



# Semantic Technology in the Department of Defense, Business Mission Area

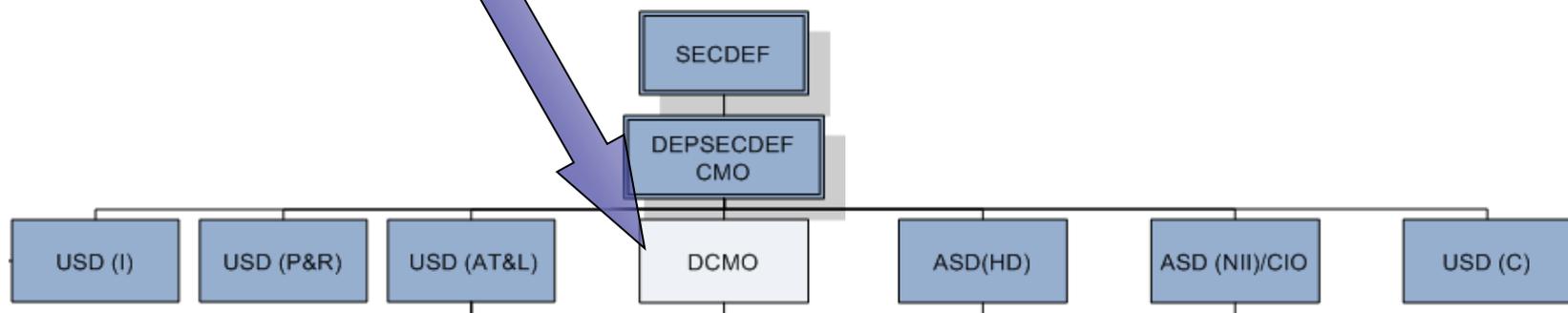
Dennis E. Wisnosky,  
DoD BMA CTO &  
Chief Architect in the  
Office of the Deputy Chief  
Management Officer

November 17, 2010



# DCMO CTO/CA

## Missions of the DoD



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





# The Business Operating Environment

## Reach of the Business Mission Area

"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."

Global Reach!



# 57% of DoD I.T. Costs are in Infrastructure

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

**Challenges!**

**Issue: Infrastructure**

DoD Contractors Build Separate Infrastructures & Dictionaries

**Issue: Redundancy**

## DoD Projects Have Own Data

Projects	07 Budget \$ Millions	Number of Projects	% of Total Budget \$	% of Projects
Project - > \$100 Million	\$10,301	43	33.9%	1.3%
Projects - > \$10 Million	\$15,013	525	49.4%	15.4%
Projects - < \$10 Million	\$5,066	2,832	16.7%	83.3%
<b>Total</b>	<b>\$30,380</b>	<b>3,400</b>	<b>100.0%</b>	<b>100.0%</b>

\$ Billions	FY05	FY06	FY07
Total DoD I.T. Spending	\$28.7	\$29.9	\$30.4
DoD Spending on Contractors	\$21.1	\$22.6	\$24.1
% of I.T. Spending Contracted Out	73.5%	75.6%	79.3%

**Issue: Data**



# A Small Slice of the As-Is



We Must Make Sense Out of This!



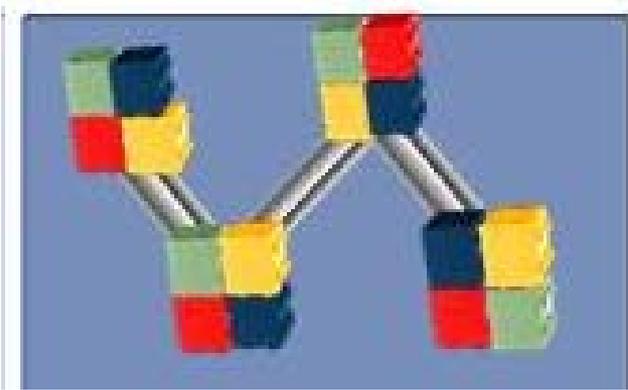
# Game-Changing Innovations

## *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

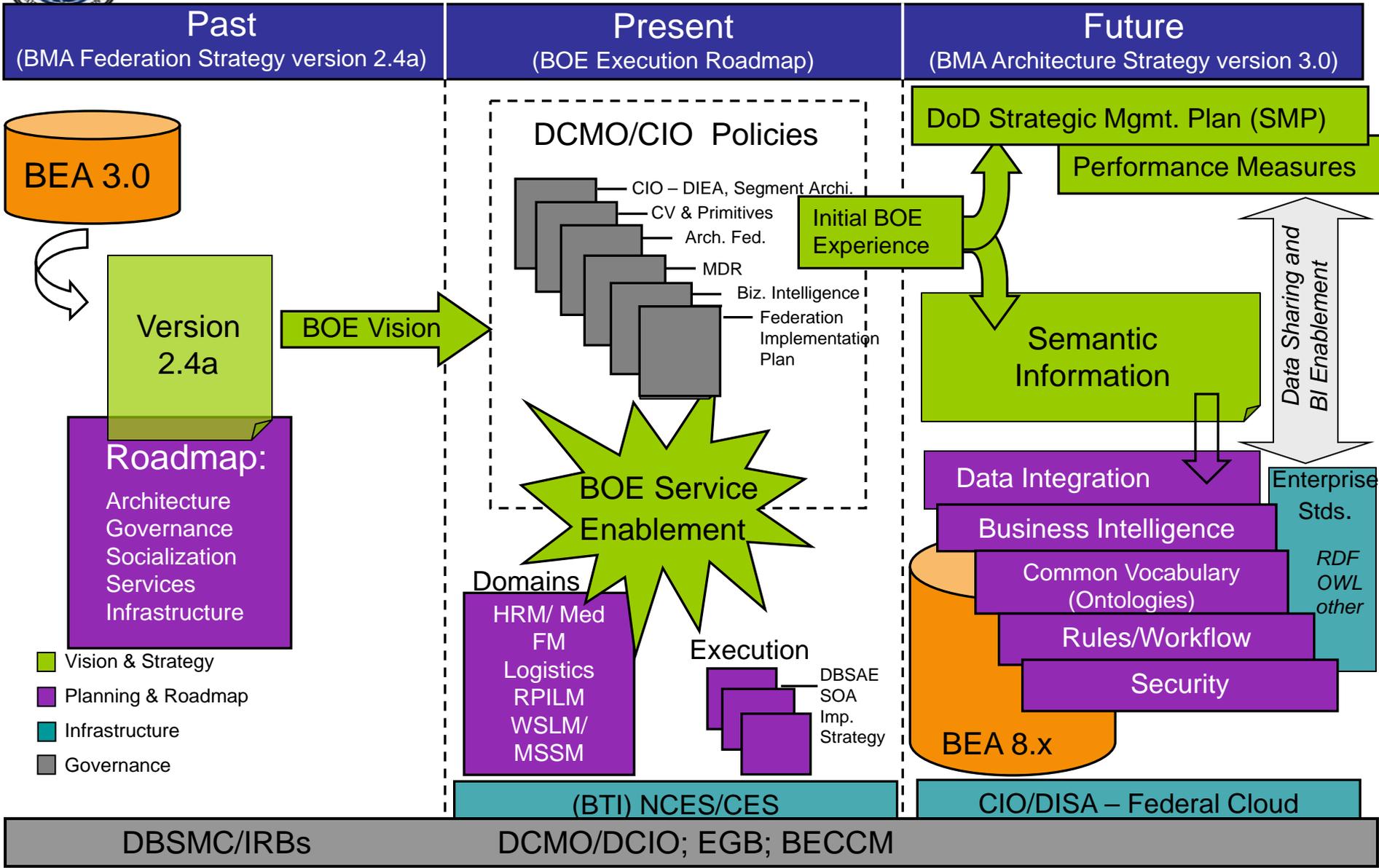


**Dynamic**, event-driven  
reconfiguration of services





# Strategy and Roadmap for DoD Business Operations Transformation





# 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



# Standards-based Architecture - Primitives

Modeling the business capability to be deployed



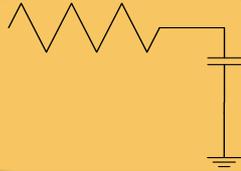
Standard Symbols

Engineering Language and Symbols:

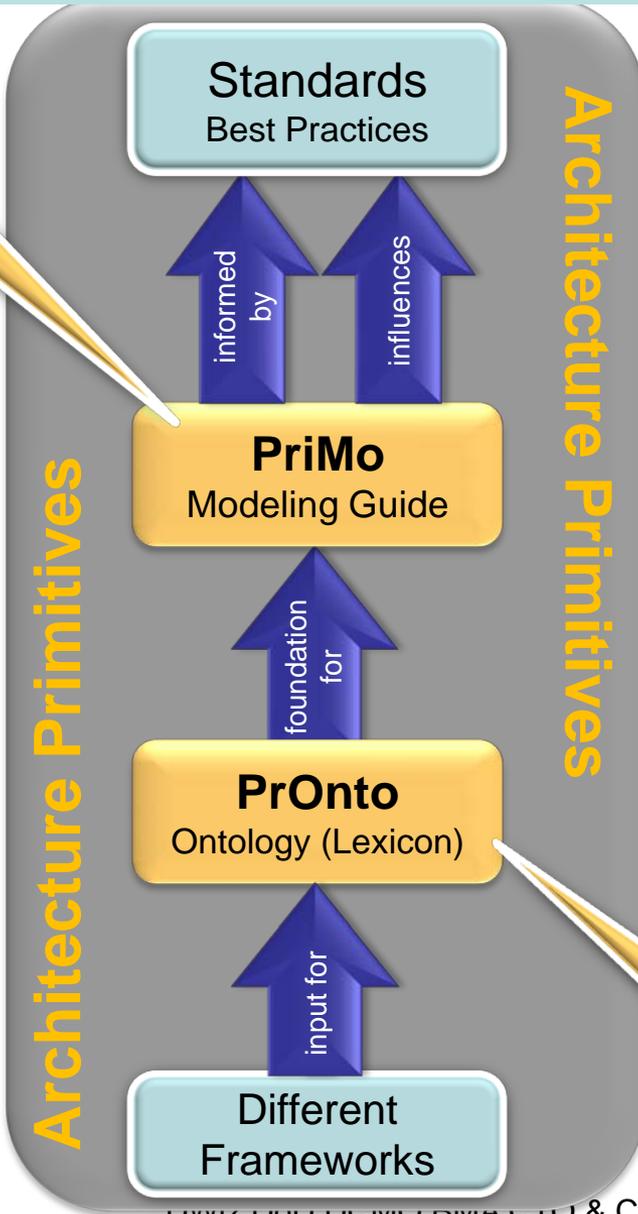
Resistor symbol 

Capacitor symbol 

*This agreed upon representation of electrical engineering allows a common understanding...*



