USE OF SPACE TECHNOLOGY IN FAIL-SAFE EMERGENCY COMMUNICATION AND ESTABLISHING LAST MILE CONNECTIVITY



24 May, 2017

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TOPICS IN THIS PRESENTATION

- Satellite Communication (SatCom)
  - Fixed Satellite Services (FSS)
    - Disaster Management
    - Last Mile Connectivity
  - Mobile Satellite Services (MSS)
    - MSS Terminals
- SatNav & SatCom Synergy
  - GaGaN
  - Navigation with Indian Constellation (NavIC)
  - Potential Applications : Case Studies

- Conclusions

ISRO & INDIA's SPACE VISION

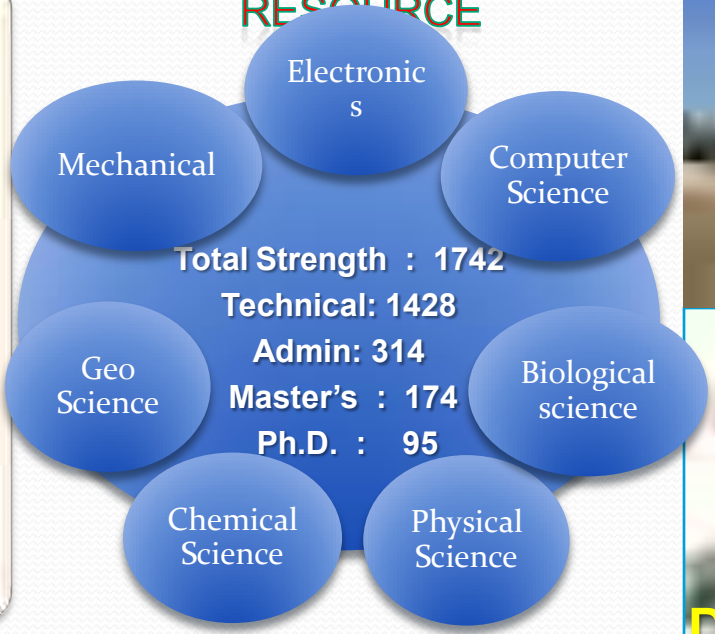
"If we are to play a meaningful role nationally, and in the comity of nations, we must be second to none in the application of advanced technologies to the real problems of man and society." - Dr. Vikram Sarabhai

SPACE APPLICATIONS CENTRE-SAC

SAC ACTIVITIES

- Technology Development
- Payload Design
- Payload Realization
- Software package Development
- Application development
- Technology Transfer
- User Interface
- Capacity Building

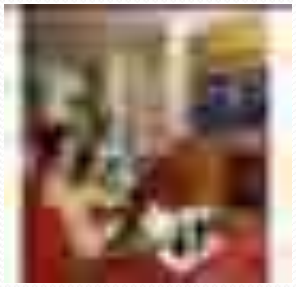
HUMAN RESOURCE



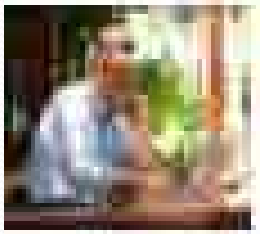
ON-GOING/PLANNED PROJECTS

- Communication/ Navigation — >15 projects
- Remote sensing / Earth observation — >15 projects
- Science/ Planetary mission — 2 projects
- Technical Development Projects — >150 projects

Familiar SatCom Applications

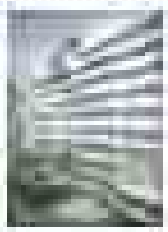


Internet TV & phone (IPTV & VoIP)



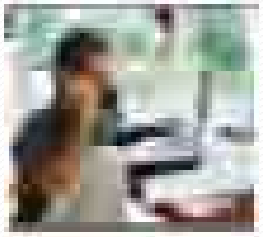
Broad band

Emergency Disaster Recovery



Community Broadband

Home Broadband



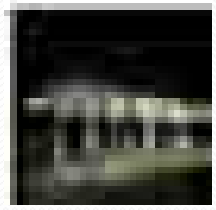
Business Broad band

Satellite News Gathering

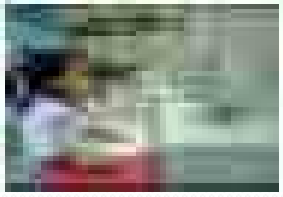
MSS Services

Rural Telephone & Internet

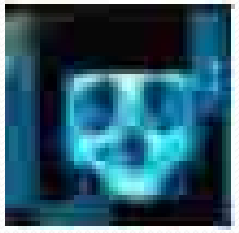
Enterprise Intranet



Surveillance Network



Tele-Education



Telemedicine

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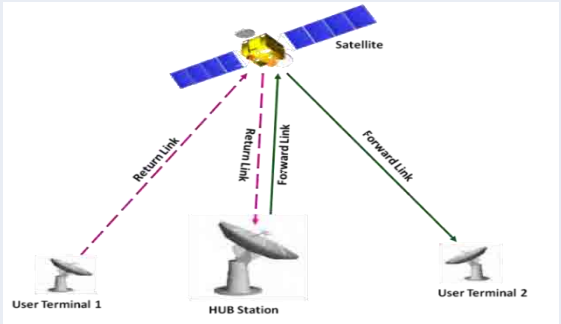
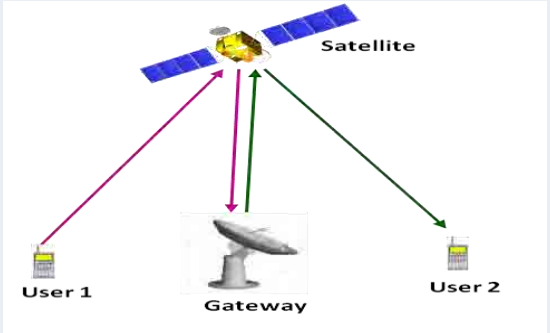
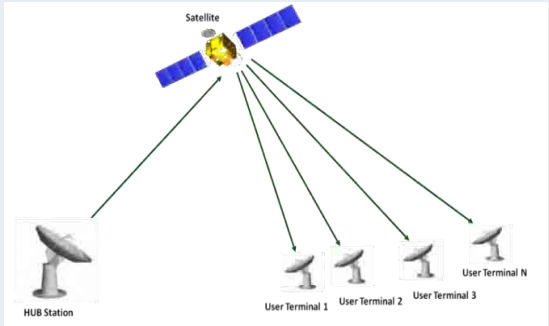
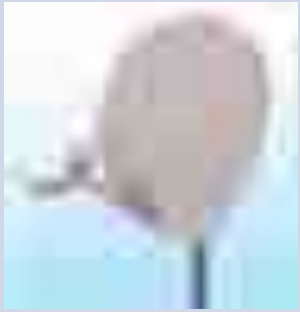
Satellite Communication Services

	Fixed Satellite Service	Mobile Satellite Service	Broadcast Satellite Service
Typical Parameters	Application : Video-conference Frequency : 6/4 GHz Data Rate : 384 kbps User Terminal : 2.4 m Satellites : INSAT-3A, GSAT-12, GSAT-10	Application : Voice, fax Frequency : User Link: S-band, Hub Link: C-band Data Rate : 6.4 kbps User Terminal : MSS-Type-D Satellites : GSAT-2, GSAT-7	Application : DTH Frequency : 14/12 GHz Data Rate : 40 Mbps per Tx User Terminal : 0.6 m Satellites : INSAT-4A, INSAT-4B, GSAT-8
Service Architecture			
Terminals	 FSS Terminal	 Type-D Portable Terminal	 DTH Terminal

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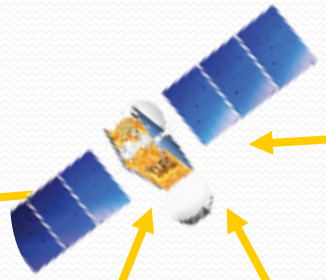
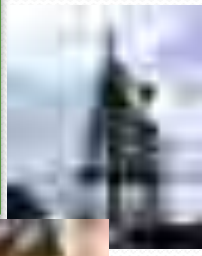
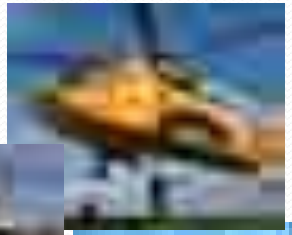
SatCom - Current Applications

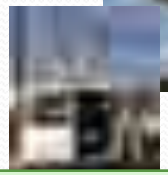


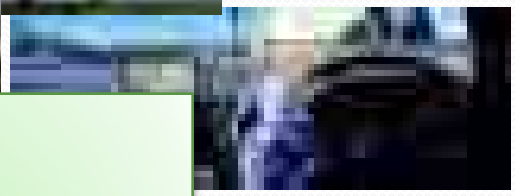
BROADCAST
- Television Broadcasting
- Direct To Home (DTH)
- TV & Radio Networking

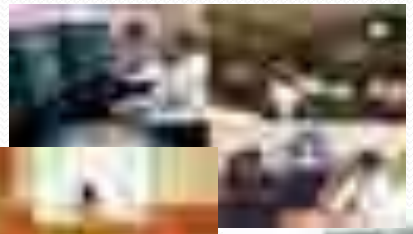
COMMUNICATION
- Speech Circuits On Trunk Routes
- VSAT Connectivity







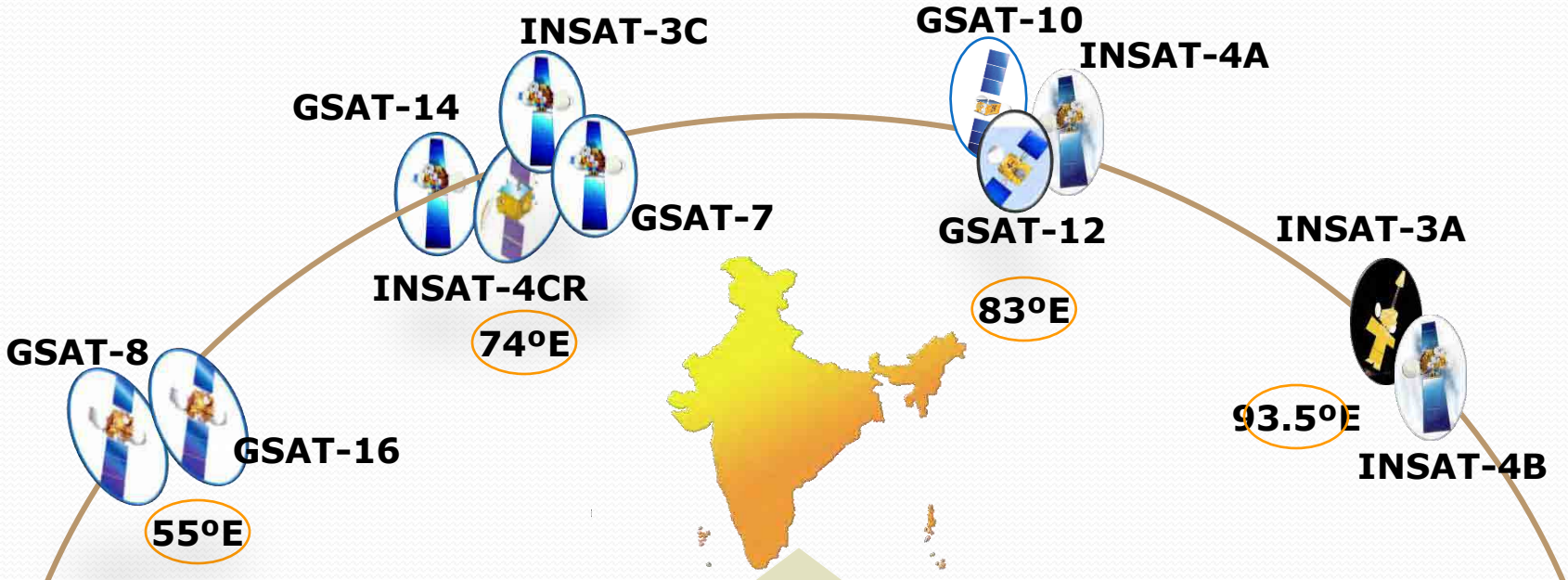




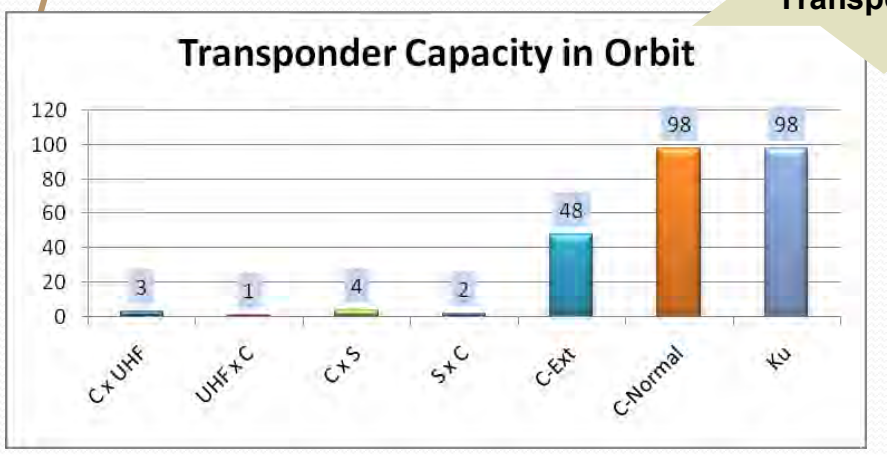
OTHERS
- Mobile Satellite Service
- Search and Rescue
- Data Collection Platform
- Disaster Warning

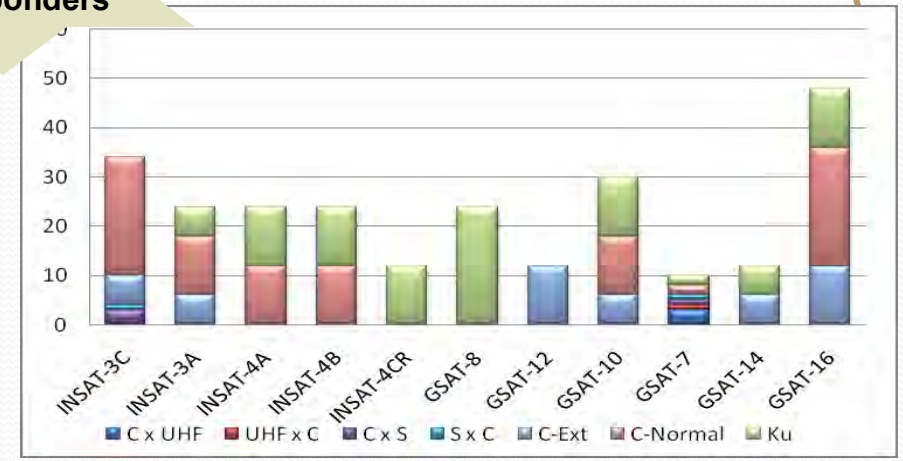
DEVELOPMENTAL
- Tele-medicine
- Tele-education
- Emergency Communication

Indian SatCom Scenario



254 Transponders





Technology Growth

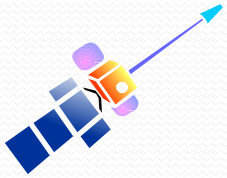
- UHF, S, C, KU-Bands
- I-1K, I-2K, I-3K spacecraft
- 1 TO 3.5 TON Lift-off
- 1.5KW TO 7 KW Power
- Standard Bent Pipe Txpdr
- Regenerative Experimental

- Ku and Ka HTS
- I-4K Spacecraft - 4.5T LOM
- I-6K Spacecraft – 6T LOM
- 1.5KW TO 15 KW Power
- Multi Beam-high Pointing
- Navigation
- Broad Band/Multimedia
- Inter Satellite Links

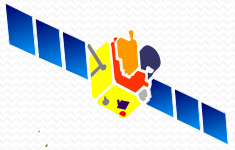
- Technology to match Commercial needs
- To contend with the absence of Protective Regulatory regime.
- Compete with terrestrial systems.
- Time to consider satellite along with complimentary terrestrial systems.
- More complex Payloads
- V-band / Optical Bands
- MEO circular Com Sats

