



# GNSS Positioning Technologies

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- Current GNSS
- Impetus for modern-day navigation
- GPS Modernisation
- Glonass Modernisation
- Galileo
- IRNSS & GAGAN
- Global GNSS Evolution
- Benefits of Modernisation
- Benefits of Interoperability
- Summary



- 30 GPS Satellites (II/IIA/IIR)
- GPS L1 civil access (L2 access via proprietary techniques) and L1/L2 military access
- GPS IIR-M satellites provide L2C service (3 satellites currently)
- 13 GLONASS satellites
- GLONASS L1 civil access and L1/L2 military access
- GALILEO in-orbit validation satellite GIOVE-A
- GPS + GLONASS provides 6 to 14 satellites above the horizon

# Present Navigation Requirements



- System accuracy
- Robustness to Interference
- Integrity without augmentation
- Integrity with accuracy
- Backward compatibility
- Adaptable to evolving requirements
- Compatibility and Interoperability
- Seamless navigation between indoors and outdoors



## GPS L2C

- Improved tracking capability (~3dB higher)
- Better cross-correlation
- Enhanced data demodulation
- Coherent carrier for higher precision – longer integration
- Improved protection against CW interference

## GPS L5

- New signal at 1176.45MHz
- Better multipath performance compared to C/A
- First satellite launch scheduled for 2007
- FOC with L5 expected to be by 2015



## GPS III

- Planned launch in 2013
- Three frequency civil service with on-board differential corrections
- Better Anti-jam capability for military applications
- Major changes in signal structure and higher power output



## **GLONASS-M satellites**

- FOC by 2010
- L2 civil service
- 7 year design life
- Better onboard clocks
- Improved ground measurement processing
- Improved Geodetic Reference Frame PZ90

## **GLONASS-K satellites under test**

- Currently under test
- First launch in 2008
- Third (L3) civil signal broadcast at 1201.74MHz –  
1208.51MHz



- First prototype Galileo satellite was launched on December 28, 2005
- ICD released in April 2006 – Changes expected for final satellites
- Signals to be broadcasted:
  - E1 – open access (L1 band)
  - E6 – commercial access (pay for use)
  - E5a,b – open access (L5 band)
- Highly accurate clocks using hydrogen maser
- Expanded navigation message structure





## IRNSS

- Autonomous Regional Satellite Navigation System
- Constellation of 7 satellites (3 geostationary + 4 geosynchronous)
- Indigenised infrastructure for regional PNT services
- Expected FOC is 2012
- Signals broadcast in the S band (2 - 4GHz)
- Multi-frequency system
- Absolute position accuracy better than 20m
- Reference time will be Indian Standard Time (IST)



## GAGAN

- India's SBAS
- Implemented by ISRO and AAI (Airport Authority of India)
- Primary Objective to support aviation in the Indian subcontinent
- Dual frequency (L1 & L5) GPS compatible, maybe compatible with GLONASS and GALILEO



- Global Satellite Navigation Systems – GPS, Galileo and GLONASS
- Global Satellite Based Augmentation Systems (SBAS) – Omnistar and Starfire
- Regional Satellite Navigation Systems – QZSS (Japan), IRNSS (India) and Beidou (China)
- Regional SBAS – WAAS (US), EGNOS (EU), MSAS (Japan) and GAGAN (India)
- Continental Ground Based Augmentation Systems (GBAS) – GRAS (Australia) and DGPS (US)
- Regional GBAS – CORS networks
- Local GBAS – single GPS reference station operating RTK corrections

# Benefits of Modernisation



- New signals provide
  - Increased immunity to interference
  - Ionospheric corrections
- Performance improvements in
  - Accuracy
  - Integrity
  - Availability
  - Reliability
- More frequencies -> faster and more reliable ambiguity resolution, better ionospheric bias estimation
- Spectrally separated signals
  - Civil and military
- New commercial opportunities

# Benefits of Interoperability



- Navigation solutions can use measurements from different systems
- Common antenna and receiver front-end
- Lower power and cost
- Common carrier tracking for higher accuracy
- Common-mode dispersive errors removed in navigation solution
- User's and Manufacturers benefit by choosing any system that meets their business needs



- Current GNSS provide navigation, surveying and geodetic services
- Additional frequencies will provide the greatest benefits for future positioning
- Growing constellation will increase the number of visible satellites
- Future signal structures should be well suited to precise positioning benign environments
- Should have around 85 GNSS satellites available by 2015
- Improving RNSS interoperability and compatibility for GNSS



Thank you!

# Spirit of Wipro

## Intensity to Win

- Make customers successful
- Team, Innovate, Excel

## Act with Sensitivity

- Respect for the individual
- Thoughtful and responsible

## Unyielding Integrity

- Delivering on commitments
- Honesty and fairness in action

