Department of Defense Business Operations Technical Transition Plan

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Version 1

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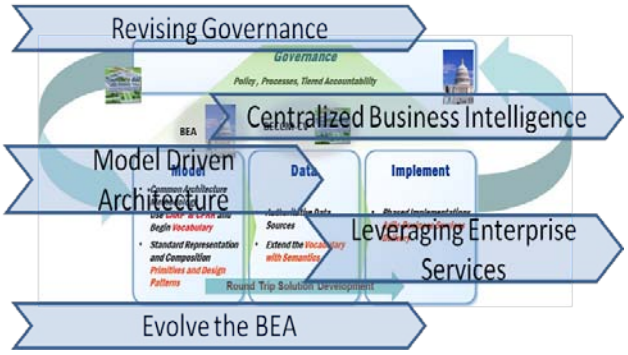
Executive Summary



The purpose of the DoD Business Operations Technical Transition Plan is to articulate a plan to achieve increased operational efficiency and mission effectiveness while generating cost savings. Central to this plan is the move to delivering business capabilities through a more agile and faster lifecycle described as **Model – Data – Implement (MDI)**. Speed of delivery and reduced cost results from utilizing technology to integrate processes that had in the past been separate functions with only limited awareness of each other. MDI brings together: Enterprise Architecture, Service Life-Cycle, Data Interoperability, Service Oriented Architecture (SOA) and Governance; each as a component of capability delivery and each dependent on the other.

Evolve the BEA - The Business Enterprise Architecture (BEA) will become dynamic and executable through the use of semantic technologies and standards such as Business Process Modeling Notation (BPMN). The BEA moves from reference to implementable when there are clear and unambiguous processes for developers to create compliant executable operational components from anywhere within the federated BEA. Systems will be able to assert compliance by linking their models and their data to the Business Enterprise ontology represented in the BEA. In turn, such systems and services will be able to leverage the executable architectural components of the BEA, thereby demonstrating their compliance in operation. Compliance is driven through implementation and becomes dynamic because it applies throughout the lifecycle of systems and services.

Model Driven Architecture - Model-driven Architecture is an established approach to the design of complex systems that is based on the successive refinement of architecture models, from abstract, platform-independent models to implementable, platform-specific models. MDI is an approach designed to achieve architectural round-tripping through the use of Semantic Technology as part of its modeling, solution generation and runtime phases. Architectural round-tripping is translation of information from models to executable code, and the propagation of changes at the executable level back to the conceptual models.

Centralized Business Intelligence - The transition from the current BEA to a semantically enabled BEA will provide for a new level of interoperability and data integration in business systems. It will facilitate the ability to create an enterprise-level Business Intelligence (BI) reporting function through a Centralized Business Intelligence Initiative. This function, when executed using Semantic Technologies, could reduce the cost of DoD business operations reporting by $840 million over three years. BI uses as its foundation the work of the Business Enterprise Common Vocabulary initiative and other ontology development work. BI capabilities will pull together information from across DoD transaction systems, then analyze and present this information to users in ways that are intelligible and intuitive.

Leveraging Enterprise Services - With a semantic life-cycle in place, MDI will accelerate the development of services components for both infrastructure and business operations functions within DOD. Planned capabilities cannot be provided from a single central organization, but must be provided by different components of the Department, working toward a common goal, using common standards, and operating under a common Enterprise Service governance structure managed by the DoD CIO.

Revising Governance - As MDI accelerates the development of services components for both infrastructure and business operations functions within DOD, the "right" governance structure is imperative due to the complexity of the DoD environment.

The Deputy Chief Management Officer (DCMO) initiatives will result in significant performance improvements in business operations and provide reductions in cost. These initiatives are aimed at transforming the business operating environment in a fashion that will result in fewer systems and smaller projects delivering capability in increments no longer than 12 to 18 months.

1 Introduction

The goal of this document is to describe how the Department of Defense (DoD) should technically transition its deployed and planned business systems/services to meet the DoD objectives of increased operational efficiency and mission effectiveness while generating cost savings. These objectives are described in the DoD Strategic Management Plan (SMP). They are the foundation of the roles and responsibilities of the Deputy Chief Management Officer[i] (DCMO). Specifically, this document is a plan that addresses the technical restructuring of the Business Enterprise Architecture (BEA), its supporting infrastructure, and business processes and technology management for the Business Mission Area.

1.1 Purpose

The purpose of this document is to provide a plan—a set of initiatives beginning with the move to a dynamic Business Enterprise Architecture (BEA)—to achieve a technical transition to a future state where Service Oriented Architecture (SOA) services and systems use enterprise services[ii], share their information securely for appropriate use and provide enterprise capabilities in agile and cost-effective ways. Today's state is defined by point solutions, redundant technologies and duplicate capabilities that exist under management silos and compete for resources. The future state is achieved when redundancy is eliminated and systems and services become interoperable and mission effective because they are agile and compliant with dynamic enterprise requirements, not because they are compliant to static architecture descriptions.

The essence of architecture is a blueprint – a plan of what is desired to be built. We know that this notion works for buildings and other physical works. For hundreds of years, working from blueprints, each craftsperson knows exactly what they must do and how their work fits into the work of others. They understand the meaning of the blueprint, perhaps not all of it, but within their domain, they know what to do and they have been trained in how to do it. The parts of the construction fit together as they are being built, and interoperate when put into service.

However, this has not always been the reality for architectures used to describe business operations because business architectures have not been executable, or often provably implementable. The technology did not allow this dream of business architects to be even remotely achieved – until now. Today, there exists the means to make the BEA a dynamic architecture. It will be implementable, able to be executed and provide capabilities directly. By leveraging existing technologies pioneered by the Department, and now championed by the public, the BEA will be used all the way through system development, and it will be detailed enough to drive solutions. The BEA will also continue to provide its original purpose, a means to achieve compliance throughout the system development lifecycle.

The BEA will be the foundation of the modeling efforts of a Model-Data-Implement (MDI) process, shown below in Figure 1. Within the overall Service Life-Cycle Methodology, the MDI consists of these three steps:

- Modeling the business capability to be deployed
- Preparing and populating a modern information model and data store
- Implementing the capability by deploying business services

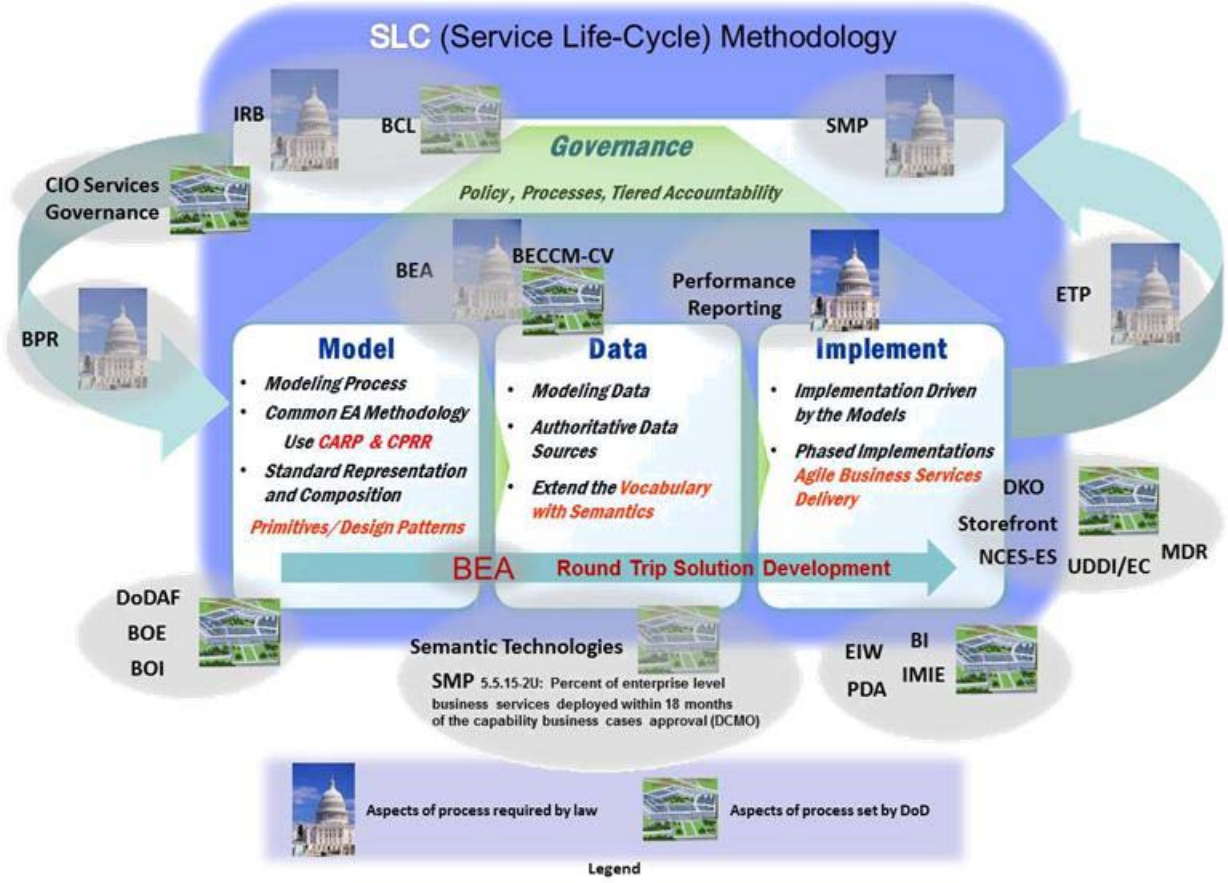


Figure 1: Model-Data-Implement in the Service Life-Cycle Methodology

To realize this approach, the ODCMO will align the governance of Business Operations and the BEA with DoD enterprise services governance. The ODCMO will work directly with the Military Department Chief Management Officers, infrastructure providers, DoD Chief Information Officer (CIO), Combatant Commands, Defense Agencies and the federal community to achieve this *technical transition*.

