Semantic Technology in the Department of Defense, Business Mission Area

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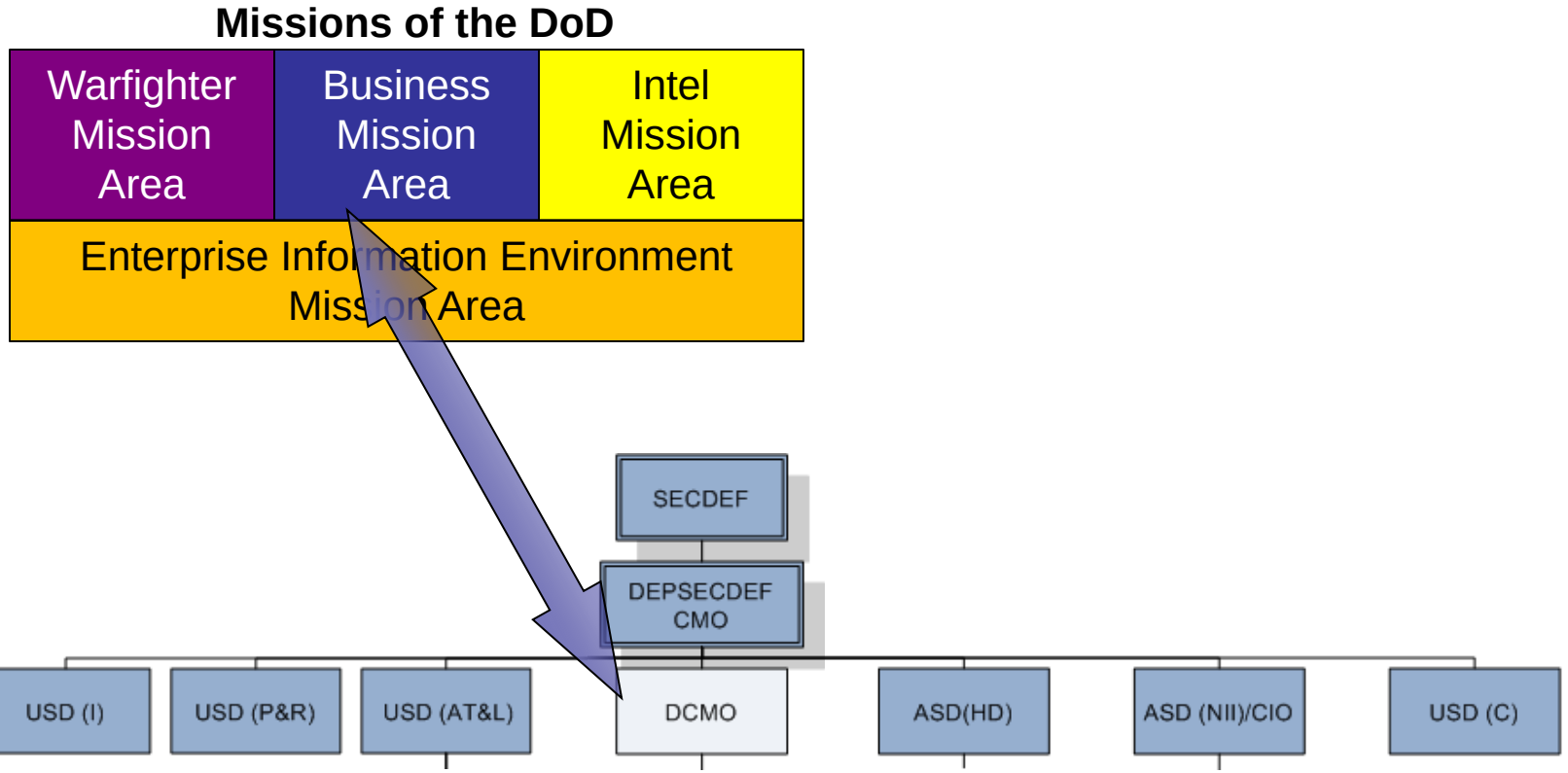
DCMO CTO/CA



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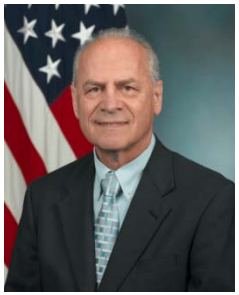


The Business Operating Environment

"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

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
Total DoD IT Spending	5,300	$33.7

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

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%
Total	$30,380	3,400	100.0%	100.0%

$ 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

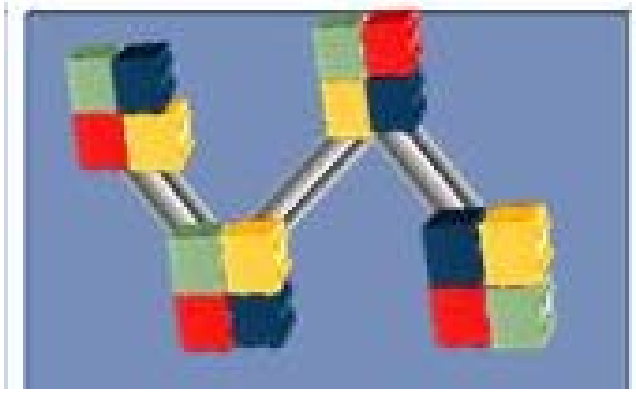
We Must Make Sense Out of This!

Game-Changing Innovations

Common Vocabulary and Primitives

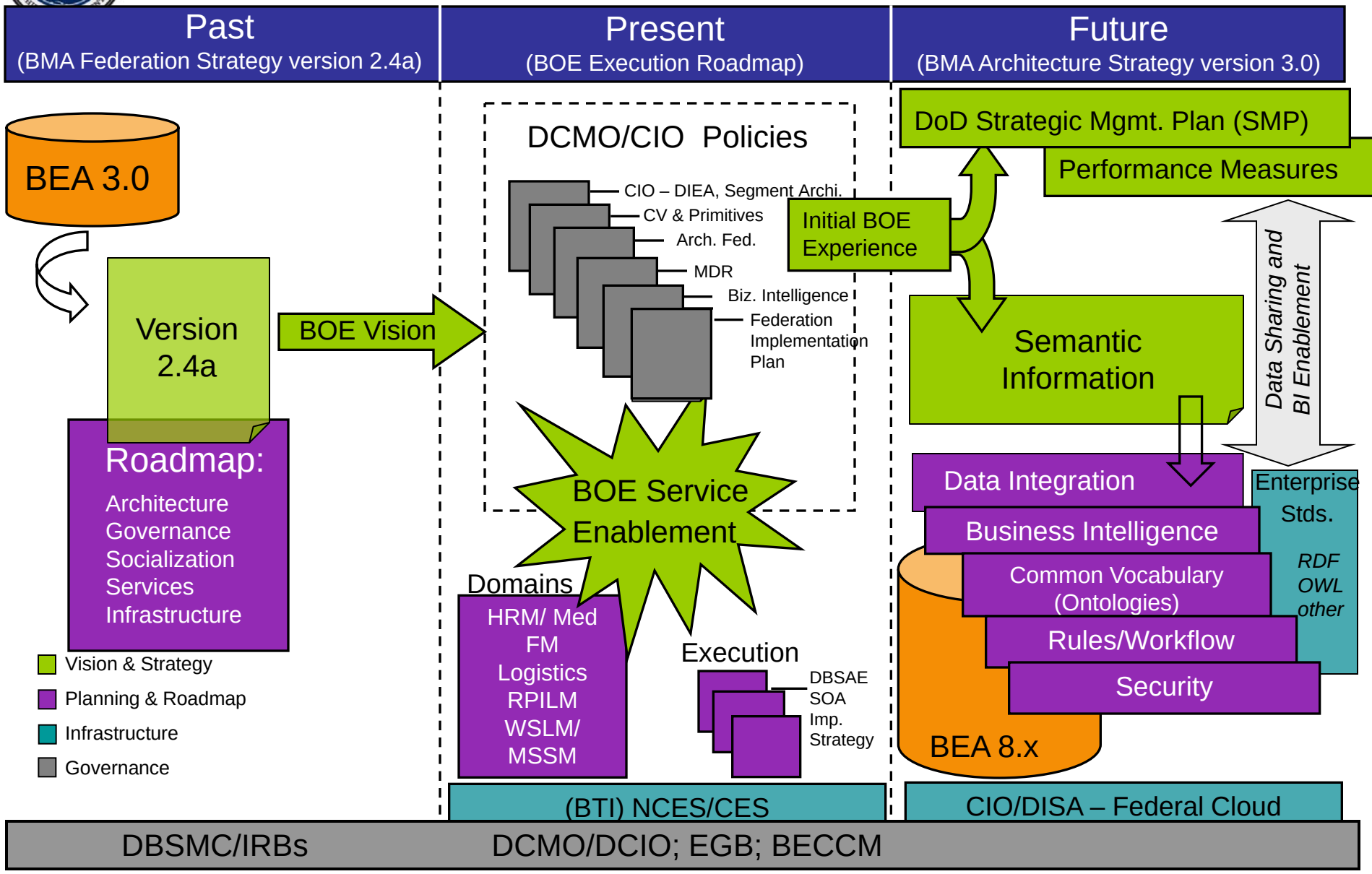
- If we can precisely state requirements and precisely describe data/services, we will be able to find them and know how to use them to facilitate:
  - Integration and Interoperability
- We must describe both the data/services and requirements with enough precision to accomplish the goal
- We use:
  - 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

Architecture Primitives

Standards
Best Practices

informed by

influences

PriMo
Modeling Guide

foundation for

PrOnto
Ontology (Lexicon)

input for

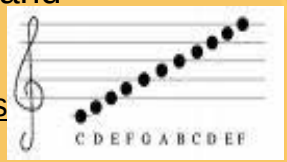
Different Frameworks

Architecture Primitives

Modeling: Primitives!

