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Conceptual Application of the Madewell Metric Framework for Acquisition Intelligence in DOD Open System Architectures

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Abstract: **With the issuance of Better Buying Power 1.0 and 2.0, open system architectures have become a necessity and a requirement for all new architecture programs. With this new requirement comes the need to identify key components of the architecture which are worthy of having the technical data rights or licenses acquired by the Department of Defense for the open system architecture. The need for a method to identify key components has been communicated by multiple authors since the issuance of Better Buying Power. The benefits of open system architectures have also been thoroughly communicated by multiple authors so are not covered here. This paper discusses a novel metric framework used to intelligently identifying key components of open system architectures. The operation of this metric framework is exposed using conceptual illustration.**

Keywords: **Open System Architecture, Non-Proprietary, Vendor Lock, Data Rights, Acquisition.**

1. INTRODUCTION

Background:

In 1999 (Gillis), the Department of Defense (DOD) mandated in Defense Regulation 5000-2R that program managers in major defense acquisition programs and major automated information system acquisitions must give consideration to open systems during the program planning and systems engineering phases. In 2009, Congress passed unanimously and with relative speed the Weapons Systems Acquisition Reform Act of 2009 (WSARA) (Winborne, 2010). WSARA requires acquisition strategies for major defense acquisition programs to include "measures to ensure competition" (Winborne, 2010, p.3). Along with WSARA, in 2010 the DOD greatly increased the significance and requirements for open system architectures and networks. In September of 2010, Dr. Ashton B. Carter (then the Under Secretary of Defense for Acquisition, Technology, and Logistics) outlined in an official memorandum the 23 principals to improve efficiency of the DOD (Carter, 2010). The title of this memo was, *Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending*. One of the 23 principals included was to promote real competition. Dr. Carter (2010, pp. 9) stated in his memo that he, "requires all program managers within the Department of Defense to present a competition strategy at each acquisition milestone." Included in that competition strategy was a new requirement for open system architectures and set rules for acquisition of technical data rights or licenses.

In support of this new mandate, the DOD wrote and published the *Open Systems Architecture Contract Guidebook for Program Managers* (Department of Defense Open Systems Architecture Data Rights Team, 2011). In this guidebook was the requirement that all new architecture programs be procured as open systems architectures. This new requirement for open system architectures drastically changed the way that the DOD procures computer networks, architectures, and components. To further solidify the new requirement, in November of 2012, Frank Kendall published the memo with the title, *Better Buying Power 2.0: Continuing the Pursuit for Greater Efficiency and Productivity in Defense Spending* (Kendall, 2012). In his memo, he outlined 36 initiatives to improve defense spending efficiency. Mr. Kendall's memo included as one of the initiatives to promote effective competition. Within that initiative, Mr. Kendall's (2012, pp. 2) requirements were even more strongly worded as, "emphasize competition strategies and creating and maintaining competitive environments as well as *enforce* open system architectures and effectively manage technical data rights." The idea of open systems architectures had been reality in DOD procurements in the recent past but become a mandated requirement at this point. With this new reality came the need to develop metrics and methods to provide a means of comparing and identifying key processor component technologies for potential acquisition of technical data rights or licenses.

Key Terms:

The definitions to follow are the definitions of terms used for the purpose of conducting and illustrating this framework only and are opinion based on the references. They should by no means be taken as the legal definition. For legal definitions of terms, please seek the advice of an attorney.

Component is a subsystem (of architecture), assembly, subassembly, or other major element of an end item (Department of Defense Open Systems Architecture Data Rights Team, 2011). For the purpose of this research, component means the item for which the data rights or licenses that needs to be procured and owned by the government. It includes hardware, software, firmware, or a combination thereof.

