Standards for Model-Driven Semantics

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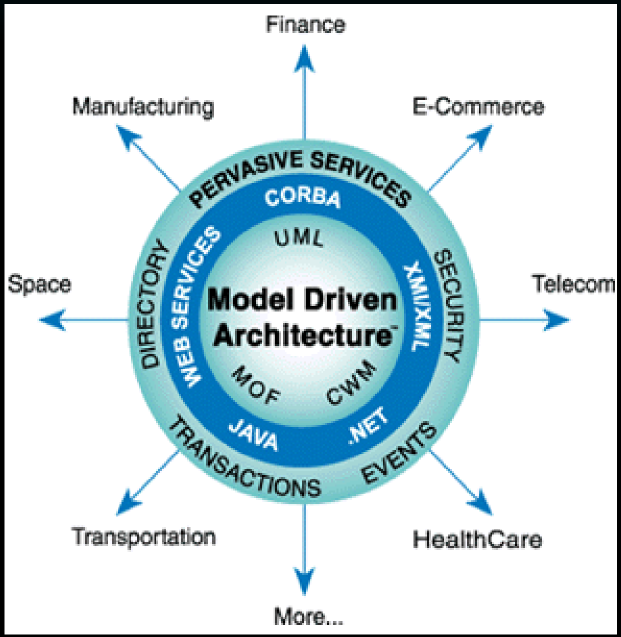
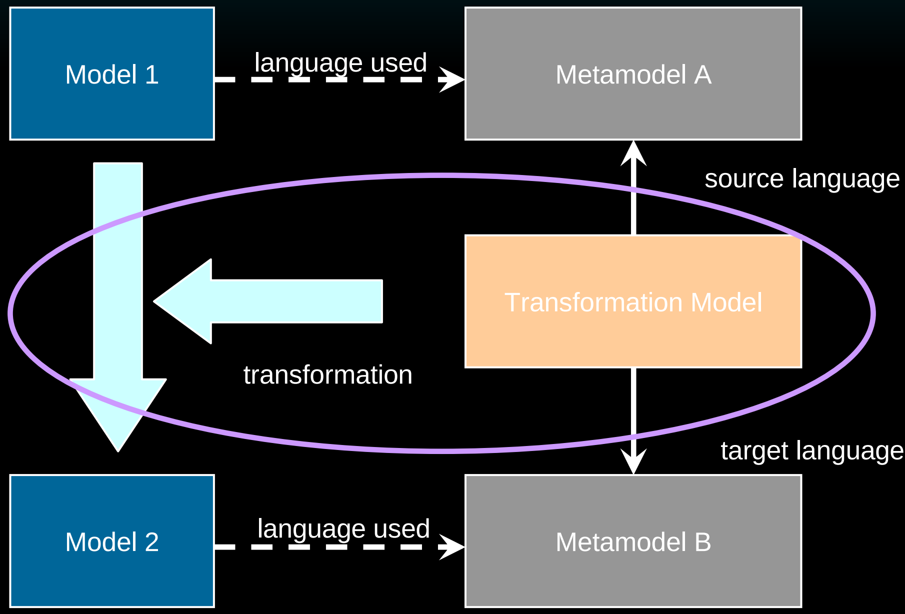
Model Driven Architecture® (MDA®)

- Insulates business applications from technology evolution, for
  - Increased portability and platform independence
  - Cross-platform interoperability
  - Domain-relevant specificity
- Consists of standards and best practices across a range of software engineering disciplines
  - The Unified Modeling Language (UML®)
  - The Meta-Object Facility (MOF™)
  - The Common Warehouse Metamodel (CWM™)
- MOF defines the metadata architecture for MDA
  - Database schema, UML and ER models, business and manufacturing process models, business rules, API definitions, configuration and deployment descriptors, etc.
  - Supports automation of physical management and integration of enterprise metadata
  - MOF models of metadata are called *metamodels*

