GNSS AND APPLICATIONS IN DISASTER MANAGEMENT

UN OOSA Training Workshop on Use of Space Technology for Disaster Risk Reduction organised by NIDM, New Delhi

Presentation

By

R. Gopalakrishnan
Group Head, SEOGD
ISRO Earth Station, Delhi
rgkishnan20032003@yahoo.co.in

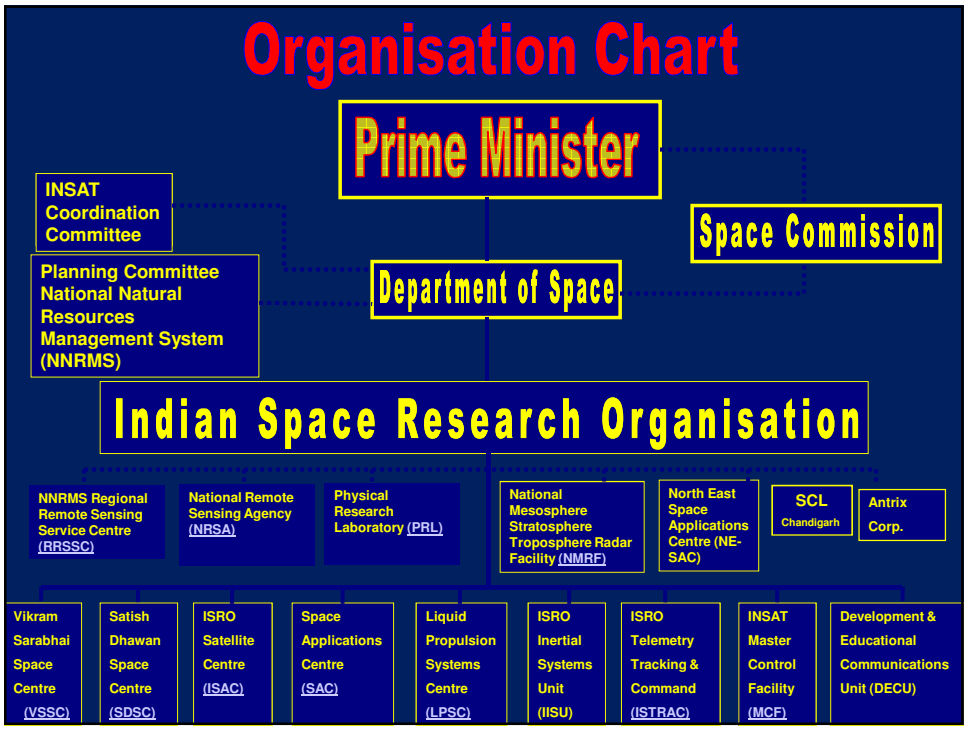
Dr.S.V. Kibe
Indian Space Research Organisation
Bangalore

