SPACE SYSTEMS SYMPOSIUM (D1)
Enabling Technologies for Space Systems (2)

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A FORMATION FLYING RADIO FREQUENCY TECHNIQUE AND TECHNOLOGY

Abstract

A satellite FF mission consists in a set of satellites flying in close configuration whose geometry is accurately measured and controlled. Ultimately this allows making space science using a so called "distributed instrument" on several spacecrafts. Several science Mission are envisioned, such as Simbol-X from CNES, or Darwin from ESA. These missions require very accurate relative positioning and control of the platforms, to achieve the instrument pointing and quality of measurements. Laser metrology will be used for this purpose. Yet a FF Radio Frequency (FFRF) metrology will be needed to provide robust and autonomous measurements throughout all the mission phases: deployment, manoeuvres, transition to laser metrology, and even during nominal observations. Typically, the altitude of the formation will be high above the geostationary altitude or even at the Lagrange L2 point. Therefore, the use of GPS signals won't be possible, the FFRF equipment will have to provide its own signal to make cross-link measurement using dual frequency S-band navigation signal. Thales Alenia Space is currently developing an S-Band FFRF instrument for PRISMA under a CNES contract. PRISMA is a FF demonstration mission scheduled for 2009 under the responsibility of the Swedish Space Corporation (SSC). FFRF concept is detailed here. Each terminal transmits two S-band carriers modulated by a GPS C/A navigation signal. Satellites emit according to a TDMA sequence so as to avoid interference and near-far effects. From signals received from all other satellites each terminal makes ranging and Line of Sight (LOS)

measurements. LOS measurements are made possible by measuring the carrier phase difference between the master and slave antennas of a 3-antenna base. Coarse measurements are made using C/A code and fine measurement with centimeter accuracy are made using carrier phase measurements. A widelane on both frequencies allows carrier ambiguity resolution. A centralized PVT is then computed using distance and LOS measurements of all satellites. In addition a pure data channel in quadrature with one of the ranging channels provides FFRF equipment with an Inter Satellite (ISL) data link capability. Multipaths created by satellite structure surrounding FFRF antennas will be the major source of error on FFRF LOS and distance measurements. Multipath errors could indeed reach several centimeters on phase measurements resulting in a significant degradation of precision. To reduce multipath impact a method of calibration of multipath errors in anechoic chamber has been set up and is presented here.