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The year in review

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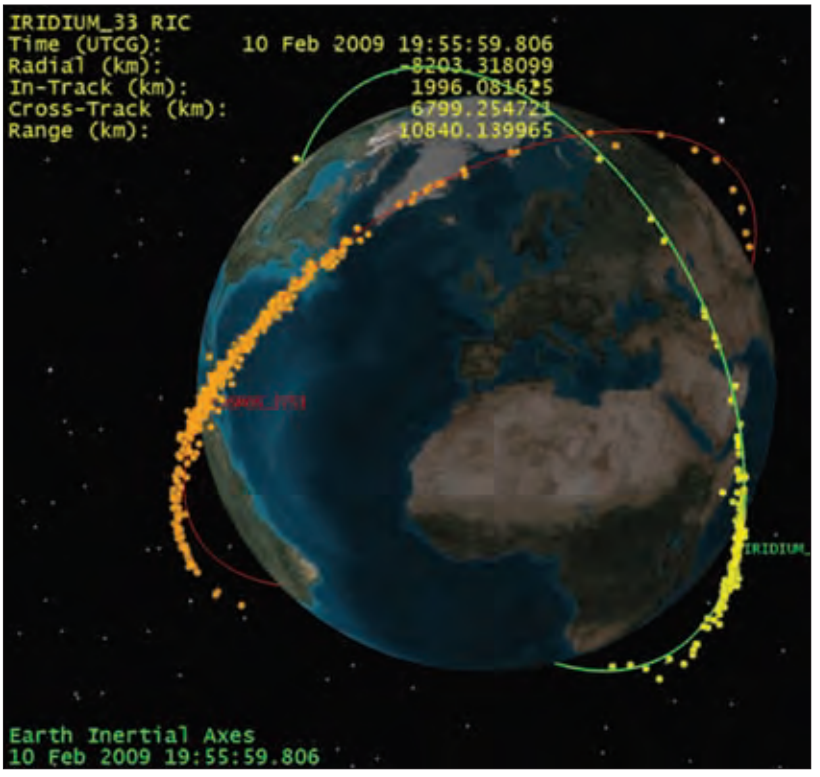
Astrodynamics

On February 10, Iridium 33—an operational U.S. communications satellite in LEO—was struck and destroyed by Cosmos 2251, a long-defunct Russian communications satellite. The debris fragments generated by this event, and by earlier on-orbit breakups, explosions, and use of antisatellite weapons, will be a growing hazard to much of the LEO satellite population for many decades to come. With a great increase in the number of expected close approaches, it is more important than ever to have widespread participation in sharing the highest fidelity orbit data in order to improve predictions of possible collisions.

There was significant activity related to flight dynamics at the Moon over the past year. The Chinese Chang'e spacecraft and the Japanese Selenological and Engineering Explorer spacecraft made planned impacts to the lunar surface in March and June, respectively. The Indian spacecraft Chandrayaan-1 arrived at the Moon and delivered a lunar probe in late 2008, and conducted science operations until it fell silent at the end of August. It was joined in orbit by the Lunar Reconnaissance Orbiter (LRO) in late June. Three spacecraft began low-energy transfers from the Earth to the Moon in 2009: the Lunar Crater Observation and Sensing Satellite, which observed the impact of its upper stage and then impacted itself on October 9, and the two outermost THEMIS/MIDEX probes, renamed ARTEMIS, which will achieve lunar orbit in 2011.



A view of Iridium 33 and Cosmos 2251 shows orbits and debris 180 min after the two communications satellites collided. (Credit: T.S. Kelso.)

The National Academies put out a call for white papers focusing on how understanding of the solar system may be advanced in the future. In response, many members of the astrodynamics community made strong contributions to several papers, advocating research in several related areas (for example, on-board navigation autonomy).

In addition, the community submitted a paper focused on astrodynamics research and analysis. This paper made the case that, while astrodynamics research has both enabled and greatly expanded the capabilities of numerous planetary science missions, including Dawn, Cassini-Huygens, and MESSENGER, funding for this research has been largely limited to the development and operations phases of missions. NASA funding for general research and analysis in astrodynamics would uncover new techniques before the formulation of new mission concepts and could motivate new classes of missions. These new techniques would not only enhance all sizes of missions, but would also expand the feasible set for new mission concepts.

In the area of low-thrust dynamics, the Dawn spacecraft performed the first flyby of another planet (Mars) by a spacecraft equipped with solar-electric propulsion. The Japanese Hayabusa spacecraft began thrusting again in the final leg of its journey back to Earth and is due to arrive in June 2010. Back on Earth, the European Gravity Field and Steady-State Ocean Circulation Explorer launched in March. It is using electric thrusters as part of a compensation system for all nongravitational forces acting on the spacecraft, leading to improved spatial resolution of the Earth's gravity field.

Finally, the Centre National d'Etudes Spatiales hosted the Fourth Global Trajectory Optimization Competition. The objective of this international astrodynamics design contest was to design a rendezvous mission to a given asteroid while visiting the largest number of other asteroids along the way. The winning team for this year was from Moscow State University. A workshop presenting the methods and results from the competitors was held in Toulouse in September.

by **L. Alberto Cangahuala**