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



## Modeling: Primitives!

Music Language and Symbols:

Music Scale symbols 

Notes symbols 

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



Standard Language (terms and definitions)





# Architecture Primitives Series

Modeling the business capability to be deployed

**Vocabulary-Driven Enterprise Architecture Development Guidelines for DoDAF AV-2: Design and Development of the Integrated Dictionary**  
December 17, 2009

**AV-2**

Enter New Term  
 Joint Chiefs Air Support  
 \$ 30  
 42009  
 draft

Term	Definition	Acronym	Synonym	Classification	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	V	W	X	Y	Z
Terminal Air Controller	Person on the ground guiding the air asset into place during the execution phase of the CAS mission.	TAC		Control																									
Target	Designated object of interest.	TGT		Control																									
Fire Support Control Measure	Activity that marks the start of the CAS mission.	FSCM		Control																									
Close Air Support	Ability to provide ground troops with an over-shoulder attack of CAS mission.	CAS		Control																									
Battle Damage Assessment	Measure of the effectiveness of CAS mission.	BDA		Control																									
CAS Request	Request for CAS mission.	CASREQ		Control																									
Intermediate Command and Control Point	Officer in the field.	ICCP		Control																									

**Enterprise Architecture based on Design Primitives and Patterns Guidelines for the Design and Development of Event-Trace Descriptions (DoDAF OV-6c) using BPMN**  
December 17, 2009

**OV-6c**

**Well Documented Intentions!**

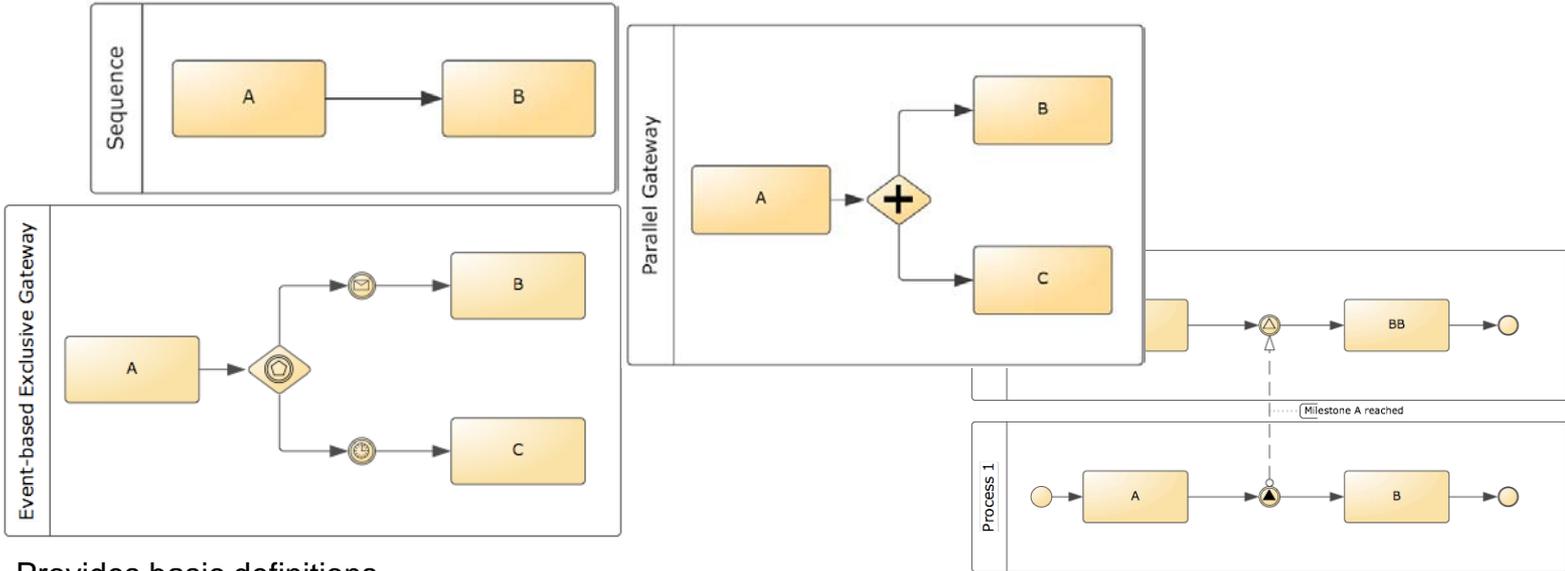
**DoD Architecture Framework Processes Best-Practice**

[http://cio-nii.defense.gov/sites/dodaf20/journal\\_exp3.html](http://cio-nii.defense.gov/sites/dodaf20/journal_exp3.html)



# Primitives Lead to Patterns

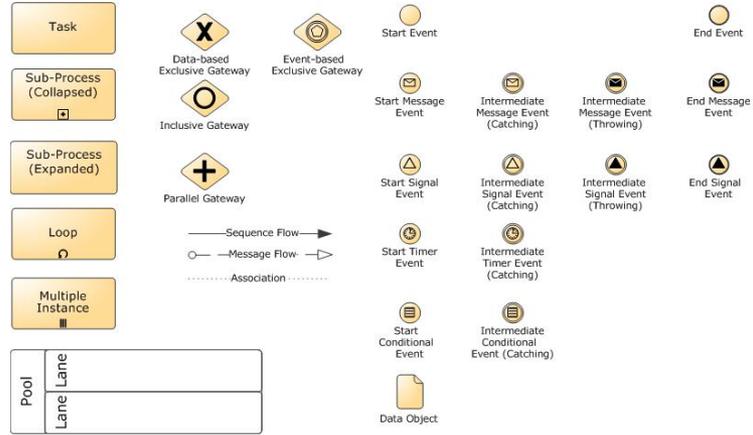
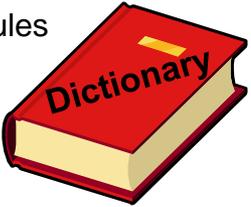
Modeling the business capability to be deployed



PriMo

- Provides basic definitions of the architecture model semantics
- Provides elementary rules for the connectivity of primitive constructs
- Provides foundation building blocks for constructing architecture products
- Caveat: A common vocabulary by itself does not guarantee high quality products

PrOnto

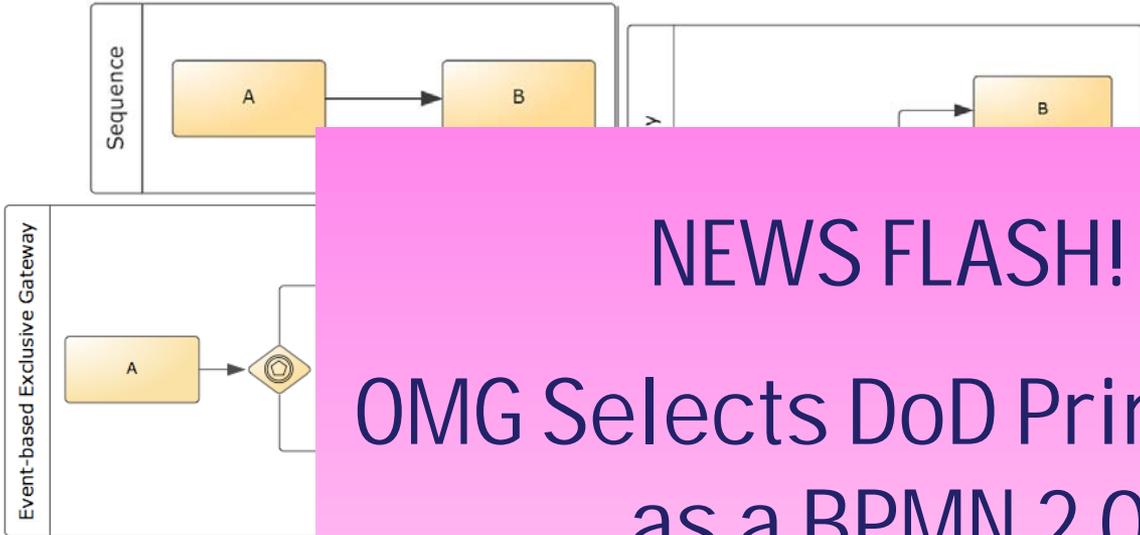


- A style guide provides subjective advice that will ensure the design of high quality products
- A style guide advises on
  - Choice of words
    - Which constructs are appropriate in a given situation
  - Choice of grammar
    - How to combine constructs to maximum effect



# Primitives Lead to Patterns

Modeling the business capability to be deployed



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

**Will Industry Care?**

- Provides basic definition of the architecture model semantics
- Provides elementary constructs for the connectivity of primitive constructs
- Provides foundation building blocks for constructing architectural products
- Caveat: A common vocabulary by itself does not guarantee high quality products



**PriMo**

- style guide provides objective advice that will ensure the design of high quality products
- style guide advises on
  - Choice of words
    - Which constructs are appropriate in a given situation
  - Choice of grammar
    - How to combine constructs to maximum effect





# We Are Underway!

Modeling the business capability to be deployed

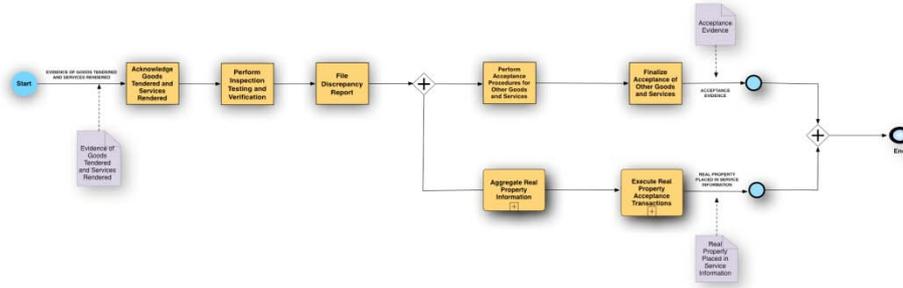
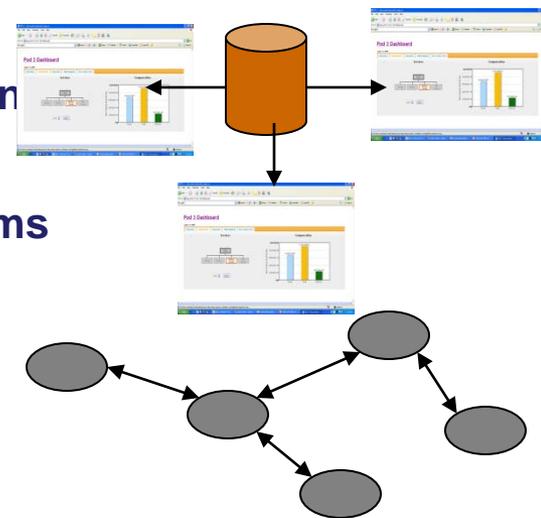




