Information Integration:
The Linchpin of a Network-Centric DOD

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Table of Contents

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A. Introduction and Summary

The drive to a network-centric Department of Defense (DOD) has placed information integration at the forefront of DOD IT objectives. Information integration is the process of integrating and transforming data and content to deliver authoritative, consistent, timely and complete information and then govern the information's quality throughout its life cycle. Information integration has itself evolved significantly as a business process with commercial products, standards and best practices. These two converging forces, an increasingly critical need and the rapidly evolving capabilities to address that need, make information integration a pivotal technology priority for DOD.

We researched current and recent information-integration efforts within the Department of Defense to answer six principal questions:

1. What are the key drivers for information integration in DOD?
2. What are the most compelling components of the business case for information integration initiatives?
3. What are the most prevalent applications of information integration in DOD?
4. How well does DOD understand information integration best practices?
5. What lessons can be learned from recent initiatives?
6. What is the future of information integration in the DOD?

Our research included review of publicly available information as well as in-depth interviews of 15 DOD, intelligence and contractor executives involved in information integration initiatives across a broad spectrum of DOD and intelligence organizations including the major services, joint organizations, Defense Advanced Research Projects Agency (DARPA), and national intelligence.

In summary, our research found:

1. Several key drivers are moving information integration to the forefront of IT initiatives across the DOD, including:
   - The move to a network-centric DOD
   - Support of the warfighter
   - DOD modernization and consolidation
   - The need for timely and accurate information
   - Increasing use of COTS (e.g., ERP) applications
2. The business case for information integration can be supported by a robust set of components, many of which lead back to the overriding goal of support of the warfighter.
3. Applications of information integration are numerous and span the business, warfighter and national intelligence domains.
4. The value of commercial information integration products, standards and best practices are becoming well understood but are still not universally embraced in the DOD.
5. There are several lessons to be learned from recent DOD information integration initiatives:
   - It is critical to leverage commercial information integration products and best practices.
   - The need for commercial information-integration approaches to mission systems is just as compelling as it is for administrative systems.
   - It is important to have a single information integration platform.
   - The information integration platform must be scalable.
6. Information integration will continue grow in importance as more standards are developed, more barriers are removed and commercial integration products and best practices are embraced.

B. The Drive to a Network-Centric DOD

A network-centric DOD is not a brand-new concept but rather an evolving transformation in the way DOD accomplishes its mission. Network-centric warfare emerged in 1997 as a new military doctrine made possible by advances in information technology. From network-centric warfare's beginnings, information integration was considered critical. In February 2000, Art Money, then Assistant Secretary for Command, Control, Communications and Intelligence, said: "Gaining and sustaining information superiority requires DOD to field information systems that are interoperable at the data level."

In a 2001 DOD report to Congress[1], the following four tenets of network-centric warfare were cited:

1. A robustly networked force improves information sharing.
2. Information sharing enhances the quality of information and shared situational awareness.
3. Shared situational awareness enables collaboration and self-synchronization, and enhances sustainability and speed of command.
4. These, in turn, dramatically increase mission effectiveness.

At the same time, the concept of network-centric warfare has evolved into a more holistic view of a network-centric DOD, which reaches beyond the realm of the warfighter to the supporting business and intelligence domains.

As an embodiment of this concept, the department has placed significant emphasis on developing a Global Information Grid (GIG)—a globally connected, end-to-end set of information capabilities, associated processes and personnel dedicated to collecting, processing, storing, disseminating, and managing information on demand to warfighters, policy makers, and support personnel. In support of this, the Net-Centric Enterprise Services program envisions a GIG enterprise services architecture that spans warfighter, business, and intelligence domains.

In a network-centric DOD, information integration is equally important to mission and programmatic systems as it is for administrative systems. This was recognized as early as August of 1999, when a summit of 60 attendees representing 28 DOD organizations reviewed data-centric projects and identified the following themes[2]:

- Data problems are not unique to any one functional area or organization.
- There is a need for policy, process, supporting infrastructure, and a plan to leverage efforts.
- Data management requires senior management champions.
- Data management is not adequately addressed in budget or acquisition processes.
- In an era of network-centric warfare, addressing the issues has never been more essential.

As this critical need has evolved, so too have the capabilities of commercial information integration technology and best practices.

[1] Network Centric Warfare Department of Defense Report to Congress, July 27, 2001
[2] Data Interoperability: Foundation of Information Superiority, Winters and Wilczynski

C. The Evolution of Information Integration Technology

Information integration capabilities have rapidly evolved, with the continued advancement of highly scalable, commercial integration platforms, standards, and best practices to enable understanding, cleansing, transformation, federation and integration of data from widely disparate sources and systems for real-time decision making.

