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Commercial Collision Avoidance Service based on JSpOC SP Catalogue

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The support from JSpOC to current collision avoidance operations is priceless. As a result, most satellite owners and operators have signed with USSTRATCOM an SSA Data Sharing agreement and have Orbital Data Requests in place in order to have access to JSpOC conjunction assessment and collision avoidance support services.

JSpOC issues CDM messages in case an upcoming conjunction is detected. These messages are the main source of information to satellite operators to proceed with their collision avoidance operations. Additionally, JSpOC supports these operations if the operator provides information on the planned station keeping and collision avoidance manoeuvres by running the screening process also against the operational ephemerides.

The main issues reported by operators in this process are the following:

- The potential discontinuation of the services provided by JSpOC who might concentrate on the monitoring of the space environment (cataloguing) and hence, the need for commercial services to answer to their particular needs.

- Short notice period for some particular upcoming conjunctions leading to urgent operations to react and perform the collision risk assessment and collision avoidance manoeuvre computation.

- Potentially iterative and long process with JSpOC during collision avoidance manoeuvre computation for post-manoeuvre analysis (to anticipate conjunctions after collision avoidance manoeuvres). This leads to additional delays and uncertainties during these critical operations.

In order to answer to these issues (and particularly the first one), GMV has reached a SSA Data Sharing Agreement with USSTRATCOM to access the Special Perturbations (SP) precise catalogue containing the US unclassified objects, to exploit it and generate derived products for the provision of commercial services. The SP catalogue is routinely downloaded from space-track site (currently, on a daily basis) and post-processed by GMV for the provision of its commercial collision avoidance services through its dedicated *focusoc* Operations Centre. Additionally, GMV has reached dedicated agreements with a large number of commercial SST data providers (radar and optical) to integrate their sensors with *focusoc* to collect data in case of high-interest events in order to perform orbit determination on target and chaser objects and refine the risk assessment in case of need.

GMV's *focusoc* Operations Centre integrates tools for conjunction detection, collision risk assessment and collision avoidance (*closeap*) and for SST data processing and orbit determination (*sstod*) which use state-of-the-art algorithms, support parallel processing and have been used in real operations by a large number of customers, integrated in operational ground control systems. This ensures the efficiency and reliability of the solutions provided by focusoc.

To mitigate the second issue listed above, GMV has also implemented an automated process to extend the span of the downloaded SP catalogue to make it cover a longer period of time both in GEO and LEO as well as MEO and HEO/GTO. This process consists on the fitting of the available ephemerides (by means of orbit determination and parameters estimation) and their propagation with detailed dynamical models. As a result, upcoming conjunctions can be anticipated before receiving CDMs from JSpOC and the urgency of collision avoidance operations is drastically reduced by counting on additional time for decision-making processes and

on the possibility to perform collision avoidance by means of adapting upcoming station keeping manoeuvres, particularly in GEO.

To mitigate the third issue listed above, GMV has automated all the processes for conjunction detection and collision risk assessment. One-vs-all assessments are performed against the operational orbit as soon as provided by the operator (including planned manoeuvres) and as soon as a new catalogue is available from JSpOC. As a result, the operator can make any post-manoeuvre analysis for all manoeuvres performed, not only those aimed at collision avoidance ensuring the safety of all their operations. No manual intervention by any man-in-the-loop is required and therefore no additional latencies are imposed to the spacecraft operations.

The *focusoc* system description and operational tools used, the nature of the services provided, the process to download, fit and propagate the SP catalogue, the performances achieved and the collision risk assessment and avoidance operations performed, including real cases, will be presented. The applicability to several orbital regimes (from LEO to GEO) and different mission phases (not only routine but also LEOP, re-location, EOL, etc.) will also be presented along with the feedback received by the satellite operators currently making use of the service.

Summary

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