



# The Role of Information Modeling in Achieving SOA Interoperability

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# Service Oriented Architecture Definitions

- Service Oriented Architecture (SOA) is a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains.
- Set of services that a business wants to expose to its customers and partners or other portions of the organization.

OASIS Reference Model for Service Oriented Architecture 1.0 - (*emphasis mine*)

Source: IBM – (*emphasis mine*)





- in-ter-op-er-a-bil-i-ty
  - ability of a system...to use the parts or equipment of another system

Source: Merriam-Webster web site

- interoperability
  - ability of two or more systems or components to exchange information and to use the information that has been exchanged.

Source: IEEE Standard Computer Dictionary: A Compilation of IEEE Standard Computer Glossaries, IEEE, 1990]

**Syntactic interoperability**

Syntactic relates to the formal structuring and expression of the data

Semantic relates to the meanings of the data and the relationships with other data

**Semantic interoperability**



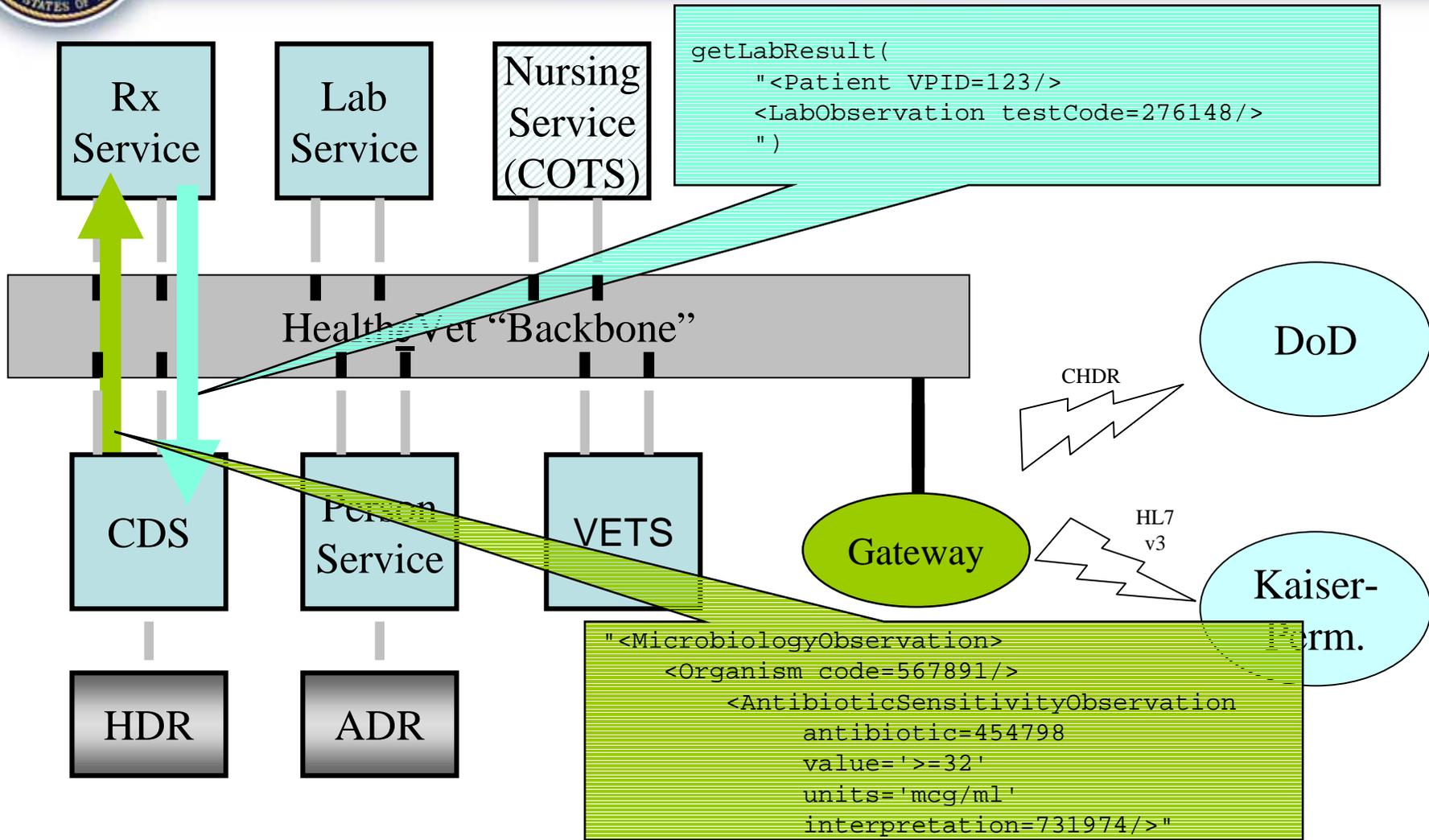
# Information is an Enterprise Asset

- **In the past organizations tried to enforce semantic interoperability by forcing all systems to use the same database structures, but this proved unworkable.**
- **Today, semantic interoperability is enforced by controlling the system interfaces and the payloads to / from those interfaces**
  - Underlying database don't need to be consistent to ensure interoperability, although there may be other benefits related to database maintenance, database splitting/merging and governance that still require consistency across databases.