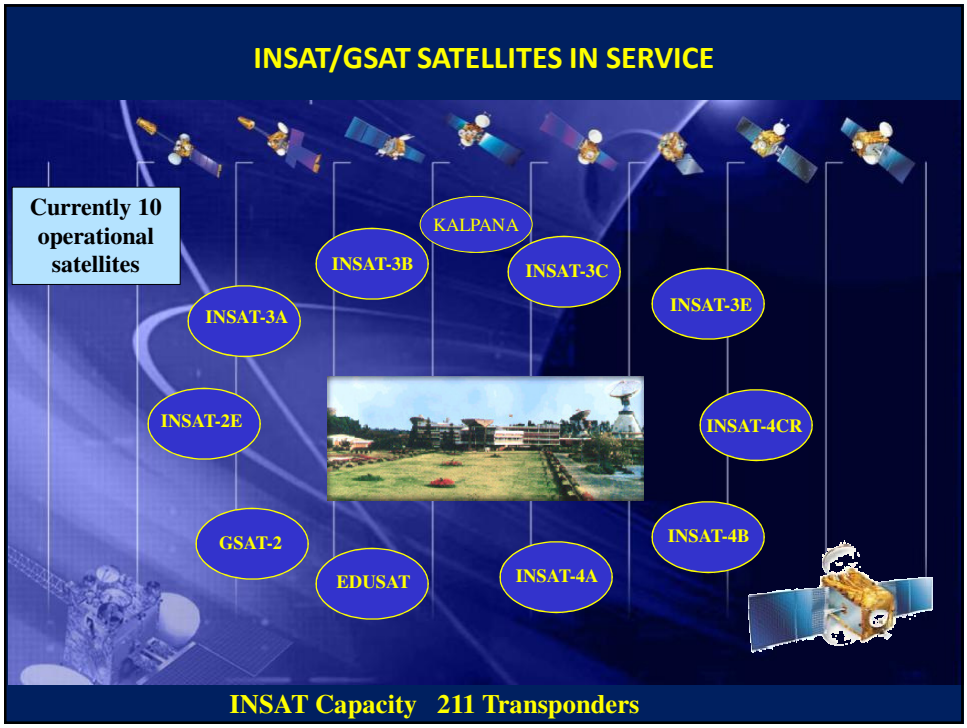
Type of Disasters

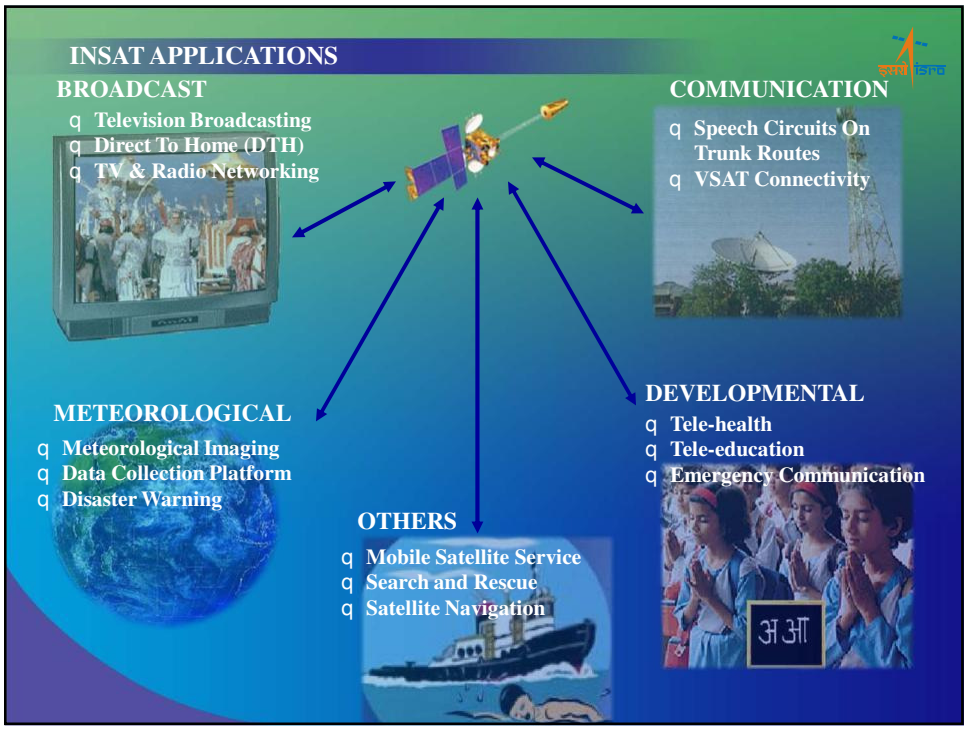
- Volcanic Eruptions
- Earthquakes
- Floods, cyclones, Tsunami
- Air accidents
- Forest fires
- Man made catastrophes: civil disorders, riots, etc.

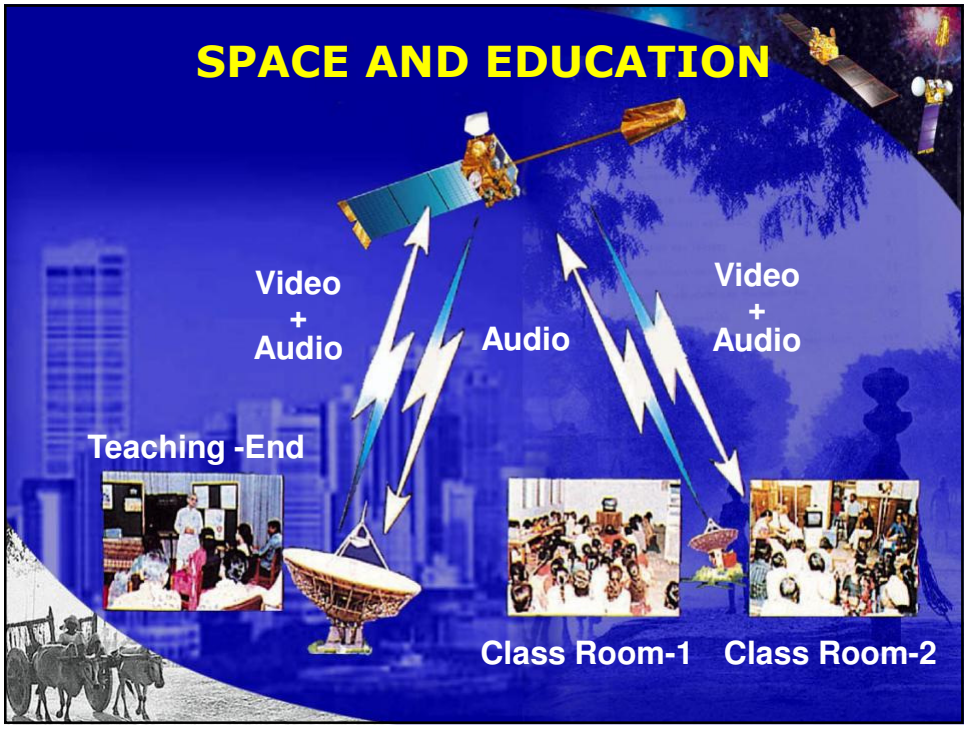
All disasters cannot be predicted. However, the damage caused to life and property can be minimised postfacto. To achieve this, rugged and easily deployable means of communication, location of disaster, search and rescue efforts through Space Based information for Disaster Management and Emergency Response (SPIDER) is required.

