



Ground Reference Station Receivers

Presented by

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And

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Our Infrastructure



- with over 80 people onboard
- More than 70 Crores turnover(Approx 18 million US)
- In-house software development capabilities





Branches

August 2007



- New Delhi
- Mumbai
- Calcutta
- Madras/Chennai
- Hyderabad
- Ahemdabad
- Bangalore
- Trivandrum
- Pune
- Guwahati
- Dehradun
- Bilaspur
- Plus subdealer network



Service Workshop



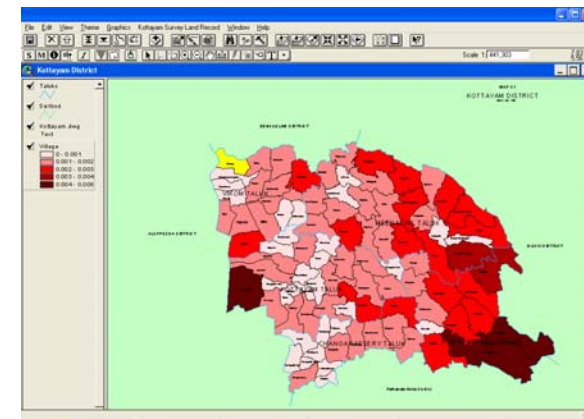
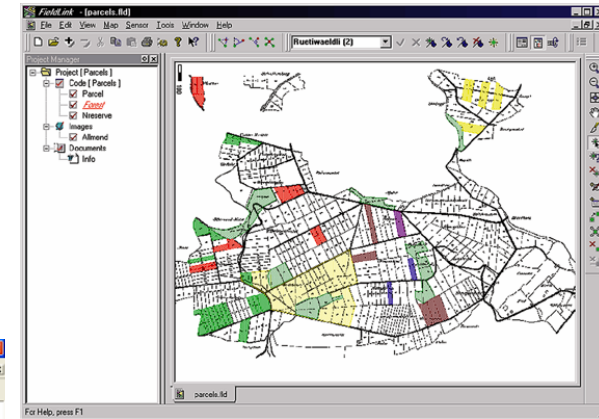
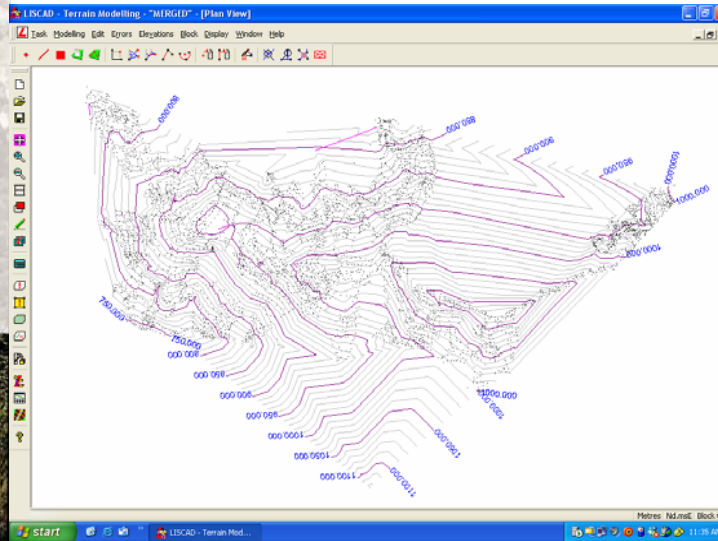


MAJOR GNSS PROJECTS EXECUTED (few Examples)

- Various surveying Applications
 - Cadastral Survey
 - Seismic survey
 - Infrastructure projects(Roads, dams, Hydro projects etc.)
 - Mine Survey and automation
- Scientific applications
 - Crustal deformation and plate tectonics
 - Ionospheric studies
 - Tropospheric studies(Weather meteorology)
 - Monitoring
- Reference stations
- First order Ground control points in WGS-84(CARTOSAT for NRSA)
- GNSS differential corrections over Beacon(DGLL and BIWTA)
- Various Defense applications