Space and Disaster Management

Convergent solution



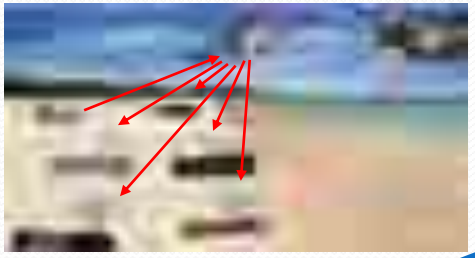
* COMMUNICATIONS
* MET IMAGING
* REMOTE SENSING DATA



VULNERABILITY ANALYSIS

RESPONSE PLANNING

PREPAREDNESS



PREDICTION

FORECAST MODELS

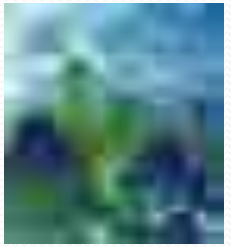
VIGILANCE SYSTEM

PRE-DISASTER

DISASTER IDENTIFICATION

IMMEDIATE RESPONSE

RELIEF



RECOVERY

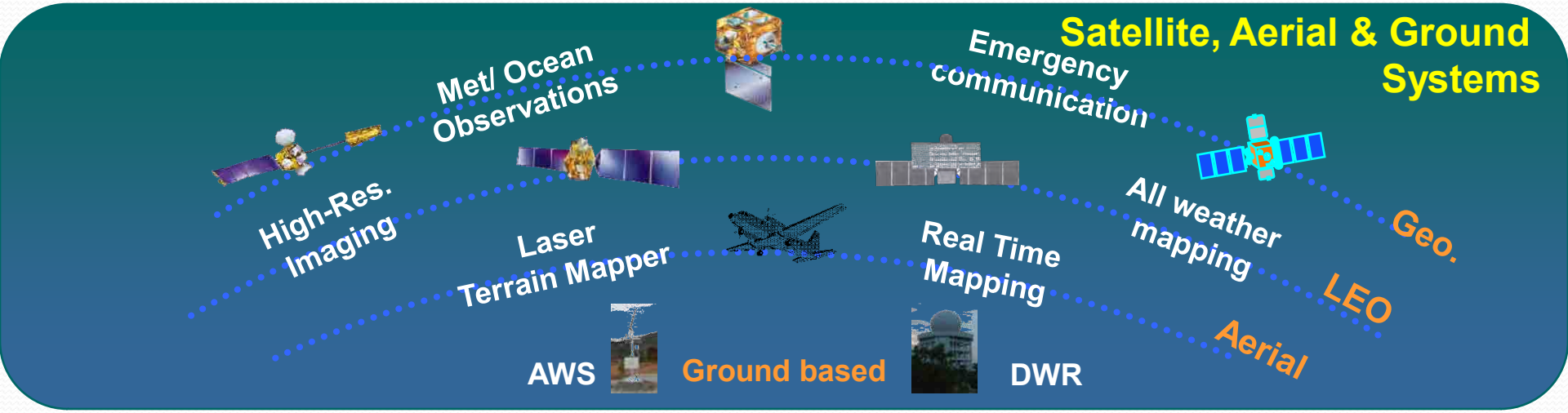
REHABILITATION

IMPACT STUDY

POST-DISASTER

Elements of Disaster Management Support (DMS) System

Assets and Infrastructure

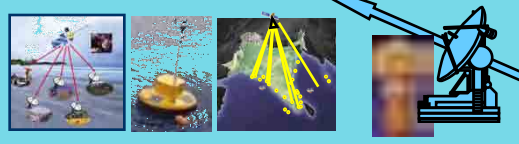


Delivery Mechanisms

CWC, IMD, GSI, MOES/ DOD, DST, FSI, ..

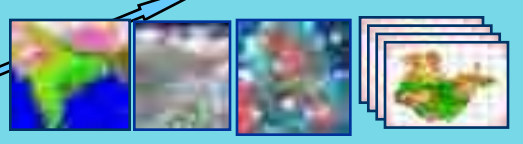
Decision Support Centre (DSC)

MHA, NDMA, MoA, PMO, State Agencies



Networking, Early Warning

Products & Services – Damage Assessment, Monitoring, ..



NDEM, Hazard Zonation, Risk Assessment, …

Technology Development & Research , Forecasting/ Simulation Models, ..

Emergency Communication Network - VPN; Support - MSS Terminal, WLL VSAT, …

Satellite Communication Technology & Disaster Management

❖ **Pre-Disaster** : Prevention by Surveillance and Early Warning

- ❖ SATCOM is Most Effective *& Robust*
  - ✓ Nation wide coverage without gaps in communication
  - ✓ Relatively immune from disasters

❖ **During Disaster** : Preparedness & Speedy Response

- ❖ Handheld & Portable terminals for first responders – MSS Network
- ❖ Communication network with minimum time for first response

❖ **Post Disaster** : Recovery & Rehabilitation

- ❖ Communication support for trapped population & administrators
- ❖ Provision for Integrated communication network e.g., Satellite with terrestrial systems like GSM/CDMA/Wi-Fi etc.

SATELLITE COMMUNICATION NETWORK IS MUST FOR EFFECTIVE DMS

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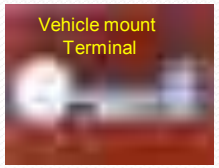
SatCom Applications & Technologies

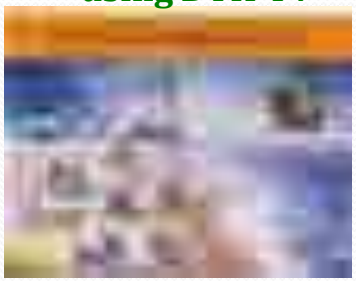
VSAT based DMS Network (Operational)



Handheld Reporting Terminal for SMS & Vehicle tracking using INSAT Satellite

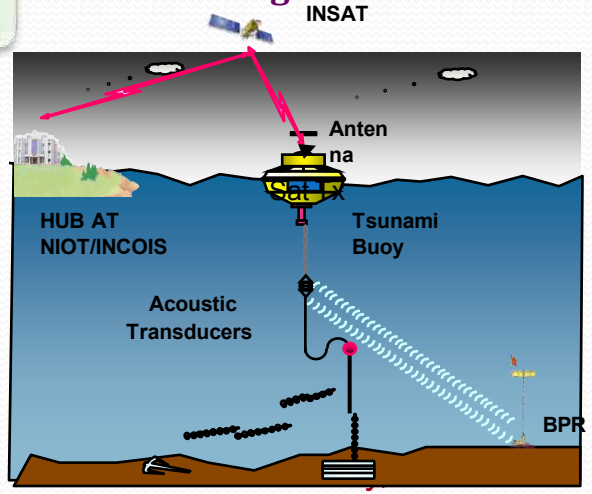
Distress Alert Transmitter Provide safety to fisherman

Cyclone warning system provide alert message to selective /community using DTH TV

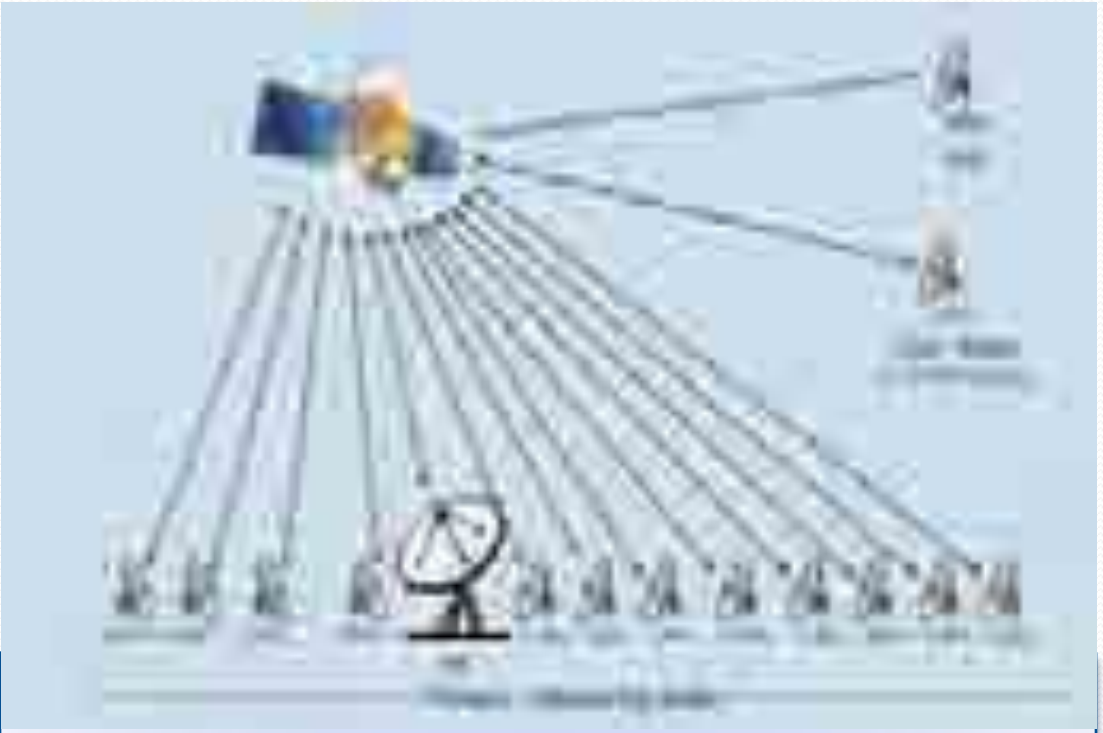


Automatic Weather Data collection through INSAT for weather prediction

Tsunami Early Warning System provides Tsunami data through satellite



INDIA's Current DMS Communication Network



Satellite	**: GSAT-12**
Orbital Position	**: 83 Degree East**
Transponder Bandwidth	**: Ext-C Band, Transponde#9**
Uplink frequency	**: 36 MHz**
Downlink Frequency	**: 6835±18 MHz**
	: 4610 ±18 MHz
Access technology	**: DVB-S / MF-TDMA**

Hub Location:

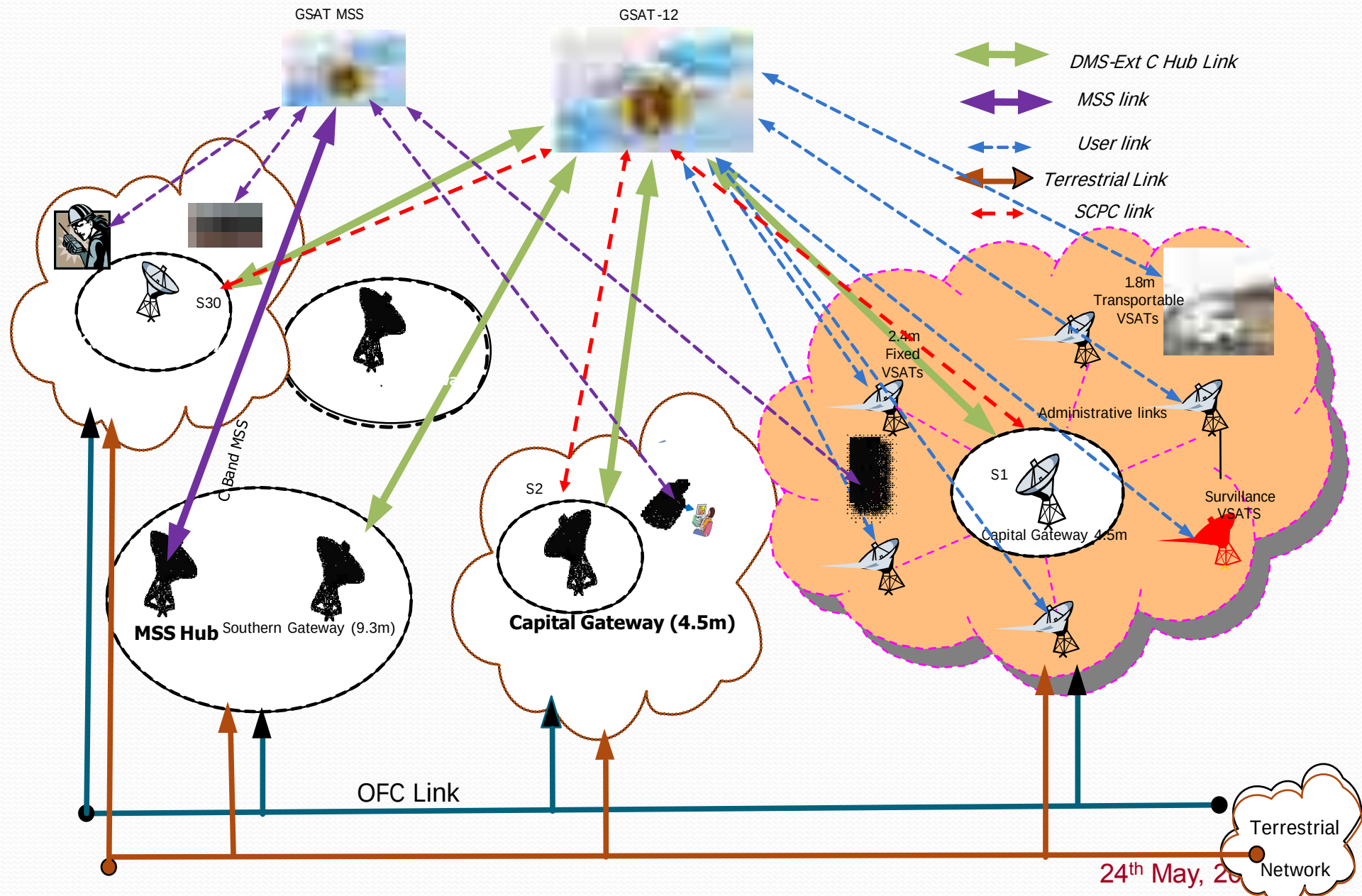
Ministry of Home Affairs (MHA),
Samanvaya Sadan, Siri Fort Road,
New Delhi-110 049

Primary Nodes Location:

1) NRSC, Balanagar, Hyderabad
2) NRSC, Shadnagar, Hyderabad
3) Central Water Commission, New Delhi
4) Geological Survey of India, New Delhi
5) IMD, Mausam Bhawan, New Delhi
6) INCOIS, Hyderabad (Andhra Pradesh)
7) Space Applications Centre, Ahmedabad
8) Master Control Facility (MCF), Hassan
9)North-East Space Applications Centre, Shilong

User Nodes : 26 State Emergency Operations Centers (SEOCs) are connected using this network to provide communication support during disaster.