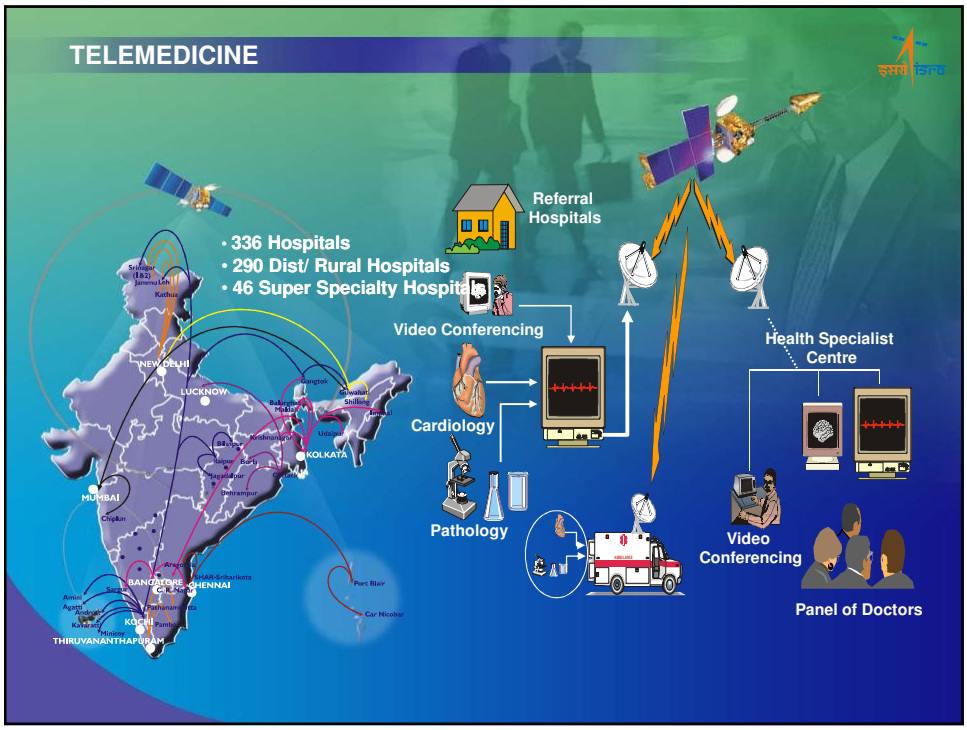
INDIAN COMMUNICATION AND REMOTE SENSING SATELLITES AND SERVICES

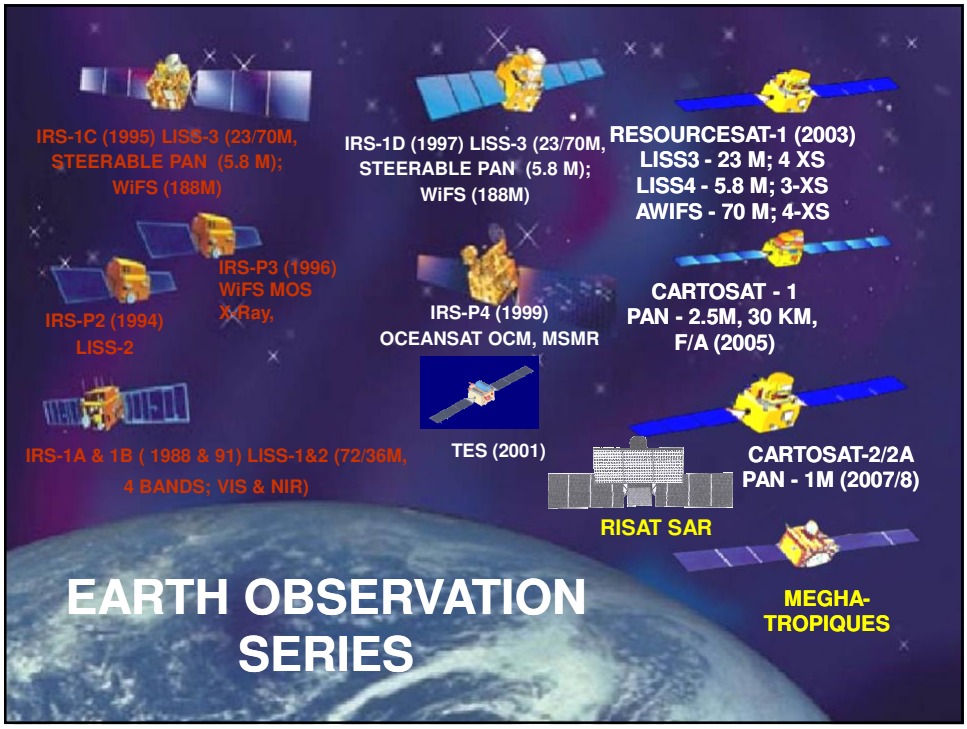


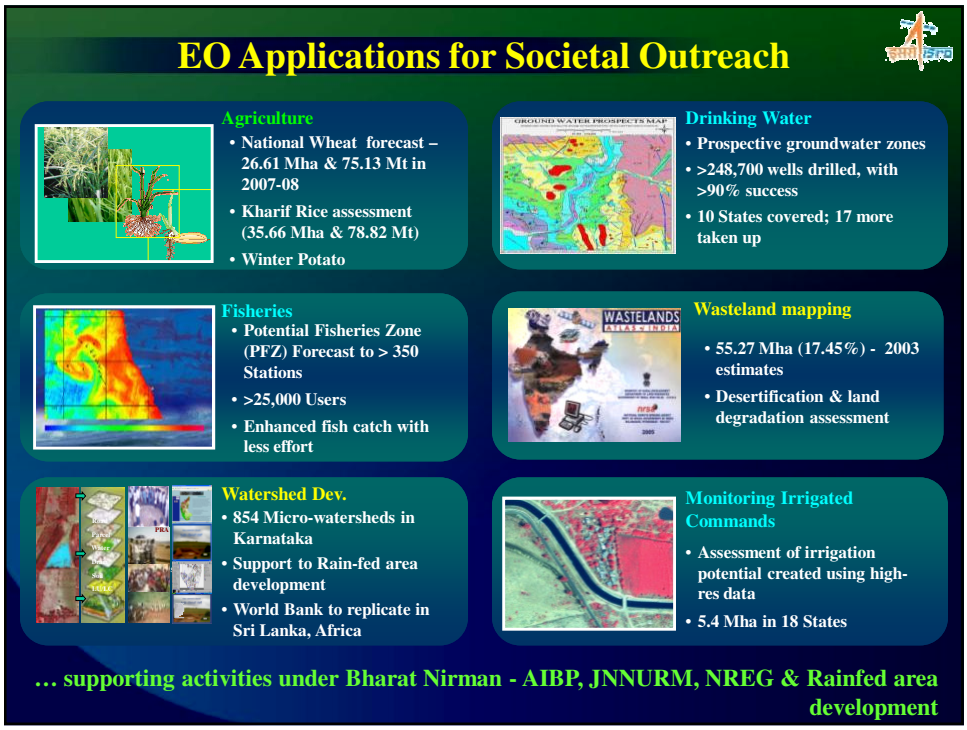

INSAT/GSAT SATELLITES IN SERVICE
Currently 10 operational satellites
KALPANA
INSAT-3B
INSAT-3C
INSAT-3A
INSAT-3E
INSAT-2E
INSAT-4CR
GSAT-2
INSAT-4B
EDUSAT
INSAT-4A
INSAT Capacity 211 Transponders


INSAT APPLICATIONS
BROADCAST
q Television Broadcasting
q Direct To Home (DTH)
q TV & Radio Networking
COMMUNICATION
q Speech Circuits On Trunk Routes
q VSAT Connectivity
METEOROLOGICAL
q Meteorological Imaging
q Data Collection Platform
q Disaster Warning
OTHERS
q Mobile Satellite Service
q Search and Rescue
q Satellite Navigation
DEVELOPMENTAL
q Tele-health
q Tele-education
q Emergency Communication
अ आ


SPACE AND EDUCATION
Video
+
Audio
