Semantic Technology in the Department of Defense, Business Mission Area

October 28, 2010
Missions of the DoD

- Warfighter Mission Area
- Business Mission Area
- Intel Mission Area
- Enterprise Information Environment Mission Area

Dennis E. Wisnosky, DoD BMA CTO & Chief Architect in the Office of the Deputy Chief Management Officer (DCMO)

Global Reach!
"The Secretary of Defense is responsible for a half-trillion dollar enterprise that is roughly an order of magnitude larger than any commercial corporation that has ever existed. DoD estimates that business support activities—the Defense Agencies and the business support operations within the Military Departments—comprise 53% of the DoD enterprise."
57% of DoD I.T. Costs are in Infrastructure

Issue: Infrastructure

DoD Contractors Build Separate Infrastructures & Dictionaries

Issue: Redundancy

DoD Projects Have Own Data

Issue: Data

Small Slice of the As-Is

<table>
<thead>
<tr>
<th>OMB Budget Grouping</th>
<th>Number of Programs</th>
<th>FY2010 IT Spending - $ Billions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communications and Computing Infrastructure</td>
<td>1,547</td>
<td>$16.3</td>
</tr>
<tr>
<td>Information Assurance Activities</td>
<td>353</td>
<td>$3.2</td>
</tr>
<tr>
<td>Functional Area Applications</td>
<td>3,244</td>
<td>$13.2</td>
</tr>
<tr>
<td>Related Technical Activities</td>
<td>156</td>
<td>$1.0</td>
</tr>
<tr>
<td>Total DoD IT Spending</td>
<td>5,300</td>
<td>$33.7</td>
</tr>
</tbody>
</table>

SOURCE: http://www.whitehouse.gov/omb/e-gov/

<table>
<thead>
<tr>
<th>Projects</th>
<th>07 Budget $ Millions</th>
<th>Number of Projects</th>
<th>% of Total Budget $</th>
<th>% of Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project - &gt; $100 Million</td>
<td>$10,301</td>
<td>43</td>
<td>33.9%</td>
<td>1.3%</td>
</tr>
<tr>
<td>Projects - &gt; $10 Million</td>
<td>$15,013</td>
<td>525</td>
<td>49.4%</td>
<td>15.4%</td>
</tr>
<tr>
<td>Projects - &lt; $10 Million</td>
<td>$5,066</td>
<td>2,832</td>
<td>16.7%</td>
<td>83.3%</td>
</tr>
<tr>
<td>Total</td>
<td>$30,380</td>
<td>3,400</td>
<td>100.0%</td>
<td>100.0%</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>FY05</th>
<th>FY06</th>
<th>FY07</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total DoD I.T. Spending</td>
<td>$28.7</td>
<td>$29.9</td>
<td>$30.4</td>
</tr>
<tr>
<td>DoD Spending on Contractors</td>
<td>$21.1</td>
<td>$22.6</td>
<td>$24.1</td>
</tr>
<tr>
<td>% of I.T. Spending Contracted Out</td>
<td>73.5%</td>
<td>75.6%</td>
<td>79.3%</td>
</tr>
</tbody>
</table>
A Small Slice of the As-Is

We Must Make Sense Out of This!

Game-Changing Innovations!
Game-Changing Innovations

**Common Vocabulary and Primitives**

- If we can precisely state requirements and precisely describe data/services, we will be able to find them and know how to use them to facilitate:
  - Integration and Interoperability
- We must describe both the data/services and requirements with enough precision to accomplish the goal
- We use:
  - BPMN/Primitives for business mission descriptions
  - OWL and RDF for domains, services, data, capabilities and requirements descriptions

**To-Be State**
To-Be State

Dynamic, event-driven reconfiguration of services

DoD Business Operations Strategy and Roadmap!
Strategy and Roadmap for DoD Business Operations Transformation

Past
(BMA Federation Strategy version 2.4a)

- BEA 3.0
- Version 2.4a
- Roadmap:
  - Vision & Strategy
  - Planning & Roadmap
  - Infrastructure
  - Governance