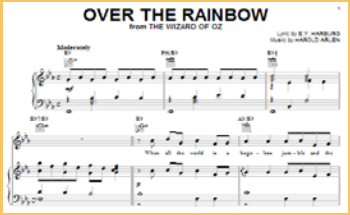
Music Language and Symbols:

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

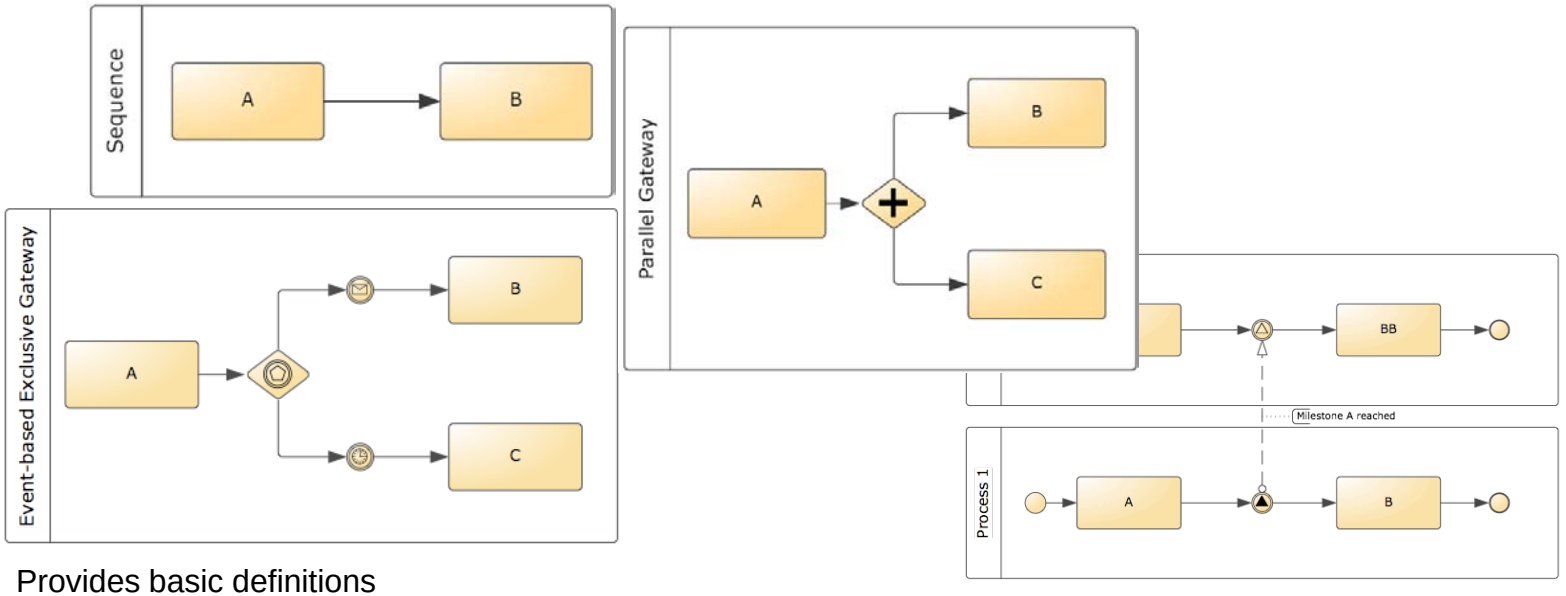
Well Documented Intentions!

DoD Architecture Framework Processes Best-Practice

http://cio-nii.defense.gov/sites/dodaf20/journal_exp3.html

Primitives Lead to Patterns

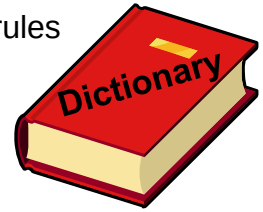
Modeling the business capability to be deployed

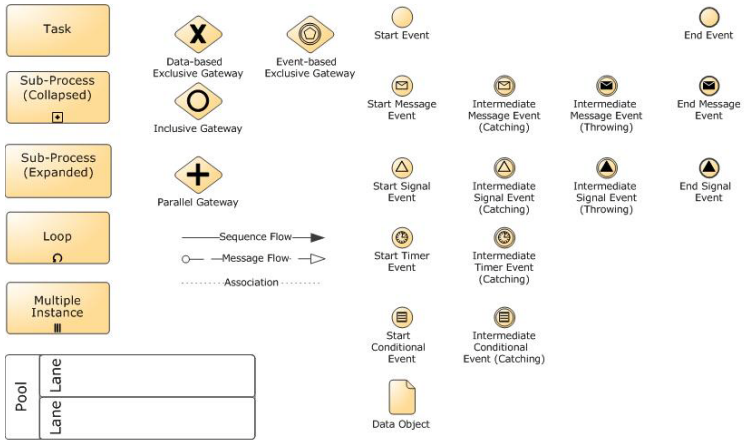


PriMo

PrOnto

- 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

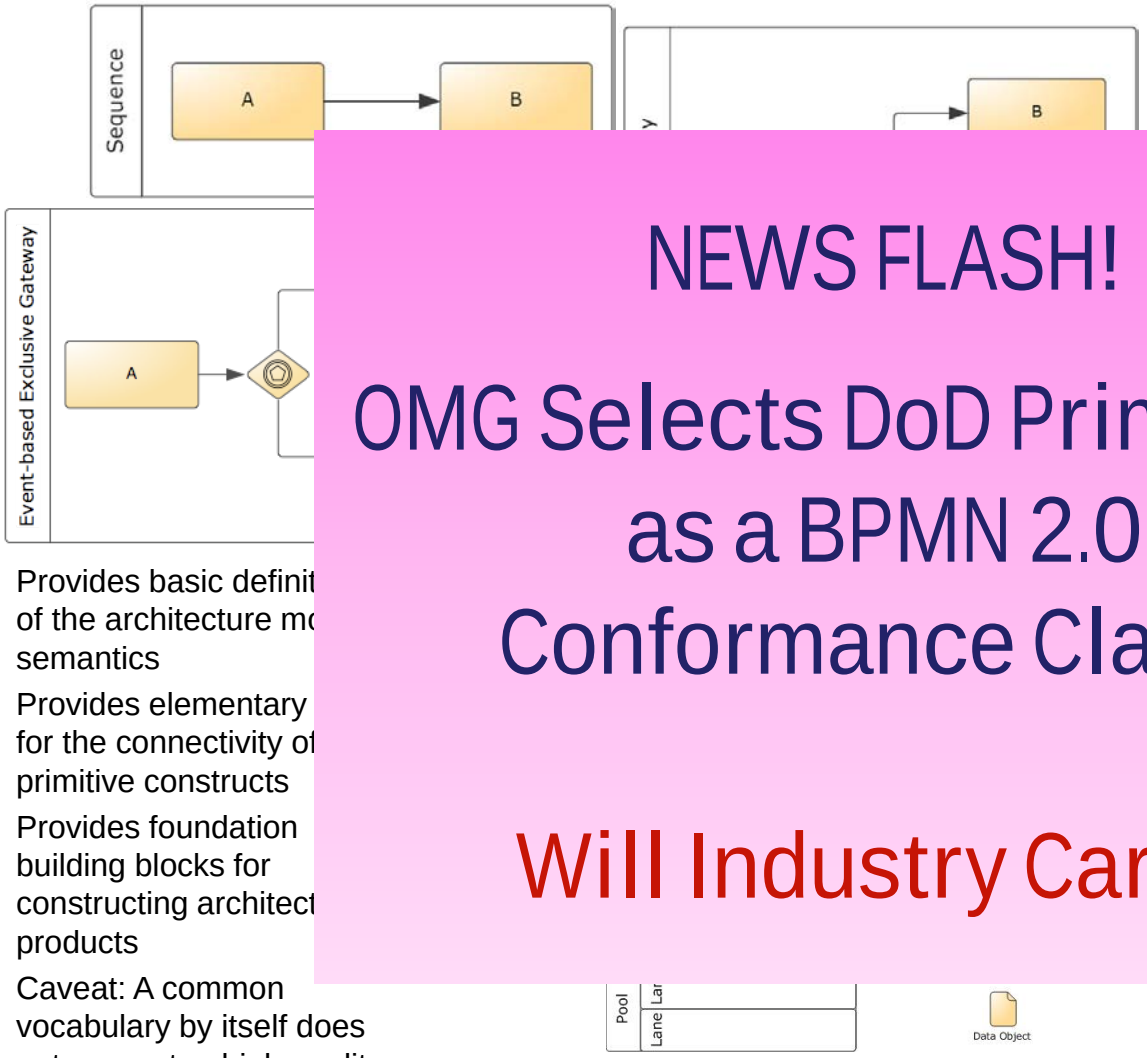




- A style guide provides subjective advice that will ensure the design of high quality products
- A style guide advises on
  - Choice of words
    - Which constructs are appropriate in a given situation
  - Choice of grammar
    - How to combine constructs to maximum effect

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

PriMo

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style guide advises on

- Choice of words
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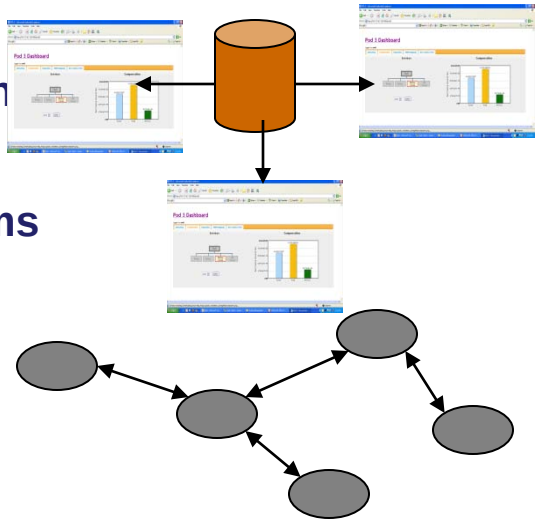
We Are Underway!

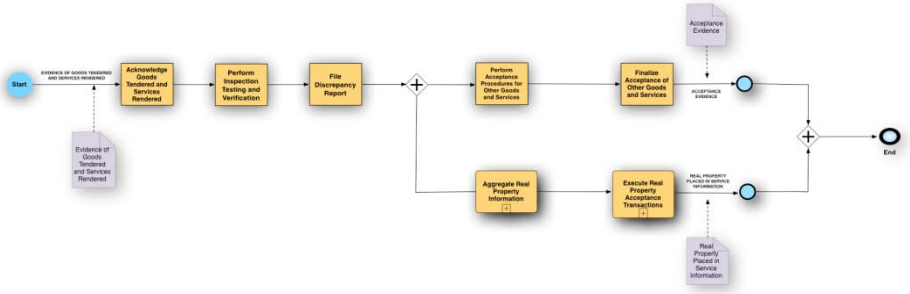
Modeling the business capability to be deployed

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

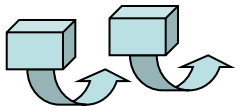
Modeling the business capability to be deployed

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

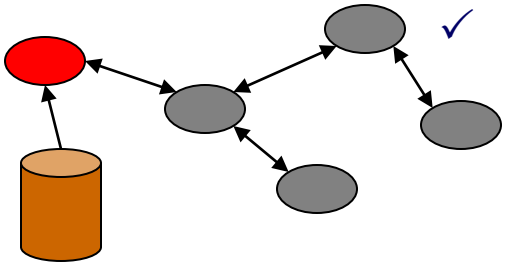
- Steps
  1. Build Domain Vocabularies: describe all of the artifacts in each domain using RDF/OWL standards
     - DoD currently does this description work, but without standards – often in Excel, Word, Powerpoint, Visio, etc
  2. Relate Domains: use RDF/OWL based descriptions to say how domains are 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)