Data rights refer to the rights given by the vendor to the customer for the use and maintenance of products or services given. Under the defense acquisition system, the program manager must ensure that all data and software required to successfully procure and sustain the network is available throughout the life-cycle of the product. This includes product definition, materials, parts information, product operational information, software, and associated information needed to competitively sustain the product throughout the life-cycle. The two major statutory categories for data rights are "technical data" and "computer software". Technical data includes: product data and documentation, computer software documentation, and computer data bases. Computer software data includes: computer programs, source code, code listings, object code listings, design details, algorithms, processes, flow charts, formulae, and related material that would enable the software to be reproduced, recreated, or recompiled. For a system to be an "open system" the DOD must have either unlimited or government-purpose rights. "Unlimited rights" means that the DOD has the right to use, modify, reproduce, perform, display, release, or disclose data in any manner, and for any purpose whatsoever, and to have or authorize others to do so. "Government purpose rights" is a middle path unique to DOD contracts. They offer a way for contractors to exploit intellectual property commercially for a limited time. The standard time is five years after which the government receives unlimited rights. During this time, the DOD gets the benefit of the intellectual property paid for by the vendor but the vendor retains the rights until the time limit is reached. This protects the vendor's investment but allows the government to get immediate benefits (Department of Defense Open Systems Architecture Data Rights Team, 2011).

Intellectual property is products or designs that a vendor has provided the funds to produce. The vendor holds all the rights to the product or design. The license rights are defined as being one-hundred percent privately owned by the vendor. The vendor can, although, give limited or restricted rights to the DOD. Limited rights given to the DOD means that the government may use the data within the government but not release the technical data outside the government except if necessary for emergency repair or overhaul. The DOD may not use data for manufacturing additional quantities of the item. Restricted data rights means that the DOD may only run the software on one computer at a time, may make only the minimum copies needed for backup, but may make modifications to the software. The software may not be released outside the government except for emergency repair or overhaul (Department of Defense Open Systems Architecture Data Rights Team, 2011).

Non-proprietary means that the products are not owned by the vendor nor are they vendor-specific. Non-proprietary means that the design is not locked-in by any one vendor and can be bid out to competing vendors as the DOD deems necessary. Proprietary systems are those in which the vendor owns the license and data rights. Non-proprietary is the opposite of proprietary. Non-proprietary systems are therefore synonymous with open systems (Department of Defense Open Systems Architecture Data Rights Team, 2011).

Open or Openness refers to an attribute of an architecture, network, or component to allow for additions, modifications, replacements, removals, or support by any vendor the DOD gives a contract to throughout the life-cycle of the product. Openness also refers to the rights given to the DOD to use, modify, reproduce, perform, display, release, or disclose data in any manner, and for any purpose whatsoever, and to have or authorize others to do so (Department of Defense Open Systems Architecture Data Rights Team, 2011). The concept of using a modular and layered approach in software development is also a form of openness. In software development, an open system interconnection stack is commonly made up of layers with each layer having a specific function. For software in open system architectures, middleware commonly separates the applications from the other layers. The middleware layer allows higher level inputs to the application which in turn functions with the lower level layers through middleware. Software within a key component of the open system architecture should exhibit this modular and layered approach to development.

Vendor-lock is a situation where acquisition choices are limited and a government organization becomes dependent on a single manufacturer or supplier for the product(s) and or service(s). The government organization cannot compete the associated work out to another vendor without unacceptable costs and or inconvenience (Department of Defense Open Systems Architecture Data Rights Team, 2011).

Overview of this Paper:

The following sections of this paper will briefly address the related works then give an overview of the methodology used for this research. After that, the concept will be illustrated in the results and discussion section. Finally, a summary of the paper, the value of the metric framework, and potential future works will be discussed.

2. RELATED WORKS

Past works on the subject of benefits of open system architectures are plentiful. The subject of consensus of the benefits of open system architectures includes vast amounts of evidence that there are clear benefits in using open system architectures. Among the most prominent benefits of open system architectures which are outlined well by these past authors are: tends to reduce total cost over the life-cycle of the program (Rendon, 2007), prevents vendor-lock (Department of Defense Open System Architecture Data Rights Team, 2011), promotes competition (Open Systems Joint Task Force, 2004), provides stable interfaces and frameworks (Obendorf, 1998), and enables the field of diminishing manufacturing sources to better implement new technologies and handle obsolescence (Livingston, 2000). These benefits tend to make open system architectures very desirable for future programs.

In the area of analysis of architectures and their components, there have been literally thousands of empirical studies conducted and articles written to discuss how to analyze many aspects of architectures. It would be impossible to list all the sources in this paper due to space limitations. For a more thorough list of past studies in this field, one should consult my previous dissertation research (Madewell, 2014). Suffice it to say that the subject of analyzing architectures has been previously covered and converges to seven major areas of research. These seven major areas are: routing (traffic management), performance analysis, network simulation, traffic characterization, buffers & queues, congestion control mechanisms, and framework (packets & protocols).

