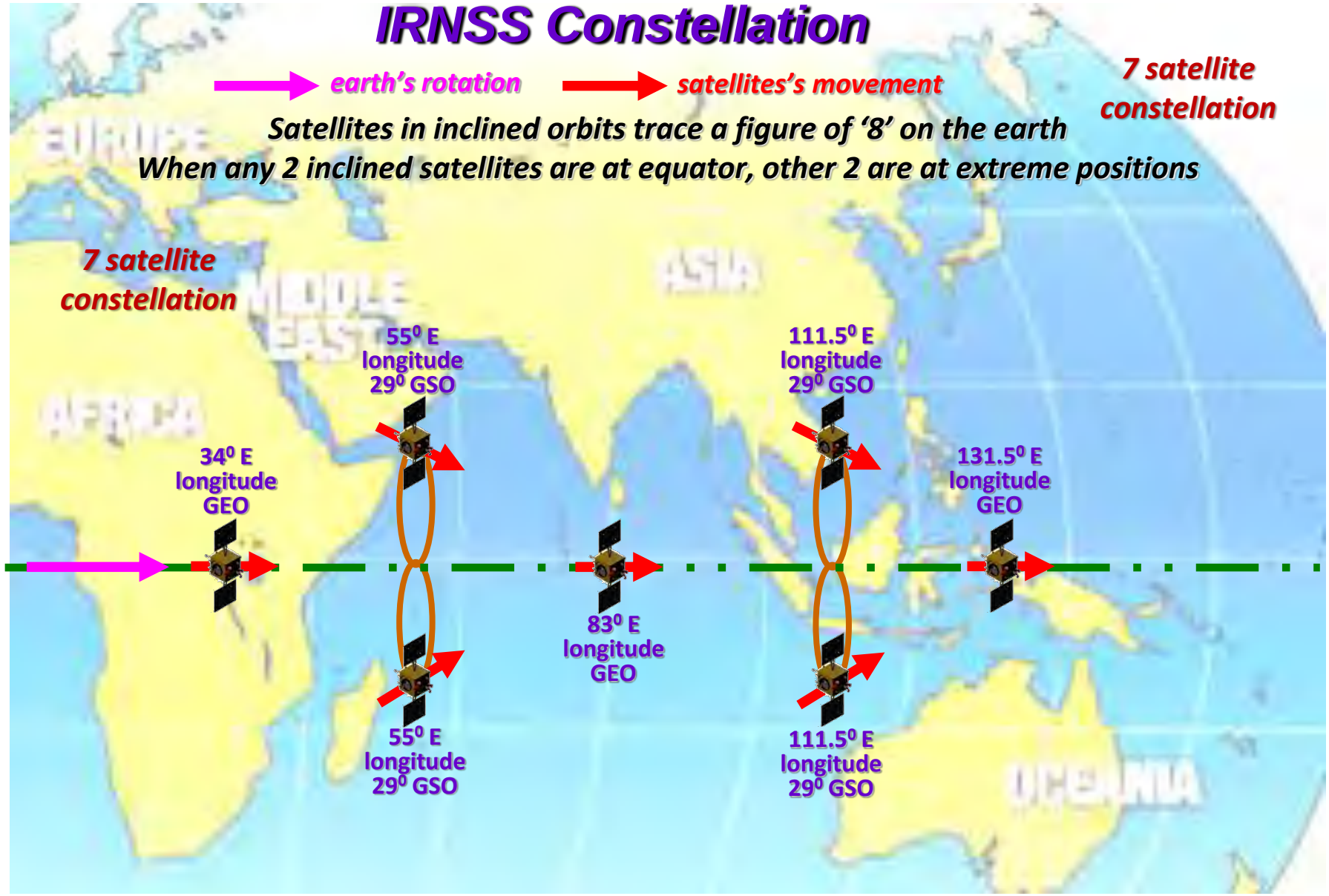
IRNSS Constellation

earth's rotation → satellites's movement

7 satellite constellation

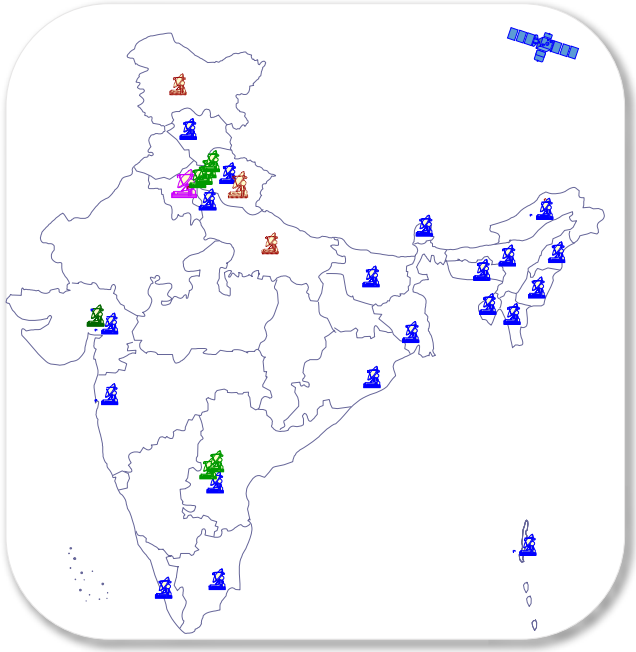
Satellites in inclined orbits trace a figure of '8' on the earth

When any 2 inclined satellites are at equator, other 2 are at extreme positions



Utilisation of SATCOM
Satellite based VPN for Disaster Management

- Satellite based Virtual Private Network (VPN) provides failsafe connectivity to DSC.
- The network connects 20 multi-hazard prone State Emergency Operation Centres with 10 Primary Nodes (data providing nodes such as NRSC, CWC, IMD, INCOIS…) and 5 observation nodes (CabSec, NEOC, PMO, …)
- 5 Nodes added in 2013 in Uttarakhand
- The network is enabled using Extended C transponder in the GSAT-12 satellite.
