The purpose of this session will be to present the issues, concerns and a notional implementation of open source and COTS products relevant to the support and implementation of the Integrated Electronic Health Record (iEHR) in the Service Oriented Architecture (SOA) Enterprise Service Bus (ESB) framework for DoD and VA Healthcare Applications. Areas this presentation will focus on are:

- **Overview of the iEHR SOA ESB Program in support of Military Health Systems and Veterans Health Administration and Process for Sandbox Access**
- **Overview of products that may become candidates for insertion into the OSEHRA repository**
- **Roadmap of the future and discussion of issues that will need to be addressed for OSEHRA products and code to be usable for the DoD and VA related to iEHR SOA ESB implementation**
- **Performance Results and criteria that will/may be required to secure and burn-in products for usage by the DoD and VA**
OVERVIEW OF IEHR SOA ESB PROGRAM

Contract Title: Service Oriented Architecture Suite Contract (SOA/ESB)
Program Office: Interagency Program Office (IPO)
Government POC: Dr. Patrick Pearcy, PM/COR,
Mr. Rich Lamberti, COR
Harris PM: Mr. Jorge Ferrand
Customer / Location: VA and DoD – Enterprise Wide

Contract Number: VA118-11-D-1011
Type of Procurement: Task Order competed and issued under T4 IDIQ

Scope: Identify, procure, configure, test and deploy a COTS SOA Suite to facilitate data sharing and application communication for implementation of an integrated Electronic Health Record (iEHR)

Award Date: March 20, 2012
Length/Type 5 year program – PMAS incremental 6 month delivery
Security Classification: MAC Level II – Sensitive (DoD/MHS) LOW/NACI (VA)
IEHR SOA SUITE STATUS

- Harris completed all major milestones for Demonstration Exercises and met requirements for Government Option 1 award
- Harris designed, developed and implemented iEHR SOA Suite “Sand Box” Environments for Trial Implementations with Open Source & COTS Products
  - Government run at Pacific JITC ITEC
  - Contractor facility at Harris in Melbourne, FL
- Contains the SOA Suite software including the IBM Stack, Mirth Connect, Layer7 SSG, and CA Application Performance Management (APM)
- Can be used to try out the software by developing components or apps and deploying within the sandbox
  - Subject to Contractual Requirements and Need
  - Subject to Government Approval and Authorization
SOA SUITE DESCRIPTION

Description:
The goal of this initiative is to acquire and implement a Commercial-Off-The-Shelf (COTS) product and Service Oriented Architecture (SOA) enabling capabilities. An integral component of this SOA Suite is an Enterprise Service Bus (ESB). The SOA Suite will be used by the Department of Defense (DoD) and Department of Veterans Affairs (VA) to facilitate the delivery and use of services by both Departments in support of the integrated health record. It will be used in support of the DoD Military Health System (MHS), the VA Electronic Health Records (EHR) and associated information management systems.

Key Tasks:
• Establish SOA Suite Contractor Sandbox by ATP + 30 (authorized)
• Establish SOA Suite Government Sandbox by ATP + 60 (authorized)
• Option One – two elements (decision post 100 DACA – (authorized)
  – Provision and integrate the COTS product with Increment 1 SOA Suite Capabilities
  – Implementation and deployment of Increment 1 into production in VA and DoD across the enterprise
The SOA Suite will contain both the robust core messaging and technical characteristics of a SOA, the ability to incorporate core Services within the CSB, and the standardization necessary to manage Health information Capabilities as they are jointly acquired for the iEHR going forward.

Primary architectural priorities:
- Flexibility
  - to support many integration patterns, transport mechanisms, and data formats
  - To support future service and integration implementations
  - To support heterogeneous DoD, VA, and Theater environments
- Reliability & Availability to ensure continued service should individual components or networks fail or degrade
- Maintainability to streamline operations and support
- Scalability to easily support current and future processing demands
“To-Be” Conceptual Architecture

Common DoD-VA Requirements: HL7 EHR-S Functional Model with DoD and VA vetted Extensions (SV-4)
Common DoD-VA Integrated Health Business Reference Model (OV-5)
Common DoD-VA “To Be” Process Flow Model (OV-6C)

Presentation
(Common GUI)

