Enabling an Agile Healthcare Enterprise Architecture
with BPM/SOA and Semantic Technologies

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AIIM Ambassador
WfMC Public Sector Chair
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* Some content from 3rd Annual DoD Symposium presentation
The rising costs of health care and health insurance pose a serious threat to the future fiscal condition of the U.S.

- Medicare and the federal share of Medicaid are projected to be about 4% of GDP in 2009 and nearly 6% in 2019 and 12% by 2050
- Policymakers will face difficult trade-offs between two objectives:
  - Expanding insurance coverage while...
  - Controlling both total and federal costs for health care
Military Healthcare Costs are Rising

Military medical costs are rising twice as fast as those nationally. Increase from 2001 to 2011:

<table>
<thead>
<tr>
<th></th>
<th>Military</th>
<th>National</th>
</tr>
</thead>
<tbody>
<tr>
<td>167%</td>
<td>84%</td>
<td></td>
</tr>
</tbody>
</table>

Sources: Defense Department, Health and Human Services Department

By Julie Snider, USA TODAY

** Article based on comments by Rear Adm. Christine Hunter, deputy director of TRICARE, alerting the Congress to a potential increase in out-of-pocket fees for the first time in 15 years.

** Center for Strategic & Budgetary Assessments

How to Solve the Stakeholders and Data Issues

Figure 1: The Current Healthcare Landscape

Source: Deloitte Center for Health Solutions. © 2010 Deloitte Development LLC. All rights reserved.
What Technologies Can Support the Learning Healthcare System?

New Technology Standards

• Business Process Modeling Notation (BPMN) 2.0
  • Business Modeling with IT Collaboration
  • Native Execution
  • Enables Agile Development

• Semantic Technologies
  • Resource Description Framework (RDF) Triplestore
  • SPARQL Protocol and RDF Query Language (SPARQL)
  • Web Ontology Language (OWL)
Business Process Management Solution Lifecycle

Process Modeling, Business Rules, Simulation and Documentation, Collaboration

Head of Agency
Manager
Director

Process Stakeholders
Process Developer

Participants
 Worklist
Process Portal
MS Office

Workspace Collaboration

Process Server and Monitoring Repository

BAM
AUDIT

Process Development and Systems Integration

ORACLE
Why Semantic Enabled Business Process Management?
DoD Example

• Business Challenges*
  • DoD spends more than $6.0B annually on building and maintaining over 2,000 systems and services
  • Systems and Processes are poorly integrated
  • Many redundant capabilities without a Holistic Enterprise View

• Combining Standards-Based Semantic and BPM Technology:
  • Supports Business Enterprise Architecture and DoDAF
  • Enables Federated Sharing of Process and Analytical Information
  • Helps Standardize Business Processes and Best Practices
  • Provides Transparency and Collaboration
  • Agile Development Life-Cycle Accelerating Capabilities to Market

*Reference: Memorandum for Secretaries of the Military Departments
Subject: Use of End-to-End Business Models and Ontology in DoD Business Architectures
Elizabeth A. McGrath, April 4, 2011
Semantic E2E Architecture

*Source Business Mission Area CTO/CA Office of the DCMO*
Goals/ Objectives/ Deliverables

**Phase 1** (POC)
- Use Primitives BPMN 2.0 to construct a business process
  - Integrate Process with RDF Triplestore
  - Enable Run-Time Primitives BPMN 2.0 Process (with no conversion)
- Have the business process interact with OWL model and output Triples
- Query Triple Store to confirm results
- Store Oracle BPMN 2.0 Primitives in OWL
- Prove COTS BI Queries using SPARQL

**Phase 2** (ongoing)
- What is the delta between Oracle BPMN 2.0 Metadata and the Metadata needed to store full capability in OWL
- What implications to the future BPMN standard and other technology standards
Proof of Concept: BPMN 2.0 Primitives Process
BPMN 2.0 Ontology

Design Principles

• Keep it simple but complete
• Close to BPMN 2.0 UML Metamodel
• Use RDF-S subClassOf for conceptual subclasses
• Object and Data Properties with meaningful names, domains and ranges
• BPMN 2.0 UML classes that got introduced for technical reasons (for containment and/or sub-classing) are not mapped to OWL
• No OWL model that is cluttered with entities from an automatic conversion from BPMN 2.0 XML-Schema or XMI.
• SPARQL queries on the model must be expressive and easy understood by both, Semantic Web AND BPM community
BPMN 2.0 Ontology