Cadastral Survey





Infrastructure Survey





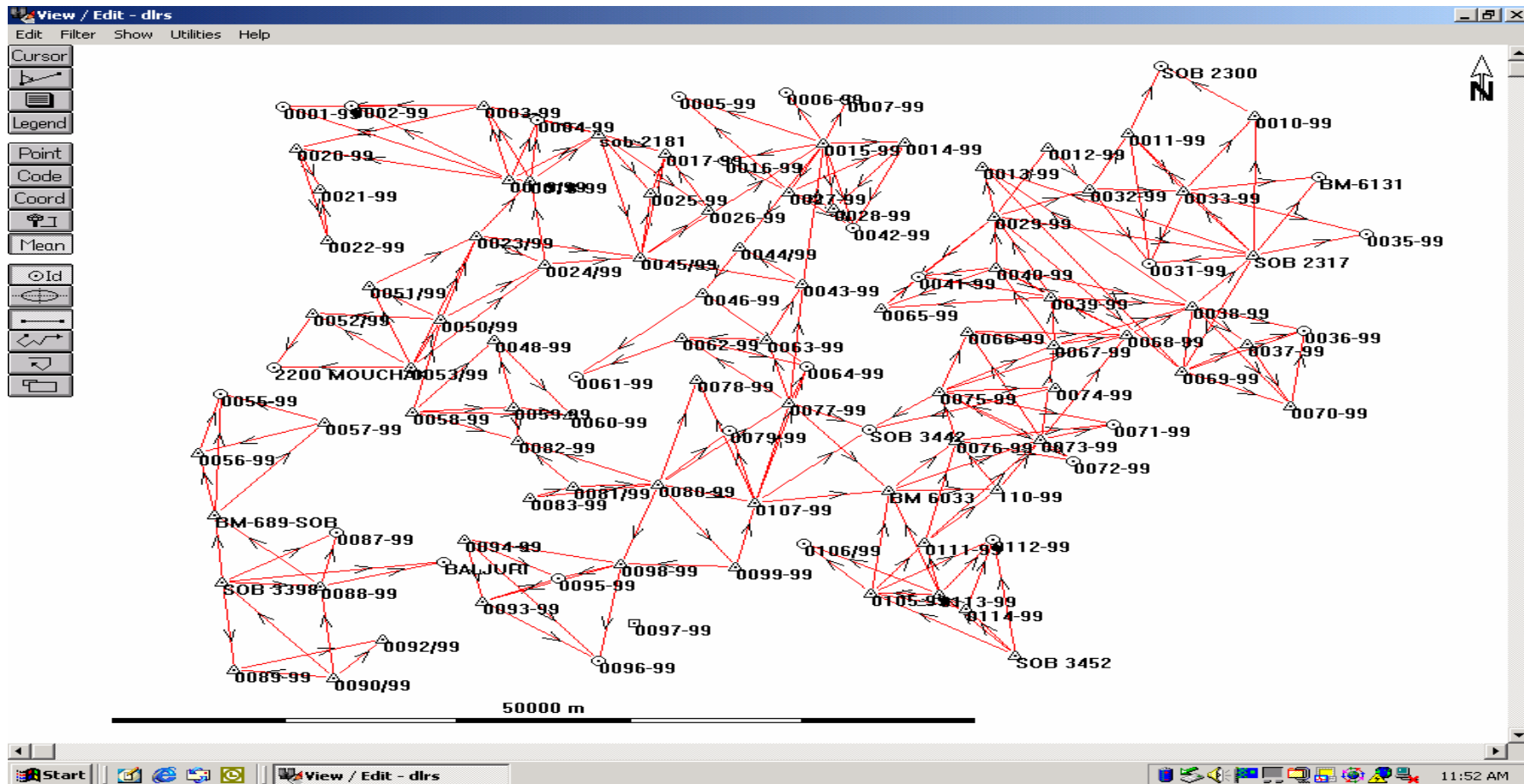
Mine survey and automation





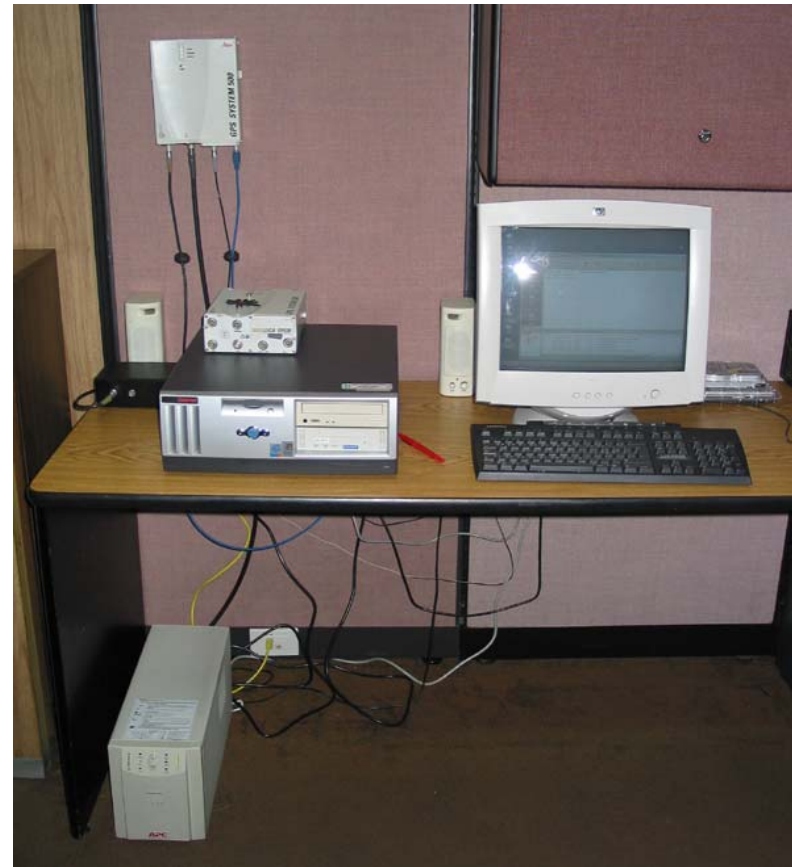
Ground control Point work