# VHIM in VistA 2.0 (Health\_eVet) Overview





# Information Modeling in SOA

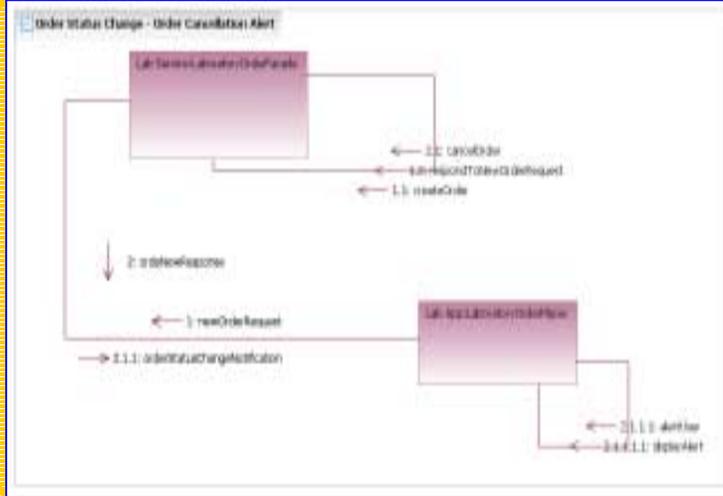
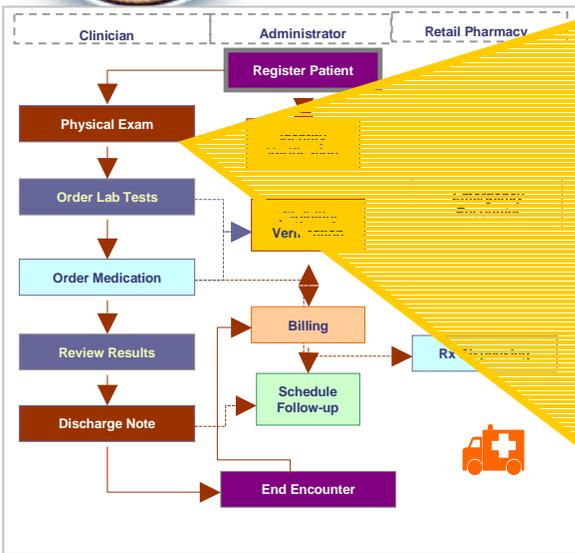
- **In order for a SOA to work, it is critical that services have a common understanding of the structure and meaning of the data being exchanged**
- **Therefore, a “model” of some kind is needed**
  - but what form? XSD is a model, so is DDL
- **This Presentation will discuss the advantages of information modeling using UML**



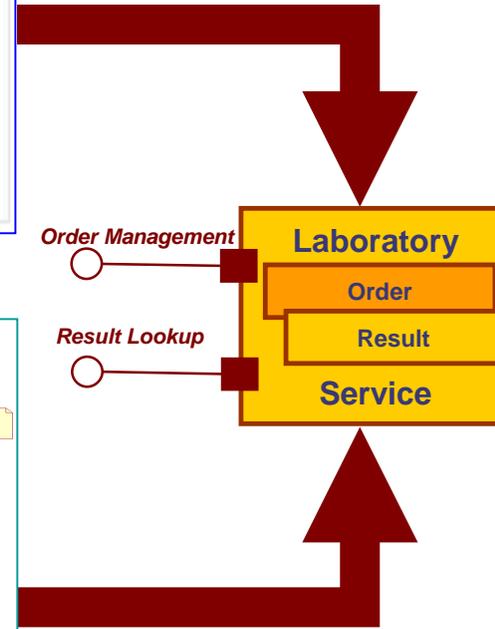


# Enterprise Modeling Overview

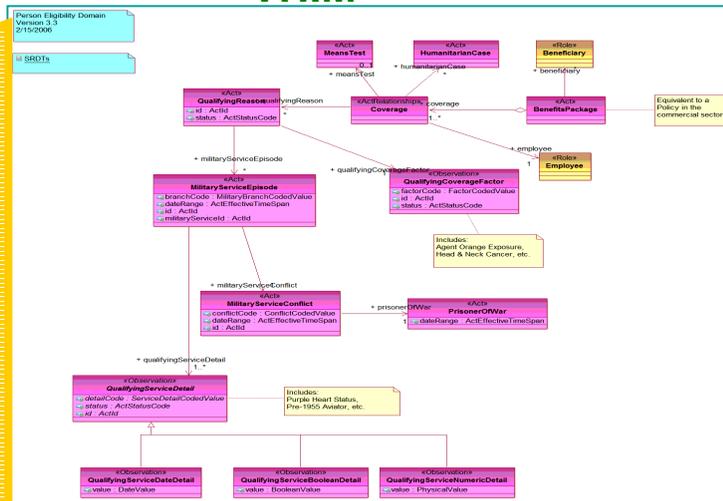
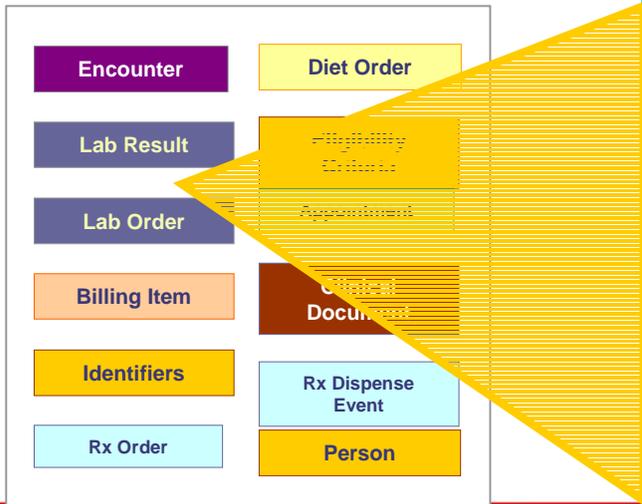
## VDIM