Proposed Upgradation : National Satcom Network for DMS



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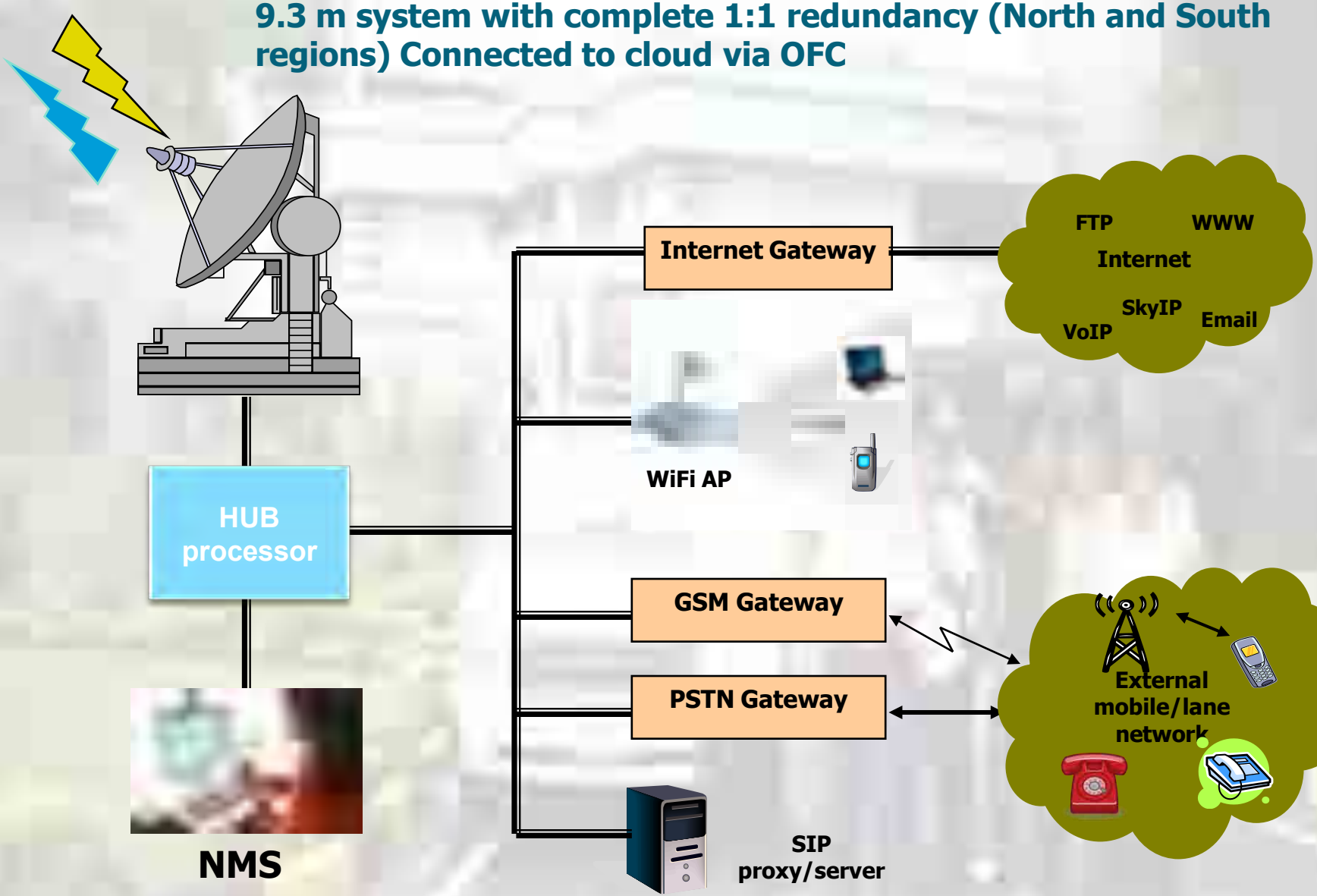
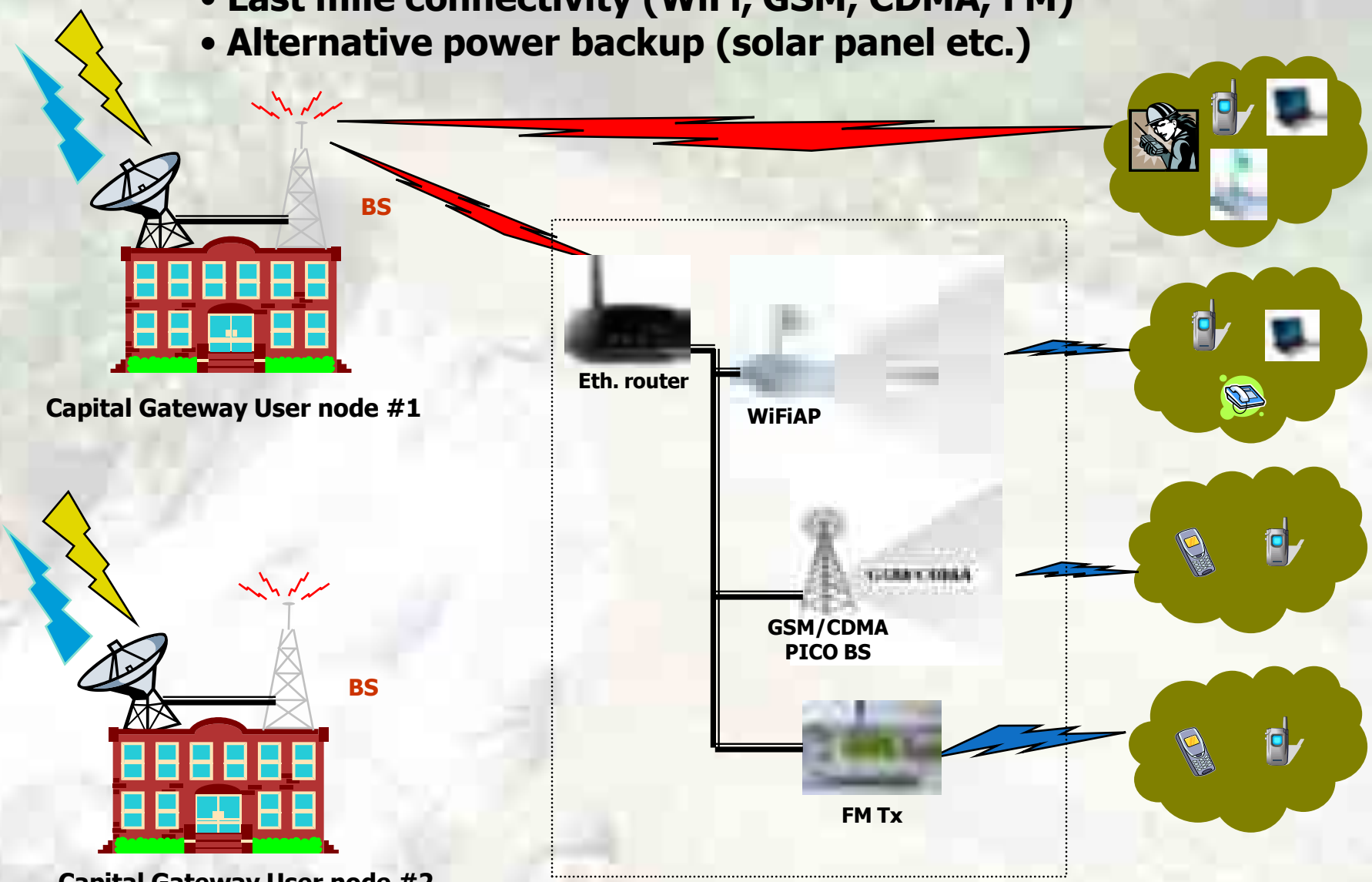
DMS Communication Network : Hub Configuration

9.3 m system with complete 1:1 redundancy (North and South regions) Connected to cloud via OFC



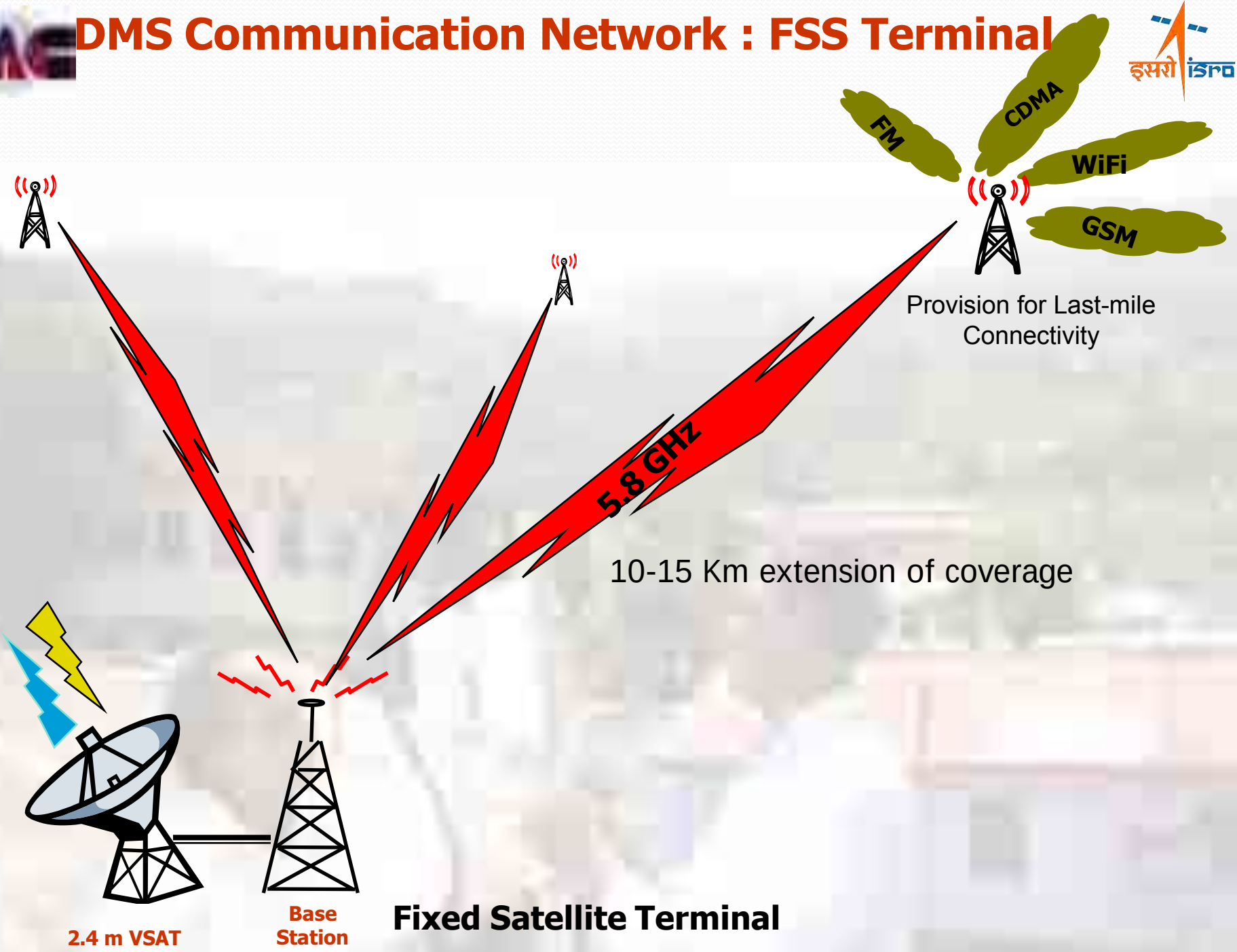
DMS Communication Network : Capital Gateway

- 4.5/2.4/1.8 m antenna fixed/portable VSAT
- Last mile connectivity (WiFi, GSM, CDMA, FM)
- Alternative power backup (solar panel etc.)

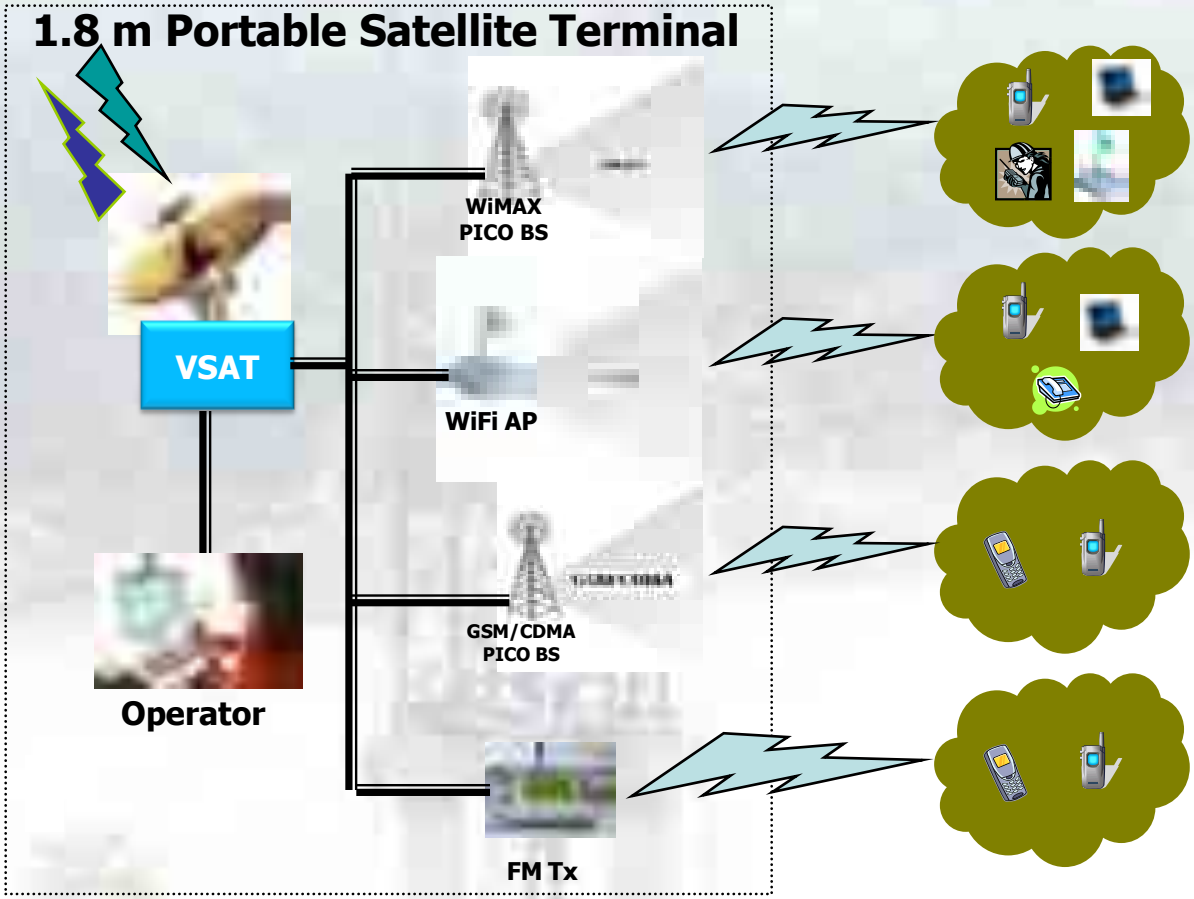


Capital Gateway With Last-mile Connectivity-wide area coverage

DMS Communication Network : FSS Terminal



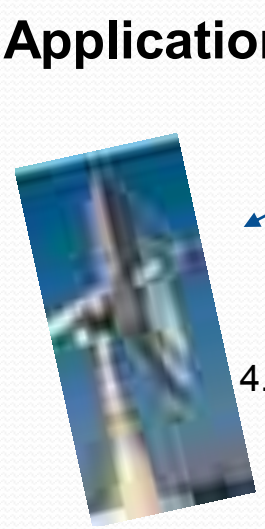
DMS Communication Network : Portable Terminal



- 1.8 M VSAT, compact and easily transportable
- Low power consumption with sufficient power backup
- Simple & speedy installation
- Provision for last mile connectivity (WiFi, Wimax, GSM, CDMA, FM)

South East Asia Satellite (GSAT-9)

- 12- Ku-band transponders
- Total satellite Bandwidth ~ 432 MHz
- VSAT & DTH Applications



4.5m HUB

VSAT and DTH Hub at DES New Delhi

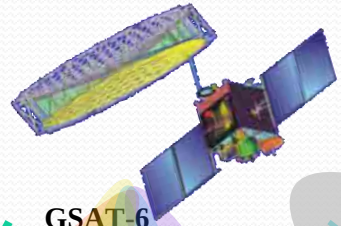
GSAT-9

1.2m VSAT Terminal

PC

TV monitor

MSS Services & Technologies



GSAT-6

S-Band

C band

Beam-5

Beam-4

Beam-3

Beam-2

Beam-1

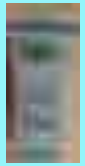
Hub Link

C-Band

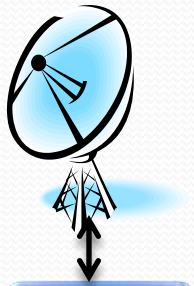
Broadcast Receiver

Satellite Mobile Radio

Portable Multimedia Terminal



Reporting Terminal



MSS Hub

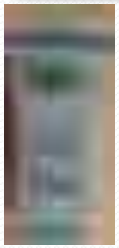
Gateway

PSTN /PSTM network

MSS Ground Terminals : Salient Features

Reporting Terminal (RT)

- Data, Position, Small msg. reporting appl.
- RS232/USB/ Bluetooth user data interface
- Weight less than 170gm/450gm




Satellite Mobile Radio (SMR) / SatSleeve

- Two way voice and small text message communication
- Supports call from terminal to terminal, terminal to PSTN or any other network
- RS232/USB data interface
- Weight ~ 1kg / 500gm

