Enhancing Interoperability through Open Systems Architecture

By Joseph Norton

A constantly changing technology landscape and expectations to adapt and innovate quickly make it challenging to acquire, integrate, and upgrade fielded systems, especially in the current economic environment. Highly integrated systems are often proprietary and vendor locked, expensive, and difficult to upgrade with emerging technology. A strategy for overcoming these challenges is to design highly interoperable systems. This means enabling systems or components to exchange services and information through seamless, end-to-end connectivity. This article describes how open systems architecture (OSA) leverages reusable components, well-defined interfaces, and standard interface specifications to enhance system interoperability. This article also discusses design principles for implementing OSA to enhance interoperability.

Open Systems Architecture—An Overview

OSA is an integrated business and technical approach to acquire and assemble interoperablecomponents using modular systems design. The business strategy is to drive down costs, enable systems to easily adapt to changing business needs, and increase the number of available vendors to create competition-driven product lines. The technical approach decomposes systems into components that interact through key interfaces according to formal specifications.

OSA aims to enhance interoperability by realizing the following benefits:

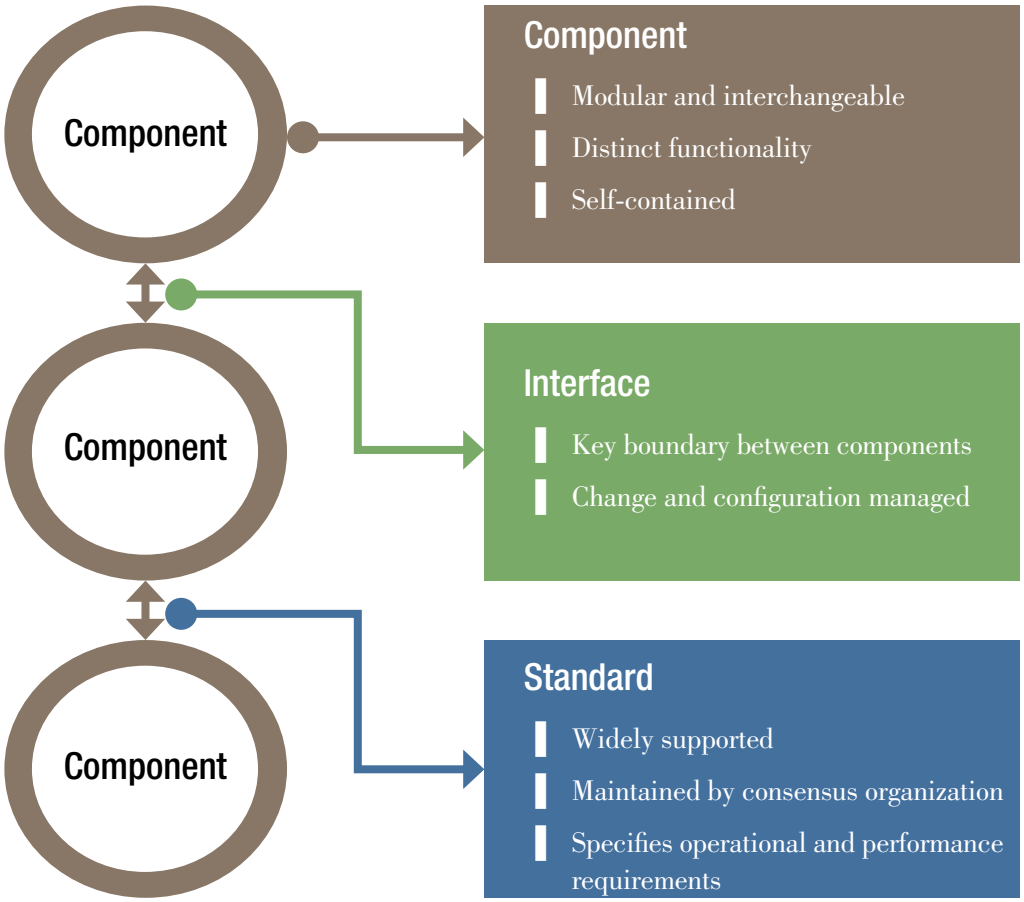
- Increased flexibility in vendor selection fostered by competitive marketplaces
- Interchangeable components to simplify maintenance, upgrades, and technology insertion
- Greater accessibility to innovative technology
- Shortened design times and streamlined development processes
- Improved information sharing and data quality
- Reduced total cost of ownership.

OSA applies to all types of systems. Although some of its most familiar uses are in computers, software, and electronics, this approach applies to other areas, such as communications, electricity production and use, and the design of weapons, vehicles, and artillery for armed forces. Computer networks are tightly integrated systems that employ standard hardware, such as cables, routers, and servers. This hardware uses standard protocol to enable devices and machines to communicate and exchange information. With constantly changing operational needs for new weapons and armor, the armed forces use a similar approach to enhance interoperability in military vehicles. By developing standard electronic platforms and mounting systems, military vehicles can quickly access electronic and information assets and introduce new weapon and sensor capabilities.