# BEA Solution Statement

Modeling the business capability to be deployed

- **Visibility:** 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
- **Access:** 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 (Federation) in BEA Approach

Modeling the business capability to be deployed

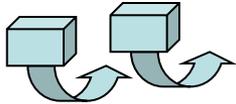
- Federation:
  - ✓ The Interstate highway system
  - ✓ The railroad system
  - ✓ The United States of America
  - ✓ DOD is a federation
- Steps
  1. Build Domain Vocabularies: describe all of the artifacts in each domain using RDF/OWL standards
    - DoD currently does this description work, but without 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





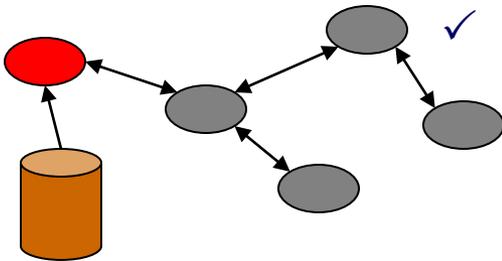
# Agility in the BEA Approach

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 DCMO 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

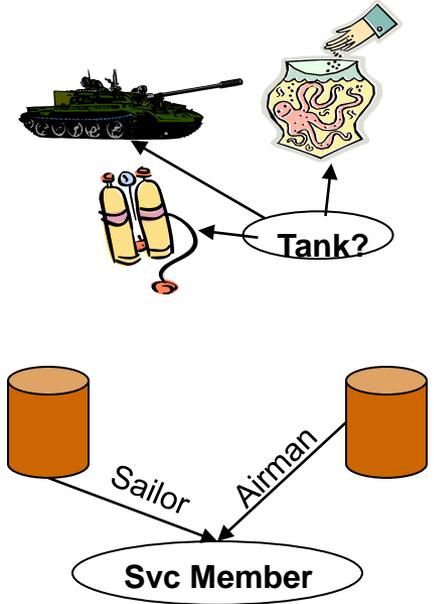
**NOTE: up-front time and labor cost of unambiguously describing assets is not trivial**



# 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



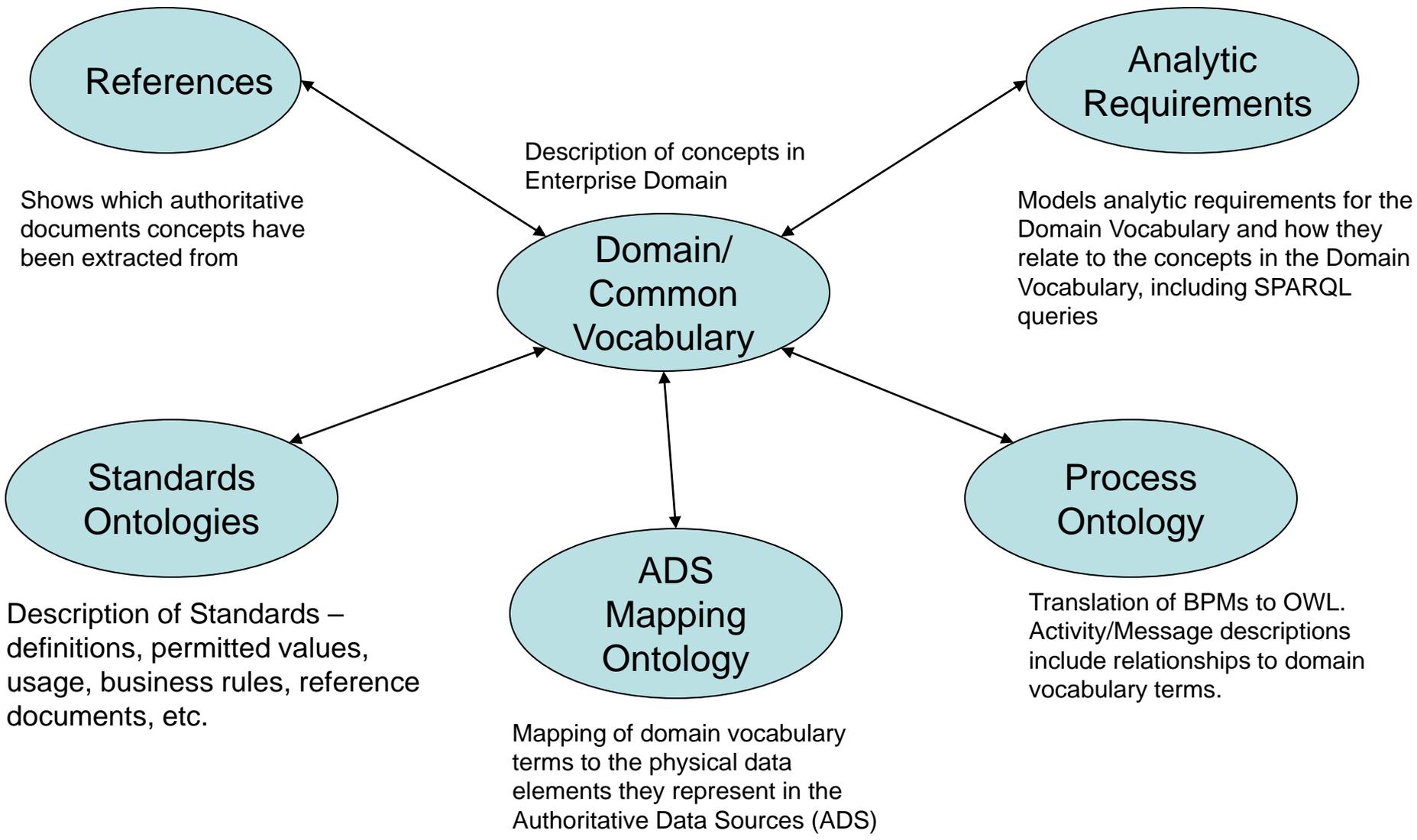
Data	Concept	System	DV to Arch?
Airman	Svc Mem	Pers Sys	
Soldier	Svc Mem	Pers Sys	
Sailor	Svc Mem	Pers Sys	
Lawyer	Svc Mem	Pers Sys	

(notional depiction only)



# DoD BEA Ontology

Preparing and populating a modern information model and data store



# Example SMP to End to End (E2E) Process

## Priority 5 – Strengthen DoD Financial Management

Preparing and populating a modern information model and data store

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

SMP Metrics also to be rolled up to Level 1



**Radio\_Frequency\_Identifier**  
The Radio Frequency Identifier must be assigned only if referenced by contract in DFAR Clause 252.211-7006

**Invoice\_Date**  
The Invoice Date must be assigned for each invoice number

**Unit\_Price\_Amount**  
The Unit Price Amount must be assigned for each Unique Item Identifier (UII)

**MILSTRIP\_Number**  
The MII STRIP Number must be assigned

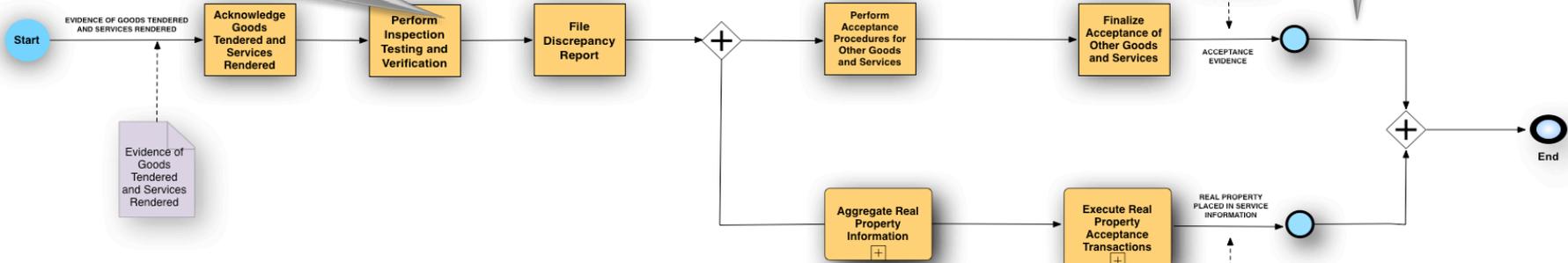
**Acceptance Evidence (Sample Business Rules)**  
City\_Acceptance  
Invoice\_Date  
City\_Ship\_To  
Contract\_Issue\_Date  
Country\_Code\_Ship\_To  
MILSTRIP\_Number  
Issuing\_Agency\_Code  
Item\_Unique\_Identifier  
Original\_Part\_Number  
Postal\_Code\_Ship\_To  
Serial\_Number

**Acceptance Evidence (Sample Minimum Data Elements)**  
Acceptance\_Date  
Receipt\_Quantity  
Site\_Unique\_Identifier

**Common Vocabulary is Necessary!**

SMP Metrics linked at Leaf Level (e.g., Level 2)