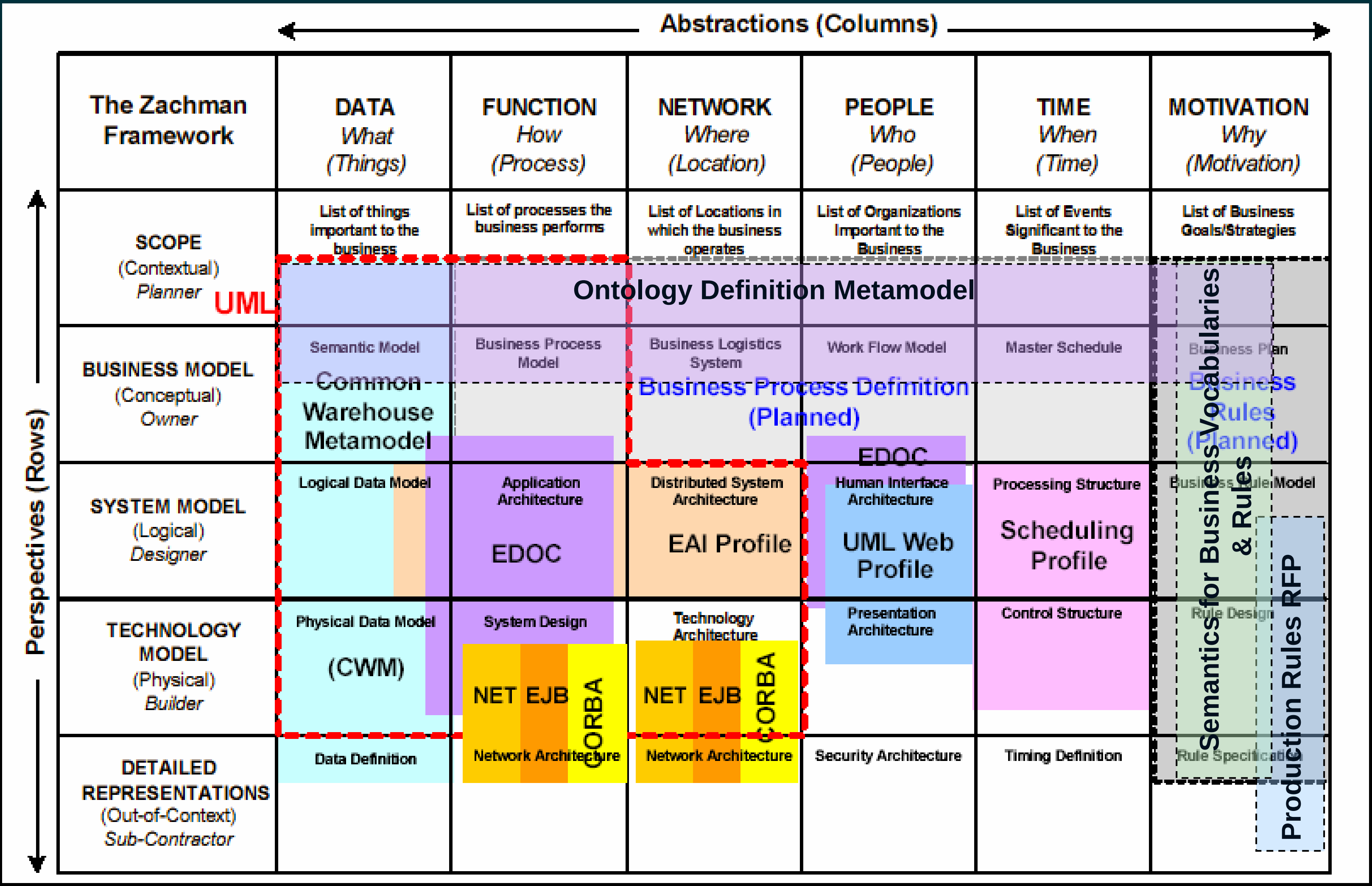


MOF-Based Metadata Management

- MOF tools use metamodels to generate code that manages metadata, as XML documents, CORBA objects, Java objects
- Generated code includes access mechanisms, APIs to
  - Read and manipulate
  - Serialize/transform
  - Abstract the details based on access patterns
- Related standards:
  - XML Metadata Interchange (XMI®)
  - CORBA Metadata Interface (CMI)
  - Java Metadata Interface (JMI)
- Metamodels are defined for
  - Relational and hierarchical database modeling
  - Online analytical processing (OLAP)
  - Business process definition, business rules specification
  - XML, UML, and CORBA IDL



OMG Standards & Zachman Framework



MDA from the KR Perspective

- EII solutions rely on strict adherence to agreements based on common information models that take weeks or months to build
- Modifications to the interchange agreements are costly and time consuming
- Today, the analysis and reasoning required to align multiple parties' information models has to be done by people
- Machines display only *syntactic* information models and informal text describing the semantics of the models
- Without formal *semantics*, machines cannot aid the alignment process
- Translations from each party's syntactic format to the agreed-upon common format have to be hand-coded by programmers
- MOF® and MDA® provide the basis for automating the syntactic transformations

MOF and KR Together

- MOF technology streamlines the *mechanics* of managing models as XML documents, Java objects, CORBA objects
- Knowledge Representation supports *reasoning* about resources
  - Supports semantic alignment among differing vocabularies and nomenclatures
  - Enables consistency checking and model validation, business rule analysis
  - Allows us to ask questions over multiple resources that we could not answer previously
  - Enables policy-driven applications to leverage existing knowledge and policies to solve business problems
    - Detect inconsistent financial transactions
    - Support business policy enforcement
    - Facilitate next generation network management and security applications

