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Precision GNSS in the Asia-Pacific Region

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June 2013

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- NovAtel Background
- GNSS Precision Vertical Markets
- Looking Forward to Multi-GNSS

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Who is Novatel?

- World's #1 GNSS OEM supplier
- High accuracy, high precision
- Large breadth of product line
- Cover many vertical markets
- High R&D to continue to innovate



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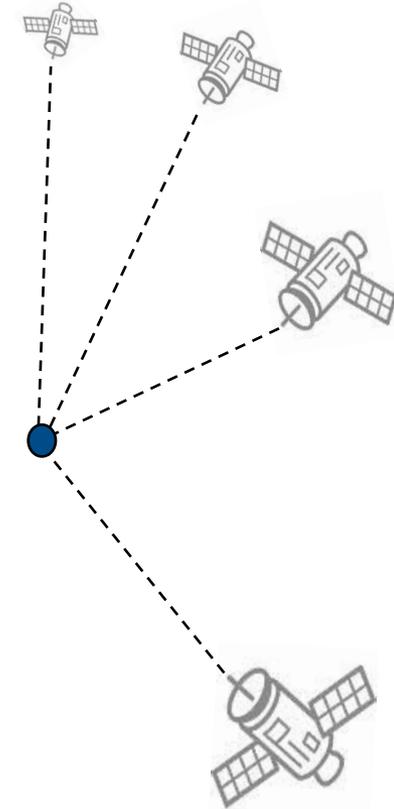
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What do we consider Precise GNSS?

- **Currently Usable Constellations**
 - **GPS (USA) – 30 sats**
 - **GLONASS (Russia) – 21+ sats**
- **Future Constellations include:**
 - **Galileo (Europe) – now 4 sats**
 - **BeiDou (China) – now 14 sats**
- **It is differential processing (DGPS, RTK) or PPP**
- **It can be real time or post-processed**
- **It is nearly always relative !!!!!!!**



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Precision GNSS Market Segments