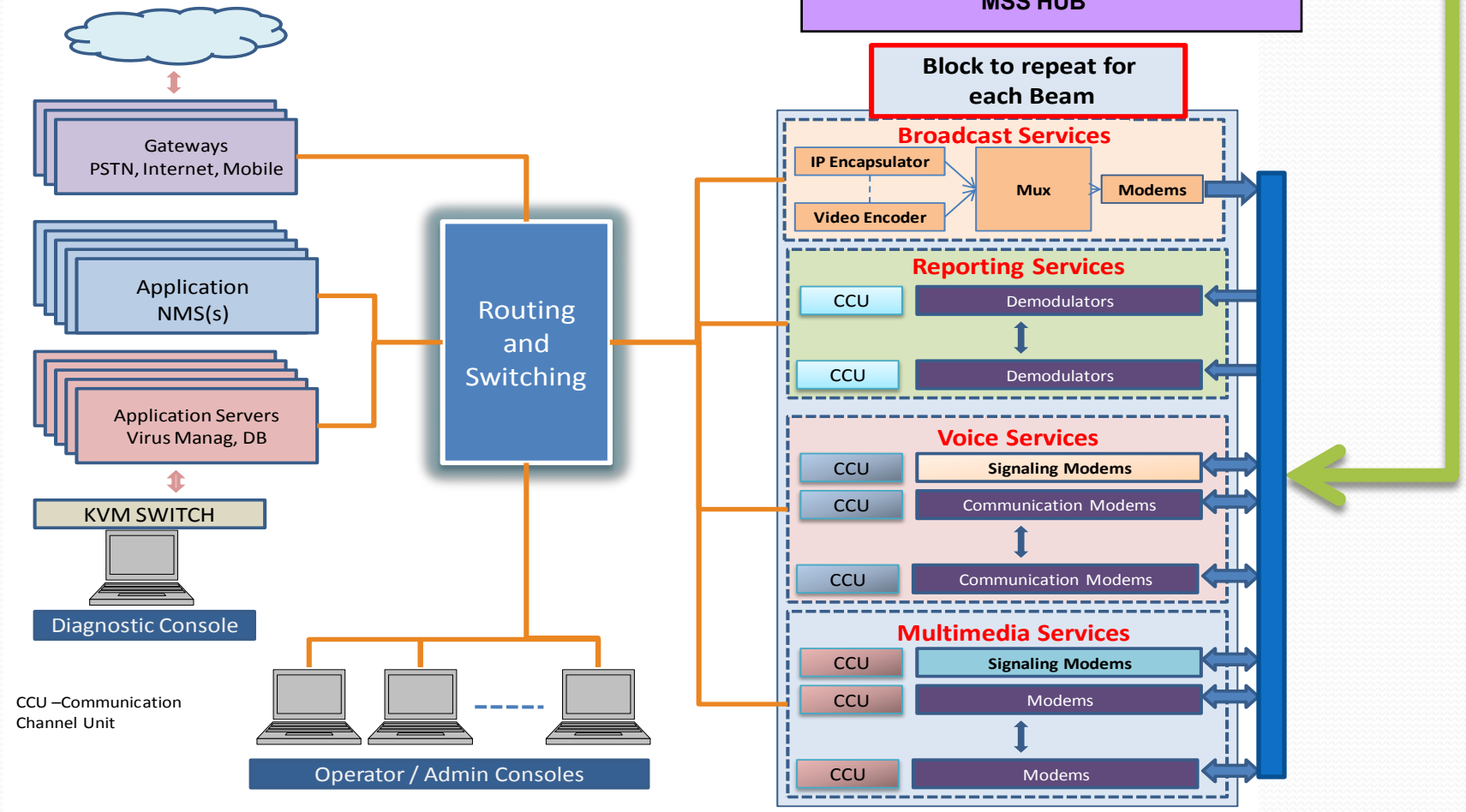

Portable Multimedia Terminal (PMT)

- Two way multimedia (video, voice) and IP data communication
- Supports Video Conferencing, IP data transfer @ 144 kbps
- Ethernet interface for user data
- Weight ~ 3.0 kg

Broadcast Receiver (BR)

- Receive Only Terminal for Multichannel Audio, Video & Data
- Terminal with interface to tablet/ smart phones & with built-in display
- Ethernet/USB output data interface
- Weight ~ 200gm

Unified Network Management System

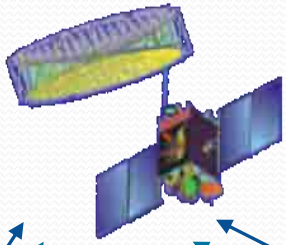


24th May, 2017

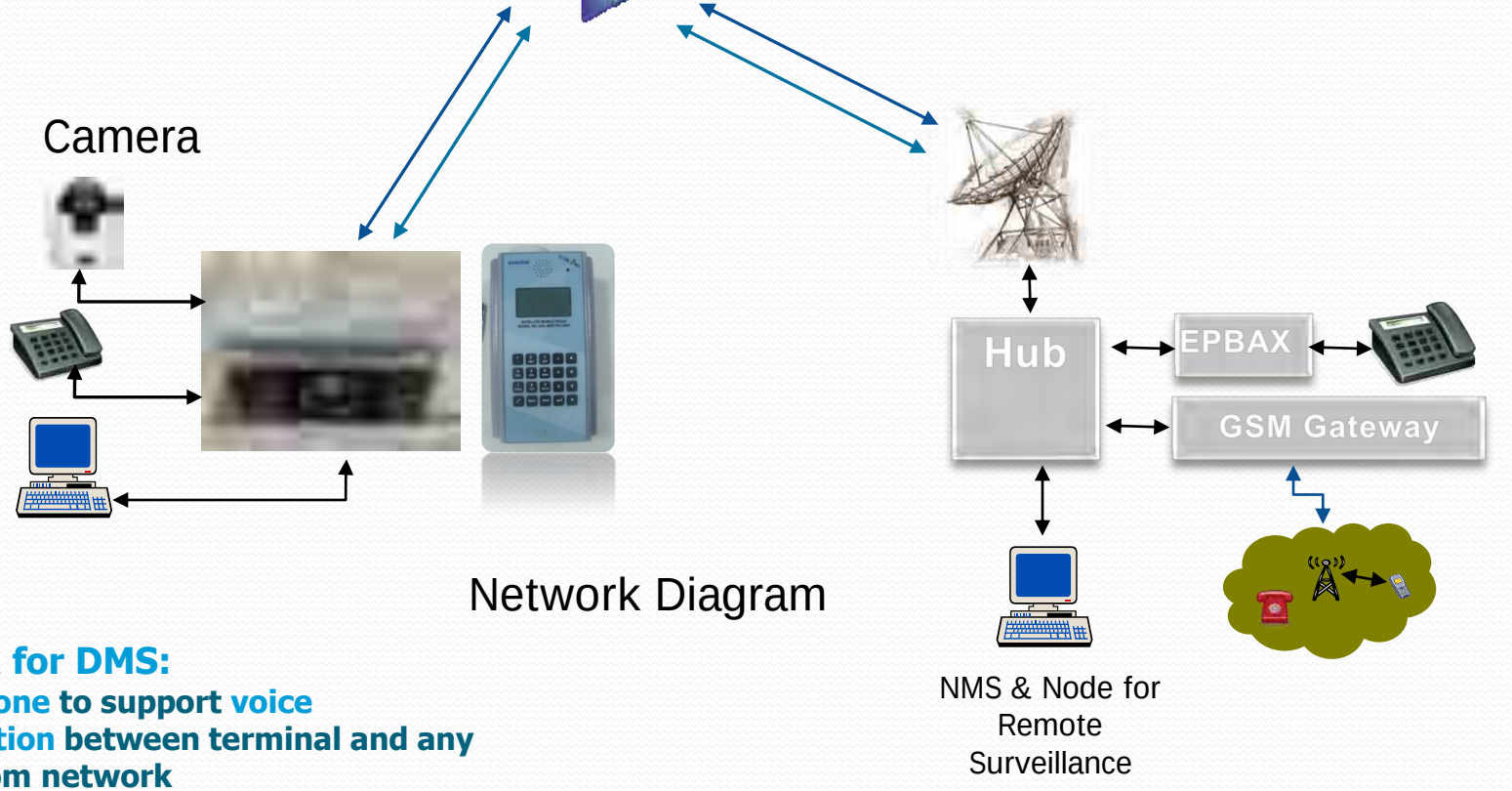
ISRO's MSS Network & Technology for First Responders

Satellite Phone

Portable Multimedia Terminal



GSAT-6



MSS Network for DMS:

- **Satellite Phone to support voice communication between terminal and any other telecom network**
- **Video Conferencing using Portable Multimedia Terminal**

ISRO's MSS Network & Technology for First Responders

Broadcast Receiver : Multichannel Audio-video and data reception terminal

Reporting Terminal : Transmitter for position and small message reporting.

Features:

- **USB powered light weight Broadcast terminals with Android Phone to disseminate data (MAPS, Warning, Governance Related) to field persons from central control / decision makers**
- **Reporting Terminal with built-in GPS to support Personnel/Vehicle/Asset tracking and small message reporting from disaster site**

Tsunami Early Warning Communication System

INSAT-3C / 3DR
S-Band / UHF

Sri Lanka, Thailand, etc,

Antenna

HUB AT
NIOT/INCOIS

Tsunami Buoy

Sat Tx

Acoustic
Transducers

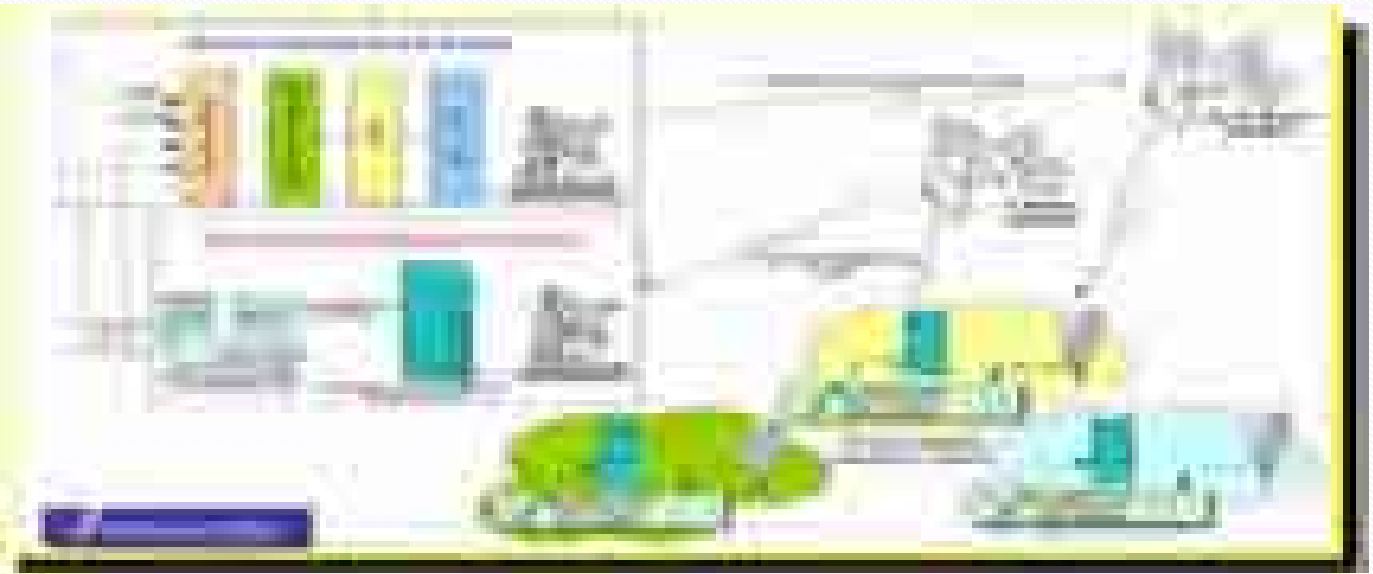
Tsunami Early warning system

- Collection of Tsunami data from sea
- Collection of tide Gauge data from sea coast
- Used for prediction of Tsunami

Bottom Pressure Recorder

Cyclone Warning System

Genesis of CWS



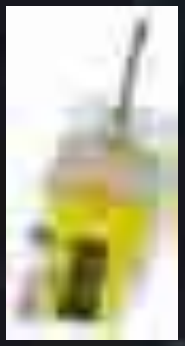
SATELLITE AIDED SEARCH AND RESCUE SYSTEM

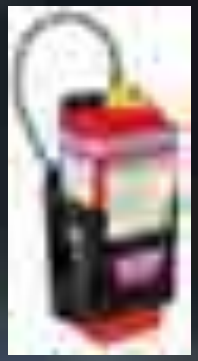
Radio Beacons – Types

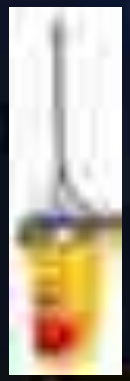
EPIRB : Emergency Position Indicator Radio Beacon

ELT : Emergency Locator Transmitter

PLB : Personal Locator Beacon





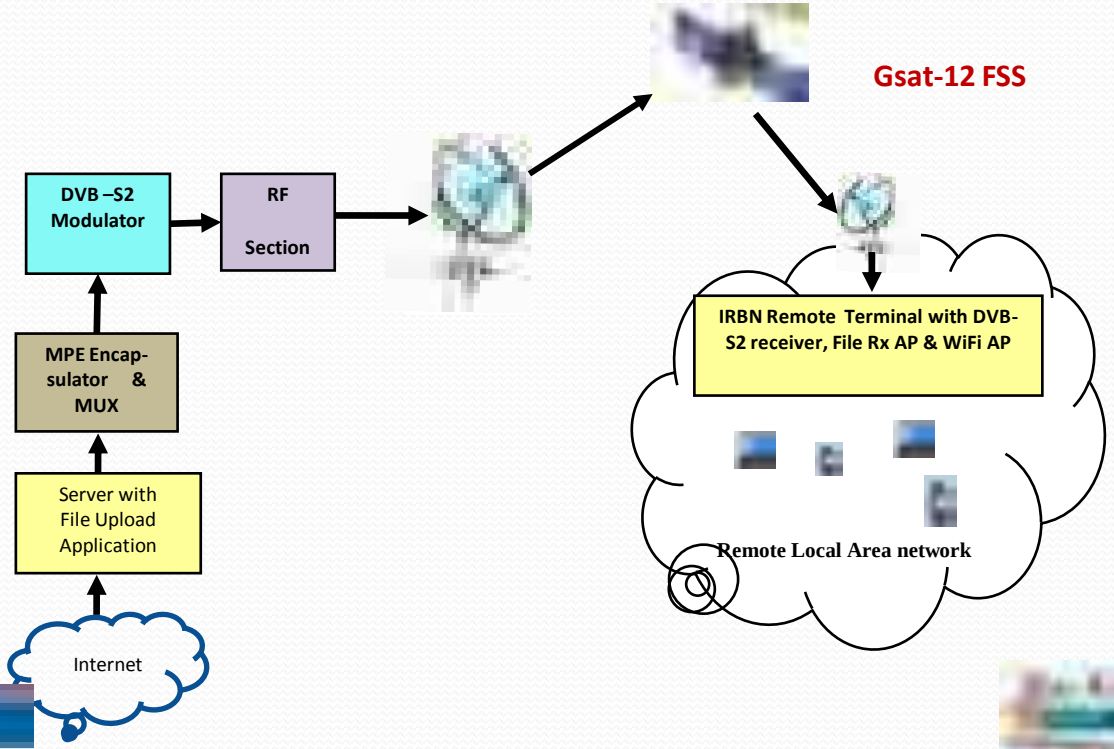


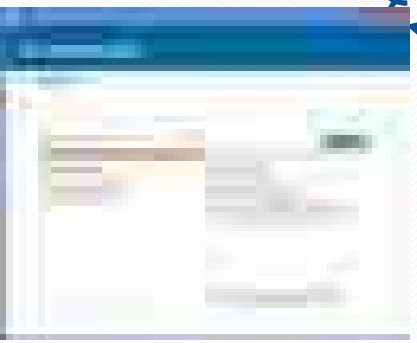
Outernet Application using MSS broadcast

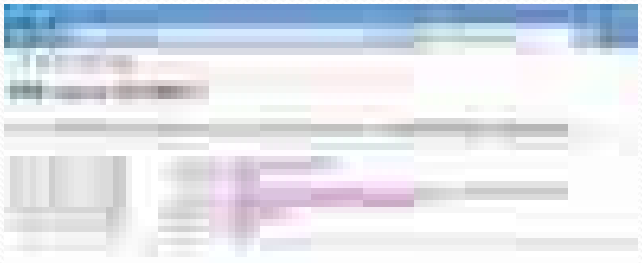
- To Provide free e-content to remote location users through broadcast channel
- Based on request made via offline/terrestrial/satellite means, when either there is no internet service available or limited connectivity
- Demo carried out using Gsat MSS