- For NRSA(CARTOSAT)
- For DMRC
- For Land Records Bangladesh





Reference station





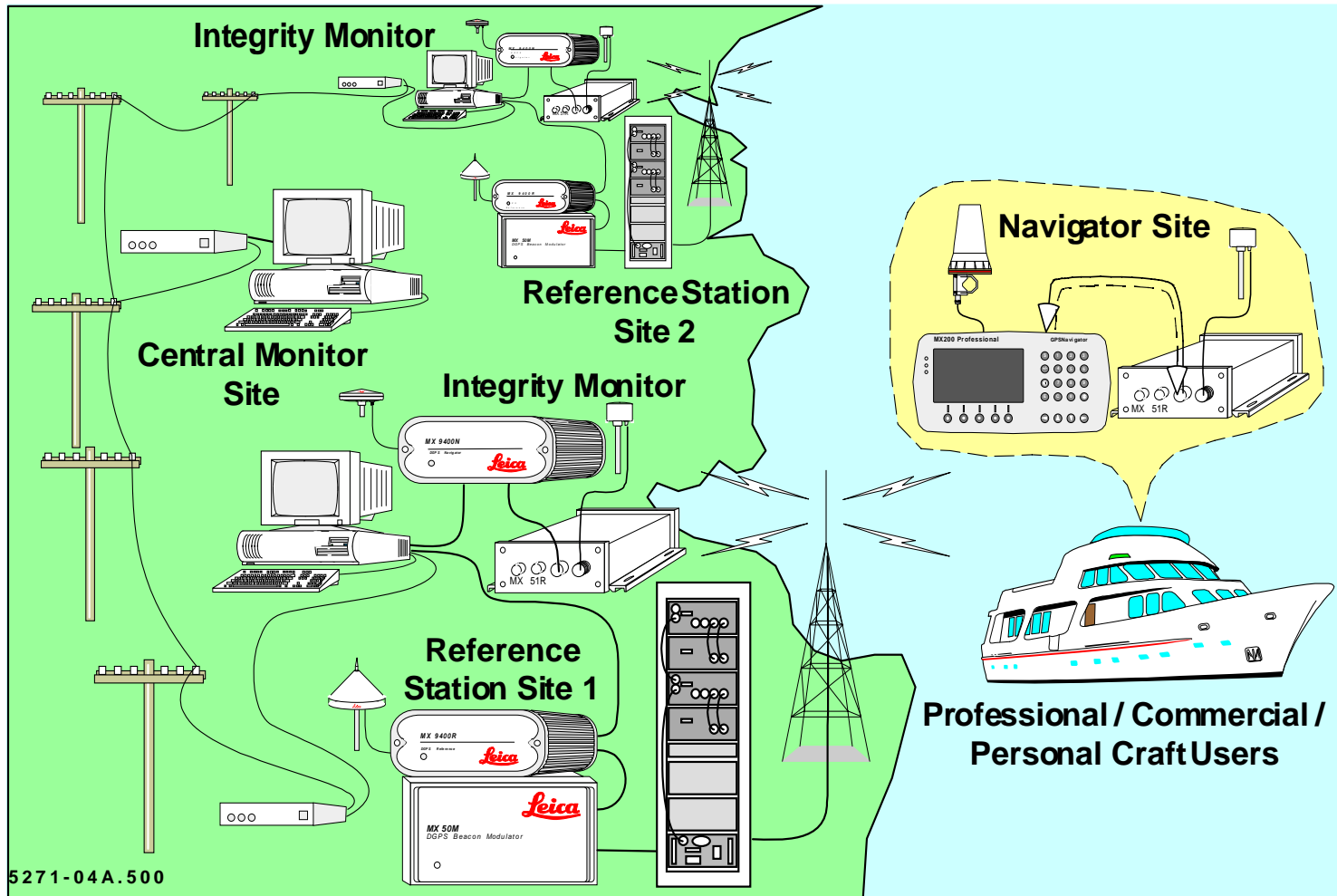
GNSS Differential transmission of corrections on Beacon