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Precision Agriculture



Real-time monitoring

Increases productivity

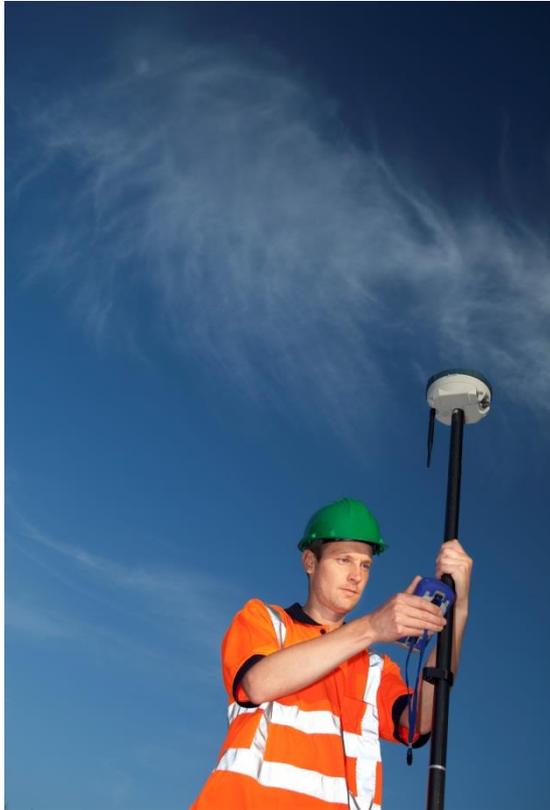
Reduces input costs

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Survey and Mapping

Decreases labour costs

Centimetre-level accuracy

Absolute **repeatable** positioning

Geodetic **reference**

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Military and Defense



Globally available

Precision in combat

Location awareness

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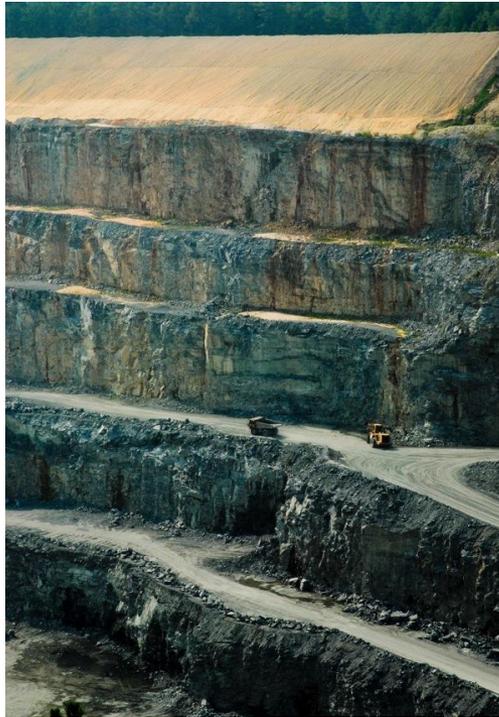


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Construction - Industrial - Mining



Collision avoidance

Maximizes efficiency

Machine control and monitoring

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Airborne and Ground Mapping



Continuous orientation

Maximum coverage

Automated workflow

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Marine

Continuous operation

Decreases resource costs

Marine specific navigation

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Aerospace

System validation

High reliable
positioning

Independent
navigation source



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Timing



Absolute global timing

Continuous synchronization

Optimize network efficiency

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Science



Space weather

High-Dynamic
positioning

Unique
measurement
source

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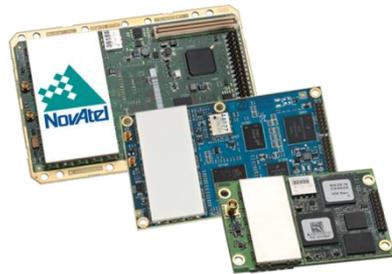


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Core Cards / Receivers



Antennas



SPAN/Sensors/software



Enclosures



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Looking Forward

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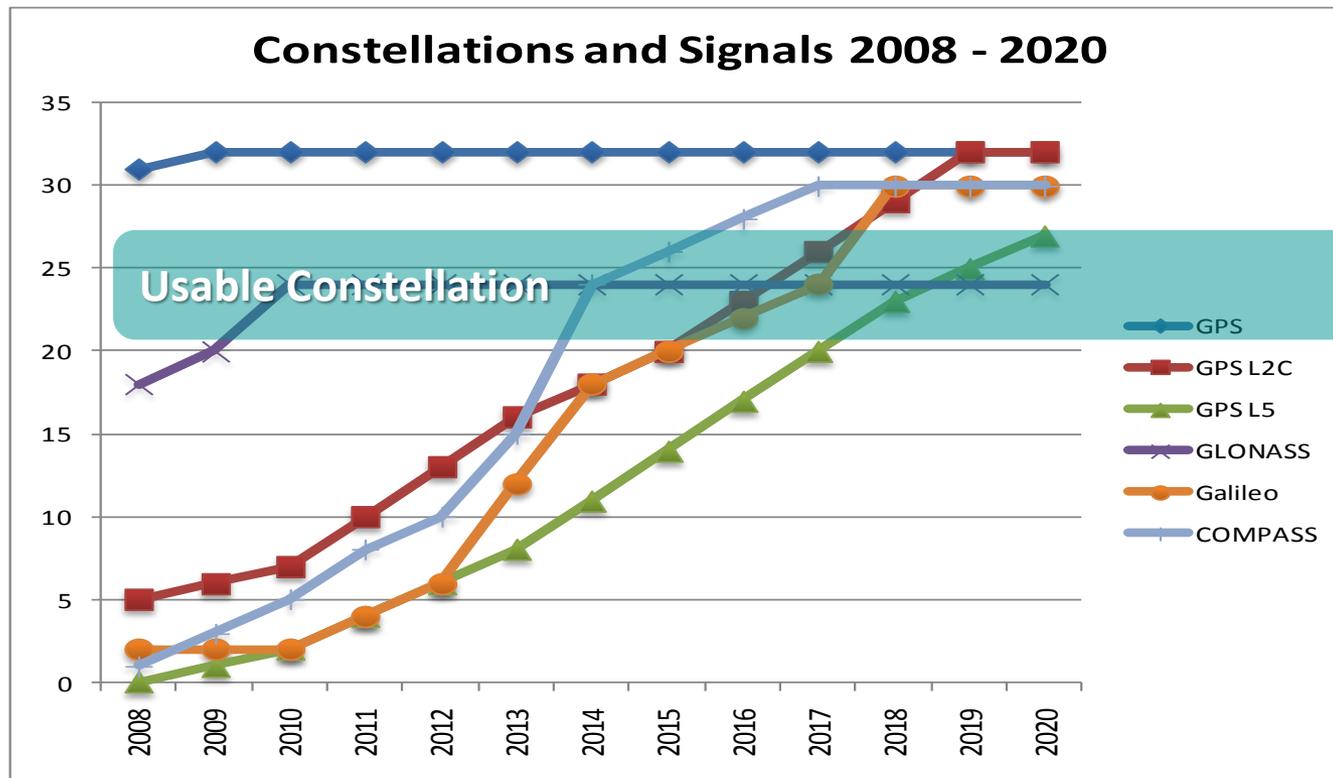