Applications and Services
(Common Joint) Applications & Services (30)
- Pharmacy
- Personal Health Record
- Laboratory
- Blood Mgmt
- Disability Evaluation
- Inpatient Orders Mgmt
- Emergency Dept Care
- Document Mgmt
- Dental Care
- Consult & Referral Mgmt
- Immunization
- Operating Room Mgmt

DoD Unique (16)
- Battlefield Care
- Pediatrics
- Military Readiness
- Obstetrics
- Enroute Care
- Veterinary

VA Unique (6)
- Nursing Home
- Long Term Care
- Rehabilitative Care
- Transient Outreach
- Pharmacy Mail Order
- Occupational Health (VA)

Common Interface Standards
(Common Services Broker
(includes Enterprise Service Bus (ESB) and Infrastructure Services)

Common Interface Standards

Common Data Centers

Common Information Interoperability Framework (CIIF)
- Common Information Model
- Common Terminology Model
- Information Exchange Specifications
- Translation Service
- Common Data Standards: SNOMED CT and Extensions, LOINC and RxNorm

Common DoD-VA Measures of Effectiveness, Measures of Performance and Key Performance Parameters
• VA - 150 hospital facilities and over 800 other locations (clinics and medical centers)

• MHS > 22 medical centers, 43 hospitals, 183 clinics with centrally managed applications located at 101 host sites worldwide
INTERFACE ARCHITECTURE OVERVIEW

Diagram showing various protocols and data conversion layers, including EDI, NwHIN, NwHIN Direct, BINARY/MQ, SOAP/JMS, HL7/MLLP, SOAP/HTTP, SOAP/HTTP, SOAP/HTTP, SOAP/HTTP, X12, RSS, FTP, CSV, HL7 2.2, HL7 2.3, HL7 2.5.1, HL7 2.6, HL7 3.0, CDA, NIEM, CDM, JDBC, ODBC, SMTP.
Goal: Provide an interim SOA Suite developer environment for DoD/VA product developers to test integration of applications (e.g. iEHR, Identity Management)
When: 30 DACA / 60 DACA
Where: Commercial location “in the cloud”; (authorized) Government location: JITC Maui (not authorized)

SOA Suite Sandboxes will allow VA/DoD product developers to develop trial integrations with the SOA Suite:
- Initial use by JALFHCC developers to:
  - Test Patient Registration, Orders Portability, and JANUS Graphical User Interface (GUI)
  - Develop familiarity with and lessons learned for future development efforts
- Interim environment available for use until migrated to final development environment
- Not designed for pre-production testing of clinical capabilities or performance
- Non-production data; no PII

DoD/VA product developers are exposed to and gain familiarity with iEHR SOA Suite shortly after product selection. (*See details in slide) notes
MIRTH OVERVIEW

• What is Mirth Connect?
  – Healthcare integration engine
  – Open source
  – Standards-based

• Who develops Mirth Connect?
  – Open source project sponsored by Mirth Corporation
  – Maintained and developed by Mirth Corporation
  – Large community of users contribute bug reports, feature requests, source code patches, and free online support
  – Product must be scanned and any security vulnerabilities corrected if and as found
  – Release management will be provided during sustainment and maintenance operations lifecycle - Harris
MIRTH CONNECT HEALTHCARE MESSAGING

Health Information Systems...

- Lab
- Pharmacy
- Radiology
- Clinic
- Hospital

• Routing
• Filtering
• Transformation
• OSS Based

...applications, protocols, connectivity, etc.

- Extensible
- Powerful
- Flexible
- Reliable

Legacy Applications

Reporting

Web Services

Database
Source: this is the “listening” side of the channel where it will receive data.

Destination: this is the “emitting” side of the channel out of which it will send information received from the source and then processed and transformed.
CHANNEL EXAMPLES

Channel Examples

- HL7 v2.x Client
- HL7 v2.x Server
- MLLP Source Channel
- HL7 ORC
- HL7 ACK
- Oracle DBMS
- JDBC
- Mirth Server
- SOAP/HTTP
- Web Services Source Channel
- HL7 ORC
- HL7 ACK
- HL7 v2.x Server
- HL7 ORC
- HL7 ACK
ACCESS MIRTH CONNECT ADMIN SCREEN

**Overview of Web Start**

Java Web Start is a framework developed by Sun Microsystems that enables launching Java applications directly from a browser. Unlike Java applets, Web Start applications do not run inside the browser.