Information integration technology approaches generally fall into several categories:

- **Extract, transform and load (ETL)**, which is the process of extracting data from various sources, transforming them into a common format and then loading them into a single database.
- **Enterprise information integration (EII),** also referred to as data federation, which provides a single virtual view of one or more source data files to give the appearance of a single data store.
- **Enterprise Application Integration (EAI)**, which involves the exchange of data and transactions between multiple application systems.

A related concept is **Service Oriented Architecture (SOA),** which is an increasingly accepted approach to software development architecture that defines the use of widely available, reusable application services that can interoperate with one another.

Each of these technologies has advantages and disadvantages and selection depends on the objectives and parameters of the integration effort. However, at the core of all of these approaches are the fundamental requirements of data understanding, data quality, and data delivery across a common definition of the data. As such, more and more organizations are adopting integrated commercial products suites that can support each of these approaches and architectures with a common platform for information integration.

Traditionally viewed as a back-office solution to link administrative and customer data, information integration has evolved into a more holistic solution focused on becoming an information bridge between mission, programmatic, supply, logistical and administrative business functions throughout the enterprise. In the evolving network-centric DOD, systems and information are viewed as interdependent where, for example, linkages from finance systems to procurement systems to inventory systems to logistics systems to readiness and deployment systems and finally to battlefield systems form a sort of “information supply line” to the

warfighter. Other solutions supporting the warfighter (for example, training and healthcare systems) are also woven into this information network.

Thus, commercially proven common platforms, standards and techniques applied to administrative systems are now being recognized (although not yet universally embraced) as applicable for all systems across the DOD enterprise.

D. Key Drivers

Our research and interviews identified several key drivers that have accelerated the importance of information integration initiatives within DOD.

1. The Move to a Net-Centric DOD

At a macro level, the key driver for information integration cited by most respondents was the change to a net-centric DOD. Government agencies respond to mandates, and at DOD most respondents took seriously the current administration's transformational efforts to build a network of systems and data to support the defense of the country.

Respondents cited several efforts across DOD to accomplish the key goals of the DOD Net-Centric Data Strategy[3], which are to:

- Make data visible
- Make data accessible
- Institutionalize data management
- Enable data to be understandable
- Enable data to be trusted
- Support data interoperability
- Be responsive to user needs

In many instances, the business cases for information integration efforts are based on this overarching mandate.

2. Supporting the Warfighter

Our research and interviews found that an increasingly important driver is the needs of the warfighter. "The most compelling

[3] "Department of Defense Net-Centric Data Strategy", Department of Defense Chief Information Officer, May 9, 2003

component of our business case was support of the war effort," one respondent emphasized. Most respondents found that almost any business case for an IT initiative should explain how the initiative will help the warfighter by either providing critical information or enabling the support infrastructure.

Support of the warfighter has become an even more compelling driver with the Global War on Terrorism. Said one respondent, "for a while, legacy systems were put off while the focus was on modernization, but the missions in Afghanistan and Iraq brought a newfound focus on integrating information between existing systems. The guy in the foxhole only cares about what information he can get now, not about what information he may have someday."

Further, support of the warfighter will become even more of a driver in the future, particularly with the increased focus on shared situational awareness. Said one respondent: "With the advent of data collection systems on every platform in battlefield, data will be flowing and disseminated to numerous places. There will be a real reliance on data exchange and integration."

3. DOD Modernization and Consolidation

Most respondents believed that a major driver for information integration is DOD modernization and the related consolidation of applications. The proliferation of stovepipe systems has created myriad islands of redundant and inconsistent data that pose significant challenges that require systematic information integration. Reducing ownership cost for these systems and repositories was cited as a primary objective of information integration. "We've got servers and applications scattered all over the countryside holding much of the same data" said one DOD respondent. "We are paying for infrastructure and manpower to maintain it all many times over."

Information integration was viewed as a critical component of any systems modernization or consolidation effort because it enables the gradual phase-in of new systems. "[DOD] finds it difficult to maintain numerous legacy environments while implementing new systems and moving to the future," said one respondent. Information integration was seen as a way to reduce risk and help ensure the success of system modernization efforts that are often like trying to fix the airplane while it is in the air.

