NASA's Global Differential GPS System

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February 03

NASA's GDGPS System
Special Value to NASA and Society

Autonomous operations in Earth orbit to enhance reliability and reduce operations and communications bandwidth

Safe operations for NASA missions

Aviation safety and efficiency

Timely monitoring and response to natural disasters

Many commercial applications

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NASA’s GDGPS System
Multiply redundant Network and data paths

- Sites stream data in parallel
- Two UTC referencesources

Flexible internetwork architecture

- Any number of data transmission centers
- Automatic fault detection and data rerouting
- Multiple data formats

No single points of failure

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NASA’s GDGPS System
GDGPOp erationsCe nter (GOC)

Track record of 99.99% reliability
Since 2000

NASA’s GDGPS System

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True global achievement:

- The penintenet

- The Iridium satellite system provides global coverage up to latitude ±75° (operated by Navcom)

- Iridium phone modems provide internet access globally (including the polar regions)
Measured Performance - GPS Orbits

meanRSS per day
[01-APR-2002 to 05-OCT-2002]

Mean: 25.5 cm

NASA's GDGPS System
Extensive flight tests
- North America, February-September 2002: NASADC-8 AirSAR
- Greenland, May 2002: NASA P-3 LIDAR
- Sweden, polar region, February 2003: NASA DC-8

Performance validation by comparison with:
- Postprocessing (precise orbits + smoothing)
- Independent local area differential techniques
- Laser ranging
Measured Performance—Airborne Users

Consistent Accuracy:
10 cm RMS Horizontal
20 cm RMS Vertical

Difference between DGPS and ADGPS (cm)

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<th>East</th>
<th>North</th>
<th>Vert</th>
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<tr>
<td>02 Jun</td>
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<td>4.6</td>
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<tr>
<td>04 Jun</td>
<td>8.0</td>
<td>6.1</td>
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Real-Time time transfer accuracy is consistent with that of positioning: nanosec level for dynamic platforms; 0.1 nanosec level for static platforms.

Time transfer from US to JP LMa ser
Position held fixed

An order of magnitude improvement compared to unaided GPS

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NASA's GDGPS System
Asses send -to-endsys tem perf ormance of pre cise real ime orb itd et ermination

- SA C-Cte stbedf ors of twarebu twi thout GDGPS orrection and atastr eam
- GDGPS perfor mance "simulated" wi th real data, real orbits, real tme filt er

A litude: 650 km

Result sf or better modeled sa tellites CHAMP (450 km), Jason-1 (1300 km):

15 - 25 cm 3D RMS

This is how well we currently perform onboard SA C-C (w/o GDGPS corrections)

This is how well we expect to perform when the complete differential GPS receiver is deployed on af uture SAC-C-like s/c
Demonstrated Performance

The sky is not the limit...

Jason-1
10 cm

GPS
20-30 cm

CHAMP
20 cm

10-20 cm

10-20 cm

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Global Differential GPS

- single GPS receiver!
- using Real Time JPL satellite orbits & clocks
- filtered positions
- difference with precisely known reference
- low dynamics

Nov. 17th, 2002
00:00 - 12:00 (GPS)

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By-Products and Cross-Cutting Benefits

Core real-time DGPS products:
- Raw GPS data from global network
- Differential corrections
- Precise orbits
- Broadcast navigation message

Environmental by-products:
- Tropospheric delays
- Total electron content

Enabled products: near-real-time (N RT) orbit determination of space sensors
- Demonstrated 2.5 cm RMS radial accuracy for Jason-1 with three-hour latency

Synergy with NRT science data from space sensors
- Seasurface height using NRT Jason-1 science data
- Space weather (global ionospheric maps) using NRT Jason-1, GRACE, CHAMP
- Improved global space weather reprocessing

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GDGPS is the only redundant real time network observing all GPS satellites all the time.