- Documentation (Interface specifications)
- Runtime Artifacts
  - WSDL
  - XSD



## VHIM





# VHA's Health Information Model – the VHIM

- **The authoritative enterprise information model for VHA**
- **A UML model of crosscutting information (i.e., information of interest to the enterprise) with classes, attributes, relationships, and definitions**
  - Computationally Independent Model within Model Driven Architecture
- **Portion of architectural strategy to ensure semantic interoperability among HealthVet components and enable “gateway” services for external communications**
- **Organized by domains such as Demographics, Pharmacy, etc.**





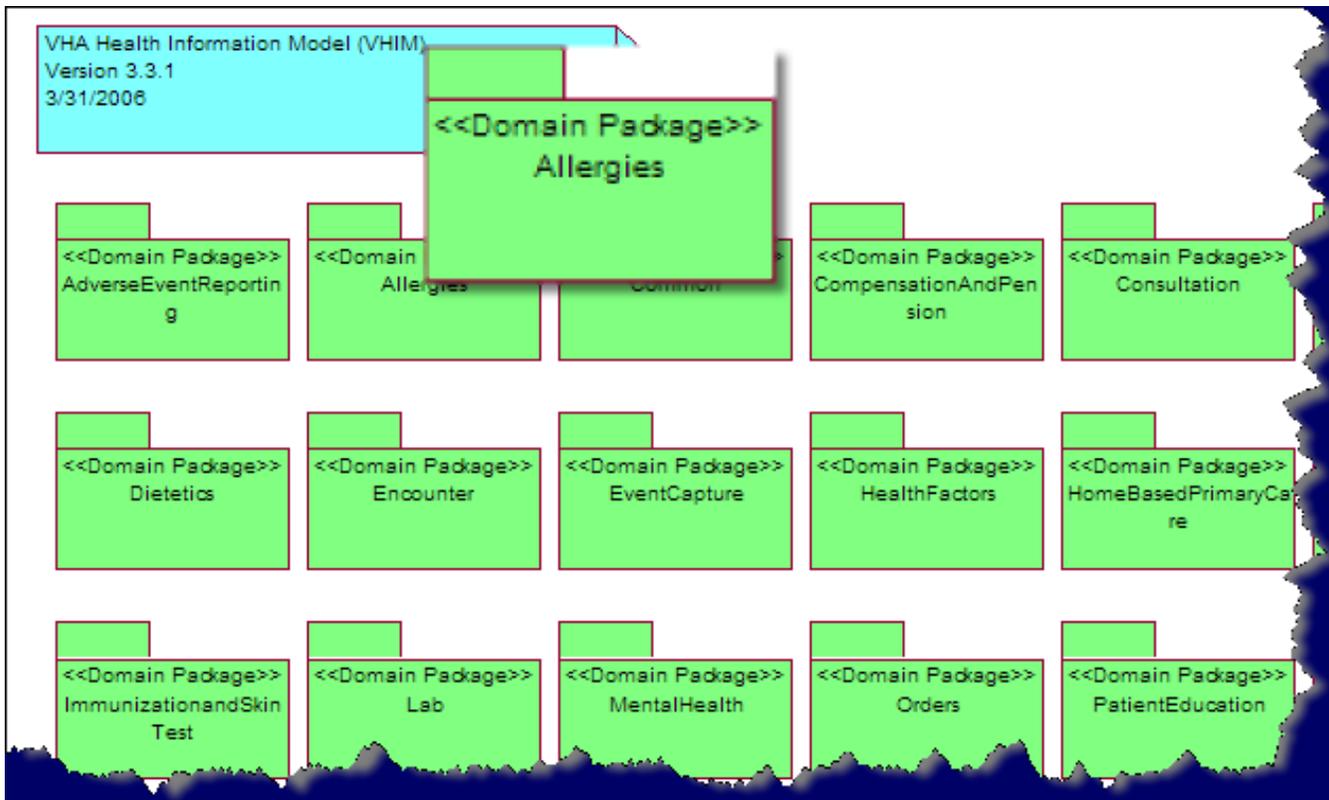
## VHA's Health Information Model – the VHIM (cont'd)

- **Ensures harmonization with industry standards through active involvement with SDOs (HL7, HITSP, NCPDP, IHE, ASC X12, DICOM)**
- **Aligned with HL7 Reference Information Model (RIM) and HL7 v3 Concept Domains**
  - Uses the RIM as a pattern to create a canonical model from which data from different trading partners can be translated into and out of
  - This ensures that transformations increase linearly, not exponentially as the number of services/applications or trading partners increases.



