Bilateral Interoperability Through Enterprise Architecture

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Abstract

This paper will address the important role of architecture planning for ensuring system interoperability in a network-centric coalition environment. As US forces become more dependent upon coalition partners to support crises around the globe, systems interoperability becomes a major concern. This problem is more acute in the Pacific theater, where the US has no equivalent to NATO to address such issues. In the Pacific, the US has numerous bilateral agreements with allied nations and as such the degree of interoperability varies from country to country. A key to understanding interoperability shortfalls is documenting the "as is" architecture for each primary allied nation to facilitate identification of key information exchange requirements for critical command and control nodes.

The importance of enterprise architecture planning should not be downplayed. Enterprise architecture planning considers both the tactical and strategic need for information exchange in supporting the organization's mission [Spewak 92]. This is especially true with the plethora of C4ISR systems scattered throughout the US Pacific Command (USPACOM) theater of operations where access to secure, quality data is vital to ongoing operations.

Headquarters (HQ) US Pacific Command (USPACOM) recognized the need for documenting baseline architectures with the publication of US Commander in Chief, Pacific (USCINCPAC) Instruction 2010-4 [USCINCPACINST 2010-4]. This instruction provided guidance to component commands on how to describe and construct systems and operational architectures. The Joint Forces Program Office was asked to assist with this effort at Alaska Command (ALCOM) in the fall of 1999. The ALCOM architecture study, using a prototype version of the Joint C4I Architecture Planning System (JCAPS), illustrated the utility of having a clearer picture of the enterprise architecture described in common lexicon. With this information, the CIO can make more informed decisions concerning resource requirements and contingency planning, to ensure information technology adequately supports Alaskan Command's mission threads.

Another result of the Alaskan Command study was the need to consolidate the numerous architectures that have been developed in recent years. Documentation of various architectures already exist to some extent--having been produced by the Intelligence Directorate (J2), the Operations Directorate (J3), the

Communications Directorate (J6) and other supporting organizations. These independent, non-collaborative efforts have resulted in information resources that often are of little use and are, consequently, shelfware. During a survey at HQ USPACOM conducted by a CINC Interoperability / Joint Forces Program Office team on 1 March 2000, approximately sixteen documented or ongoing architecture efforts were revealed across the J2, J3, and J6. Each effort is separate and distinct. No centralized data repository exists. The existence of a relational architecture database that could be easily updated, maintained and reused would reduce repeated duplication of efforts and multiple data requests and improve contingency and resource planning and allocations.

What are the implications of understanding the Enterprise Architecture for Joint/Coalition interoperability? Enterprise architecture provides a top-level model of how information flows across the organizations within the enterprise domain. It identifies the key nodes, potential constraints, and may identify duplication of efforts. It is a cornerstone to integrating or updating technologies and understanding what data is needed where and when. [Spewak 92]

This paper will discuss the application of commercial best practices into the development of military C4ISR architectures and the effective consolidation of existing C4ISR architectures.

The Challenge

Since the end of the Cold War, there has been a significant reduction in the ranks of the US military. US presence overseas has also been greatly reduced. Yet, the operations tempo has increased during the last decade with the US involved in numerous peacekeeping missions and humanitarian and regional conflicts. These joint operations have also included allies and coalition partners. In today's environment, with US forces stretched thin, any crisis will demand US and Allied coalitions. Recent coalition operations have revealed interoperability shortfalls and lack of C4ISR and logistic systems synergies. These shortfalls impede the ability of joint US and coalition warriors to effectively and efficiently use all available information systems to perform the assigned missions, be they major regional conflicts, peacekeeping missions or humanitarian relief. Some suggest that the US work their own inter-service interoperability challenges first and foremost before engaging with its principle allies. This would be a serious mistake. Working US interoperability issues without addressing principal Allied force interoperability would only further exacerbate the capabilities gap. In order to understand the magnitude of the interoperability issues, consider viewing the C4ISR domain in terms of the enterprise architecture.

Enterprise Architecture

What is enterprise architecture? The DoD C4ISR Architecture Framework document describes architecture as a "mechanism for understanding and managing complexity." [C4ISR 97] David Sims of SharpAngle.Com, states, "Enterprise architecture provides the underlying framework, which defines and describes the platform required by the enterprise to attain its objectives and achieve its vision." [Sims 00] The enterprise architecture consists of four interrelated views: Information, Business, Application, and Technology.

The information architecture consists of data models and databases that serve all that have access within the business domain. This suggests a universal common database exists that is the shared, distributed, accurate, and consistent data resource. The data providers of this repository ensure the quality of the information made available.