Audio
Video
+
Audio
Teaching -End
Class Room-1
Class Room-2


TELEMEDICINE
• 336 Hospitals
• 290 Dist/ Rural Hospitals
• 46 Super Specialty Hospitals
Referral
Hospitals
Video Conferencing
Cardiology
Pathology
Health Specialist
Centre
Video
Conferencing
Panel of Doctors
NEW DELHI
LUCKNOW
KOLKATA
MUMBAI
BANGALORE
CHENNAI
THIRUVANANTHAPURAM


IRS-1C (1995) LISS-3 (23/70M, STEERABLE PAN (5.8 M); WiFS (188M)
IRS-1D (1997) LISS-3 (23/70M, STEERABLE PAN (5.8 M); WiFS (188M)
RESOURCESAT-1 (2003)
LISS3 - 23 M; 4 XS
LISS4 - 5.8 M; 3-XS
AWIFS - 70 M; 4-XS
IRS-P3 (1996)
WiFS MOS
X-Ray,
IRS-P2 (1994)
LISS-2
IRS-P4 (1999)
OCEANSAT OCM, MSMR
CARTOSAT - 1
PAN - 2.5M, 30 KM,
F/A (2005)
IRS-1A & 1B (1988 & 91) LISS-1&2 (72/36M, 4 BANDS; VIS & NIR)
TES (2001)
CARTOSAT-2/2A
PAN - 1M (2007/8)
RISAT SAR
MEGHA-TROPIQUES
EARTH OBSERVATION SERIES