Present
(BOE Execution Roadmap)

- DCMO/CIO Policies
- CIO – DIEA, Segment Archi.
- CV & Primitives
- Arch. Fed.
- MDR
- Biz. Intelligence
- Federation Implementation Plan

Future
(BMA Architecture Strategy version 3.0)

- Data Integration
  - Common Vocabulary (Ontologies)
- Business Intelligence
- Rules/Workflow
- Security
- BEA 8.x
- Initial BOE Experience

Enterprise Stds.
- RDF
- OWL
- other

Data Sharing and BI Enablement

Semantic Information

DBSAE
- SOA Imp. Strategy

(BOE) NCES/CES

DBSMC/IRBs

DCMO/DCIO; EGB; BECCM

Vision & Strategy
Planning & Roadmap
Infrastructure
Governance

10/28/2010

Business Operations thru Semantic web Solutions
Business Operations thru Semantic web Solutions

- Semantic Web Initiative
  - Business IT development methodology 3-step pattern
    - Modeling the business capability to be deployed
    - Preparing and populating a modern information model and data store
    - Implementing the capability by deploying business services
  - “Model-Data-Implement” semantic web pattern is designed to field capabilities in 60-90 days; this supports the Departments goal to move away from monolithic systems that take years to deploy
  - Current application of this pattern to achieve high performing business operations:
    - Enterprise Information Web (EIW)
    - Performance Data Automation (PDA)
  - DCMO is preparing policy and instructions to fully instantiate the Semantic Web initiative and take advantage of W3C and OMG standards and semantic technologies that the commercial sector is widely deploying

Modeling: Primitives!
Standards-based Architecture - Primitives

Modeling the business capability to be deployed

- DoDAF 2.0 serves as the foundation for architecture primitives
- Use Cases being developed and used to drive pilots

Pronto
Ontology (Lexicon)

PriMo
Modeling Guide

Standards
Best Practices

Differen
Frameworks

Music Language and Symbols:
Music Scale symbols
Notes symbols

This agreed upon representation of music allows a common understanding...

Standard
Language (terms and definitions)

Well Documented Intentions!
Architecture Primitives Series

Modeling the business capability to be deployed

DoD Architecture Framework Processes Best-Practice


Primitives lead to Patterns
A style guide provides subjective advice that will ensure the design of high quality products.

- Choice of words
  - Which constructs are appropriate in a given situation
- Choice of grammar
  - How to combine constructs to maximum effect

Caveat: A common vocabulary by itself does not guarantee high quality products.

Will Industry Care?

NEWS FLASH!
OMG Selects DoD Primitives as a BPMN 2.0 Conformance Class!

Patterns & Primitives
Modeling the business capability to be deployed
We Are Underway!

Modeling the business capability to be deployed

BEA Solution Statement
BEA Solution Statement

Modeling the business capability to be deployed

- **Virtualization**: pull & display (vice store!) enterprise information directly from the authoritative data sources
- **Agility**: plug-and-play federated environment so new systems or analytical needs can come online and go offline without disrupting the overall environment
- **Federation**: build federation into the solution
- **Standards**: leverage BPM and Semantic Web technology standards (RDF/OWL) developed by DARPA and approved by W3C and OMG
- **Savings**: People readable Architecture, Machine readable Architecture, Executable Architecture, Long-term re-use of authoritative data

**Interoperability**
Interoperability (Federation) in BEA Approach

Modeling the business capability to be deployed

- Federation:
  - The Interstate highway system
  - The railroad system
  - The United States of America
  - DOD is a federation

- Steps
  1. Build Domain Vocabularies: describe all of the artifacts in each domain using RDF/OWL standards
     - DoD currently does this description work, but without standards – often in Excel, Word, Powerpoint, Visio, etc
  2. Relate Domains: use RDF/OWL based descriptions to say how domains are related
     - This is the big missing piece of the current “standards” approaches
  3. Relate domain data to Domain Vocabulary: Use RDF/OWL to say how all of the data in each domain is related to the Domain vocabulary
  4. Query the Domain Vocabulary for any information

