

FreeFlyer® GPU propagating the debris catalog and performing an all-vs-all screening

FreeFlyer® GPU

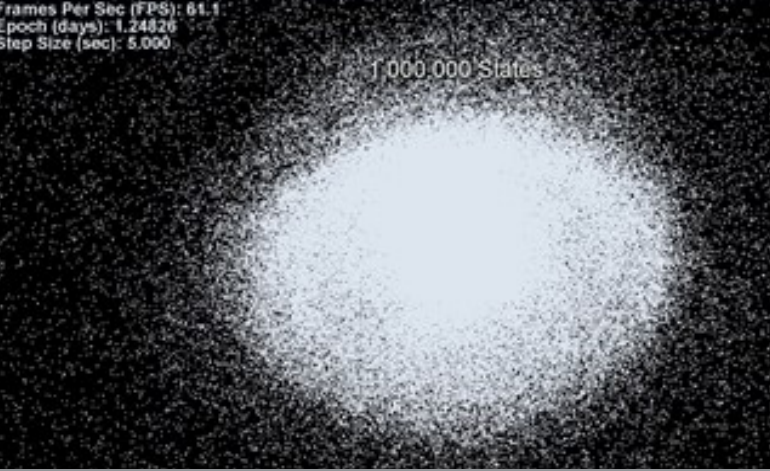
Parallel Propagation and Conjunction Assessment

FreeFlyer® Graphics Processing Unit (GPU) is a high performance extension of a.i. solutions' FreeFlyer® astrodynamics software, optimized for customers who require high-speed parallel processing. Users can perform **more than 100 million state propagations per second** due to implementation of simultaneous calculation algorithms. FreeFlyer® GPU is used for daily operations on NASA's Magnetospheric Multiscale (MMS) mission where our customer realized a 1,000 times performance improvement for inter-spacecraft collision detection.

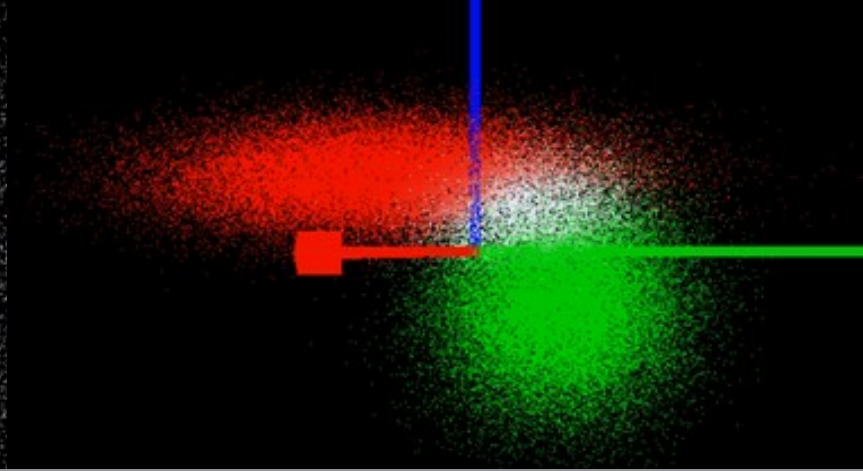
Operational Success

a.i. solutions utilized FreeFlyer® GPU to realize a 1,000 times increase in the speed of the inter-spacecraft collision detection problem on MMS for our NASA customer. This capability is used daily for MMS operations at NASA Goddard Space Flight Center.

1,000,000 States



FreeFlyer® GPU propagating 1 million objects in parallel at a 5 second step-size



FreeFlyer® GPU calculating the probability of collision based on a Monte Carlo sampling of the object covariances

System Architecture

The FreeFlyer® GPU is built using NVIDIA's CUDA libraries, and will run on any NVIDIA GPU compatible with CUDA version 2.1 or greater. It features multi-GPU asynchronous kernel streams to support extremely large processing jobs spread across multiple GPUs.

Dynamic Modeling

The FreeFlyer® GPU features several innovations in the area of dynamic modeling. The propagation is based on Runge-Kutta integration optimized for maximum throughput. In addition to simple point-mass accelerations for planetary bodies, the FreeFlyer® GPU models non-spherical gravitation through high-fidelity gravity grid interpolation via texture memory, and uses OpenGL modeling to compute 3D-model based solar radiation pressure accelerations.

Conjunction Assessment

In addition to large-scale propagations, the FreeFlyer® GPU supports all-vs-all screening for conjunction detection and probability of collision calculations for risk assessment. The FreeFlyer® GPU uses advanced search techniques to improve performance, and this allows conjunction detection to be performed at every time-step of the propagation.

When conjunctions are detected, the FreeFlyer® GPU uses Monte Carlo techniques to sample the covariance information of the conjuncting objects to compute a probability of collision. The parallelism of the GPU allows for sufficiently large sample sizes to compute any value of P_c to a high level of confidence.