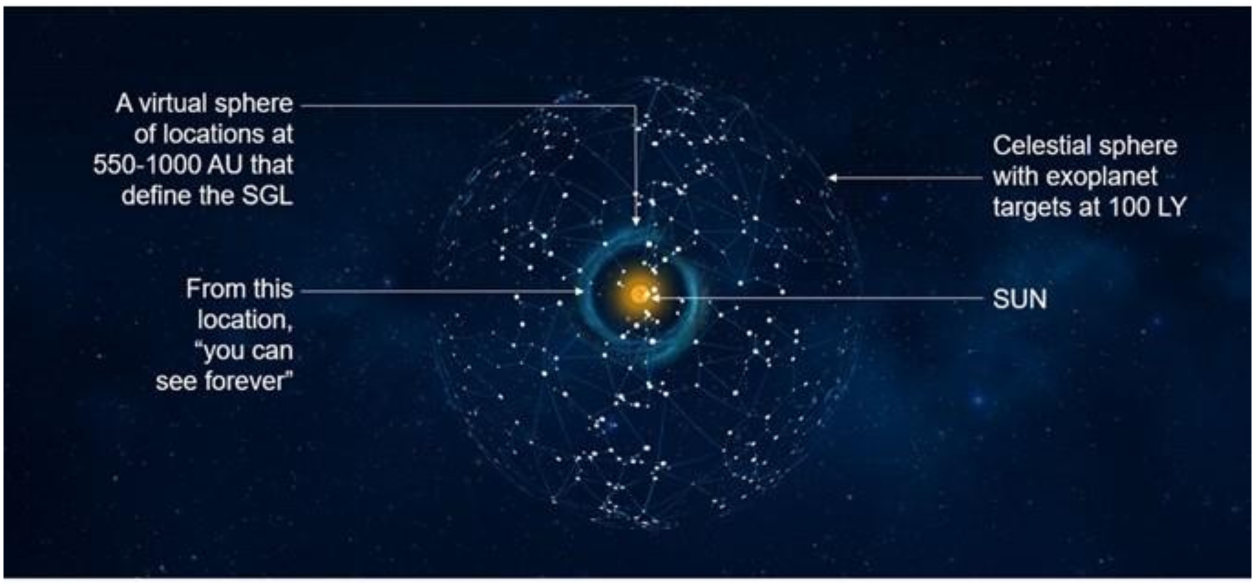
DELIVERING VALUE

From a “Hamburger Size” Satellite Concept to the Imaging of Exoplanets – A 3-Decade Journey of Innovation at Aerospace



Concept for the Solar Gravity Lens Project

Well before the era of Cubesats, the small satellite revolution started in the Aerospace laboratories in 1993 when three intrepid researchers wrote a paper on the concept of the nanosatellite and assembled a community of interest to study emerging miniaturization technologies. There are now over 400 nanosatellites in orbit and launch rates have doubled every 2.44 years. When NASA was seeking a solution to develop a viable strategy for directly imaging exoplanets, they turned to Aerospace for a solution. The Solar Gravity Lens Project, now funded for further development through the third-ever awarded Phase 3 NASA Innovative Advanced Concepts program, uses an Aerospace-developed architecture comprising spacecraft miniaturization technology pioneered at Aerospace nearly 3 decades ago.

Background: In the early 1990’s launching payloads to low-earth orbit required a huge investment ($30,000/kg) while miniaturization techniques for electronics and mechanical devices were rapidly developing. Aerospace scientists created a vision for small satellites that could potentially deliver remote sensing and communication systems to orbit at a fraction of the cost. Using a combination of Aerospace research and development funds funds and external grants, the three Aerospace scientists created a community of early adopters, including visionaries in the National Security Space community.

Due to several concurrent developments in micro/nanoelectronics, communications, photonics, power, materials development, and the increasing "cloud"-based computational capabilities available in your hand or on your wrist, small satellites have become a reality, and there is no evidence to suggest that the exponential growth rates should not continue. Small satellites are now being used for numerous missions, including the recent Mars planetary visit by JPL's Mars Cube One satellites, but some applications have yet to be imagined.

The concept of using the sun's mass as a gravity lens has been under discussion in the scientific community, including evidence of this phenomenon which was inadvertently recorded by the Hubble Space Telescope. However, a recent detailed analysis of the solar gravity effect at JPL strongly suggests that direct multi-pixel imaging of exoplanets becomes possible if an imager can be placed at 548 Astronomical Units from the sun. If a 1-meter telescope could be placed in this region, it would be possible to image features on 100 Light-Year distant exoplanets, such as seasonal changes, oceans, continents, and surface topography. JPL turned to Aerospace to develop an architecture that could capture these stunning images within realistic budget and time constraints.

Aerospace Actions: Building on their knowledge of small satellites and their proven capabilities, Aerospace proposed an architecture that will meet mission goals. This architecture uses multiple small satellites, propelled with solar sails (for high exit velocities), in an innovative "string of pearls" architecture in which each pearl comprises a cluster of formation-flying small satellites. As pearls are sequentially launched, they provide the required communication relays, observational redundancy, Artificial Intelligence based "mentor-student" learning, technology upgrading, and data management needed to perform the mission. By employing these small satellites using Artificial Intelligence technologies to operate independently, mission cost and risk are reduced. As a result of this work, Aerospace is part of a team that has been awarded a NASA Innovative Advanced Concepts Phase III grant, where the mission concept will be further refined leading to a technology demonstration mission in the 2023-24 time frame and a full-scale mission a decade later.

Aerospace Value: The Aerospace laboratories were an incubator and technology push of a radical idea in the early 1990's which has blossomed into a technology now employed in nearly all aspects of civil, commercial, and military space. When presented with a challenge by NASA to create a viable architecture for imaging exoplanets, Aerospace provided a solution built on a legacy of nearly 30 years of persistence, innovation, and company-wide teamwork. Aerospace scientists and engineers thrive in a matrix of technical breadth and depth where interdisciplinary teams can solve the hardest problems. In the length of time since Aerospace started the small satellite revolution, photons from a possible habitable planet will reach our solar system, and because of Aerospace ingenuity, will be captured afar but studied here on Earth.

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