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GNSS Constellation Forecast



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BEIDOU

- Chinese Beidou system reached Asian regional coverage in late 2012 with 4 Geostationary, 6 Geosynchronous and 4 MEO satellites. Full global operations of 30 satellites by 2020.



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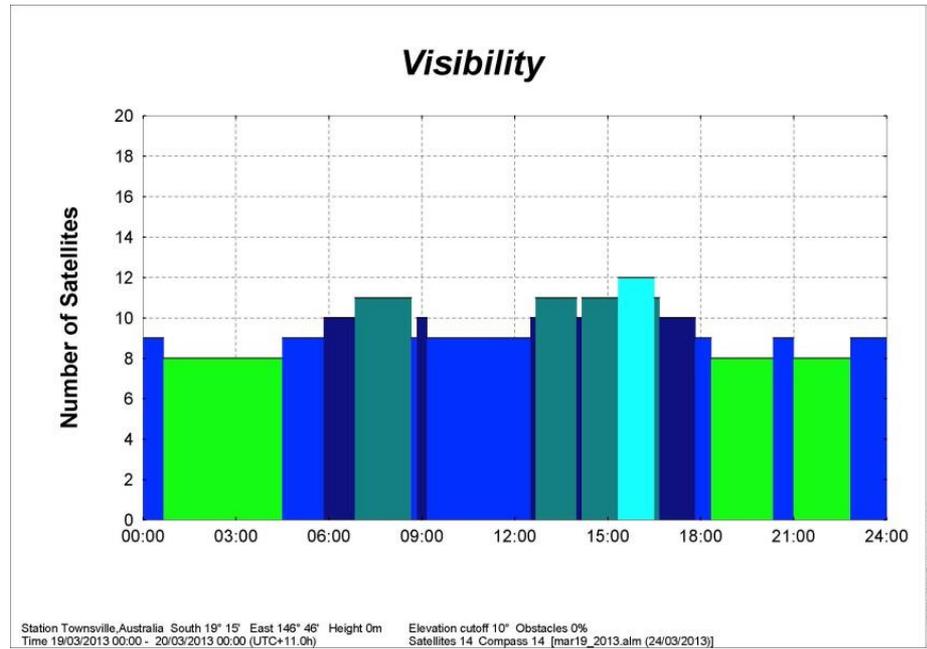
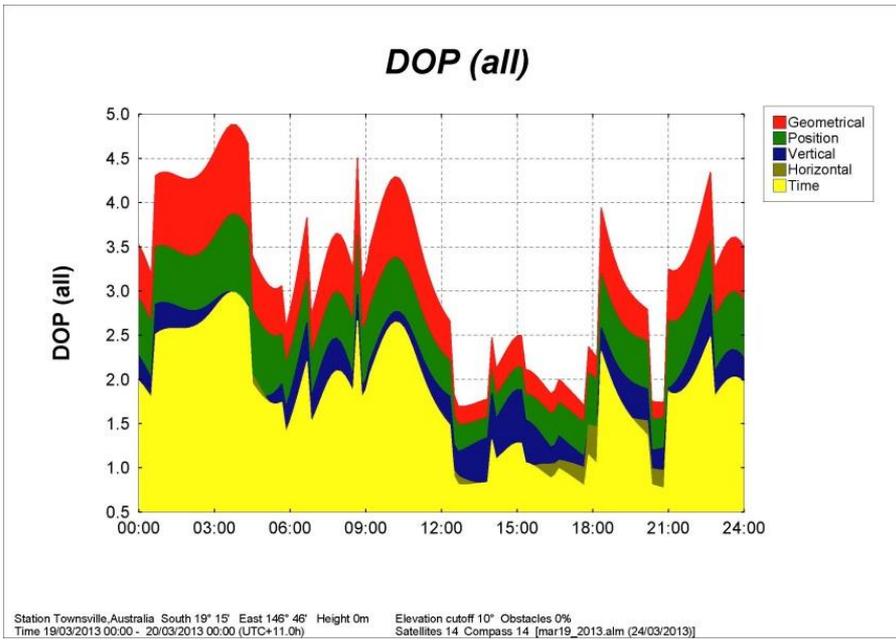