This document describes how the *technical transition* leverages enterprise architecture (EA), enterprise services and semantic technologies through a set of key initiatives, *aiming at reducing total cost of ownership for DoD Business Operations.*

1.2 Guiding Principles

The following sections review the work done by the DCMO and provide an overarching vision for moving forward based on one unifying principle: *Leverage technical transition to reduce total cost of ownership for DoD Business Operations IT.*

This unifying principle is supported by eight related initiatives:

1. Create a common understanding of data and processes
2. Use DoD mandated data and technical standards for technical transition
3. Determine and enforce the use of authoritative and accountable sources for data
4. Integrate DoD Business Operations Governance, DoD IT Technical Governance and Federal Governance
5. Apply Semantic Technologies based on identified standards.

6. Centralize Business Intelligence (BI) to support Department-wide Business Operations
7. Mitigate duplicative data to reduce storage requirements and eliminate duplicative services
8. Minimize redundant development by ensuring services are reused when needed, either directly by applications and systems, or in composite services, including automated business processes.

The initiatives strengthen the utility of architecture in creating real solutions to business requirements by creating architectures that are implementable and even executable. An architecture is *implementable* when there is a clear correspondence between elements of the architecture and components of an actual system solution, with a clear process for creating the latter from the former. This is especially true if the process can be further automated, such that the code and configuration for the system components can be generated automatically from the architectural elements. When architectural elements (such as a Business Process Modeling Notation - BPMN model) can directly drive a runtime engine to accomplish business goals, or semantic knowledge models from the architecture can be consulted actively at run time to accomplish business goals, then the architecture is *executable*.

There are three key concepts employed in realizing these initiatives, *net-centricity*, *interoperability*, and *federation*. ***Net-centricity*** refers to the interconnection of systems for the exchange of information, allowing each system to focus on its primary concerns, so that each can provide information within its domain and share it with others, reducing redundant efforts to capture and qualify data. ***Interoperability*** refers to the ability of two or more systems to work together effectively in the accomplishment of a business goal that neither could do alone—achieving this requires that they be integrated. ***Federation*** refers to the coordination of multiple organizations, efforts or systems that are effectively doing the same thing, but with appropriate division of labor (over disjoint domains, for instance) and effective overall governance and guidance, such as the many State Governments in the United States, and the overall role of the Federal Government.

1.3 Business Operations Technical Transition Initiatives

DCMO initiatives will result in significant performance improvements in business operations and provide reductions in cost. These initiatives are aimed at transforming the business operating environment in a fashion that will result in fewer systems and smaller projects delivering capability in increments not longer than 12 to 18 months.

To accomplish this transition, the DCMO will:

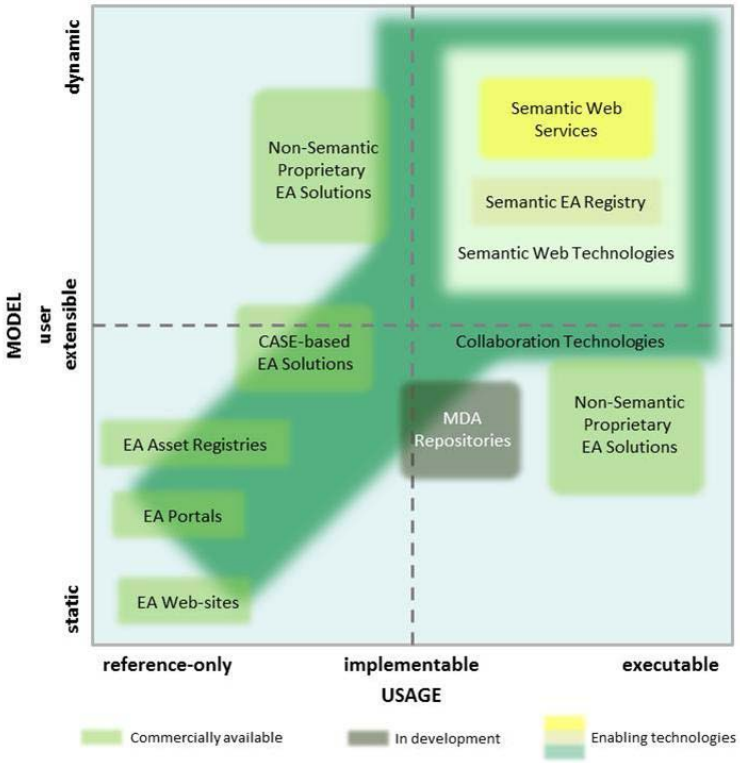
1. *Evolve the Business Enterprise Architecture to insure systems* interoperability and architecture federation. Take advantage of World Wide Web Consortium (W3C) and Object Management Group (OMG) standards and Semantic Technologies.
2. *Move to Model-Driven Architecture*. Use the proven three-step Model-Data-Implement approach to develop capabilities as reusable services, driven by the BEA.
3. *Establish Centralized Business Intelligence*. Centralize reporting functions on performance improvement and performance management by leveraging Semantic Technologies.
4. *Leverage Enterprise Services*. Take advantage of standard DoD infrastructure including cloud computing and common infrastructure services.
5. *Revise Governance*. Add information model governance and instantiate its initiatives with policy, instruction and guidance for portfolio management and data governance.

2 Evolving the Business Enterprise Architecture

Building on the experience of establishing the *Federation Strategy's* initial Business Operating Environment, this section describes how to move Enterprise Architecture forward so that it plays a central role in achieving Net-Centricity, Federation and Interoperability. Specifically, this section focuses on two keys for transitioning the BEA:

- Evolving Architectural Compliance to set the stage for implementable architecture
- Using architecture to achieve interoperability

The BEA will transition through the Enterprise Architecture solution space from static, reference-only architectures toward dynamic, executable architectures. Figure 2 illustrates this.



Based on a Diagram from TopQuadrant, modified for this paper's purposes.

Figure 2: Moving Forward with Enterprise Architecture

Annually the BEA serves as the articulation of requirements that reflect the investment community objectives. It then guides pre-Milestone A acquisition decisions that select and plan for systems and services. Systems under development target compliance with the version of the BEA in effect at their inception. Thereby, compliance is a moving target and is asserted through a manual mapping process to a static set of architecture models that describe the target version of the BEA.

The BEA will become dynamic and executable through the use of semantic technologies and standards - Web Ontology Language (OWL), Resource Descriptive Framework (RDF), Simple Protocol and RDF Query Language (SPARQL) and Business Process Modeling Notation (BPMN). In general, architecture moves from reference to implementable when there are clear and unambiguous processes for developers to create compliant executable components. They become executable when the architectural models become sufficiently specific and semantically rich that they can either be executed directly by runtime facilities, or they can be automatically processed to generate runtime executable code. Systems will be able to assert compliance by linking their models and their data to the Business Enterprise ontology represented in architectural models. In turn, such systems and services will be able to leverage the executable architectural components of the BEA, thereby demonstrating their compliance in

operation. Compliance is driven through implementation and becomes dynamic because it applies throughout the lifecycle of systems and services.

2.1 Trust through Architectural Compliance

Today, compliance means that Programs of Record and the Defense Business Systems (DBSs) they encompass demonstrate by assertion that they are aligned with specific Laws, Regulation, and Policies (LRPs), business rules, data synonyms and attributes for the portions of the BEA that cover their functionality. BEA Compliance allows for a level of trust that a particular DBS is in compliance with appropriate policies.

Systems and Initiatives delivering capabilities and functionality are reviewed and approved by the Investment Review Boards (IRBs) and Defense Business System Management Committee (DBSMC) based on their stand-alone solution architecture.

Tomorrow, compliance with the BEA will be based on 'linkage' between business process models and semantic vocabularies of the DBS solution architecture and those of the BEA. This provides several benefits to the programs that leverage the BEA.