- Expansion of the network to multi-hazard prone districts is planned



Emergency Communication

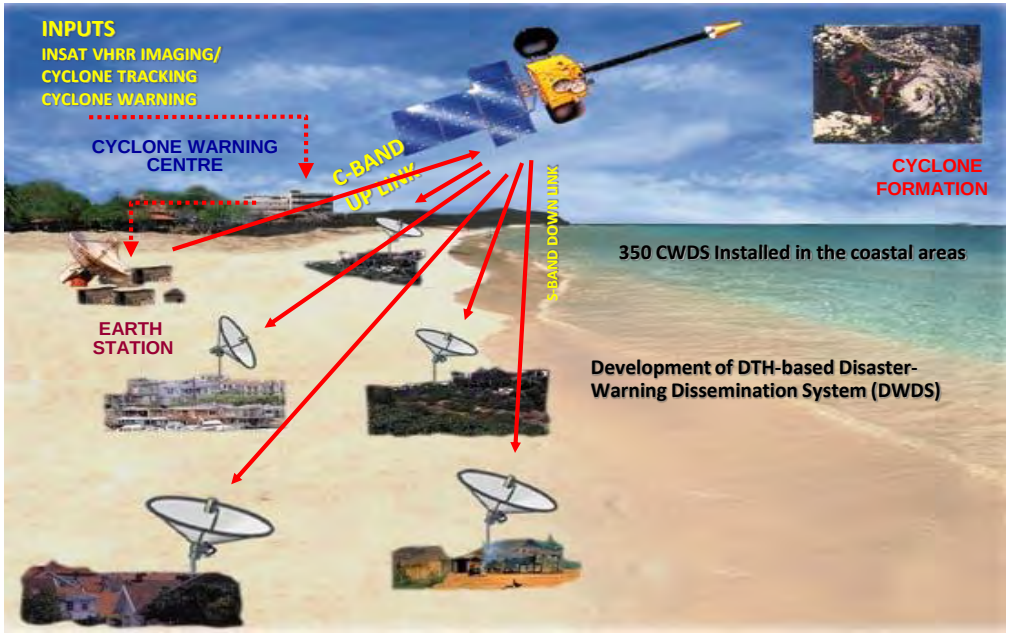
Distress Alert Terminal (DAT)

- Low cost UHF Satellite
- Floatable; suitable for marine environment
- Quadrifiller helix antenna quasi-directional antenna
- Type of emergency: Fire, Boat sinking, Man overboard, Medical
- Inbuilt GPS to give position and time information
- Battery operated (battery life minimum 24 Hrs.)

Type-D Satellite Phones

- Connectivity on Demand: Terminal to Terminal; Terminal to PSTN; PSTN to Terminal
- Technology transfer to Indian industry in year 2010
- 50 terminals (Astra make) procured are being used by CRPF & for DMS
- Hub at DES (Delhi Earth Station) operational 24x7.