The business architecture represents the business processes. In a military vernacular, the business architecture describes the operational functions or what activities or tasks must be performed. Roger Founier of *Information Week* describes the application architecture as the core business applications

required to enable business process to successfully run the business enterprise [Sims 00]. It also assesses the health of current applications and forecasts new ones to satisfy future business needs.

The technology architecture describes the hardware platforms which link up the application, business and information architectures to provide interoperable systems that meets the needs of the users through out the business domain.

The META Group has projected that architecture enterprise planning and analysis is a growth industry. Their forecast in this discipline includes the following:

> *Through 2005, the primary business drivers for enterprise architecture will be: 1) right sourcing business components via disaggregation ...(i.e., corporate agility); 2) delivering customer intimacy and erecting exit barriers within a customer life-cycle management strategy; and 3) driving information value creation* [Meta 00].

The problem of network aggregation/deaggregation is one that parallels the military need for rapidly changing command organizations that can add or subtract command levels based on the current situation. For a detailed discussion of the aggregation/deaggregation problem, see [Hamilton, Nash and Pooch 97].

Results of the US Alaskan Command Architecture Effort

When discussing enterprise architecture, it is instructive to consider what can be learned by actually constructing an architecture. In late 1999, the Joint Forces Program Office undertook the construction of a baseline, "as-is" architecture at US Alaskan Command (USALCOM). This project supported both USPACOM, as the first project to attempt execution of their new architecture generation instruction [USCINCPACINST 2010-4]; and US Joint Forces Command (USJFCOM), who was interested in the feasibility of theatre architecture development. Among other goals, the project provided a "live-fire test" for the then-current prototype of the Joint C4I Architecture Planning System (JCAPS) tool.

This effort was very carefully scoped, to include only the systems in the USALCOM headquarters – about 100 systems. Despite this limited scope, the effort took around 2100 staff-hours – more than a full staff year – to complete. A closer examination of how the time was spent will show some clear benefits to an enterprise architecture approach. The methodology that was followed is shown in Figure 1, with the number of staff-hours spent on each task in the lower right hand corner of each block.

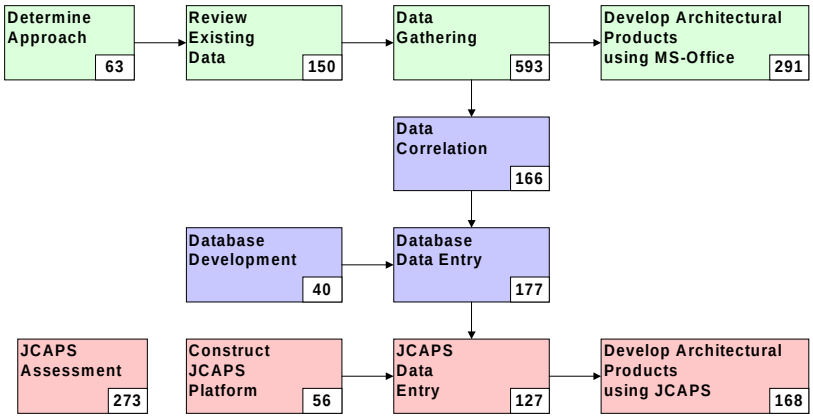

Figure 1. ALCOM Architecture Methodology and Levels of Effort

First, the review of existing documentation and the data gathering took almost 750 staff-hours. This extremely laborious and time consuming process included collection and review of fragmented, uncorrelated, uncoordinated depictions of system connectivity for the system views, as well as interviews of operators about how they accomplished their missions for the operational views. Considering the large amount of time invested in this step, it is no wonder that architectures have been difficult to document.

An enterprise approach to architecture planning would help mitigate this level of effort. By integrating the collection and maintenance of architectural information into existing business processes, the experts' knowledge can be captured in a way that is usable not just by them, but by others. Rather than having a specialized "architecture" group gather data from the experts, the experts themselves can maintain the data. By providing a uniform tool for this across the enterprise, experts can team and share knowledge more effectively. This might ultimately result in a reduction in effort across the organization by making key information more readily accessible – in contrast to the high cost of collection observed when the generation of the architecture was completely decoupled from the business process.

Another key indicator in terms of level-of-effort was the amount of time required to perform data correlation. Multiple data sources had to be reconciled and fused in order to produce a coherent, consistent set of architectural data. This process, including the development of a lightweight tool to support it, took nearly 400 staff hours. There are several systemic issues that lead to such a high cost here – the existence of overlapping and uncoordinated data sources was only aggravated by the absence of common terms of reference and means of representation. Not only were there multiple sources of data (which did not necessarily agree on *what* they said), but the sources each said the same things in different ways. Even when they were in agreement, the data would often have to be repackaged into a form that would be consistent across the enterprise.

