Towards Real Time

National Geodetic Survey / NOS / NOAA
Silver Spring, MD
Main Concepts

• Modify CORS sites for real time data transmission
• GNSS receiver data
• Transmission via the Internet
• Standardized protocols and formats
• Not a navigation service!
Framework for Real Time GNSS Networks

- Federal Network
  - 200 CORS sites
  - NDGPS, WAAS, NOAA, PBO sites
  - Stream GNSS data, not correctors
  - via NTRIP and tcp/ip protocol over the Internet,

- Regional and local Networks
  - Use Federal network to calibrate and/or enhance local networks
CORS Site Modification

• Receiver modifications
  – Firmware
  – Multiple satellite systems
  – Data interval
• Communications / Network modifications
  – Routers
  – Increased bandwidth
  – Internet
• Software
Network Design Issues

- What format?
- What stations?
- What software?
- What distance?
- What data rate?
- What latency?
Data Distribution Formats

- RTCM-SC104
  - Versions – 2.0, 2.1, 2.2, 3.0
  - Type 1   Fixed GPS corrections (1 sec)
  - Type 3   GPS reference station parameters (10)
  - Type 16  GPS special message (30,60)
  - Type 18  RTK uncorrected carrier phases (1)
  - Type 19  RTK uncorrected pseudoranges (1)
  - Type 22  Extended station parameters (15)
  - Type 59  Proprietary messages (1)
Data Collection Formats

• Raw
  – Topcon/Javad Compact (1)
  – Ashtech MBEN (5) / PBEN (5) / SNAV
  – Thales ASCII
  – SP3 ASCII
  – Trimble RT17, concise
  – Leica LB2
  – RINEX
  – BINEX
Communications

- Frame Relay – USCG, NDGPS CORS **
- Internet (FTP, rcp) – State DOT’s, WAAS, university CORS.
- Satellite / Modem – Hawaii, PBO CORS
- NTRIP – RTK CORS **
Software

• NTRIP - Networked Transport of RTCM via Internet Protocol (version 1.5)
• NTRIP is an RTCM standard
• Application-level protocol streaming Global Navigation Satellite System (GNSS) data over the Internet
• Based on hypertext transfer protocol (HTTP/1.1)
• Simultaneous connections from PC’s, laptops, receivers to a broadcast host
• Streams data to stationary and mobile users
NTRIP

PROS

• RTCM standard
• Open documentation
• Software components developed under GNU General Public License
• Communications through a HTTP port

CONS

• Workload on server side
• Not supported by mobile IP provider
Processing Considerations for Real Time

• Centralized Processing - NGS
  – Correction models
    • Ionospheric – dynamic or recent data
    • Tropospheric – dynamic or recent data
    • Satellite clocks
    • Multipath – from past data
  – Ambiguity resolution of reference station observables
  – Usually one communications channel

• Several processing locations
  – Many reference stations lead to many corrector streams
  – Several communications channels needed
Positioning Limitations from Real Time Networks

• DGPS
  – L1 code corrections
  – Range 200 – 400 km
  – Meter level accuracy
  – Time delay – varies up to a few seconds
  – Continental coverage

• RTK – Single Base Station
  – L1 code, L1 / L2 carrier corrections
  – Range 10 to 15 km
  – Centimeter level accuracy
  – Time delay – typically less than a second
  – Regional and local coverage
Post Processing Applications

• Post mission static positioning.
  – cm-level accuracy with a few hours of data, dm-level accuracy with one minute of data.
  – Solution delay - one hour.

• Post mission kinematic positioning.
  – dm-level accuracy for an aircraft, boat, or terrestrial vehicle.
  – Solution delay – more than one hour.

• Geophysics - crustal motion.

• Meteorology - water vapor in atmosphere.

• Space weather - free electrons in ionosphere.
Real Time Applications

- Structural monitoring
- GIS – Rapid Response, 911
- Precision guidance – machines
- Meteorology - water vapor in atmosphere
- Space weather – ionosphere, troposphere
- Positioning – OPUS (rapid solution)
- Assist other real time applications - RTK
PROPOSED POLICY FOR STREAMING GPS DATA VIA THE INTERNET

- NOAA’s National Geodetic Survey is exploring the possibility of streaming GPS data (not correctors) from selected CORS via the Internet.
- These data will be publicly available and free of direct user fees.
- NGS is openly distributing these data to enable other organizations to provide location based services relative to the NSRS.
PROPOSED POLICY

• Monitor the distribution of free electrons in the atmosphere.
• Monitor the distribution of precipitable water vapor in the atmosphere.
• Record the passage of seismic waves.
• While these GPS data may be applied to track the path of a moving platform--such as an aircraft, water vessel, or land vehicle–these data will not possess sufficient “integrity” to support a robust navigation service.
NTRIP Installation at NGS

• NGS Broadcaster 140.90.112.133  2101
  – Converting NDGPS and other sites for NTRIP.
  – RTK messages.

• NTRIP Server
  – Modifications made to send receiver ID and password.
Conclusion

• Streaming GNSS data over the Internet is feasible
• No significant lack of performance compared to other transportation media
• Advantages for user / service providers
• Developments for various products
• Promising solution for GIS
• Faster data access
Questions / Comments