Study of Total Electron Content Variations Which Affect to Satellite Signals of High Accuracy Clock (HAC) Project.

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Abstract

The dual frequency radio signals of the Global Positioning System (GPS) at an altitude of 20,200 km allow the measurement of the total number of free electrons, called total electron content (TEC), along ray path from GPS satellite to receiver and then the GPS signal ionosphere delay.This delay is one of the considerable error sources of GPS time comparison. The Engineering Test Satellite VIII (ETS-VIII) missions will include application experiments using Cesium atomic clocks as same as Cesium atomic clock in GPS in space. Using this satellite, the CRL (Communications Research Laboratory) and the JAXA (Japan Aerospace Exploration Agency) is planning to conduct a precise time and frequency transfer between an atomic clock on-board the satellite and a ground-reference clock. Under the auspices of the JAXA mission,the ETS-VIII will be the first Japanese satellite to be equipped with an onboard atomic clock. The goal of this project is not to develop the atomic clock itself, but rather to confirm the in-orbit performance of a cesium atomic clock used in GPS and other applications, as well as to establish basic satellite positioning technologies. To evaluate the in-orbit performance of the ETS-VIII onboard atomic clock, the CRL has proposed a method of precision two-way timecomparison between the onboard atomic clock and the ground reference clock. Generally, precision time comparison can be realized through the two-way time-comparison method, since propagation delay and variation in the ionosphere and the troposphere is, in principle, canceled out, as are the effects of satellite motion. However, in the current experiment, ionospheric delay cannot be canceled out, since the system uses different S-band frequencies for uplink and for downlink. Therefore, both S-band and L-band signals will be issued by the satellite for ground reception, to allow for correction due to ionospheric delay . In this system, HAC will be installed both on the satellite and in the ground station, resulting in coherent carrier and modulated signals, as seen in GPS applications. It will thus become possible to use the phase information not only of the modulated signal but also of the carrier signal. This will enable comparison of distances on the order of millimeters and time comparison featuring picosecond-level precision. In Thailand, there is one monitor station of this HAC project. We study the effect of ionospheric total electron content which affect to satellite signals of HAC by cooperation of JAXA , CRL and satellite communication laboratory of ReCCIT, King Mongkut's Institute of Technology Ladkrabang (KMITL) Thailand.