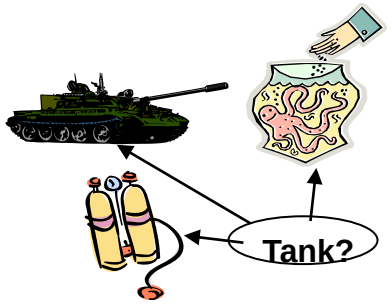
- Agility in query development
  - ✓ Queries are machine and human readable
  - ✓ Fast to develop across disparate ADSs

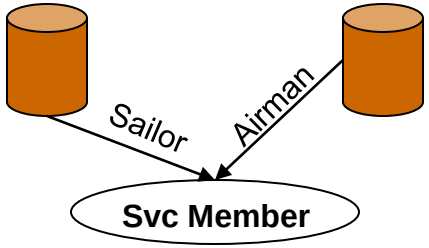
NOTE: up-front time and labor cost of unambiguously describing assets is not trivial

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



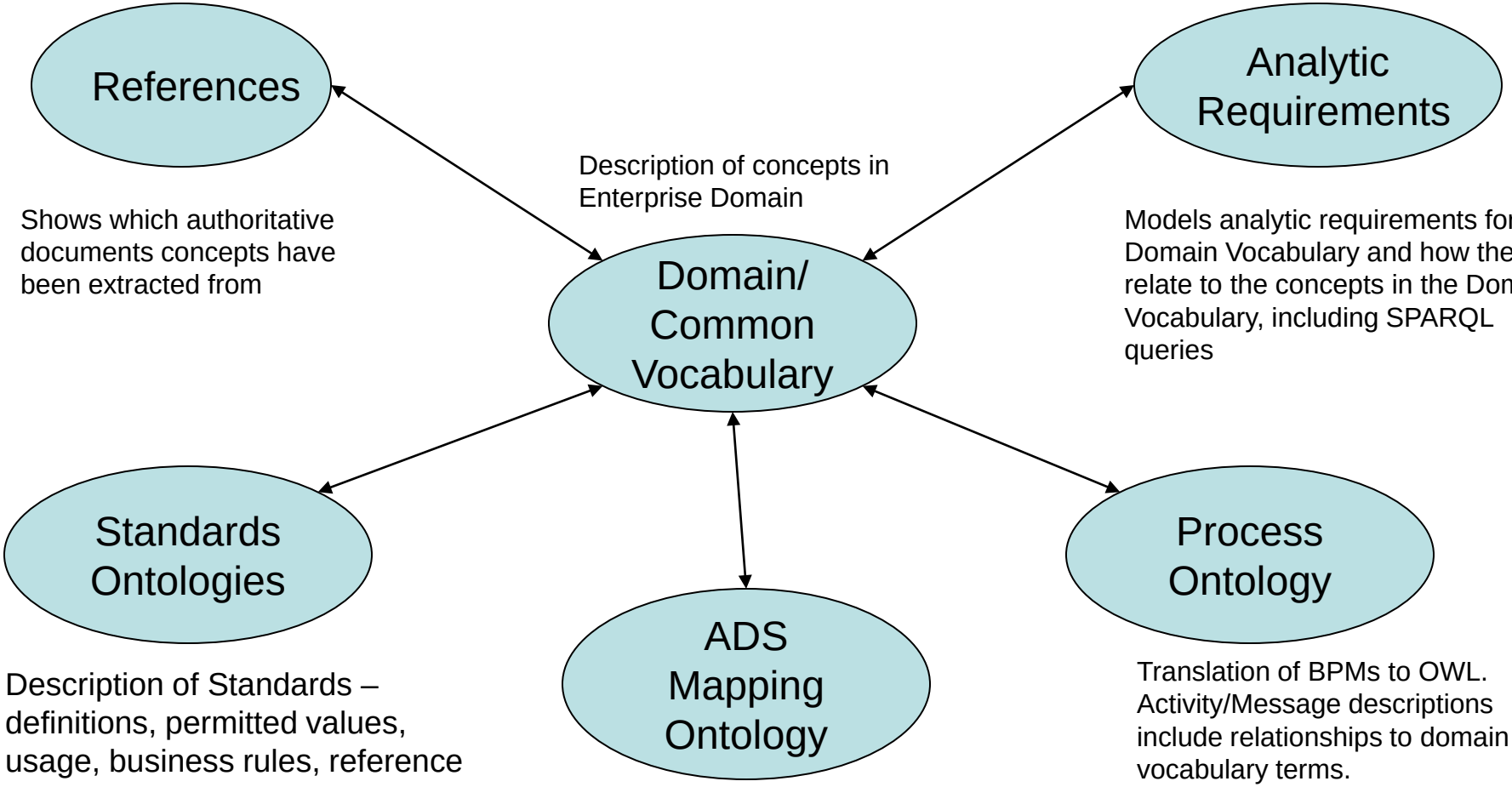


Data	Concept	System	DV to Arch?
Airman	Svc Mem	Pers Sys	
Soldier	Svc Mem	Pers Sys	
Sailor	Svc Mem	Pers Sys	
Lawyer	Svc Mem	Pers Sys	

(notional depiction only)

DoD BEA Ontology

Preparing and populating a modern information model and data store

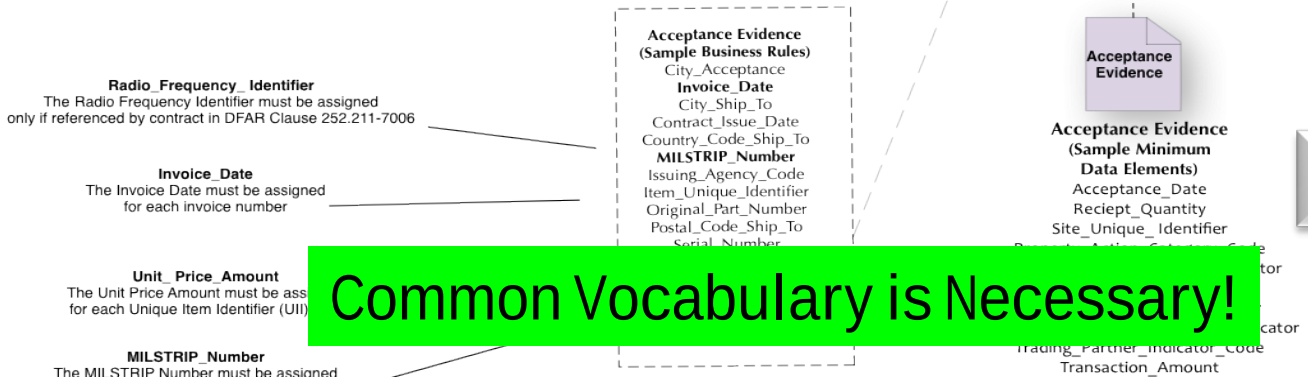


Example SMP to End to End (E2E) Process
Priority 5 – Strengthen DoD Financial Management

Preparing and populating a modern information model and data store

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

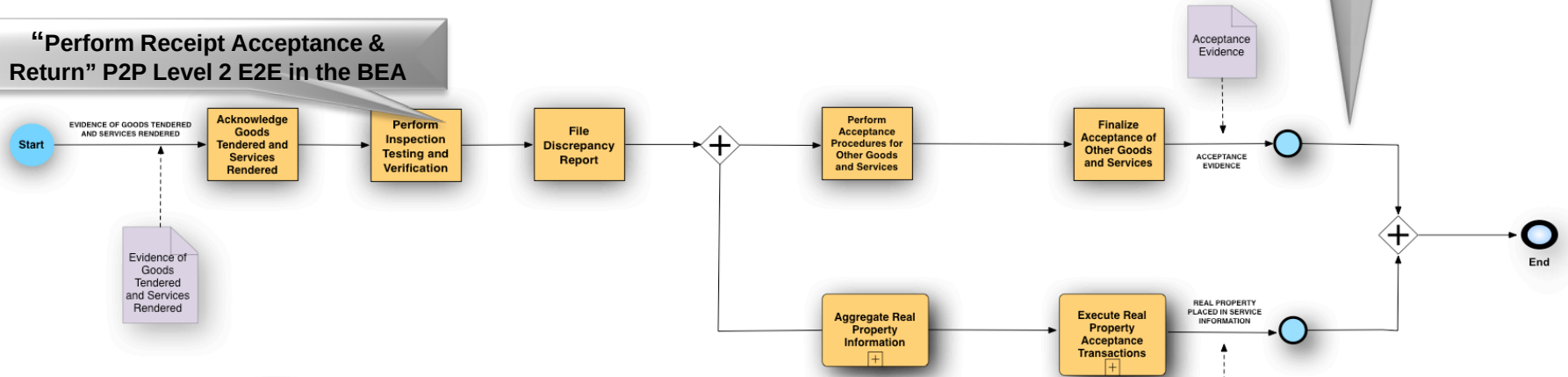
SMP Metrics also to be rolled up to Level 1



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

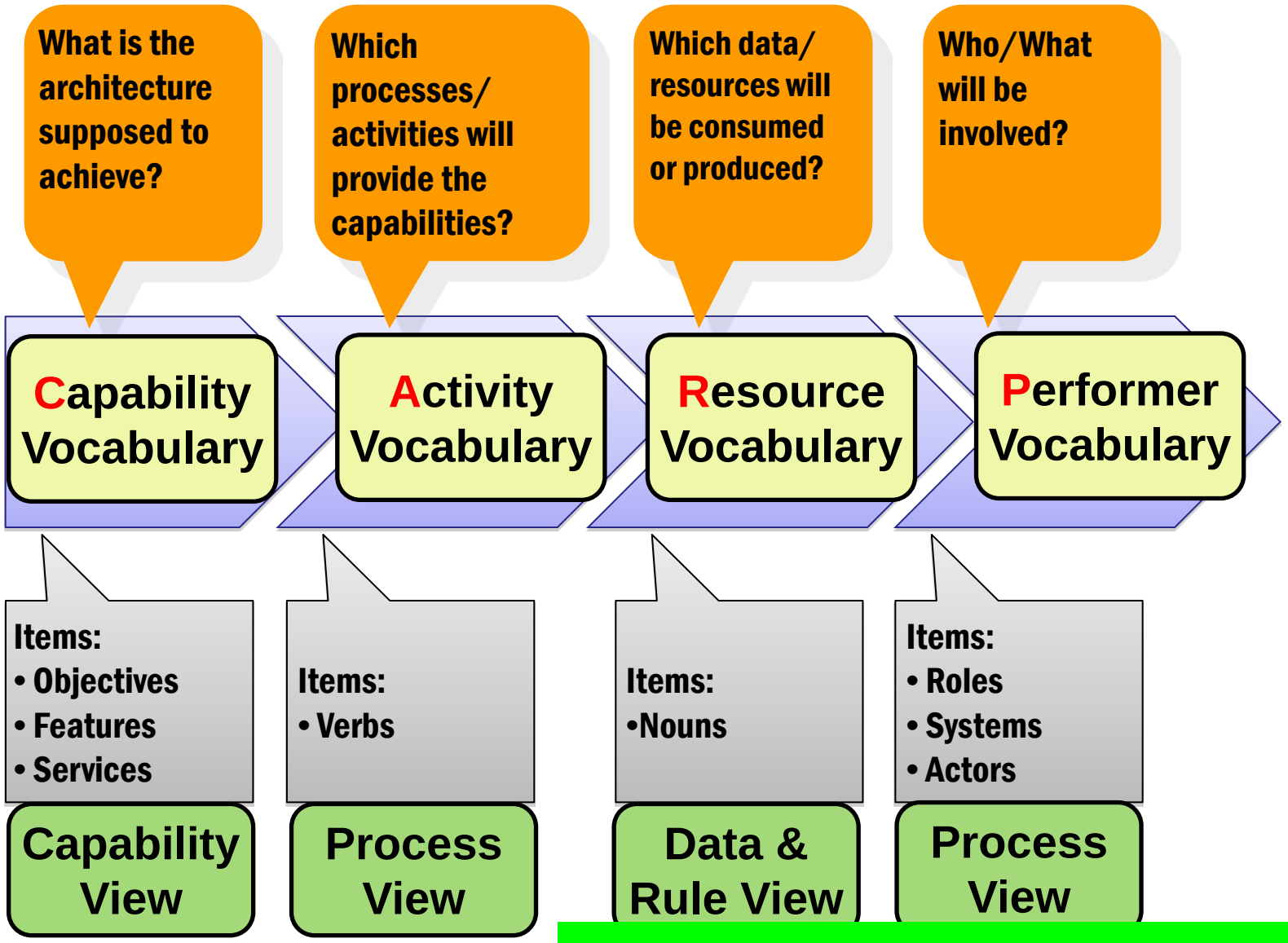
Preparing and populating a modern information model and data store