1. Trust that compliance with the BEA provides compliance with the policies that the BEA articulates.
2. Trust that compliance with the BEA provides a level of "guarantee" that one particular program will be able to interoperate with another program that is also compliant.

The compliance that will allow for this trust to exist will be enabled by utilizing a combination of Model Driven Architectures and Semantic Technologies to develop and represent architecture content. These two capabilities combined make up the approach, pioneered by the DCMO called Model-Data-Implement, and is discussed in detail in Section 3 of this document.

2.2 Interoperability through Architecture

Future versions of the BEA will leverage Semantic Technologies to create and document a common vocabulary and associated ontology, establishing business service interoperability through a semantic layer in the BEA. The BEA provides the overall governing layer for the BMA in DoD, defining the scope and boundaries of Component and program architectures. This is in line with Tiered Accountability, a key concept in the federation of DoD IT capabilities. Simultaneously, the BEA operates as a federated component of higher level DoD and overarching Federal Government architecture models. This is illustrated in
Figure 3.

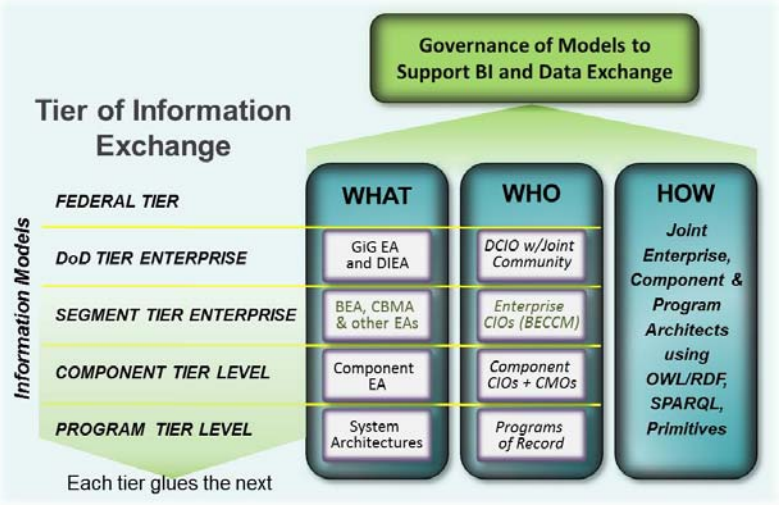


Figure 3: Tiered Accountability through Information Models
(This model maps to the Defense Information Enterprise Architecture.)

Business system and service interoperability results from a number of factors:

1) Architectures specifying systems and services are properly federated and organized, as shown in the diagram above, providing common vocabulary(ies) and standard patterns using modeling techniques such as the Business Process Modeling Notation (BPMN) Analytic conformance class and the related DoD Primitives[1] Design Guide among others.
2) Systems and services then use the common or standard vocabularies set out in the architectures to express the data that they exchange in order to integrate. Standard ontologies define the semantics of the vocabulary so that all recipients of the exchanged data are able to determine the meaning of the data they receive.
3) Systems and services are built using the common set of standards and patterns for integration defined in the architectures and related guidance for interconnection so they can make effective use of capabilities provided by other systems and services, eliminating ad hoc, costly and laborious interface development to adapt one to the other. This is an essential benefit of SOA.

The Business Enterprise Common Vocabulary (BECV) is being developed through the DCMO Common Vocabulary (CV) initiative. The CV initiative's goal is to make data understandable and interoperable across the Department within the Model-Data-Implement construct. It provides the basis for the specification of the common vocabulary and semantics in the BEA, and leverages Semantic Technologies such as RDF and OWL to create standard semantic models. This work will be governed by the Department's End to End Governance Board.

The strategy moves the CV and Semantic Technologies into the mainstream of DoD's system and service development, acquisition, deployment and operation. This will increase agility and flexibility in the face of emergent and rapidly changing requirements, improving support to the warfighter and decreasing costs of developing and maintaining software solutions.

[1] *Primitives are the set of symbols, and the rules that govern their use, in building Business Process Models. They are called primitives because they are a redaction of the full Object Management Group (OMG) BPMN standard into a subclass known as the "Analytical Conformance Class Version 2.0. Primitives are to building Architectures as notes are to writing music.*

3 Moving to Model Driven Architecture

Model-driven Architecture (MDA) is an established approach to the design of complex systems that is based on the successive refinement of architecture models, from abstract, platform-independent models to implementable, platform-specific models. This approach has been defined by OMG in a 2001 white paper[iii] and is widely accepted as a structured design approach to (information) systems. While MDA is popular for analysis purposes, there often is a gap between the platform-specific models and actual system implementations. An advanced version of MDA calls for Model-driven Execution (MDE), where the actual behavior of a running system is controlled by and fed back to a set of models that describe the operating concepts of the system. In certain domains the goal of MDE has been achieved (for example in workflow management systems that are driven by a graphical representation of the executable process), but in the data management area, challenges remain.

Model Driven Implementation (MDI) is an approach designed to achieve architectural "round-tripping" through the use of Semantic Technology as part of its modeling, solution generation and runtime phases. Architectural "round-tripping" is the translation of information from models to executable code, and the propagation of changes at the executable level back to the conceptual models.

As shown in Figure 4, MDI is a three step approach with the following structure:

1. **Model** the business capability to be developed in terms of baseline vocabulary, rules, and end-to-end (E2E) processes.
2. **Data:** Extend the baseline vocabulary with semantic content, additional terms and rules, i.e. build an ontology which allows unambiguous understanding of the vocabulary in the context of the business capability.
3. **Implement** the capability and deploy it as a business/data service

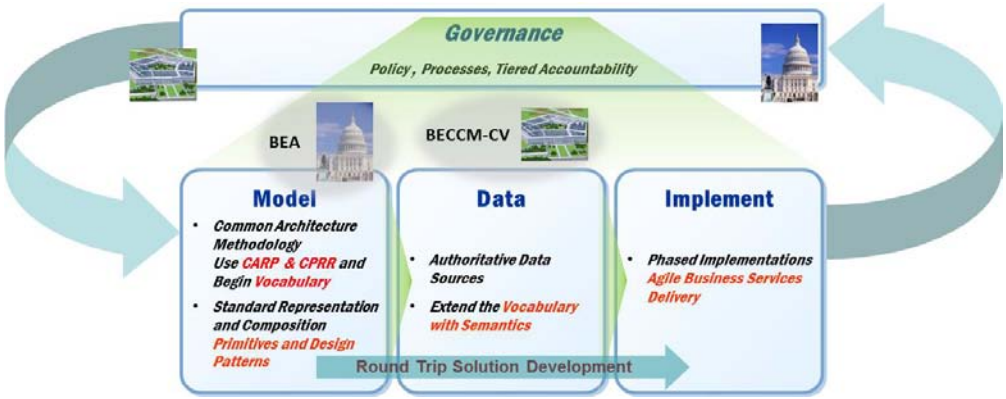


Figure 4: The Model-Data-Implement Pattern for Achieving Interoperability and Agility in DoD Business Operations

To realize round-trip architecture, the MDI approach uses a structured process to elicit the baseline vocabulary (called CARP (Capabilities, Activities, Resources, Performers)), a process to develop structural rules (called CPRR (Concepts, Priorities, Relationships, Rules)), and a bottom-up process for the refinement of the vocabulary. In order to represent end-to-end processes we rely on the analytic conformance class of the OMG BPMN. Business rules are represented using the OMG Semantics of Business, Vocabulary and Rules Structured English format (SBVR-SE)[2]. Both BPMN and Semantics of Business, Vocabulary, and Rules (SBVR) are complemented by the Primitives design guidance issued by the DCMO. The domain information and the resulting ontologies are represented using the Semantic Technologies OWL/RDF, and can be queried using SPARQL. The Semantic

[2] *SBVR-SE is an OMG standard that defines the vocabulary and rules for documenting the semantics of business vocabularies, business facts, and business rules. SBVR-SE in combination with the evolving W3C Rules Interchange Format (RIF) provide mechanisms for executing Business Process Models.*

Technologies address input and output, the Primitives address workflow and rules, and the methodology for building architectures addresses how to put these building blocks together.

The MDI approach can be used to incrementally field capabilities in short timeframes, as has been shown in the Enterprise Information Web (EIW) Project. EIW Proof of Deliveries (PoDs) take 60-90 days and are reusable. This breaks the habit of attempting to field large, multi-function business systems that take years to implement and are costly to develop and maintain.

3.1 Model-Data-Implement — Step 1: Model

The first step of MDI, modeling, starts with architectural descriptions, Enterprise Architecture and Primitives-based Modeling. Standardized approaches to modeling architecture descriptions, such as the Primitives approach developed by the DCMO, generate models that are both grounded in the Semantic Technologies described here, and are the basis of generating executable specifications directly, without requiring human translation into programming languages.