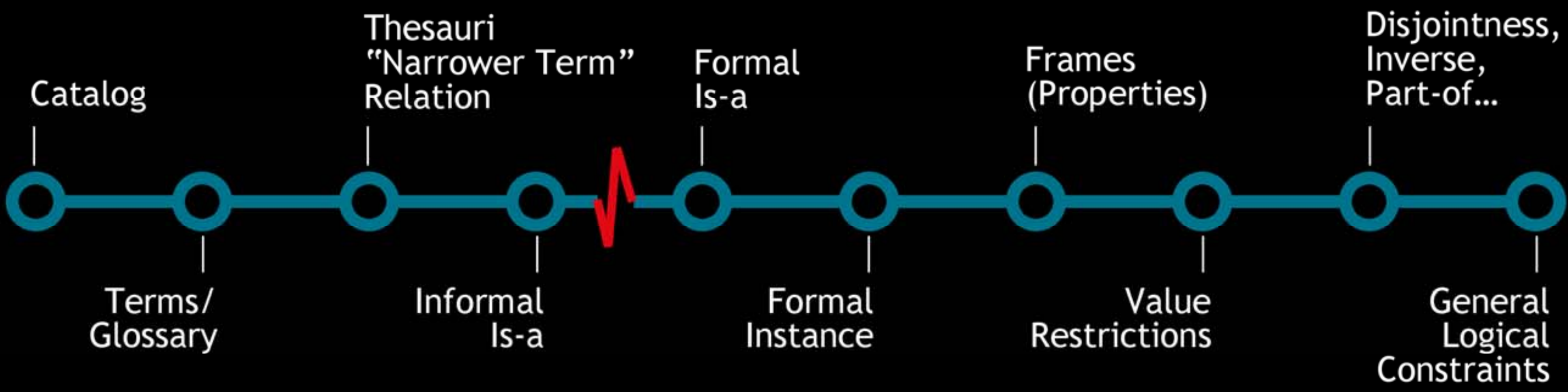
  while integrating with existing RDBMS and OLAP data stores
- MOF provides no help with reasoning
- KR is not focused on the mechanics of managing models or metadata
- Complementary technologies – despite some overlap

Level Setting

An ontology specifies a rich description of the

- Terminology, concepts, nomenclature
- Properties explicitly defining concepts
- Relations among concepts (hierarchical and lattice)
- Rules distinguishing concepts, refining definitions and relations (constraints, restrictions, regular expressions)

relevant to a particular domain or area of interest.