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- BeiDou coverage in South Asia sees all 14 Satellites, but Poor DOP due to Geo's "stuck" in the North segment.

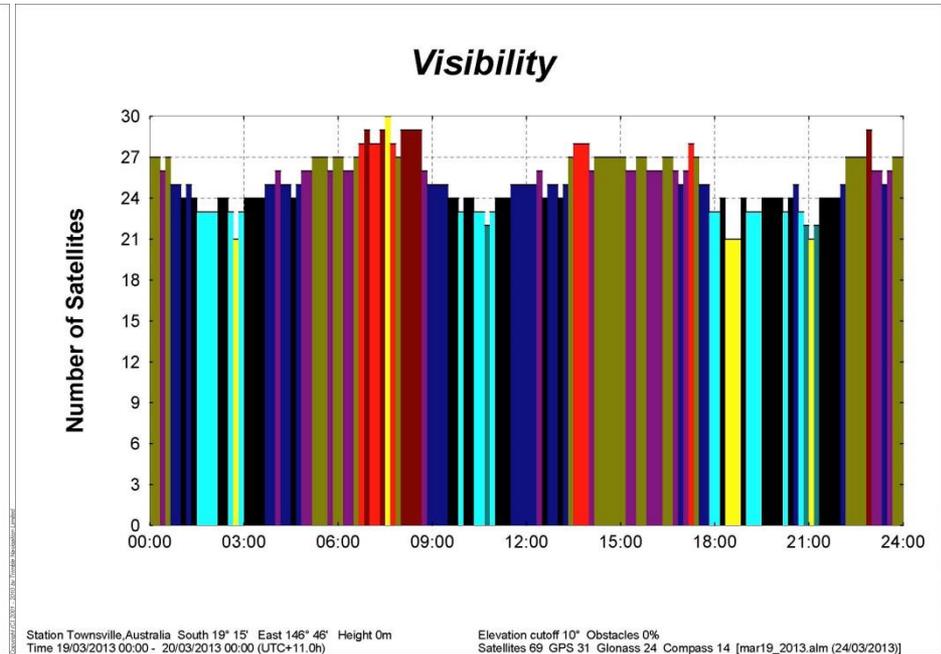
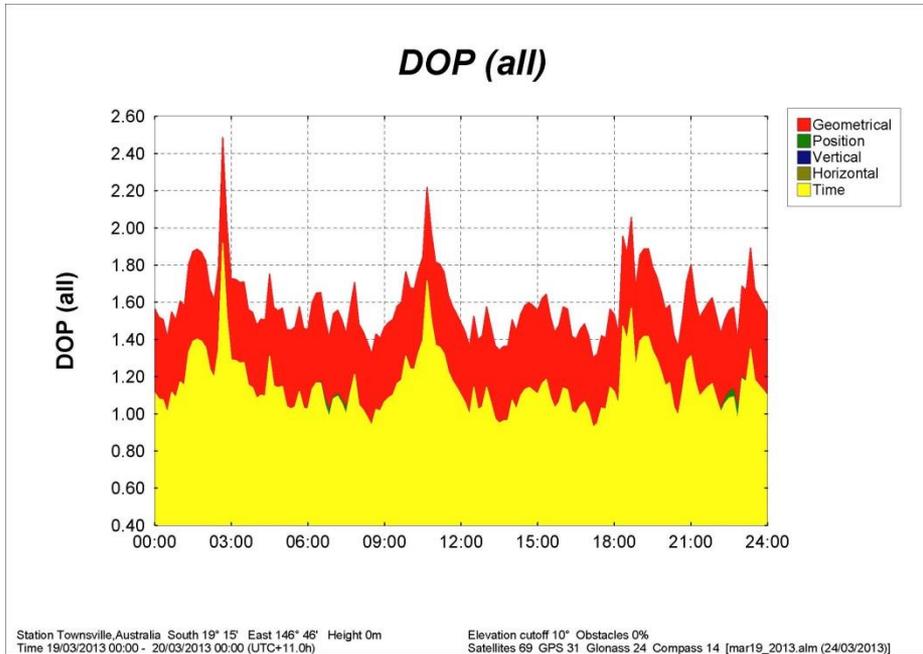