- Result: BEA Enables Enterprise Information Web
Agility in the BEA Approach

Preparing and populating a modern information model and data store

- Agility in process:
  - “Agile” development method; quarterly “deliverables”; lessons learned influence next deliverable;

- Agility in product:
  - Once assets are unambiguously described, whole environment becomes “plug and play”
  - Eg: New CIO policy issued:
    - Today: additions/changes to relational environment very costly
    - BEA: RDF/OWL graph-based information model is infinitely extensible and inexpensive to change; just add concept to the graph and point to its authoritative data source (ADS)

- Agility in query development
  - Queries are machine and human readable
  - Fast to develop across disparate ADSs

NOTE: up-front time and labor cost of unambiguously describing assets is not trivial
Example Savings in this BEA Approach

Preparing and populating a modern information model and data store

- **Flexibility & Data accuracy**
  - Current “standards” approaches force rigid conformity in understanding and representation of data. Result: very painful and expensive retroactive coding.
  - Semantic approach allows for variation in understanding while prescribing conformity in representation. Result: flexibility at the instance level and accuracy at the enterprise level

- **Interface development**
  - E.G.: 5 systems require interfaces to each other (20 interfaces). If each system’s information model is semantically described, only have to describe 5 interfaces

- **Portfolio Management**
  - Once information assets are unambiguously described, Domain vocabulary can assess gaps and redundancies in the portfolio and the architecture based on factual assessments

<table>
<thead>
<tr>
<th>Data</th>
<th>Concept</th>
<th>System</th>
<th>DV to Arch?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airman</td>
<td>Svc Mem</td>
<td>Pers Sys</td>
<td></td>
</tr>
<tr>
<td>Soldier</td>
<td>Svc Mem</td>
<td>Pers Sys</td>
<td></td>
</tr>
<tr>
<td>Sailor</td>
<td>Svc Mem</td>
<td>Pers Sys</td>
<td></td>
</tr>
<tr>
<td>Lawyer</td>
<td>Svc Mem</td>
<td>Pers Sys</td>
<td></td>
</tr>
</tbody>
</table>

(notional depiction only)
DoD BEA Ontology

Preparing and populating a modern information model and data store

References
Shows which authoritative documents concepts have been extracted from

Domain/Common Vocabulary
Description of concepts in Enterprise Domain

Analytic Requirements
Models analytic requirements for the Domain Vocabulary and how they relate to the concepts in the Domain Vocabulary, including SPARQL queries

ADSMapping Ontology
Mapping of domain vocabulary terms to the physical data elements they represent in the Authoritative Data Sources (ADS)

Standards Ontologies
Description of Standards – definitions, permitted values, usage, business rules, reference documents, etc.

Process Ontology
Translation of BPMs to OWL. Activity/Message descriptions include relationships to domain vocabulary terms.

Example: SMP-E2E

Preparing and populating a modern information model and data store

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Example: SMP-E2E
Example SMP to End to End (E2E) Process
Priority 5 – Strengthen DoD Financial Management

"Procure to Pay" (P2P) Level 1 E2E in the BEA

SMP Metrics also to be rolled up to Level 1

Leaf Level decomposition used to identify and define requirements “rolled up” to and visualized at Level 1

Common Vocabulary is Necessary!
Common Vocabulary Development

Preparing and populating a modern information model and data store

- Identify information to communicate
- Agree on terms and contextual use
- Communicate

“Now! That should clear up a few things around here!”

DoD BMA Architecture Methodology
Building Common Vocabularies

Preparing and populating a modern information model and data store

What is the architecture supposed to achieve?
Which processes/activities will provide the capabilities?
Which data/resources will be consumed or produced?
Who/What will be involved?