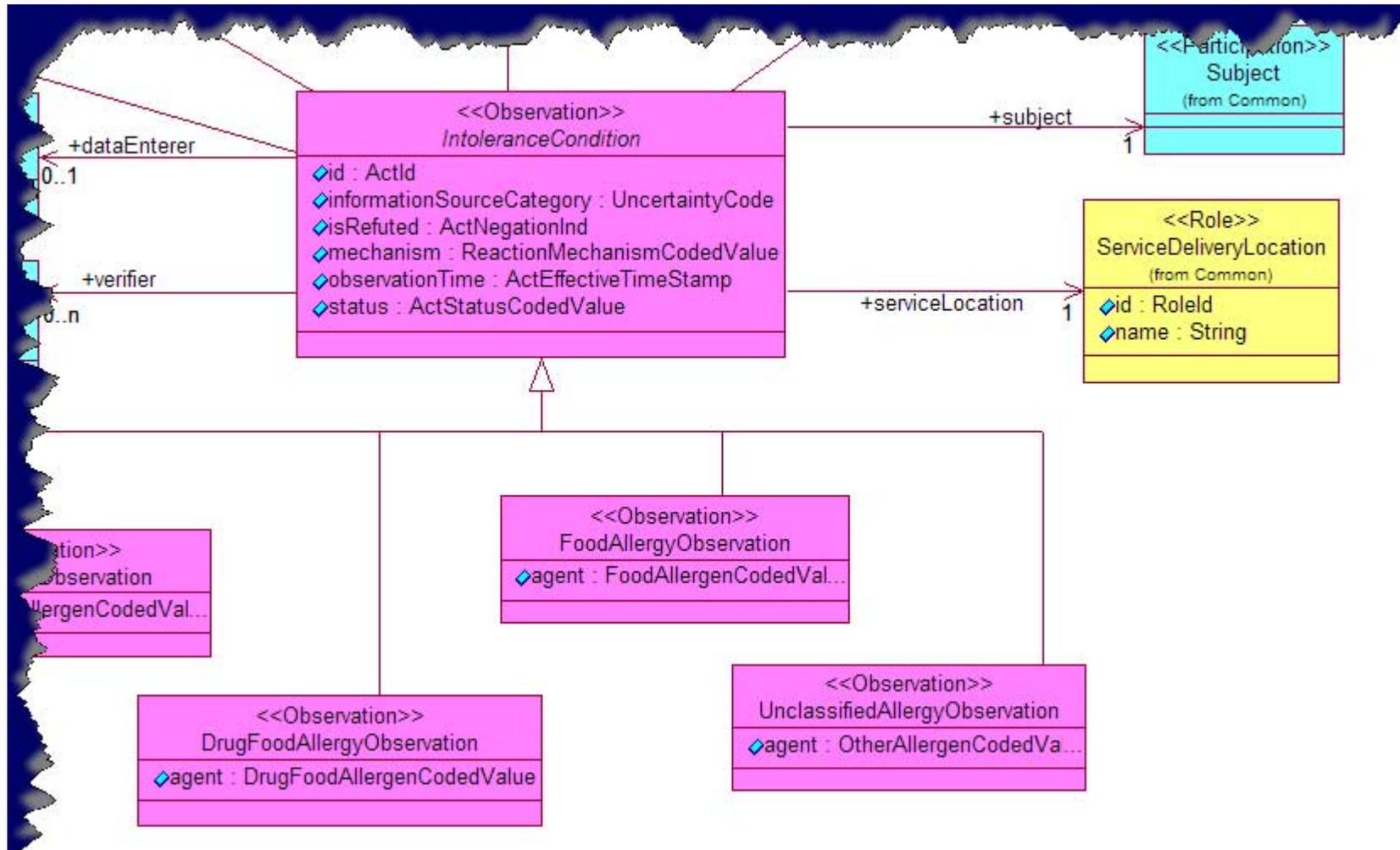


# What is the VHIM? Information Domains





# What is the VHIM? Allergies Domain





# VHIM Versions

- **VHIM 2.x**

- Consumers: Federal Health Information Exchange (FHIE), Bi-directional Health Information Exchange (BHIE), Health Data Repository Interim Messaging Solution (HDI IMS)
- Uses Object Management Group's (OMG's) COAS structures / datatypes

- **VHIM 3.x**

- Consumers: Health\_eVet, HDR II, Clinical Data Service (CDS)
- Uses HL7 v3 Datatypes; aligned with HL7 v3 Reference Information Model (RIM)
- Modeled 32 domains out of approx 120 domains identified so far:

Adverse Event Reporting	Allergies	Audiology / Speech Pathology	Blood Bank
Clinical Decision Support	Compensation And Pension Exam	Consultation Request	Dental
Nutrition and Food Service (Dietetics)	Encounter	Event Capture	Health Factors
Home Based Primary Care	Imaging	Immunization / Skin Test	Lab
Mental Health	Oncology Registry	Orders	Patient Education
Person Demographics	Patient Eligibility	Pharmacy	Problem List
Prosthetics	Radiology	Social Work	Spinal Cord Injury
Surgery	TIU (Clinical Documents)	Vital Signs	Women's Health





# VHIM Details

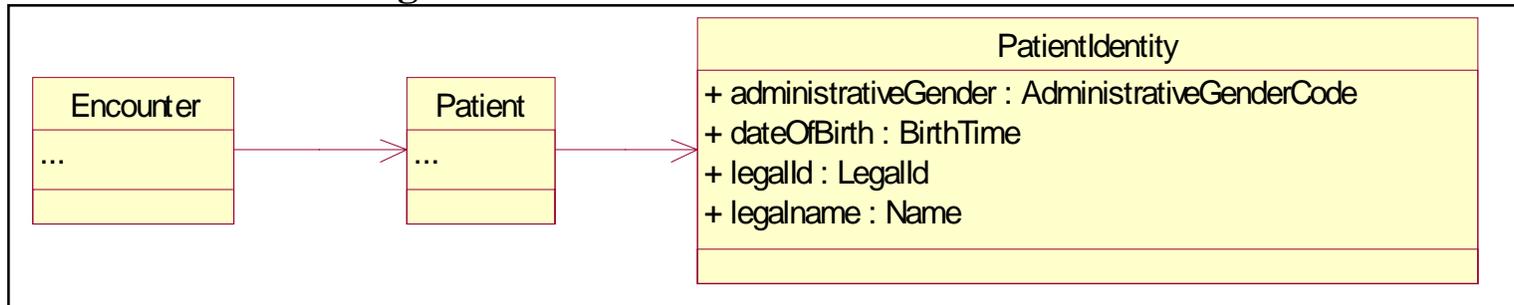
- **How can one static data model meet all the implementation needs (database, domain model, payload structure)?**
- **Answer: Model transformations**
  - Computationally Independent Model (CIM) – conceptual model
  - Platform Specific Model (PSM) – logical model
  - Model implementation – physical model
- **Model Driven Architecture (MDA) and UML software provide tools for automating model transformations**





# VHIM – Implementation

## VHIM Class Diagram



## XML Schema Definition (XSD)

```
<xs:element name="PatientIdentity" type="Valentity"
substitutionGroup="personIdentity" />
- <xs:complexType name="PatientIdentity">
- <xs:complexContent>
- <xs:extension base="PersonIdentity">
- <xs:sequence>
- <xs:element name="administrativeGender"
type="AdministrativeGenderCode">
- <xs:annotation>
<xs:documentation>A value representing the gender (sex) of a person.
The for allowable values for this field as specified by the DS DAT for
Demographics are: F (Female), M (Male) and UN
(unspecified).</xs:documentation>
</xs:annotation>
...
```

## Java

```
public interface PatientIdentity extends personSRDTs.PersonIdentity
{
    livingSubject.AdministrativeGenderCode getAdministrativeGender();
    void setAdministrativeGender(livingSubject.AdministrativeGenderCode
administrativeGender);
    livingSubject.AdministrativeGenderCode
addNewAdministrativeGender();
    livingSubject.BirthTime getDateOfBirth();
    void setDateOfBirth(livingSubject.BirthTime dateOfBirth);
    livingSubject.BirthTime addNewDateOfBirth();
    ...
}
```

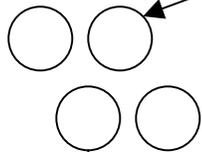


# VHIM Details

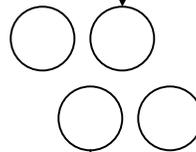
○ ○ VHIM CIM



## Conceptual to Logical: Model to Model Transformations

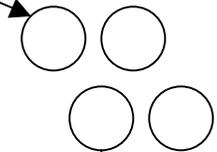


**Database PSM**

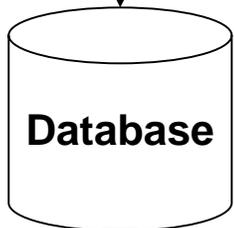


**Java Object PSM**

**Payload PSM**



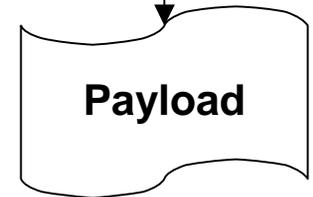
## Logical to Physical: Model to Implementation Transformations



