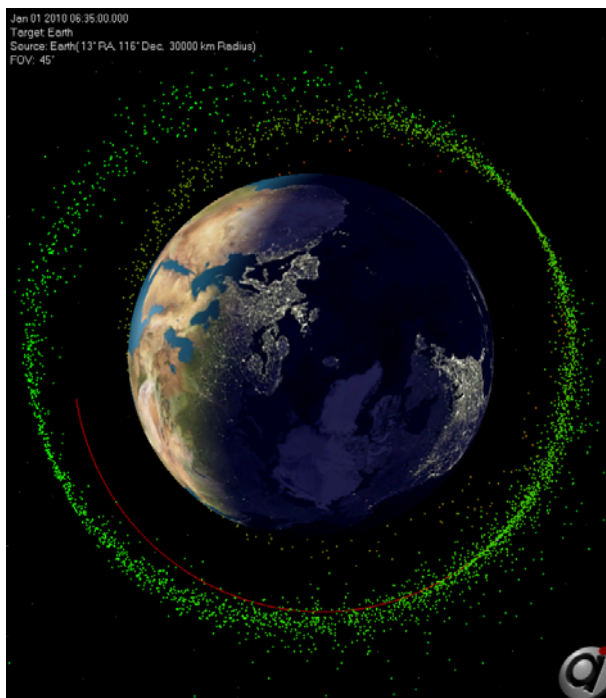




FreeFlyer® and High Performance Computing

Bringing Supercomputing to Space Mission Analysis and Operations

Orbital debris poses a significant threat to spacecraft health and safety. Tracked objects in US Strategic Command's (USSTRATCOM) Space Object Catalogue number more than 13,000, with the number of objects increasing by the hundreds each year. A collision between an operational satellite and debris could end a mission, underscoring the need for risk assessment and mitigation strategies.



In 2005, **a.i. solutions** developed a FreeFlyer-based Automated Conjunction Assessment System (AutoCAS), now operational for 24 NASA missions, including the Earth Science Constellation (ESC). With the January 2007 destruction of the Fengyun-1C Chinese Weather satellite in a similar orbit, the ESC conjunction assessment team began noticing a marked increase in daily collision threats. By June 2007, the first ESC risk mitigation maneuver as a direct result of the Chinese debris was performed by the Terra spacecraft.

This June 2007 Collision Avoidance maneuver confirmed that the Fengyun-1C break-up had already begun to have significant operational impacts on the ESC member missions. GSFC asked **a.i. solutions** to assess the operational impacts of the Fengyun debris on ESC satellites over the next 20 years. Such long-term intensive analyses meant creating high fidelity orbit propagations of the several thousand pieces of debris. Using traditional single processor computing would take months. GSFC wanted results sooner.

The Results

With only minor modification to FreeFlyer, **a.i. solutions** configured FreeFlyer to perform in a clustered, high performance computing (HPC) environment. The specific solution consisted of off-the-shelf PC hardware, Microsoft® Windows® Compute Cluster Server Operating System, and FreeFlyer. Using 10 "clustered" computers, the 20-year analysis was completed in less than 3 days. The end result shows that the Fengyun debris continues to remain a threat to the ESC member missions in the near future. Furthermore, the analysis shows that the number of conjunction threats the ESC missions will triple by the year 2027.

The Conjunction Assessment Team found that, compared to other flight dynamics analysis tools, FreeFlyer was uniquely qualified to perform high fidelity analysis in a clustered environment. The **a.i. solutions** Conjunction Assessment Team is now planning to use the FreeFlyer HPC environment to assess even longer term impacts – up to 100 years into the future!

The Customer
NASA's Goddard Space Flight Center

The Challenge
The Chinese anti-satellite test (ASAT) in early 2007 generated a massive amount of space debris in orbits similar to ESC missions, causing a marked increase in collision threats, necessitating the need to assess long-term operational impacts.

The Solution
Enable FreeFlyer to perform in a clustered environment to create 20 year, high fidelity orbit predictions of each debris object and analyze its future interaction with the Earth Science Constellation.

The Results
GSFC now has a good understanding of the behavior of the Fengyun debris and the operational impact to the ESC missions over the next 20 years.

More engineering cycles. Smarter analysis. Better solutions.

a.i. solutions is proud to be a part of GSFC's Conjunction Assessment Team.