- 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

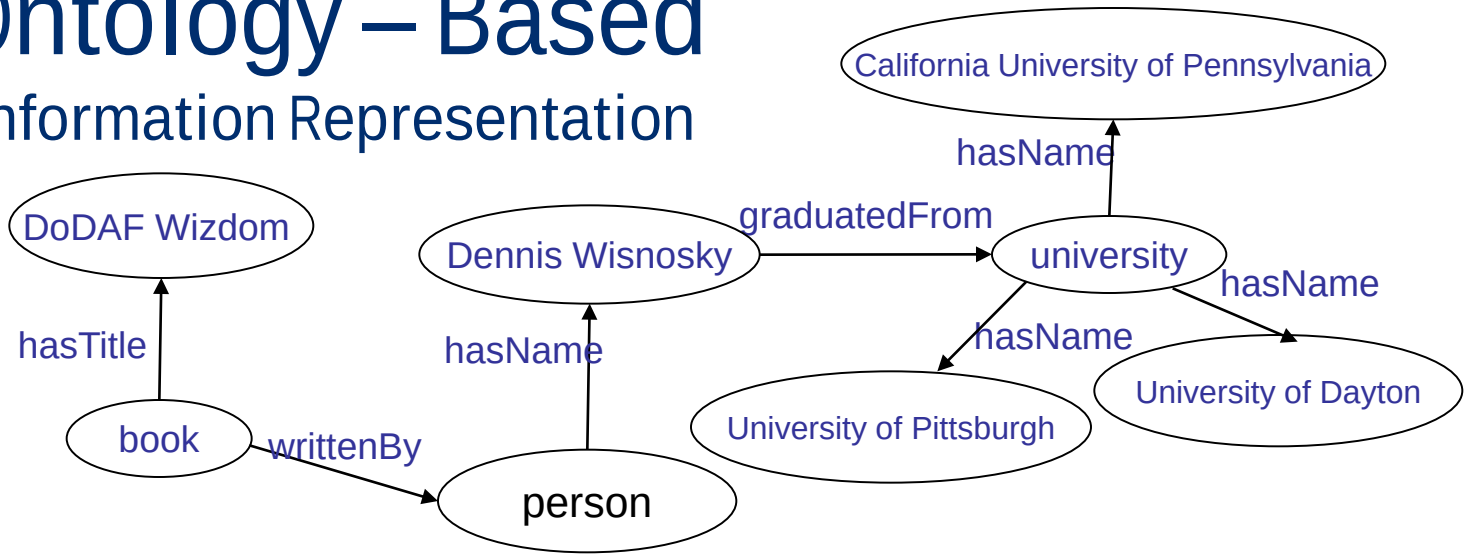


DoD BMA Architecture Methodology

Ontology – Based

Information Representation

DBpedia (Wikipedia) Dataset



Graph1

Who wrote “DoDAF Wizdom”?

Common Vocabulary in Action!

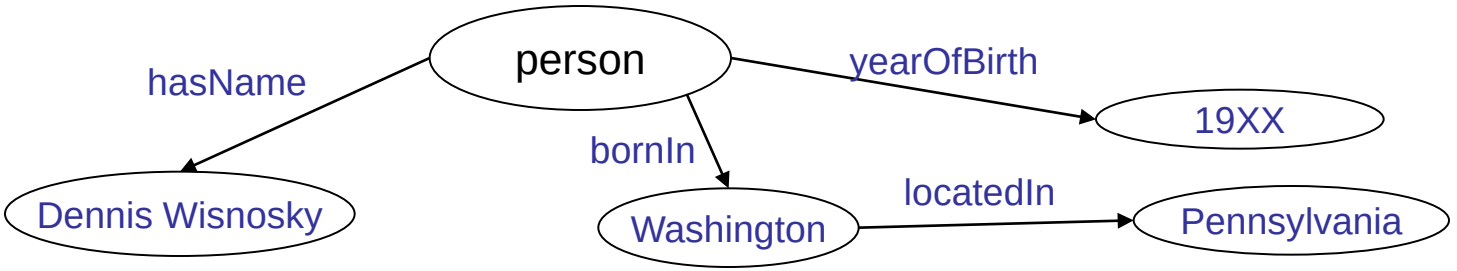
Ontology – Based

Information Representation

Where was Dennis Wisnosky born?

