Predictive Autonomous Orbit Control Method for Low Earth Orbit Satellites

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AOC can provide both significant operations cost reduction and increased mission performance. By controlling the orbit to match a chosen reference, ground operations are significantly reduced and scheduling becomes highly predictable. AOC gains in value for very low Earth orbit satellites, when the effects of atmospheric drag must very often be compensated for.

Even if the use of Autonomous Orbit Control (AOC) enables easing the station-keeping management, the assessment of the debris collision risk becomes more complicated. Indeed, station-keeping at low altitude involves frequent orbit control maneuvers. Moreover, the increasing number of monitored objects in LEO leads to heighten the collision alerts during station-keeping operational phase.

The collision alerts management process requires from ground segment an accurate knowledge of the satellite orbit. The current AOC implementation does not enable this fine knowledge because the maneuvers scheduling and completion are no-predictive - the future maneuvers are known on-board just before their occurrences.

This issue has led CNES to study and develop an algorithmic method for both in-track and cross-track controls. This method enables AOC to become more predictable by adding a frozen horizon for upcoming maneuvers. In other words, the predictive AOC method particularly enables the ground segment team to be warned soon enough of the future maneuvers computed by the AOC. If the future maneuvers are known, the orbit is fully predictable and the position of the spacecraft within this period is known in advance within a better accuracy. This is particularly useful to assess the debris collision risk because the predicted satellite trajectory can be compared to known near debris ephemeris.

A conclusive evaluation of the station-keeping performances has been performed using numerical simulations from realistic low-earth-orbit mission’s data.