“Perform Receipt Acceptance & Return” P2P Level 2 E2E in the BEA



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



# Common Vocabulary Development

Preparing and populating a modern information model and data store

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

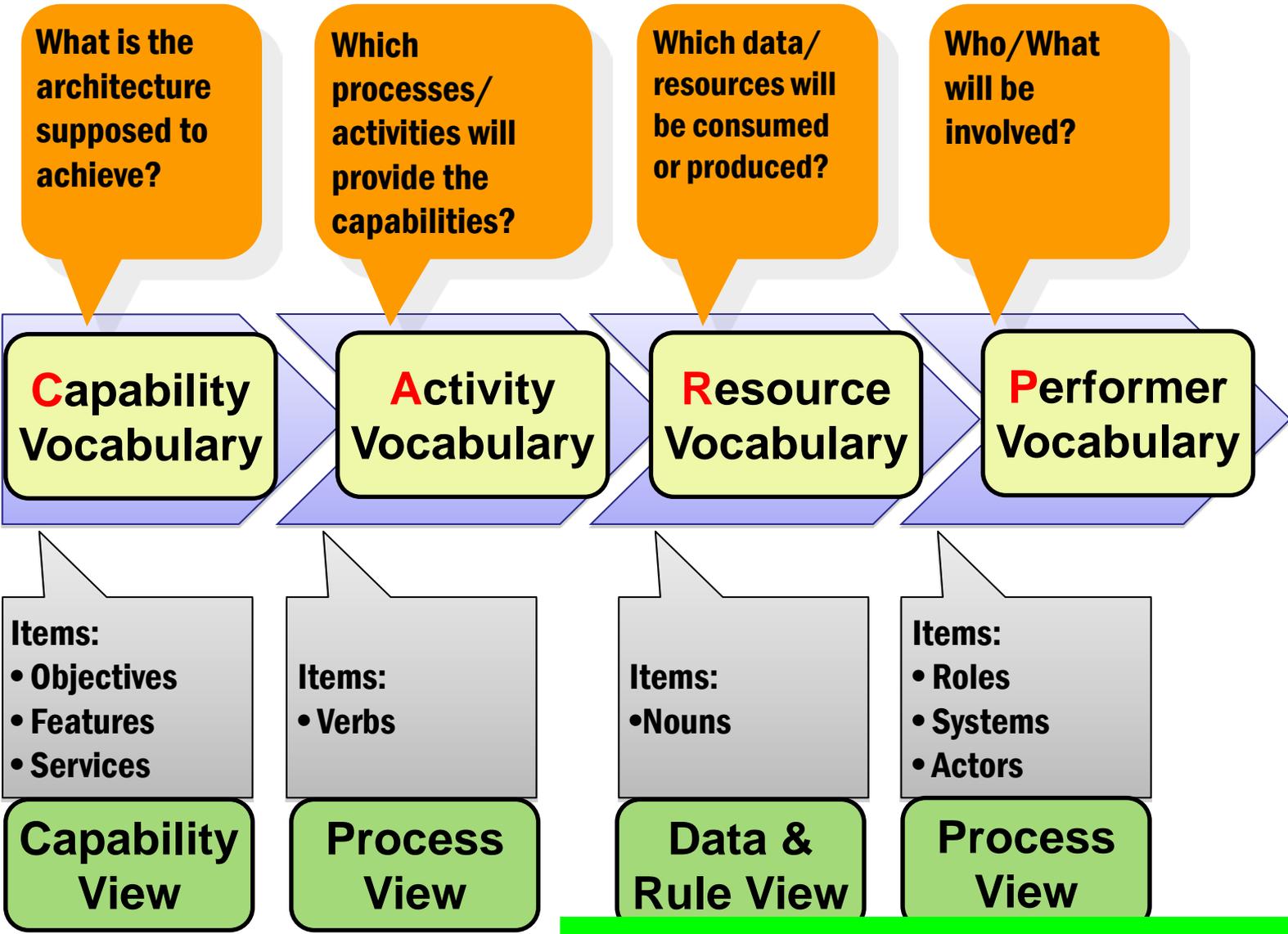


**“Now! *That* should clear up a few things around here!”**



# Building Common Vocabularies

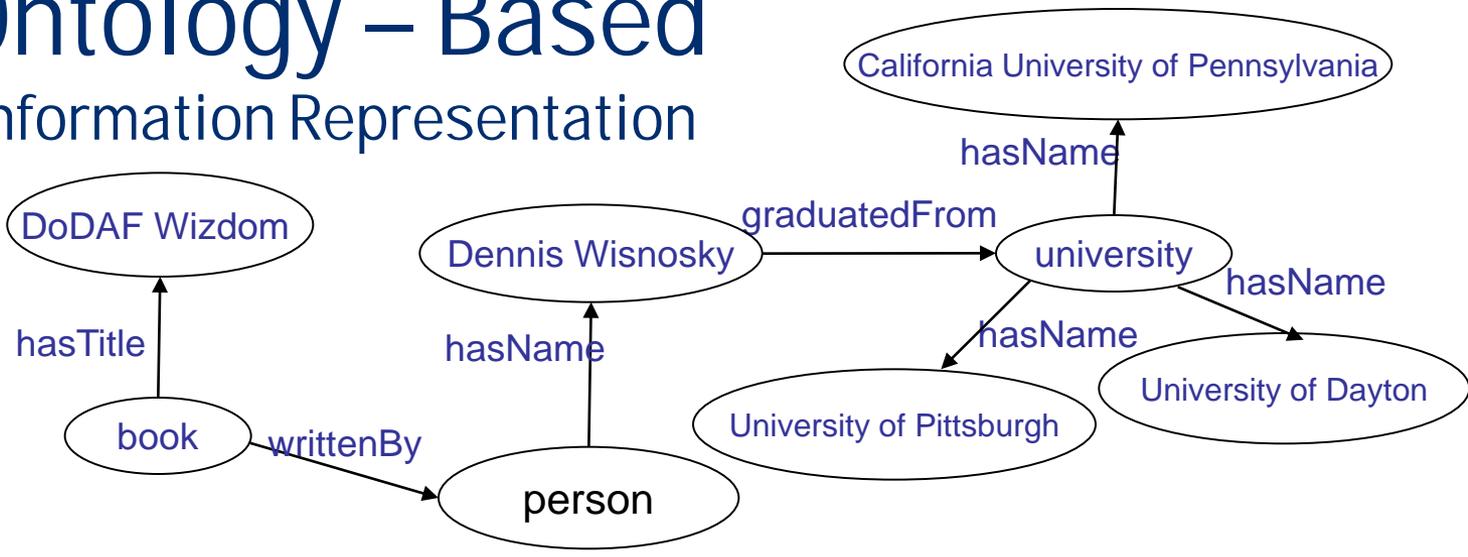
Preparing and populating a modern information model and data store





# Ontology – Based Information Representation

DBpedia  
(Wikipedia)  
Dataset



Graph1

Who wrote “DoDAF Wizdom”?

Common Vocabulary in Action!

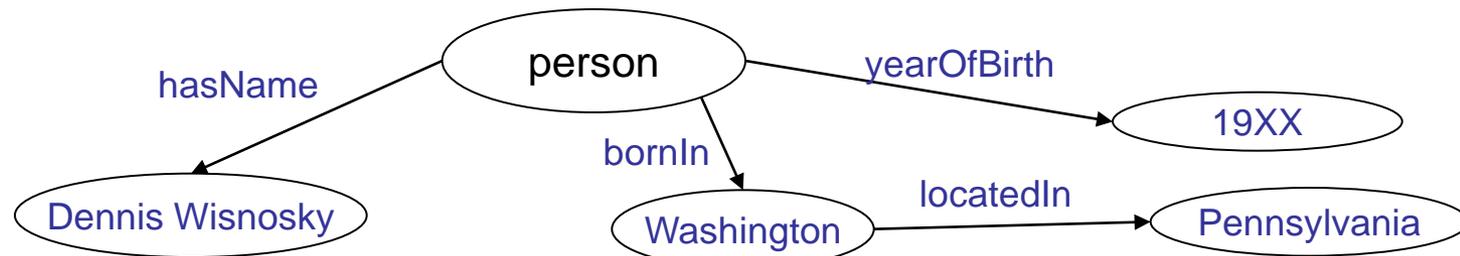


# Ontology – Based Information Representation

Where was Dennis Wisnosky born?

Graph2

DoD HR  
Dataset

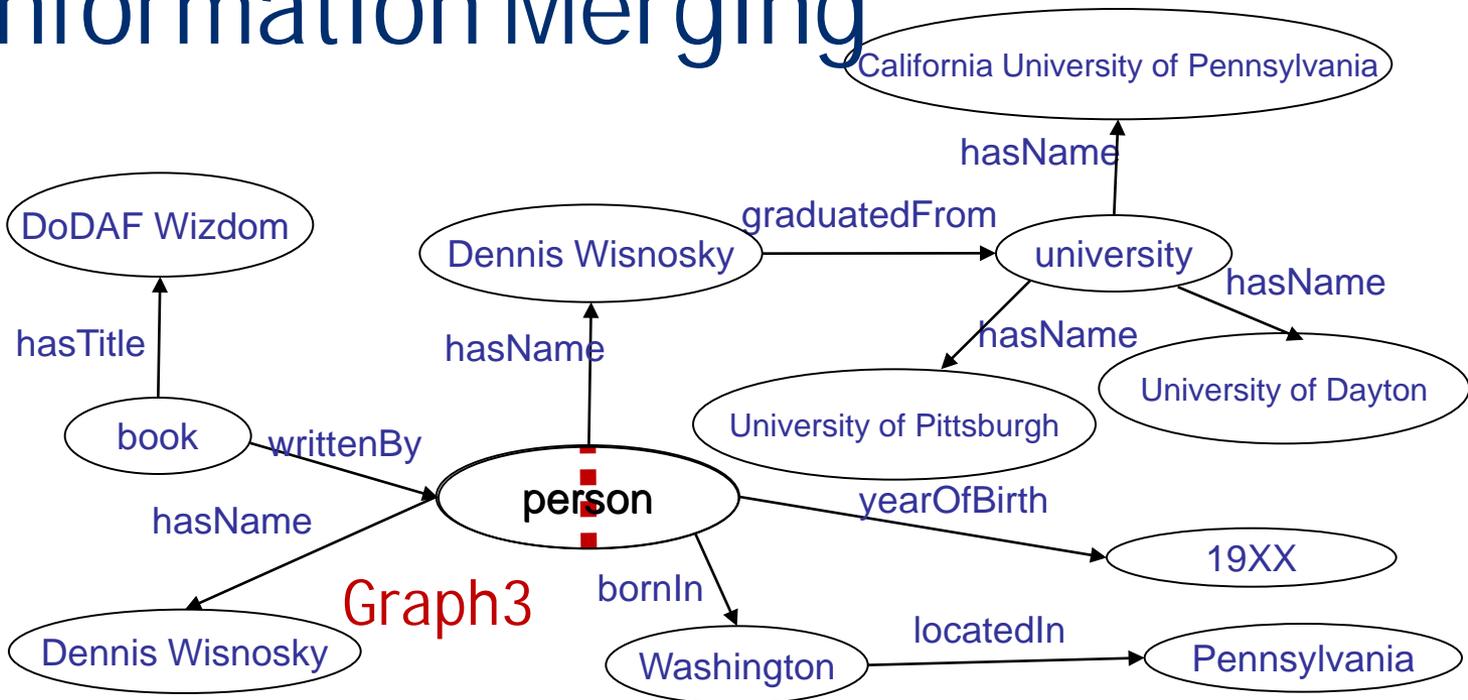




# Information Merging

DBpedia  
(Wikipedia)  
Dataset

DoD HR  
Dataset



Graph3

- 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?