3. METHODOLOGY

The methodology used in this research is to use a conceptual illustration based on performance results from simulation output to highlight the use of a novel framework for intelligently identifying key components of the open system architecture. The framework, made up of metrics and the utilization of discrete-event simulation, was found to be consistently useful across a broad spectrum of analysis types dealing with architectures and networks. For more detailed information as to how the framework was developed, please reference my dissertation (Madewell, 2014). The conceptual illustration will include the basic setup of the government request for proposals and three conceptual designs received from potential vendors. The conceptual illustration will walk through the use of the framework with this example case and highlight the best timing of when to use the framework in the Defense Acquisition System (DAS) which is a stage-gate acquisition process. It is commonly known that stage-gate acquisition processes require that certain metrics and measures be met before being approved to go to the next phase. This conceptual illustration will highlight in which phases to best use the framework as well as the potential benefits of its use.

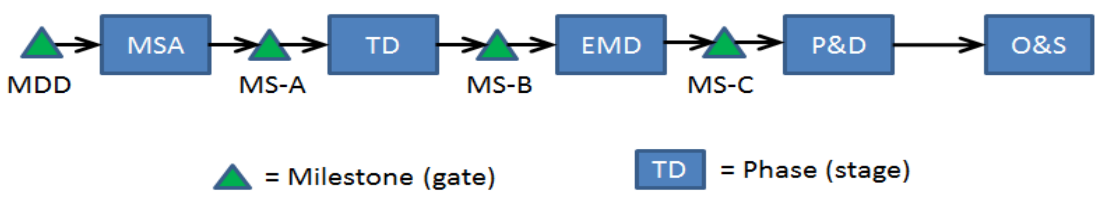

Figure 1.0, DOD DAS Process

DAS consists of five major acquisition phases which include: Material Solution Analysis (MSA), Technology Development (TD), Engineering and Manufacturing Development (EMD), Production and Deployment (P&D), and Operations and Support (O&S). The DAS process includes a major decision point before the start of each phase. These are called milestones and there are four milestones shown in this research. MDD is the milestone document decision that starts the process. MS-A is milestone A which is the decision required before the TD phase can start. MS-B is milestone B and is the decision required before the EMD phase can start. MS-C is milestone C and is the decision required before the P&D phase can start. These milestones are the decision gates prior to each major phase of development.

4. RESULTS AND DISCUSSION

The Novel Framework:

In my dissertation research I successfully developed a framework of metrics and a method which were consistently found to exist in architecture analyses spanning seven categories of study. The final set of six metrics determined in this research was concluded to be: queue length, wait time, process time, process utilization, overall process time, and overall throughput. Furthermore, the prevalent analytical method found is this research was the use of computer simulation. The use of methods such as test or mathematical analysis was found to be infinitesimal as compared to the prevalent use of simulation in architecture analysis. Thus, the final novel framework consists of analyzing the potential vendor concepts using computer simulation and the set of six metrics. The results of the exercise of this framework will illustrate the best components to procure as well as the best overall architecture design to acquire.

Illustration of the Concept:

The metrics, analysis method, and framework developed in this research can be used in a variety of ways. To help illustrate the usefulness of this framework, a brief simulated scenario is outlined. The how and when of the framework is depicted to point out key elements of the framework's use. In this scenario, the DOD has sent out a request for proposal (RFP) for a new system. Along with this RFP, the DOD supplied a specification that outlines the specific requirements that must be met along with all interoperability and interface constraints. The overall DOD requirements of the system stated that the system shall receive all messages in a specified format from one or more sensors, process the message to pinpoint a particular target, transfer the output of processor unit to a server unit, run algorithms to optimize the use of a set of four final resource nodes, and send a command to one of the four final resource nodes to perform the terminal function. The functional block diagram specified by the DOD for this system is shown below in Figure 2.0.

