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DEPARTMENT OF THE NAVY
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SPOTLIGHT
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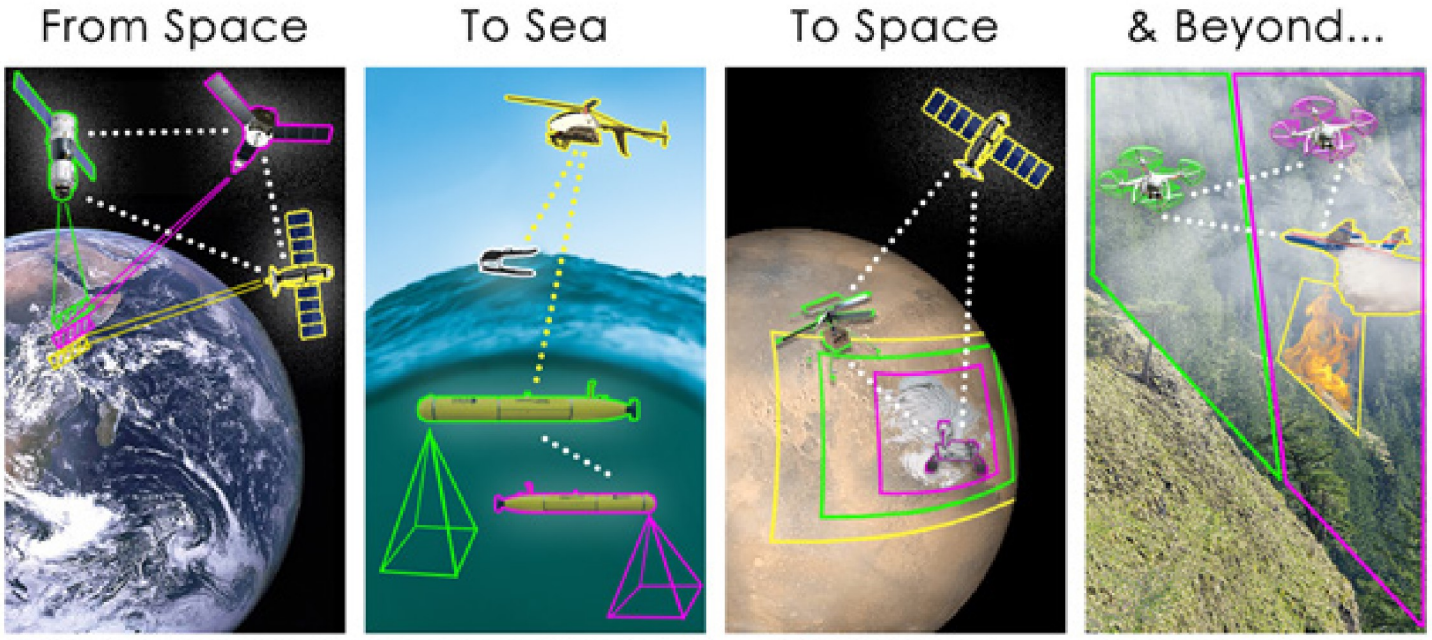
Orbit Logic's APS Enables Autonomous Operations on Earth and in Space

Orbit Logic's Autonomous Planning Software (APS) technology is truly multi-domain: Originally developed for satellites, it has since been applied to undersea Navy operations and lunar and Martian exploration. The power and flexibility of APS is unique in a field dominated by single-purpose solutions. By working closely with domain experts, adapting software and algorithmic components where possible, and building new supplementary mission-specific modules where warranted, Orbit Logic is able to quickly deploy powerful solutions for a wide variety of planning and scheduling problems.

MinAu, the deployment of APS targeting Navy applications, enables heterogeneous swarms of robotic assets for missions including collaborative bottom mapping and patrol/detect/track, and is undergoing in-water testing with NIWC-PAC on their SeaRover Unmanned Underwater Vehicles (UUVs).

