

APPLICATION OF SIMULATION MODELING FOR AIR FORCE ENTERPRISE IT TRANSFORMATION INITIATIVES

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ABSTRACT

Simulation modeling can be a key enabler and method for mitigating risk within the Department of Defense's Enterprise Transformation, especially in the area of the IT systems that enable transformation. This paper provides a brief overview of the Air Force's approach to enterprise architecture development and demonstrates how modeling and simulation (M&S) can be used to optimize Enterprise IT architecture design to meet the needs of operational end users.

1 INTRODUCTION

The Department of Defense (DoD) has embarked on comprehensive, enterprise-wide transformation initiatives that are among the world's largest with regard to functional scope, geographic dispersion, and number of end users (Hartman and Morgan Borszcz Consulting 2007). In a broader context, the DoD Enterprise Transition Plan (ETP) began in September 2005 to transition the DoD to a nimble, adaptive, flexible, and accountable organization, enabling improved processes, systems, and information flows to support 21st Century national security requirements (USDoD 2007a). Within the ETP, twelve Enterprise Resource Planning (ERP) systems will be implemented throughout the DoD, replacing out-of-date legacy systems. For example, the Air Force is undergoing a complete transformation of both its supply chain and financial management business areas. These initiatives began in 2007 and will replace well over 500 legacy systems. By 2013 the supply chain ERP, known as the Expeditionary Combat Support System (ECSS), will be fully operational and the legacy systems it will replace will retire by 2020. The financial ERP, known as the Defense Enterprise Accounting Management System (DEAMS), will be fully operational by 2010 and all the corresponding legacy systems will retire that same year (USDoD 2007a). At the core of the transformations is the acquisition of a new IT architecture,

encompassing the physical hardware systems and software to enable its users and their transformed activities.

Simulation modeling is an ideal application for helping to design, develop, and deploy the IT infrastructure for the transformed enterprise. Simulation can be applied to both the systems themselves and their support to the end users. In fact, simulation offers a unique opportunity to measure the impact of the new systems on operational end users. That is, the systems and processes under consideration consist of complex interactions and their design requires inputs from multiple disciplines (GoldSim 2008). Thus it is virtually impossible for any one person to easily understand the complete, end-to-end enterprise. A simulation model can act as the framework to integrate the various components in order to better understand their interactions and it can be a management tool that keeps leadership focused on the "big picture" without getting lost in unimportant details. Per an OUSD AT&L study, updated in 2007, simulation has "tremendous value as "an enabler of integrated product and process development" in the acquisition of new weapon systems, including IT applications. That study also cites a return on investment as high as \$99 for every dollar spent on modeling and simulation (OUSD AT&L 2007).

2 ENTERPRISE DESIGN

Within DoD and the Air Force in particular, the design of the transformed enterprise starts with a process called area blueprinting. Blueprinting is an activity that brings together planners, enterprise architects, and Subject Matter Experts (SMEs) (Cain 2007). It is typically led by the functional communities but is conducted in concert with the acquisition community. The SMEs that are engaged include experts for the legacy systems and the various functional areas that will be addressed by the new enterprise systems. For many of the enterprise transformation initiatives, blueprinting is conducted with a standard in mind. For ECSS (the Air Force supply chain systems transforma-

tion), the Supply Chain Operations Reference (SCOR) architecture is used. SCOR modeling is used during the blueprinting process to minimize unsatisfied system requirements. This is done via various process divisions: plan; source, make and repair; deliver and return; and enable (Cain 2007). The end result of blueprinting is details of the new processes and ultimately a listing of the IT systems that will support those processes. In short, blueprinting provides input for the transformed Enterprise Architecture (EA).

Enterprise Architecture has become common practice for IT organizations because it clarifies the processes, systems, and interactions within an organization, which facilitates consistency across the enterprise. With an understanding of the functionality and requirements of all enterprise aspects, collaboration and integration can more easily be implemented. However, improper implementation of EA can be costly. For example, the FBI has spent more than \$500 million on a failed attempt to create a virtual case-filing system, while the Ford Company lost \$400 million attempting to build an integrated purchasing system (Sessions 2006).

DoD mandates EA with DoD Architectural Framework (DoDAF) modeling (Dandashi 2003). The DoDAF is composed of four views: Operational View (OV), Services View (SV), Technical Standards View (TV), and All-View (AV) (USDoD 2007b). These views implement diagrams, tables, and text to capture the complexity of DoD architectures. The OV captures the activities, tasks, and information required to accomplish DoD missions. Figure 1 shows an example OV model. The SV captures the systems, services, and interconnection functionality that support operational activities, and the TV describes the arrangement, interaction, and interdependence of the systems. Some aspects of architecture span all three views, so the AV is implemented to encapsulate the entire architecture.