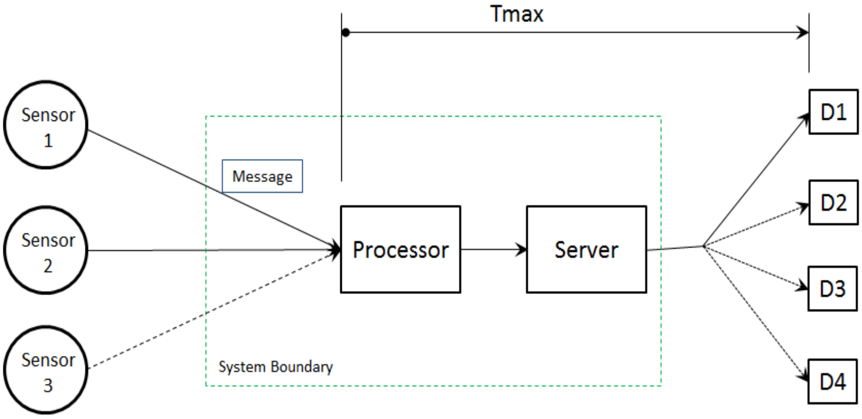

Figure 2.0, Notional System View from DOD RFP

The DOD requirements also states that the message traffic bandwidth in and out of the system is Gigabit Ethernet and therefore there are no system concerns on bandwidth. There are also no assumptions that required storage of data being processed while in the system. The DOD requirement further states that the message traffic is in a standardized format, interoperability is assumed, and no messages shall be dropped due to the criticality of the system. The main performance requirement is stated by the DOD requirements as the total time from entry into the process to a command being reached at one of the four final resource node (D1, D2, D3, or D4) to be less than or equal to Tmax. Again, Tmax is required due to the time criticality of the system. For the system analyses presented by the potential vendors, the DOD requirement states that the given latency between server and final resource node is to be assumed as 0.68 seconds.

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In this illustration, the DOD receives proposals from eight potential vendors. After careful consideration, the DOD selects three potential vendors for a competition starting at the beginning of the MSA (Materiel Solution Analysis) phase. This down-select is based upon past performance of vendors. The plan is to let all three vendors compete and provide their conceptual designs by the end of the MSA phase. At that point the DOD will evaluate the potential vendor conceptual designs and determine how to proceed from there. Each vendor is required to provide the architectural view of the concept design as well as predicted performance data for the system. Also, the vendor is required to describe the source of the performance data. Vendor performance data is typically generated from one of three approved sources: predictions from historical data of like systems, data from prototype tests, or actual performance data from testing of the real system. Thus, the DOD now will have in-hand a probabilistic model (Cumulative Distribution Function, CDF) for performance of each the vendor components along with the vendor concept design model.

Vendor One submits their concept design model as shown in Figure 3.0 below.

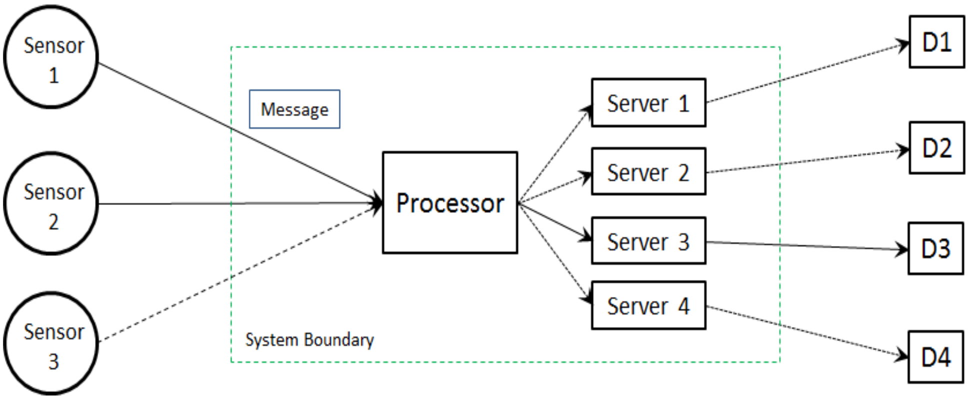

Figure 3.0, Vendor One Concept Design

Vendor Two submits their concept design model as shown in Figure 4.0 below.

