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Table of Content

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BeiDou position solution from North Eastern India

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Abstract

Global Navigation Satellite System (GNSS) is widely used for myriads of applications. Along with GPS, GLONASS and Galileo providing global coverage, BeiDou is the fourth global navigation satellite system developed, deployed and controlled by China, initiated operation science 2020. BeiDou performance from India is limitedly reported and this manuscript presents the results of BeiDou performance from north-eastern India using a compact, low cost, single frequency multi-GNSS module. The results show better satellite visibility for BeiDou compared to other constellations. The useable number of satellites in case of BeiDou matches that of GPS, GLONASS and Galileo hybrid operation. BeiDou shows modest position solution quality and signal strength comparable to or better than other constellations. The reports would be useful for understanding the potential of BeiDou for seamless good quality position solution required for various mass market applications.

INTRODUCTION

GPS, the first global satellite-based navigation system was developed by the USA; following the path, Russia developed GLONASS, European Union developed Galileo and China developed BeiDou (abbreviated as BDS). All the four navigation satellite systems have global, all-weather coverage. QZSS (Japan) and NavIC (India) are the active regional navigation satellite systems. These navigation systems provide high-accuracy positioning, navigation and timing services to global or regional users.

Countries located in the Asia Oceania region including India is expected to receive signals from all satellite-based navigation systems for multi-GNSS hybrid operation. From India, around 50 satellite signals are found be available [1], though the extremely high satellite visibility does not always ensure a favorable signal availability in time and location specific cases. It is seen that, even in the presence of 20 GPS, GLONASS and Galileo signals, during some parts of the day no GNSS satellite is available above 60° elevation angle from large parts of India and the world [2]. This may create problem in seamless, good-quality navigation solutions in the locations where visibility of the satellites is obstructed due to lower elevation angles. It would be interesting to study whether the 4th global navigation system, BeiDou, can supplement the situation. BeiDou is expected contribute around 23% of the global satellite positioning, navigation, and timing (PNT) system from the view of dilution of precision and overall GNSS integrity and reliability [3-4] and would augment the situation if multi-GNSS hybrid solution is utilized. [5].

BeiDou is developed by China following a three-step strategy. First step was the construction of the BDS-1 to provide services to China by the end of 2000. Second step was the construction of the BDS-2 to provide services to the Asia-Pacific region by the end of 2012, and deployment of BDS-3 system was the third step to complete the construction of the BDS and provide services worldwide around 2020. As on October 31, 2021 total satellites in BeiDou constellation are 49, out of which 44 Satellites are included in operational orbital constellation [6].

Along with the development of the BDS and service ability, related products are widely being applied in communication and transportation, marine fisheries, hydrological monitoring, weather forecasting, surveying, mapping and geographic information, forest fire prevention, time synchronization for communication systems, power dispatching, disaster mitigation and relief, emergency search and rescue, and other fields. These products are gradually penetrating every aspect of social production and people's life, injecting new vitality into the global economy and social development.

BeiDou development is primarily focused on the Asian region and India is favorably located to receive signals from all navigation systems, therefore, it is of interest to study the benefits of BDS from India. The work has not been much reported. A simulation-based work on BDS availability from India is reported in [7], and preliminary report on BeiDou stand-alone position solution from eastern India is reported in [8]. But the scope for detailed work based on systematic, real-time data exists, that has been taken up in this work. This paper presents a details study of stand-alone BeiDou positional performance along with visibility, signal strength comparison with GPS, GLONASS and Galileo from North-eastern part of India. The discussion starts with a brief overview of the BDS.

BEIDOU: BRIEF OVERVIEW:

Based on its national interests, China independently developed the BeiDou system in a three-step strategy of development. By the end of 2000, BeiDou-1 or Phase I construction was completed and provided services to the