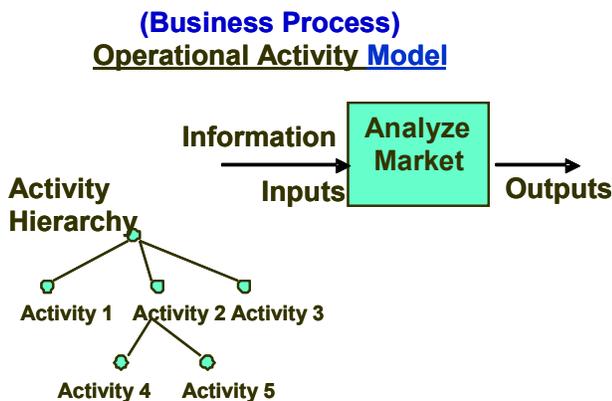


Figure 1: Sample OV Model (Dandashi 2003)

Both the process area blueprinting and DoDAF modeling activities are comprehensive and intensive, but they

document static processes that cannot provide measurement of the impact of key interactions and real-world constraints in a dynamic manner. This is where simulation can be a key enabler for transformation. That is, simulation modeling can help to answer the following questions:

1. How will the transformed enterprise work end-to-end?
2. Have all key activities been included?
3. What will the support be for the operational end user?
4. What will happen during the transitional phases of enterprise transformation, i.e., when a subset of legacy system functionality has been migrated to the new enterprise and translational activity between the old and new systems will routinely be required?
5. How will the systems support deployed end users?
6. How will the system scale for additional users and capability? What will the impact be of budget cuts for systems acquisition?

It is interesting to also note that DoD has a policy that its acquisition programs will develop a Systems Engineering Plan (SEP) and that the SEP calls for the use of modeling and simulation (M&S). While widely used for traditional weapon systems acquisition, M&S has not been exploited for Enterprise IT acquisition within DoD. The SEP “provides a context within which (acquisition professionals) can make decisions about individual programs” to “achieve credibility and effectiveness in the acquisition and logistics support processes.” The SEP was designed to “help drive good systems engineering practices back into the way we do business.” (Reuss 2008). Within the SEP, modeling and simulation is explicitly described as a key product and deliverable as well as a key method for conducting systems analysis. However, a current general lack of knowledge about how M&S can be applied to enterprise IT acquisition prevents many of DoD’s acquisition professionals from employing M&S in that critical area.

The remaining sections of this paper will describe how simulation can be used to enable the design and development of Enterprise IT acquisition (e.g., the Air Force ERPs) and will also present a demonstration of this usage.

3 SIMULATION APPROACH

Using simulation in the IT community is not new. Many commercial industry and DoD organizations have used simulation modeling for the design or support of IT systems. For example, MITRE has built a library of Service-Oriented Architecture (SOA) models for DoD using the Manufacturing Enterprise Systems Association’s simulation library (Sloane 2007) and the Air Force used simulation to support the development of the Contractor Integrated Technical Information Service (OUSD AT&L 2007). In fact, when LexisNexis, a leading global provider of business information solutions, migrated to a web-

enabled product environment in the late 1990s, an enterprise systems simulation model was built to examine the transformed architecture. Of particular interest was the projected support to end users, i.e., paying customers. The LexisNexis model is highly representative of an Air Force systems transformation because both environments consist of multiple tiers of systems, including mainframe computers, UNIX servers, Windows servers, web servers, layered security, and a proliferation of desktop end users that are numerous and globally dispersed. And like the Air Force, LexisNexis has a round-the-clock, daily operational requirement for maximum reliability and availability.

Within DoD, a simulation model was built in the early 1990s to assist with the migration of Air Force base-level computing to Regional Processing Centers (RPCs) (Fitzgerald et al. 1992). A simulation model was built of the proposed RPC architecture and workload. The model provided the way ahead for the RPC design and Service Level Agreements, and also uncovered dirty data and corrected conventional sizing methods. Figure 2 shows the basic RPC model.

