Setting the Standard for GPS Networks

Leica Geosystems Reference Network solutions

- when it has to be right
Reference Network Solutions
Overview

- Motivation for a new standard in GNSS Reference Networks
- The Master-Auxiliary Concept
  - Interoperability in network applications
- Conclusions
Network RTK solution
Fundamentals

- GPS Positioning (RTK) is expected with homogeneous and high
  - Accuracy ... in required datum
  - Reliability ... repeatability/precision
  - Availability ... of corrections

- Through:
  - Measurement ... of the GPS signals
  - Modelling ... estimation of the magnitudes of GPS errors of distance-dependent systematic error sources
  - Representation ... of these errors as corrections for rovers
    - Creation and output of correction data (typically RTCM)
Network RTK solution
Operational concept

RTK Network software running:
- Site Server
  - Collecting measurements
  - Control & Management of RS
- Network Server
  - Error modeling
  - Creation of correction data
  - RTCM output

RTCM corrections via GSM / GPRS / Radio
Existing network RTK concepts
Current issues

- All existing concepts (FKP, VRS, iMAX) do not conform to the RTCM philosophy
  - Both use modelled data, not raw data
- No current approach fully conforms to RTCM standards
  - Always proprietary solutions not fully described or documented
- No interoperability between different control center
  - Yesterday 2, today 3 different proprietary solutions: How many tomorrow?
- No real interoperability between network control centre and rovers
  - Rover is performing not better as the networking software does…
- How will these technology improve with additional signals (L5, Galileo)?

➡ Solution urgently needed
Network RTK messages
Leica’s proposal (1)

- Leica’s joint proposal to RTCM for network RTK messages:
  - To transmit network RTK corrections over less bandwidth than currently possible using RTCM 20 & 21
  - To provide real interoperability between systems (CC and rovers)
- To introduce the concept of “Master-Auxiliary Correction Differences”
- RTCM SC-104 has decided to use this proposal’s concept as the standard for network RTK messages in RTCM V3.x
Network RTK messages

Leica’s proposal (2)

- Leica researchers have already published results from their studies into the user of network RTK messages by rovers

http://www.leica-geosystems.com
Network RTK messages
RTCM standard

- RTCM committee has adopted MAC as new standard (last week) and MAC will be part of new RTCM v3.1 to be release in 1-2 months.
MAC Network RTK Transmission Concept

1 Master Reference Station + Several Auxiliary Reference Stations = 1 Network Cell

- Receiving Corrections (1004) for Master and Correction Differences (1015/1016) for the Auxiliary; e.g. interpolating the corrections ...
- Network Estimation process including. **Ambiguity Resolution**, forming messages of proposed type; transmission of Corrections (1004) for Master and of Correction Differences for each Auxiliary.
1. Network server is providing raw data from ALL stations in the network to the cluster

2. Cluster is creating a global model just to determine a common level of ambiguity for ALL stations. Not more!
   Creates corrections differences for all auxiliary Stations within a CELL.
   Raw data manipulation is limited to reduction into corrections differences split in dispersive and non-dispersive being sent at different rate
   Raw data of Master are being sent at 1Hz

3. Realtime server is broadcasting corrections to rover

4. Rover can apply ANY method to compute position (interpolation, multi-baseline, …)
Example of Corr. Diff. for Iono generated by SpiderNet

-0.0025
-0.002
-0.0015
-0.001
-0.0005
0
0.0005
0.001
0.0015
0.002
0.0025
129000 130000 131000 132000 133000 134000 135000 136000 137000 138000
Series 1
Series 2
Series 3
Series 4
Series 5
Series 6
Series 7

- when it has to be right

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Conclusion
Benefits of MAC concept…

- As it is a standard, ALL processes are fully described & documented.
- No need for any additional proprietary message
- Fully interoperability is guaranteed between rovers and control center and between different control center themselves
- Networking Software is “transparent” regarding Reference Station data
- Network Operators will concentrate on valuable additional services, not more on expensive hot-line to end-users

➔ **Rover will finally perform optimally**