Respondents felt that information integration could reduce the cost of systems modernization efforts, enabling the extended life and continued leverage of existing legacy systems while next-generation systems are developed. Moreover, information integration was

viewed as enabling a “more graceful” legacy transition, ensuring the interoperability of systems as modernized systems are phased in

However, some respondents said that this value of information integration is only realizable if standard, reusable, commercial off-the-shelf (COTS) integration platforms are employed because the constant re-writing of custom code as the systems evolve magnifies costs and project risk.

4. Need for Timely, Accurate and Consistent Information

In addition to the cost impact of supporting and maintaining myriad systems, inconsistent quality of information was also cited as a major problem. As one respondent complained, “it drives our decision makers absolutely batty to ask a simple question and have three analysts go off and come back with three accurate but different answers. It undermines credibility.” As another put it, “the biggest driver for us is the need to ensure consistency of data.” Still another respondent said, “There is not a shortage of data; we have plenty of that. The real need is for information, which is to say the right data that we can make decisions with.”

5. Enablement of COTS

Another driver mentioned by respondents was the enablement of systems based on COTS application software such as enterprise resource planning (ERP) applications. Some respondents felt that information integration was critical to ensuring the success of ERP implementations. “The business value was saving a project” said one respondent. “The value was in cleaning our legacy data to ensure success.”

Many felt that the DOD has had challenges making COTS systems, which were originally developed with commercial business practices in mind, fit naturally into its unique processes. Information integration has become recognized as a key enabler of successful COTS implementation by providing a common thread for weaving COTS into the fabric of systems supporting agency-unique business processes. Information integration was believed to play an important role in filling what were called “gaps” in business processes, data and emergent requirements.

Once again, however, respondents cautioned that this was only effective when standards and a reusable off-the-shelf integration platform are adopted. Building custom-coded interfaces or “hooks” into COTS application software packages was viewed as counterproductive to the whole purpose of COTS.

E. Key Components of the Business Case

Respondents said a sound business case for information integration should strive to answer as many of the following questions as possible:

1. How will this information integration support the warfighter?
2. Does it give us access to information we would not otherwise have?
3. Will it reduce workload, freeing up critical resources to be applied to other, potentially higher-value activities?
4. Will it lower IT costs, improve efficiency, reduce redundancy or decrease maintenance costs?
5. Will it lower project risk?
6. Will it enable a more successful systems modernization or COTS application (e.g., ERP) effort?
7. Will it extend the value of an existing system?
8. Will it support more rapid decision-making?

While most respondents identified one or more of these as key components of their business case, respondents generally felt that supporting the warfighter was the most important because, especially in a time of war, everything DOD does needs to tie back to that.

Most respondents felt that a good business case needed to appeal to multiple audiences. One respondent responsible for justifying an information integration project said: "If we are at the senior management level, investment and dollar returns definitely matter. The folks that are out in the field don't care as much about that kind of thing…they're definitely more interested in what gets them better information so they can do what they need to do…we have to speak to both of those groups of people when we're trying to make our sales pitch, so to speak."

F. Applications of Information Integration

Respondents cited myriad applications for information integration ranging across the business, warfighter and national intelligence domains. Just some of the prime applications for information integration that were mentioned include:

- Integration of administrative applications, including:
  - Accounting and finance

    - Budget
    - Human resources
    - Acquisition
    - Multi-instance enterprise resource planning
    - Cross-service functions
- Movement tracking solutions
- Logistics and supply solutions
- Personnel
- Medical
- Command and control
- Combat readiness
- Force application
- Combat operations
- Systems to give a common operating picture
- Intelligence sharing and collaboration
- Data mining applications
- Decision support solutions

Respondents felt that DOD was either continuing or beginning to integrate information between the systems within and across these areas and that such integration would benefit from common and consistent approaches and tools.

G. Information Integration Maturity

We explored the maturity of DOD information integration initiatives relative to the leverage of commercial tools, use of full life cycle best practices and implementation of master data management concepts.

1. Commercial Tools

Our research found that there was an emerging understanding of the value of commercial information integration technology. Respondents were generally aware of that there are information integration tools available that support processes traditionally accomplished by custom development, and all who understood this clearly preferred a COTS foundation product over custom development.

One respondent said: “The biggest cost savings was downstream maintenance costs…not being dependent on programmers to maintain (linkages).” Added another respondent: “DOD is starting to realize the benefits of COTS and you are starting to see it in RFPs.”

Most respondents were encouraged by the evolution of commercial information integration platforms and tools. “The tools are getting better, and there have been some drastic improvements over past few years” said one respondent.