- Current Status
  - All BPMN 2.0 Flow Elements mapped to OWL classes
  - Verified by manually creating Triples for a sample BPMN process
  - Deployed Triples to Oracle Database and performed sample SPARQL Queries

- Next Steps
  - Automatic creation of (and underlying BPMN 2.0 process models, WSDL, XSD etc.)
  - Map missing BPMN 2.0 concepts to OWL classes
    - Data, Input, Output, Data Associations etc.
    - Service Model, Messages, Message Flow and Correlation
  - Provide extensions for Human Workflow, Organizational Data, Business Rules etc.
Example Triples from BPMN Process

- Sequence Flow between BPMN 2.0 Exclusive Gateway and User Task
- Shows object property for ‘inLane’
SPARQL Example I:
Select User Tasks in Lanes

SELECT ?usertask ?lane
WHERE

<table>
<thead>
<tr>
<th>usertask</th>
<th>lane</th>
</tr>
</thead>
</table>
SPARQL Example II:
Select all Flow Elements from Lane DCMO

```
SELECT ?flowelement
WHERE
{ ?flowelement rdf:type bpmn:Flow . ?flowelement bpmn:inLane p1:DCMO }
```

Oracle SPARQL Endpoint Query Results

<table>
<thead>
<tr>
<th>flowelement</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://xmlns.oracle.com/bpm/samples/MyProcess#Select_Metric_for_Review">http://xmlns.oracle.com/bpm/samples/MyProcess#Select_Metric_for_Review</a></td>
</tr>
<tr>
<td><a href="http://xmlns.oracle.com/bpm/samples/MyProcess#Get_Role_Assignments">http://xmlns.oracle.com/bpm/samples/MyProcess#Get_Role_Assignments</a></td>
</tr>
<tr>
<td><a href="http://xmlns.oracle.com/bpm/samples/MyProcess#Need_to_Collect_Metric">http://xmlns.oracle.com/bpm/samples/MyProcess#Need_to_Collect_Metric</a></td>
</tr>
<tr>
<td><a href="http://xmlns.oracle.com/bpm/samples/MyProcess#Metric_accepted?">http://xmlns.oracle.com/bpm/samples/MyProcess#Metric_accepted?</a></td>
</tr>
<tr>
<td><a href="http://xmlns.oracle.com/bpm/samples/MyProcess#Send_Acceptance">http://xmlns.oracle.com/bpm/samples/MyProcess#Send_Acceptance</a></td>
</tr>
<tr>
<td><a href="http://xmlns.oracle.com/bpm/samples/MyProcess#Review_Reported_Metric">http://xmlns.oracle.com/bpm/samples/MyProcess#Review_Reported_Metric</a></td>
</tr>
<tr>
<td><a href="http://xmlns.oracle.com/bpm/samples/MyProcess#Metric_Collection_Time">http://xmlns.oracle.com/bpm/samples/MyProcess#Metric_Collection_Time</a></td>
</tr>
<tr>
<td><a href="http://xmlns.oracle.com/bpm/samples/MyProcess#Save_Measurement_to_Triple_Store">http://xmlns.oracle.com/bpm/samples/MyProcess#Save_Measurement_to_Triple_Store</a></td>
</tr>
</tbody>
</table>
SPARQL Example III:
Select all Flow Elements that have sequence flow to “Approve Metric for Release”

SELECT ?source ?target
WHERE
  ?flowelement bpmn:hasTarget p1:Approve_Metric_for_Release }
Executing the BPMN 2.0 Primitives Process
Instantiate the Process
Running Primitives BPMN 2.0
Human Interaction with the BPMN 2.0 Primitives Process
By-Directional Integration Between Runtime BPMN 2.0 Primitives and RDF
Executing Process Updates RDF
Query RDF Triplestore