3.1.1 Vocabulary-Driven Architecture Development

Enterprise Architecture modeling requires a shared understanding of the problem domain among all stakeholders. Such an understanding is best built on the foundation of a common vocabulary. The CARP process provides structured guidance for the development of a baseline vocabulary. One iteration of the CARP loop provides a seed vocabulary of Capabilities, Activities, Resources and Performers that form the basis of: capability taxonomies (i.e., dependencies among the desired capabilities of a system) end-to-end business process models, and conceptual data models This is the first step toward the rigorous documentation of Business Rules necessary to execute the model. The figure below depicts the CARP process and shows its role in determining key architectural characteristics that need to be captured in EA.

The development of federated architectures should be conducted in a format compatible with the DODAF 2.0 MetaModel (DM2) Taxonomy. Since the DM2 provides a large number of constructs, architects need to prioritize certain information classes over others. The CARP process is a vehicle that assists in making these decisions. It mandates that the first concepts an architect should document in the DoDAF Integrated Dictionary (AV-2) are capabilities, activities, resources and performers. Once these core concepts are established, other information classes can be documented. By mapping the captured concepts in the AV-2 to the information classes of the underlying DM2 it is possible to trace the relationship between a concept and the different architecture models in which this concept should occur.

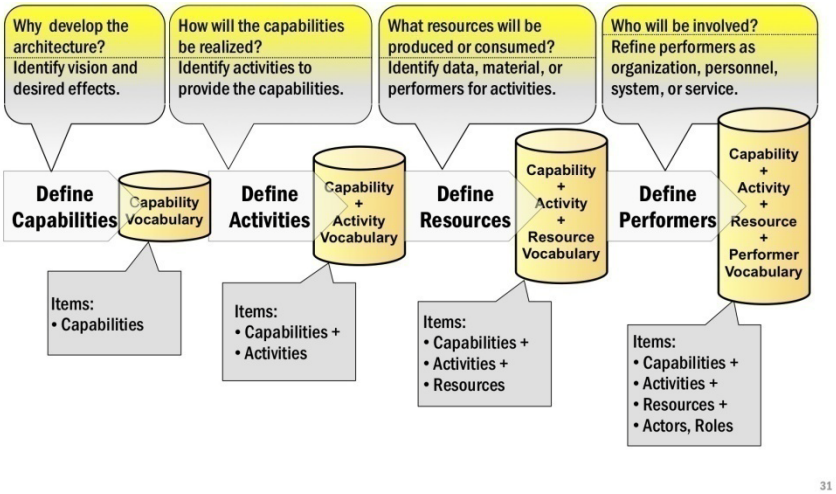


Figure 5: CARP Process

The output of the CARP process is a baseline description of a system's scope, processes, major information objects, and stakeholders. To bring this information into a format suitable for semantic reasoning, CPRR should

be followed. CPRR identifies Concepts, their Properties, Relationships, and Rules that govern properties and relationships. The output of the CPRR process is an integrated vocabulary and rule-base that can be represented in SBVR (for human-readable representation) and OWL/RDF (for machine-readable applications). The figure below outlines the CPRR process.

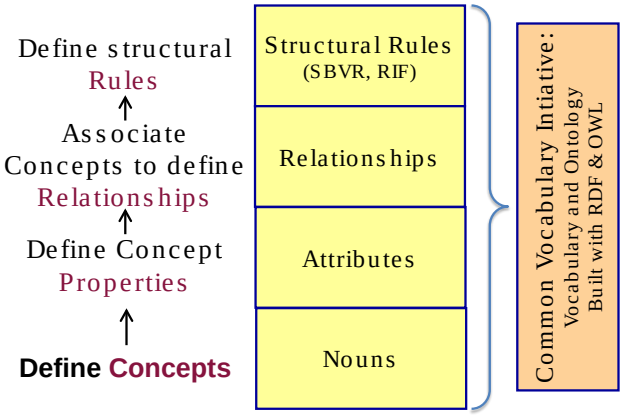


Figure 6: CPRR Process

The application of CARP and CPRR results in a baseline common vocabulary and rule base that is the starting point for additional modeling activities, focused on the identification of end-to-end processes that occur to deliver the capability in question, and the rules that constrain these processes.

3.1.2 Business Processes in a Model-Driven Environment

The scope of systems in the Business Mission Area is defined by the End-to-End processes they support. The processes themselves represent services, and their inputs and outputs define the interoperability requirements that are placed on process customers and participants. An Enterprise Architecture approach to document and design these systems must therefore be based on a detailed understanding of these end-to-end processes.

In order to convey the semantics of a process model in a standardized fashion, the visual representation of the process must conform to the Business Process Modeling Notation (BPMN 2.0) standard, and within that standard to the BPMN Analytic conformance class known as Primitives. Because the underlying data of the BPMN models is represented in RDF/OWL, architecture federation is virtually automatic. The BPMN process models can be transferred to a Business Process execution environment (e.g., a workflow engine or a Business Process Management System) in a BPMN executable serialization format, such as the Extensible Markup Language (XML) Schema defined in the OMG BPMN 2.0 specification, the Business Process Execution Language (BPEL) defined by OASIS, or the XML Process Definition Language (XPDL), defined by the Workflow Management Coalition. In time, the RDF/OWL data representation will itself be executable with no intermediate steps.

Only when the process models are correct, complete, comparable, and systematically designed will integration cost be reduced. The Primitives design guide contains reusable patterns for common modeling scenarios. The consistent use of the Primitives design guide in combination with the well-defined semantics of the BPMN standard ensures that the intended behavior of a process translates seamlessly from the design to the execution environment. In addition, similar process structures and their interfaces can be detected easily, reducing the need to develop new processes whose semantic is already covered by other processes.

3.1.3 Business Rules in a Model-Driven Environment

Business Rules are used to govern the structure and behavior of system components, both human and technical. A typical application for rules in a federation is the creation of compatibility and connectivity constraints between independent elements. In principle, the specification of global rules and their enforcement ensure interoperability that individual elements are unable to ensure by themselves. There are many styles of rules in practical use today, and a very heterogeneous tool base for the definition and enforcement of these rules exists in practice.

Business Rules are specified in a declarative fashion on the basis of a common vocabulary, starting with a set of concepts, properties of these concepts, relationships between the concepts, constraints on the relationships and properties, and – eventually – behavioral rules that govern the actions of the concepts, following the CPRR process described above. Initially, Business Rules are expressed in SBVR-SE. They naturally integrate with a Semantic Technology approach to federation since the specification of a common vocabulary is at the root of both approaches. For technical implementation, the SBVR rules have to be translated into a machine-readable format. For this purpose, the W3C has developed a standard named Rules Interchange Format (RIF), which facilitates the interoperability and exchange of rules between systems.[iv]

3.1.4 Bottom-Up Vocabulary Build Process

The Business Enterprise Common Vocabulary (BECV) is the DoD Business Mission Area's Controlled Vocabulary. Figure 7 below describes an 8-step process that is currently used to develop the BECV from various existing system and COI vocabularies. This process complements and augments the CARP top-down process for developing the standard Common Vocabulary. New sources from systems and COI architectures are mapped against the existing baseline using semantic and lexical mapping techniques. New terms discovered (terms that do not map to existing ones) are added to the baseline, and homonyms and synonyms are de-conflicted and recorded as such, extending the thesaurus. Automated mapping results are validated by DoD Subject Matter Experts as a part of maintaining a high-quality standard for the CV. The result of this process is an updated authoritative baseline vocabulary for the BMA. The CARP process adds additions into the rich ontology that provides the reference semantics for the CV. Both this and the top-down process are iterative, increasing the reach and quality of the CV for inclusion in the BEA and a foundation for systems integration and interoperability.

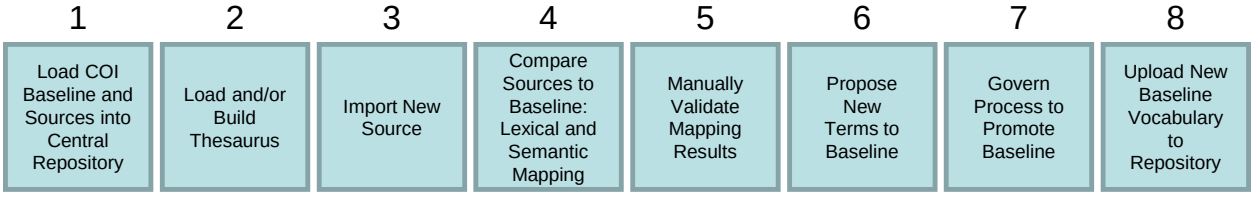


Figure 7: Bottom-Up Vocabulary Build Process

3.2 Model-Data-Implement — Step 2: Data

This step focuses on building information models that are formalized as ontologies using the W3C standards OWL 2.0 and RDF. These ontologies define the core concepts of different Communities of Interest (domain ontologies) and are linked to the information model in the Business Enterprise Architecture, allowing the navigation between different COI ontologies using shared concepts in the BEA ontology.