We can examine how an enterprise approach to architecture might have reduced some of this cost. Rather than generating several sets of node connectivity diagrams in several different applications for different purposes, all node connectivity data would be captured in the same data source. By understanding how the organization would use this sort of data – the elusive "so what?" of architecture – the right data can be captured. An agreement across the organization can be reached that will allow data compiled by different users to be used together to make decisions, without having to go through the time-consuming and complex cost of comparing data that is represented differently. Thus, the investment in standardization at the enterprise level pays off by allowing the organization to leverage the data embedded throughout the organization.

Finally, we can consider the amount of time constructing products. As summarized in Figure 2, two sets of products were generated in this effort – one in JCAPS and another in PowerPoint. A significant amount of time was spent in product generation after the data had been entered. It took nearly 300 staff-hours to generate the PowerPoint products, and while the time required to generate the JCAPS products from the data was less – about 170 staff-hours – the generation of these products was made somewhat easier by the presence of the first set. It is hoped that, in the future, better tools can reduce this time.

Again, however, we see a clear advantage to employing an enterprise architecture strategy. This effort was geared toward producing the *products* specified in the USCINCPAC instruction, rather than contributing to a shared, dynamic enterprise architecture. By embedding the *data* and the use of that data into the business processes of the organization, the demand for (static) products is reduced, if not eliminated.

Applicable Architecture Product	Product Reference	Architecture Product	Essential or Supporting	General Nature
Operational	OV-1	High-level Operational Concept Graphic	**Essential**	High-level graphical description of operational concept (high-level organizations, missions, geographic configuration, connectivity, etc.)
Operational	OV-2	Operational Node Connectivity Diagram	**Essential**	Operational nodes, activities performed at each node, connectivities & information flow between nodes
Operational	OV-3	Operational Information Exchange Matrix	**Essential**	Information exchanged between nodes and the relevant attributes of that exchange such as media, quality, quantity and the level of interoperability required
Operational	OV-4	Command Relationships Chart	Supporting	Command, control, coordination relationships among organizations
Systems	SV-1	System Interface Description	**Essential**	Identification of systems and system components and their interfaces, within and between nodes
Systems	SV-2	Systems Communication Description	Supporting	Physical nodes and their related communications laydowns

Figure 2. Architecture products for Framework 2.0 supported by JCAPS Version 2.0 R14

Ultimately, the investment in architecture development must yield returns if it is to be continued throughout the enterprise. Looking through the perfect lens of hindsight at the architecture developed for USALCOM, we see that its utility is directly related to a set of well-defined goals or objectives for the use of the architecture. Perhaps the most important lesson learned from the ALCOM effort was that these goals must come first and be used to drive what data is collected. A clear understanding of the need for and uses of an architecture is required in order to ensure a favorable return on investment. In a nutshell, this is the purpose of the enterprise architecture strategy.

Architecture Consolidation:

During the ALCOM Architecture outbrief to the USPACOM J6, it was suggested that all of HQ USPACOM's architecture data should reside in one repository (the "Holy Grail" as then-USPACOM-J6 BG Byran described it) in order that the data can be readily accessed, centrally managed, updated and reused. In order to determine the organization's "as-is" architecture baseline, one should consider collecting, deconflicting, and normalizing all existing architecture data that has been accomplished previously.

Various architectures already exist to some extent--having been produced by J2, J3, J6 and other supporting organizations. These independent, non-collaborative efforts have resulted in information resources that often are of little use and are consequently shelfware. A cursory review during the 1 Mar 2000 visit to HQ USPACOM by the CINC Interoperability / Joint Program Office team revealed approximately 16 documented or ongoing architecture efforts across the J2, J3, and J6. Each effort is separate and distinct. No centralized data repository exists for the data collected. A relational architecture database that can be easily updated, maintained and reused would reduce repeated duplication of efforts and multiple data requests and improve resource planning and allocations. A proposed methodology for executing architecture consolidation in the JCAPS relational database is shown in Figure 3.

