LINCOLN LABORATORY
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Tech Notes

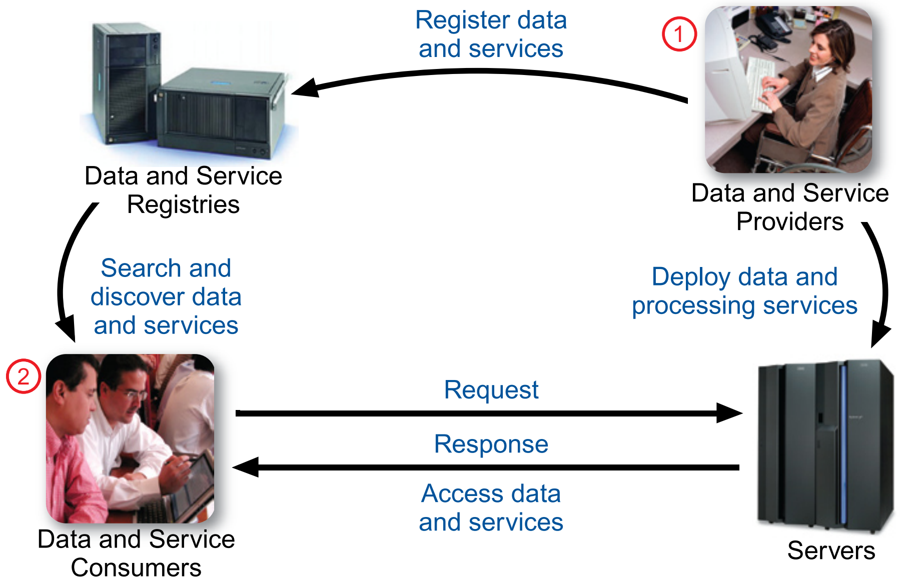
Extended Space Sensors Architecture

Lincoln Laboratory is demonstrating a service-oriented network architecture that enables the space community to share information and services from the varied systems of the Space Surveillance Network.

Since the first manmade satellites orbited the earth in the 1950s, space assets have become essential to national security. Satellites provide communications and navigation for military personnel. Naval strategists use satellite surveillance data to monitor ship movements, while meteorologists gather information relayed from space to track weather patterns. Both manned and unmanned exploration flights contribute to military scientists' understanding of space. To protect these assets from both natural and manmade harm, the United States first has to have an accurate picture of everything in space and what it is doing—i.e., space situational awareness.

In an SOA, data and service providers "register" their offerings in common online registries. Users in need of data or processing can perform a web search to find appropriate data and services.

MIT Lincoln Laboratory is working to provide an information technology structure to enable access to and distribution of space situational awareness data to the space community. Its Extended Space Sensors Architecture (ESSA) project is an Advanced Concept Technology Demonstration to explore the issues, highlight the benefits, and demonstrate the use of a service-oriented architecture (SOA) in support of space missions. In an SOA, data and service providers "register" their offerings in common online registries. Users in need of data or processing can perform a web search to find appropriate data and services. By visiting the referenced website, users obtain full instructions for how to automatically


Register data and services
1
Data and Service Registries
Data and Service Providers
Search and discover data and services
Deploy data and processing services
2
Request
Response
Access data and services
Data and Service Consumers
Servers

Service-oriented architectures make data and services readily available to both anticipated and unanticipated users by allowing providers (1) to register and post information and services that consumers (2) can search for and then access.

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request information or processing and a description of what exactly will be returned. Users can then configure their systems to access and use this information or processing. The loose coupling between providers and users, and the use of registries to advertise and discover capabilities, greatly facilitates integration of new value-added processing and services to the SOA.

The need for a structure such as ESSA is driven by the fact that the information technology infrastructure for the United States' array of sensors is still largely based in early 1980s technology. This infrastructure adequately accommodated space surveillance when it was simply concerned with tracking and cataloguing a small population of satellites. During the 1950s and 1960s, satellites were launched infrequently and had limited capabilities. However, over the years, as many countries established their presence in space, the space population grew to tens of thousands of objects, ranging from large payloads to microsatellites to debris. In response, the United States developed and deployed an array of sensors—radar and optical—to find, track, categorize, catalogue, and assess the status of satellites; yet, the technology used to distribute and integrate these sensors' data lagged behind.

Since users do not necessarily know when data will be available, and hence when to request it, a "pub-sub" (publish and subscribe) messaging service that publishes all new information to one of many "channels" to which users can subscribe is highly valuable.

Currently, the data produced by the Space Surveillance Network are largely routed point-to-point, hub and spoke, with bandwidths less than those of today's home Internet dial-up services. This structure limits access by users outside the conventional space community, as well as among the various mission areas within the space community, resulting in the underutilization of data. Furthermore, this network infrastructure can prevent utilization of space information in other mission areas. The existing architecture also impedes development and deployment of new capabilities by making it difficult not only to access and distribute information, but also to integrate data and processing into the current, sometimes proprietary, system.

The ESSA concept makes all domain-specific services available, but several common "core" services are also needed by all to make an SOA interoperable. In particular, since users do not necessarily know when data will be available, and hence when to request it, a "pub-sub" (publish and subscribe) messaging service that publishes all new information to one of many "channels" to which users can subscribe is highly valuable. All of these interactions must also be secure to protect Department of Defense (DoD) information. To enable network interoperability, a common security service is essential for avoiding the problem of different usernames, passwords, and policies for different websites/services.

The Defense Information Security Agency has initiated the Net-Centric Enterprise Services (NCES) program to provide the DoD with pub-sub, security, and other common services, as well as data, service, and user registries with which to instantiate SOAs.

In the ESSA SOA, Lincoln Laboratory has attached auxiliary computers (referred to as sidecars) to three operational Space Surveillance Network radars in the continental United States and the Marshall Islands, and has deployed three more sidecars—one to an operational optical site in New Mexico, another to a space assets ground station in Colorado, and a third to a DoD radar in Hawaii. The system in Hawaii is included to demonstrate cross-mission asset interoperability.

New data from any of these systems are published to one of the NCES messaging channels. Data are also archived by these sidecars and are searchable and retrievable by users after the fact. The Laboratory has similarly tapped two processing facilities: the Space Defense Operations Center, which publishes high-level space situational awareness information such as satellite launch, decay, maneuver, and orbital element sets information; and the Lexington Space Situational Awareness Center (LSSAC) in Massachusetts. The LSSAC hosts a number of services that can be used by clients in the SOA, including satellite status, satellite viewing, threat assessment, and conjunction predictions (satellite close approaches), and change detection information. All channels and services are protected via NCES security.

The ESSA effort is demonstrating the ability to deliver space situational awareness information and capabilities that were not previously available to the space community or to other DoD users. It is likewise illuminating networking infrastructure, core service, and policy and procedure issues that will need to be addressed in the future to support operational SOAs. ■

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