DGLL stations



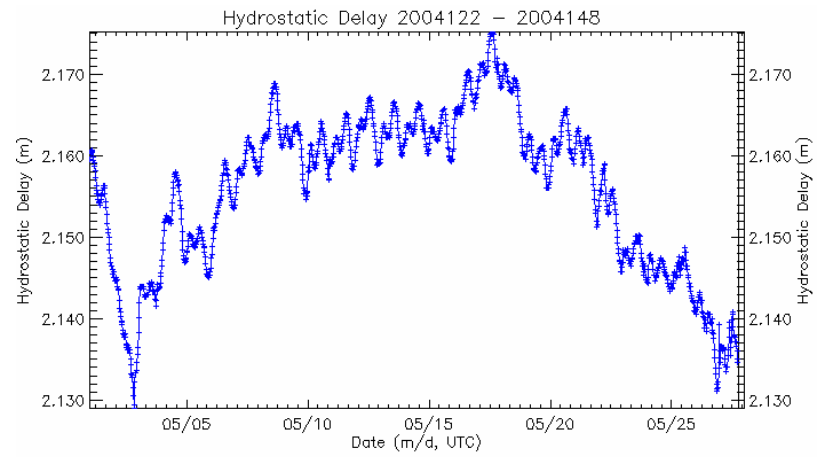


DGPS BEACON SYSTEM WITH CENTRAL MONITOR



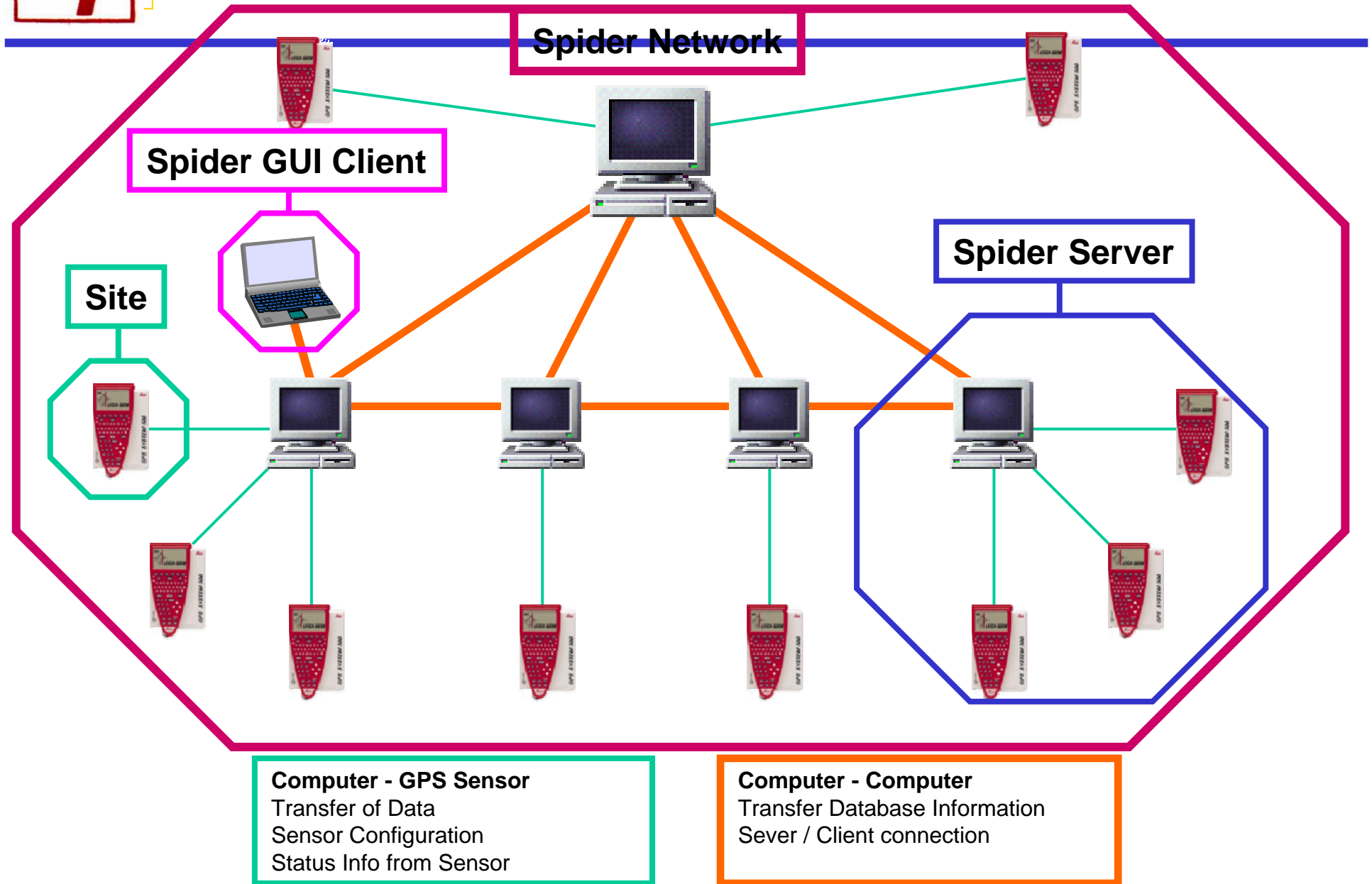


Weather Meteorology





Reference station Network



Computer - GPS Sensor
Transfer of Data
Sensor Configuration
Status Info from Sensor

Computer - Computer
Transfer Database Information
Sever / Client connection



NovAtel

A Precise Positioning Technology Company

ISRO Presentation



ISO 9001:2000
FM 92323



Precise thinking



Our Organization

- **Canadian corporation headquartered in Calgary, Alberta, Canada**
- **Established in 1983 - Initially in Telecommunications, now 100% GNSS/Precise Positioning**
- **Initial public offering in 1997 (NASDAQ: NGPS)**
- **2006 Revenues \$77.6m Cnd**
- **271 employees**