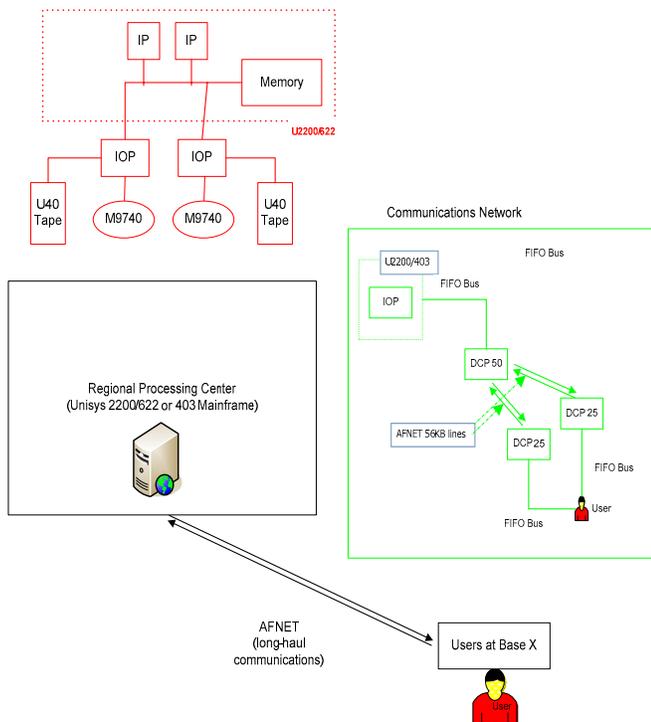


Figure 2: RPC Model

The modeling examples cited above were accomplished via both organic (proprietary) software and Commercial-Off-the-Shelf (COTS) software. For DoD’s enterprise transformation initiatives, it is highly desirable to employ a simulation software approach that is timely, flexible, reusable, and affordable. Thus the use of COTS tools is recommended. In fact, the DoD enterprise transformations

themselves are using COTS to host their systems for similar reasons (Panaro 2004).

A very suitable COTS simulation tool that is currently widely used within DoD and industry is the ExtendSim® software. ExtendSim® is a general-purpose simulation software package used for modeling and analyzing systems and processes. ExtendSim® is used by industry leaders such as Caterpillar Inc, Boeing, and IBM (Imagine 2008). The graphical interface and use of drag-and-drop blocks enables rapid, flexible, and scalable modeling. Many organizations within the Command and Control (C2) community use ExtendSim® to model the global information grid and the sensor-to-shooter environments. Also, the various MITRE-built SOA models cited previously were built for DoD using the ExtendSim® software.

4 A DEMONSTRATION

To demonstrate the “art of the possible” and the applicability of simulation for DoD IT transformation, Nova Technology Solutions (novatechsol.com), in partnership with DSD Laboratories (dsdlabs.com) and Wright State University, constructed a small discrete event simulation model to emulate the Air Force ERP environment at a very high level. The model was built in ExtendSim® and it examined the impact of the Air Force’s Service Delivery Point (SDP) capacity on ERP end user delivery. An SDP is a combination of routers, switches, and firewalls. The SDP at each base serves to connect the base Local Area Network (LAN) to the Air Force’s Wide Area Network (WAN). As application servers are located at AF bases throughout the nation, a user generating a transaction may have to access another base’s network. Each base SDP is configured for 100 MB/s capacity, but each base has a limited budget so it is necessary to equip the SDP with the minimal capacity to operate at the required level. The objective of the demonstration model was to examine the current and future ERP end user response time and correlated infrastructure utilization for varying levels of SDP capacity. By accurately modeling network traffic behavior, the effects of the ERP workload and IT infrastructure can be analyzed.

The demonstration model simulated information packets from a user transaction on Base X traveling to an application server on Base Y, as well as the return trip. As seen in Figure 3, these packets must travel through Base X LAN, Base X SDP, the WAN, Base Y SDP, Base Y LAN, Base and application server, and the reverse combination to complete the user transaction. Because this model was intended for demonstration purposes, the detail was kept at a low level. That is, instead of modeling functional details of network components or the application servers, a processing delay was implemented. For example, an activity delay in ExtendSim® was used to represent the function of routers and switches. The Hierarchical view of the model is shown in Figure 4.