Graph2

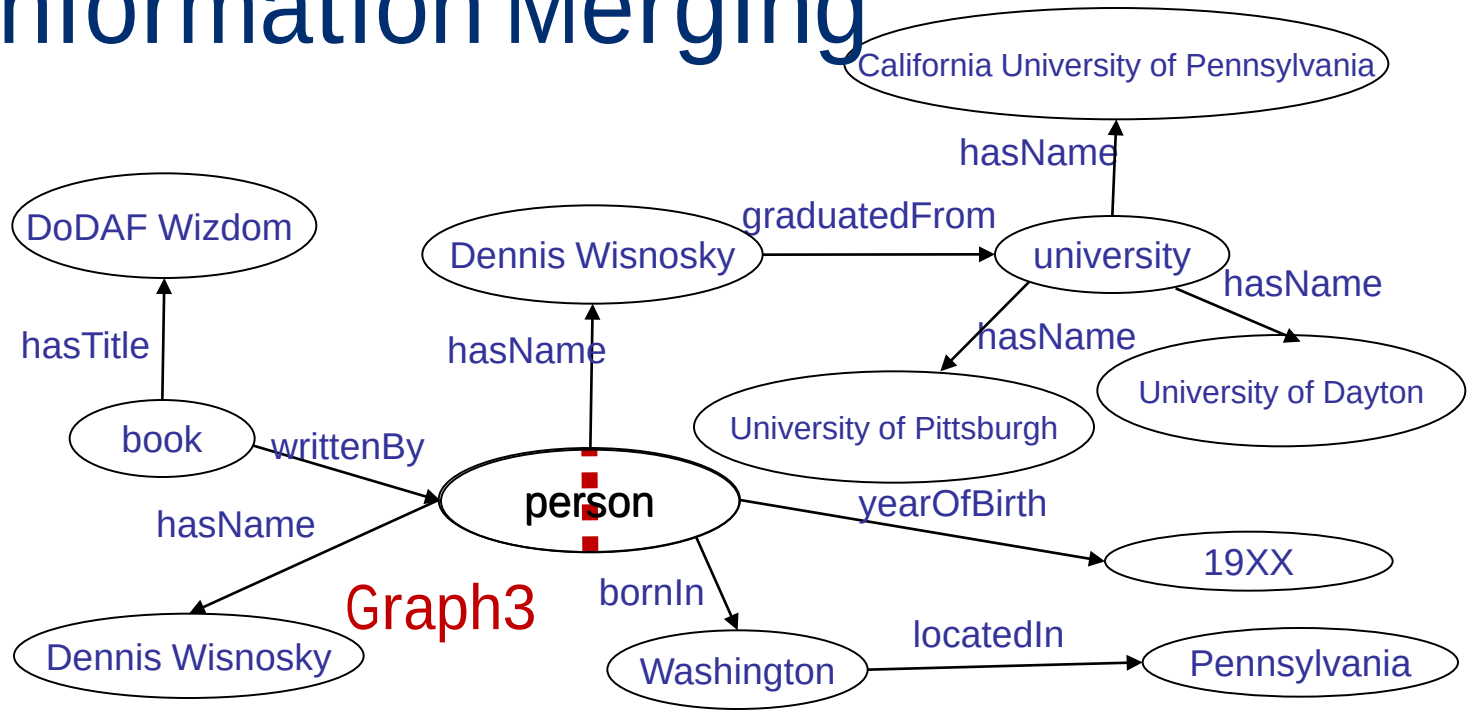
DoD HR Dataset



Information Merging

DBpedia (Wikipedia) Dataset

DoD HR Dataset



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

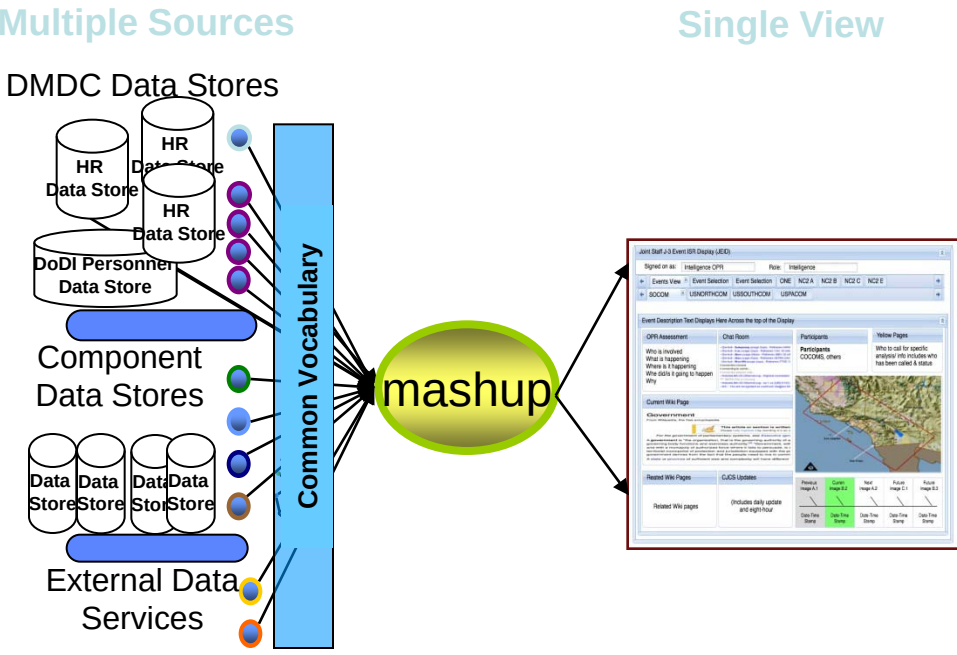
Crawl, Walk, Run - EIW

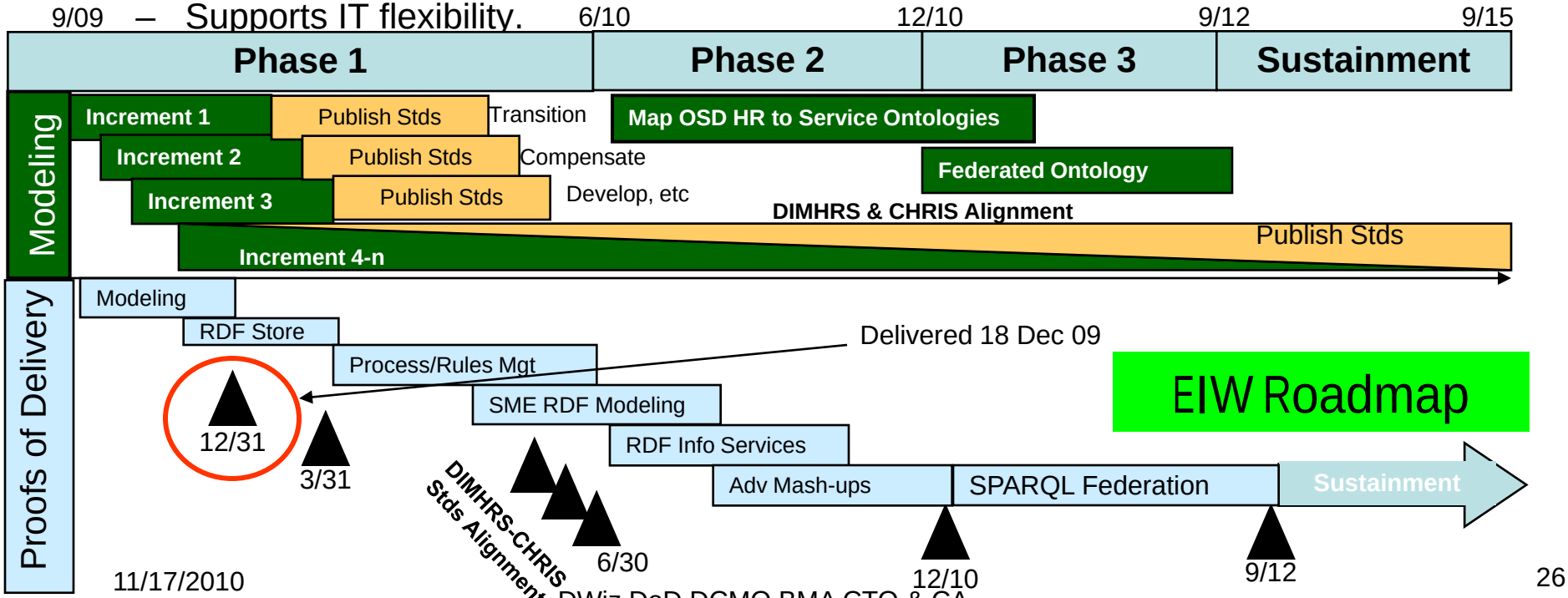
Implementing the capability by deploying business services

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.
- Supports IT flexibility.





HR Domain Ontology

Implementing the capability by deploying business services

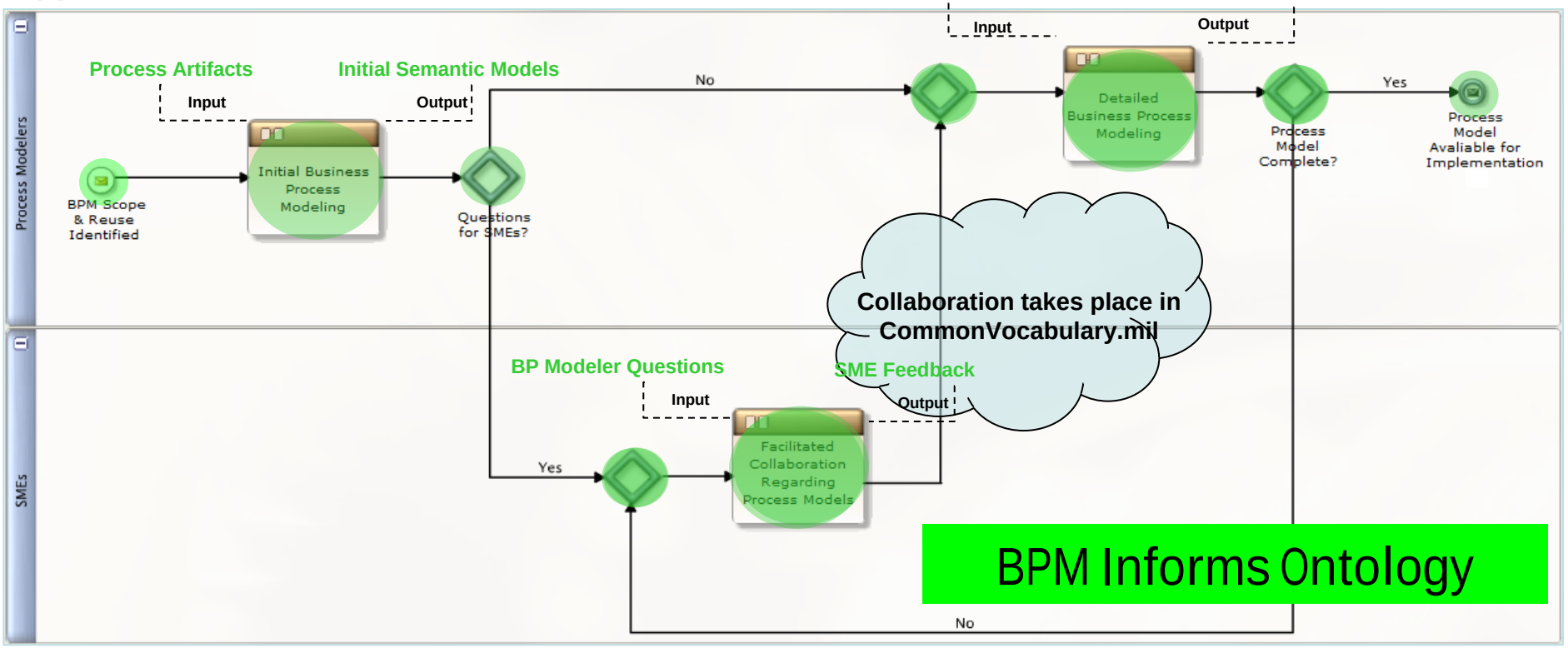
- Information discovery, interoperation, and integration all depend on description
  - If we do not *know* what something is we cannot possibly know how to integrate it with other things or even how it should be used
- If we describe everything, we are in a position to have a knowledge-based web
  - 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:



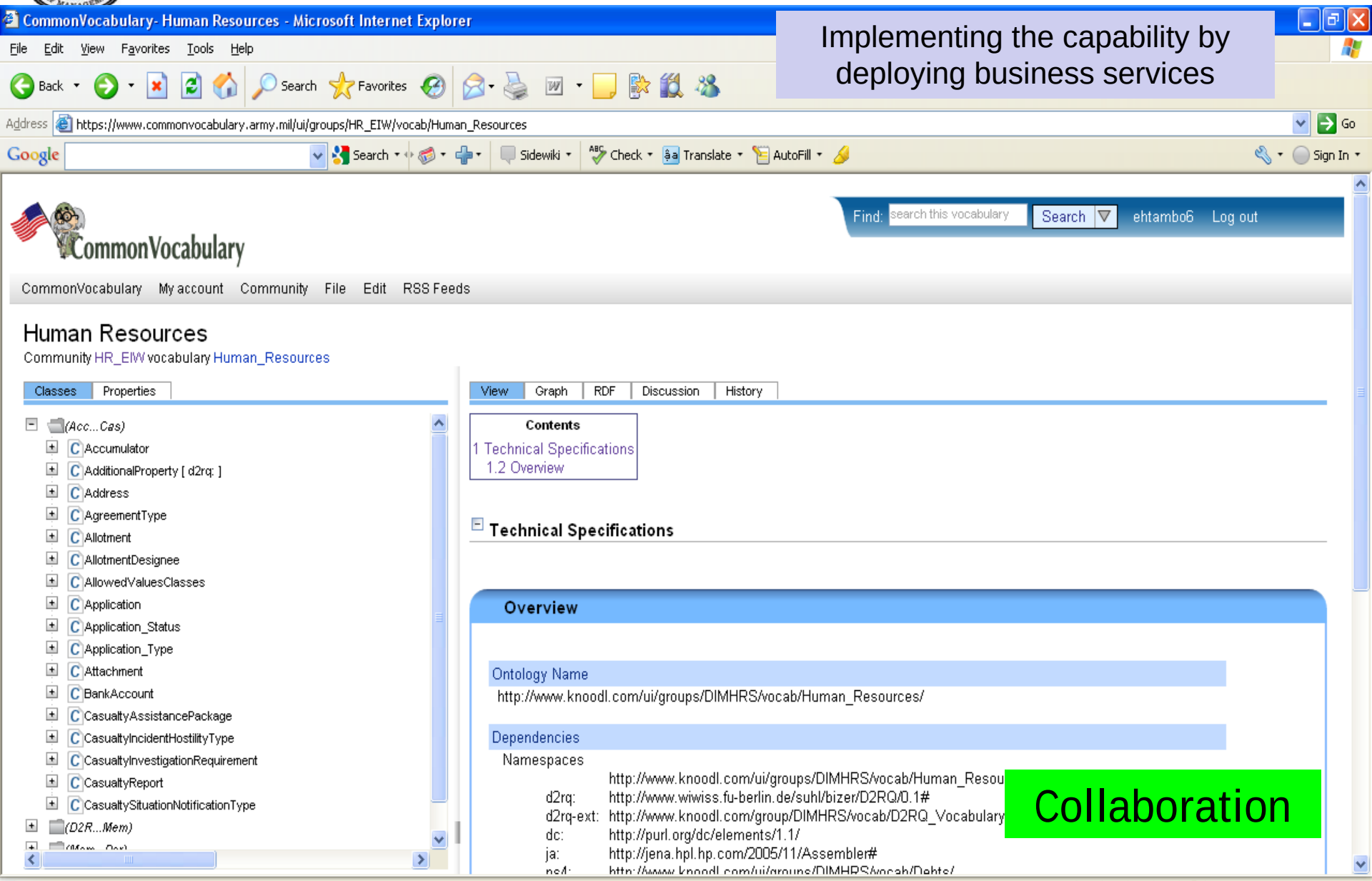
Benefits:

- 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

Community Workspace: www.Common Vocabulary.army.mil

https://www.commonvocabulary.army.mil/ui/groups/HR_EIW

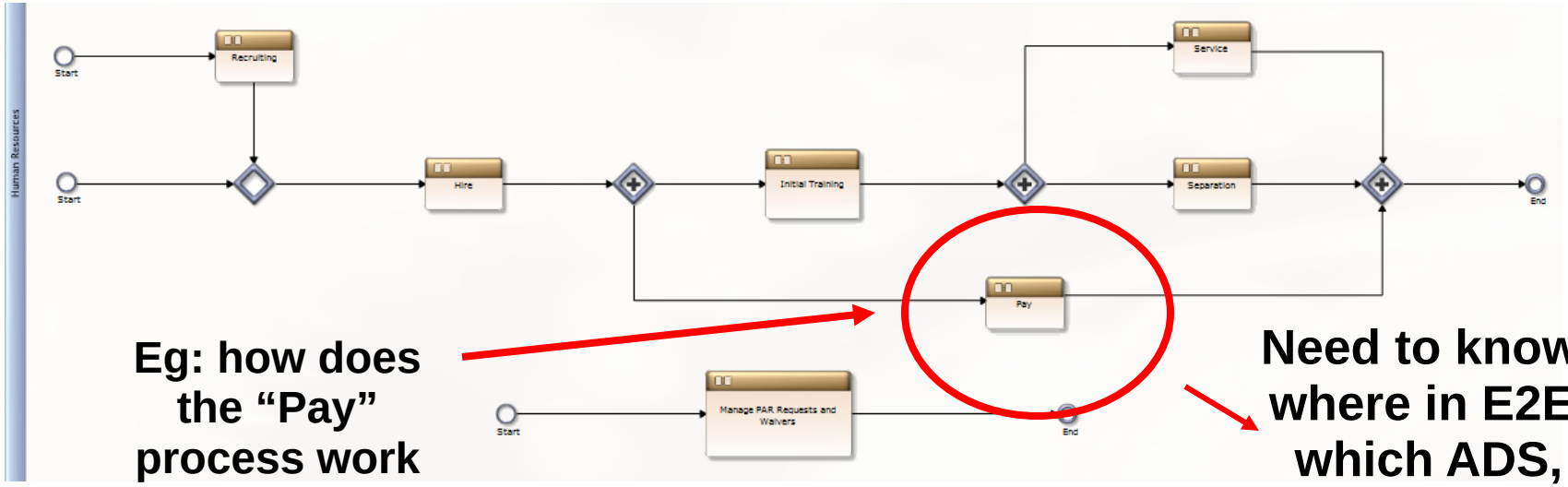
Implementing the capability by deploying business services



HR EIW 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

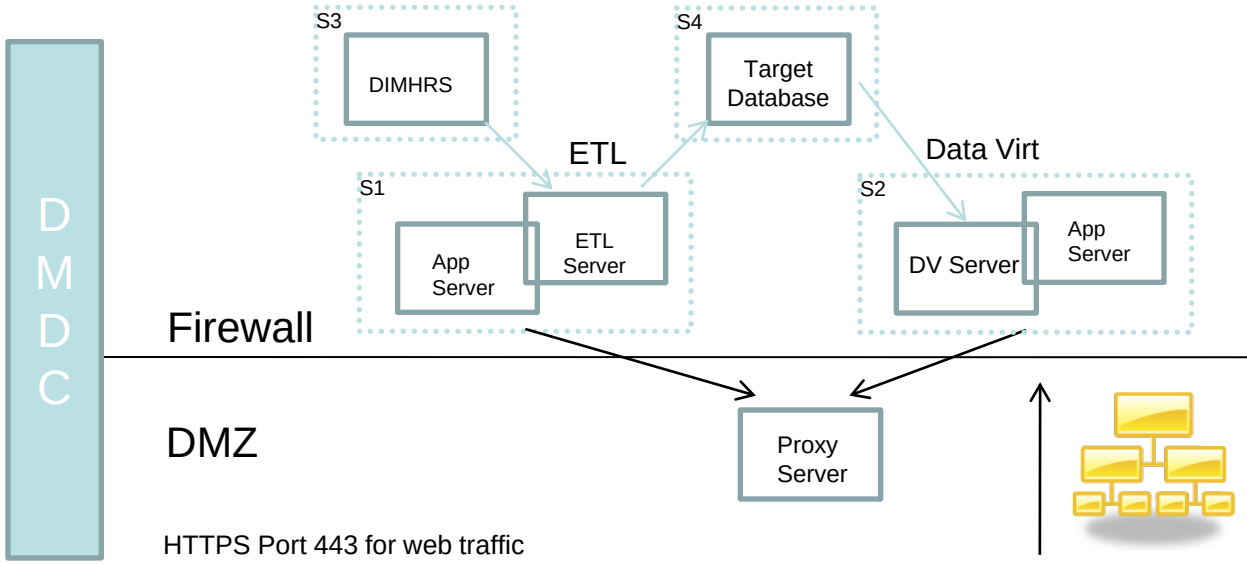


Eg: how does the "Pay" process work across DoD in the E2E?

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**

SOAP/XML

XML File

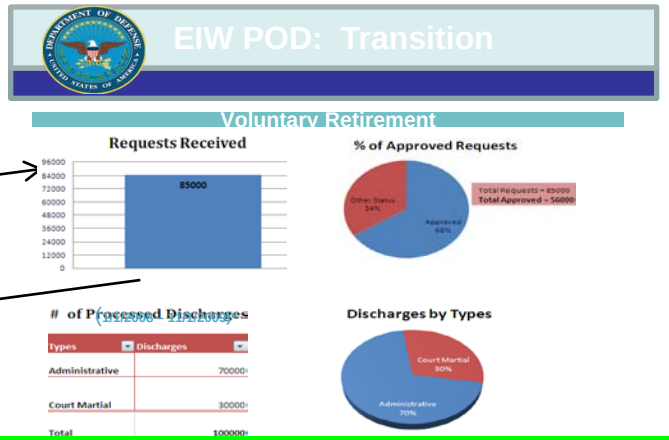
Web Service Call (bind)

DKO

Port 443 open for web traffic to DMDC

HTML

HTTPS

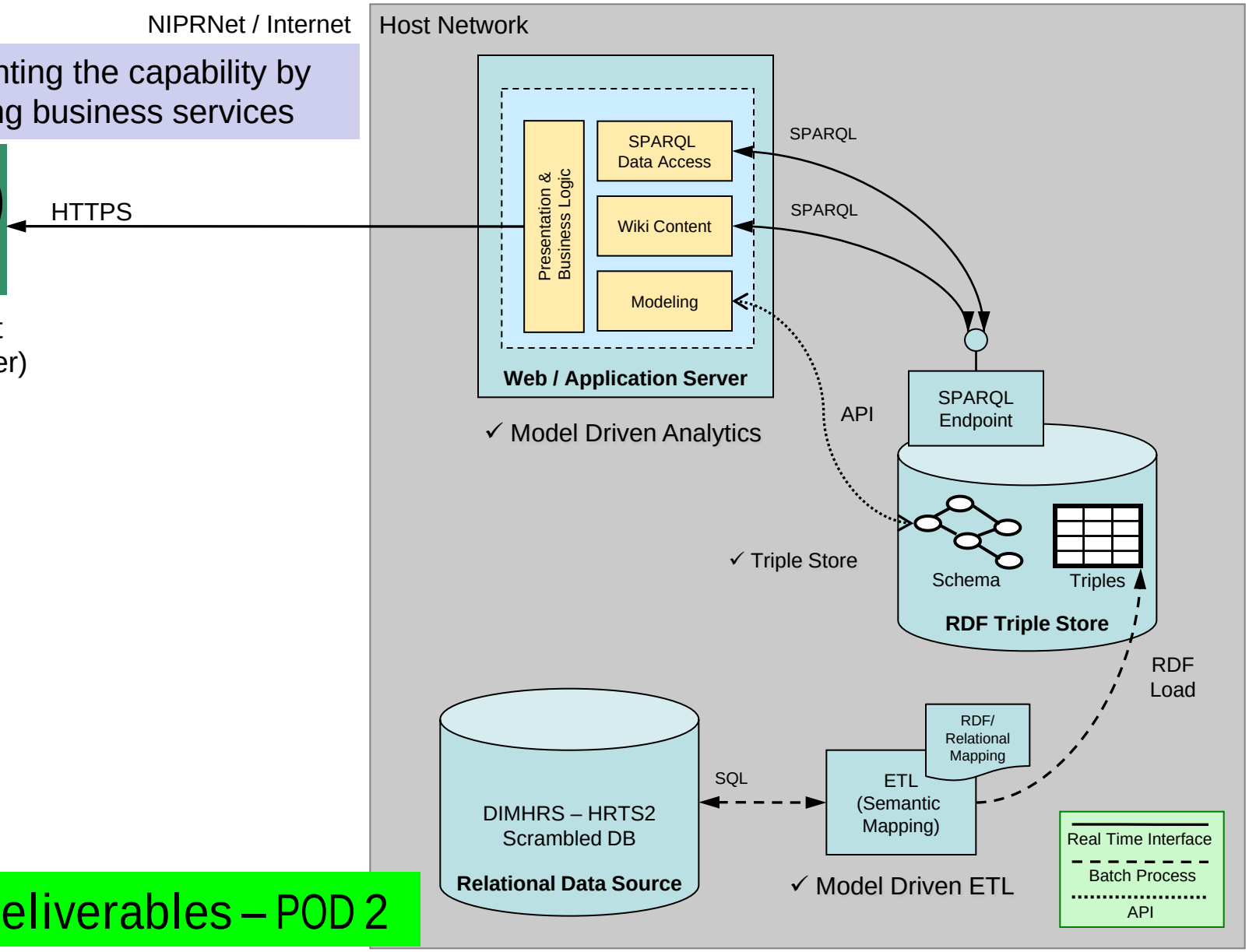


90 Day Deliverables – POD 1

RDF Warehouse Architecture (POD2)

