Paper ID: 90753
interactive
student

IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Interactive Presentations - IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (IP)

Author: Mr. Lucas VIVACQUA
Universidade Federal do Rio Grande do Norte - UFRN, Brazil

Dr. José Henrique Fernandez
Universidade Federal do Rio Grande do Norte - UFRN, Brazil

ON RELATIVISTIC EFFECTS IN THE GNSS CLOCKS

Abstract

The greater stability of the atomic clocks in the new generation's satellites and better corrections are enabling applications of navigation systems at activities of increasingly smaller level precision. We recently had the launch of the last GALILEO satellites, the completion of the QZSS constellation, and the new generations of GLONASS and COMPASS. All this made the integration of the navigation satellite systems an even more pressing matter. Therefore old questions are bought back and it's impportant to know how they should be addressed now from the perspective of a single integrated GNSS. This study approaches the issue of relativity acting on the onboard atomic clocks in all six navigation constellations in operation nowadays. Therefore, we set out to find the temporal distortion of each vehicle of the following constellations: GPS, GLONASS, GALILEO, COMPASS, IRNSS, and QZSS. Through the ephemeris data, extracted from the constellations almanacs and the analytical equations of Special and General relativity, we were able to find a fixed and two periodic offsets, influenced by the orbit's semi-major axis, eccentricity and inclination. For GPS, e.g., the fixed offset is 445.6 ps for each second elapsed on the ground. More importantly, if we take each satellite individually we found that deviations from the average go up to about 50 nanoseconds a day. For PRN 21 of the same constellation, we found a periodic effect bounded to the eccentricity of its orbit with an amplitude of 56.6 ns with a period equal to the orbital one. This may impact applications with precisions of tens of meters. 38.9% of the satellites require this kind of correction for applications in order of meters. Yet another periodic effect was found, one caused by the Earth's oblateness with a period of half the orbital one and an amplitude that from MEO satellites goes from 60 to 100 ps, and thus causes trouble for applications that require centimeter-level precision. Having this kind of estimation for all 116 GNSS vehicles currently in operation helps us better understand the importance of having the right relativistic correction for the right applications.