There are two general pathways that lead to the design of an ontology: An iterative top-down approach, beginning with the CARP process outlined in section 3.1.1, and a bottom-up vocabulary generation process, as described in section 3.1.4. These approaches are not mutually exclusive. An architect can choose to outline the core elements of a system following the CARP approach, build a first ontology following the CPRR process, and then map existing systems to this baseline ontology using a bottom-up process. This generic process for building an ontology uses requirements analysis, design, implementation and test workflows in an iterative manner and results in an ontology that can serve both human and technical systems.

In the requirements analysis workflow, ontology engineers and subject matter experts establish the guidelines for building the ontology, specify the domain of interest, purpose, scope, related use cases and test cases. Using these guidelines, in the analysis phase, the baseline ontology is extended through the integration of existing resources based on the BECV process described in section 3.1.4.

Requirements and analysis workflows support the design workflow. Concepts and their relationships as defined through the CPRR process are further grouped and structured in the ontology design. During the implementation workflow the ontology design is formalized in OWL and RDF in order to be machine understandable. Following

the implementation, a test workflow is used to validate the ontology based on the test cases laid out in the requirements analysis phase. In order to make the ontology and the information model based on the ontology accessible the W3C standard SPARQL that provides a query interface to RDF and OWL ontologies is leveraged. Once the ontology has been defined and tested, the SPARQL endpoints of the ontology are defined and registered so authorized clients can access the information model.

New data sources can be integrated, and incremental prototypes can be realized through iterations of the BECV process from step 2 onward. This iterative building approach leads to continually improving data quality by building and refining domain representations from feedback provided by all users. Semantic Technologies enable this approach. They do not require a fundamental redesign of the baseline ontology, but allow for the information model to grow naturally.

3.3 Model-Data-Implement — Step 3: Implement

The implementation step is driven by the models and data generated in the previous steps. One goal of the IT strategy transformation is to achieve architecture round-tripping through a model-driven approach to the development and deployment of DoD Business Mission Area IT solutions. Architecture round-tripping is accomplished when a solution architecture results in executable code and changes to executable code get captured and described in solutions architecture with very little, if any, human intervention. The major building block for this strategy is a SOA environment based on Semantic Technology. Key components of this environment are SOA Services, a Business Rules Engine, and a Business Process Automation engine.

In a model-driven environment, models are created of the current state (as-is) and the desired solution state (to-be), and can be created with sufficient detail so that the necessary technical products that can be deployed for execution can be generated, or that the models can be executed directly in the appropriate run-time environment, such as a Business Process Automation engine. Within the DoD environment, at the least, the models will serve as a specification to buy or build commercial services or applications.

The Business Process Automation engine will instantiate and execute the process models created in the model step of the MDI approach. It will call on the Business Rules engine when decisions need to be made through the execution of appropriate business rules. It will also call on SOA services to accomplish particular steps in the business processes, as defined in the process models. The Business Process Automation engine may interact directly with human users if it is a workflow management system, or it may indirectly interact with humans via the capabilities of the SOA Services and the applications that expose such services. The basic interaction between the different components is shown below in Figure 8.

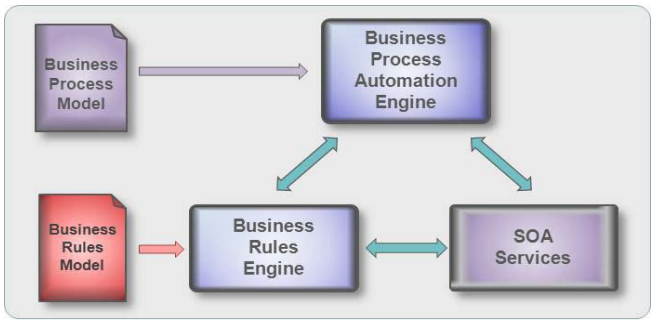


Figure 8: Process and Rule Models in MDI

The initial source of the models is based on an overall reference architecture such as the BEA. The models are further detailed in federated architectures and solution architectures, to the point that they are suitably detailed for execution. When changes to these detailed models can be automatically propagated to the more abstract models at higher levels, then the overall objective of architecture round-tripping has been achieved.

3.4 Service Lifecycle Management

Establishing clear and concise guidance for all current and future business service programs will require a consistent understanding of the tasks and controls established for developing and deploying business services. Developing and deploying effective business services is a business process in itself. As such, it is appropriate to apply enterprise architecture disciplines to establishing a Service Lifecycle Methodology (SLM), Figure 9. The Model-Data-Implement Methodology has already utilized these disciplines to drive the Model and Data portions of the methodology in Sections 5.1 and 5.2. These also represent the first two phases of an SLM as described by Figure 9.

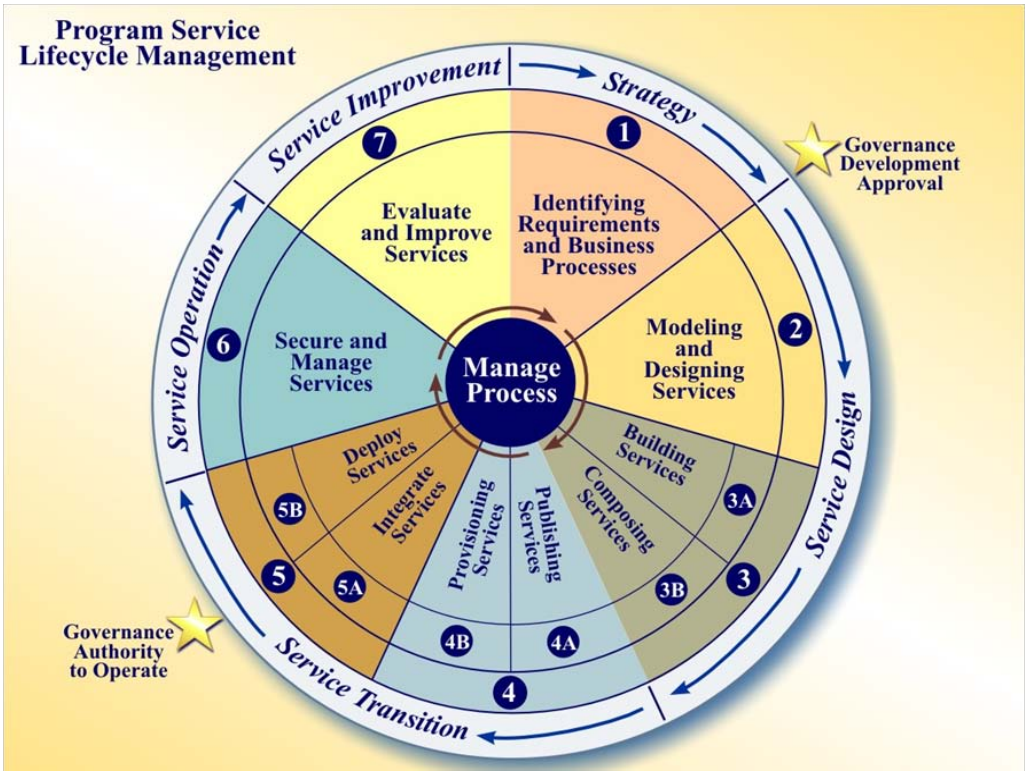


Figure 9: Program SLM Concept Definitions[v,vi]

The seven phases of an SLM are:

1. Identify Requirements and Business Processes—the effort to establish the scope of the capability to be delivered by the proposed service. The capability is defined by the business processes supported, the vocabulary used to describe the process activities, data and outcomes, the business rules to be applied and the performance requirements to be met.
2. Model and Design Services—translating the requirements into a service description that can be used by programmers to build the service. Articulating the service description in terms of architecture data and views and the standards to be applied.
3. Build and Compose
   a. Building Services—creating the complete service design package that includes the executable code for the proposed service.
   b. Composing Services—orchestrating the proposed service with the overall process and service end-points within the target business service environment.
4. Publish and Provision

a. Publishing Services—exposing the proposed service description to the target business service environment along with its end-points and metadata.
b. Provisioning Services—preparing the proposed service for deployment by acquiring the infrastructure capability, preparing the user community, and establishing the metrics for performance monitoring.

5. Integrate and Deploy
   a. Integrate Services—ensuring that the target business and infrastructure service environments are fully prepared to receive the ready to be deployed service. This includes all the change management activities to ensure the maximum user experience and approval for acceptance into the capability portfolio. Scheduling deployment consistent with capability portfolio transition planning.
   b. Deploy Services – initiating Business Activity Monitoring (BAM) that tracks and informs users of the state-of-the business events of the business service environment, including the new or revised service, as they are tied to the infrastructure events. Users will be made aware through BAM in changes in the service's ability to meet Service Level Agreements (SLAs).
6. Secure and Manage Services—completing information assurance certification and accreditation to ensure a fully operational BAM and customer support capability.
7. Evaluate and Improve Services—monitor the customer and user experience and performance metrics and outcomes. Inform the appropriate service capability portfolio manager of issues and service gaps in order to support capability portfolio continuous process improvement and subsequent new BPR.