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- However GPS+GLONASS+BEIDOU coverage is very good



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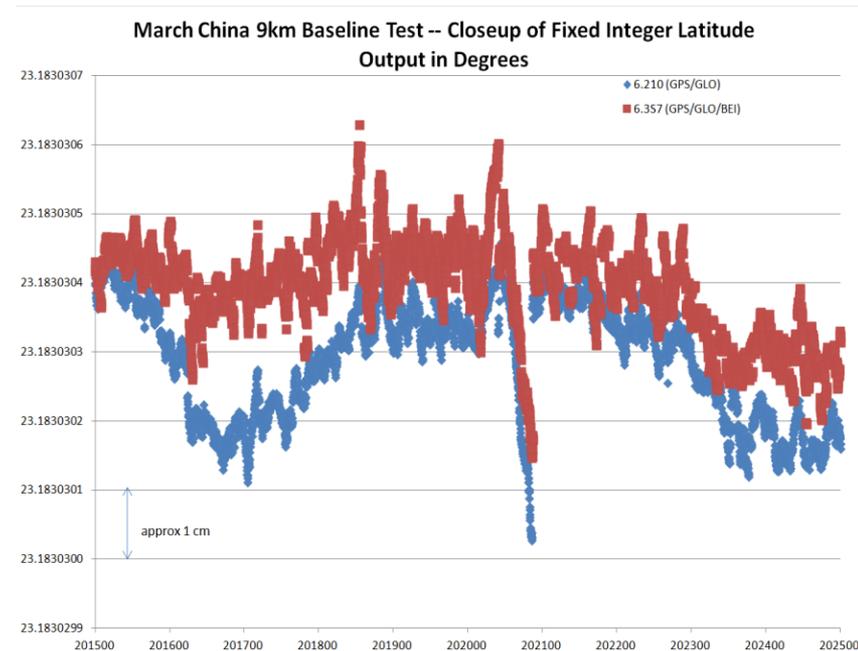


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- Novatel is selling GPS+BeiDou and GPS+GLONASS+BeiDou systems for data and RTK
- Shows better availability and integrity for RTK
- Interest shown from Mining & Construction groups



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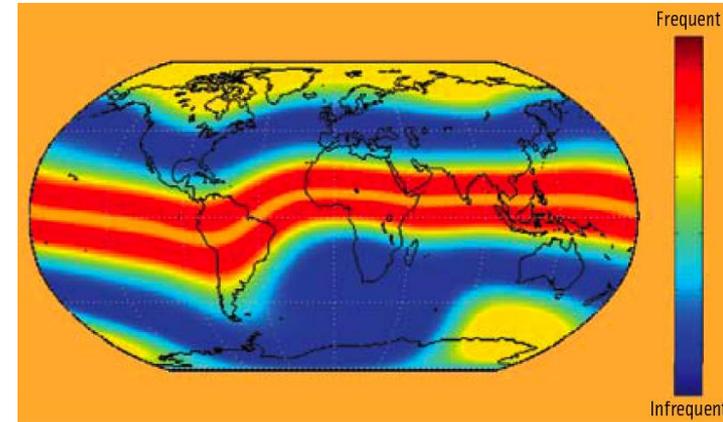
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Space Weather Monitoring