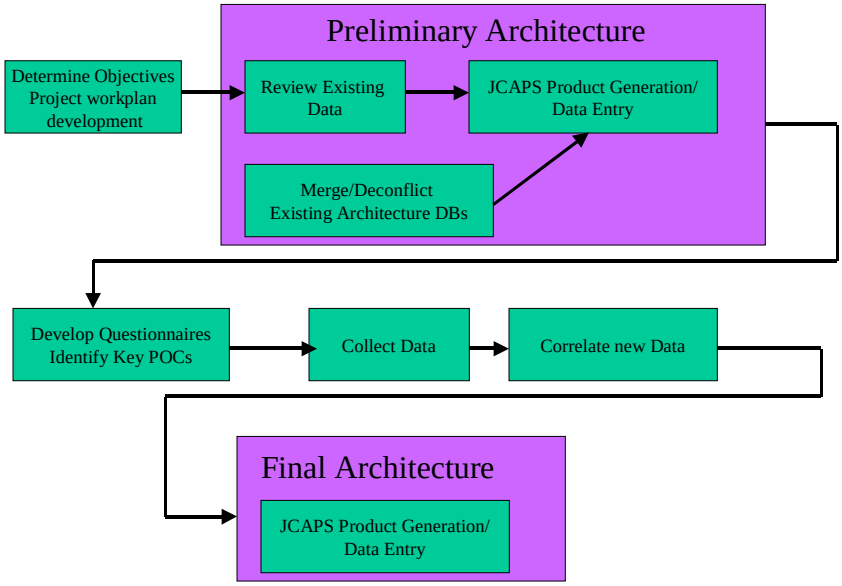

Figure 3. Proposed Methodology for Executing Architecture Consolidation in JCAPS.

In addition, by consolidating existing architecture data, a clearly defined enterprise architecture advances C2 capability through enhanced integration of C4ISR architectures. This in turn promotes alignment of Joint and Service force modernization initiatives with concept of operations and joint war fighting doctrine. Consolidating existing architectures also provides a vehicle to highlight potential interoperability shortfalls within the enterprise domain.

Developing the enterprise architecture is no small task. Ample resources should be made available for such an undertaking, as well as strong management support [Spewak 92]. Consolidation of existing architecture data is the cornerstone to developing the enterprise architecture. Consolidation and integration of existing and ongoing C4ISR architecture efforts into a single reusable and maintainable data repository can be accomplished in three steps. First, decompose existing architectural threads into constituent objects. Then, deconflict instances of objects within each class, predicated upon a configuration management and confliction resolution process. This is the most tedious part of the consolidation activity, as it requires much analysis and is database-query-intensive. Third, reconstruct the architectural thread using normalized objects. This is the result of the deconfliction process as shown in Figure 4. A configuration control and maintenance process is required to ensure data integrity upon

completion of consolidation efforts. This task may be delegated based on the data owner, type, location, organization or any combination thereof. [Manley 00]

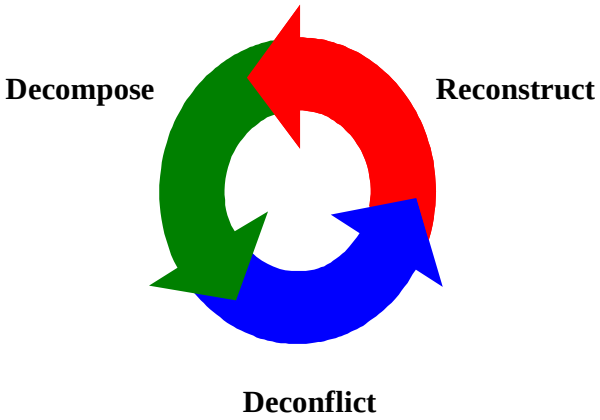

Figure 4. Architecture Consolidation Methodology [Manley 00].

By consolidating the existing architecture data, a collective understanding of what is "built to date" is established. This will illuminate areas that require further development within the enterprise domain and provide a launching point for assessing baseline requirements through gap analysis. The organization, then, can prioritize follow-on efforts to fill in the architecture gaps. The impact in a joint coalition environment is profound. Understanding the enterprise architecture is vital to coalition forces ability to effectively operate in a plug and play environment.

Implications For Coalition Interoperability

C4ISR architecture development and implementation is complicated when the systems belong to different services and nations. Combined interoperability – that is, interoperability between different services from different nations – is challenging. Sustained interoperability cuts across two dimensions: laterally between countries and horizontally over time. The essential starting point for combined C4 planners is the existing communications architecture. Common architecture formats greatly expedite combined C4 planning. This is particularly obvious in operational architecture planning for US Forces, and there is no reason to think that resolving differing architecture formats would be any easier in a combined operation.

Conclusions.

In this paper, the authors have outlined a practical strategy for consolidating existing C4ISR architectures. Using our practical architectural success in the US Alaskan Command, we suggest that this methodology can be applied across large, combined, theaters of operation. Our recommendation to USPACOM is to evaluate this premise by implementing an enterprise architecture with a coalition partner. We envision such an evaluation to be a JCAPS-based effort similar in size and scope to the US Alaska Command architecture effort. Such a development would provide practical coalition C4 architecture planning benchmarks.

References:

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