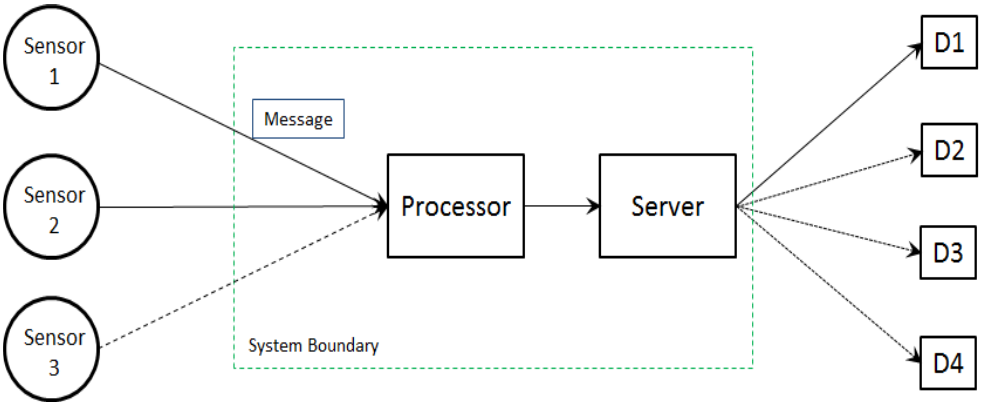

Figure 4.0, Vendor Two Concept Design

Finally, Vendor Three submits their concept design model as shown below in Figure 5.0.

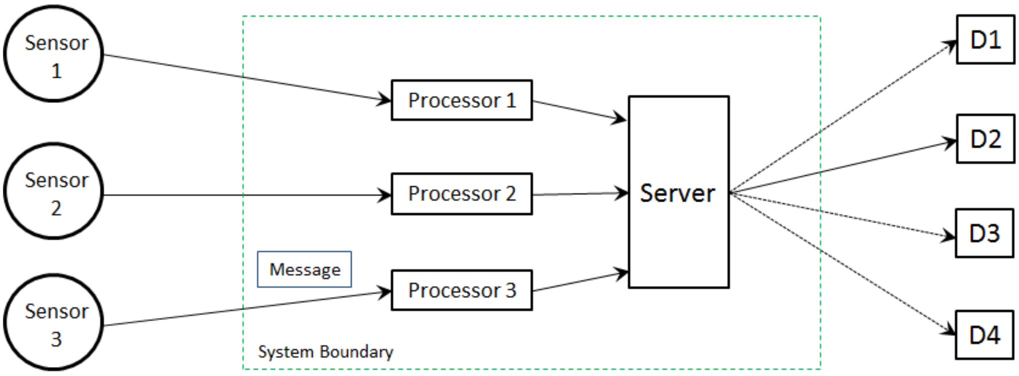

Figure 5.0, Vendor Three Concept Design

With the component model and the architecture concept model now submitted by each vendor, this fulfills the requirements of the MSA phase. It is now time for the DOD to exercise the metrics framework in order to determine the optimal next step for the acquisition of this system.

The DOD would now use the metrics, analytical method, and framework to help narrow down the selection of the vendors and reduce the overall acquisition process cost (while providing a solution that meets the system requirements). In this illustration, the DOD would then construct the discrete-event simulation model of the system using the concept design models and component performance models supplied by each vendor. Now that the system model is constructed by the DOD for each of the vendor solutions, thirty or more iterations are run to determine and validate the overall performance of the system. Since the performance models were supplied by and validated by the vendors and the DOD prior to the vendor submitting it, the system model produce credible performance predictions that are used to pick between competitors. The results of the system model performance assessment are then compiled with the statistically significance required by DOD specified standard error and uncertainty limits. Once the simulation runs are completed for each of the vendor architecture concept designs, the DOD rates each vendor design using the technical the metrics: Overall Process Time and Overall Throughput. To insure that the system is not losing or dropping injected messages, the DOD subtracts the Overall Throughput metric from the total number of messages input throughout the simulation run. If the system design is dropping messages, that vendor design is disqualified based upon the supplied DOD system requirements and therefore does not meet the requirement of no dropped messages. Further, in this illustration, if any vendor system does not meet the requirement of Tmax (which is the Overall Process Time metric), that particular vendor is removed from consideration for the system architecture concept. This analysis is the first step and fulfills the performance check at the system architecture level.