# 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

Crawl, Walk, Run - EIW



Implementing the capability by deploying business services

# HR EIW

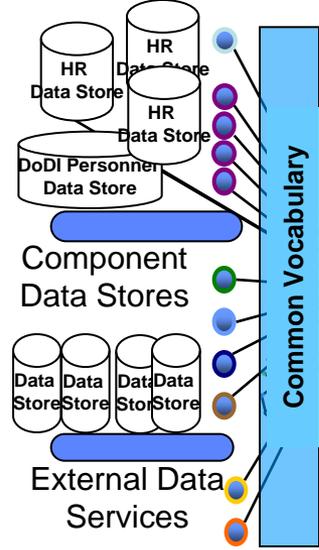
The HR EIW is a mechanism for reaching into service applications to satisfy enterprise HR information needs. It accomplishes three things:

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

## Multiple Sources

## Single View

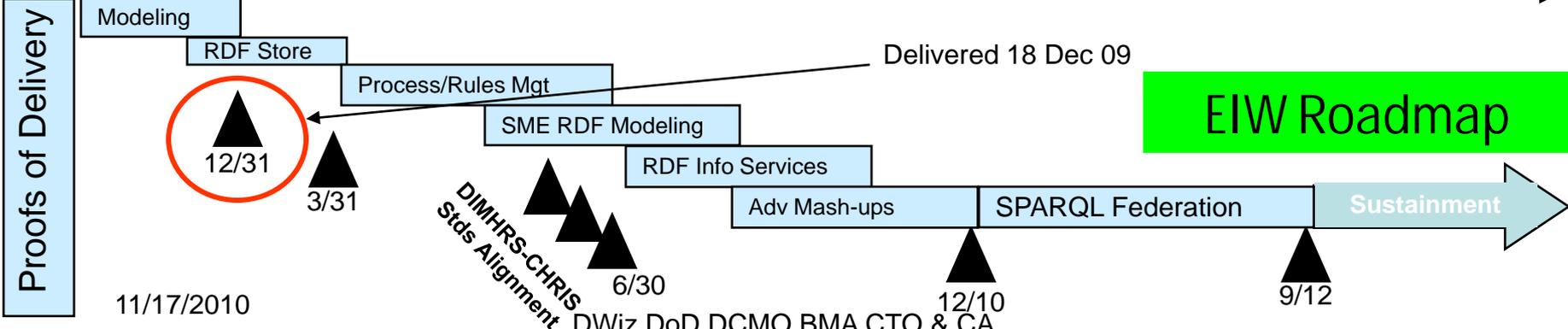
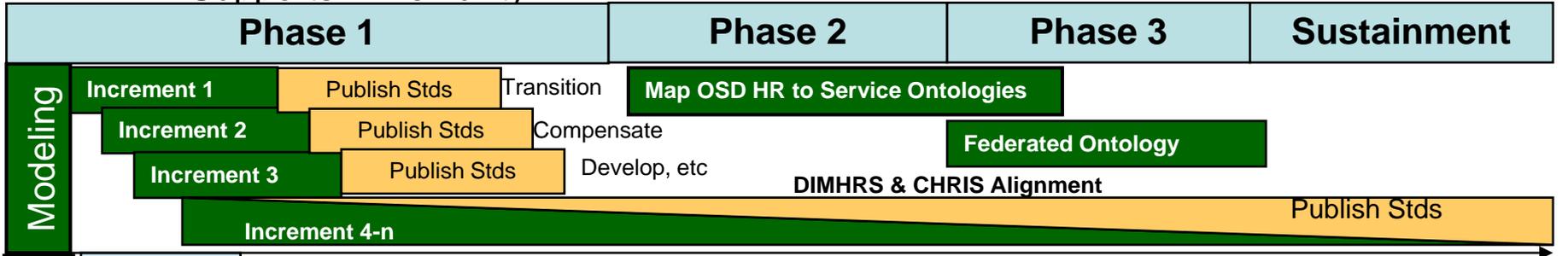
DMDC Data Stores



mashup



9/09 – Supports IT flexibility. 6/10 12/10 9/12 9/15



Delivered 18 Dec 09

**EIW Roadmap**



# 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

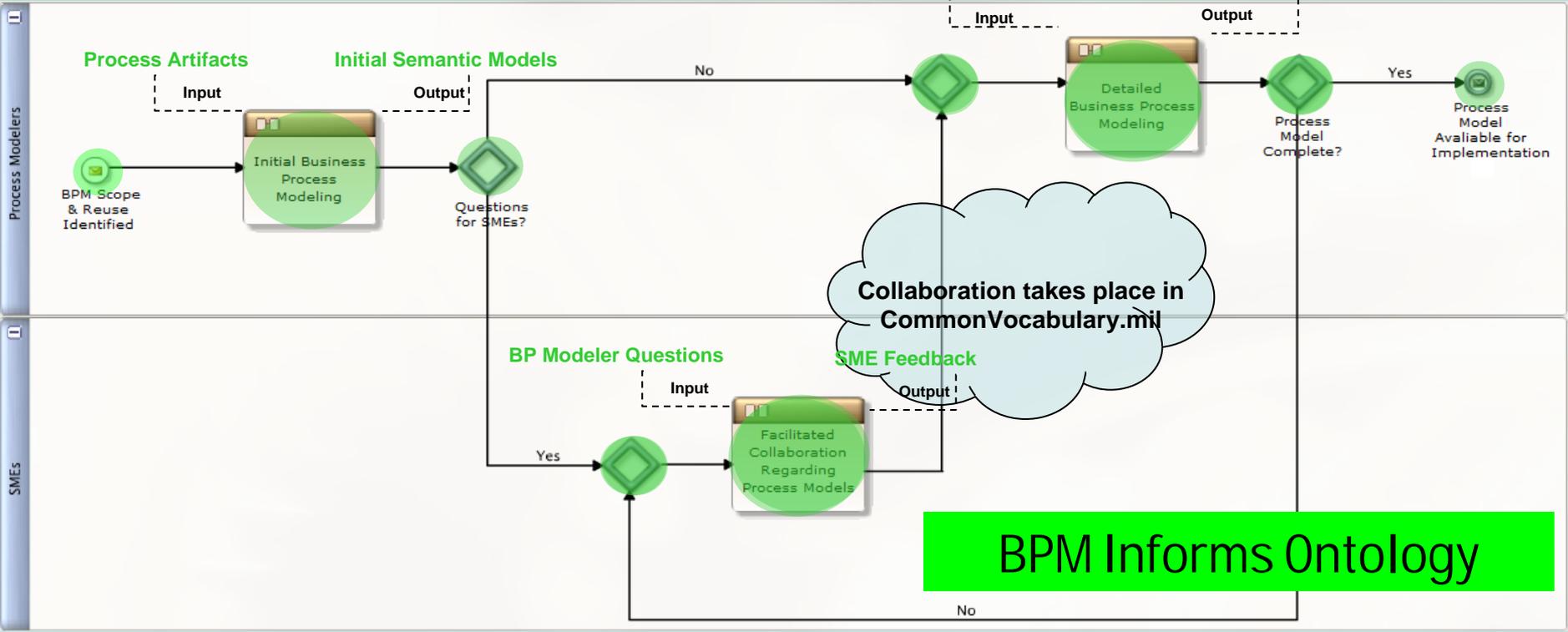


Implementing the capability by  
deploying business services

# BPM Methodology

**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



Implementing the capability by  
deploying business services

CommonVocabulary - Human Resources - Microsoft Internet Explorer

File Edit View Favorites Tools Help



Address [https://www.commonvocabulary.army.mil/ui/groups/HR\\_EIW/vocab/Human\\_Resources](https://www.commonvocabulary.army.mil/ui/groups/HR_EIW/vocab/Human_Resources)



Find:  search this vocabulary Search ehtambo6 Log out

CommonVocabulary My account Community File Edit RSS Feeds

### Human Resources

Community [HR\\_EIW](#) vocabulary [Human\\_Resources](#)

Classes Properties

- (Acc... Cas)
  - Accumulator
  - AdditionalProperty [ d2rq: ]
  - Address
  - AgreementType
  - Allotment
  - AllotmentDesignee
  - AllowedValuesClasses
  - Application
  - Application\_Status
  - Application\_Type
  - Attachment
  - BankAccount
  - CasualtyAssistancePackage
  - CasualtyIncidentHostilityType
  - CasualtyInvestigationRequirement
  - CasualtyReport
  - CasualtySituationNotificationType
- (D2R... Mem)
  - Mem... Cas

View Graph RDF Discussion History

**Contents**

- 1 Technical Specifications
- 1.2 Overview

#### Technical Specifications

#### Overview

**Ontology Name**  
[http://www.knoodl.com/ui/groups/DIMHRS/vocab/Human\\_Resources/](http://www.knoodl.com/ui/groups/DIMHRS/vocab/Human_Resources/)

**Dependencies**  
Namespaces

- d2rq: <http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#>
- d2rq-ext: [http://www.knoodl.com/group/DIMHRS/vocab/D2RQ\\_Vocabulary](http://www.knoodl.com/group/DIMHRS/vocab/D2RQ_Vocabulary)
- dc: <http://purl.org/dc/elements/1.1/>
- ja: <http://jena.hpl.hp.com/2005/11/Assembler#>
- ns4: <http://www.knoodl.com/ui/groups/DIMHRS/kncsh/Dcsh/>