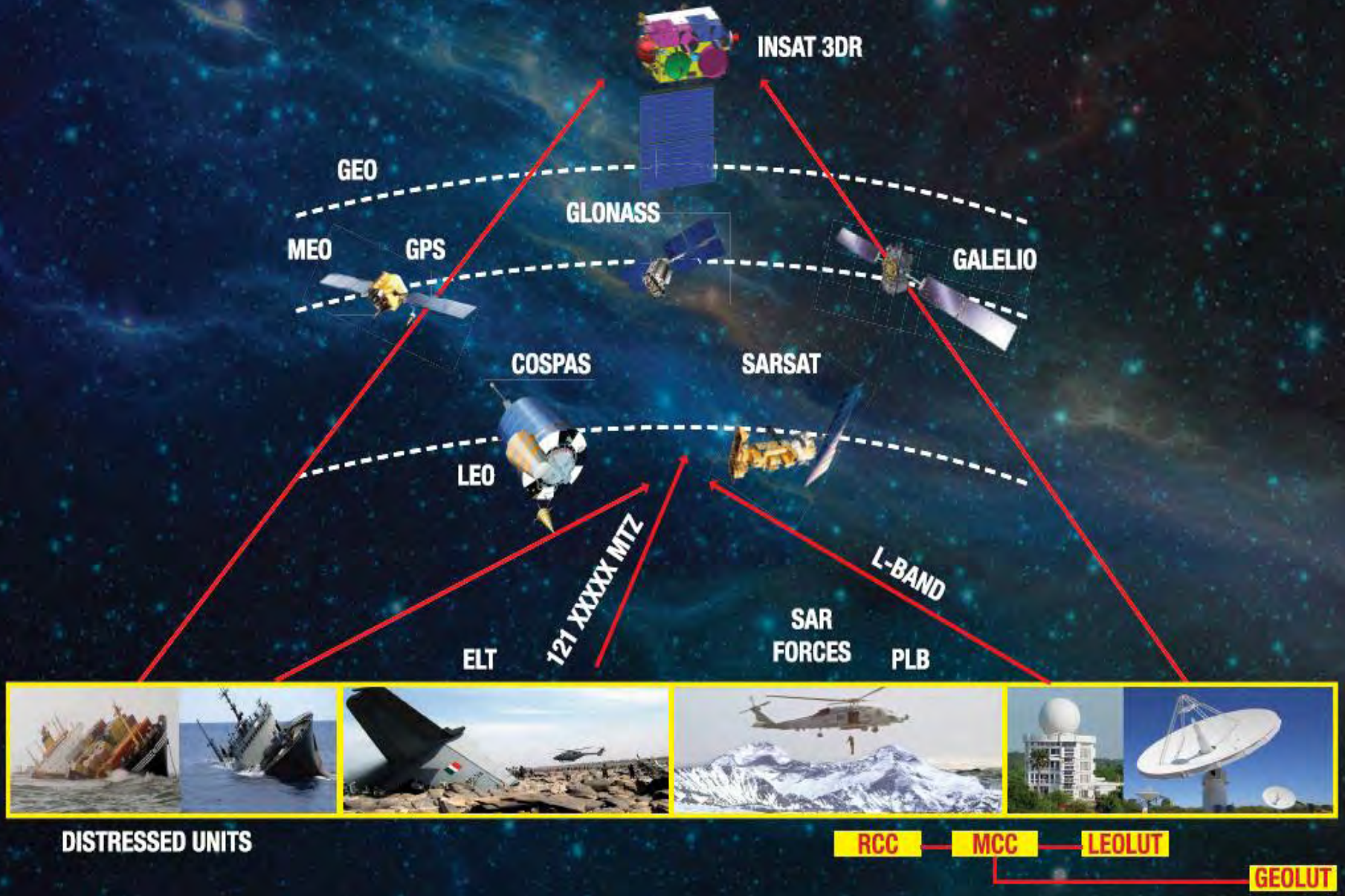
DTH BASED DISASTER WARNING DESSEMINATION SYSTEM



- Uses low-cost DTH-technology in Ku-band
- Allows user to watch FTA DTH bouquet during “quiet-period”.
- Interrupts current program to give warning
- Any STB or a group of STBs or all STBs can be selected for issuing warnings
- Warnings are preceded by a long hooter
- Warnings-issuing from multiple independent locations (remote head ends) in local languages
- Doesn’t need TV if aim is to receive only disaster-warnings.