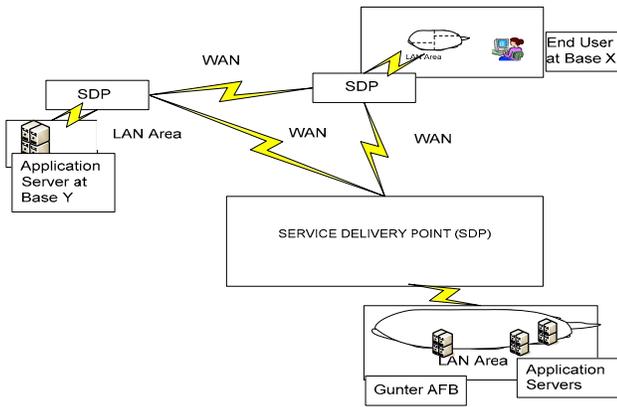


Figure 3: Air Force SDP Logical Model

Input for the model included SDP capacities, process delays (WAN, LANs, and application server), Base X and Base Y incoming and outgoing traffic, and end user transactions. To model contention at the SDPs, packets were generated to flow in and out of the SDPs. Base traffic and end user transactions were generated with various interarrival times and split into packets of specified sizes. At the SDPs, the packets wait for the necessary capacity, according to its size, in order to proceed through the SDP. After being processed at the application server, the number of packets returning to the end user is increased. End user wait time and SDP utilization are the performance measures gathered from the simulation model. By varying interarrival times and packet sizes, the effects of different ERP workloads on end-user wait time can be analyzed. Furthermore, SDP utilization can be analyzed to determine optimal capacity level.

After validating the model output by comparing to actual queue data and capacity utilization, test excursions were run to show the effects of increased workload.

Among these excursions, an increased workload of only 15% resulted in a 250% increase in response time and extensive queuing, as seen in Figure 5. Although, it was not explicitly represented in this model, packet loss and packet retries could strongly impact all users and applications on the Air Force network. By using simulation models such as the one described, the Air Force can plan appropriately for SDP capacity and also engineer the ERP solution to optimize performance given infrastructure constraints.

As depicted in section 2, the DoD models architecture complexity for many different missions. Thus much of the input needed for a simulation model can be taken directly from DoDAF models, which are largely being documented in the ProVision® software. ProVision® is an industry leading enterprise modeling software for business and IT (Metastorm 2008a), and is used by HP Consulting and Integration, IKON, and other industry leaders (Metastorm.com 2008b). It is an ideal tool for DoDAF modeling and is being employed by the Air Force for its supply chain transformation (ECSS ERP). While ProVision® has simulation capabilities, the use of a more general purpose tool like ExtendSim®, in concert with ProVision®, can offer the Air Force a highly robust and comprehensive enterprise architecture modeling capability that would enable rapid, flexible, and comprehensive architecture modeling. This type of modeling could ultimately maximize support for the enterprise’s operational end users.

5 WHY HAS THIS NOT BEEN DONE BEFORE?

A recurring question has been: “If simulation is so useful for the design and support of Enterprise IT infrastructures, then why hasn’t it been done before within DoD?” On a smaller scale, similar modeling has been done before within DoD, but primarily only for the infrastructure needs of the C2 community (Walsh 2005). Outside the C2 comm-