Oracle SPARQL Service Endpoint using Joseki

Simple query test interface. You can put in your own query. The queries are submitted against the dataset specified in Joseki’s configuration file.

```sparql
PREFIX do: <http://purl.org/do/elements/1.1/>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#

SELECT ?agency_name ?abbr ?budget_amount ?quarter
WHERE {
  ?agency_name <http://localhost/ontologies/budget.owl#hasAbbreviation> ?abbbr .
  ?agency_name <http://localhost/ontologies/budget.owl#hasBudgetAmount> ?budget_amount .
  ?agency_name <http://localhost/ontologies/budget.owl#hasQuarter> ?quarter .
}
```

Oracle SPARQL Endpoint Query Results

<table>
<thead>
<tr>
<th>agency_name</th>
<th>abbr</th>
<th>budget_amount</th>
<th>quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://localhost/Defense_Advanced_Research_Projects_Agency">http://localhost/Defense_Advanced_Research_Projects_Agency</a></td>
<td>&quot;DEF. ADV. RESEARCH PROJ.&quot;</td>
<td>&quot;4630383&quot;</td>
<td>&quot;FY2010Q4&quot;</td>
</tr>
<tr>
<td><a href="http://localhost/United_States_Navy">http://localhost/United_States_Navy</a></td>
<td>&quot;UNITED STATES NAVY&quot;</td>
<td>&quot;1093024&quot;</td>
<td>&quot;FY2010Q4&quot;</td>
</tr>
<tr>
<td><a href="http://localhost/United_States_Navy">http://localhost/United_States_Navy</a></td>
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<td>&quot;FY2010Q4&quot;</td>
</tr>
<tr>
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<td>&quot;235980&quot;</td>
<td>&quot;FY2010Q4&quot;</td>
</tr>
<tr>
<td><a href="http://localhost/United_States_Navy">http://localhost/United_States_Navy</a></td>
<td>&quot;UNITED STATES NAVY&quot;</td>
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<td>&quot;0&quot;</td>
<td>&quot;FY2010Q4&quot;</td>
</tr>
<tr>
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<td>&quot;1387107&quot;</td>
<td>&quot;FY2010Q4&quot;</td>
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<tr>
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<td>&quot;BUSINESS TRANSFORMATION AGENCY&quot;</td>
<td>&quot;0&quot;</td>
<td>&quot;FY2010Q4&quot;</td>
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<tr>
<td><a href="http://localhost/Defense_Business_Transformation_Agency">http://localhost/Defense_Business_Transformation_Agency</a></td>
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<td>&quot;FY2010Q4&quot;</td>
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<td>&quot;BUSINESS TRANSFORMATION AGENCY&quot;</td>
<td>&quot;0&quot;</td>
<td>&quot;FY2010Q4&quot;</td>
</tr>
</tbody>
</table>
Business Analytics Combining Process and Operational Data
SPARQL Gateway

**Oracle Specific**
- OBIEE (BI Server XML Gateway)

**SPARQL Gateway**
- SPARQL Protocol
- HTTP
- XSLT

**Standard Compliant**
- SPARQL Endpoint

---

**Oracle**
- SPARQL Gateway
- OBIEE (BI Server XML Gateway)
SPARQL Gateway Data Flow

- BI Server XML Gateway sends HTTP request to SPARQL GATEWAY
  - http://<sparql_gateway>/sparqlgateway/sg?query=...

- SPARQL Gateway
  - retrieves the query body
  - makes a call out to a remote SPARQL endpoint
  - receives SPARQL query results in XML
  - performs necessary XSLT transformation
  - serializes XML

- BI Server XML Gateway receives XML metadata
<table>
<thead>
<tr>
<th>Agency Name</th>
<th>Abbreviation</th>
<th>Quarter</th>
<th>Budget Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defense_Advanced_Research_Projects_Agency4</td>
<td>DEF. ADV. RESEARCH PROJ.</td>
<td>FY2010Q4</td>
<td>$4,630,383</td>
</tr>
<tr>
<td>Defense Business Transformation_Agency4</td>
<td>BUSINESS TRANSFORMATION AGENCY</td>
<td>FY2010Q4</td>
<td>$3,259</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$4,492,935</td>
</tr>
<tr>
<td></td>
<td>BUSINESS TRANSFORMATION AGENCY Total</td>
<td></td>
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</tr>
<tr>
<td>UNITED STATES NAVY</td>
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<tr>
<td>UNITED STATES NAVY Total</td>
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</tr>
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<td></td>
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<td></td>
<td>$2,272,239</td>
</tr>
<tr>
<td></td>
<td>STRATEGIC COMMAND Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td></td>
<td>$15,117,076</td>
</tr>
</tbody>
</table>