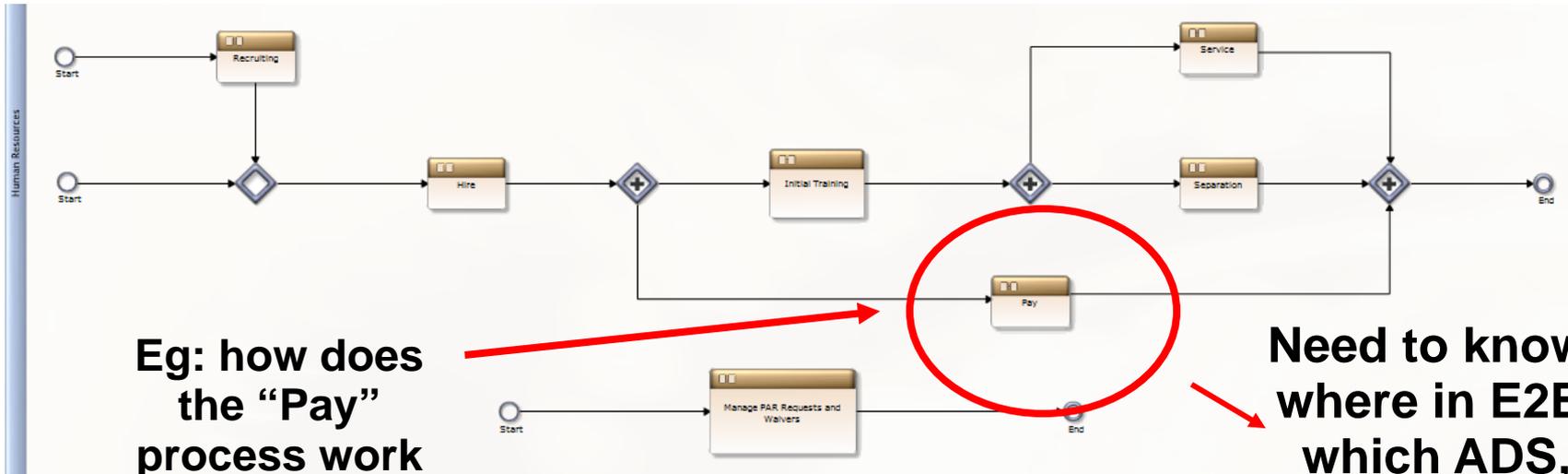
Collaboration



# 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



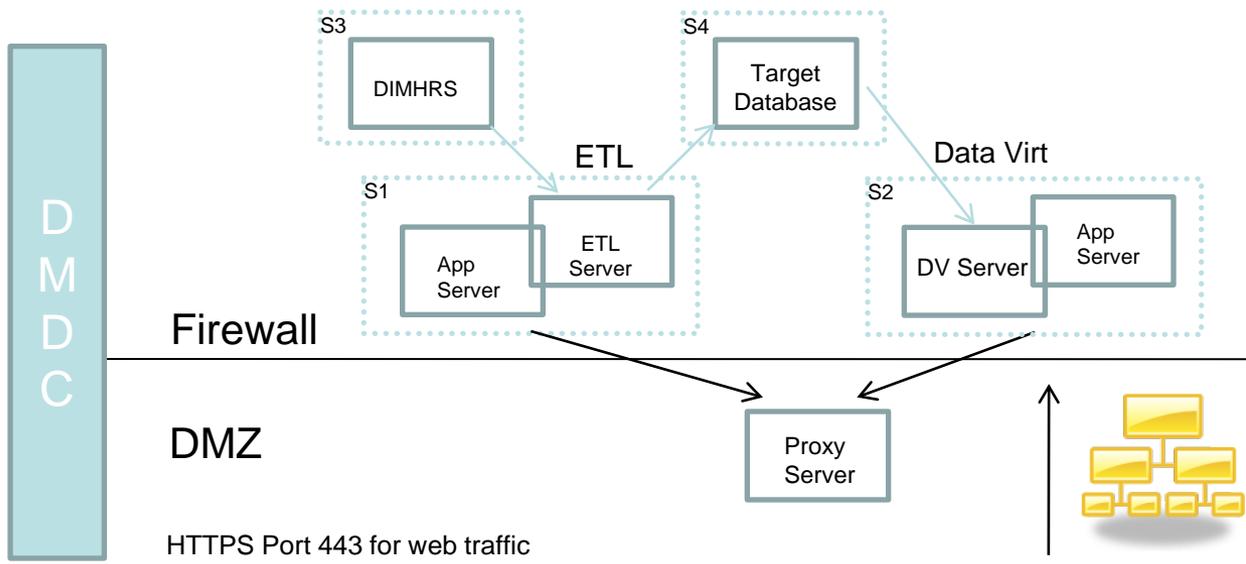
**Eg: how does the “Pay” process work across DoD in the E2E?**

**Need to know: where in E2E, which ADS, semantics (meaning) of data, and access**



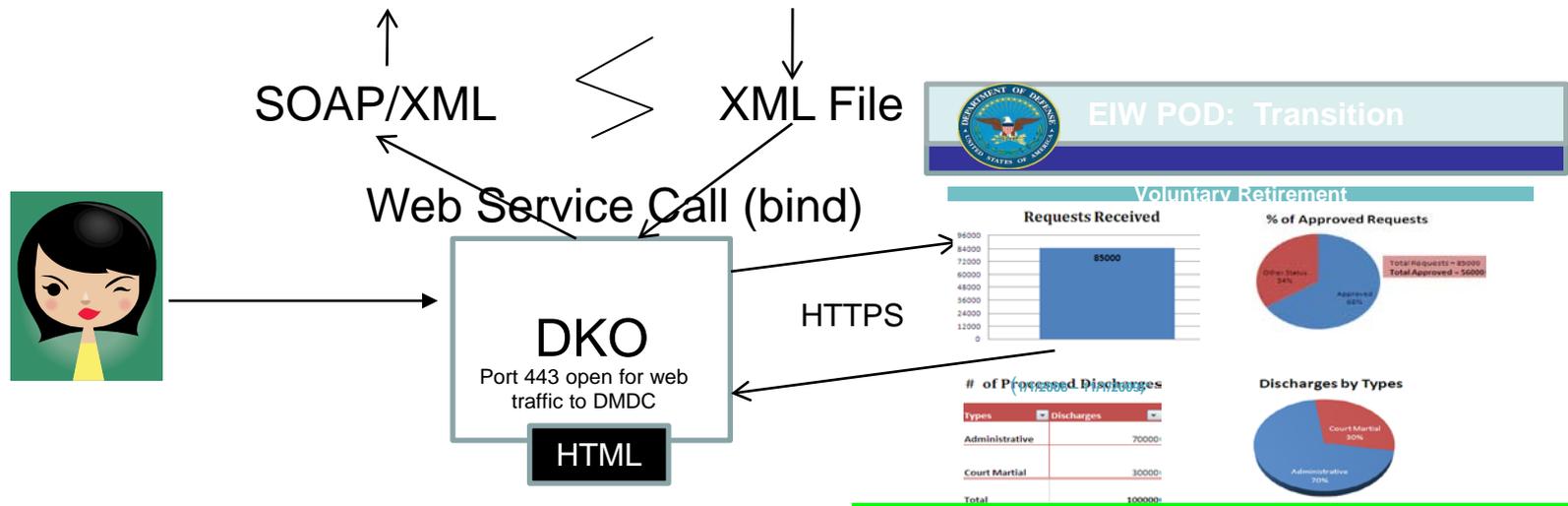
Implementing the capability by deploying business services

# Backend PoD1 Architecture



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

HTTPS Port 443 for web traffic





# RDF Warehouse Architecture (POD2)

NIPRNet / Internet

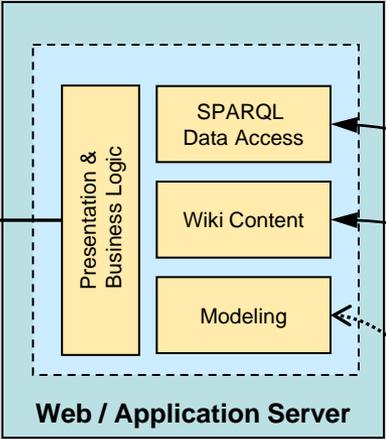
Host Network

Implementing the capability by deploying business services



HTTPS

User Agent (Web Browser)

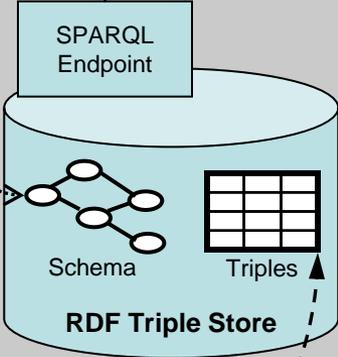


✓ Model Driven Analytics

SPARQL

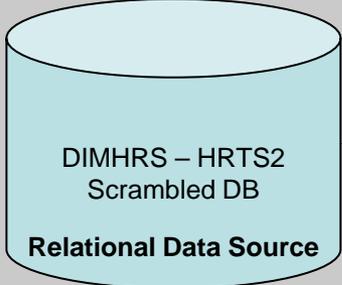
SPARQL

API

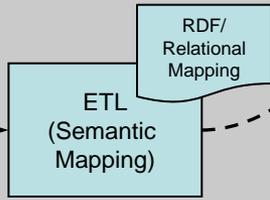


✓ Triple Store

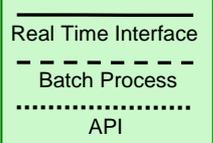
RDF Load



SQL



✓ Model Driven ETL



90 Day Deliverables – POD 2



Implementing the capability by deploying business services

# RDF Web Extensibility (POD3)

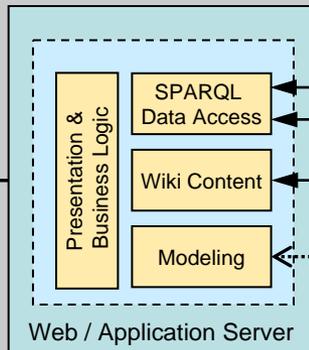
NIPRNet / Internet

DMDC Network

User Agent  
(Web Browser)



HTTPS



Real Time Interface  
 ---  
 Batch Process  
 .....  
 API

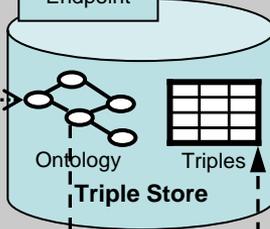
SPARQL

SPARQL

SPARQL

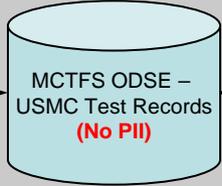
API

SPARQL Endpoint



OWL + Relational Mappings

USMC Records (Relational)



Army + USMC (Triples)

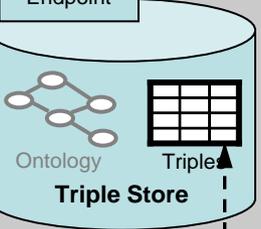
Army + USMC (Triples)



Army Records (Relational)



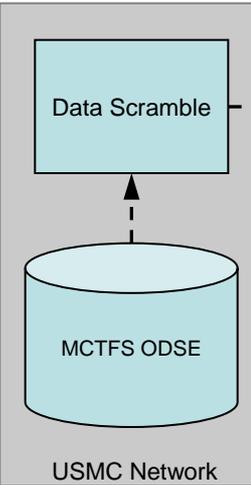
SPARQL Endpoint



Identical data loaded into both triple stores.