- GNSS based monitoring
 - Global basis, all-weather and continuous fashion
 - Constellation: multiple pierce points
- Ionospheric measurements
 - Refraction: Total Electron Content (TEC) unit
 - Scintillation: Amplitude (S_4) and phase ($\sigma\phi$)
- Challenges
 - Phase: Receiver oscillator phase noise
 - Amplitude: Multipath fading
 - TEC: Semi-codeless L2 P(Y) tracking
 - Narrow loop bandwidths



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BeiDou Tests

- GPStation-6 GISTM set up in Hyderabad, India in June 2013
- Specialised Multi-GNSS with high accurate inbuilt OCXO and firmware
- Real time TEC and Scintillation indices over a full 24 hour period



BeiDou regional coverage is in blue

Hyderabad, India 17°N, 78°E



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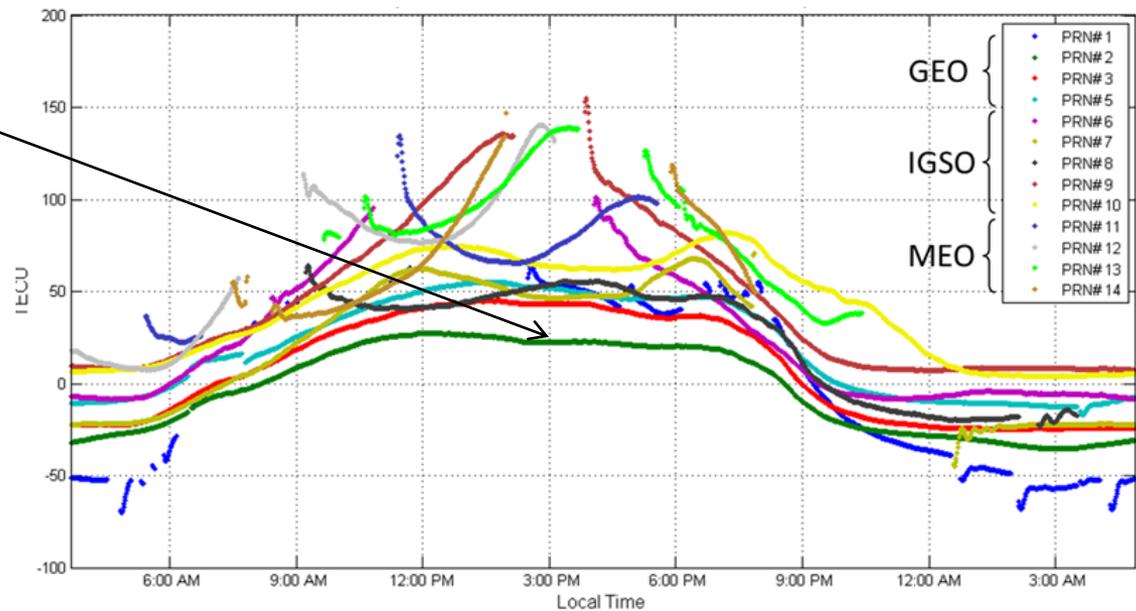


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- Uncalibrated TEC B1-B2 values for all 14 satellites obtained in Hyderabad, India – June 2013.
- The 4 Geostationary satellites track throughout the whole 24hr period.



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GNSS Industry Trends

Emerging Applications



Attitude Determination

Signal Availability



Interference / Jamming

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Relative RTK+Attitude

- Boeing Little Bird Helicopter Auto-landing on a ship (Allure Shadow) in 2012.
- 2 SPAN Systems provides Relative position and attitude between moving platforms
- Idea for UAV's, sensor arrays, targets, etc



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Thank You

Contact: rod.macleod@novatel.com

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