EO Applications for Societal Outreach
Agriculture
• National Wheat forecast – 26.61 Mha & 75.13 Mt in 2007-08
• Kharif Rice assessment (35.66 Mha & 78.82 Mt)
• Winter Potato
Drinking Water
• Prospective groundwater zones
• >248,700 wells drilled, with >90% success
• 10 States covered; 17 more taken up
Fisheries
• Potential Fisheries Zone (PFZ) Forecast to > 350 Stations
• >25,000 Users
• Enhanced fish catch with less effort
Wasteland mapping
• 55.27 Mha (17.45%) - 2003 estimates
• Desertification & land degradation assessment
Watershed Dev.
• 854 Micro-watersheds in Karnataka
• Support to Rain-fed area development
• World Bank to replicate in Sri Lanka, Africa
Monitoring Irrigated Commands
• Assessment of irrigation potential created using high-res data
• 5.4 Mha in 18 States
… supporting activities under Bharat Nirman - AIBP, JNNURM, NREG & Rainfed area development

INSAT infrastructure and services

- The INSAT (Indian National Satellite) system has been operational in India since 1982.
- At present, the INSAT system consists of 11 satellites, 200 transponders in C, Ext-C & Ku-bands, Mobile Satellite System (MSS) & Broadcast Satellite System (BSS) transponders in S-band.
- INSAT satellites carry a Data Relay Transponder (DRT) & Satellite Aided Search & Rescue (SAS&R) transponders.
- The GAGAN Payload is yet another value addition to the INSAT system for PNT Services.
- INSAT system provides capacity for societal applications such as, tele education, telemedicine and Village Resource Centres.

Use of Communications & Navigation infrastructure in Space for disaster management

- Use of Space based Information for Disaster management and Emergency Response (SPIDER) requires quick access to the location of the disaster, setting up of communication links & dissemination of information to the relief support systems.
- The INSAT system offers telecom, navigation, search and rescue & cyclone detection & warning system. These services together with the outreach through societal networks such as, teleeducation, telemedicine & village resource centres can be effectively utilised for disaster management through a centrally administered programme.

GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

What is GNSS?

- GNSS stands for Global Navigation Satellite System.
- The global ones: GPS (USA), GLONASS (RUSSIA), Galileo (European Union), Beidou/COMPASS (China) & GINS (INDIA). All satellites in Medium Earth Orbit (MEO)
- The Regional ones: QZSS (Japan), IRNSS (India) : Satellites in Geo or elliptical orbits
- The Augmentation Systems: WAAS (USA), EGNOS (Europe), MSAS(Japan), GAGAN (India) & GRAS (Australia).All augmentation satellites in Geo-stationary orbit.
- In the next 5-10 years there would be more than 70 satellites in the world for Satellite Navigation.
- GNSS receivers are small receive only terminals.

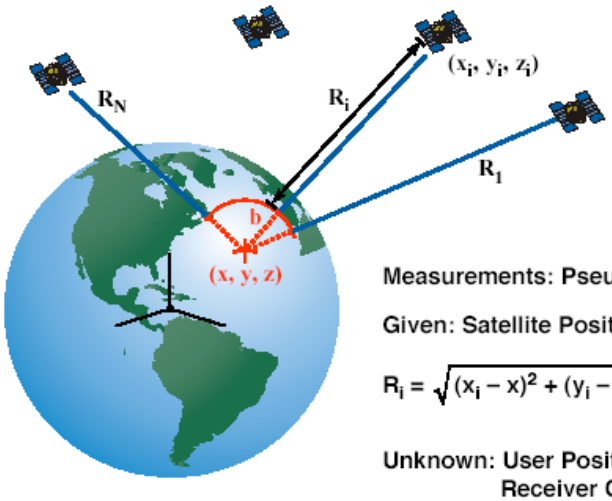
REQUIREMENTS OF NAVIGATION AND POSITION LOCATION SYSTEMS

- ALL WEATHER
- UNIVERSAL ACCESS
- MULTIMODAL
- CIVIL CONTROLLED
- MAINTAIN SOVEREIGNTY OF NATIONS
- HIGHEST SAFETY REQUIREMENTS
- HIGH REAL TIME POSITION ACCURACY

NAVIGATION AND POSITION LOCATION SYSTEMS STANDARDS ARE DRIVEN BY CIVIL AVIATION

Global Positioning System GPS

Satellite Navigation
Position Estimation by Trilateration



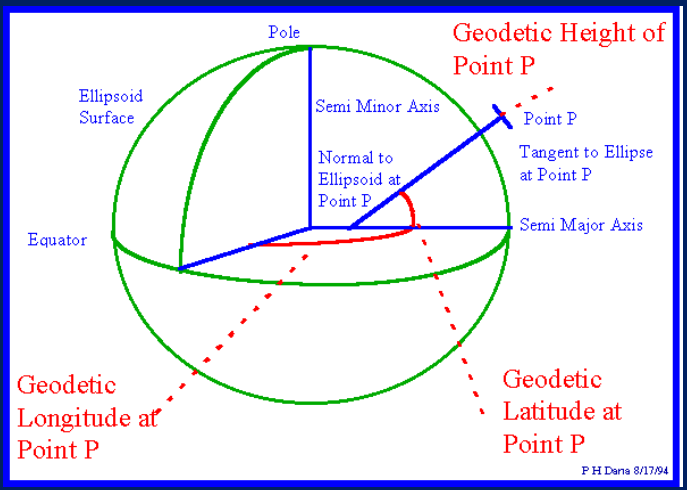
Measurements: Pseudoranges $\{R_i\}$

Given: Satellite Positions $\{(x_i, y_i, z_i)\}$

$$R_i = \sqrt{(x_i - x)^2 + (y_i - y)^2 + (z_i - z)^2} - b, \quad i = 1, 2, \ldots, N$$

