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

Author: Prof. Ignazio Ciufolini
Università del Salento, Italy, ignazio.ciufolini@unile.it

Prof. Antonio Paolozzi
Sapienza University of Rome, Italy, Antonio.Paolozzi@uniroma1.it
Mr. Claudio Paris
Sapienza University of Rome, Italy, claudio.paris@uniroma1.it
Dr. Giampiero Sindoni
Sapienza University of Rome, Italy, giampiero.sindoni@uniroma1.it

PRECISE GLOBAL POSITIONING AND HIGHER ORDER RELATIVISTIC CORRECTIONS

Abstract

Precise *global* Point Positioning (PPP) of an object, at the centimetre level, is extremely useful for a number of applications to our everyday life. Applications that require centimetre level accuracies include surveying, measurements of crustal motions, upwelling magma, ground water motions, mining, marine navigation, precision farming and agricultural automation, asset tracking, machine guidance and machine automation. PPP needs in principle only four GNSS spacecraft above the object to be positioned and uses only a single GNSS receiver, i.e. it is not dependent on local base stations and no local reference stations are needed in the vicinities of the user, therefore, PPP is a *global* positioning technique.

Since PPP is not affected by the operating range spatial limit of differential positioning, it will be the future *global* positioning at the centimetre level (presently it may reach decimetre level accuracy). Nevertheless, there are a number of basic problems that need to be solved before reaching those accuracies. Among some of the main problems to be taken care we list the need: to improve the ionospheric corrections, the satellite clock corrections, the improvement of the satellite ephemerides, the "higher order" relativistic corrections, offset and variations of satellite antenna and receiver antenna phase centres, displacements due to solid Earth tides, ocean loading, plate tectonic motion and polar tides. In addition, a more stable and more accurate determination of the ITRF would improve the PPP positioning. If one does not include the main relativistic effects in the GNSS, the positioning error would amount to a number of km in just twelve hours, nevertheless the main relativistic effects are already implemented in GNSS, however, much smaller relativistic effects, currently not modelled, imply positioning errors of the order of centimetres or perhaps even decimetres. The small relativistic and gravitational effects on GNSS, which we study, include: the time-delay in the propagation of electromagnetic waves or Shapiro time-delay; the effects of solar and lunar potentials (tidal), and of the quadrupole and higher multipole moments of the Earth's gravity potential on clocks; the effect of the space curvature generated by the Earth mass on the change of proper distance between global navigation satellites and receivers (in part responsible for the Shapiro time delay); post-Newtonian orbital effects of the GNSS spacecraft such as their perigee precession. In this paper the effects described will be studied in detail.