Click the big green button below to launch the Mirth Connect Administrator using Java Web Start.

![Launch Mirth Connect Administrator]
LAYER7 SECURE SPAN GATEWAY CONSOLE LOGIN

Layer 7 Technologies - Policy Manager

Login

Connecting to the Gateway

User name: admin
Password: ******
Log in
Layer 7 Policy Manager Home

Please select a task below.

Tasks

- Create LDAP Identity Provider
- Create Simple LDAP Identity Provider
- Create Federated Identity Provider
- Create Internal User
- Create Internal Group
- Search Identity Provider
- Publish SOAP Web Service
- Publish REST, Web API, or Other Service
CENTRALIZED ENFORCEMENT VIA POLICY

Layer 7 SOA Gateway

Web Services Client

Policy Manager
WebSphere Message Broker (WMB) enables corporations and agencies with:

- Universal connectivity engine: connect anything to anything
- Rapid time to value with prebuilt nodes and integration patterns
- Increased business agility and flexibility by decoupling service consumers from service providers
Within iEHR, WMB will provide the DOD and VA with the ability to:

- Connect applications via a wide variety of open standards and protocols – enabling exchange of HL7, HIPAA, standard, legacy, SAP, Siebel messages etc.

- Connect to a wide variety of healthcare systems, including medical devices, clinical applications, device gateways, billing systems, and health information exchanges.

- Provide assured delivery of information between applications across the environment.

- Allow rapid integration of new and existing applications using productivity tools.
WebSphere Service Registry and Repository (WRSS) enables corporations and agencies to:

- Apply governance policies and best practices throughout the service life cycle
- Increase service visibility and promote reuse of existing services
- Provide support for dynamic endpoint lookup, service versioning, and policy enforcement
- Federate multiple ESBs
Within iEHR, WSRR will provide the DoD and VA with the ability to:

- Federate multiple ESBs from the VA local, regional, and central sites and between DoD and VA
- Better manage service assets and services across SOA domains
- Enable DOD and VA ESB to be more dynamic, more flexible, and more adaptable

Enable your ESB to be more dynamic, more flexible, and more adaptable!
FUTURE ROADMAP VIEW OF IEHR SOA SUITE
CA Introscope will provide IEHR the ability to manage the performance and availability of applications that use Websphere Message Broker, IBM Business Process Server and IBM ESB.

- 24 by 7 real time monitoring
- Provide immediate Root Cause information for performance issues
- Reduce the Mean Time to Identify (MTTI) and Mean Time to Repair (MTTR)
- Conduct transaction-problem triage across complex applications using Web Services and ESB’s
PERFORMANCE DASHBOARD FOR WEBSPHERE MESSAGE BROKER SERVICE BUS

High level alerts for Websphere MB and Websphere MQ.
Dashboard shows health of Client and Server calls.
PROVIDE ROOT CAUSE OF APPLICATION SLOWDOWNS

Shows Root Cause and Metrics from Applications making Web Service calls
USE CASE 2 DEMONSTRATION PURPOSE

- Demonstrate performance capabilities of the system under demo for heavy volume traffic
- 12 hour phase
- Message configuration
  - *Injection on all sites of*
    - 1k XML (“small document”) request with a 1k XML response message
    - 1k HL7 message with a 1k HL7 response
- DTC test escalation steps
  - 100 TPS for Local instances, then
  - 1500 TPS across Regions, then
  - Remainder loaded to Central
- Goals
  - *Threshold*: 13,725 MPS across the domain
  - *Objective*: 52,500 MPS across the domain
  - *Steady state without failures for the 12 hour run*
**DEMONSTRATION – PHASE 3**