Outernet Application using Ku-band broadcast

- To Provide free e-content to remote location users through broadcast channel
- Based on request made via offline/terrestrial/satellite means, when either there is no internet service available or limited connectivity
- Demo carried out using Ext. C-Band FSS (Gsat-12)







Outernet Demonstration Set-up

24th May, 2017

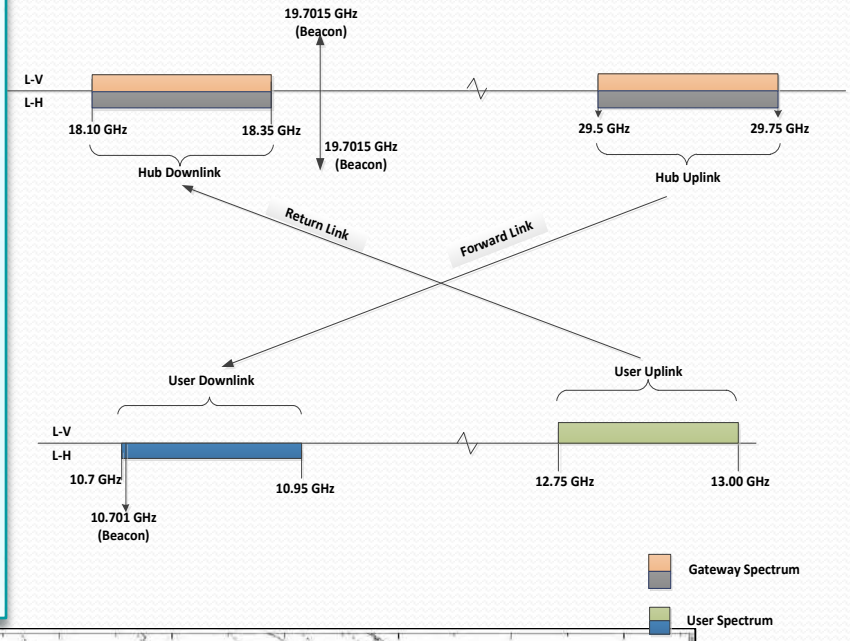
ISRO's Future Satcom payloads

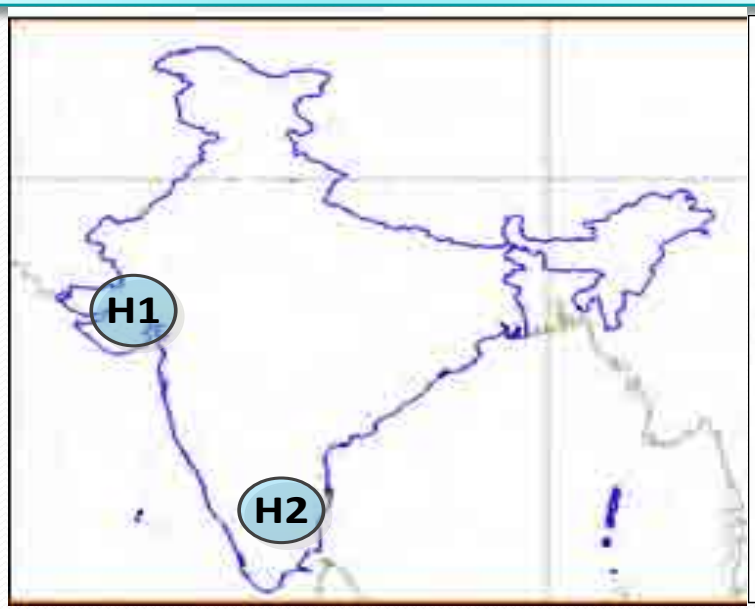
GSAT-11	• Ka-band Hub link, Ku-band User links • Ka x Ka link (125 MHz BW) across two hub beams • Total Throughput : ~10 Gbps (for FSS & Broadband)	Broadband Services
GSAT-20	• GEO Platform for Handheld Mobile Applications • C x S Forward Link; S x C Return Link • Spot Beam & wide beam coverage • 12m unfurlable antenna with DBFN	Services to Mobile users
I-6K Payload	• 88# Ka-band beams • Very high capacity : > ~200 Gbps • High data rate broadband applications • 0.4 to 0.8 m terminals	Broadband Services to Home users
GSAT-17	• Capacity Augmentation • Transponders in C & Ext. C-band • C x S & S x C transponders for MSS. • DRT & SAS&R Transponder for Disaster management	VSAT & DTH Services
GSAT-18	• Capacity Augmentation • Transponder in C, Ext. C & Ku-band • Total : 48 Transponders	

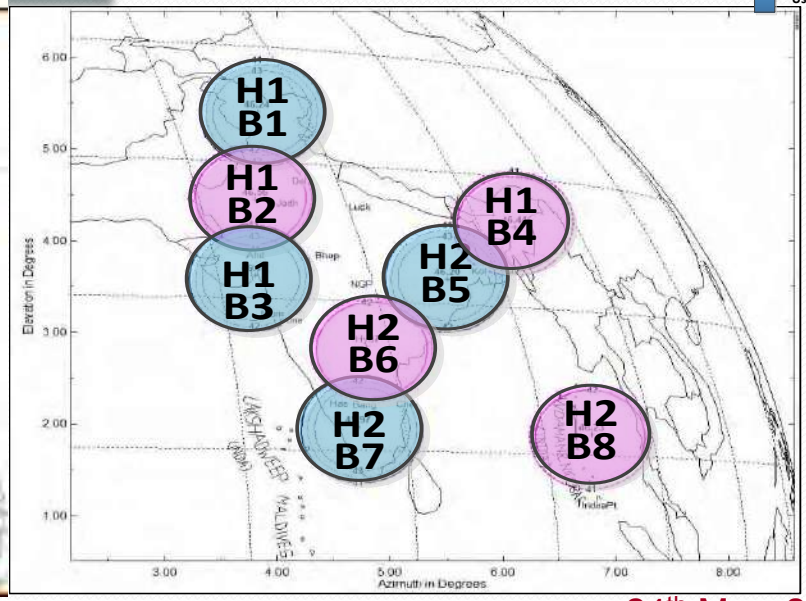
Gsat-19: High Throughput Satellite Precursor

System Configuration

- Beam Configuration
  - 8 Spot-beams (Ku-band)
  - 2 Gateway beams (Ka band)
- Ku-Planned band(partial GSAT-11 band) for user beams
- Hub link frequencies : 29.5 – 29.75 GHz/18.1 - 18.35 GHz (in both pol.)
- Hub beams proposed at Ahmedabad & Bangalore







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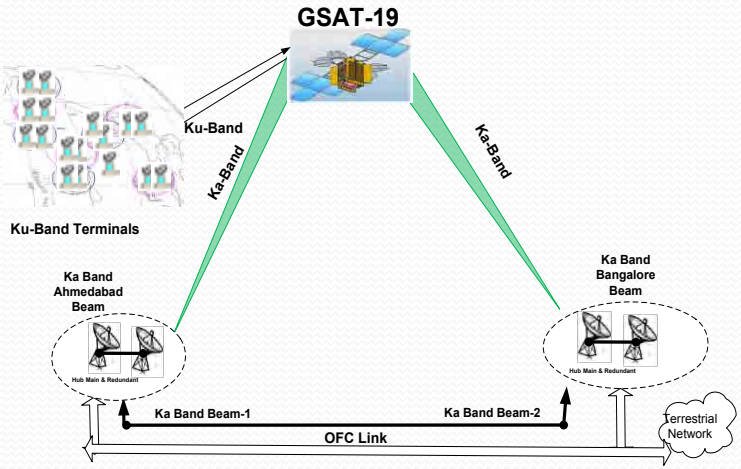
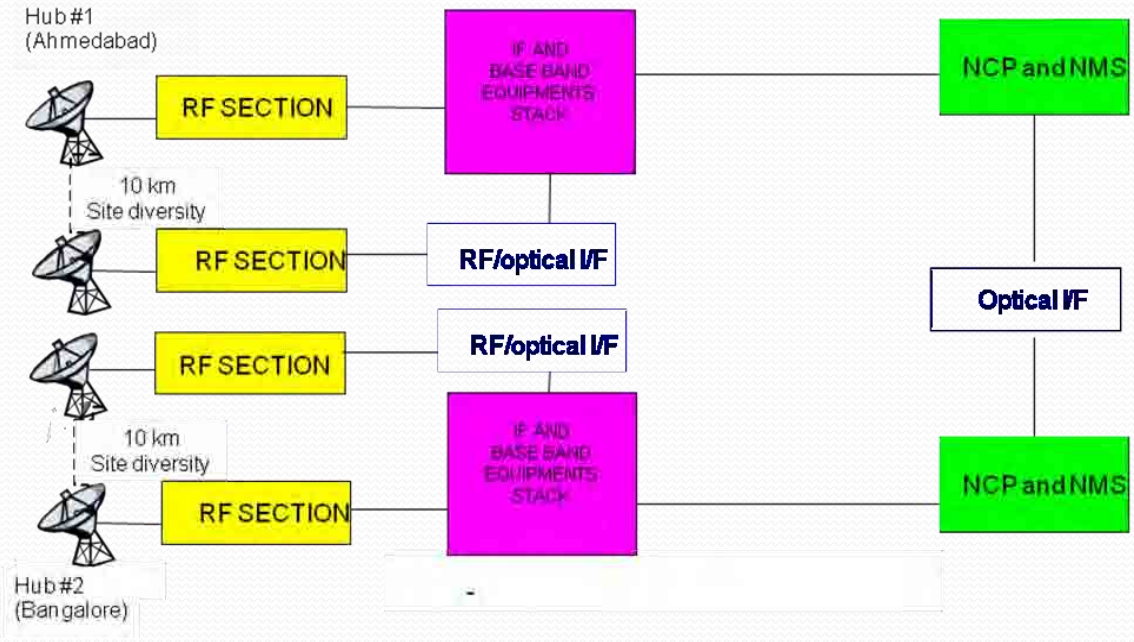
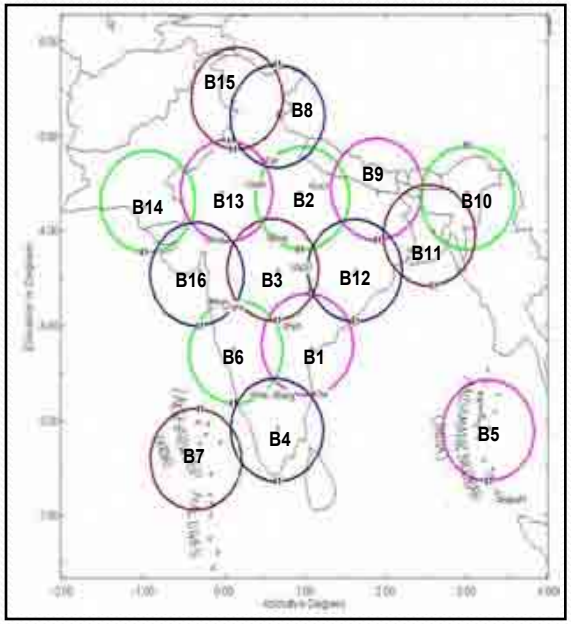
GSAT-19: Ground Network





Gsat-11: High Throughput Satellite

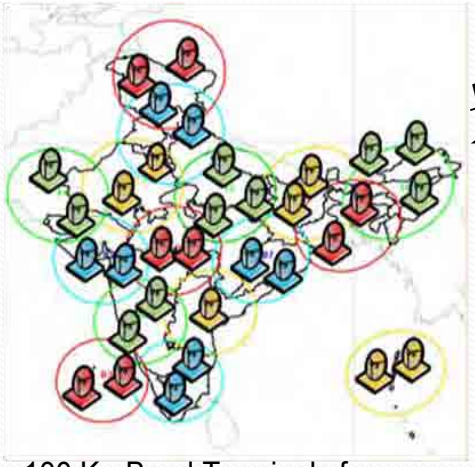
- High throughput advance communication satellite
- Covers Indian mainland and Islands with multiple spot beams
- High EIRP, G/T with frequency re-use
- User links in Ku-band and Gateway links in Ka-band



32 (16x2) Ku-band user beams

Four Ka-band Gateway beams

Gsat-11: HTS Ground Segment



100 Ku-Band Terminals for Phase-1 Testing and Demostration

GSAT-11

Ku-Band User Beams

Ka-band Beam(Vertical & Horizontal Polarization)

Ku-Band

Ku-Band Beacon Terminals

Ka-band Beam(Vertical & Horizontal Polarization)

MCF

Ka-band Beam(Vertical & Horizontal Polarization)

Ku-Band

Ku-Band Beacon Terminals

Ku-Band

Ka-band Beam(Vertical & Horizontal Polarization)

Ku-Band Beacon Terminals

Gateway Main & Diversity Site

Gateway Main & Diversity Site

Gateway Main & Diversity Site

Gateway Main & Diversity Site

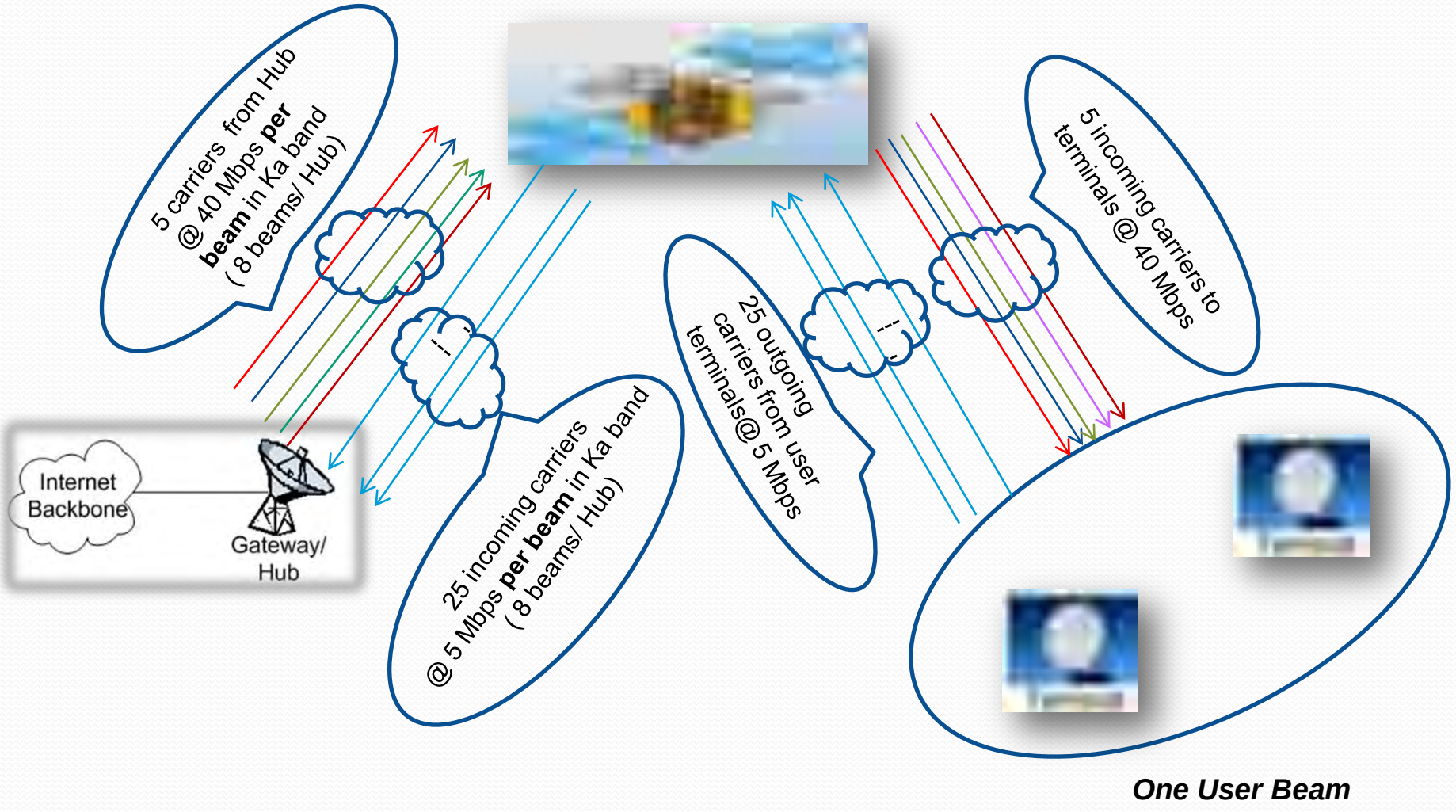
OFC Link

Terrestrial Network

Potential Applications

General Applications	**The services for Home users** • Internet / Broadband connectivity
Societal Applications	**The societal service for rural & remote area users, Government agencies, Universities** • Distance Learning • Tele-medicine • **Disaster Recovery and Emergency Management** • Mobile command posts • Satellite News Gathering
Commercial Applications	**The commercial service for professional and industrial uses** • Bank ATM, Reservation System • Enterprise & Private Networks • Cellular Backhaul • Movie Distribution
Strategic user specific Applications	**These applications are for strategic users** • Military Tactical Networks