The benefit of partitioning the SLM is so that clear entrance and exit criteria can be described for each phase and that each phase can be monitored and reported. Performance metrics can be established around each phase and dashboards created to provide visibility to the service delivery processes.

3.5 Key benefits of Interoperability through "Model-Data-Implement"

As stated earlier in this document, DoD will realize significant savings by improving interoperability. Currently there are many impediments to accomplishing this goal but those can be overcome by establishing the trust required to have a true interoperable environment. The Model-Data-Implement approach and utilization of semantic understandings and relationships, along with governed federation and discipline of the various elements of each phase of the SLM, will establish that trust.

4 Establishing Centralized Business Intelligence

This section describes leveraging architecture for managing Business Operations through Business Intelligence (BI).

The transition from the current BEA to a semantically enabled BEA will provide for a new level of interoperability and data integration in business systems capabilities. It will facilitate the ability to create an enterprise-level Business Intelligence reporting function through a Centralized Business Intelligence Initiative. This function, when executed using Semantic Technologies, it could reduce the cost of DoD business operations reporting by $840 million over three years[3].

BI uses as its foundation the work of the Business Enterprise Common Vocabulary initiative and other ontology development work. These ontologies, when formalized through OWL/RDF and queried through SPARQL, provide semantic information to enable advanced distributed BI and analytics. Semantic tools exist today that provide advanced search and analysis functions. Planned BI capabilities will pull together information from across DoD transaction systems, then analyze and present this information to users in ways that are intelligible and intuitive. This is illustrated in Figure 10 which depicts the role of semantic capabilities in DoD Business Operations.

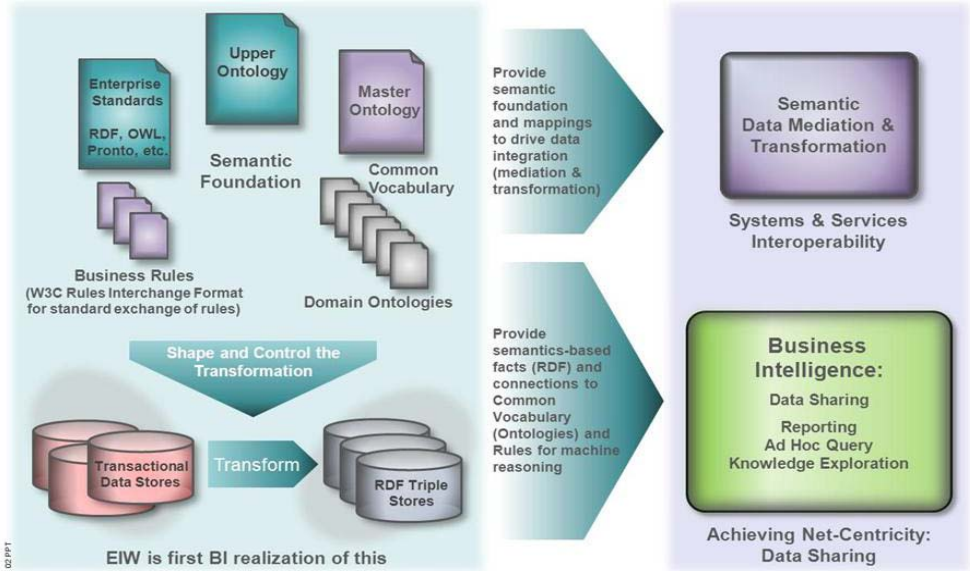


Figure 10: The Semantic Landscape in DoD Business Operations

Semantic Technology is used to drive semantic data mediation and advanced Business Intelligence.

The remainder of this document provides the DoD strategic approach for applying this pattern to achieve much greater and more efficient interoperability across DoD Business Operations, and an outline of how this will be governed.

[3] *The Business Value of Semantic Technology: From Vision to Mainstream Markets, 2000 – 2010; TopQuadrant, Mills Davis April 7-8, 2005.*

5 Leveraging Enterprise Services

With a semantic life-cycle in place, MDI will accelerate the development of services components for both infrastructure and business operations functions within DOD. With this acceleration of service offerings, DCMO will have the means to blueprint a coordinated infrastructure plan, together with the DoD CIO and DISA, to meet the technical capability requirements (i.e., the Business Operations Infrastructure or BOI) of the Business Operating Environment. This infrastructure was first described in *Federation Strategyv2.4 (Federation Strategy)* and was referred to as the Business Transformation Infrastructure. This section presents the overall plan and approach for completing the realization of the Business Operating environment (BOE) and BOI. Planned capabilities cannot be provided from a single central organization, but must be provided by different components of the Department, working toward a common goal, using common standards, and operating under a common Enterprise Service governance structure.

The activities covered in the technical transition plan will do the following:

1. Update each BOI pattern to support Semantic Technology requirements
2. Link the BOI patterns into the Business Enterprise Architecture in its proposed future form
3. Identify existing or planned Enterprise Services (ES) to meet the BOI components
4. Require and create a business case for new Enterprise Services based on industry benchmarked cost models and to include the future computing environment/s
5. Sponsor, along with an appropriate DoD service provider or COI, the BOI requirement as a candidate Enterprise Service
6. For each Defacto Enterprise Services, sponsor the service as a Candidate Enterprise Service

This plan leverages, to the greatest extent possible, existing and planned Enterprise Services. DoD-wide Enterprise Services are enterprise capabilities to achieve an efficient, effective, interoperable DoD Information Environment, assisting DoD to acquire new information capabilities rapidly and at low cost.

The following table describes the three formal designations for Enterprise Services as well as two designations that characterize services still awaiting formal designation.

Enterprise Service Designation or Status	Description
Mandatory Core Services	Designated DoD Enterprise Service providing enterprise-wide access and use of information in an efficient, effective, interoperable shared infrastructure.
Shared Services	Designated DoD Enterprise Services enabling capability(ies) to enterprise applications; not core to the infrastructure or a functional capability and not mandatory
Functional Capability Services (*includes Enterprise Business Services*)	DoD Enterprise services that provide functional capability across the DoD; includes enterprise wide business and war-fighting capabilities.
Candidate Enterprise Service	A candidate service is one which has started the on-boarding process and has a service sponsor, but has not received endorsement through appropriate governance.
Defacto Enterprise Service	Service which, due to wide scope of use and adoption within the Department, plays the role of an Enterprise Service, even though it has not been designated as such.

Table 1: Enterprise Services Designations[vii]

The plan looks to DoD Segment Owners of Enterprise Services to field them. The Segment Owners are for, non-Functional Capability Enterprise Services, fall into three categories – these categories are often called "Core" services by Industry.

The BOI requirements primarily are met through Enterprise Services which fall into the IT Infrastructure and Cyber, Identity and Information Assurance Segments.

The Model-Driven Architecture methodology leverages Enterprise Services during the Implement step to further reduce development cost and shorten development time. Figure 11 illustrates how the Model-Driven Architecture's Model-Data-Implement approach can leverage existing Enterprise Services.

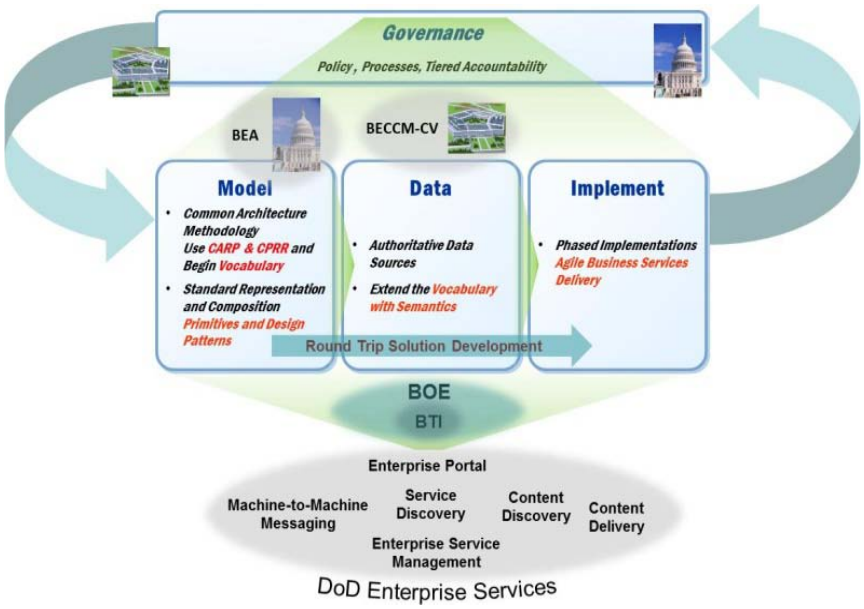


Figure 11: Moving Forward with for Business Operations Technical Transition

5.1 Business Operations Infrastructure Met Through Enterprise Services

Since releasing *Federation Strategy and Roadmap v2.4,* additional constituents of the Business Operating Environment (BOE) have been identified:

- Business Intelligence Services
- The Semantic Layer
- Cloud Computing

These three newly visible components extend the concepts of the Business Operating Environment and its primary component - the Business Operating Infrastructure (BOI).