Implementing the capability by deploying business services

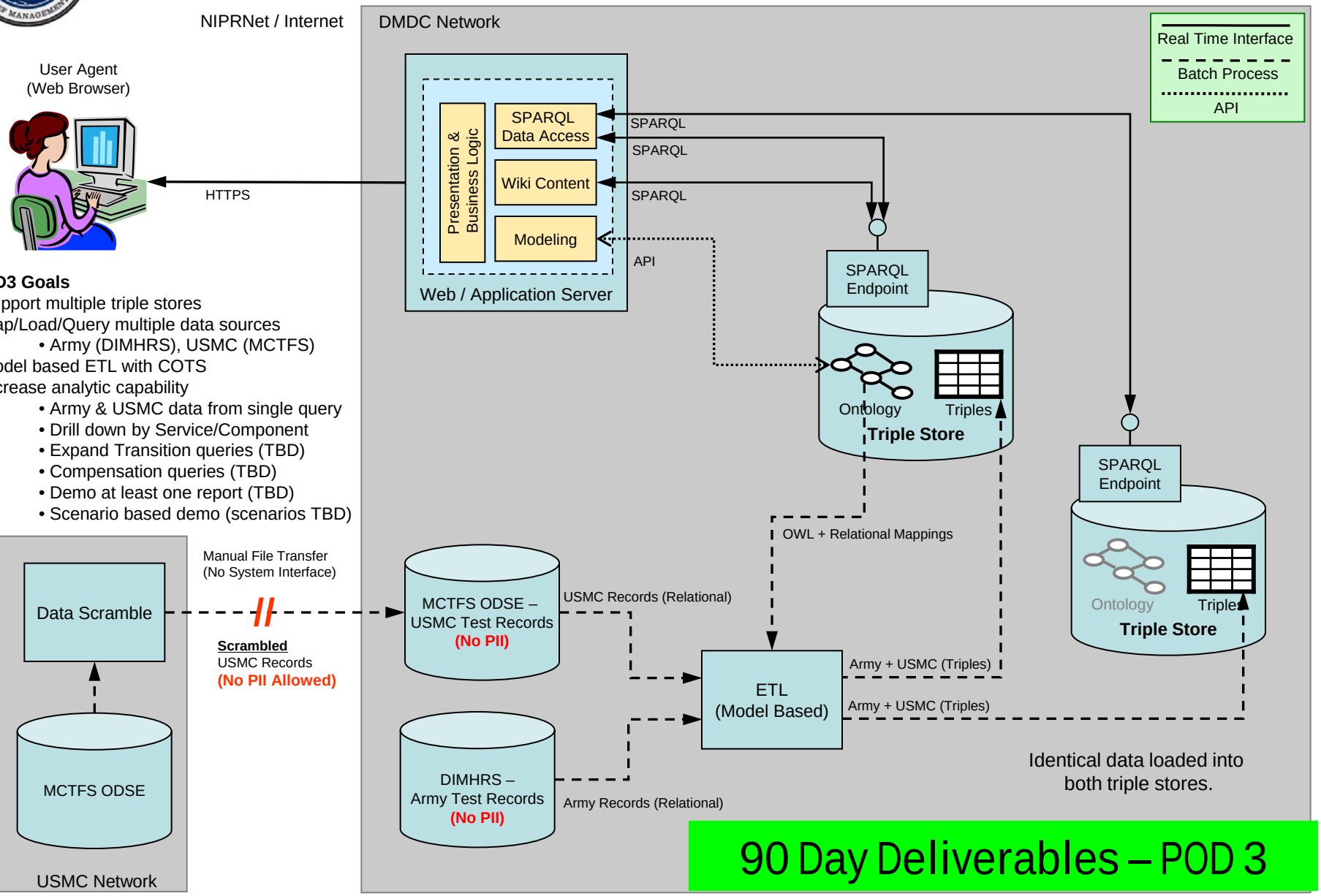
User Agent
(Web Browser)



90 Day Deliverables – POD 2

Implementing the capability by deploying business services

RDF Web Extensibility (POD3)

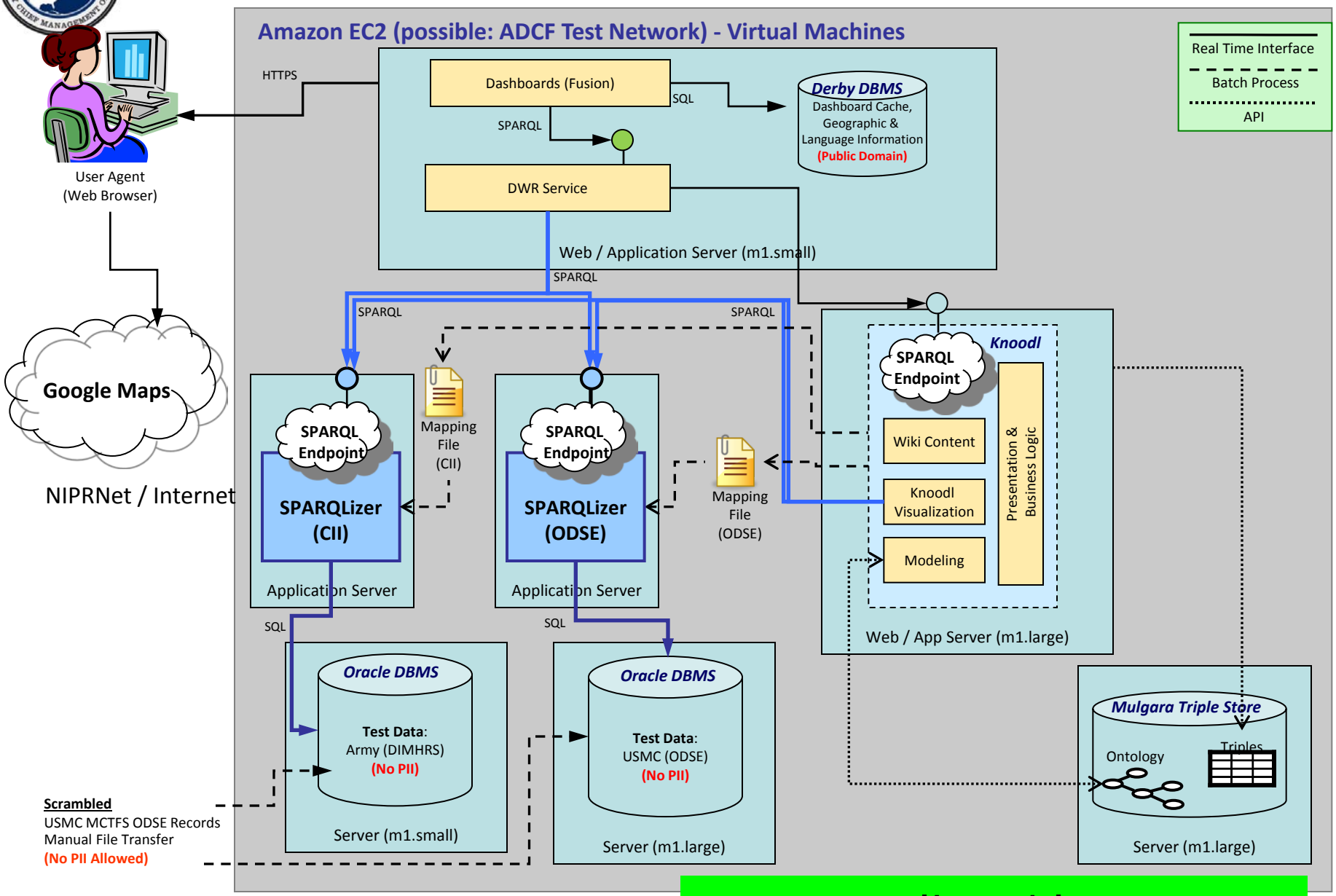


POD3 Goals

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

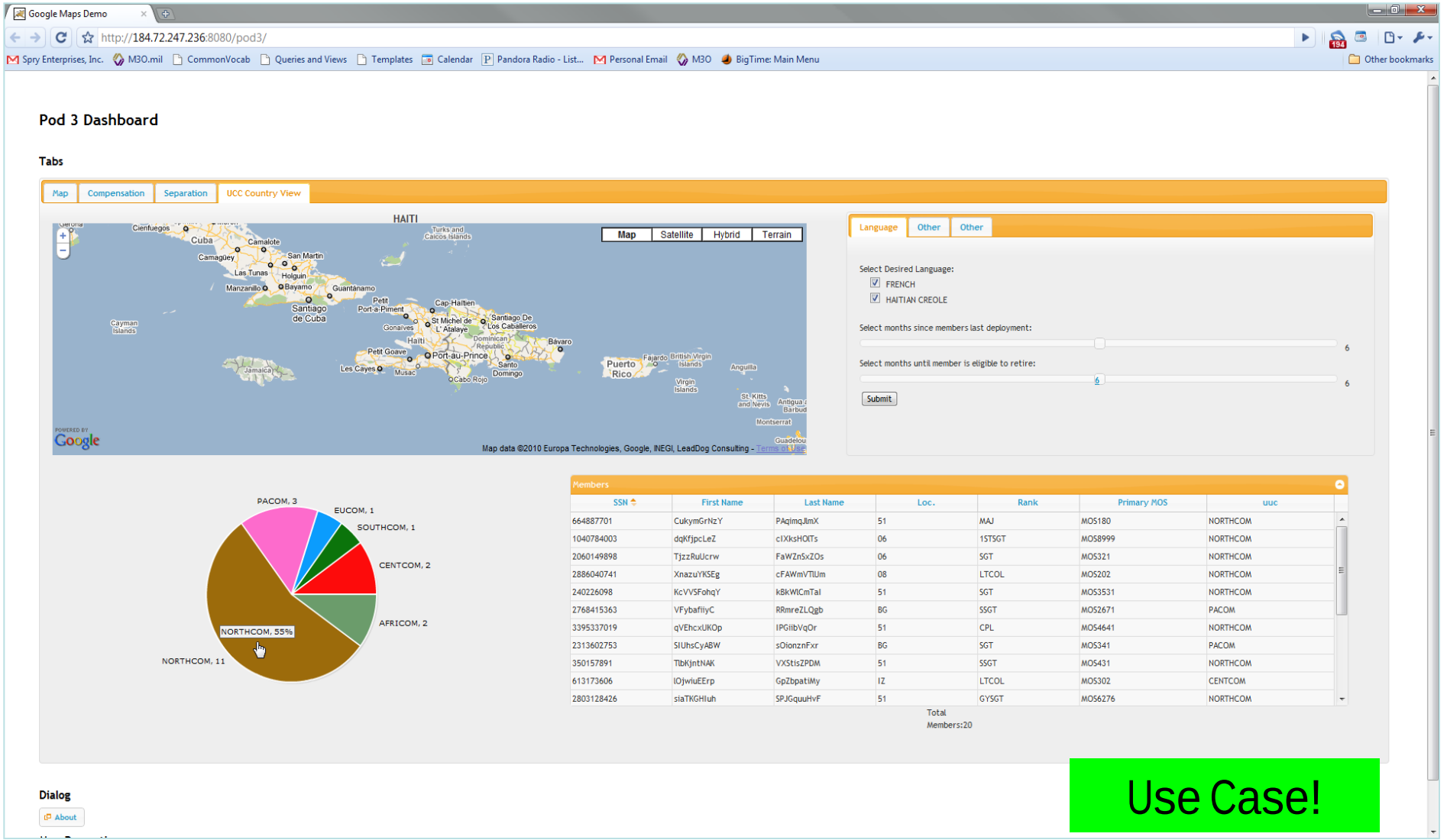
90 Day Deliverables – POD 3

RDF Service "SPARQLizer" (POD4) – Deployment View



90 Day Deliverables – POD 4

Operations – Country View: User Defined Query



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

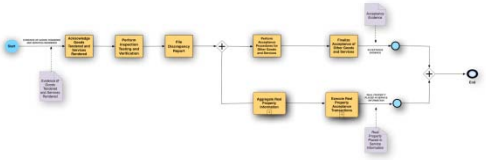
DCMO: Oversight

DFAS: Assessing HR-related pay requirements for the EIW

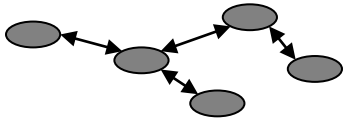
Military Services: Identifying ADSs, providing functional SMEs, & validating modeling

HR EIW Technical Summary!