Proposed Network Configuration

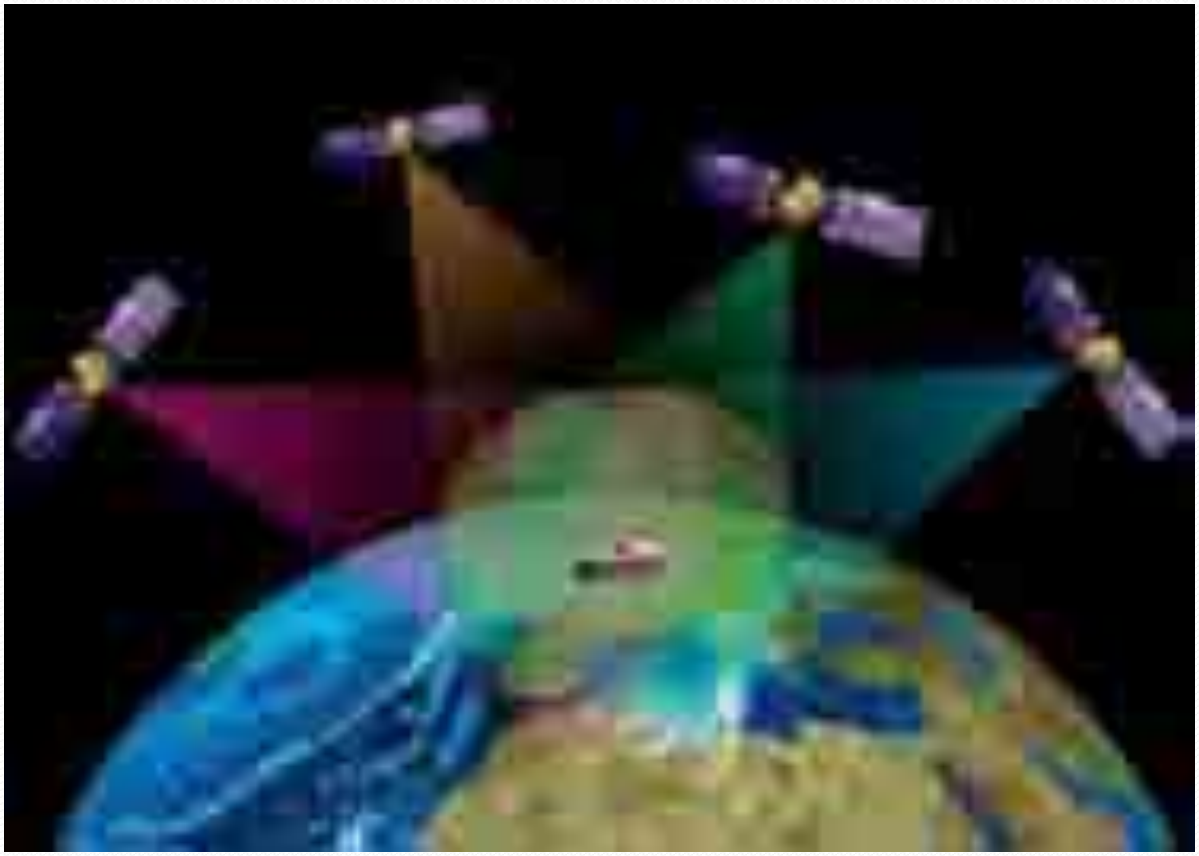


Network Configuration for Inter Beam and Hub to Beam Configuration (STAR NETWORK TOPOLOGY)

SatCom & SatNav : Synergetic Application & Technology Initiatives

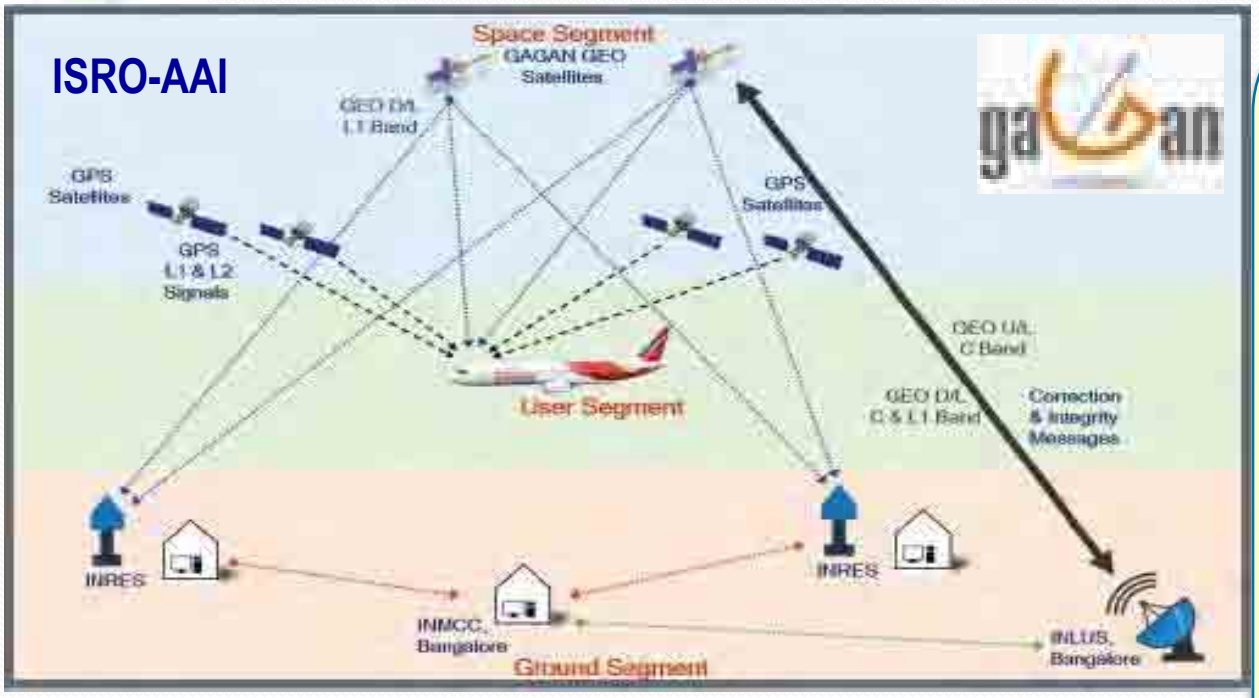
24th May, 2017

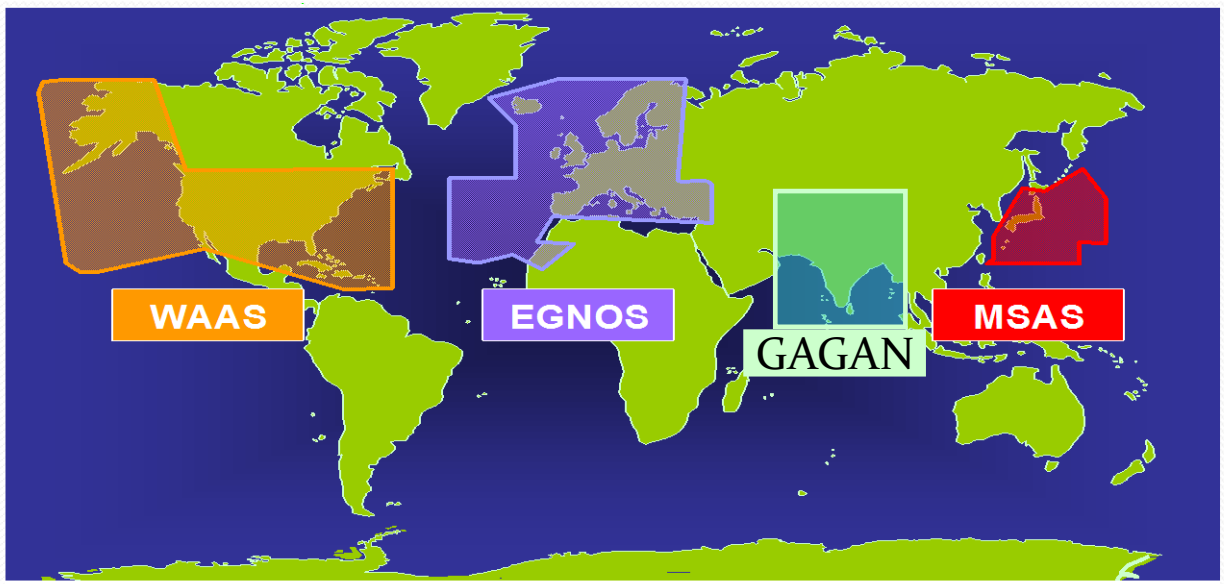
Satellite Based Navigation & Indian Scenario



- **Receiving & Processing Signals from min. 4 Satellites**
  - **Calculate P,V,T / P,N,T**
- **Indian Scenario**
  - **2015-GAGAN (GPS Aided Geo Augmented Navigation)**
  - **2016-NavIC (Navigation with Indian Constellation)**

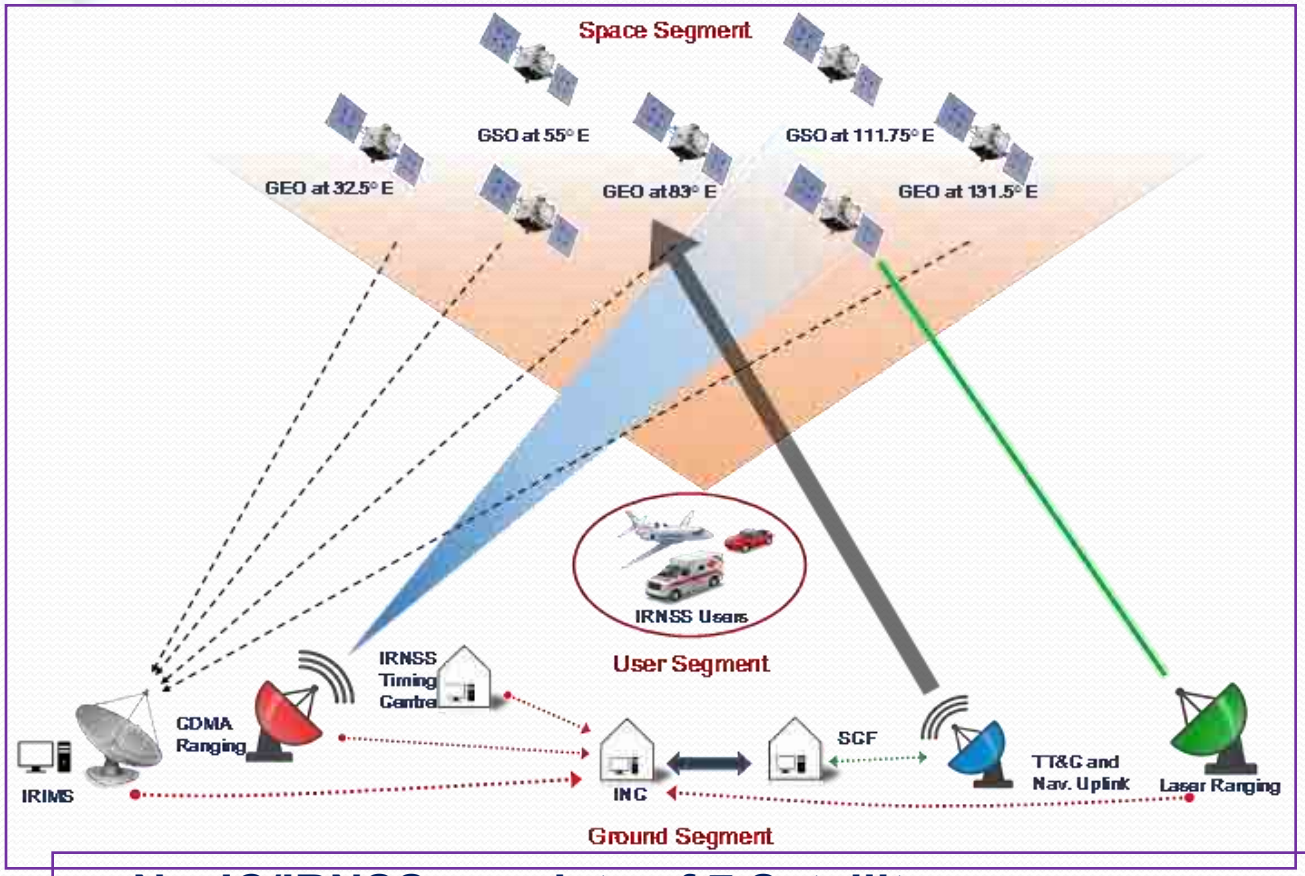
GAGAN (GPS Aided Geo Augmented Navigation)





- *Jointly implemented by ISRO & AAI*
- *Wide Area Augm. for Civil Aviation (Gsat-8 / 10 / 15)*
- *GAGAN is the first SBAS system in the world to have the capability of vertical guidance in the Equatorial Anomaly Regions, i.e. India*

Navigation with Indian Constellation (NavIC)



- **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 MHz) and S band (2492 MHz)**

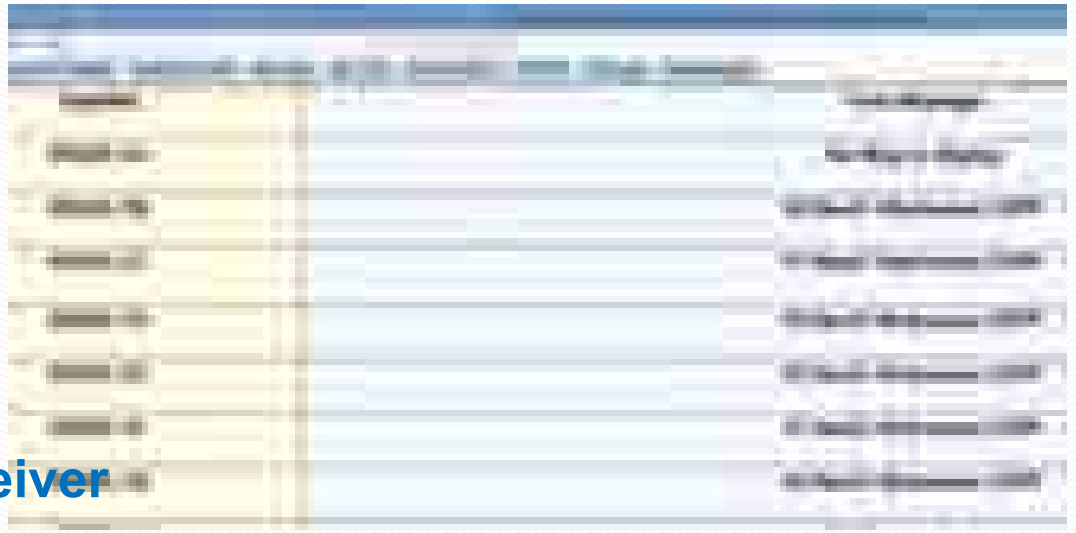
Disaster Management & Support

- Disaster assessment, management and prevention
- Monitor possible danger situations that may cause disaster (e.g. monitor flood levels, tsunami prediction, earthquake)
- Rapid emergency communication
- Rapid command schedule

