RTCM 10403.3, Differential GNSS (Global Navigation Satellite Systems) Services - Version 3, October 7, 2016

This standard (referred to as Version 3) has been developed by RTCM Special Committee 104 as a more efficient alternative to the standards entitled "RTCM Recommended Standards for Differential Recommended Standards for Differential GNSS (Global Navigation Satellite Systems) Service, Version 2.x". (Current version is 2.3, now designated as RTCM 10402.3.) Service providers and vendors represented on the SC104 Committee wanted a new standard that would be more efficient, easy to use, and more easily adaptable to new situations. The main complaint was that the Version 2.x parity scheme, which uses words with 24 bits of data followed by 6 bits of parity, was wasteful of bandwidth. Another complaint was that the parity was not independent from word to word. Still another was that even with so many bits devoted to parity, the actual integrity of the message was not as high as it should be. Plus, 30-bit words are awkward to handle. The new standard, Version 3, is intended to correct these weaknesses.

Unlike Version 2.x, this standard does not include tentative messages. The messages in Version 3 have undergone testing for validity and interoperability, and are considered to be permanent. Amendments to the standard may change the meaning of reserved bits or provide additional clarifying text, but no changes will be made in the data fields. Changes will require new messages to be developed. In addition to the messages described in the current standard, the Committee continues to develop new messages, which are described in separately published amendments, and periodically gathered into a new edition of the standard. RTCM 10403.x for DGNSS services is proving useful in supporting highly accurate differential and kinematic positioning as well as a wide range of navigation applications worldwide.

Note that Version 3 messages are not compatible with Version 2.x. Since many receivers have been designed and programmed for use with Version 2.x messages, RTCM is maintaining both standards 10402.3 and 10403.3 as "current" standards.

Version 3.0:

The initial edition consisted primarily of messages designed to support real-time kinematic (RTK) operations. The reason for this emphasis is that RTK operation involves broadcasting a lot of information, and thus benefits the most from an efficient data format. Version 3.0 provided messages that support GPS and GLONASS RTK operations, including code and carrier phase observables, antenna parameters, and ancillary system parameters.

Version 3.1 (RTCM Standard 10403.1):

The next edition, Version 3.1 (RTCM Standard 10403.1), incorporated GPS Network Corrections, which enable a mobile receiver to obtain accurate RTK information valid over a large area. In addition, new GPS and GLONASS messages provide orbital parameters to assist in rapid acquisition. A Unicode text message is also provided for the transmission of textual data. Finally, a set of messages are reserved for vendors who want to encapsulate proprietary data in their broadcasts. The GPS Network Corrections enable a mobile receiver to obtain accurate RTK information valid over a large area. The Network RTK correction information provided to a rover can be considered as interpolated corrections between the reference stations in the RTK network. This interpolation is not perfect and varies with the actual conditions of the atmosphere. A residual interpolation error has to be expected. With sufficient redundancy in the RTK

network, the network server process can provide an estimate for residual interpolation errors. Such quality estimates may be used by the rover to optimize the performance of RTK solutions. The values may be considered by the rover as a priori estimates only, with sufficient tracking data available the rover might be able to judge residual geometric and ionospheric errors itself.

Version 3.1, Amendment 1:

Amendments 1 was an extensive addition that adds RTCM messages containing transformation data and information about Coordinate Reference Systems. For RTCM data supporting a RTK service, coordinates are measured within the ITRF or a regional realization. Surveyors and other users of RTK services must normally present their results in the coordinates of local datums. Therefore, coordinate transformations are necessary. By having RTCM messages that contain transformation data and information about the Coordinate Reference Systems, the users of the RTK service can obtain their results in the desired datum without any manual operations. The RTK service providers can then ensure that current information for the computation of the transformations is always used. The convenience of this method will promote the acceptance of RTK services.

Version 3.1, Amendment 2:

Amendment 2 added residual error messages to support the use of Non-Physical or Computed Reference Stations in a Network RTK environment.

Version 3.1, Amendment 3:

Amendment 3 addressed differences in the way GNSS receiver manufacturers have implemented carrier phase encoding of some Version 3 messages so that carrier phase observations are in phase for all carrier phases of a specific frequency, i.e. they correct for quarter cycle phase shifts. Others retain the quarter cycle offset between the carrier phase observations in the data. This amendment documents the way different manufacturers have handled the phase shift issue, and prescribes a uniform approach for future products.

Version 3.1, Amendment 4:

Amendment 4 added sections 3.5.13 on GLONASS Network RTK Correction Messages and 3.5.14 on FKP Network RTK Correction Messages. Related revisions were also made elsewhere in the document.

Version 3.1, Amendment 5:

Amendment 5 added section 3.5.12 on State Space Representation. Related revisions are also made elsewhere in the document, along with some editorial corrections.

Version 3.2 (RTCM Standard 10403.2):

Version 3.2 consolidates Version 3.1 and all five amendments into a new edition, and it adds Multiple Signal Messages (MSM) as well. The Multiple Signal Message (MSM) format generates receiver observables in the same way for all included satellite systems. The messages include compact and full messages for Pseudorange, PhaseRange, Carrier to Noise Ratio (standard and high resolution), and PhaseRangeRate.

A table near the beginning of the standard lists which messages were included in each separate edition and amendment, so it should not be necessary for users to refer to older versions. Multiple Signal Messages are a generic format that will be followed for all GNSS systems. Version 3 originally consisted of messages for GPS and GLONASS, each in their own format. Now with the imminent addition of signals for BeiDou, Galileo, and QZSS, as well as new signals provided by modernized GPS and GLONASS satellites, the need for a consistent generic format became evident. Service providers and users are urged to migrate to the MSM messages to make it easier to accommodate new GNSS services.

(See "The RTCM Multiple Signal Messages: A New Step in GNSS Data Standardization") Another new message is the GLONASS Bias Information message. This message provides information which is intended to compensate for the first-order inter-frequency PhaseRange biases introduced by the reference receiver code-phase bias.

Version 3.2, Amendment 1:

Added Galileo F/NAV Satellite Ephemeris Data (msg. 1045) and BDS MSM (msgs. 1121-1127)

Version 3.2, Amendment 2:

Added QZSS Ephemeris (msg. 1044) and QZSS MSM (msgs. 1111-1117)

Version 3.3 (RTCM Standard 10403.3):

This new edition adds Satellite-Based Augmentation System Multiple Signal Messages to previously adopted messages for GPS, GLONASS, Galileo, and QZSS.

A new ephemeris message has been added for BeiDou (BDS) and a new I/NAV ephemeris message has been added for Galileo. The new edition also reserves 100 messages be used exclusively by SC104 for new message development.

Finally, the new edition makes consolidates previous amendments and makes numerous editorial improvements.