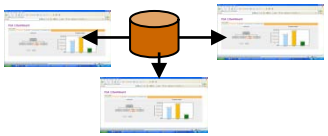
Many DoD and Industry Participants, Learning!



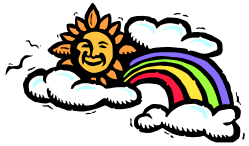
Makes full use of Business Process Models Built on BPMN (OMG) Standard!



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



Ad Hoc and Standard Displays use ADS!

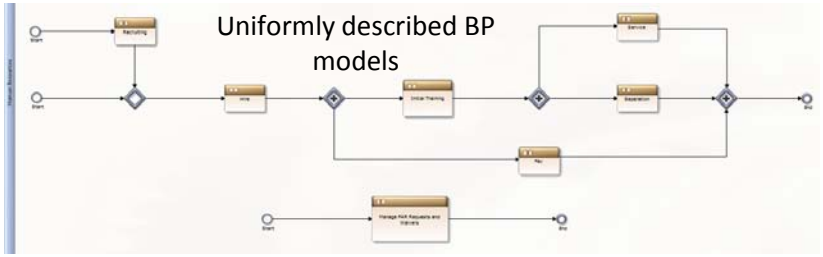


Implemented in the 'Cloud'!

90 Day Deliverables!

Built on a Shoe String!

EIW and the Direction of DoD Solution Architectures



Legend: W3C Open Standards

Relationship described in OWL

Data described in RDF

Data described in RDF

DoD Authoritative Data Source

User executes BP

User Agent (Web Browser)

BP executes via BEA directly

NIPRNet / Internet

BEA

Acq Domain Vocabulary

Log Domain Vocabulary

Real Prop Domain Vocabulary

Fin Domain Vocabulary

HR Domain Vocabulary

Svc Member

OUID

Airman

Sailor

position

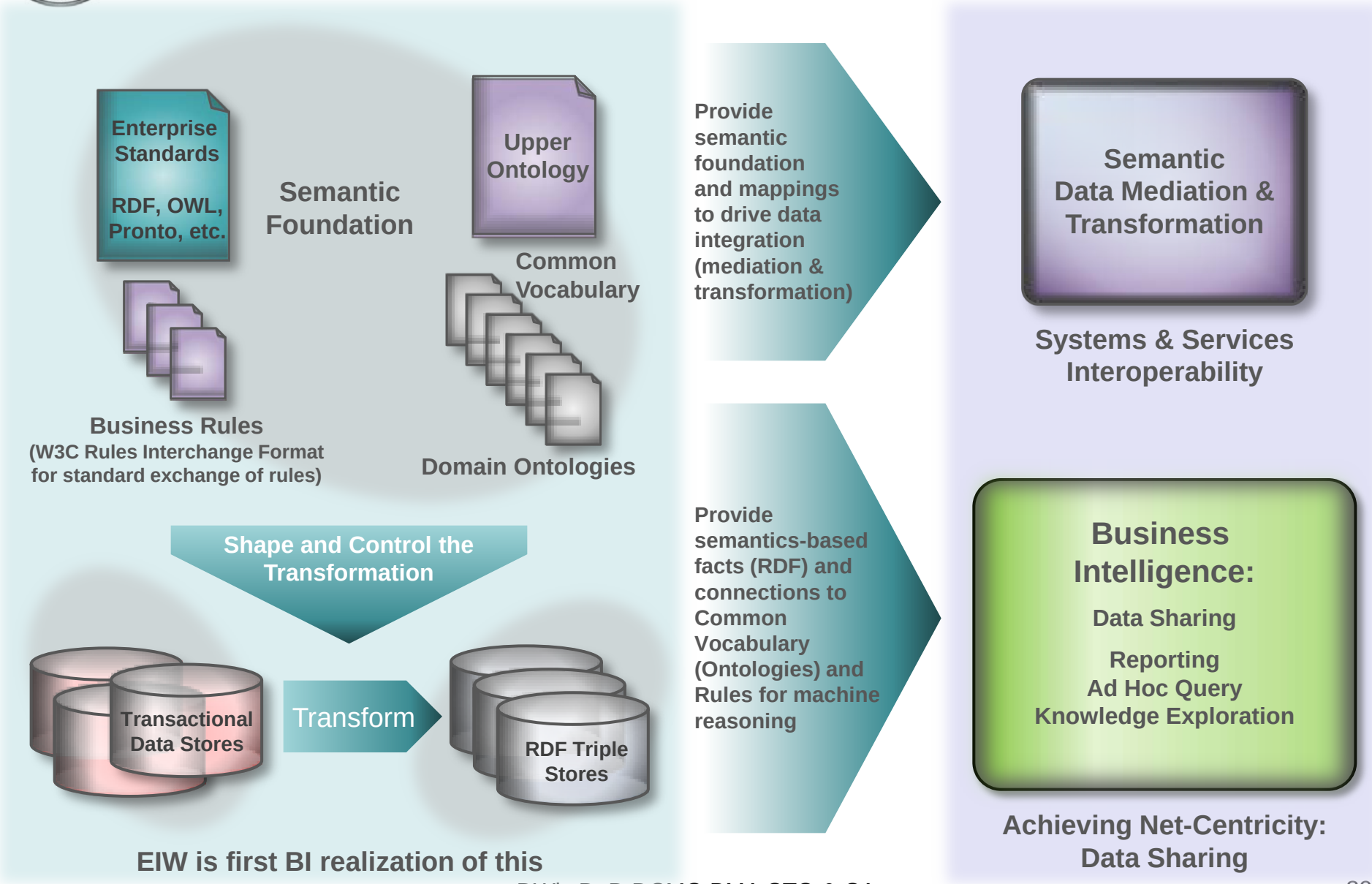
billet

dept

Federated Business Enterprise Architecture (BEA) queried directly for:

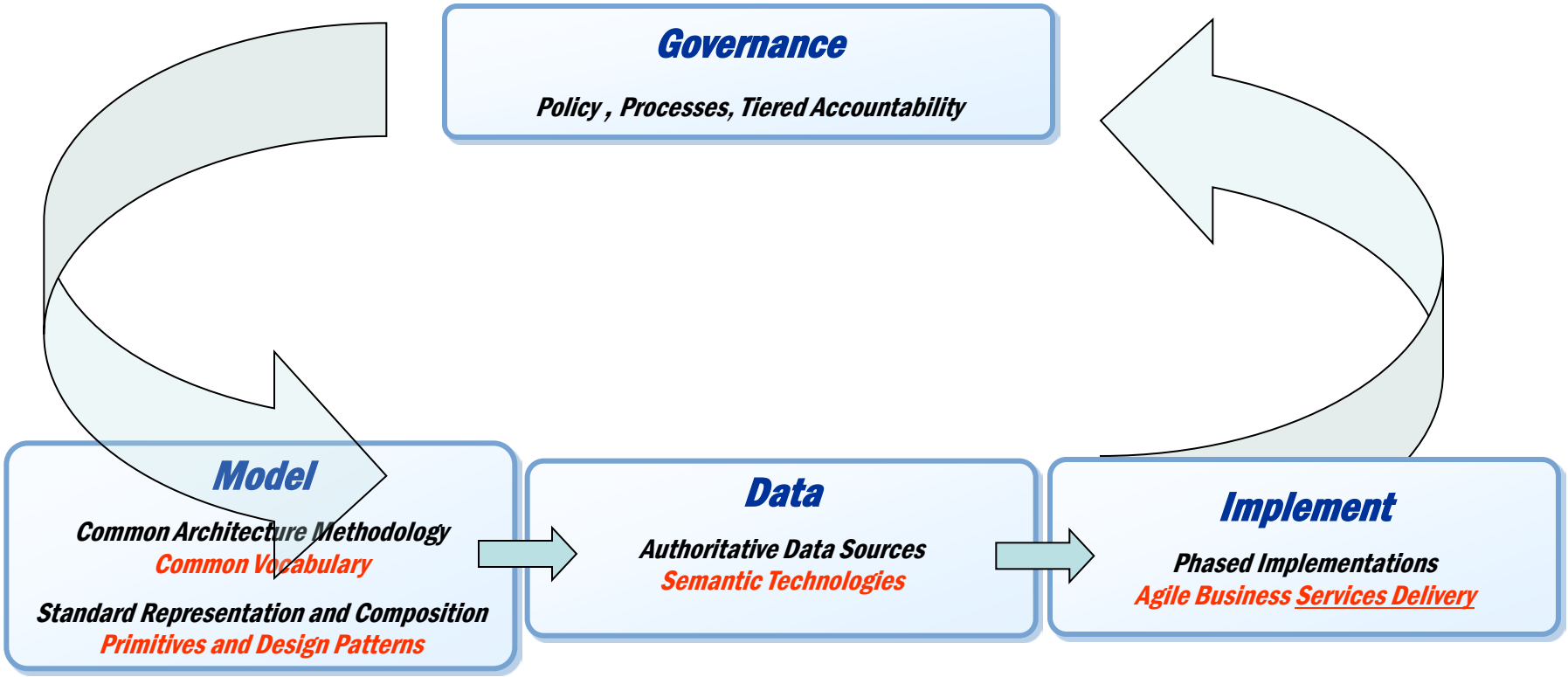
- **Enterprise analytics**
- **Compliance**
- **IRB/portfolio management**

DoD Business Operations Semantic Landscape



02 PPT

Agile, Architecture-Driven, DoD Business Capability Delivery



Model to Guide Transformation
Data to Improve Performance
Implement to Deliver Capabilities

Thank you!

Questions?

Dennis.Wisnosky@osd.mil