Precise thinking





Strategic Partners & Customers

Aviation/Ground Market

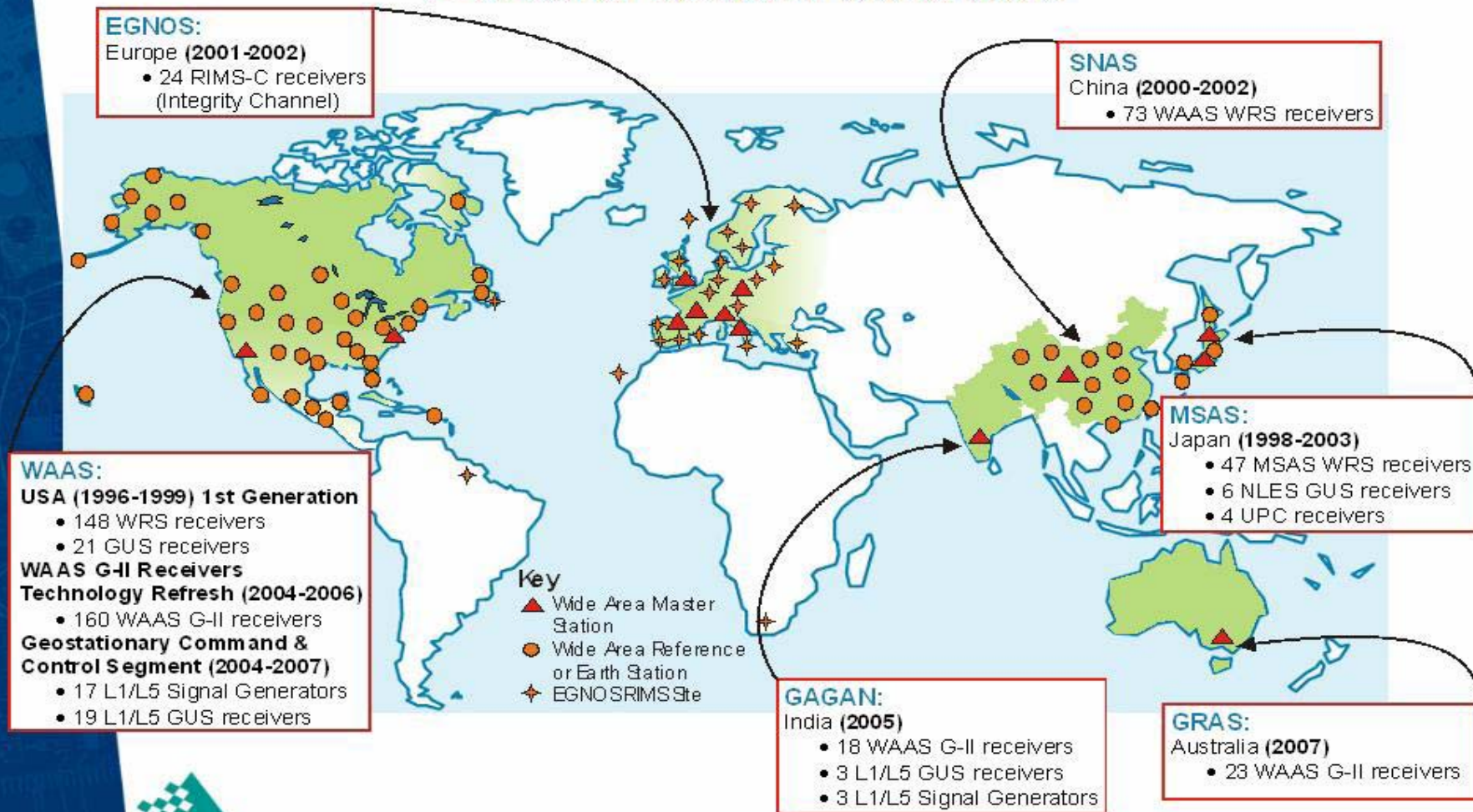


Precise thinking



Empowered by Innovation

SBAS and NovAtel Worldwide





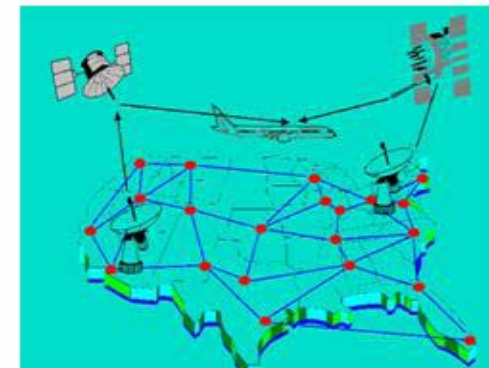
US WAAS Program Status



- Delivered 148 WRS receivers (first-generation)
- Delivered 21 GUS receivers (first-generation)
- Provided software support for 12 years
- Developed WAAS G-II receiver to refresh technology for WAAS FOC – delivered 160 WAAS-GII units – installed throughout US & also in Canada and Mexico
- Geostationary Command & Control Segment (3/4GEOs)
 - Delivered 13 L1/L5 Signal Generators
 - Delivered 15 L1/L5 GUS Receivers



Precise thinking



EGNOS Program Status

- European Space Agency/Euro-Control
- Alcatel, Toulouse Prime Contractor
- Similar to WAAS - GPS, GEO & GLONASS
- NovAtel supplied RIMS C reference receiver
- Sub-contracted to Thales Avionics (UK) who supplied RIMC-C station –processes & controls data flow to EGNOS Central Processing Facility (CPF)
 - RIMS-C - delivered 22 receivers thru 2002, 2 more spares in 2005
 - EGNOS Operational Readiness Review completed June 2005, system operational





SNAS Program Status



- Delivered 73 WAAS WRS receivers 2000-2002
- Provided hardware & support for over 4 years
- Chinese military customer
 - System development underway
 - Initial reference sites fielded
 - 4 Beidou GEO & 1 MEO satellites