Unknown: User Position (x, y, z)
Receiver Clock Bias b

WGS-84 ELLIPSOID



What does GNSS bring to the party?

- GNSS provides Position, Navigation and Timing (PNT) services.It provides a Geodetic Reference Frame.
- Compatibility and Interoperability between GNSS systems is important.
- Position accuracies of the order of a few metres are possible with core constellations and augmentations.
- Augmentations provide integrity, availability and continuity of services.
- Timing accuracies of the order of 20 nanosecs are easily achievable.

Location Based Services with GNSS and Mobile phones

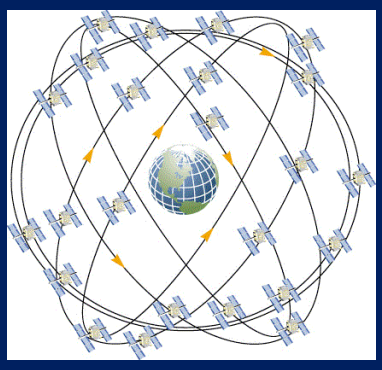
- Mobile phones are getting integrated with GNSS chipsets to provide location based services.\
- Geo Information System (GIS) is integrated into the mobile handset to provide accurate navigation over a wide geographic area.
- The navigation data structure is being improved constantly to achieve better performance and compatibility with other services.
- Handsets and GNSS receivers are progressively smaller in size and affordable

GPS

- **US GPS is the only operational satellite navigation system in the world with 30 satellites.**
- **It has a C/A code for civilians and a precision (P) code for military applications.**

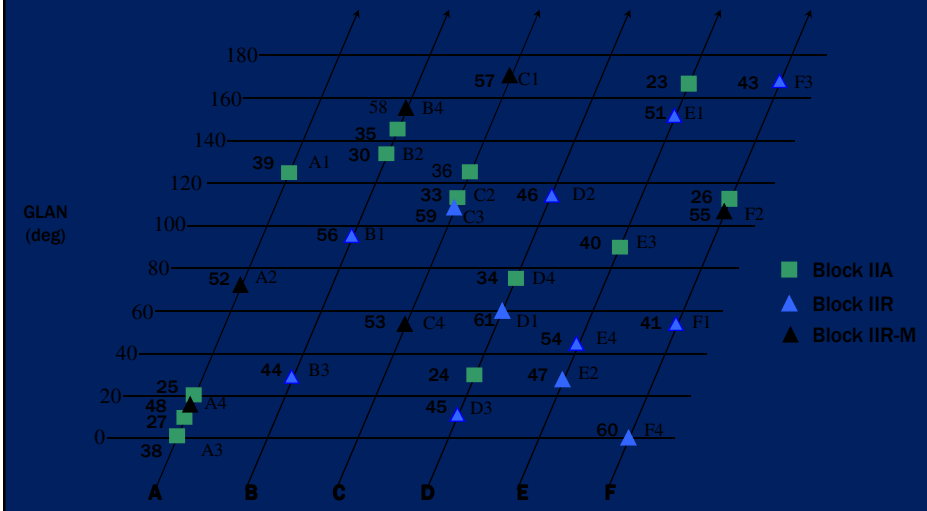
GPS Constellation

- Six planes
- 55 ^{o} inclination
- 20,182 km altitude
- 12 hour orbits
- Twenty four primary slots
- Seven additional satellites (currently)



22

Three Blocks of Satellites in Current GPS Constellation



23

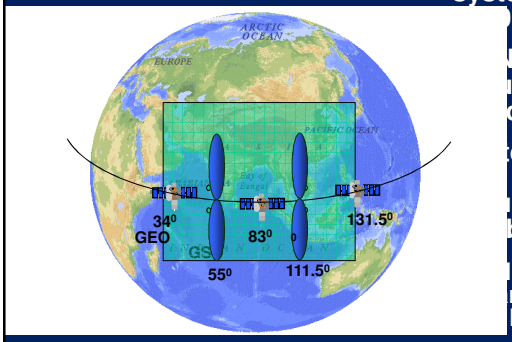
GLONASS Constellation Status

- 17 Satellites on Orbit
  - 1 "Glonass" Satellite
  - 16 "Glonass-M" Satellites
- Next launches:
  - 25 December 2008 – 3 "Glonass-M" sats
  - September 2009 – 3 "Glonass-M" sats
  - December 2009 – 3 "Glonass-M" sats