**Budget Amount**

- **FY2010Q4**:
  - BUSINESS TRANSFORMATION AGENCY: 29.74%
  - DEF ADV. RESEARCH PROJ.: 30.63%
  - STRATEGIC COMMAND: 19.10%
  - UNITED STATES NAVY: 20.52%
### Presentation
- A: Sample Sales
- B: Sample Quotas
- C: Sample Headcount
- D: Department of Defence Budget
- E: Department of Defence Budget2
- DOD XML Source
  - Measures
  - Agency Name
  - Quarter
- E: Sample Essbase
- F: Sample Essbase Federated
- G: Sample Essbase GL
- H: Sample Olap
- I: Sample BAM
- J: Fusion Order Demo
- K: Commentary and Annotations
- L: Scheduled Jobs
- M: TC
- N: Usage Tracking

### Business Model and Mapping
- 01: Sample App
- 02: Essbase Sample
- 03: Sample Federated
- 04: Essbase GL
- 05: Olap Sample
- 07: Datamining
- 08: Fusion Order Demo (OLTP)
- 09: Bus Process Monitoring (BPM)
- 10: Scheduled Jobs
- 11: Usage Tracking
- DOD
- DOD XML
- DOD XML2
  - Agency NameDim
  - QuarterDim
  - Agency Name
  - Measures
  - Quarter
  - TOTCONSOL

### Physical
- 01: Sample App Data (ORCL)
- 02: Sample App Xml Data
- 03: Essbase Sample E1
- 04: Sample E2 (Default Import)
- 05: Essbase GL Sample Flat
- 06: Essbase GL Sample Hierarchical
- 07: Oracle DataMining
- 08: Fusion Order Demo (OLTP)
- 09: BPM Data (ORCL)
- 10: Scheduled Jobs (ORCL)
- 19: System Data (ORCL)
- administrative: HvaADM; driver: demodrive; TOTCONSOL
- DOD
- DOD XML
- sq_query=qbl
  - abbr
  - agency_name
  - budget_amount
  - quarter

Connection Pool:"DOD XML2":"DOD XML2"
## Manage Sessions

View session information below.

### Total number of sessions: 6

<table>
<thead>
<tr>
<th>User ID</th>
<th>Host Address</th>
<th>Session ID</th>
<th>Browser Information</th>
<th>Logged On</th>
<th>Last Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>weblogic</td>
<td>c-67-189-127-252.hsd1.or.comcast.net:67.189.127.252</td>
<td>1270001.2126f7b</td>
<td>Mozilla/5.0 (compatible; MSIE 8.0; Windows NT 6.0; WOW64; Trident/4.0; SLCC1; .NET CLR 2.0.50727; .NET CLR 3.0.30618; .NET CLR 3.5.30729; InfoPath.2; .NET CLR 1.1.4322; .NET40; .NET4E)</td>
<td>6/9/2011 7:29:57 PM GMT-05:00</td>
<td>6/9/2011 7:20:03 PM GMT-05:00</td>
</tr>
<tr>
<td>weblogic</td>
<td>demodrive</td>
<td>1270001.281598.12</td>
<td>Mozilla/5.0 (Windows; U; Windows NT 6.0; en-US; rv:1.9.2.3) Gecko/20090403 Firefox/3.5.1 (.NET CLR 3.5.30729)</td>
<td>6/9/2011 5:28:39 PM GMT-05:00</td>
<td>6/8/2011 5:29:15 PM GMT-05:00</td>
</tr>
<tr>
<td>weblogic</td>
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<td>1270001.281598.12</td>
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<td>6/9/2011 5:36:12 PM GMT-05:00</td>
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<td>6/9/2011 6:56:47 PM GMT-05:00</td>
<td>6/9/2011 7:04:41 PM GMT-05:00</td>
</tr>
</tbody>
</table>