However, most felt that a culture of custom development and reliance on hand-coded integration was still prevalent in many areas of DOD and remained a barrier that increases risk, cost, maintenance efforts associated with information integration efforts—to the point of threatening the ultimate success of such initiatives.

2. Full Life Cycle Best Practices

There was increasing maturity of understanding of best practices and the information integration process. However, not all respondents felt they or other government projects were moving forward on all components. In most cases, this was because of difficulties in making the business case for such important processes as data profiling and cleansing. Most respondents feel these processes offer considerable value to their effort but are difficult to translate into specific functional bells and whistles that funding entities look for. “That would be very difficult to sell,” said one respondent. “They’re not getting a paint job with the tune-up.”

Data profiling (the process of discovering and developing an understanding of usage and meaning of existing data) in particular was viewed as a major challenge that is often not addressed well in information integration projects. “I think discovery is probably the most difficult challenge,” said one respondent. “In some cases there is minimal or no documentation involved in the existing system and there’s not necessarily a center of expertise that you can go to understand how data interacts with other data.”

The data preparation and quality process was often cited as being perhaps the most important stage of integration but one that has traditionally not been done well. “Historically, it has been a funding issue,” said one respondent. “It’s got to be something that we get a flag endorsement for and therefore there has to be something clearly delivered to the functional side…..a new capability preferably, not just an enhancement in response time or a lowering of IT cost.”

Added an industry respondent, “DOD has good vision but in reality hasn’t executed real well or enforced their standards. In RFPs, they will include statements about profiling, quality and activities surrounding information integration so they are aware of it….I’m just not so sure they are walking the talk.”

Respondents believed that most of the focus of has been on the data delivery side standards (XML, for example). However, most felt that the bigger obstacle is in understanding the context of data and defining what the "authoritative" data is. "Identifying authoritative sources, cleansing and preparing the data is the hardest part of the process" said one respondent. "We have 10 different definitions for 'name.'"

3. Master Data Management

There was a general understanding of the value of master data management (or creating a single, enterprise-wide directory of information), although the term itself was not universally used or understood. One respondent said: "To us it is a 5 (out of 5 in terms of importance), but in terms of it being a concept that we would be able to explain outside of our group, it is a 3."

Many felt that they were only on the cusp of master data management and some questioned whether the government has come to grips with the degree of commitment required to accomplish this. Said one respondent: "Master data management is very difficult for us because there are so many disparate systems that utilize the same data." Another respondent said: "We've made a couple of runs at it and when they were not initially successful or when we were unsuccessful in getting the money needed to finish them, we had to stop and restart. So right now we have working groups who are looking at overall enterprise."

Others wondered whether the enterprise-wide initiatives had the right mix of expertise and user involvement. One respondent said: "The people who are doing this are not at the user level. The tendency is to tell the user what they need rather than the other way around."

"Context (of the data) is a challenge" said another. "The technical folks tend to see [data] redundancy when redundancy isn't there" he said, referring to the challenge of making data decisions without a clear understanding of how the data is used.

While the many of the drivers and requirements may be different, most felt that DOD was not unique in many of the issues it faces. "I was in a meeting with my civilian counterparts just the other day and it appears that they have identically the same issues we have," said one respondent.

H. Challenges to Overcome

Respondents cited several hurdles in the path of successful information integration.

Respondents felt that there was a shortage of knowledgeable and experienced resources to execute and maintain the results of integration projects. As one respondent put it, “a key constraint is the number of government employees as well as the number of contractors that you can bring in because of your funding. You’ve got people who have to do two and three different jobs at the same time.” Even more challenging than finding resources to accomplish new initiatives is the heavy dependence on people with experience in integrating existing systems and the risk of losing them mid-project. Most respondents mentioned this as a particular hazard when integration points are developed by custom code or without the use of commercial tools and processes that make them easier to maintain.

Respondents also cited organizational barriers as a problem that needed to be overcome. In some cases, getting other organizations to share information has been a challenge. One respondent mentioned acquisition of external information as an example of this: “Obviously, if you own the systems the data it is fairly easy. When you knock on someone else’s door and need their data, they are not so happy to hear from you, and working through the interface agreement is very challenging.”

Another potential challenge cited was the scarcity of clean, accurate data. One respondent said, “Accuracy of data is the biggest data challenge right now. It is consistently being addressed in everything we do.” Standardization and developing an understanding of the true meaning of data were also cited as related challenges. Most felt that the use of commercial tools to profile and cleanse data was critical to overcoming these challenges.

Interoperability and scalability were cited as ongoing concerns. As one respondent in a large DOD agency put it: “Scalability is constantly on our minds, and that is one of the things we challenge vendors on a lot is it going to scale across an enterprise our size?”