**Database**



**Java Application**



**Payload**



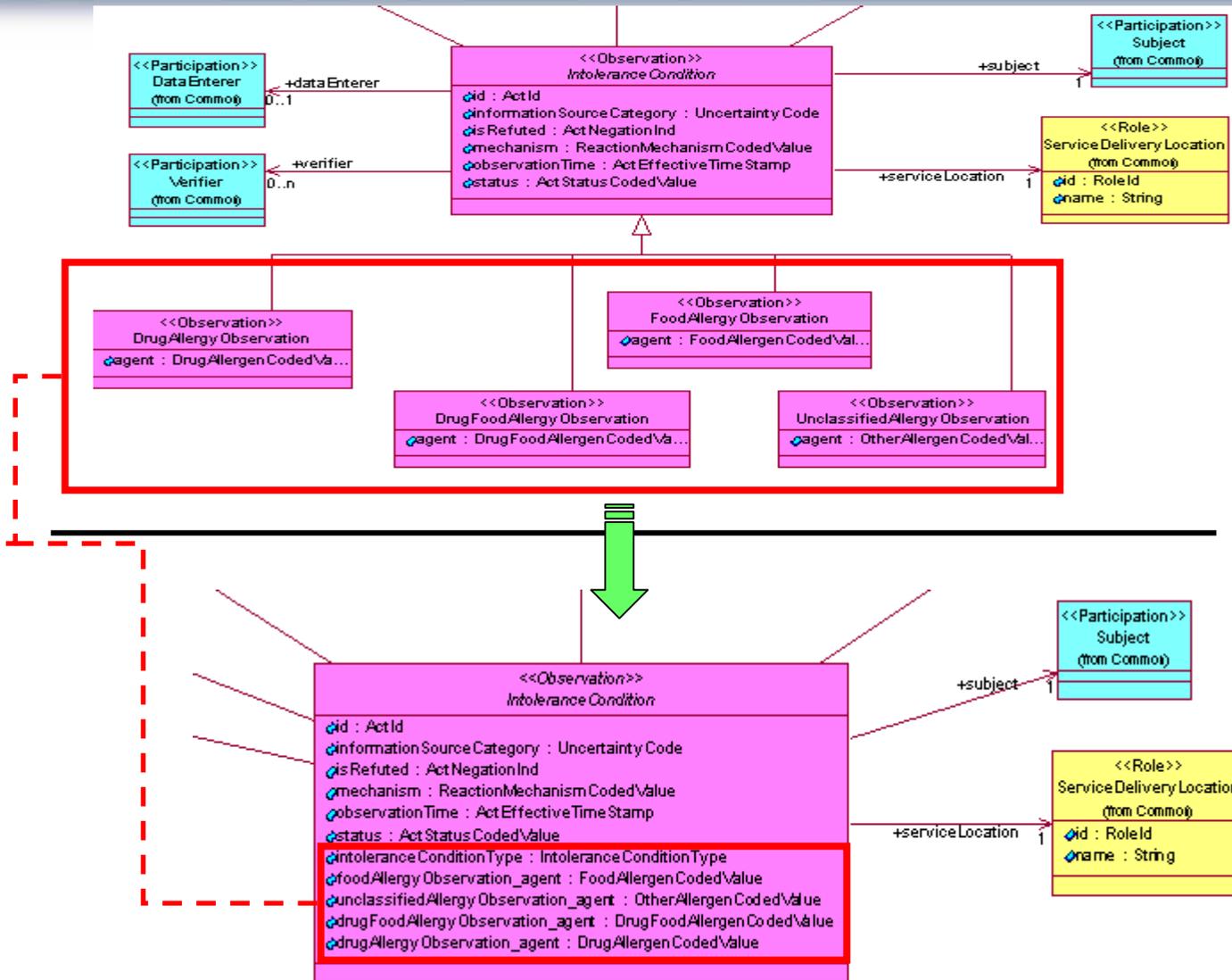
# VHIM Details – CIM to PSM Example

The VHIM model is a “Computationally Independent Model”, which does not have built-in bias towards a particular implementation platform

Note that the model contains four subclasses to distinguish the type of the allergy. But databases don’t understand subclasses. They use “type codes” to determine what kind of a thing is in the record.

So, we transform the model into another model, which is more conducive to databases, from which we can then generate a database. The same can be done for XML, Java, etc.

The advantage is that from a single model, other models can be automatically produced for suit particular purposes – importantly, the derived models all have the same semantic meaning, thus preserving the integrity of the data regardless of how or where it’s used.





# VHIM Payload Definition (“Templates”)

- **The VHIM enables HealtheVet information exchange**
  - The VHIM UML Model is transformed into XML Schema Definitions (XSDs) called VHIM Templates
  - Templates define the structure of the information that will be exchanged within a transaction between two systems or services
  - All interactions with a service shall be done via VHIM templates
- **Templates are a subset of the VHIM used to define service payloads**
  - Example: From the Lab domain, we may specify ChemistryResult, MicrobiologyResult, etc.
- **A “Template Registry” will be maintained where templates will be documented and available for re-use**





# Lessons Learned

- **There will be a time between the As-Is and the To-Be where you have a mixture of both**
  - Transforms to/from the VHIM and HL7 v2 EDI were created
  - One challenge was the mapping to/from HL7 v2 data types and HL7 v3. Certain v2 data types were created for “backward compatibility”
  - The VHIM contains several structures to begin supporting the To-Be environment; these structures were disabled because they will not be used until re-engineering.