SATELLITE AIDED SEARCH AND RESCUE SYSTEM

SAVIOURS IN SPACE



Cospas-Sarsat System Concept

LEO & GEO (INSAT-3A & 3D)

2

SEARCH & RESCUE SATELLITES

1544.5 MHz

3

BLR & LCK

LOCAL USER TERMINAL (LEO & GEO)

4

MISSION CONTROL CENTER

1

DISTRESS CALL UTILIZING EMERGENCY BEACON

EPIRB

406 MHz

ELT

PLB

5

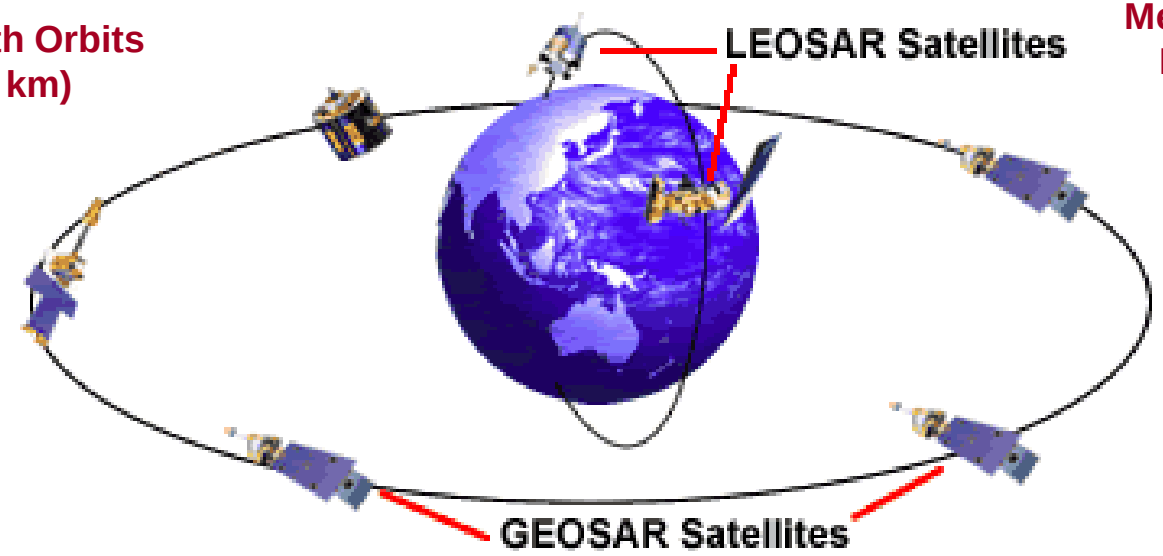
RESCUE COORDINATION CENTER

RCCs & MRCCs

LEO, GEO & MEO CONSTELLATIONS

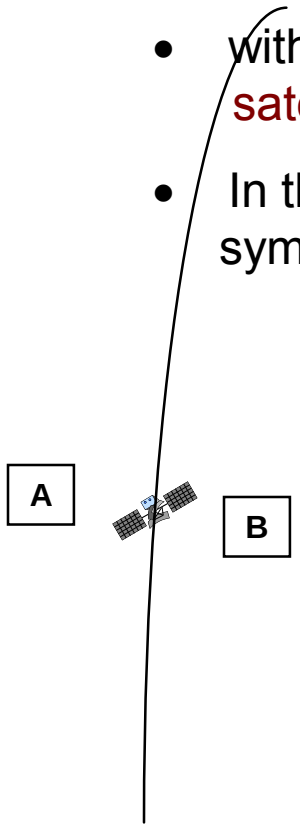
Three Types of Satellites:

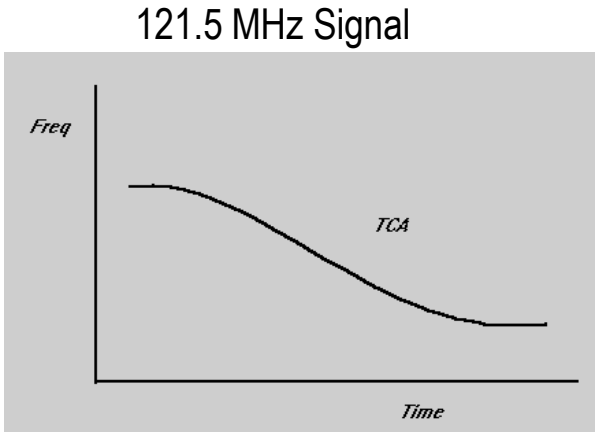
- **Low Earth Orbiting (LEOSAR): Doppler positioning, Delayed detection due to wait time, Global**
- **Geosynchronous Earth Orbiting (GEOSAR): Continuous coverage (no wait time) between 70°N and 70°S, beacon position only through GNSS system**
- **Medium Earth Orbiting (MEOSAR): Instantaneous Beacon Position using Triangulation, Global**