Capability Vocabulary
Activity Vocabulary
Resource Vocabulary
Performer Vocabulary

Capability View
Process View
Data & Rule View
Process View

Items:
• Objectives
• Features
• Services

Items:
• Verbs

Items:
• Nouns

Items:
• Roles
• Systems
• Actors

Common Vocabulary in Action!
Ontology – Based
Information Representation

Who wrote “DoDAF Wizdom”? 

Graph1

DBpedia (Wikipedia) Dataset

Preparing and populating a modern information model and data store
Ontology – Based Information Representation

Where was Dennis Wisnosky born?

Graph2

DoD HR Dataset

10/28/2010
Information Merging

DBpedia (Wikipedia) Dataset

DoDAF Wizdom

hasTitle

book

writtenBy

Dennis Wisnosky

hasName

hasName

graduateFrom

University

California University of Pennsylvania

hasName

University

University of Dayton

hasName

University of Pittsburgh

person

Crawl, Walk, Run - EIW

Wikipedia Dataset: Who wrote “DoDAF Wizdom”?

DoD HR Dataset: Where was Dennis Wisnosky born?

Combined Dataset: Where was the person who wrote DoDAF Wisdom born?

10/28/2010
HR Enterprise Information Web (EIW)

Implementing the capability by deploying business services

- Building an HR Common Vocabulary that will make future integration and development simpler
- Building an executable information model to provide accurate and timely enterprise Personnel Visibility for the first time
- Making “compliance” (eg: SFIS, IRB, BEA) exercises simpler, faster, meaningful, easier to maintain

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DWiz DoD DCMO BMA CTO & CA
The HR EIW is a mechanism for reaching into service applications to satisfy enterprise HR information needs. It accomplishes three things:

- Reports real-time, authoritative HR information on-demand.
- Supports HR enterprise information standards.
- Supports IT flexibility.

**HR EIW**

Implementing the capability by deploying business services

**Multiple Sources**

- DMDC Data Stores
- Component Data Stores
- External Data Services

**Common Vocabulary**

**mashup**

**DMDC Data Stores**

**HR Data Store**

**DoDI Personnel Data Store**

**Component Data Stores**

- Data Store
- Data Store
- Data Store
- Data Store

**External Data Services**

**HR Domain Ontology**

Delivered 18 Dec 09

- RDF Store
- Process/Rules Mgt
- SME RDF Modeling
- RDF Info Services
- Adv Mash-ups

**Increment 4-n**

- Transition
- Map OSD HR to Service Ontologies
- Federated Ontology
- DIMHRS & CHRIS Alignment

**Phase 1**

- Increment 1
- Publish Stds
- Transition

- Increment 2
- Publish Stds
- Compensate

- Increment 3
- Publish Stds
- Develop, etc

- Increment 4-n

**Phase 2**

- Map OSD HR to Service Ontologies

**Phase 3**

- Federated Ontology
- DIMHRS & CHRIS Alignment

**Sustainment**

- Publish Stds

**Proofs of Delivery**

- 12/31
- 3/31
- 6/30
- 9/12
HR Domain Ontology

Implementing the capability by deploying business services

- Information discovery, interoperation, and integration all depend on description
  - If we do not know what something is we cannot possibly know how to integrate it with other things or even how it should be used

- If we describe everything, we are in a position to have a knowledge-based web
  - Rich analytics
    - Requirements gap analysis
    - Authoritative Data Source discovery
    - Answer any Personnel & Pay question
  - Integrate and interoperate

- RDF & OWL are the technology used to describe “things”
  - both machines and people can understand the descriptions

BPM Informs Ontology
Goal: Develop correct, consistent, human and machine readable, high quality business process models

Approach:

Benefits:
- Consistent, semantically aligned (end-to-end HR) business processes
- Communicate effectively with the Services
- Machine readable (queryable) business processes
- Perform gap analysis
- Standards based models result in fewer errors during implementation

Collaboration takes place in CommonVocabulary.mil
Community Workspace: www.Common Vocabulary.army.mil
https://www.commonvocabulary.army.mil/ui/groups/HR_EIW

Implementing the capability by deploying business services

HR EIW & H2R E2E
HR EIW and H2R E2E

Implementing the capability by deploying business services

Personnel Visibility not possible if DoD doesn’t understand the Enterprise H2R E2E processes, information flows, data sources, integration points, standards and exceptions.