1. Messaging Test
2. Routing
3. Encryption/ Decrypting
4. Rules based Routing
5. QoS Monitoring
6. Logging
7. Auditing

---

<table>
<thead>
<tr>
<th>Phase</th>
<th>Objective</th>
<th>Request Data Type</th>
<th>Response Data Type</th>
<th>Description</th>
<th>Scope</th>
<th>Duration</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>At a minimum, demonstrate the following ESB Capabilities: 1. Messaging Test 2. Routing 3. Encryption/ Decrypting 4. Rules based Routing 5. QoS Monitoring 6. Logging 7. Auditing</td>
<td>HL7 1k per message</td>
<td>HL7 1k per message</td>
<td>Test the SOA Infrastructure messaging, routing, encryption/decryption, rules based routing, QoS monitoring, logging and auditing capabilities by sending VA style HL7 requests and responses.</td>
<td>R1L1 to R1 to R2 to R2L1 while simultaneously R2L2 to R2 to R1 to R1L2</td>
<td>Recommend 12-24 hours</td>
<td>To measure and assess scalability by increasing throughput between Threshold and Objective over an extended period to demonstrate that the product is robust and capable of supporting our infrastructure needs.</td>
</tr>
</tbody>
</table>

---

**Diagram:**

- **Requests (VA Style):**
  - R1L1 to R1L2
  - R1L2 to R1
  - R2L1 to R2L2

- **Responses (VA Style):**
  - R1 to R2
  - R2 to R1L1

---

**Legend:**

- **Request (VA Style)**
- **Response (VA Style)**
1. Messaging Test
2. Routing
3. QoS Monitoring
4. Orchestration (Statefullness with Rollback)
5. Logging

### DEMONSTRATION – PHASE 4

<table>
<thead>
<tr>
<th>Phase</th>
<th>Objective</th>
<th>Request Data Type</th>
<th>Response Data Type</th>
<th>Description</th>
<th>Scope</th>
<th>Duration</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>At a minimum demonstrate the following ESB Capabilities: 1. Messaging Test 2. Routing 3. QoS Monitoring 4. Orchestration (Statefullness with Rollback) 5. Logging</td>
<td>Small Document</td>
<td>XML 1k per message</td>
<td>Recommend demonstrating other capability of SDA infrastructure R1L1 to R1 to R2 to R2L1 while simultaneously R2L2 to R2 to R1 to R1L2</td>
<td>Recommend 12-24 hours</td>
<td>To measure and assess scalability by increasing throughput between Threshold and Objective over an extended period to demonstrate that the product is robust and capable of supporting our infrastructure needs.</td>
<td></td>
</tr>
</tbody>
</table>
USE CASE 2 RESULTS - LOCAL THROUGHPUT ON REGION 1

R1MQ Local Enqueue Count (XML & HL7)

ALL COUNTS ARE MESSAGES PER 16 MINUTES

Legend:
- REGION1_D1_R1_L1_01_IN
- REGION1_D1_R1_L2_01_OUT
- REGION1_D2_R1_L1_01_OUT
- REGION1_D2_R1_L2_01_OUT
- REGION1_D1_R1_L2_01_IN
- REGION1_D2_R1_01_IN
- REGION1_D1_R1_L1_01_OUT

Start: 8/8/12 5:00 PM   End: 8/9/12 9:00 AM
USE CASE 2 RESULTS - LOCAL THROUGHPUT ON REGION 2

R2MQ Local Enqueue Count (XML & HL7)

ALL COUNTS ARE MESSAGES PER 16 MINUTES

Legend:
- REGION2_D1_R2_L2_01_IN
- REGION2_D2_R2_L2_01_OUT
- REGION2_D2_R2_L1_01_OUT
- REGION2_D2_R2_01_IN
- REGION2_D1_R2_L1_01_IN
- REGION2_D1_R2_L2_01_OUT
- REGION2_D1_R2_L1_01_OUT

Start: 8/8/12 5:00 PM
End: 8/9/12 9:00 AM
USE CASE 2 LOCAL TOTALS

- Target is 96,000 TP16M (100 TPS)
- Messages in Local held @ 156 TPS for remainder of the test
USE CASE 2 RESULTS - THROUGHPUT ON REGION 1

R1MQ Regional Enqueue Count (XML & HL7)

ALL COUNTS ARE MESSAGES PER 16 MINUTES

Legend:
- QM_REGION1_1|Queues|D1_R1_02_IN
- QM_REGION1_1|Queues|D1_R1_02_OUT
- QM_REGION1_2|Queues|D1_R1_02_IN_XML
- QM_REGION1_1|Queues|D2_R1_02_IN
- QM_REGION1_1|Queues|D2_R1_02_OUT
- QM_REGION1_2|Queues|D1_R1_02_IN