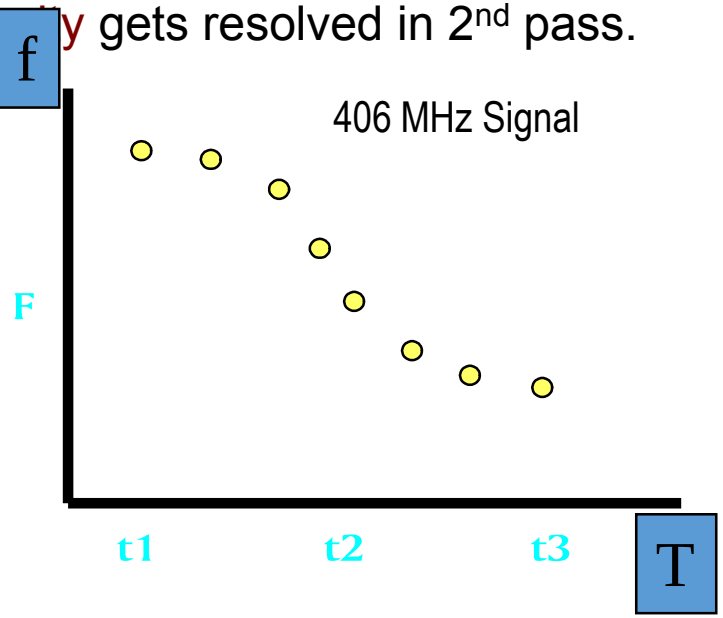


LEOSAR OPERATING PRINCIPLE

- System works on the principle of Doppler effect.
- The person in distress carries a device called Radio Beacon capable transmitting signal in the event of distress.
- The signal radiated is subjected to Doppler shift when received at satellite due to relative motion between the satellite and the device radiating the signal.
- with the precise measurement of Doppler shift and with the knowledge of satellite orbit, position of distress signal can be estimated.
- In the first pass, there will be two locations (real and image) due to symmetry of the satellite orbit, this ambiguity gets resolved in 2nd pass.