# Lessons Learned (cont'd)

- **HL7-VHIM transformations required more QA and troubleshooting than initially anticipated**
  - Some HL7 messages did not conform to HL7 specifications
  - Validation of mappings has been manually intensive and thus time consuming
- **Data migration / transformation will bring to light data quality issues**
  - Some data may be cleansed
  - Adjustments are made to VHIM templates, the transformations, and/or VHIM model
- **Some issues require the involvement of the authoritative source to make changes on their side**
  - Business input is important here – VHA established a data stewardship program to ensure authoritative business entities for semantics, governance, and error resolution / data quality

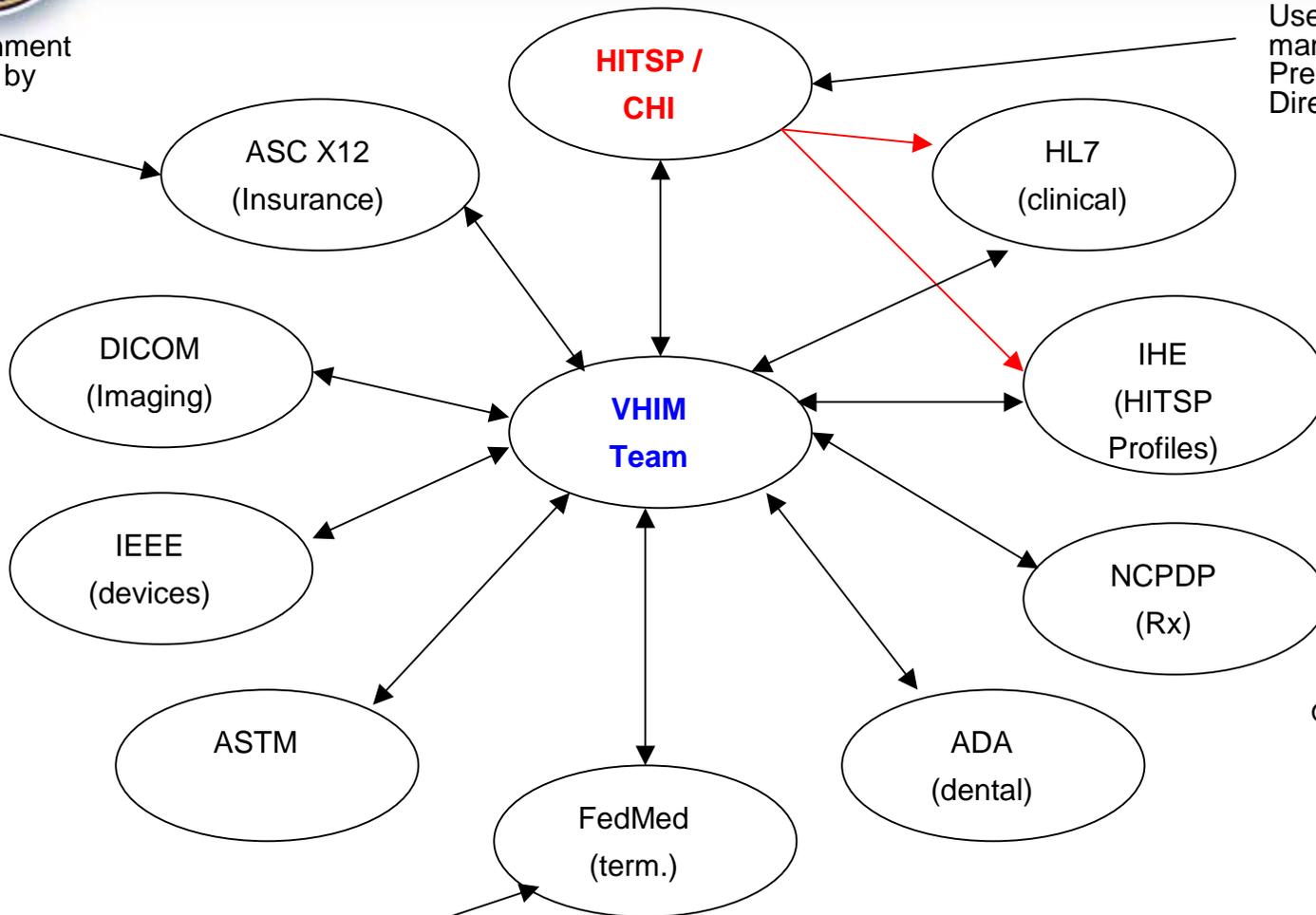




# Standards also a big driver for the VHIM

Use / alignment  
mandated by  
HIPAA

Use / alignment  
mandated by  
Presidential  
Directive



A collaborative terminology effort involving VHA, DOD, FDA, HHS, NLM, NCI, and CDC

In addition, we monitor developments at:  
Open Health Tools (OHT)  
ISO 215  
CEN 251  
OpenEHR  
---  
Canada Health Infoway  
UK Natl Health Svc  
AU NEHTA