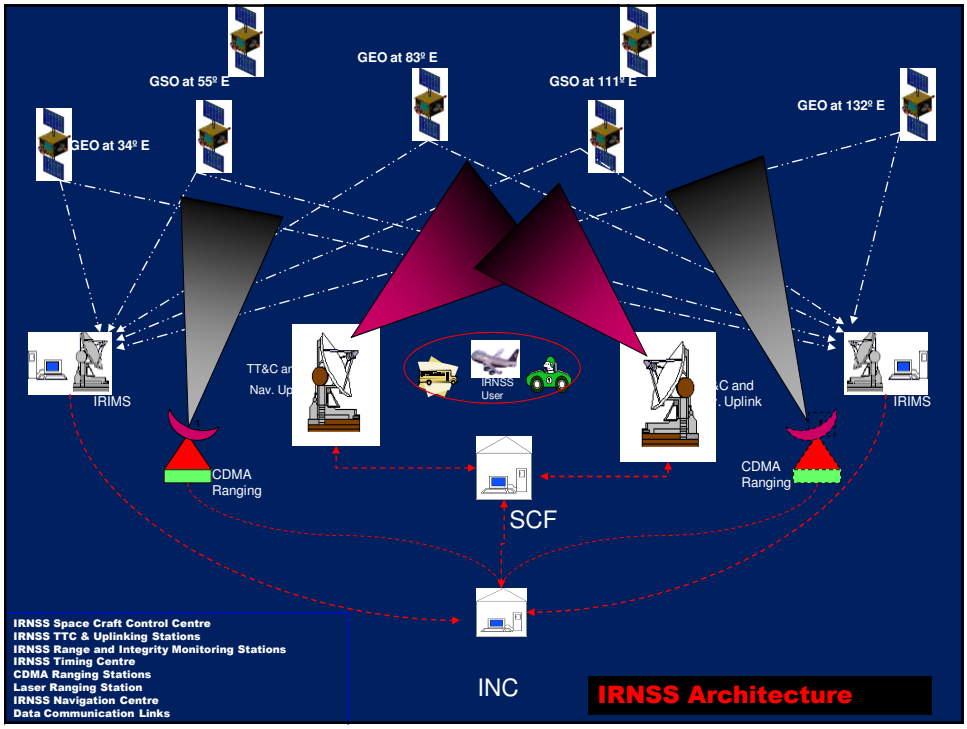
17 Healthy Satellites
As of December 8, 2008 (Baseline Constellation: 24)

REGIONAL SYSTEMS

Indian Regional Navigation Satellite System



- IRNSS is planned to be an independent regional navigation system covering an area of about kms around India.
- NSS can provide dependable and rate services for Defence & cal Strategic Applications.
- tensive simulations indicate that 7 satellites and a commensurate nd segment, an Indian system be developed.
- l provide 20 m accuracy over the n Ocean Region and <10 m accuracy India and adjacent countries.



I. System description

Concept of the QZSS (1/2)

- *QZSS is designed so that at least one satellite out of three satellites exists near zenith over Japan.*
- *Three satellites are in elliptical and inclined geosynchronous orbits in different orbital planes to pass over the same ground track.*

(a=42,164km, e=0.06-0.09, i=39-47deg, Ω= 120deg apart)

QZSS Ground Track

AUGMENTATIONS

What is Augmentation?

- Space Based Augmentations (SBAS)
  - e. g. WAAS, EGNOS, MSAS
- Ground Based Augmentations(GBAS)
  - e. g. LAAS
- Aircraft Based Augmentations (ABAS)
  - e. g. RAIM, Inertials
- Add to GNSS to Enhance Service
  - Improve integrity via real time monitoring
  - Improve accuracy via corrections
  - Improve availability and continuity

Why Augmentation?

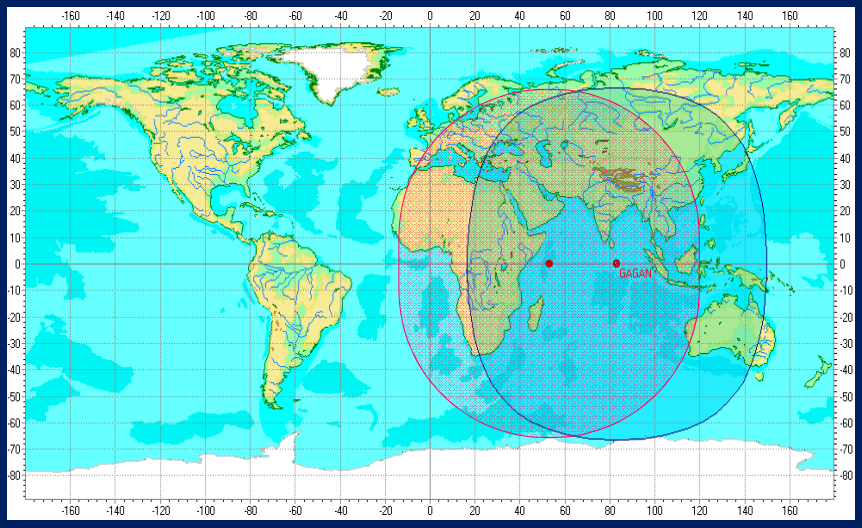
- Current GPS Constellation Cannot Support Requirements For All Phases of Flight
  - Integrity is Not Guaranteed
    - All satellites are not monitored at all times
    - Time-to-alarm is from minutes to hours
    - No indication of quality of service
  - Accuracy is Not Sufficient
    - Even with SA off, vertical accuracy > 10 m
  - Availability and Continuity Must be Met

