**Input paper: [[1]](#footnote-1)** ENG14-3.1.3.5

**Input paper for the following Committee(s):** **Purpose of paper:**

(Select as appropriate)

ARM  ENG  PAP  Input

ENAV VTS  Information

**Agenda item** [[2]](#footnote-2) 3.1

**Technical domain/ Task number** 2 Radionavigation services

**Author(s)/Submitter(s)** Sulgee PARK, Sanghyun PARK (KRISO), Hyun KIM, Sak Lee (MOF)

Maritime Precise Positioning and Integrity Monitoring Project Preliminary Results

# BACKground

Maritime precise positioning requirements for future Global Navigation Satellite System (GNSS) in International Maritime Organization (IMO) are 10cm horizontal and vertical accuracy, respectively. However, DGPS, which guarantees meter-level service, is only satellite-based augmentation system in Korea’s maritime environments. Thus, the development of maritime precise positioning and navigation services is necessary, because DGPS service could not satisfy maritime precise positioning requirements.

Moreover, maritime autonomous surface ship (MASS) which represents the maritime fourth industrial revolution, and a variety of maritime applications such as hydrographical surveys, automatic docking, docking support, and smart ports require maritime precise positioning and navigation services. To provide users with resilient and accurate PNT information and guarantee safety, Republic of Korea (R. O. K) has decided to the maritime augmentation advanced service.

Maritime precise positioning and navigation services in R. O. K will provide users with generated centimetre level augmentation information, through the use of the current DGNSS and additional GNSS reference station information and Global Positioning System (GPS) carrier phase measurement.

# Point project preliminary design

In the R. O. K, planning research on precise positioning services was conducted in 2015 that confirmed the existing demand for advanced maritime augmentation services. Based on this research, the R. O. K initiated the Precise Positioning and INTegrity monitoring (POINT) project in April 2020. POINT project aims to develop an infrastructure that provides users with precise positioning and integrity monitoring information in the maritime area and to achieve an improved location accuracy and integrity of 5cm (95%, horizontal) within 100km of the Korean coastline. In the POINT research and development(R&D) project, GPS raw measurements acquired from reference stations and monitoring stations will act as the central processing station to provide centimetre-level augmentation information (precise positioning and integrity monitoring information). The augmentation information thus generated by a central processing station will be broadcasted through ground-based communication media, such that users within the service coverage area can receive the positions with centimetre accuracy and guaranteed integrity. In addition, a prototype receiver will also be developed to avail the centimetre level accuracy services furnished by the POINT project, which will also be used to verify the performance of POINT in testbed and real sea environments.

The POINT system is a centralized structure which transmits the raw measurements of the reference station/monitoring station to the central station in real time. The correction information for the satellite orbit, satellite clock, satellite bias, tropospheric delay and ionospheric delay is estimated and provided to the user. As all data are processed by the central station, it is designed with redundancy to satisfy the performance requirements for continuity and is switched according to the quality of the correction information. In addition, if the raw measurements from the reference station are not provided, the performance of the ionospheric delay and tropospheric delay, which are regional error factors, rapidly deteriorates. Therefore, the reference station and the monitoring station are both installed with two antennas and two receivers each through duplexing, which allows the central station to switch according to the data quality. Currently, the DGNSS reference stations/monitors have a redundancy system, which is a requirement for the POINT reference stations. However, the target performance was not met by the DGNSS reference stations/monitoring stations with a horizontal position accuracy 95% of 6 cm and a vertical position accuracy (95%) of 14 cm. An additional base station was analysed based on the performance evaluation indicators to satisfy the target performance of the station in the R.O.K. As a result, 14 additional reference stations were established. To predict the reference station performance of the most optimal base station layout, the target performance was kept at 3 cm in the horizontal and 8 cm in the vertical. The results are the simulation results for performance prediction, which differ from the actual performance.

The first stage of the performance verification of this project will be conducted in 2022 at a testbed port. The testbed port identified is the Daesan Port, located in, the northern part of the West Sea of Korea. Additionally, a total of six new stations will be included in the testbed service for which construction will begin, as shown in Figure 1.

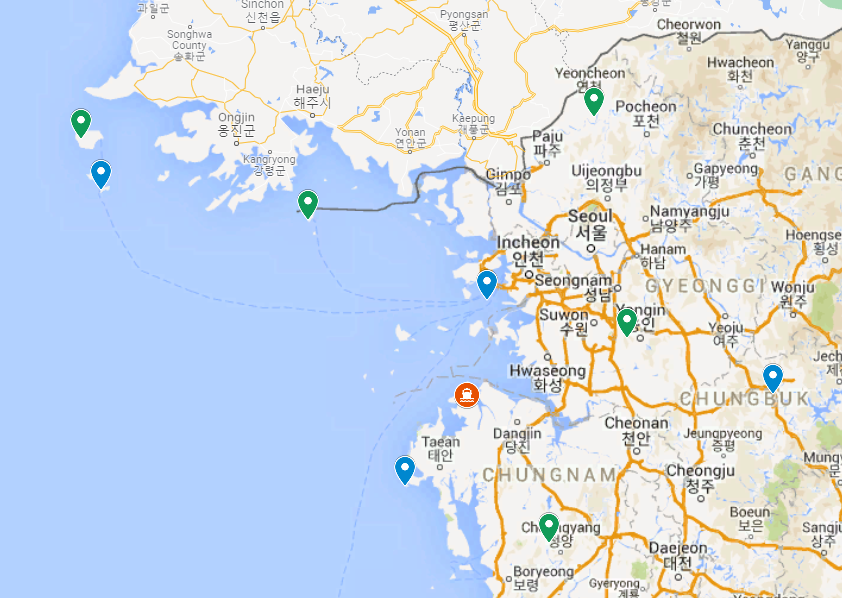


Fig. 1. Testbed port and reference station (blue: DGNSS reference stations, green: new reference stations)