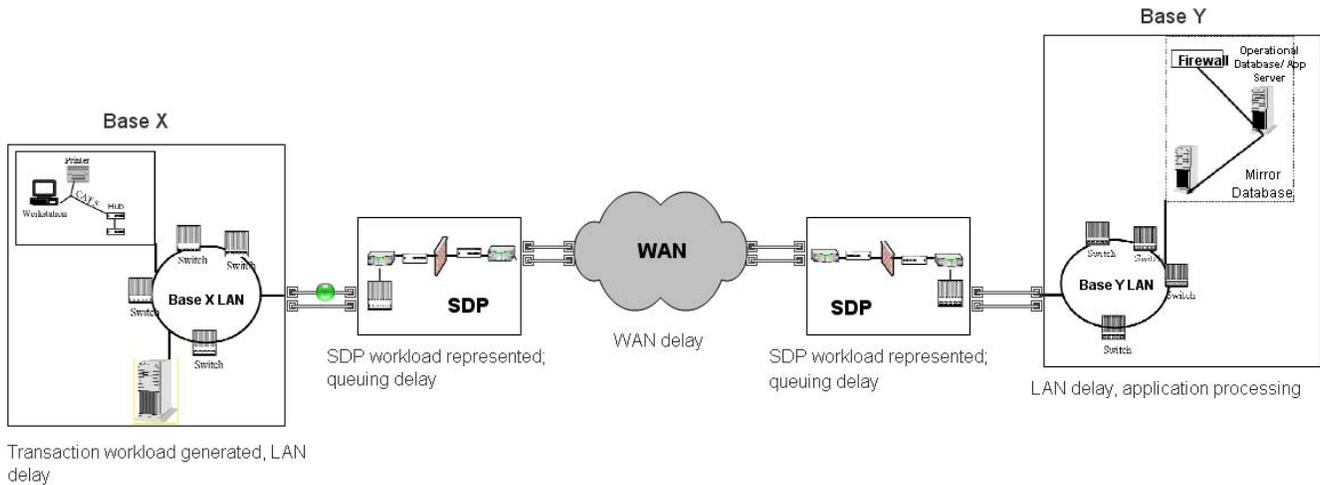


Figure 4: Hierarchical View of SDP Model in ExtendSim®

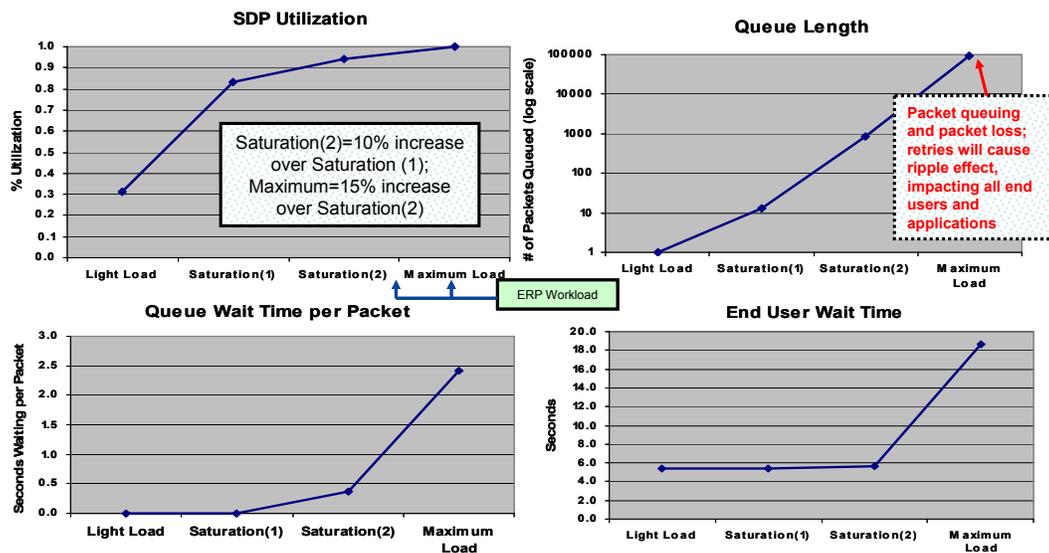


Figure 5: Model Output

unity (Walsh 2005). Outside of the C2 community, simulation of IT systems has been very limited in scale and not done for Enterprise applications—largely because Enterprise IT applications are a fairly recent manifestation. Also, in the mid-1990s, the Department of Defense significantly reduced its organic capacity for conducting modeling and simulation as well as computer engineering and other technical endeavors (Seaman 2007).

In response to the recognized benefits of M&S in a time of diminished funding and resources and an ever-increasing military scope of operations, the DoD and each service has issued a plan to revitalize M&S (OUSD AT&L 2007).

At the same time, the Information Age has matured to the point that it has brought the concept of Enterprise IT to DoD (Builder 1999). Traditionally, IT programs in DoD were confined to embedded computer systems on aircraft, base-wide, functionally and geographically disparate systems for business-type end usage or email service, etc. In fact, the dispersion of Air Force IT for business systems is manifest in the existence of over 500 disparate “legacy” IT systems to support the Air Force supply chain alone. This does not include the myriad of additional disparate systems that support financial, personnel, force protection, deployment, medical, etc functional activities.

As the concept of Enterprise IT has arisen within DoD, more affordable methods for conducting simulation have also become available (Christie 1999). Given the proven return on investment of simulation for acquisition within DoD (OUSD AT&L 2007), it is prime time to take advantage of simulation for the acquisition and management of Enterprise IT.

6 CONCLUSION

The DoD has initiated a complex and vast transformation effort to support 21st Century national security requirements. Modeling and simulation can be used throughout these initiatives to ensure optimal improvement in processes, systems, information flows, and all other enterprise aspects. Much of the input for these models is already being collected via various ERP blueprinting and DoDAF modeling activities. This paper has presented a model that demonstrates how simulation can be used in the DoD Enterprise transformation initiatives, specifically within ERP implementation. In particular, the use of COTS tools such as ExtendSim®, especially when used in concert with ProVision®, can provide a low-cost, flexible, auditable, reusable, and responsive decision support capability for Enterprise development, deployment, and support that maximizes capability for operational end users.

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