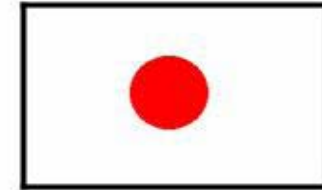


Precise thinking



MSAS Program Status

- **NEC Prime Contractor**
- **Delivered 47 MSAS WRS receivers**
- **Delivered 8 NLES GUS receivers**
- **Delivered 2 UPC receivers (Uplink Power Controller)**
 - **Functionally identical to US WAAS and GUS receivers**
- **Hardware & systems support for over 7 years**
- **Beginning transition to WAAS-GII receiver**



Precise thinking



Indian Gagan Program



- Indian Space Research Organization (ISRO) & Airports Authority of India (AAI) joint project
- Raytheon Prime Contractor
- Technology Demonstration System (TDS) + Initial Experimental Phase (IEP) underway = TDS - Extended
- 8 Reference Stations, 1 Master Station & 2 Uplink Stations
- Qty 18 WAAS-G2 receivers, qty 3 GUST-G2 receivers and Qty 3 L1/L5 Signal Generators delivered Q2 2005
- System validation and next phase planning underway
 - GSAT-4 GEO in July 2007
 - Final Operational Phase (FOP) planned for 2008





Australian GRAS Program



- Ground-based Regional Augmentation System
- Uses WAAS ground infrastructure, but transmits correction messages via extensive existing ground VHF infrastructure.
- GBAS/LAAS correction message
- Air Services Australia – end customer, Honeywell Prime
- 23 WAAS-G2 receivers for development lab and initial test-bed network



Precise thinking



NovAtel's Galileo Programs

- NovAtel's has actively participated in Galileo receiver definition & development work for over six years
- *Programs include:*
 - **Signal Validation (European Space Agency (ESA))**
 - **User Receiver Requirements (Thales Avionics)**
 - **Ground Reference Receiver (GRR) Requirements (Thales)**
 - **GPS/Galileo Interoperability (Canadian Space Agency(CSA))**
 - **GRR specification, architecture & modelling (ESA)**
 - **Three prototype receiver & transmitter development programs (CSA)**
 - **Galileo Receiver Chain (GRC) reference receiver (Alcatel Alenia Space – Italia)**





GTR SoL Receiver

- **GTR based on WAAS G-II enclosure developed for US FAA WAAS System**
- **GTR SoL Configuration**
 - GPS/GEO L1 & L5
 - Galileo L1 & E5a & E5b
- **Used as basis for Galileo reference receiver**



