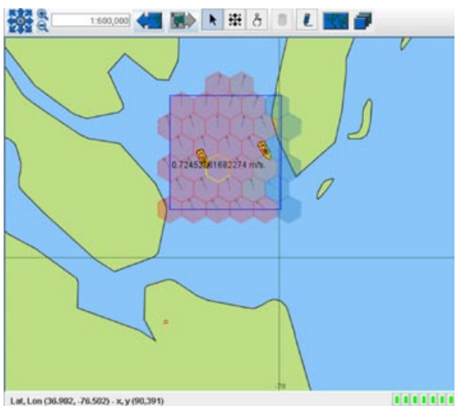
National Aeronautics and Space Administration

software

Adaptive Sensor Fleet

A fleet-control system for planetary, oceanographic, search-and-rescue, military, and security missions

(photo courtesy of U.S. Navy)



This screen capture illustrates ASF performing a simulation of an oceanographic mission at the mouth of the Chesapeake Bay using data conditions from Hurricane Isabelle. Boats are represented by the yellow figures, while the blue square indicates the area to be mapped or studied. Thehexagons show points from which the boats have already gathered data.

Researchers at NASA Goddard Space Flight Center (GSFC) have developed the Adaptive Sensor Fleet (ASF)—a software architecture that allows remote-controlled platforms, such as boats, aircraft, rovers, satellites, or other vehicles or hardware, to work collaboratively in support of a single scientific goal. ASF functions as a control system, supervising and autonomously sending commands and tasks to such platforms. The system offers extreme versatility in the variety of science goals it can be made to accomplish, and ASF is ideal for oceanographic and planetary research; search-and-rescue operations; and military, mining, and security missions.

Benefits

- **Flexible**: Can monitor and control mobile (i.e., boats) and stationary (i.e., buoys) platforms
- **Centralized communications**: Allows a fleet of platforms to work in concert without communicating with each other
- **Compatible**: Works with both legacy and newer systems, enabling scientists to use ASF without first upgrading older systems
- **Economical**: Requires very little to no ongoing management of a scientific study, making the software much more accessible for studies with limited funds and/or manpower
- **Simplified**: Requires little to no additional software writing for individual missions, making it simpler and more time-saving to use

technology opportunity

Applications

- **Oceanographic studies**: Control boats and buoys to map algal blooms, ocean currents, temperature, and other measurements
- **Unmanned space exploration**: Remotely operate satellites, rovers, robots, or other vehicles on the Moon, Mars, or possibly other planetary surfaces
- **Rescue missions on land or water**: Control robots seeking survivors in earthquake rubble, the aftermath of a hurricane or other storm, terrorist attack, or other disaster
- **Military**: Direct fleets of unmanned vehicles for missions in which human presence is too dangerous
- **Mining**: Manage fleets of robots or drills/mining machines for detection, mapping, and collection of coal, oil, and other natural resources
- **Topography**: Study topographic changes using fleets of mobile platforms, helping scientists understand the evolution of Earth's landscape

How It Works

Taking high-level input from a scientist or other user, ASF uses the input to define a goal and then autonomously accomplishes the goal by remotely controlling the fleet at its disposal. For example, a goal might be to map the extent of an ocean oil spill using a fleet of boats. Once the goal is entered into the simplified, Web-based interface, the system divides the work and directs each platform to its scientific target, autonomously changing directions as needed throughout the course of the study. Or the system might perform preprocessing on the initial science goal and return information that lets scientists know that the proposed study may not be feasible for any number of reasons (e.g., there are not enough platforms employed to carry out the requested measurements). Up-to-the-minute information about the test environment is displayed on a computer screen for scientists to view and evaluate. This environmental knowledge is stored in a database and displayed in standardized external forms. These could be in the form of nautical charts for oceanographic studies, remote sensed data from satellites or low-flying aircraft, or terrain maps for studies that need to avoid obstacles such as steep hills and holes. Once ASF begins executing the goal, the system uses this data retrieved from the platforms to "fill in the blanks" in the environmental knowledge and to build an internal science-data model.

Why ASF Is Better

ASF offers many advantages over other fleet-monitoring or -control software platforms. While many technologies offer only monitoring or control of a fleet of platforms, ASF offers both monitoring and control together in one software architecture. A major benefit of this feature is the ability to perform a widely varied collection of missions, ranging from simple monitoring of stationary environmental sensors through much more complicated missions involving the monitoring and control of mobile platforms in changing environmental conditions or scientific needs. In addition, unlike most other technologies available, the communication within the ASF system is centralized rather than distributed, enabling platforms to work in concert without communicating with each other and providing compatibility with both legacy and newer systems, further strengthening the technology's potential applications and enabling scientists to use ASF without first upgrading older systems.

One of the hallmarks of the ASF system, autonomous operation is also unique compared with most competing technologies. Little to no ongoing management of a scientific study is needed, making the software much more accessible for missions with limited financial and human resources. In addition, ASF employs sophisticated algorithms capable of taking an initial set of data regarding a scientific goal, automating a mission plan, and carrying it out. The robust nature of the software requires little to no additional software writing for individual missions, making it simple for even non-technical users. In contrast, most competing technologies require programming for either individual platforms or groups of platforms (or both) and may even require a dedicated network administrator to oversee the mission. Finally, ASF uniquely enables researchers to carefully plan missions using "what-if" scenarios that help determine the optimal path-planning technique and number of platforms to use, before committing resources to the project. Potential cost savings are inherent because researchers will avoid the errors of deploying more platforms than are necessary to complete the science goals.

For More Information

If you are interested in more information about this technology (GSC-15033-1), please contact:

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