The next step is to identify which components are key and provide better performance. Even if a vendor's overall system fails to meet the Tmax criteria, their components may outperform other vendor's components and may therefore be acquired independently by the DOD as a component. Thus, the second step is executed for each vendor and for each component. The basis of open system architectures hinges on being able to acquire components independent of the architecture vendor. The goal of the DOD is therefore to get the best overall combination of components and system design to attain most optimal overall performance. This means that the DOD is also able to purchase the technical data rights or licenses for those components found to be of key importance and significance. To identify the key components within the system being offered by a vendor, metrics are again utilized. Thus, the metrics for Queue Length, Wait Time, Process Time, and Process Utilization are calculated for each of the components offered by the vendors. The results found by the DOD in this set of illustrated simulation runs for each vendor is as follows.

	Best		
	System Architecture Concept		
Metric	Vendor One	Vendor Two	Vendor Three
Average Overall Process Time (Tmax in seconds)	0.63	0.65	0.78
Average Overall Throughput (# messages)	3389	3279	2653
Traffic Loss (Verification Check)	None	None	None

			Best
	Processor Design		
Metric	Vendor One	Vendor Two	Vendor Three
Average Processor Queue Length (# messages)	7.80	7.60	5.36
Average Processor Wait Time (seconds)	0.16	0.18	0.13
Average Processor Process Time (seconds)	0.16	0.18	0.14
Average Processor Process Utilization	82%	80%	73%

		Best	
	Server Design		
Metric	Vendor One	Vendor Two	Vendor Three
Average Server Queue Length (# messages)	8.10	7.60	9.32
Average Server Wait Time (seconds)	0.15	0.14	0.25
Average Server Process Time (seconds)	0.16	0.15	0.26
Average Server Process Utilization	89%	81%	99%

The simulation analysis results from this conceptual illustration shown above depict both the system architecture concept and component metric results that are generated using the vendor supplied models. The results above also show that Vendor Three did not meet the overall requirement for Tmax and therefore could not win the competition for overall system architecture concept. Vendor Three could, however, potentially win one or more competitions for each of its component designs. Vendor One and Vendor Two both meet the requirements for no message drops and Tmax and are still in the competition for overall system architecture design. The performance metric of Tmax (Overall Process Time) for Vendor One is less than Vendor Two so Vendor One is chosen as the winner of the system architecture concept design. The Overall Throughput for Vendor One is also greater than the other two vendors. Thus, through the use of the metrics of Queue Length, Wait Time, Process Time, and Process Utilization, it is determined that Vendor Three has the best performance for processor design and Vendor Two has the best performance for server design. Even though Vendor One does not have the best processor design or the best server design, it wins the best system architecture design concept based upon performance. This exercise illustrates that the best system architecture design concept does not always contain the best components and a more optimal mixture can be developed using the concepts of open system architectures.

Through the use of the metrics, analytical method, and the framework exercised in this research, the DOD (or a similar organization) is now able to identify which overall system concept design is best. The DOD is also able to identify which components being offered by all vendors are the key components to be acquired. In this scenario, Vendor One wins the competition for overall system concept design. Vendor Three wins the competition for best processor design. Vendor Two wins the competition for best server design. Furthermore, there are many reasons that one vendor's component design may be better than another. The internal factors that could affect component performance include: processor speed, memory, algorithm design, software elegance, better selection of hardware or software, or internal message traffic transfer. By using this framework, the DOD is now able to formulate a better competition and contract structure for the next phase in the life cycle development process. For example, the DOD can now simply award a contract to Vendor One to fully develop their system architecture concept but put in the contract that Vendor One must utilize the processor supplied from Vendor Three and the server supplied from Vendor Two. At the same time the DOD could award a contract to Vendor Three to fully develop the processor component and provide a final cost estimate that includes the required technical data rights or licenses. The same would be said for Vendor Two for the server component individual contract award.

Since a more efficient contracting strategy is now achievable, the DOD can potentially save the cost of all the subsequent competitions that historically would have happened in the subsequent phases which include the Technology Development (TD) and Engineering & Manufacturing Development (EMD) phases. By the time the DOD is ready to award the Production and Deployment (P&D) phase contract, ideally they potentially could have acquired all technical data right necessary to bid out the system production as well as the component production to any vendor at the lowest cost. This is due to the fact that the DOD identified (early in the process) which components were key and purchased the technical data rights required to allow them to bid the component manufacturing out independent of the original design vendor. This also allows the DOD to bid out the repair and maintenance of these key components in the Operations and Sustainment (O&S) phase of the development life cycle. This method of identifying the key components early and purchasing the required technical data rights can yield millions of dollars in savings over the life cycle of the system being procured.