Precise thinking



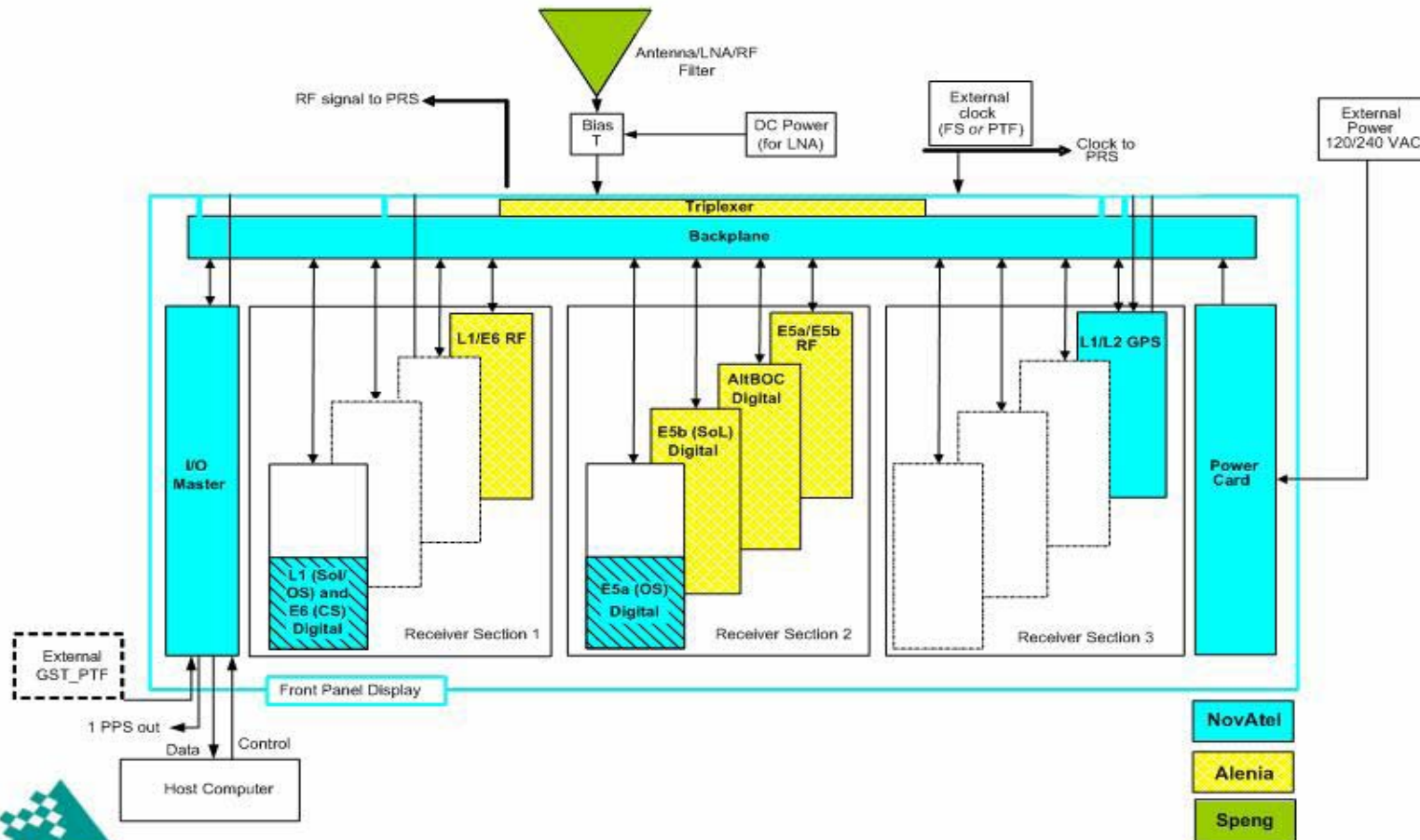
Galileo Receiver Chain (GRC) receiver

- Reference receiver for Galileo Ground Control System
- All frequencies and services except Public Regulated Service (PRS)
- Team
 - Alcatel Alenia Space – Italy (Prime)
 - NovAtel – receiver subcontractor
 - Space Engineering (Italy) - reference antenna



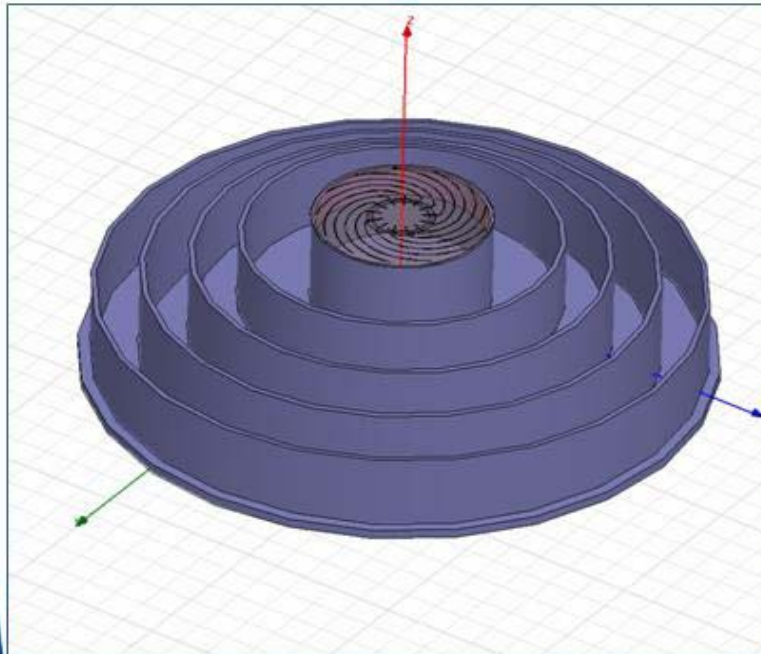


Galileo Receiver Chain (GRC) receiver block diagram



Precise thinking

Wideband Choke Ring Antenna



- **GNSS Capability**
 - GPS (L1, L2 and L5)
 - GLONASS (G1, G2 and G3)
 - Galileo (L1, E5a, E5b, E6)
 - L-Band
- **LNA Gain: 40dB**
- **Superior Out Of Band Rejection Performance**
 - 30dB at $f_c \pm 100\text{MHz}$ typical
 - 50dB at $f_c \pm 100\text{MHz}$ typical
- **Element based on NovAtel's proven Pinwheel technology**
 - Outstanding phase center stability