Start: 8/8/12 5:00 PM                End: 8/9/12 9:00 AM
USE CASE 2 RESULTS - THROUGHPUT ON REGION 2

ALL COUNTS ARE MESSAGES PER 16 MINUTES

Legend:
- QM_REGION2_2|Queues|D1_R2_02_IN
- QM_REGION2_1|Queues|D1_R2_02_OUT
- QM_REGION2_1|Queues|D2_R2_02_IN
- QM_REGION2_2|Queues|D1_R2_02_IN_XML
- QM_REGION2_1|Queues|D2_R2_02_OUT
- QM_REGION2_1|Queues|D1_R2_02_IN

Start: 8/8/12 5:00 PM          End: 8/9/12 9:00 AM
USE CASE 2 REGION TOTALS

- Target is 1.44M TP16M (1500 TPS)
- Messages in Region held @ 1500 TPS for remainder of the test
NOTE: Only 4 of 12 Central Servers were used for this test
USE CASE 2 CENTRAL TOTALS

The simulation averaged around 12M TP16M (12,500 TPS) for the 12 hour test run.
USE CASE 2 OBSERVATIONS

• Achieved desired Threshold using only 4 Central servers
• Local and Regions performed within test specifications
  – Resource Contention on the Regional systems kept the TPS tightly bounded around the test thresholds
• Total Load in the environment averaged approximately 14,100 TPS under full load
  – Additional Central systems on the network will further distribute load, and can be tested when the current DTC migrates to the UCS racks in November
  – Current DTC configuration will not likely lead to higher performance
• Resource contention is evident in the higher volume test on the current configuration
  – Relief at the end of the 12 hour LISA injection shows:
    • Increased queue backlog throughput on Regions
    • Increased activity on receiving Local systems
    • Effort parity on the Central servers
SPECIAL THANKS TO OUR PARTNERS

Partners
- HMS Technologies
- Ellumen
- Forgentum
- Four Points
- 7Delta

Vendors
- IBM
- Mirth
- Layer7
- Computer Associates
- Red Hat
IEHR SOA SUITE REFERENCE ARCHITECTURE: THE RIGHT TOOLS FOR THE RIGHT JOB

Business Process Management (BPM)
Runtime: IBPM aka Process Server
Tools: WebSphere Integration Designer

Use for:
- Clinical and other complex workflows (especially human-centric workflows)
- Complex integration scenarios / Orchestration beyond ESB’s capabilities

Business Rules Management System (BRMS)
Runtime: WODM aka ILOG
Tools: Several ILOG Tools / various platforms

Use for:
- Complex business logic (not necessarily routing logic – many interrelated rules)
- Logic that changes frequently, especially when utilized by multiple systems / services

Enterprise Service Bus (ESB)
Runtimes: WebSphere Message Broker (regional / central), Mirth Connect (local sites)
Tools: WebSphere Message Broker Toolkit, Mirth Connect Administrator

Use for:
- Service Oriented Architecture, Message Oriented Middleware, Event Driven Architecture
- Exposing services (either running on the ESB or elsewhere, such as BPM and BRMS services)
- Integration single point of control / management
- Messaging (formatting, routing, connectivity hub – HL7, etc)
## USE CASE EXAMPLES FOR RUNTIMES

### Business Process Management (BPM)
- Data Quality Analysts manually resolving patient identity concerns between VA and state immunization registries
- Clinical Process Improvement workflows – especially when work encapsulates functionality of multiple applications
- Capturing KPIs / metrics – i.e. JCAHO / Meaningful Use quality metrics, etc

### Business Rules Management System (BRMS)
- Clinical Decision Support
  - Diagnosis, Care Protocols, Adverse Reaction prevention, etc
- Patient Eligibility...
  - Insurance, Procedures, Clinical Study Participation, etc
- Patient Identity EMPI-like logic (if not using an EMPI)

### Enterprise Service Bus (ESB)
- Classic “Interface Engine” use cases
  - Message Oriented Middleware, HL7 transformation and routing, Propagating events / clinical data across ancillary systems
- Beyond traditional interface engine cases
  - Aggregating data for continuity of care documents / HIE exchange / NHIN / PHR Integration
- Creating composite services / applications father and more efficiently than via custom software development, that can be called / invoked by VistA/CPRS, CHCS/AHLTA, Essentris etc.