### 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)
  - Compensation queries (TBD)
  - Demo at least one report (TBD)
  - Scenario based demo (scenarios TBD)



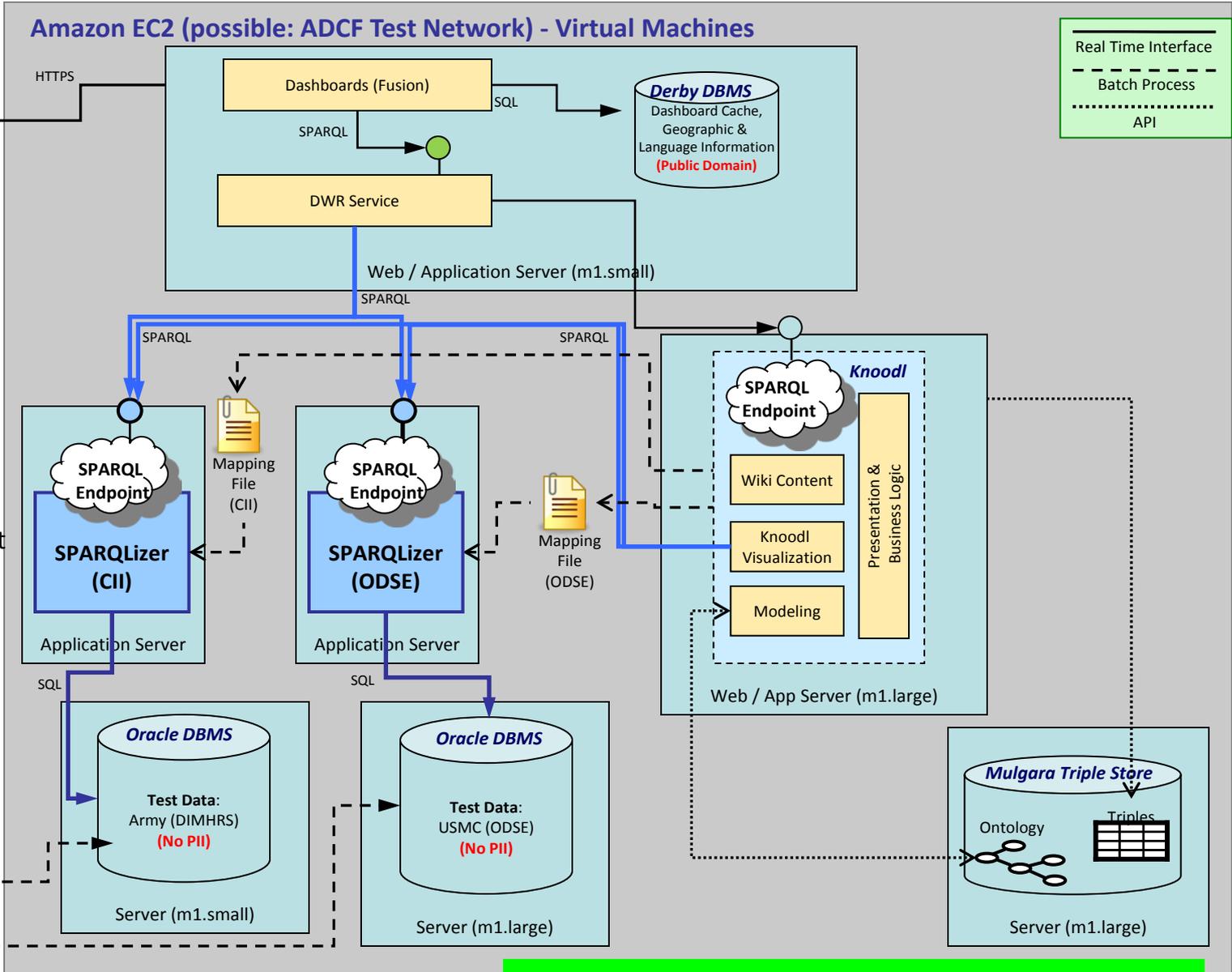
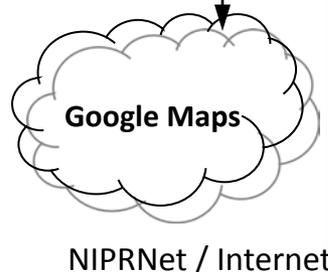
Manual File Transfer  
(No System Interface)

Scrambled  
USMC Records  
(No PII Allowed)

90 Day Deliverables - POD 3



# RDF Service "SPARQLizer" (POD4) – Deployment View





# Operations – Country View: User Defined Query

Pod 3 Dashboard

Map Compensation Separation **UCC Country View**

Language Other Other

Select Desired Language:  
 FRENCH  
 HAITIAN CREOLE

Select months since members last deployment: 6

Select months until member is eligible to retire: 6

Submit

SSN	First Name	Last Name	Loc.	Rank	Primary MOS	uuc
664887701	CukymGrnzY	PAqimqJmX	51	MAJ	MOS180	NORTHCOM
1040784003	dqKfjpcLeZ	clXksH0Ts	06	1STSGT	MOS8999	NORTHCOM
2060149898	TJzzRuUcrrw	FaWZn5xZOo	06	SGT	MOS321	NORTHCOM
2886040741	XnazuYKSEg	cFAWmVTUlm	08	LTCOL	MOS202	NORTHCOM
240226098	KcVVSFohqY	kBkWiCmTal	51	SGT	MOS3531	NORTHCOM
2768415363	VfYbafiiyC	RrmreZLQgb	BG	SSGT	MOS2671	PACOM
3395337019	qVEhcxUKOp	IPGibVqOr	51	CPL	MOS4641	NORTHCOM
2313602753	SIUhsCyABW	sOionznFxr	BG	SGT	MOS341	PACOM
350157891	TibKjntNAK	VXStisZPDM	51	SSGT	MOS431	NORTHCOM
613173606	IDJwluEErp	GpZbpatIWy	I2	LTCOL	MOS302	CENTCOM
2803128426	siaTKGHUlh	SPJGquHvF	51	GYSGT	MOS6276	NORTHCOM

Total Members:20

Use Case!



# 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



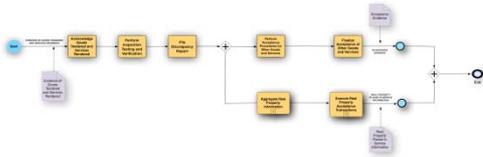
DFAS: Assessing HR-related pay requirements for the EIW



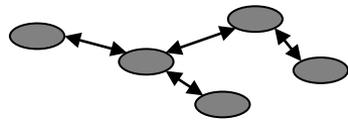
Military Services: Identifying ADSs, providing functional SMEs, & validating modeling

# HR EIW Technical Summary!

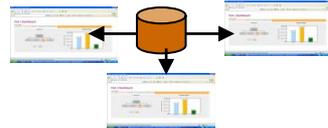
Many DoD and Industry Participants, Learning!



Makes full use of Business Process Models Built on BPMN (OMG) Standard!



Built with Open Source Software and Open Standards (W3C)!



Ad Hoc and Standard Displays use ADS!



Implemented in the 'Cloud'!



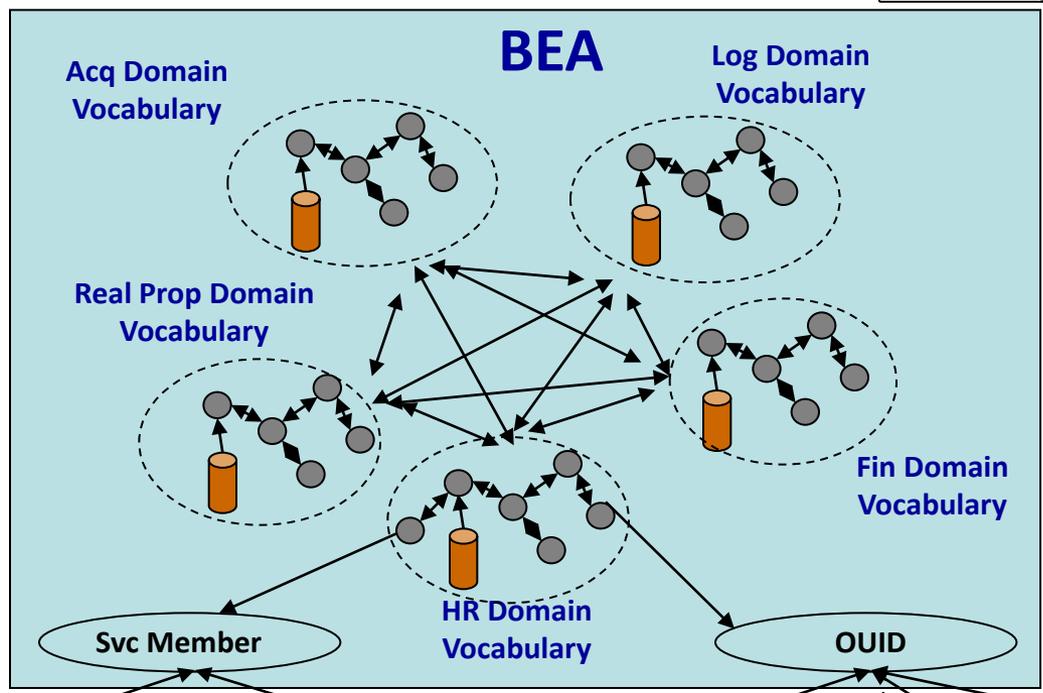
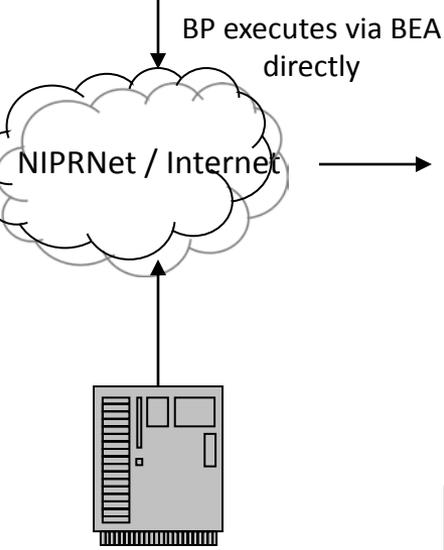
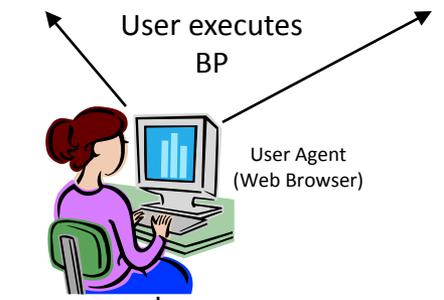
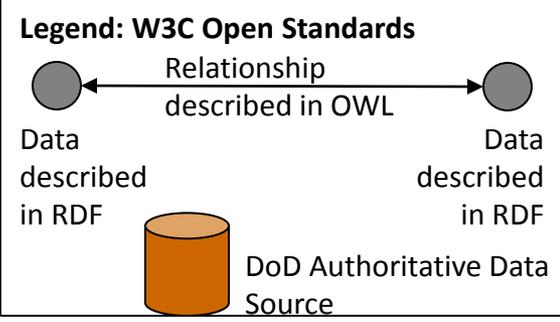
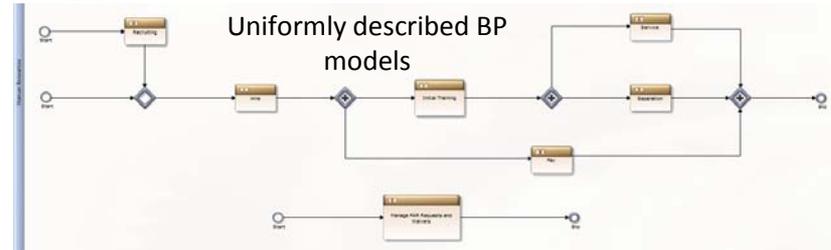
90 Day Deliverables!