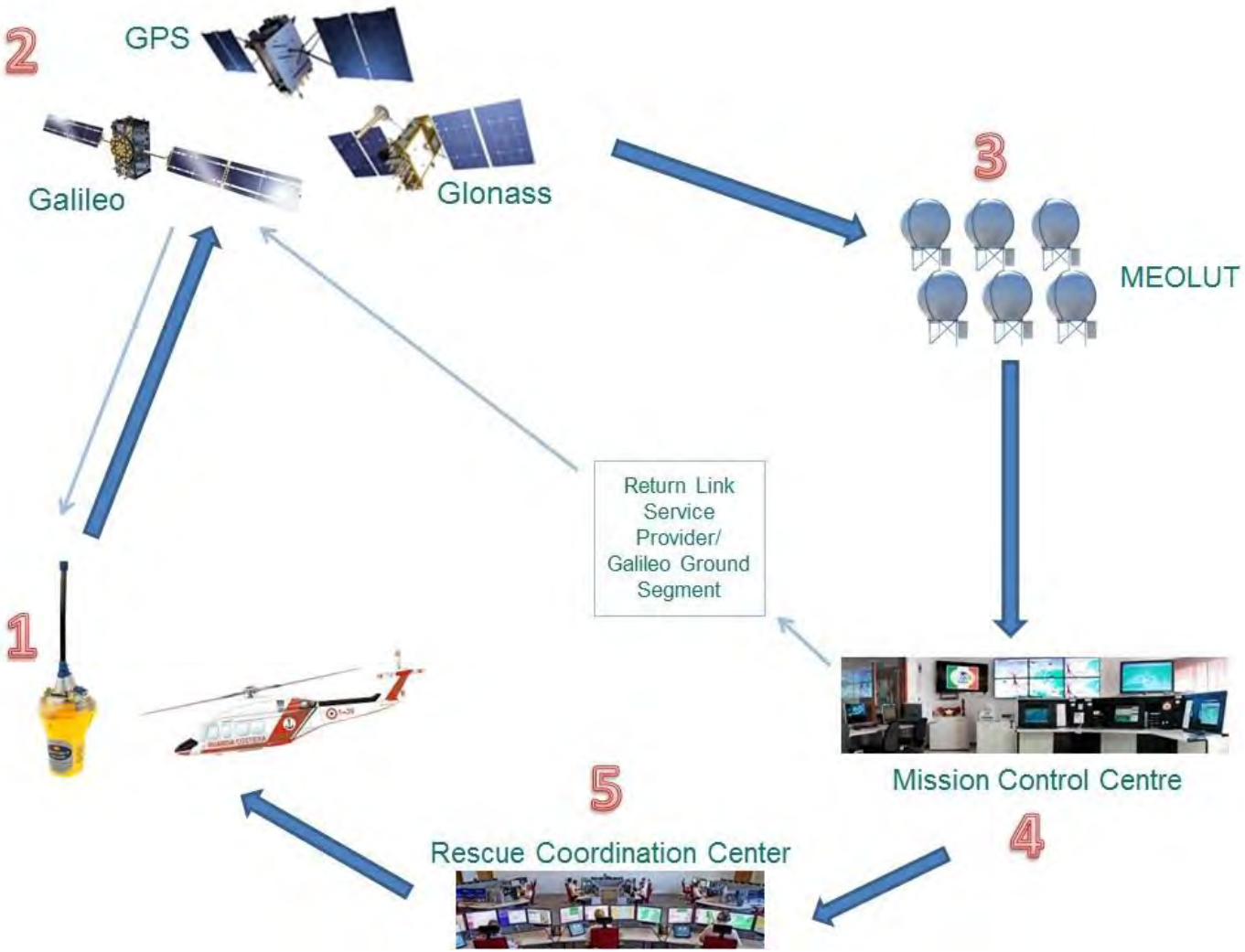




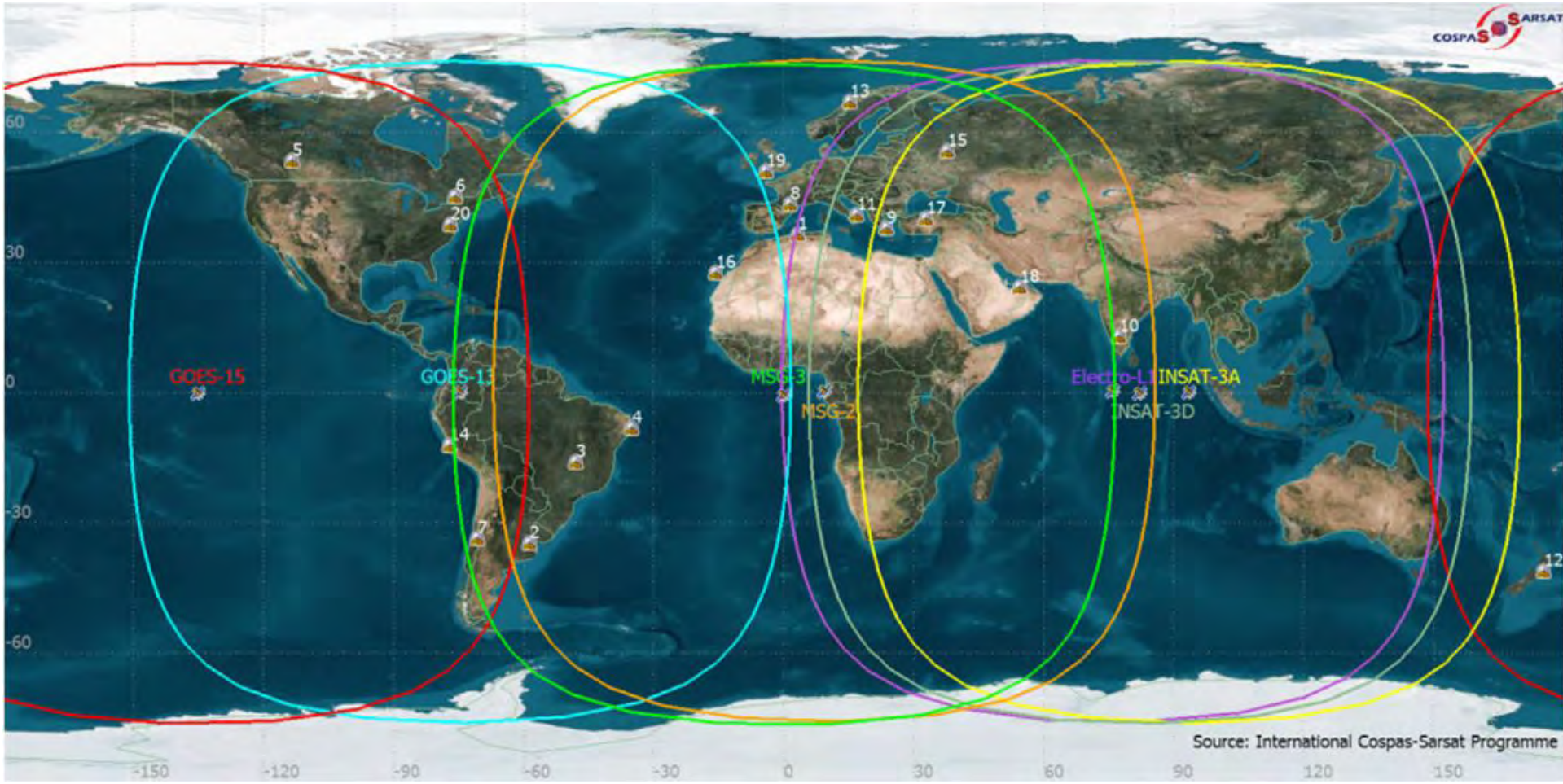
MEOSAR

- The current LEOSAR and GEOSAR systems that detect and locate distress beacons have shortcomings that MEOSAR will overcome.
- The GEOSAR system constantly covers the entire Earth except the high-latitude (i.e., polar) regions.
- GEOSAR system can receive beacons distress messages across most of the globe, but it cannot locate a beacon unless the location is encoded in the beacon's message from a local navigation (GNSS) receiver.