Business Intelligence (BI) Services are the foundation for an Enterprise standard approach and competency for Business Intelligence including information access, analysis and presentation, based on the semantic approaches pioneered with EIW and emerging commercial technology. The Semantic Layer provides the standard vocabulary for information exchanges and the ontologies that create the machine processable meaning that allows system processes, such as those in the BI Services, to exchange information with a minimum of one-off interfaces and specialized adaptation processing. Cloud Computing is introduced to extend the concept of DoD Infrastructure Services, further loosening the coupling between the provision of computing capacity, its management, and the standup of business solutions. This also increases DoD agility with the ability to increase an application's capacity on short notice, to accommodate surge requirements as situations demand. Such Cloud Computing capability is based on the extended uses of virtualization technology now making its way into the mainstream of IT operations.

Figure 12 shows a projection from the original graphical concept of the BOE to the extended set of layers to be found there, now including Business Intelligence Services, The Semantic Layer and Cloud Computing. This

diagram also shows a basic notional allocation of the BOE/BOI constituents to providers of the capability. Each of the technical components depicted here, from top to bottom, have designated, candidate or defacto Enterprise Services which meet them. As the BOE matures, they will all have mature and supported designated Enterprise Services to make available the capability in support of DoD business operations.

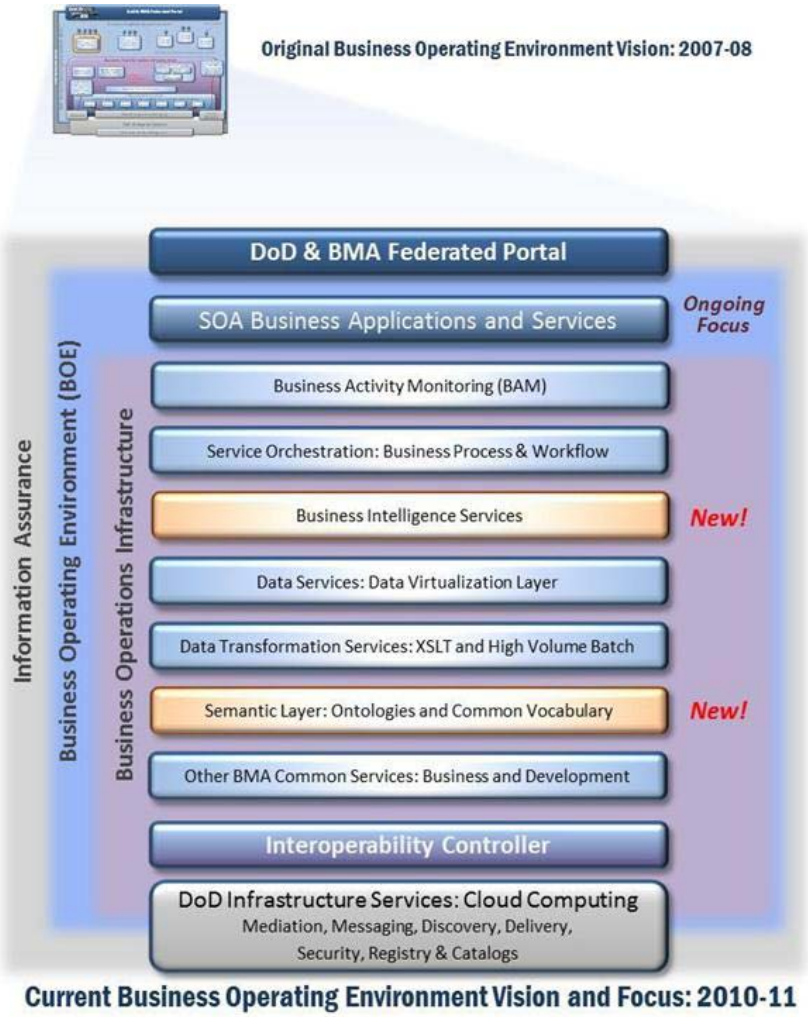


Figure 12: The Constituents of the BOE/BOI and the DoD Capability Providers of Each

The basic plan and approach for the realization of each of the constituent capabilities is provided in Table 2 which maps the existing, candidate and defacto Enterprise Services to the BOI. To see a pattern and description of each BOI component, please see Appendix A.

BOI Component	Service, Provider	Designation	Issue
DoD & BMA Federated Portal	Emerging DISA Enterprise Portal	Defacto	Designation, Cost
	CIO Storefront, DoD CIO	Candidate	Designation, not complete
DoD & BMA Federated Service Registry, Data Catalog and Metadata Registry	Metadata Registry (including its components), DISA NCES	Mandatory Core	Not compliant to semantic requirements

Service Discovery	Service Discovery, DISA NCES	Mandatory Core	
Interoperability Controller	Global Exchange –T (GEX), DLA	Shared	Future state, Not complete, designation, transition
Machine to Machine Message	Machine to Machine Messaging, DISA NCES	Shared	
	Global Exchange (GEX), DLA	Defacto	Designation, in transition
Information Assurance and Service Security	Partially met through Enterprise-wide Access to Network and Collaboration Services (EANCS), DoD CIO/DISA	Candidate	Not Complete, 2 year horizon, Designation
Business Process and Workflow Automation	Emerging DISA Enterprise Portal	Defacto	Cost, Designation, Not Standardized
Mediation	Global Exchange (GEX), DLA	Defacto	
Development Services	FORGE.mil, DISA	Defacto	Cost, Designation, Development environment cannot access external service end points
Cloud Computing	RACE, DISA,	Defacto	Cost, Designation, Development environment
Semantic Layer – Common Vocabulary	CV Tool, DCMO	Defacto	Designation, Not compliant to semantic requirements for building info model
Semantic Business Intelligence	Enterprise Information Web, DCMO	Defacto – HR	Designation, Pathfinder, Scope restricted to DIMHRS
	Business Information Enterprise Systems	Defacto – FM	Designation, Environment for Semantic BI required
Enterprise Service Management	Enterprise Service Management, DISA NCES	Shared	

Table 2: BOE/BOI Components Met through Enterprise Services

5.2 Business Operations Infrastructure Desired as Enterprise Services and Federation

While many of the BOE/BOI components are met by Enterprise Services today, many are not. And in cases where they are met, often the full, desired capability does not exist. When a need for a specific technical capability exists and has been described, but is not met by the Enterprise, DoD Components may feel compelled to acquire them. These acquisitions are done independently without a view to reuse across the Enterprise. While well intentioned, this invariably leads to proliferation of Service-Oriented Architecture stacks in Programs of Record and the requirement to federate SOA infrastructure between programs.

Currently, the following BOE/BOI components are not met at an enterprise infrastructure level, but an equivalent capability may exist within a Program of Record.

BOI Component	Service, Provider	Designation
Identity and Access Management		
Data Virtualization	None	
Service Wrappering	None	
Service Choreography	None	
Service Orchestration	None	
Development Services	None	
Rules Engine	None	
Business Activity Monitoring	None	
Data Integration		

Table 3: BOE/BOI Components not yet met through Enterprise Services

The office of the DCMO is committed to work with the DoD CIO and with DISA to either discover these BOI components for reuse, or to cause them to be built as enterprise services.

6 Revising Governance

As MDI accelerates the development of services components for both infrastructure and business operations functions within DOD, the "right" governance structure is imperative due to the complexity of the DoD environment. This section describes how services are to be authorized for use and to what degree and when they must be used in order to achieve our interoperability goals.

6.1 DoD Enterprise Service Governance

Across the DoD Enterprise, DoD CIO led IT governance exists to "identify, designate, and oversee the delivery of enterprise solutions by establishing a mechanism that motivates providers and customers to both use and advance" Enterprise Services as enterprise solutions. These ENTERPRISE SERVICEs fall into three formal designated categories, discussed in the above Section 5: Mandatory Core, Shared, Defacto, and Candidate.

The DoD Enterprise Services are meant to be leveraged by Components as an enterprise level foundation for Net-Centricity, Federation and Interoperability. The Enterprise Service Governance Process and Structure work in conjunction with the Business Operations Governance for Enterprise Services and Information Sharing. As candidate Enterprise Services are on-boarded through the Enterprise Service process, those services which are designated as Functional Capability Enterprise Service are passed to the Segment Owners for implementation through their respective governance processes. To the extent possible, DoD Functional Managers looks to the DoD Enterprise to provide commonly needed infrastructure capabilities and services that will be used across the enterprise, as described by the Department of Defense Information Enterprise Architecture (DIEA).

