NEWS from the **Radio Technical Commission for Maritime Services (RTCM)**

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The Radio Technical Commission for Maritime Services (RTCM) Issues an Amendment of its Standard for Differential Global Navigation Satellite Systems

Summary: RTCM Special Committee 104 has just completed an amendment to RTCM 10403.2, the widely-used "Version 3" standard for Differential Global Navigation Satellite System Services (DGNSS). RTCM's standard supports very high accuracy navigation and positioning through a broadcast from a reference station to mobile receivers. Looking forward to the use of new satellite positioning systems, the amendment introduces an ephemeris message and a set of the new Multiple Signal Messages (MSM) for the Japanese Quasi–Zenith Satellite System (QZSS). The new signals join the GPS and GLONASS messages, as well as the recently added Galileo and BeiDou System (BDS) messages The amended standard is available from RTCM at its secure online publication store. Visit www.rtcm.org and click on "Publications."

In this new amendment: The QZSS ephemeris message contains satellite ephemeris, accuracy and health status (signal and data) information. This message could be broadcast to ensure homogenous ephemeris information is used at the reference station application and at the user equipment.

Seven new messages for QZSS are introduced in the new Multiple Signal Message (MSM) format. The messages include compact and full messages for Pseudorange, PhaseRange, Carrier to Noise Ratio (standard and high resolution), and PhaseRangeRate.

RTCM's "Version 3" standard: RTCM 10403.2 is a further evolution of RTCM's "Version 3" DGNSS standard supporting the Real-Time Kinematic (RTK) method. RTK allows immediate and precise determination of a mobile receiver's position, without having to post-process data, as was necessary with earlier techniques. The "Version 3" series supports the dissemination of Network RTK information over large areas covered by a network of reference stations. It is designed to support a variety of networking techniques, while maintaining interoperability of service provider and user equipment. Earlier editions of "Version 3" included generic messages, as well as messages for the U.S. Global Positioning System (GPS) and the Russian GLONASS system.

RTCM 10403.2 introduces Multiple Signal Messages (MSM). The similar nature of the observables for each of the currently known GNSSs (both operational and planned) allows all observables for each GNSS to be presented in a universal format. The generic MSM structure is described first using generic field (MT) numbers. The definitions for each of the GNSS follows, which includes definitions for the GNSS specific fields. The MSMs are split into compact messages and full messages, similar to the previous RTCM approach.

MSMs are designed to cover the following:

- Maximum compatibility with RINEX-3
- Replace legacy RTCM-3 messages (MT1001-1004 and MT1009-1012), transmitting the most essential information in a generalized form, incorporating new signals and GNSS.
- Universality for all existing and future GNSS signals
- Compactness of presentation
- No ambiguity in interpretation
- Simplicity of generation/decoding
- Flexibility and scalability

The message organization is equally well suited for:

- Fully deployed GNSS with each satellite transmitting the same set of signals.
- GNSS transition period when different satellites transmit different sets of signals.

Background on GNSS and DGNSS: Global Navigation Satellite Systems (GNSS) provide geographical positioning information from a constellation of satellites in orbit to receivers at sea, on the ground, and in the air. The best known of these systems are the U.S. Global Positioning System (GPS), and the Russian GLONASS system. Similar services will be provided by the European Galileo system, and the Chinese BeiDou system. Together they are known as Global Navigation Satellite Systems, and they can provide position accuracies in the 10 meter to 15 meter range. The regional Japanese Quasi-Zenith Satellite System (QZSS) is now included.

As impressive as GNSS systems are, they may not directly provide accuracies that are good enough to rely on for ships entering harbors, or docking, for example. Although the satellites have the potential to provide more accurate positions, atmospheric and other effects degrade the quality of the satellite signals. The satellite signals can be corrected by using reference stations at precisely known locations, which broadcast corrections to GNSS receivers nearby. This technique is known as Differential GNSS (DGNSS) service, and it has enabled precise navigation not only by ships, but also aircraft, and ground vehicles. A DGNSS technique known as Real-Time Kinematic (RTK), can provide accuracies in the centimeter range. This has enabled tractors to cross agricultural fields in precisely the same track every time, improving crop yields, and snow plows to operate quickly over roads buried beneath an otherwise trackless snow field. Geodesists use DGNSS to precisely document the movement of the earth's tectonic plates, and surveyors and engineers use it not only for land surveys, but also to track the movements of tall buildings. New applications continue to be developed.

Standards developed by RTCM's Special Committee 104 (SC 104) have been widely used for DGNSS services. "Version 3" of the standard (RTCM 10403.x series) supports very high accuracy navigation and positioning through a broadcast from a reference station to a group of mobile GNSS receivers. The broadcast contains data that augment the information obtained from the GNSS satellites, improving the accuracy from a few meters to as little as a few centimeters. For conventional differential operation, the data include pseudorange [1] corrections that mitigate the effects of ionosphere, troposphere, and inaccuracies in the satellite ephemeris [2] data. For higher accuracy real-time kinematic (RTK) operations, the data elements are code and carrier-phase observables that support double-differencing algorithms in the mobile units. [3] Ancillary data that support these techniques and facilitate ease of usage are also broadcast.

Compared to the Version 2 series, the Version 3 series standard is more efficient, incorporates a higher integrity scheme, and is easier for the receiver designer to use. The initial release of the standard, i.e., Version 3.0, consisted primarily of messages designed to support RTK operations. RTK operation involves broadcasting a considerable amount of information, and thus benefits the most from an efficient data format. A typical Version 3 RTK application uses less than half the data required by the previous version. Version 3.0 provided messages that support GPS and GLONASS RTK operations, including code and carrier phase observables, antenna location and descriptors, and ancillary system parameters.

Version 3.1 (RTCM 10403.1) included an interoperable definition for Network Real-Time Kinematic (Network RTK) operation, which supports centimeter-level accuracy positioning service over large regions. With RTCM 10403.1, Network RTK services providers could serve their customers with reliable information regardless of the brand of equipment their customers are using. After its initial release, RTCM 10403.1 was amended 5 times to introduce improved message descriptions, network RTK residual messages, physical reference station position message (for virtual reference stations (VRS)), receiver and antenna description messages, handling of quarter-cycle phase

[1] The pseudorange is the estimated distance between a satellite and a mobile unit, determined by calculating the time required for the satellite's signal to reach the mobile unit.
[2] The satellite ephemeris data is information about the satellite's orbit and its onboard clock.
[3] GNSS satellites broadcast a digital code on a radio frequency known as the carrier. GNSS systems derive the pseudorange from the code. Differential GNSS systems improve the accuracy of the pseudorange by analyzing the carrier using the double-differencing mathematical technique.

shifts, GPS and GLONASS FKP, GLONASS Master-Auxiliary Concept(MAC), and State space representation.

RTCM 10403.2 introduces Multiple Signal Messages (MSM) and like earlier versions, will be amended from time to time. Online purchasers of RTCM 10403.2 will be automatically provided with these amendments by E-mail as they are published.

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