- The LEOSAR system can locate a beacon without location information being transmitted in the beacon message but the LEOSAR satellites have a view of only a small part of the Earth at any given time.
- While LEOSAR and GEOSAR still provide valuable search-and-rescue capabilities, MEOSAR is a revolution in technology, by combining best of both.

MEOSAR CONCEPT



INSAT-3A & 3D: Providing Continuity to Global Coverage
(70°N and 70°S)



Radio Beacons

Radio Beacons – Types

EPIRB - Emergency Position Indicator Radio Beacon

ELT - Emergency Locator Transmitter

PLB - Personal Locator Beacon

Frequency

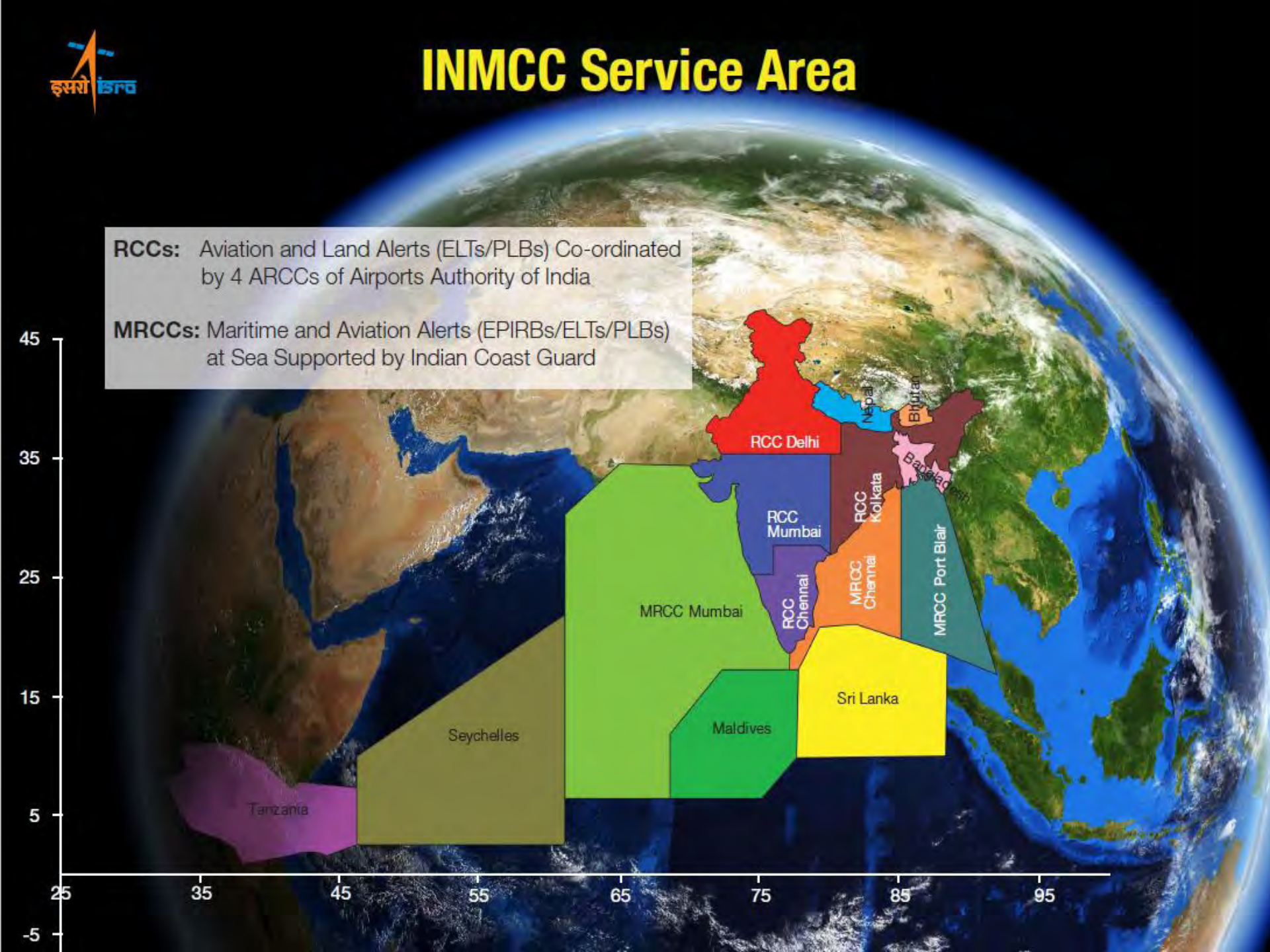
- 406 MHz - SASAR
- 121.5/243 MHz – Phased out