These diverse deployments accelerate technical maturation through synergy; MinAu-equipped Navy UUV swarms benefit from lessons learned in APS satellite deployments, and vice versa. "The technology is applicable to any domain," describes Ella Herz, Chief Operating Officer at Orbit Logic. "We started with space, the Navy pushed the technology in new directions, and then we brought those advancements back to space."

APS takes into account the evolving mission situation, including the environment, the assets, and each asset's components—replanning as necessary. This expands mission capabilities; for example, if multiple UUVs are



Collaborative Satellite Imaging with Rapid Reaction to Events

Collaborative UUV Bottom Mapping or Patrol/Detect/Track with UAV Data Ferry Facilitating Communication to USV Mothership

Collaborative Planetary Exploration/Survey Using A Variety of Science Sensors on Satellites, Rovers and Atmospheric Craft

Collaborative UAV Forest Fire Hot Spot Detection and Fire Suppression Tasking

Image Courtesy of Orbit Logic

deployed in a collaborative patrol/detect/track mission and one identifies a red asset, the UUVs can reallocate searching and tracking responsibilities so that they track the asset while continuing to search the area of responsibility. APS also improves resilience and robustness; for example, if one asset loses power or communication, APS enables the other assets to reallocate tasks so that the malfunctioning asset's responsibilities are fulfilled. "Planning is dynamic so if one asset is not responsive or goes off the grid, the other assets will realize they need to compensate for the loss of that asset's capabilities and adjust their plans accordingly. The same applies if an asset reappears, such as if it regains signal," explains Dr. Neil Dhingra, Business and Program Leader at Orbit Logic. Moreover, increased efficiency through adaptive replanning decreases power usage, allowing for longer and more capable deployments of unmanned assets.

Developed as a commercial off the shelf (COTS) product, APS is modular, flexible, and scalable. Orbit Logic initially created APS to support satellites in low Earth orbit (LEO) and geosynchronous Earth orbit (GEO) for missions including Earth imaging, where APS ensures data coverage on areas of interest, and local space situational awareness (SSA), where APS empowers satellites to monitor their vicinity for debris or other satellites and react appropriately. APS will fly on a DARPA Blackjack demonstration mission in June 2021 and on an MIT Cubesat in 2022.

Under a Phase II STTR effort with the Navy, Orbit Logic adapted APS in the MinAu program to coordinate heterogeneous robotic teams of UUVs, Unmanned Aerial Vehicles (UAVs), and Unmanned Surface Vehicles (USVs). MinAu has been applied to two missions. The first is bottom mapping, where UUVs survey the ocean floor with sonar and then surface to upload findings and measurements to a UAV data ferry that flies it to a USV mothership or shore station for further evaluation. The second mission is patrol/detect/track, where collaborating UUVs search a 3D area for red assets and then coordinate which UUVs will continue to track them. MinAu is undergoing in-water testing using SeaRover UUVs from NIWC-PAC.

Building on the success of the MinAu program, Orbit Logic has begun efforts with NASA to apply APS to robotic exploration of Mars and the moon. The Mars/Interplanetary Swarm Design and Evaluation Framework (MISDEF) effort applies APS for swarms of rovers, rotorcraft, and satellites for Martian exploration, while the Intelligent Navigation, Planning, and Autonomy for Swarm Systems (IN-PASS) applies APS to lunar exploration systems composed of rovers, surface stations and satellites. IN-PASS is also prototyping means by which astronauts can participate "on-the-loop" with the robotic team.

Beyond military applications, APS has immense potential for commercial space applications, related UxV missions such as firefighting and search-and-rescue, and even Internet of Things (IoT) household devices. Through SBIR/STTR funding, the Navy is enhancing multi-domain autonomy and is leveraging development begun under AFRL and DARPA funding. With applications in space and on Earth, Mars, and the moon, APS is a versatile technology whose possibilities seem endless.

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