Performance of MADOCA PPP Service from India using Compact GNSS Modules

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GNSS Precise Point Positioning (PPP) is a popular GNSS-based position solution technique, as globally it can deliver high quality point positioning solutions using a single GNSS receiver, thereby eliminating the constraints of simultaneous observation at both rover and reference stations and limited baseline length as required in case of differential GNSS techniques. PPP positioning is feasible in remote areas and regions of low GNSS reference stations. But in case of PPP, the final solutions can be found only after post-processing the collected data using International GNSS Service (IGS) products and the user needs to wait even up to a few days to complete the processing.

The Quasi-Zenith Satellite System (QZSS) is a regional satellite navigation and positioning system developed by the Japan Aerospace Research and Development Agency (JAXA), providing positioning and timing service within its coverage. L-band experiment (LEX) signal is an enhanced signal broadcasted by QZSS, designed to achieve real-time precise point positioning (RT-PPP), and time transfer by transmitting high-precision correction data such as GNSS satellite orbit, clock corrections and ionospheric corrections. This can avoid data delay, data transfer instability and other shortcomings of the traditional ground-based transmission network used in case of PPP. Based on the multi-GNSS advanced demonstration of orbit and clock analysis (MADOCA) software, JAXA provides correction information of MADOCA-LEX transmitted by LEX signal for RT-PPP. Currently, the correction information includes precise satellite orbit and clock corrections as well as the User Range Accuracy (URA) and code and phase biases for GPS, GLONASS and QZSS satellites.

This study presents the first reports from India on the performance evaluation of QZSS Multi-GNSS Advanced Demonstration of Orbit and Clock Analysis – Precise Point Positioning (MADOCA-PPP) in static operation based on experiments carried out during February 2022. Data is collected from two locations in Eastern India using compact, low-cost GNSS receiver together with a low-cost antenna in hybrid, multi-GNSS operation.

A low-cost, compact, dual frequency GNSS receiver uBlox ZED F9P and a Skytraq survey grade antenna under open sky is used both at the two static locations- one at GNSS Laboratory Burdwan (GLB), The University of Burdwan and at the other at Chandipur, India. The F9P compact GNSS module at the user end is directly connected to a PC running MADOCA software, and the streamed MADOCA correction data is received through NTRIP (Networked Transport of RTCM via Internet Protocol), those are processed together for position solution. The performance of Real Time (RT-MADOCA) PPP is evaluated by calculating the 2D [2DRMS (Root Mean Square), CEP (Circular Error Probable)] and 3D accuracy parameters [SEP (Spherical Error Probable), MRSE (Mean Radial Spherical Error)] of the solutions obtained from MADOCA RT-PPP at the two locations w.r.t. the respective reference locations calculated through offline PPP using a popular and capable open-source GNSS data processing software, RTKLIB.

It is observed that, after some time (~30 min) provided to the setup for solution convergence, maximum deviations in latitude and longitude are less than 1m, and in altitude are around 1.562m for both the Indian observation locations. Solution accuracy parameter values (2DRMS, CEP, SEP and MRSE) lie below 30cm and the standard deviations of solutions also fall between few mm to less than 25cm. QZSS availability from India shows the scope for using the constellation from India, and therefore, MADOCA-PPP can be used from India for online PPP service reducing the post-processing time. The encouraging results would be of interest for the GNSS user community of the region to obtain Real Time (RT-PPP) solutions. From September 2022 onwards, MADOCA correction stream will also include Galileo data, and therefore, is expected to provide improved solution quality.

The presentation will consist of discussion on QZSS satellite availability from India, details of the experimental scheme, data analysis techniques, and the results.