- Emits distress signal for more than 24 hrs using internal battery, when activated in a distress situation
- Automatic or Manual activation in the event of any distress
- 406 MHz beacons are registered to establish identity of the user
- 50 Manufacturers, 210 approved models available globally

INMCC Service Area

RCCs: Aviation and Land Alerts (ELTs/PLBs) Co-ordinated by 4 ARCCs of Airports Authority of India

MRCCs: Maritime and Aviation Alerts (EPIRBs/ELTs/PLBs) at Sea Supported by Indian Coast Guard



Cospas-Sarsat Current System Status (Global)

Green color indicates CS Member countries coverage

Participants:

- 43 member countries including 4 Parties (USA, France, Canada, Russia), 28 ground segment providers, 9 user states, and 2 Organizations

Space Segment:

- 5 LEOSAR satellites (SARSAT-7,10,11,12,13), 13 GEO satellites (3 GOES, 2 INSAT, 4 MSG, 2 Electro-L, 2 Loch) 39 MEOSAR (18 GALELIO, 20 GPS, 1 GLONASS)

Ground Segment: 53 LEOLUTs, 23 GEOLUTs, 31MCCs

Radio Beacons:

Global

- Total Number of beacons estimated: 2,000,000
- No. of Registered Beacons Globally: 1,513,000 :

INDIA

- No of Registered Beacons : 15139 (ELT: 3696, EPIRB:8351, PLB: 3092)
- Registered Users : 851

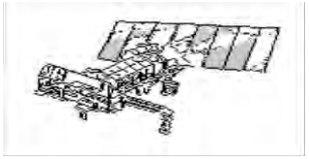
Lives Saved (globally): Saving of 41,750 lives in 11788 incidents- (1982 to 2015);

Lives Saved (INMCC): Saving of 2030 in 118 incidents from 1991 till date

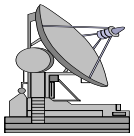
International Regulatory Authorities: ICAO, IMO

SAR RESPONSE TIME

Beacon



Satellite Detection



LUT

MCC

RCC

GEO	Immediate	Immediate **(No Polar Coverage)**	4 min.	0.3 min.	2-4 min.
LEO	Immediate	**15 -200 min.**	2 min.	1 min.	2-4 min
MEO	Immediate	**Immediate** **(single burst, Global)**	50ms	0.3 min	2-4 min

EVERY MINUTE COUNTS

South Asia Satellite (GSAT-9)

GSLV-F09 , 05/05/2017

THANK YOU