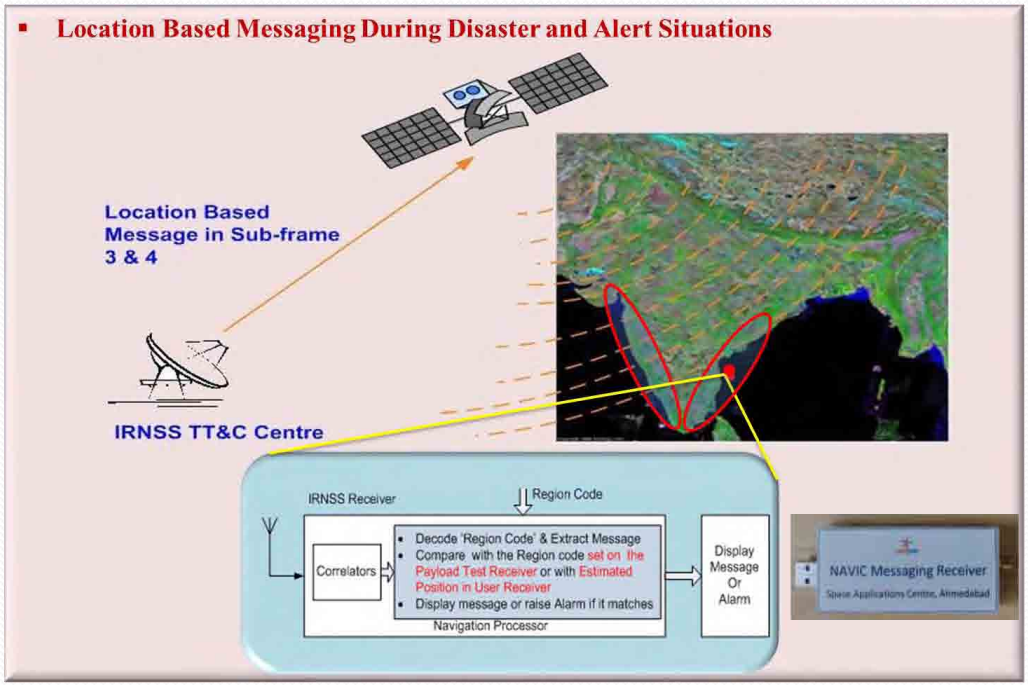
E-CALL(Emergency Calling)

- Vehicle automatically dials E-CALL (emergency number) in case of accident
- Sends NavIC /GPS co-ordinates to emergency service
- Sends vehicle data (point of impact data)
- Communication through GSM/GPRS Modem or Satellite Terminal
- Improves response time

Messaging using NavIC: Disaster Warning, Alerts



Single Channel Messaging Receiver : Display on Smart Device



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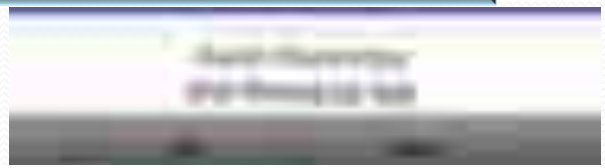
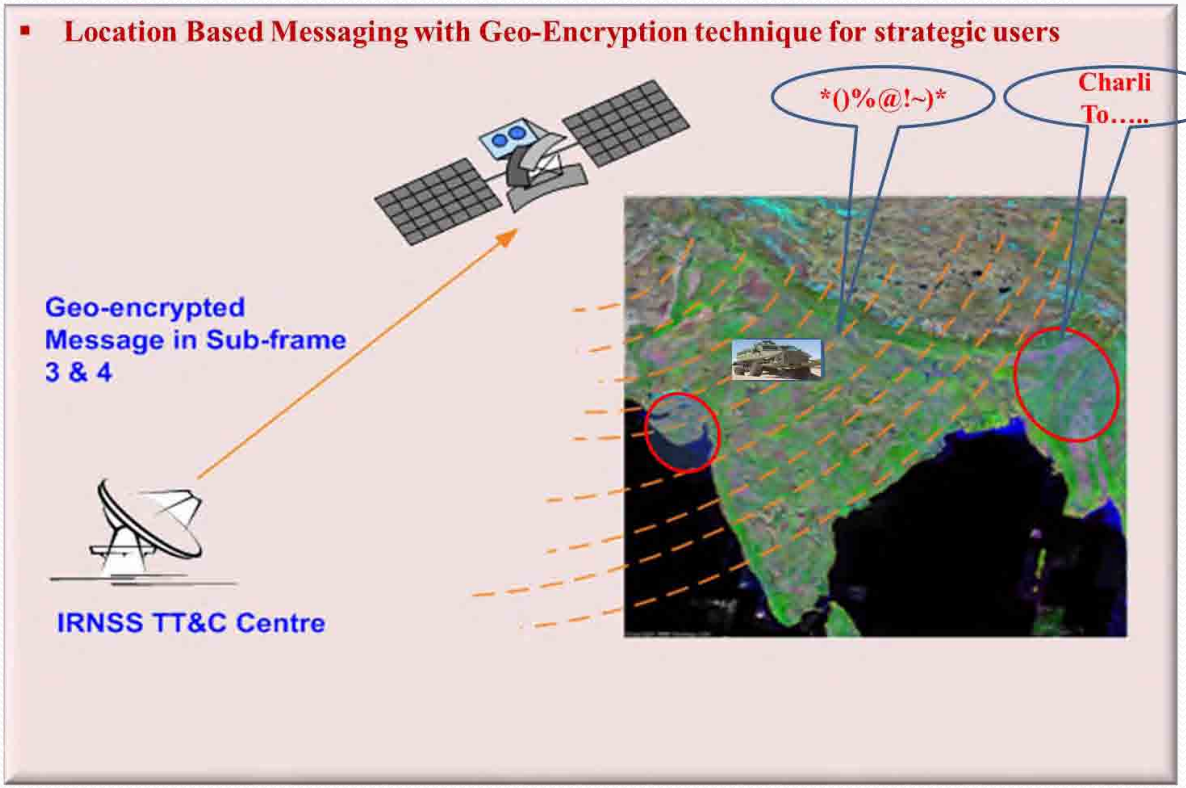
Strategic Messaging using NavIC: Geo-Fencing



7-Channel Position & Messaging Receiver



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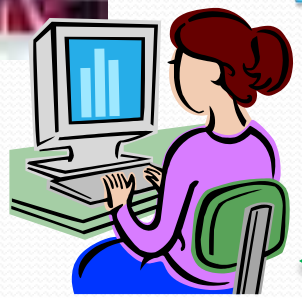
Messaging service overall flow – with1 A



feedback

User register & upload msg to web Server

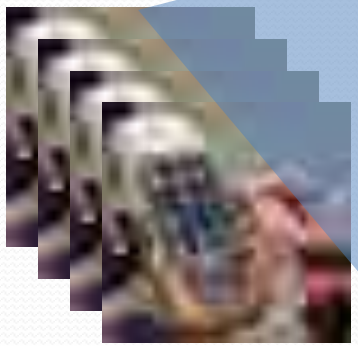
Navigation software allots msg ID , packs msg and transmit to MCF.

IRNSS Nav data & text msg generation at INC

IRNSS 1A

Broadcast of message to the user receiver

Identified User decodes messages through msg ID



IRNSS 1B - 1G

IRNSS Nav user; capable to receiver normal text msg

Message transmission to the satellite from MCF

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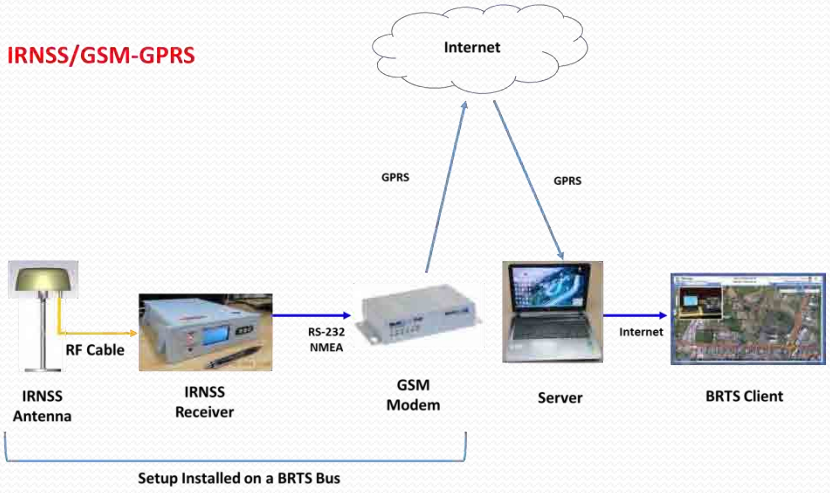
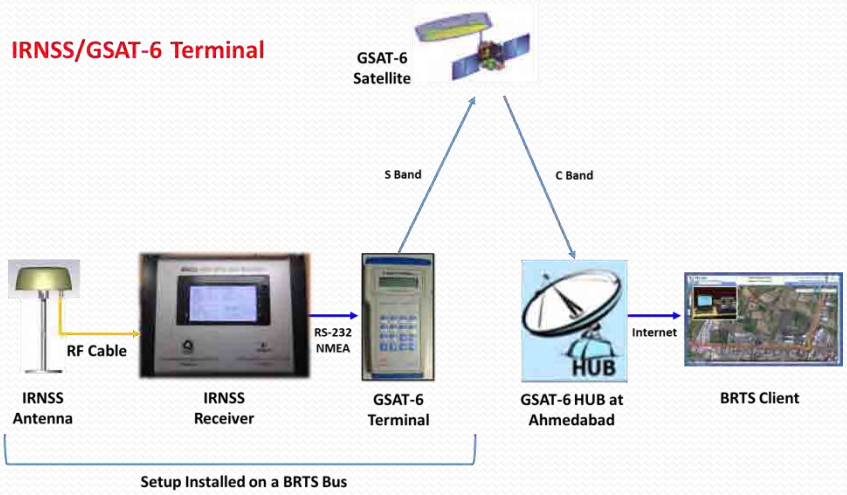
Typical Demo of NavIC & MSS based Vehicle Tracking : 19 Sept.-2016





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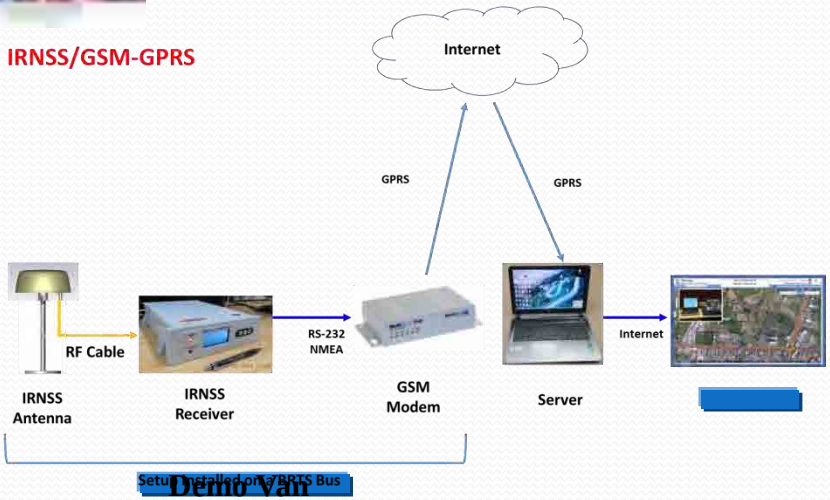
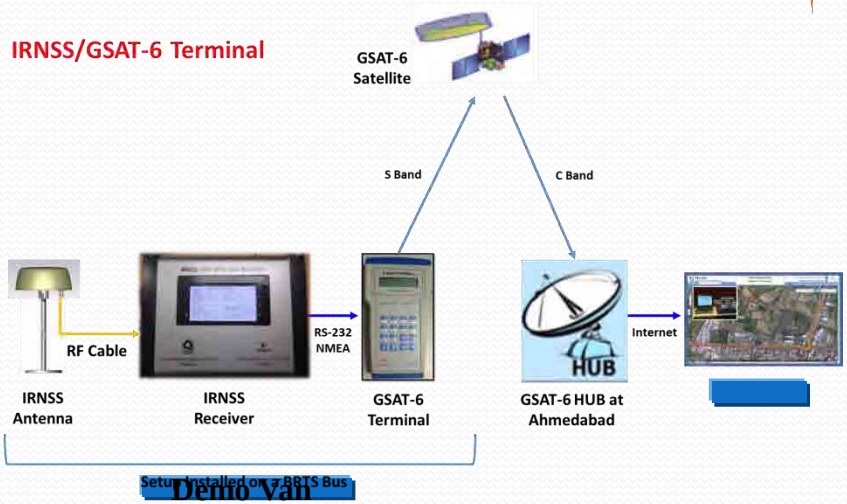
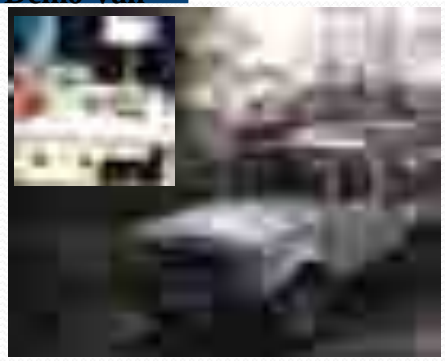
Live Demo: Vehicle Tracking at New Delhi & Ahmedabad





SAC's Demo Van in Ahmedabad

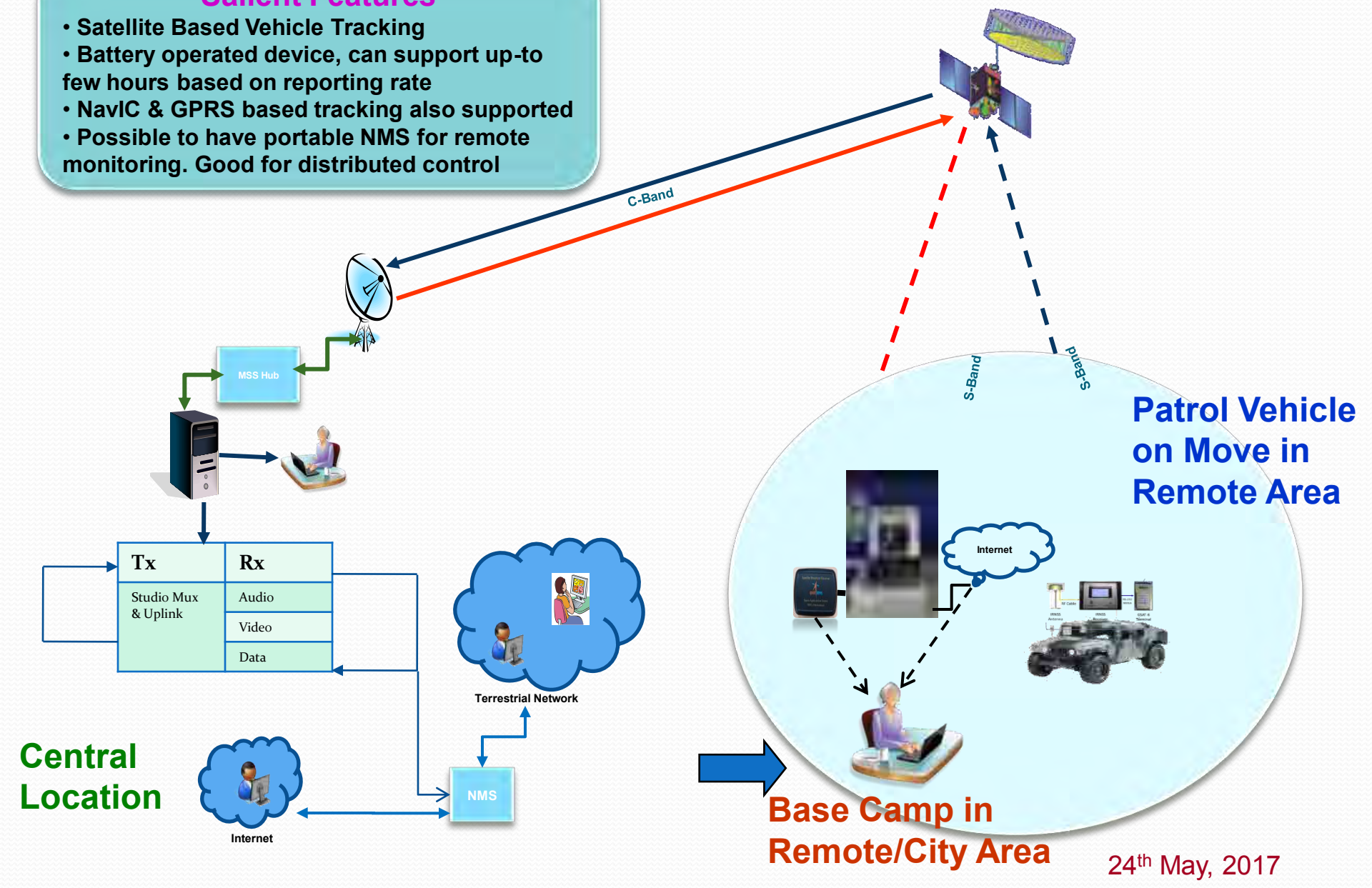


Gypsy Vehicle in New Delhi

Strategic Application: Satellite Based Vehicle Tracking

Salient Features

- Satellite Based Vehicle Tracking
- Battery operated device, can support up-to few hours based on reporting rate
- NavIC & GPRS based tracking also supported
- Possible to have portable NMS for remote monitoring. Good for distributed control



