

High-Throughput Processing of Space Debris Data

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Space Debris are defunct objects in space, including old space vehicles (such as satellites or rocket stages) or fragments from collisions. Space debris can cause great damage to functional space ships and satellites. Thus detection of space debris and prediction of their orbital paths are essential for today's operation of space missions. To detect the space debris, sensor networks of optical telescopes, radars, and laser systems are distributed at various places over the earth. The goal is a catalogue containing as many of the small debris items as possible. Based on the catalogue, a mission support system is built that gives real-time orbit information, collision detection, and re-entry prediction for each debris item.

The talk shows the software infrastructures BACARDI (Backbone Catalogue of Relational Debris Information) and Skynet (Network for surveillance of the sky). BACARDI is a high-level, domain-specific system for gathering space debris data from the various data sources, such as sensor networks or existing databases, for storing the data in databases, and for performing the data processing, such as object identification or orbital collision detection. BACARDI sits on top of Skynet. Skynet is a distributed computing infrastructure for high-throughput data processing. The architecture of Skynet was designed as a scalable, self-organizing network of nodes. Nodes communicate via decentralized message queues with minimal network overhead. The implementation is based on standard technologies. For the network infrastructure and for messaging, Skynet uses ZeroMQ. Computations on each node are performed by highly optimized and well-evaluated codes implemented in Fortran. The serialization of data that goes through the distributed network is done using Google Protocol Buffers, which guarantees a minimal protocol overhead. Skynet records Provenance information for traceability and provability of all processed data. This allows backtracking of each produced data product (e.g., ephemerides, state vectors, correlated objects, ...) and guarantees reproducibility of all generated data. Provenance is recorded of all activities during runtime and stored in a graph database.

Summary

Space Debris are defunct objects in space, including old space vehicles or fragments from collisions. Space debris can cause great damage to functional space ships and satellites. Thus detection of space debris and prediction of their orbital paths are essential. The talk shows a Python based infrastructure for storing space debris data from sensors and high-throughput processing of that data.

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