Eg: how does the “Pay” process work across DoD in the E2E?

Need to know: where in E2E, which ADS, semantics and access.

90 Day Deliverables – POD 1
Backend PoD1 Architecture

Objectives Achieved:
- Web Service
- DKO CAC Authentication
- Data Virtualization
- ETL Process
- DMDC MOU
- P&R HR Ontology Models
- DIMHRS Reuse

Implementing the capability by deploying business services

DMZ

HTTPS Port 443 for web traffic

SOAP/XML

XML File

Web Service Call (bind)

DKO

Port 443 open for web traffic to DMDC

HTML

90 Day Deliverables – POD 2

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DWiz DoD DCMO BMA CTO & CA
RDF Warehouse Architecture (POD2)

Implementing the capability by deploying business services

User Agent (Web Browser)

HTTPS

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DIMHRS – HRTS2
Scrambled DB

90 Day Deliverables – POD 3
RDF Web Extensibility (POD3)

POD3 Goals
- Support multiple triple stores
- Map/Load/Query multiple data sources
  - Army (DIMHRS), USMC (MCTFS)
- Model based ETL with COTS
- Increase analytic capability
  - Army & USMC data from single query
  - Drill down by Service/Component
  - Expand Transition queries (TBD)
  - Demo at least one report (TBD)
  - Scenario based demo (scenarios TBD)

Use Case!
Implementing the capability by deploying business services

Identical data loaded into both triple stores.
Operations – Country View: User Defined Query

Semantics is a Team Sport!
Semantics is a Team Sport: EIW Extended Team

- **BTA**: Developer of the EIW
- **OUSD (P&R)**: Functional sponsor and owner of the HRM Enterprise Standards (HRM ES) & Common Human Resource Information Standards (CHRIS)
- **Joint Staff, COCOMs, OSD analysts**: Future User Community
- **DMDC**: Future hosting site for the EIW
- **DCMO**: Oversight
- **DFAS**: Assessing HR-related pay requirements for the EIW
- **Military Services**: Identifying ADSs, validating modeling

**Interoperability through:**

**Model – Data – Implement!**
Interoperability through “Model-Data-Implement”

Common Architecture Methodology

Common Vocabulary

Standard Representation and Composition

Policy, Processes & Tiered Accountability

Authoritative Data Sources

External Data Services

Semantic Technologies

End-to-End Processes

Agile Business Services Delivery

DoD Semantic Landscape
DoD Business Operations Semantic Landscape

Enterprise Standards
- RDF, OWL, Pronto, etc.

Semantic Foundation
- Upper Ontology
- Common Vocabulary
- Domain Ontologies

Business Rules
- (W3C Rules Interchange Format for standard exchange of rules)

Shape and Control the Transformation

Transactional Data Stores

Transform

RDF Triple Stores

Semantic Data Mediation & Transformation
- Provide semantic foundation and mappings to drive data integration (mediation & transformation)

Systems & Services Interoperability

Semantics-Based Facts (RDF) and connections to Common Vocabulary (Ontologies) and Rules for machine reasoning

Business Intelligence:
- Data Sharing
- Reporting
- Ad Hoc Query
- Knowledge Exploration

Achieving Net-Centricity:
- Data Sharing

 EIW is first BI realization of this

The One Takeaway

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DWiz DoD DCMO BMA CTO & CA
Agile, Architecture-Driven, DoD Business Capability Delivery

Governance
Policy, Processes, Tiered Accountability

Model
Common Architecture Methodology
Common Vocabulary
Standard Representation and Composition
Primitives and Design Patterns

Data
Authoritative Data Sources
Semantic Technologies

Implement
Phased Implementations
Agile Business Services Delivery

Model to Guide Transformation
Data to Improve Performance
Implement to Deliver Capabilities
My own transformation…
Thank you!

Questions?
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