### Cursor Cache

<table>
<thead>
<tr>
<th>ID</th>
<th>User</th>
<th>Hits Status</th>
<th>Time Action</th>
<th>Last Accessed</th>
<th>Information</th>
<th>Records</th>
</tr>
</thead>
<tbody>
<tr>
<td>5531</td>
<td>weblogic</td>
<td>Finished 0s</td>
<td>Close View Log</td>
<td>6/8/2011 6:56:53 PM GMT-05:00</td>
<td>SELECT s_0, s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_10, s_11 FROM (</td>
<td>13</td>
</tr>
</tbody>
</table>

```sql
SET VARIABLE QUERY_SRC_CD='Report",SW_DASHBOARD_P�"/users/weblogic/Portal',SW_DASHBOARD_P×"/users/weblogic/Dod";SELECT s_0, s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8, s_9, s_10, s_11 FROM ( | 13 |

FROM[dod xml source]
```
Summary and Next Steps

- Completed Basic Executable Process
- Test Process and Validate Results
  - Process Executes Routes
  - Data Stored Correctly (Operational) to RDF
- Finalize / Discuss Target Ontology for BPMN 2.0
- In Parallel
  - BPMN 2.0 Primitives Conversion using Ontology
  - Business Intelligence Integrated using SPARQL
- BPMN 2.0 Primitives / Triplestore Research
- Implications on Other Technologies
  - Business Intelligence
  - Web 2.0 / Enterprise 2.0
  - Other
Purchasing Review Process

BPMN 2.0 Stored Semantically
For BPMN Primitives, where does RDF come into play?

- Dependency Analysis
  - Mostly: “Given an asset Foo (variable) in the SOA catalog, what is the impact to other assets if I want to modify Foo?” (we can not answer this today)
  - Envisioning a “BPM Ontology” for the assets in the SOA catalog (*)
  - Continuous refinement and extensibility of the semantic model
- Find out new things
  - Enable graph merge with other structured information available on the Web (FOAF, dbpedia, calendars, etc.)
- Semantic Search rather then stupid text search
- Enabler to share assets rather then duplicating assets
  - Today we have a large degree of redundancy and proliferation of metadata all over the place

(*) Related Work: SOA Ontology
Examples

- proc:LoanRequestProcess rdf:type proc:BusinessProcess
- task:HomeLoanTask rdf:type task:UserTask
- org:ScottTiger rdf:type org:User
- org:ScottTiger org:performs task:ApproveHomeLoanTask
- proc:LoanRequestProcess proc:executes task:ApproveHomeLoanTask
- proc:LoanRequestProcess proc:executes svc:CreditCheckService
Demonstration Video

- BPMN 2.0 Executable
- Query TripleStore
- Use Business Intelligence
  - Show it is using SPARQL
- Show BPMN 2.0 Conversion to TripleStore
- Query Stored BPMN 2.0 TripleStore
- Q & A

Accessible with the Presentation from Conference Site
Opportunities & Challenges

- Not-for-profit integrated regional health care delivery system that includes four acute-care hospitals, three specialty hospitals, two affiliated medical groups and a health plan, plus a full spectrum of other facilities and services
- Improve the healthcare experience and quality of care for its patients
- Provide patients with a unified view of their healthcare information

Solution

- Leveraging the standards-based infrastructure and comprehensive connectivity of SOA to integrate health record information in three disparate patient-care applications already in use in its hospitals and medical groups
- Integrates GE Centricity Business, Allscripts Touchworks EHR and content management solutions.
- Uses Advanced Database technologies to increase efficiency, reduce costs of managing data and improve the overall performance of the company’s data warehouse

Results

- More than 48,000 patients rely on the mySharp portal to securely access medical records, view lab results and interact with their health care provider’s office
- Patients can also manage tasks like scheduling appointments and paying bills. Parents can also sign-up and manage their children’s healthcare records

“Consumers today expect to have information at their fingertips, when and where they need it. Progressive healthcare organizations, like Sharp HealthCare, understand that this same requirement increasingly applies to patients’ interactions with their healthcare providers,” said Marc Perlman, global vice president, Healthcare and Life Sciences, Oracle. “Sharp HealthCare gained a new level of connectivity with its patients by harnessing Oracle solutions as the foundation for its new patient portal, which seamlessly integrates information from diverse systems to provide a single, secure view of a patient’s information and interactions with Sharp HealthCare.”

Questions