The IGS Real-Time Service: A Spur to Innovation

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Steve Fisher
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IGS-RTS...

A new service to support scientific & other precise PNT applications
IGS Real-Time Service (RTS)

- International effort of many contributions
- Maintain & extend real-time infrastructure (data transfer, broadcasting, product generation, combination, quality control)
- Develop necessary data formats & transmission protocols together with RTCM SC104
- Launched on April 1, 2013... after many years of study
- Currently GPS + experimental GLONASS real-time orbit & clock products
- Open data & open standards policy
- Working towards Operational Service & multi-GNSS capability
- Supports scientific & other PP applications
The International GNSS Service (IGS) has ensured the availability of open access, high-quality GNSS data products since 1994. These products enable access to the definitive global reference frame for scientific, educational, and commercial applications – a tremendous benefit to the public.

Through the Real-time Service (RTS), the IGS extends its capability to support applications requiring real-time access to IGS products. RTS is a GNSS orbit and clock correction service that enables precise point positioning (PPP) and related applications, such as time synchronization and disaster monitoring, at worldwide scales. RTS is based on the IGS global infrastructure of network stations, data centers and analysis centers that provide world standard high-precision GNSS data products.

The RTS is currently offered as a GPS-only beta service for the development and testing of applications. The Russian GLONASS is initially provided as an experimental product and will be included within the service when the RTS reaches its full operating capability at the end of 2013. Other GNSS constellations will be added as they become available.

This service is made possible through partnerships with Natural Resources Canada (NRCan), the German Federal Agency for Cartography and Geodesy (BKG), and the European Space Agency’s Space Operations Centre in Darmstadt, Germany (ESA/ESOC). Support is provided by 160 station operators, multiple data centers, and 10 analysis centers around the world.

The RTS is operated by the IGS as a public service. Users are offered open and readily available access through subscription.
150+ stations

IGS-RTS Tracking Network...
Note:
- IGS01/IGC01 (GPS-only) and IGS02 (GPS-only) streams
- IGS03 (GPS+GLONASS) “experimental” stream
- RTCM-SSR message streams
- Reference frame is ITRF2008
- Stream access via BKG NTRIP Client (BNC) or RTKLIB
- Register for user access (via web site)
- Products:

<table>
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<tr>
<th>Stream Name</th>
<th>Description</th>
<th>Ref Point</th>
<th>RTCM Messages</th>
<th>Provider / Solution ID</th>
<th>Bandwidth kbits</th>
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APC: Antenna Phase Center CoM: Center of Mass, (not compliant with current RTCM-SSR standard). The figures in brackets next to each RTCM message ID denote the message sample interval in seconds.
IGS01/IGC01 Products (1)

http://www.igs.org/rts/monitor

GPS Wk 1869
IGS01/IGC01 Products (2)

http://www.igs.org/rts/monitor

GPS Wk 1869
IGS-RTS...

Enables RT-Precise Point Positioning
Real-Time PPP...

GNSS Satellite Orbit and Clock Corrections (via internet link)

GNSS Rx

GNSS Constellation(s)

CPH & PR measurements

IGS CORS Network

GNSS Satellite Orbit and Clock Corrections (via internet link)

Coordinates & Time
IGS-RTS IGS01...
RT-PPP GPS-only Results

Realtime-PPP Displacements for FFMJ5 using IGS01 - (C) BKG

Height Displacements, RMS +/-0.043 m
East Displacements, RMS +/-0.060 m
North Displacements, RMS +/-0.053 m
Number of GPS Satellites

http://www.igs.org/rts/monitor
IGS-RTS IGS03...
RT-PPP GPS+GLONASS Results

http://www.igs.org/rts/monitor
IGS-RTS... who is using it?

- 80 user registrations within days of launch
- 583 user registrations by 9 October 2015, from 72 countries
IGS-RTS... who is using it?

Current RTS User Statistics by Application

- Academic Research/Instruction: 28.1%
- Testing/Comparison of Positioning Systems: 17.0%
- Surveying/Mapping/GIS: 19.2%
- Telecommunications/Smart Phone Positioning: 1.5%
- Targeting/Guidance: 0.9%
- Time Synchronization: 1.0%
- Other: 1.4%

Other applications:
- Agricultural: 3.1%
- Automotive/Vehicle Navigation: 2.2%
- Aviation/Runway Mapping/Integrity Monitoring: 0.2%
- Control Surveying: 2.2%
- Meteorology: 2.9%
- Mining/Oil/Gas: 2.3%
- Seismology/Earthquake Warning: 2.2%
- Photogrammetry/Airborne LIDAR: 0.7%
- Radiation Monitoring: 0.2%
- Single Frequency PPP Development: 6.7%
- SBAS Development: 0.5%
- Robotics: 1.9%
IGS-RTS... who is using it?

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<th>RTS User Statistics by Application</th>
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IGS-RTS... who is using it?

Current RTS Registration Statistics by Organization

- Academic: 36.6%
- GNSS Equipment/Software: 17.1%
- Engineering Services/Consulting: 21.4%
- Aerospace: 2.4%
- Civil Aviation Authority: 0.5%
- Consumer Electronics: 0.2%
- Government (Geodetic/Mapping): 5.8%
- Government (General): 3.3%
- Government (Geological/Geophysical): 1.0%
- Military/Defense: 0.5%
- Positioning Services: 3.3%
- Other: 4.6%
- Telecommunications: 2.7%
- Government (Meteorology): 0.5%
IGS-RTS... who is using it?

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<th>Statistics as of: 9-Oct-15</th>
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Total: 80 161 163 177 183 188 200 207 221 224 269 310 350 370 370 444 469 495 584 584
IGS-RTS...

Geoscience & geospatial applications
IGS-RTS spurring innovation...

- Geohazard... seismic displacements, tsunami prediction
- (Near-)real-time comparison of UTC(k)’s... time transfer
- IGMA parameter estimation... orbits, clocks, etc
- Atmospheric remote sensing, meteorology
- Precise orbit determination
- Geodesy, datum studies/monitoring, kinematic positioning
- Buoys, wave height measuring, hydrography
- Surveying, mapping, UAV platforms, agriculture, etc
- Performance statistics... intercomparisons, RTK v PPP v SBAS
- Testing, demonstrations, investigations... manufacturers, academic
- Low-cost GNSS receiver studies
- Intelligent Transport System (ITS) positioning
- Outdoor robotics, wearables, IoT
- Education
- ...

...
IGS-RTS Geodetic Applications

- Enables RT-PPP at global scales for scientific applications, atmospheric & space weather forecast, multi-GNSS performance monitoring, & more...
- E.g. rapidly detecting, locating & characterising hazardous events such as earthquakes, tsunamis, landslides, etc.
- Contributes to IAG’s GGOS Focus Area 2 “Geohazards Monitoring”
Pre-, Co-, Post-Seismic Displacement...

GNSS CORS, rapid measurement analysis
Japan, March 11, 2011

Tsunami warning? (Based on seismic data alone)

Seismology predicted $M_w=8.1$... too low

GNSS displacement estimate $M_w=8.7$...
GNSS-augmented Tsunami Early Warning Network

IUGG Resolution adopted July 2015: Commence trial in the Pacific Basin region

GNSS-CORS + IGS-RTS = RT Site Displacement and Ionospheric Anomaly Mapping
RT Geodetic Services: Utilising Over 3000 Pacific Basin GNSS CORS