Position Paper: Enabling Service Oriented Architectures for Disadvantaged Users

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Introduction

Service Oriented Architectures (SOAs) hold promise of providing loosely-coupled software components that are self-describing, communicate via messaging, and can be composed into operational threads to fulfill a particular mission or business need. However, many current SOA approaches, specifications and implementations require the availability of high throughput networks with plentiful resources that are consistently available. The current methods of SOA development may not provide reliable capabilities to disadvantaged users, where resources and communications are often constrained. One of the key challenges to supporting these disadvantaged users is to provide them with SOA-based capabilities that function properly in the environment in which they operate. The role of SOAs to fulfill their information sharing needs is largely unexplored.

While much of the use cases presented in this paper focus on the tactical edge within the DoD, there are commercial examples that reveal similar issues, e.g. field support/sales operations, medical support "in the field", mobile cell phone users, and embedded devices.

Background and Use Cases

Tactical edge or disadvantaged users are often characterized as mobile, intermittently connected, and working under constrained resources. Furthermore, they serve as direct effectors and/or sensors of a military operation in the immediate line of fire. At the tactical edge, users often work in small teams within local enclaves and operate within a focused area of interest. Teams include not only Warfighters, but also weather forecasters, lawyers, and others where each team member may require access to different types of data. In one instance, tactical users retrieve up-to-date data, to make critical decisions (e.g., weapons release). In another instance, tactical users submit or provide tactical information to strategic data centers. Both modes of interactions require the use of shared communication infrastructures that are being made available to various tactical team members in accordance with a prioritization scheme.

Tactical environments may consist of airborne platforms, manned and unmanned vehicles, ground sensors, and maritime platforms. Generally, these edge users are viewed across a number of dimensions (Figure 1), in terms of their:

- Resource availability (processing, storage, and power)
- Network connectivity (intermittently connected, latency, bandwidth)
- Information assurance (encryption, access control, accountability)
- Data characteristics (type, size, frequency, structure)
- Data exchange patterns, e.g. data dissemination among producers and consumers such as one-to-many and many-to-many.

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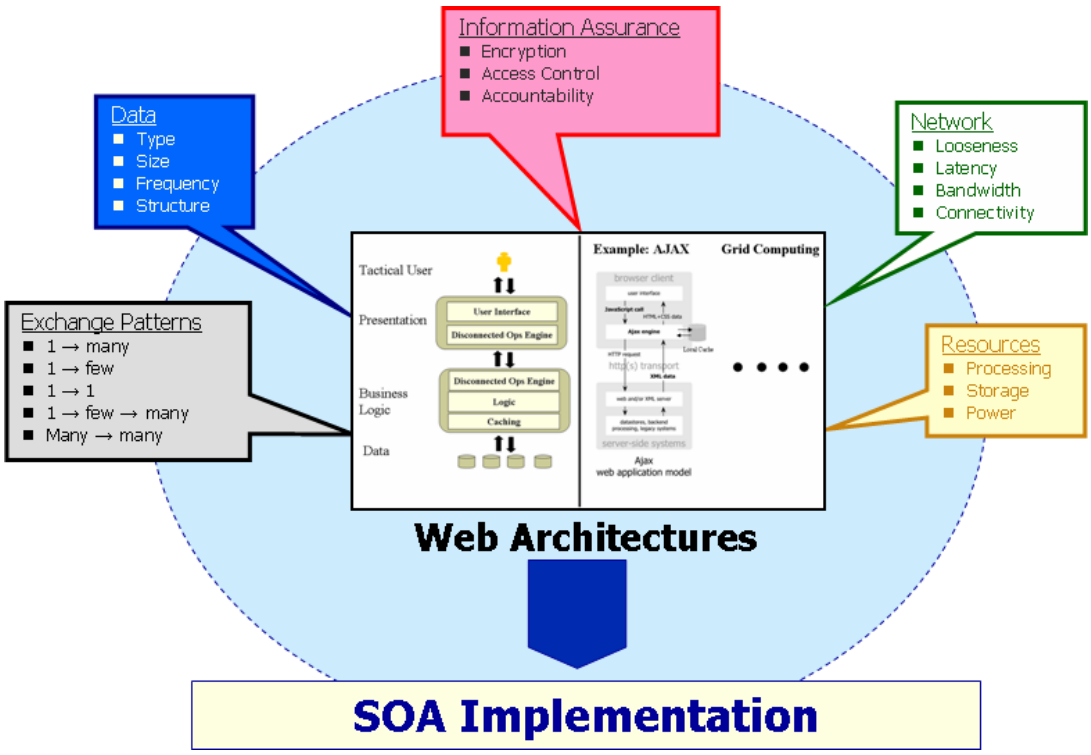

Figure 1. Dimensions of information sharing environment at the tactical edge

Thus, the tactical edge has the following characteristics which are important to consider in web architecture and standard definitions:

- Tactical edge infrastructure needs to provide varying quality of service for different users.

- Communication and computing infrastructure is shared and not dedicated. That is, the tactical users cannot simply buy a dedicated T1 in order to accommodate increased traffic.

- An application cannot assume immediate access to the network. Intermittent to no connectivity is often a reality in tactical environments. This is not the case within many highly connected commercial applications.

- Data presented to tactical users is often pre-processed, customized for the end consumer, and of actionable quality.

SOA approaches adopted by the commercial world need to be evaluated for the tactical environments. Constraints presented within tactical environments require specialized specifications and solutions, different than those currently developed for typical, resource-rich commercial environments. Such specialized needs must be further identified and addressed to realize SOA at the tactical edge.

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Recommendations for the W3C

The W3C should consider standardizing specifications that define Web architectures and Web systems operating within or interacting with tactical edge environments or similarly restricted environments or users. Although our investigation is in its early stages, representative examples of recommendations to the W3C might include:

- Web clients that support asynchronous operation (e.g. Ajax) work effectively in disadvantaged environments. The automatic refreshing of web pages reduces the number of round trips needed to achieve a particular functionality. Standardization to support this class of interfaces is important.

- Replication of services supporting multiple modalities, and the synchronization of the services is important within tactical environments. As an example, consider an employee that uses Microsoft Outlook to receive and send e-mails when he is in his office. When the same employee is on the road, however, a web-based email client, PDA or phone can be used for a similar purpose. Synchronization across these devices and underlying services is important. Often, technologies in application delivery and virtualization are at the heart of these solutions.

- Embedding of metadata (e.g. quality of service) in web pages (e.g. using HTML 4.1), imagery, video, and other types of textual and non textual data is useful for effective data prioritization, dissemination and consumption at the tactical edge.

- Optimization of data exchange via compression and caching techniques will facilitate information exchange across the tactical edge. Web architectures to support use of these technologies will be valuable to ensure efficient information exchange within constrained environments.

- Enhancing architectures for authentication, encryption, policy enforcement and policy decisions that work effectively in tactical edge environment are important for managing mission-sensitive information.

As we continue our investigations, these recommendations will continue to evolve as we gain more experience in applying existing standards to the tactical edge problemspace.

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