Some respondents also mentioned sorting through the complexity of integration options as a challenge. Many felt the variety of technical architectures and of potential approaches to data integration (ETL, EAI, EII, service-oriented architecture, etc.) could lead to multiple initiatives that create islands of integration without a unified architecture. Most felt that a single platform that supported multiple

approaches and multiple technical architectures would offer a valuable foundation.

I. Key Lessons Learned

Several key lessons emerged from the research.

1. **It is critical to leverage COTS information integration products**. Most cited the reusability of a single, standard platform as a key reason for this. Speed of development and ease of maintenance were cited as important related reasons. Some believed strongly that it is counterproductive to integrate COTS ERP systems with home-grown "hooks."

2. **Information integration should be treated as a full-lifecycle best practice.** Most respondents agreed that data discovery and data cleansing were vital components of the larger, end-to-end information integration process and that managers should view information integration as a full lifecycle best practice. Many believed that future projects should learn from the lessons of past, problematic efforts that ignored these steps.

3. **The need for mission systems to use commercial information-integration tools and best practices is just as compelling as it is for administrative systems.** Respondents felt that all the same issues that have driven adoption of commercial information integration tools and best practices for administrative applications apply to mission-related applications as well. Further, a critical tenet of a net-centric DOD is to leverage the linkages between administrative processes, systems and data all the way to the warfighter in the battlefield, using a common information integration foundation with consistent data standards and quality. Respondents cited supply chain and logistics applications as a prime example of these required linkages.

   Respondents believed that as some COTS tools evolve to provide greater support of real-time integration, such platforms should be embraced for mission systems integration. As one respondent summed up, "The biggest difference between integrating administrative systems and integrating mission systems is the greater need for real-time information. The technology for this is getting better and better….soon everyone will want and will get this."

4. **It is important to have a single information integration platform.** The line between static and real-time information integration is blurring and the fundamental data profiling, preparation and metadata management requirements are similar regardless of whether data is delivered via ETL, EII or EAI. As such, there is real value to a common integration platform that can support both static and real-time information integration through all stages of the process, via any of these delivery approaches. Moreover, it is important that such a platform support service-oriented architecture in order to achieve the vision of information delivered as a service.

5. **The information integration platform must be flexible and scalable.** Most felt that the platform must be flexible to support the spectrum of hardware and software infrastructures still in place within the department. Furthermore, scalability was one of the most frequently cited requirements of information integration. To be valuable to the department, information integration must be able to support rapid decision making while leveraging large volumes of information from multiple, disparate sources.

J. The Future of DOD Information Integration

When asked to project how information integration will evolve in the coming years, respondents felt that a key to achieving the vision was establishing the information delivery infrastructure. Some respondents felt connectivity (especially with respect to information reaching the warfighter) would be an important challenge. Related to this, security was also cited as a critical issue that will need to be addressed, especially as more information flows through the GIG. Most felt the department was continuing to make great strides in this area.

Most of the respondents cited standardization as an important effort in near future. “Going forward, standards are going to be the biggest hurdle” said one respondent. Almost all were involved with or aware of several inter- and intra-agency standardization task forces and working groups.

However, some voiced concern that standardization should be viewed in the bigger picture of DOD IT efforts to integrate information across and beyond domains. Some cited overlapping standards groups as an issue while others were concerned that standardization efforts are too internally focused on data definitions

within the enterprise, which may lead to systems that can't integrate beyond the enterprise to constituents and partners.

Many felt that emerging technology approaches like service-oriented architecture would garner significant interest but felt the department was still very early in adopting them. One respondent said, "service-oriented architecture is going from a 2 to a 4+ (out of 5 in terms of importance). People are recognizing this is what's necessary for us to move forward." But another respondent cautioned: "I think we are just scratching the surface with service-oriented architecture."

Finally, most believed that information integration was approaching a new era where the concepts of master data management combined with the greater use of COTS information integration platforms would help simplify the information integration process and provide greater accuracy, consistency, quality and reliability of information across systems. As one respondent put it, "There will be a continued push toward using COTS systems and standard information integration services, using the same systems to share and move data."

At a time of continually increasing threats to our national security, realizing the vision of network-centric DOD is becoming a crucial strategic goal. Advances in technology have enabled a new era in national defense; one in which battlefield dominance and the security of our country can be achieved through seamless information superiority, all of which will make information integration play a vital role in the defense of our nation as the linchpin for a network-centric Department of Defense.

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