# Point project preliminary result

The preliminary results were derived based on the data obtained from a temporary reference station in a location similar to the reference station, which will be constructed in the future, as depicted in Figure 2. The establishment of a new reference station is expected to be complete in the second half of 2021, which will be used for the 2022 testbed-based performance verification. The preliminary correction information was generated only for the satellite orbit, satellite clock, ionosphere delay, and tropospheric delay using the data obtained from the relevant temporary reference station. The user performance verification was carried out at the Anheung reference station near the testbed port. As a result, the user positioning performance was fulfilled with a horizontal positioning error (95%) of 4.52 cm and a vertical positioning error (95%) of 5.59 cm.

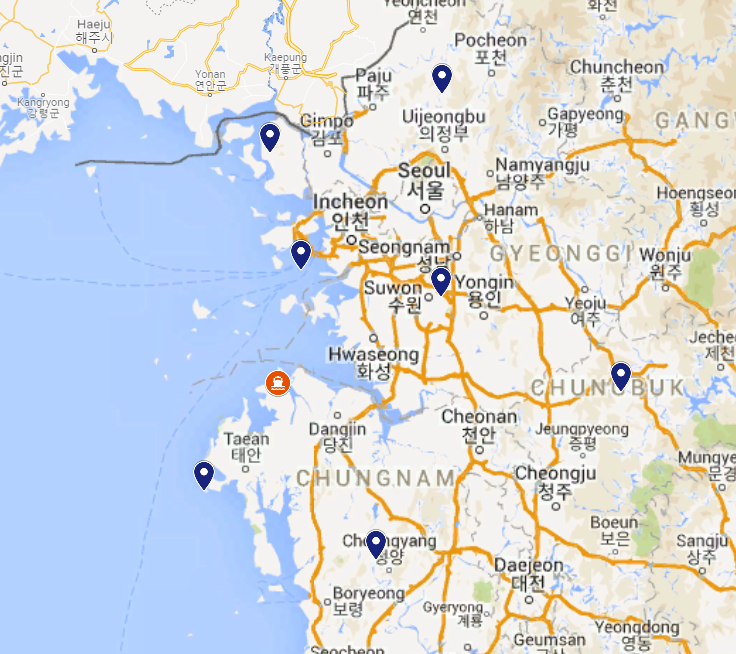


Fig. 2. Preliminary test reference stations

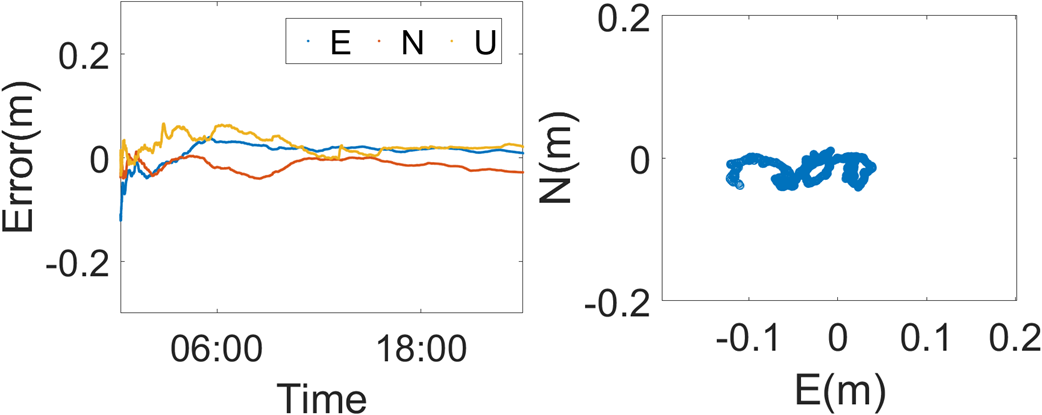


Fig. 3. Preliminary results

# Point project future plan

The POINT project will be carried out in two phases from 2020 to 2024. The first phase, to be completed by 2021, will comprise the completion of the critical design review the reference station, central processing station, and receiving platform for precise positioning services. Thereafter, the production is scheduled to be completed by 2022, along with the verification of the pilot service performance through the testbed. In the future, satellite bias correction information will be added to the correction information of the preliminary test for the first stage performance verification, and performance will be improved through an unspecified search. In the second phase, the critical design of the reference station, monitoring station, central processing station as well as the receiving platform for the navigation services are expected to be completed by 2023, aiming for the Korea maritime service by 2024. The Korean Positioning System (KPS) project is expected to be carried out in 2022. Further plans include development of the technology by 2035 using the KPS project as a centimetre service based on ground communication.

Efforts are also being undertaken to expand the precise maritime related technologies by periodically sharing the status of the POINT R&D project with IALA member countries through the IALA ENG Committee.

1. Input document number, to be assigned by the Committee Secretary [↑](#footnote-ref-1)
2. Leave open if uncertain [↑](#footnote-ref-2)