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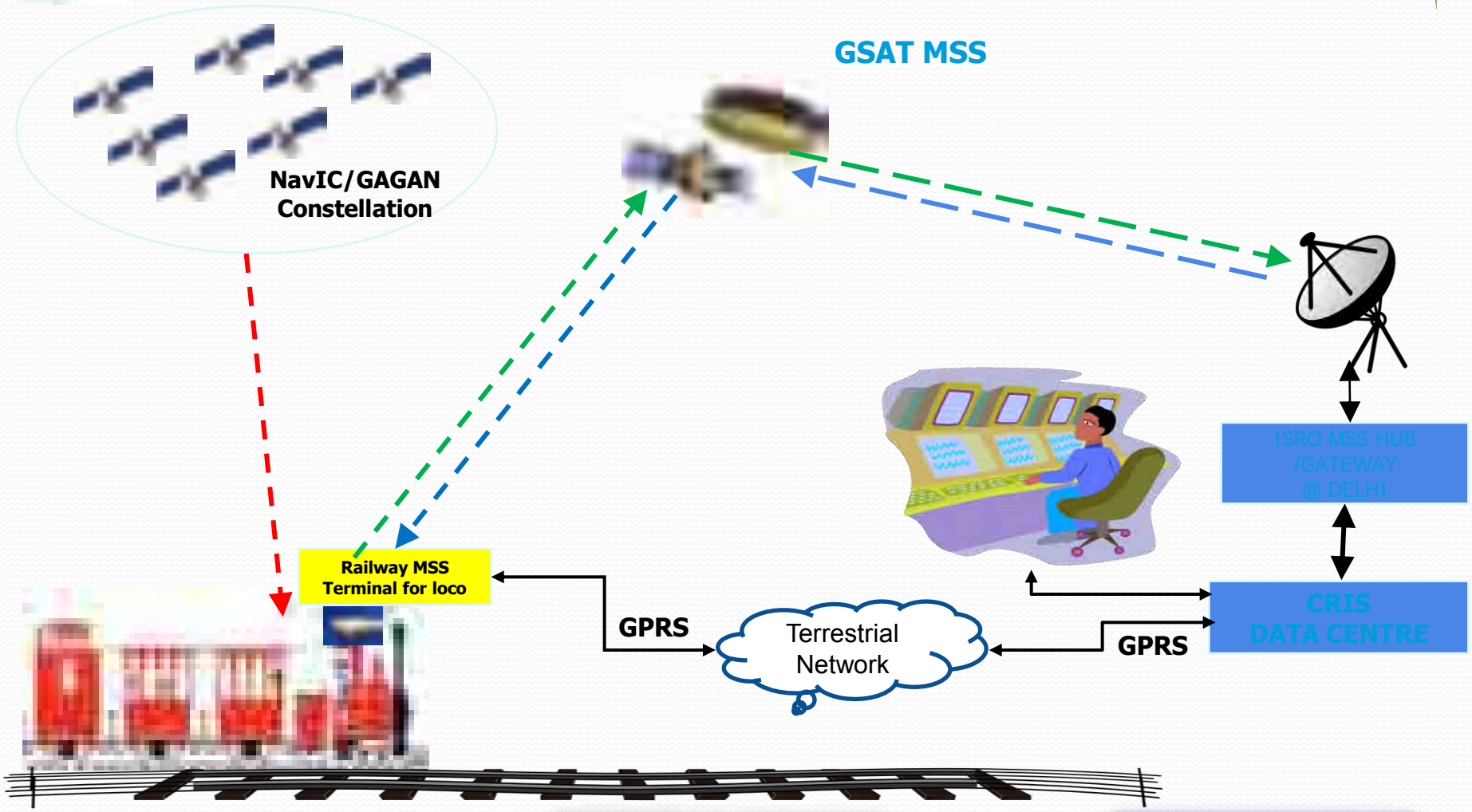
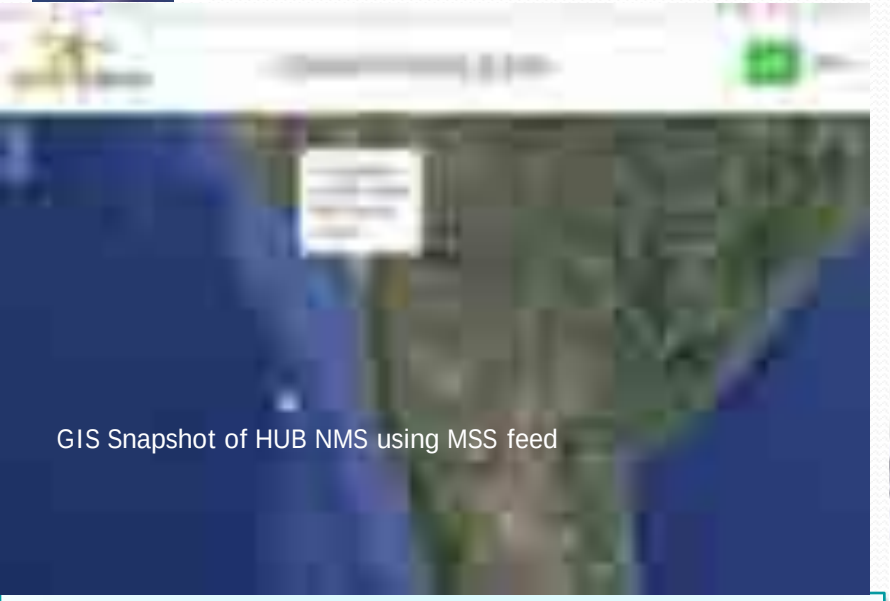
MSS Network For Indian Railways

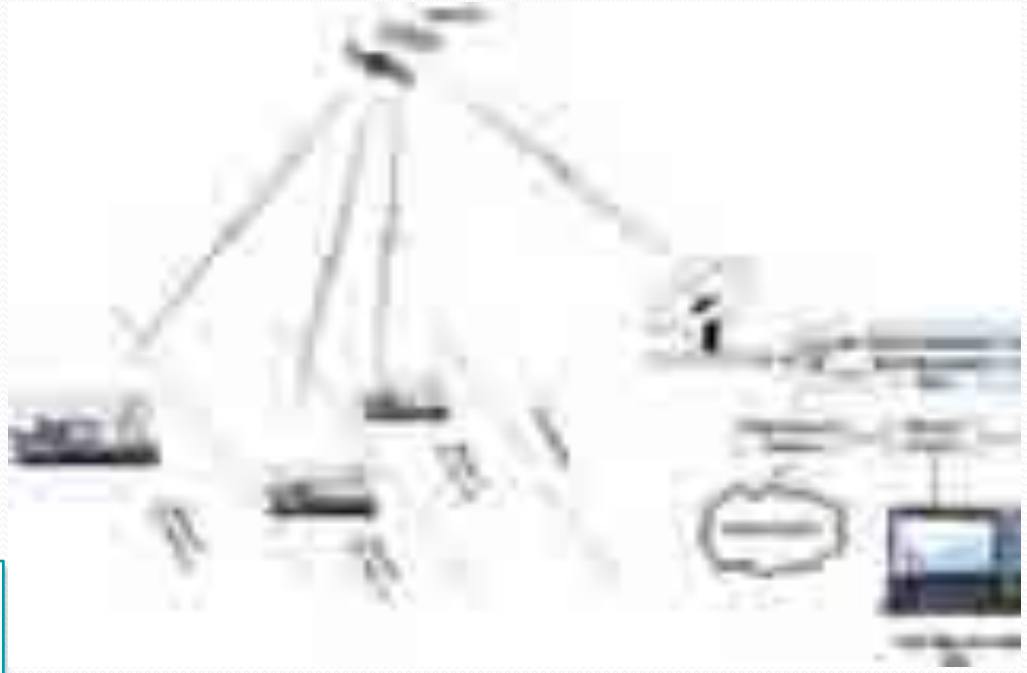


MSS Terminal

MSS Network for Tracking, Emergency Messaging & Disaster Warning for Sub-20m Boats



GIS Snapshot of HUB NMS using MSS feed



Network Block Diagram

Terminal Developed by SAC-ISRO

Satcom & Satnav Applications for Remote Locations

Tracking of Soldiers in Remote Areas, Siachen Etc.

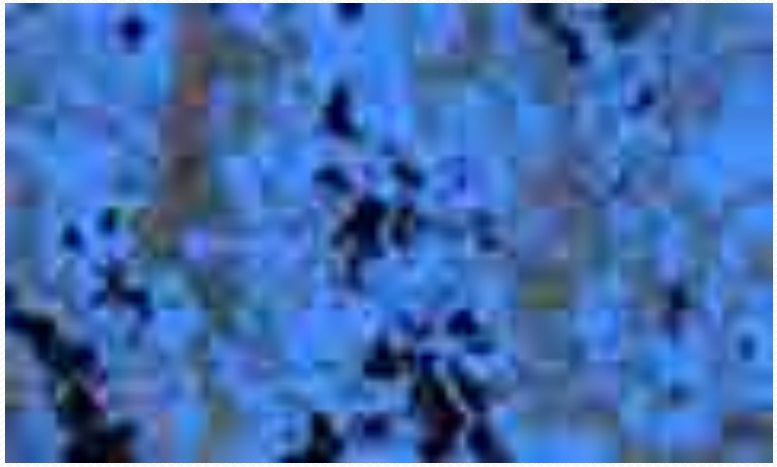
- **Avalanches and Snow Storms**
- **Search and Rescue Operations**
- **Need of Innovative Antenna**
- **Low Power, Miniaturized Battery operated**
- **NavIC Rx + MSS Terminal rolled into One unit**

24th May, 2017

DMSAR

C-Band DMSAR (Ver-1)
FIRST FLOWN ON NOV 26, 2005

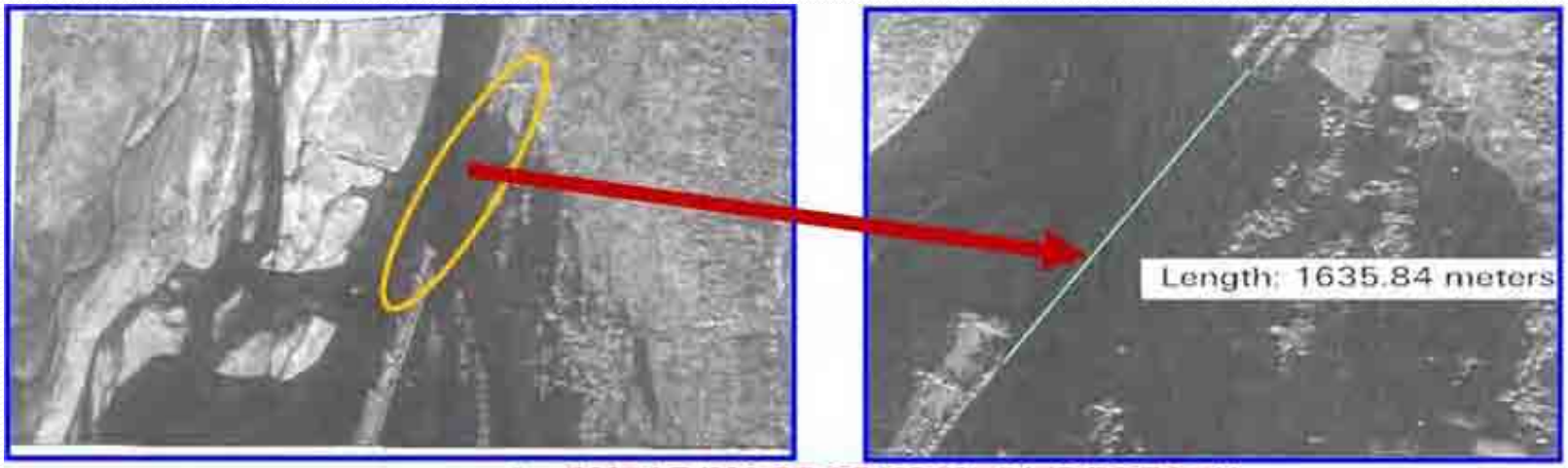
C-Band DMSAR
(Ver-2), 2011



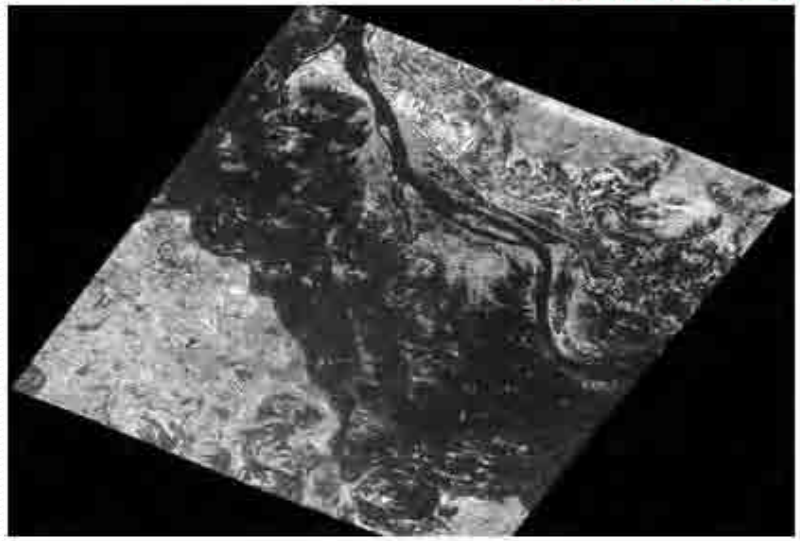
Extent of Flood over Dharbhanga, Bihar in 2007 (Blue: Flood) As viewed by DM-SAR

Operating frequency	**5350 MHz**
Polarization	**HH, VV**
Slant range resolution	**<2 m (Exp), 3 m, 5 m, 10m**
Azimuth resolution	**<2 m (Exp), 3 m, 5 m, 10m**
Swath coverage	**6 Km (Exp), 25 km, 45 km, 60 km**

DMSAR WIDE SWATH IMAGES



1m DMSAR IMAGE OF KOSI RIVER BREACH



Bihar Flood

5m Image

24th May, 2017

DMSAR HIGH RESOLUTION IMAGES

SCIENCE CITY, AHMEDABAD

NANO FACTORY, SANAND

24th May, 2017

ISRO Disaster Management SATCOM Support in Jammu & Kashmir

Discussion with Minister

reach unrea...

Kashmir: An Aerial; View after flood

SATCOM to help in governance at Rajbhawan

VSAT-Installation at Sri-Nagar

Kashmir: Seven days after initial flooding

Our system @ use

SAC Team @ WORK

Gift to Raj Bhavan

Our onsite effort

SAC/ISRO: Capacity Building & Public Outreach

Centre for Space Science & Technology Education in Asia and the Pacific (CSSTEAP)

(Established in Nov 1, 1995, currently 15 Member Countries)

Provides Training and education in:

- Satellite Meteorology & Global Climate (SATMET)
- Satellite Communications (SATCOM)
- Satellite Navigation (SATNAV)

Public outreach : VSSE Exhibitions, Publications

CONCLUDING REMARKS

- SAC/ ISRO's SatCom and SatNav Programmes
  - Vigilant Eyes in the Sky
  - Serving Nation's interests : Civilian, Disaster Management, Science, Strategic

ACKNOWLEDGEMENTS

- SAC & ISRO Colleagues

- SAARC Disaster Management Centre (SDMC)
- Gujarat Institute of Disaster Management (GIDM)
- Programme Participants

- Shri Tapan Misra, Director, SAC, Ahm.
- Shri A.S.Kirankumar, Chairman, ISRO, Blr.

THANK YOU

The future depends on what we do in the present.

24th May, 2017

Mahatma Gandhi

If you want Right answers, Never ask Wrong Questions!

- Old Maxim

It is better to debate a question without settling it than to settle it without debating it.

- Joseph Joubert, French Moralist