Components, Interfaces, and Standards

OSA abstracts systems into three key elements: components, interfaces, and standards. Figure 1 describes these elements and their characteristics. These are generic to any system and span several dimensions of interoperability, including technical, informational, and organizational. This involves the physical connections and communications between components, their information flows, and relationships between people and organizations.

Figure 1. Elements of Open Systems Architecture



Components are the physical modules of a system. Each component has distinct functionality and operates independently and with limited impact on the rest of the system. This decouples the components from each other and makes it possible to interchange units provided by alternate vendors. The desired functionality and inner workings of components may also vary across vendors.

Interfaces define the key boundaries between components and how they interact. The types of interfaces depend on the physical connections, information, or services the components need to exchange. Interfaces should be standardized, change and configuration managed, and publicly available.

Standards define the specifications for how components interact through defined interfaces. These include operational and performance requirements, such as security, reliability, and maintainability, that describe how an interface should perform. Standards should be managed by consensus groups and widely accepted to ensure they meet the requirements across all systems.

Design Principles to Ensure Interoperability

OSA considers interoperability through the entire life cycle of a system. A program must design its systems to be interoperable from the time it acquires and defines its components, interfaces, and standards through the time when those systems become operational and eventually are decommissioned. Several critical success factors contribute to successfully implementing OSA principles:

- Firm commitments and well-defined governance
- Available, reliable, and economical components
- Controlled interfaces
- Mature standards.

Firm Commitments and Well-Defined Governance

Interoperability requires cooperation. The programs and involved systems should be dedicated to an enterprise-wide strategy to implement and realize the benefits of OSA. This includes developing a strategic sourcing approach for acquiring system components, contributing to the ongoing development of open standards to meet business and system requirements, and providing guidance and oversight to align systems to OSA principles. Political and financial support from program offices, project managers, and senior managers who understand the long-term benefits of OSA are crucial to its successful implementation.

A program implementing an OSA system should establish enterprise governance through policy, guidance, and enterprise planning to develop and maintain its systems. Interdisciplinary practices, such as systems engineering and enterprise architecture, enable organizations to manage system complexity and align resources with an OSA strategy.

Organizations should establish governing bodies supported by communities of interest and working groups or committees to oversee design and implementation, champion enterprise-wide adoption, and assess benefits realization. Governing bodies should make funding and approval decisions for systems to proceed through key life-cycle milestones.

Available, Reliable, and Economical Components

OSA focuses on decomposing systems into modular components. In order for these components to be interoperable, easily upgraded, and maintained, there must be a broad range of components that meet the functional and performance requirements of a system. The specifications for components must be formal and publicly available to encourage broad commercial support. This will allow a number of vendors to produce the same or similar components with standardized functionality. This will also promote competition between vendors to produce usable, reliable, and economical components and to incentivize productivity and innovation.

Controlled Interfaces

Controlled and consistent interfaces enhance the interoperability of components. Interfaces should be controlled, monitored, and published to clearly and fully define all inputs and outputs of a component. Interfaces separate the functionality of each component and define the requirements that interface standards need to support. By monitoring the number of interfaces within a system, their rate of change, and their conformance with standards, a program will be able to assess the openness, interoperability, and affordability of a system over time.

Mature Standards

To mitigate the risks associated with enhancing interoperability, systems should use standards that are well-developed and stable and that have achieved widespread adoption by industry. This will ensure that interfaces meet current industry-wide operational and performance requirements, adapt to changes due to emerging technology or innovation, and are published. Programs should participate in standards development to ensure that their adopted standards continue to meet their business and technical requirements.

Standards organizations often manage the overall production and evolution of mature standards among a wide base of adopters. These organizations benefit from collaborative participation from industry, universities, and government to develop robust and comprehensive interface specifications. Well-known standards organizations such as the ISO, International Electrotechnical Commission, and International Telecommunication Union have developed standards for all types of interfaces, including physical, data, network, and applications. These standards support various OSA-based approaches, such as the Open Systems Interconnection (OSI) model and service-oriented architectures. Consistent with an OSA approach, OSI decomposes communications systems into functional layers where components within each layer interact through well-defined protocols. Similarly, service-oriented archi-

tectures separate software systems into loosely coupled pieces of software that communicate using standard web-based services and that can be published and discovered. In both cases, mature standards enable interoperable machine-to-machine interaction over a network.

Summary

OSA decomposes systems into components, interfaces, and standards to enhance interoperability. As long as the interfaces are fully defined and there are mature standards to govern them, system owners can interchange components with the same or similar ones. OSA overcomes the challenges of highly integrated, proprietary systems by using a modular architecture that allows commercial companies to build systems or subsystems to common industry specifications. This enables organizations to directly impact the interoperability, supportability, and affordability of their systems.

About the Author

Joseph Norton is an enterprise architect with LMI. He manages systems engineering and information technology projects, with a focus on facilitating enterprise architecture development and adoption within the federal government.