Towards Real Time

National Geodetic Survey / NOS / NOAA
Silver Spring, MD

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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!

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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

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CORS Site Modification

- Receiver modifications
  - Firmware
  - Multiple satellite systems
  - Data interval
- Communications / Network modifications
  - Routers
  - Increased bandwidth
  - Internet
- Software

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Network Design Issues

- What format?

- What stations?

- What software?

- What distance?

- What data rate?

- What latency?

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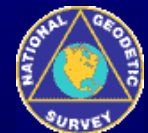**Silver Spring, MD**

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)

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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

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Communications

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

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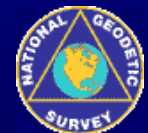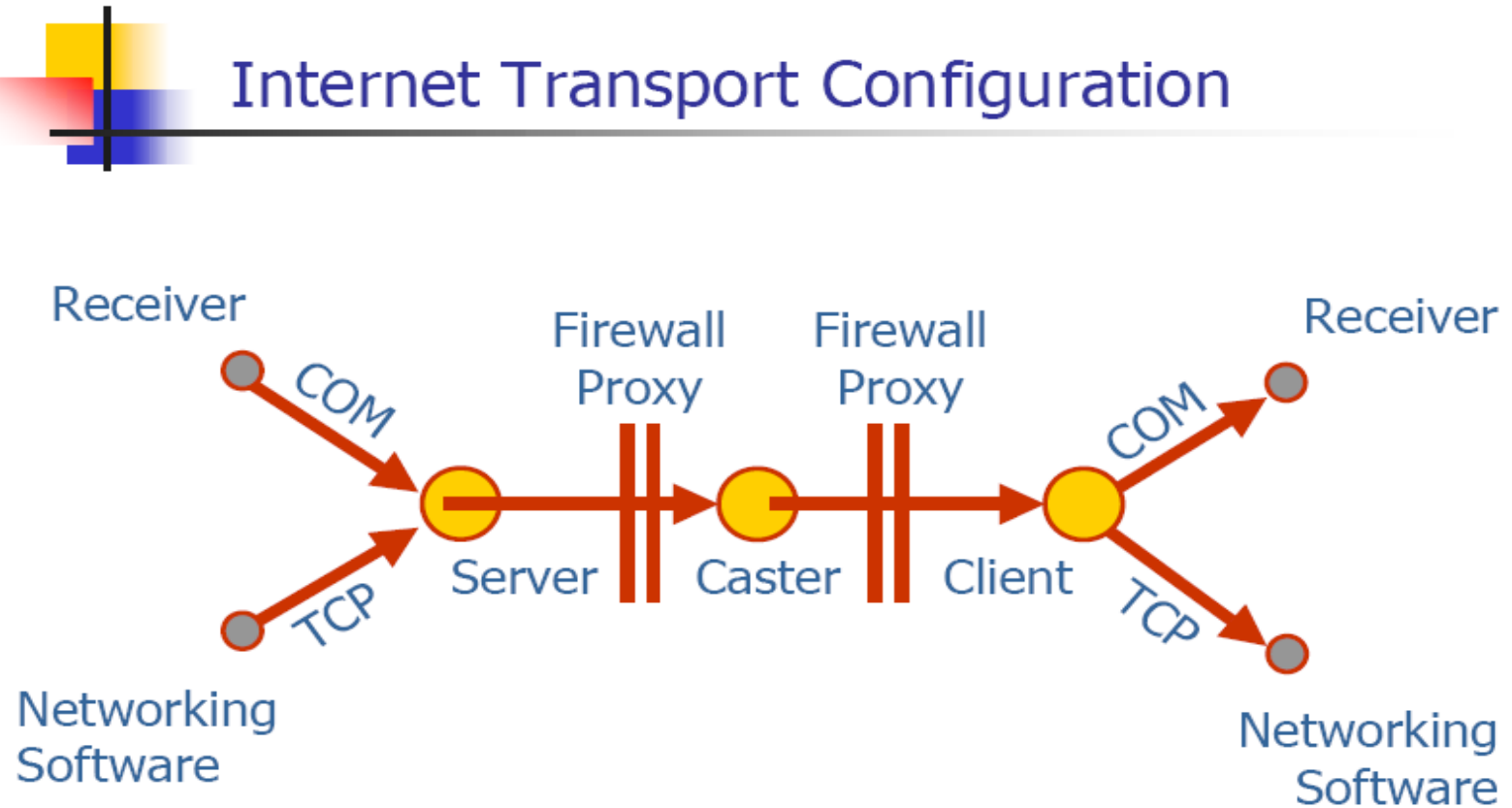**National Geodetic Survey, NOAA**
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Software

- 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

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Internet Transport Configuration

RTCM PAPER 166-2003/SC104-314

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CORS Users Forum
FT Worth, TX
September, 2006

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

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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

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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
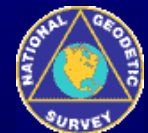 - Regional and local coverage

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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.

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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

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# 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.

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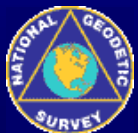
PROPOSED POLICY

- 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.

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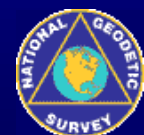
NTRIP Installation at NGS

- 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.

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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

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Questions / Comments

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