6.2 DoD Business Operations Governance

DoD Business Operations governance must address policy, oversight and facilitation of the Business Operating Environment in order to enable Net-Centricity, Federation and Interoperability.

As such, it must accomplish the following:

- Revise governance structure for portfolio management and data governance. Add information model governance and instantiate the initiatives with policy, instruction and guidance.
- Reform acquisition strategy to distinguish BI/analytics projects from major information systems.

Business Operations functional capability services are any which show in the BEA. DCMO takes lead over the governance process which defines and enables them through the E2E Governance Board.

6.2.1 Necessity for Information Sharing Governance for Acquisition and Portfolio Management

It is DoD policy that Information shall be considered a strategic asset to the Department of Defense; it shall be appropriately secured, shared, and made available to those performing DoD's mission. This means:

- The information itself and the Department's oversight of the information life cycle must be managed.
- The processes, including risk management, associated with managing information to accomplish the DoD mission and functions must be governed
- Activities related to designing, building, populating, acquiring, managing, operating, protecting, and defending the information enterprise must be overseen

- Related information resources such as personnel, funds, equipment, and IT, including national security systems must be controlled

In order to ensure the above requirements are met, this plan recommends that an information sharing steering group be convened as part of the End to End Process Governance Board. As one of its responsibilities, this board will be responsible for meeting the requirements identified in the above bulleted list for DoD Business Operations and governing the Business Enterprise Common Core Metadata COI (BECCM).

6.2.2 DoD Information Sharing Governance and the Common Vocabulary – BECCM COI

The BECCM COI shall govern information exchanged between and across End to End business processes at the DoD Enterprise Tier. This is the common core for the DoD Business Operations.

The Department of Defense (DoD) has placed a high priority on common vocabulary governance in order to tighten the strategic alignment of programs and assets to the core mission of the warfighter. The creation of the DCMO and in turn the BECCM COI is an outgrowth of this priority.

The BECCM COI seeks to reach consensus on business and technical data standards across the BMA, the Enterprise Tier. Accordingly, its membership has been designed to be representative of the existing oversight structures within the Department.

Typically, the BECCM will stand up a working group (WG) of Subject Matter Experts (SMEs) representing the effected domains. This working group will then look at the business and technical contextual use of the topic and make recommendations to the BECCM for mediation.

Standards agreed upon by the BECCM are updated to the common vocabulary baseline of the BEA. Once in the BEA, these standards are then referenced for compliance when systems come before an IRB for review.

7 Conclusion

The Office of the DCMO is tasked to ensure that the business operations of the Department are effective, efficient and supportive of the needs of the Warfighter. Currently, this operating environment can be characterized as an environment where data and capabilities are not seamlessly shared, which results in many redundancies in capabilities and data.

Building the business operating environment described here using DoD developed methodologies and practices including MDI, CARP and others, based upon open standards including BPMN – OMG Analytical Conformance Class, and Semantic Technology standards - W3C will give the department major advances from today's world.

> **Visibility** – that is, ability to pull and display data in real time or near real time from the authoritative source – no matter where that source is;
>
> **Agility** – when assets, the data, are unambiguously described, the entire environment becomes plug-and-play. Graph based models are by definition infinitely extensible, linkable to one another and therefore straight forward to change.
>
> **Federation** – domain vocabularies described in RDF/OWL and an ontology that describes how domains are related means that federation, linking architectures is virtually automatic.
>
> **Savings** – today, a significant part of the DoD IT budget is spent in the meaningless process of converting one data format to another. In the industry, this is referred to as Extract, Transform, Load or ETL. Once a cottage industry, building translation maps and interfaces between systems is today a major part the DoD IT infrastructure. An ontology makes this unnecessary process unnecessary. There will be no worry about an exact syntax match for sailor or airmen. The ontology says that they are both service members. The authoritative sources can keep their data formats, there schemas - as they want them. A query to the DoD Semantic Technology will find the data. The amount of interface development will be reduced by orders of magnitude.

Executable Architecture – exciting as visibility, agility, federation and even savings are, they are just the tip of the ice berg. While it cannot be said definitively for all but relatively simple business process models, research suggests that an end to end business process modeled using OMG standards can be executed directly by an OMG BPMN Executable format standard-based runtime engine, or even a properly constituted BPEL engine. Standardization of such execution also depends on the processes using DoD standard messages built using the DoD Common Vocabulary defined in the ontologies referenced above, and implementing standardized service interface contracts. In this way, the business processes can by executed in a distributed fashion by DoD components and agencies while remaining demonstrably compliant with the BEA definitions of standard end-to-end business processes. This compliance is ensured because the components and agencies would be executing at the highest level of their process automation exactly the processes defined in the BEA. The (web) services orchestrated by the processes would work with the standard processes, and in many cases, also work directly with the exposed DoD Semantic Technology RDF data. In other words, build the business process model, make it use the common vocabulary and standard messages to interact with services, and have the services use the authoritative data sources and hit run. This is the ultimate goal.

Acronym List

Acronym	Definition
ASRG	Architecture and Standards Review Group
BAM	Business Activity Monitoring
BEA	Business Enterprise Architecture
BECCM	Business Enterprise Common Core Metadata
BECV	Business Enterprise Common Vocabulary
BEP	Business Enterprise Priority
BI	Business Intelligence
BMA	Business Mission Area
BOE	Business Operating Environment
BPEL	Business Process Execution Language
BPMN	Business Process Modeling Notation
BTA	Business Transformation Agency
BOI	Business Operations Infrastructure
CA	Chief Architect
CARP	Capabilities, Activities, Resources, Performers
CBM	Core Business Mission
CIO	Chief Information Officer
COI	Community of Interest
CPRR	Concepts, Priorities, Relationships, Rules
CPU	Central Processing Unit
CTO	Chief Technical Officer
CV	Common Vocabulary
DBSAE	Defense Business Systems Acquisition Executive
DBSMC	Defense Business Systems Management Committee
DCMO	Deputy Chief Management Officer
DIEA	Defense Information Enterprise Architecture
DM2	DoDAF 2.0 MetaModel
DoD	Department of Defense
DoDAF	Department of Defense Architecture Framework
EA	Enterprise Architecture
EGB	Enterprise Governance Board
EIW	Enterprise Information Web
ES	Enterprise Service
ESRG	Enterprise Services Review Group

HR EIW	Human Resources Enterprise Information Warehouse
IM	Information Management
IRB	Investment Review Board
IT	Information Technology
LRPs	Laws, Regulations, Policies
MDA	Model Driven Architecture
MDE	Model Driven Environment
MDI	Model-Data-Implement
ODCMO	Office of the Deputy Chief Management Officer
OMG	Object Management Group
OSD	Office of the Secretary of Defense
OWL	Web Ontology Language
PDA	Performance Data Automation
RDF	Recourse Descriptive Framework
RIF	Rules Interchange Format
SBVR	Semantics of Business Vocabulary and Rules
SBVR-SE	Semantics of Business Vocabulary and Rules Structured English
SLA	Service Level Agreement
SLM	Service Lifecycle Management
SME	Subject Matter Expert
SMP	Strategic Management Plan
SOA	Service Oriented Architecture
SPARQL	Simple Protocol and RDF Query Language
UCore	Universal Core
UI	User Interface
URI	Universal Resource Identifier
W3C	World Wide Web Consortium
WG	Working Group
XML	Extensible Markup Language
XPDL	XML Process Definition Language

[i] See Department of Defense DIRECTIVE, NUMBER 5105.82, October 17, 2008, SUBJECT: Deputy Chief Management Officer (DCMO) of the Department of Defense

[ii] Enterprise Services may be mandatory or shared infrastructure services or functional capabilities. DoD-wide Enterprise Services and Solutions are enterprise capabilities that are meant to achieve an efficient, effective, and interoperable DoD information Environment.

[iii]Object Management Group: Model Driven Architecture (MDA). Document number ormsc/2001-07-01. Framingham, MA, 2001

[iv] This is the RDF/XML representation specified by the World Wide Web consortium, the Rule Interchange Format (RIF). It is based on a common core that is shared by different dialects that accommodate distinct rule representations. The first two dialects are RIF-BLD (basic logic dialect) for logic-based rules and RIF-PRD (production rule dialect) for production-style rules.

[v] Service Lifecycle Model, Air Force Electronic Systems Group, Enterprise Integration and Service Management, Maxwell Air Force Base – Gonter Annex, Al.

[vi] Service Design Phases, ITIL V3 Service Design Book, 30 May 2007.

[vii] Draft DoD Instruction 8115.cc, Subject: Enterprise Service Designation, Sustainment, and Termination, unedited.