Built on a Shoe String!

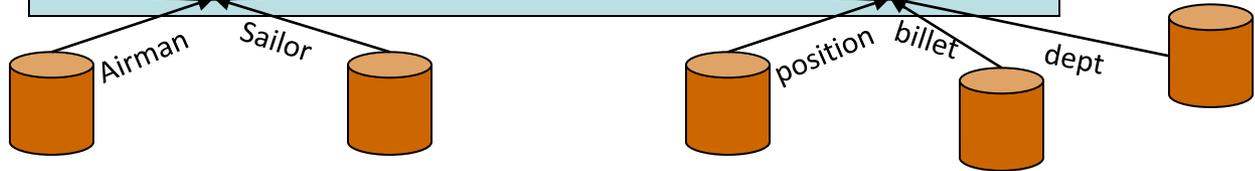


# EIW and the Direction of DoD Solution Architectures



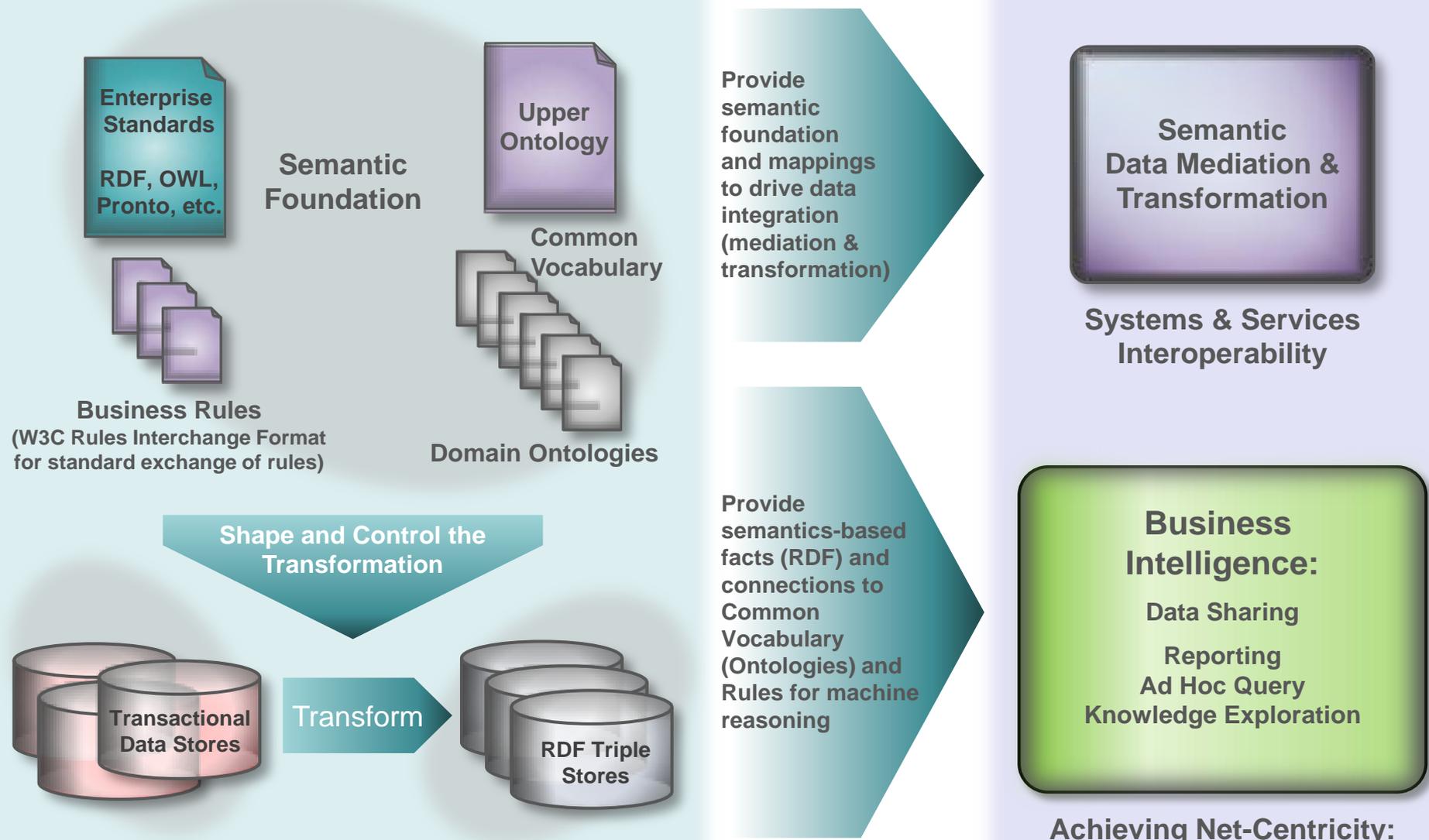
**Federated Business Enterprise Architecture (BEA) queried directly for:**

- Enterprise analytics
- Compliance
- IRB/portfolio management





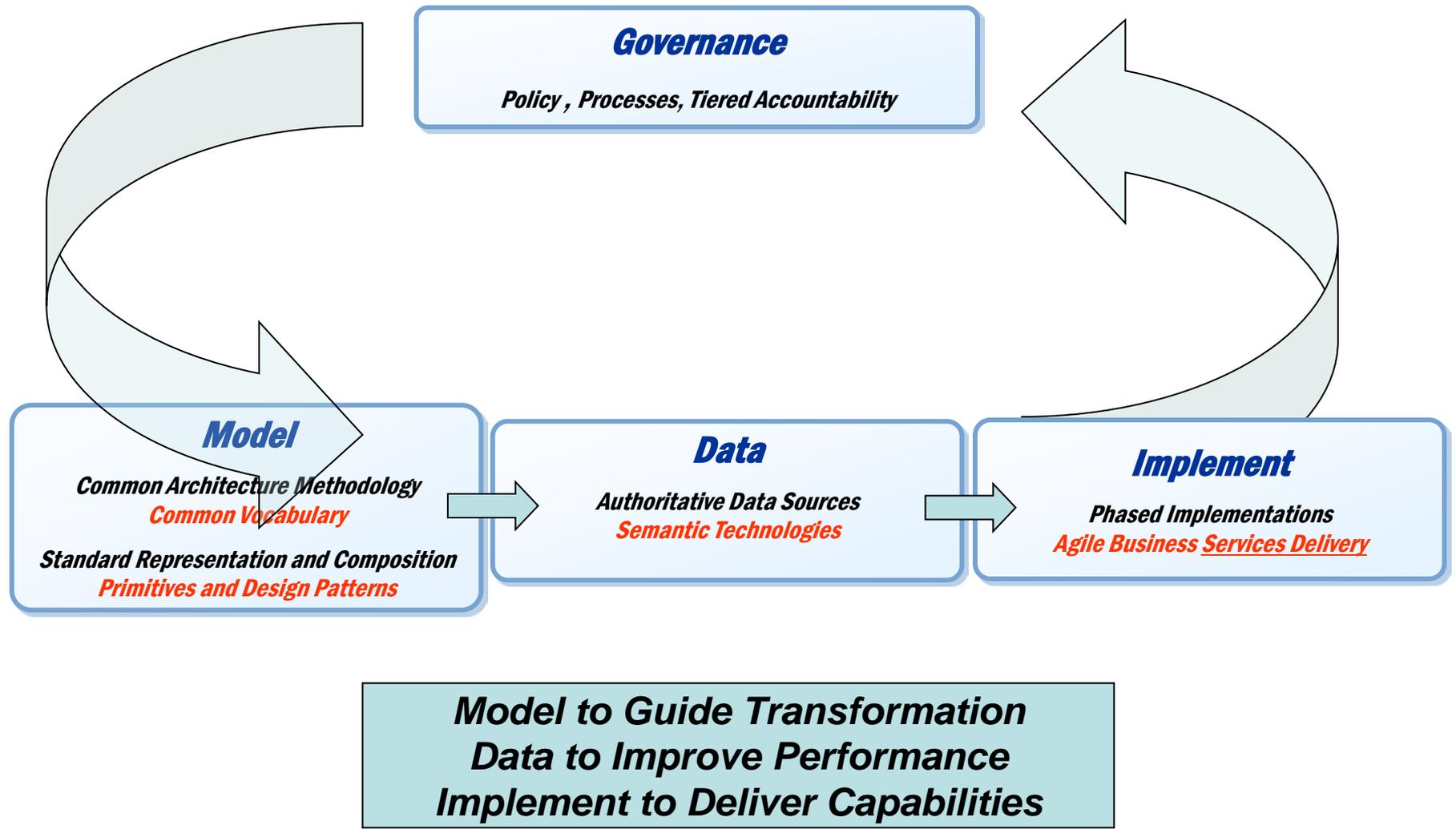
# DoD Business Operations Semantic Landscape



EIW is first BI realization of this



# Agile, Architecture-Driven, DoD Business Capability Delivery





# Thank you!

Questions?  
Dennis.Wisnosky@osd.mil