# Relationship to the HL7 RIM

- **The HL7 RIM is used as a UML Profile, allowing VHA to create rigorous transformations to/from HL7 v3 artifacts**
  - In fact, VHA can import HL7 MIF files into the UML model
  - It is possible to generate HL7 MIF directly from the VHIM, however, VHA has not invested in such tooling
- **Additionally, VHA is encouraging ASC X12 and NCPDP to use UML modeling to produce their standards, preferably re-using the VHIM style and transformations**





# Mechanism to align Classes with HL7 v3

```
«Observation, VHIMClass»  
MicrobiologyObservation  
«VHIMTimeProperty» accessionDate : Date  
«VHIMTimeProperty» reportDate : Date  
«VHIMTimeProperty» verificationDate : Date
```

*The Class Code and mood Code are explicitly identified in the model; allowing for computable transformations to/from HL7 v3 message structures*

The screenshot shows the 'Properties' window for the class «Observation, VHIMClass». The 'Applied Stereotypes' table is as follows:

Stereotype	Profile	Required
Observation	RIM	False
VHIMClass	VHIM	False

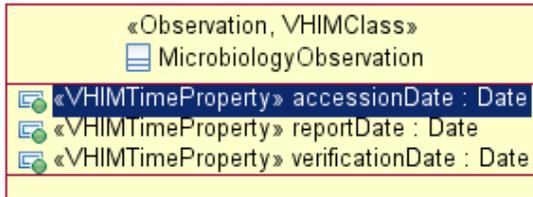
The 'Stereotype Properties' table is as follows:

Property	Value
classCode	40 - OBS
moodCode	1 - EVN
client	Entries: 1
convertToChoice	False
hl7Mood	2 - event (occurrence)
isEntryClass	False
isMultiObservation	False
updateMode	Entries: 0

*In addition, this allows one to perform automatic model validation – If the class is stereotyped as Observation, the class code must be “OBS” or a “child” code – in other words a class code of “PROC” (procedure) is invalid.*



# Mechanism to align Attributes with HL7 v3



*The HL7 RIM Attribute and constrained datatype are identified in stereotype properties, not in the model itself.*

Properties  Tasks **Console** Bookmarks Problems

General

Stereotypes

Documentation

Constraints

Advanced

<Property> «VHIMTimeProperty» accessionDate

Keywords:

Applied Stereotypes:

Stereotype	Profile	Required
VHIMTimeProperty	VHIM	False

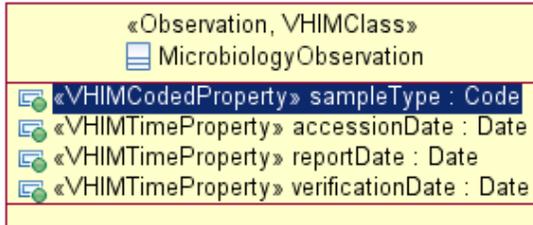
Apply Stereotypes... Unapply Stereotypes

Stereotype Properties:

Property	Value
<input type="checkbox"/> VHIMTimeProperty	
canBeImprecise	False
client	Entries: 1
hl7Attribute	48 - effectiveTime
hl7Datatype	65 - TS
hl7ObservationClassName	
updateMode	Entries: 0



# Mechanism to align with Terminology



*The model explicitly links to both the VHA Unique concept Identifier (VUID) and to the HL7 value set.*

Properties | Tasks | Console | Bookmarks | Problems

General | Stereotypes | Documentation | Constraints | Advanced

<Property> «VHIMCodedProperty» sampleType

Keywords:

Applied Stereotypes:

Stereotype	Profile	Required
VHIMCodedProperty	VHIM	False

Apply Stereotypes... | Unapply Stereotypes

Stereotype Properties:

Property	Value
VHIMCodedProperty	
client	Entries: 1
hl7Attribute	24 - code
hl7Datatype	12 - CD
hl7ObservationClassName	
updateMode	Entries: 0
valueSetVuid	12345
vocabularyDomainMnemonic	SMPLTYP
vocabularyDomainName	ActSampleType



# UML Style benefits

- **The UML Style provides:**
  - More computationally independent models; HL7-isms and XML-isms not in the diagrams
    - Easier for Subject Matter Experts to understand and validate
  - Ability to automate Quality Assurance checks based on the semantics of the model, not just structure
    - This is done through Eclipse extensions using the EMF Validation Framework





- **The VHIM does not yet employ any ontology or semantic web technologies**
  - Research is being conducted to explore the linkage between UML and RDF(S), OWL, and SBVR  
See the OMG Ontology Definition Metamodel (ODM) and the Eclipse (EODM) efforts
  - The VHIM Team intends to actively explore the use of ontologies and semantic web technologies
  - Currently, terminology in the VHA is “modeled” using terminology authoring tools such as Apelon’s TDE.
  - The VHIM references value-set VUIDs, which provides the linkage between UML modeling and terminology





# Summary

- **To design a SOA, you need:**
  - Dynamic (Behavioral) Models
  - Static (Information) Models
  - Terminology Models
- **UML can be used effectively for the first two**
  - Enables the benefits of Model Driven Architecture
  - Can link to terminology in UML Profile
- **We are exploring closer linkages between Information and Terminology modeling**