5. CONCLUSIONS AND FUTURE WORK

From the conceptual illustration described in the previous section, it is easy to understand that the earlier the best system design and key components are identified, the more funding can be saved in subsequent development phases. Conversely, the later the system design and key components are identified, the greater the life cycle cost will be for the system acquisition. This example has illustrated the use of the metric framework, shown the best timing of use, and highlighted the potential benefits. There is no doubt that it is a daunting task to identify key components of open system architectures. Obviously, the thrust of the examples in this illustration were presented from the DOD perspective but they can be extended to any organization that requires the components of their infrastructure to be open, accessible, and maintainable for all the customers the organization serves. Thus, this research can be directly extended to cloud service providers who offer software-as-a-service since that type service requires that the customer have the technical data rights or licenses to access both hardware and software. This article successfully illustrated a very useful framework to identify key components in open system architectures.

One area of future research that could be pursued is to conduct more research on when is the most optimal time to utilize this framework in the acquisition process with respect to actual cost savings. In other words, conduct research to output cost savings expectations at each step in the acquisition process and determine where the break-even points are for use of this framework. This research indicates the sooner in the acquisition life cycle, the better such as at the end of the materiel solutions analysis (MSA) phase. In reality though, it may be more optimal to exercise this framework at the end of the next phase (TD phase).

REFERENCES

[1] Carter, A. (2010). Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending. Retrieved from https://dap.dau.mil/policy/Documents/Policy/Memo%20for%20Acquisition%20Pro-fessionals.pdf.

[2] Department of Defense Open Systems Architecture Data Rights Team (2011, December). DOD Open Systems Architecture Contract Guidebook for Program Managers, Volume 0.1. Retrieved from https://acc.dau.mil/OSA Guidebook.

[3] Gillis, Matt (1999). Open Systems Joint Task Force gets the word out: PMs Now Expected to Consider using Open Systems. Retrieved from www.acq.osd.mil/osjtf/pdf/gillisja.pdf.

[4] Livingston, H. (2000). GEB1: Diminishing manufacturing sources and material shortages (DMSMS) management practices. In Proceedings of Government Electronics & Information Technology Association G-12 Solid State Devices Committee. Retrieved from http://www.dmea.osd.mil/docs/geb1_paper.pdf

[5] Kendall, Frank (2012). Better buying power 2.0: Continuing the Pursuit for Greater Efficiency and Productivity in Defense Spending. Retrieved from http://www.dau.mil/InformationDocs/USD(ATL)%20Signed%20Memo% 20to%20Workforce%20BBP%202.0%20(13%20Nov%2012)%20with%20attachments.pdf.

[6] Madewell, C. (2014). Technical metrics for identifying key processor components for acquisition in open system architectures and non-proprietary infrastructures. Retrieved from ProQuest Dissertations and Theses Database.

[7] Oberndorf, Patricia (1998). SEI Monographs on the use of Commercial Software in Government Systems: COTS and Open Systems. Pittsburgh: Carnegie Mellon Software Engineering Institute Publication.

[8] Opens Systems Joint Task Force (2004). A Modular Open Systems Approach to Acquisition, (version 2.0). Retrieved from http://www.acq.osd.mil/se/initiatives/init_mosa.html

[9] Rendon, R. (2007). Using a modular open systems approach in defense acquisitions: Implications for the contracting process.In Proceedings of IEEE International Conference on System of Systems Engineering (SOSE'07), 1-6.

[10] Winborne, Jr., G. (2010). Who's killing the goose? In Proceedings of American Bar Association Section of Public Contract Law Program Intellectual Property in Government Contracts—What you didn't learn in Kindergarten. Retrieved from https://acc.dau.mil/adl/enUS/401584/file/54029/Winborne_ABAPCL_paper_Who's_Killing_the_Goose_For%20_Release.pdf.

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Dr. Charles D. Madewell holds a Bachelor of Science and Master of Science in engineering from the University of Alabama in Huntsville as well as a Doctor of Computer Science from Colorado Technical University in Colorado Springs, Colorado. Dr. Madewell utilizes his education and experience to conduct independent research focusing on the areas of architecture analysis, metrics, simulation, data analytics, predictive analytics, operational intelligence, and business intelligence.