NavCom Sapphire Board - Network RTK Compatibility

Single Base RTK

Principal:

1) Base station is setup on a known point
2) Corrections are sent to rover via an appropriate communication link (e.g. Radio Modem or GSM connection)
3) Both base and rover must observe common set of satellites
4) Base station provides its positions and corresponding satellite observations
5) Rover combines base observations with its own observations to compute RTK positions
6) Using this technique a rover can provide successful results for baseline length up to 40 Km

Limit on the baseline length is the main disadvantage in single base RTK. The validity of estimated corrections at the base station diminishes as the rover moves away from the base. For a longer baseline length, corrections at the base may not be suitable for the rover environment. As the distance from base increases the reduced capability of resolving ambiguities affects rover position accuracy.

Network RTK

Principal:

1) The goal of Network RTK is to remove baseline length dependency.
2) A network with a minimum of five stations, which are less than 70 Km apart from each other, can significantly reduce distance dependent errors at the rover.
3) The reference stations continuously stream their individual satellite observations to a server. The Network RTK software in the server accurately resolves ambiguities of the satellites that are observed by the participating network stations.
4) The rover within the bounds of the network receives the corrections from the server via an appropriate communications link.
5) The server Network RTK software along with the rover software algorithm helps minimize the distance dependent position errors.

A user with a network rover unit subscribes to a Network RTK service to receive RTK corrections without having to setup a base station. The rover software must support each broadcasted message type received from the server in order to take full advantage of the Network RTK method.

Today, network RTK service providers implement various methods to generate precise corrections, such as, Master-Auxiliary Concept (MAC), Individualized MAX (iMAX), Virtual Reference Station (VRS), and Flachen-Korrektur-Parameter (FKP; developed by GEO++).

For the VRS method, the network rover calculates its approximate location and transmits it to the computation server via the National Marine Electronic Association (NMEA) message format. The server then generates a virtual reference station near the network rover's initial position. The pseudorange and carrier phase data from the closest reference station are directly translated to the virtual station and interpolated corrections that are added from the network error model. This VRS data is transmitted to the

network rover using network transport RTCM via internet protocol NTRIP messages. At this point the network rover uses its traditional single base RTK algorithm as if the VRS is a base station close by.

There are several types of Network RTK in use today. The following list gives commonly used Network RTK types:

- **Continuously Operated Reference Stations (CORS)**
  - Provides a Single Base RTK Correction (typically RTCM message types 18/19 or 20/21)
- **Network Access**
  - Rover establishes a connection and the network assigns the nearest base to provide a Single Base RTK Correction (typically RTCM message types 18/19 or 20/21)
- **Network Adjusted**
  - Rover establishes a connection and the network provides a 'best-fit' adjusted RTK Correction (typically RTCM message types 1003 to 1012)
- **Network VRS**
  - Rover establishes a connection and the network provides a 'best-fit' adjusted RTK Correction (typically RTCM message types 1003 to 1033)
  - Can refer to one of several types where pseudo-reference sites are established with 1km of the rover position
    - *Trimble VRS*
    - *Leica VRS (referred to as iMax and similar in concept to Trimble VRS)*
    - *FKP*
  - Network provides data to rover and rover establishes a pseudo-reference site within 1Km of the rover position (typically RTCM message types 1003 to 1033)
    - MAC (Master Auxiliary Concept; Leica specific application)
  - New multi-constellation compact messaging (typically RTCM message types 1003 to 4095)
    - MSM (Multiple Signal Message)

NavCom Receiver Network RTK Capabilities

1) Over the years, NavCom receivers have been performing successfully with a single base to rover setup with up to 40 Km baselines.
2) NavCom receivers meet single base RTK 1-□ (68% probability) specifications of:

   Horizontal: *0.01 m +/- 0.5 ppm, and*
   Vertical: *0.02 m +/- 1.0 ppm*

3) In a Network RTK setup a NavCom receiver, within a network of at least five reference receivers, performs as the single base to rover as long as the closest reference station is within 40 Km.
4) NavCom receivers do accept corrections from third party base station receivers.
5) NavCom receivers accept all RTCM message types that are broadcasted by the third party base, but support only selected essential message types with its RTK positioning software algorithm.
6) The NavCom rover remaining within the bounds of a VRS Network RTK transmits its approximate location to the processing server in NMEA format. When it receives the corrections via VRS RTCM messages, it implements its proven single base to rover algorithms where VRS is considered as the base station close by.

7) A NavCom rover that is within a network, tracking only GPS satellites, meets the single base to rover RTK specification, as stated in (2) above.
8) At higher latitudes within a network, GPS+GLONASS tracking has shown improvement in rover position accuracies.
9) Extensive testing on VRS networks is ongoing in an effort to fully characterize NavCom performance.
10) VRS Network software varies by network operator. Several variants are being deployed globally. NavCom receivers have not been tested against all variants of VRS network software scenarios.
11) Tracking GLONASS in addition to GPS satellites does offer some advantage by increasing satellite availability. The network correction message types for GLONASS have not yet been fully developed and tested with NavCom network rover receivers.