WIDE AREA DIFFERENTIAL TECHNIQUE

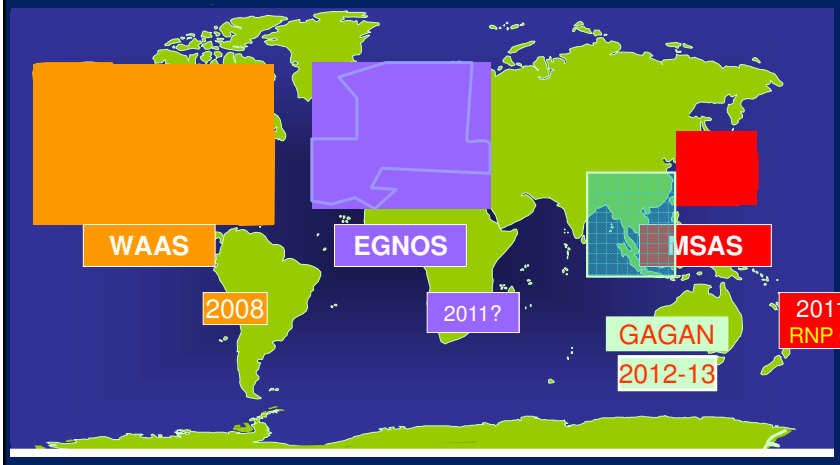
SEPARATION OF ERRORS

ATMOSPHERIC ERROR - 3D
EPHEMERIC ERROR - 3D
CLOCK ERROR - 1D

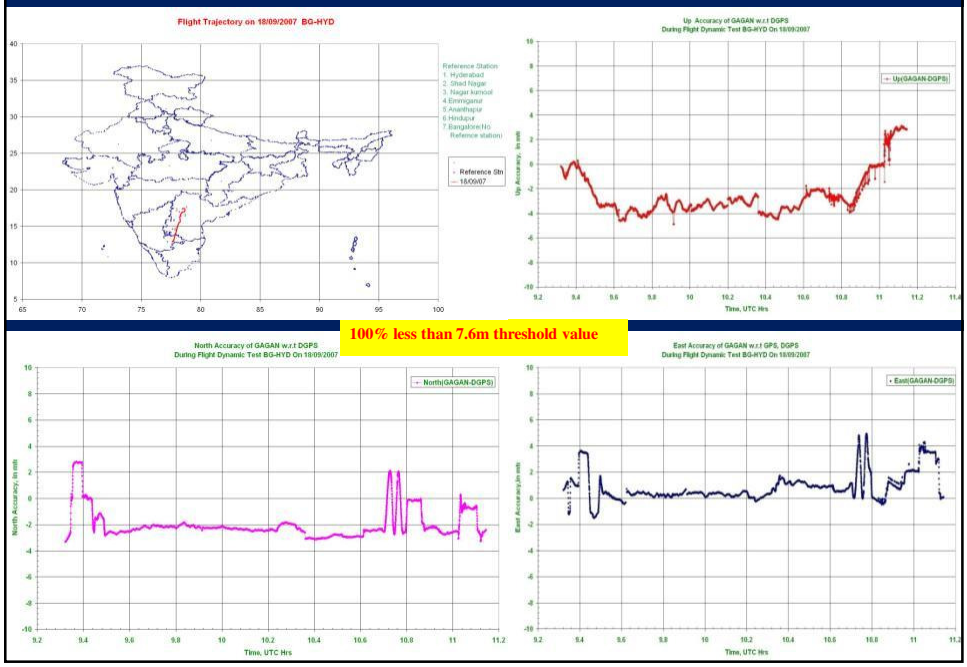
COVERAGE FROM 82 & 55 Deg.E



GPS Augmentation systems in the World (For APV - 1.5 capability)



Position Accuracy of GAGAN, BG- HYD Sortie on 18/09/2007



Int'l Committee on GNSS (ICG) Responsibilities

(a) benefit users of GNSS services through consultations among members of the committee;

(b) encourage coordination among providers of GNSS core systems and augmentations in order to ensure greater compatability and inter-operability;

(c) encourage and promote the introduction and utilization of satellite positioning, navigation and timing services particularly in the developing countries through assistance with the integration of GNSS services into their infrastructures;

(d) Assist both the members of the Committee and international user community

(e) Better address future user needs in the GNSS development plans and applications; and

(f) Periodically report its activities to the UN COPOUS