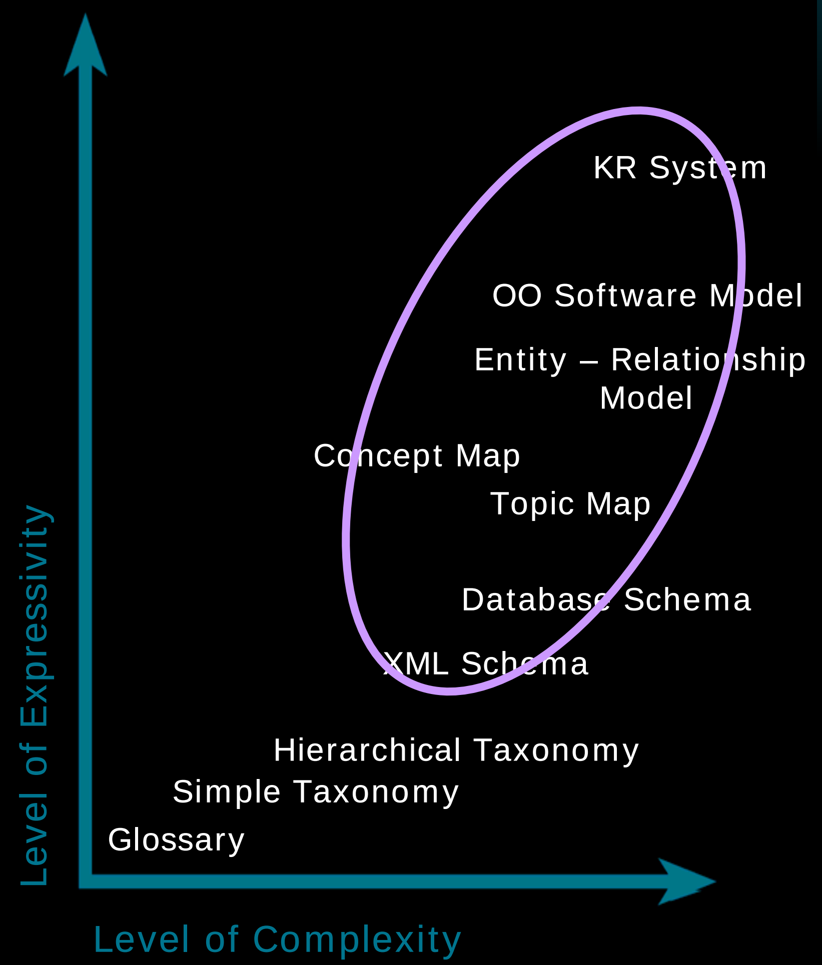


*Based On Aaai '99 Ontologies Panel - Mcguinness, Welty, Ushold, Gruninger, Lehmann

Classifying Ontologies

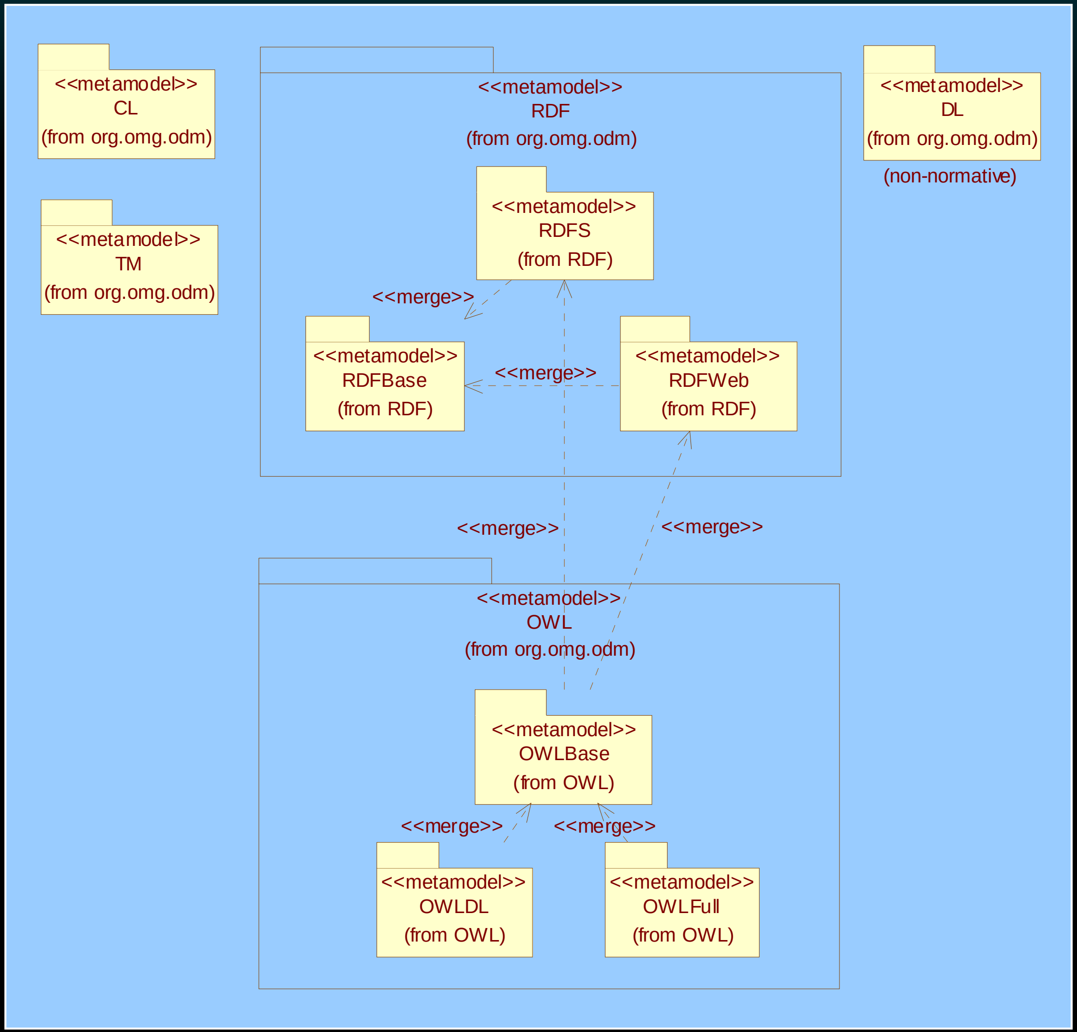
Classification techniques are as diverse as conceptual models; and generally include understanding

- Methodology
- Target Usage
- Level of Expressivity
- Level of Complexity
- Reliability / Level of Authoritativeness
- Relevance
- Amount of Automation
- Metrics Captured and/or Available



Towards a Model Driven Semantic Web – ODM

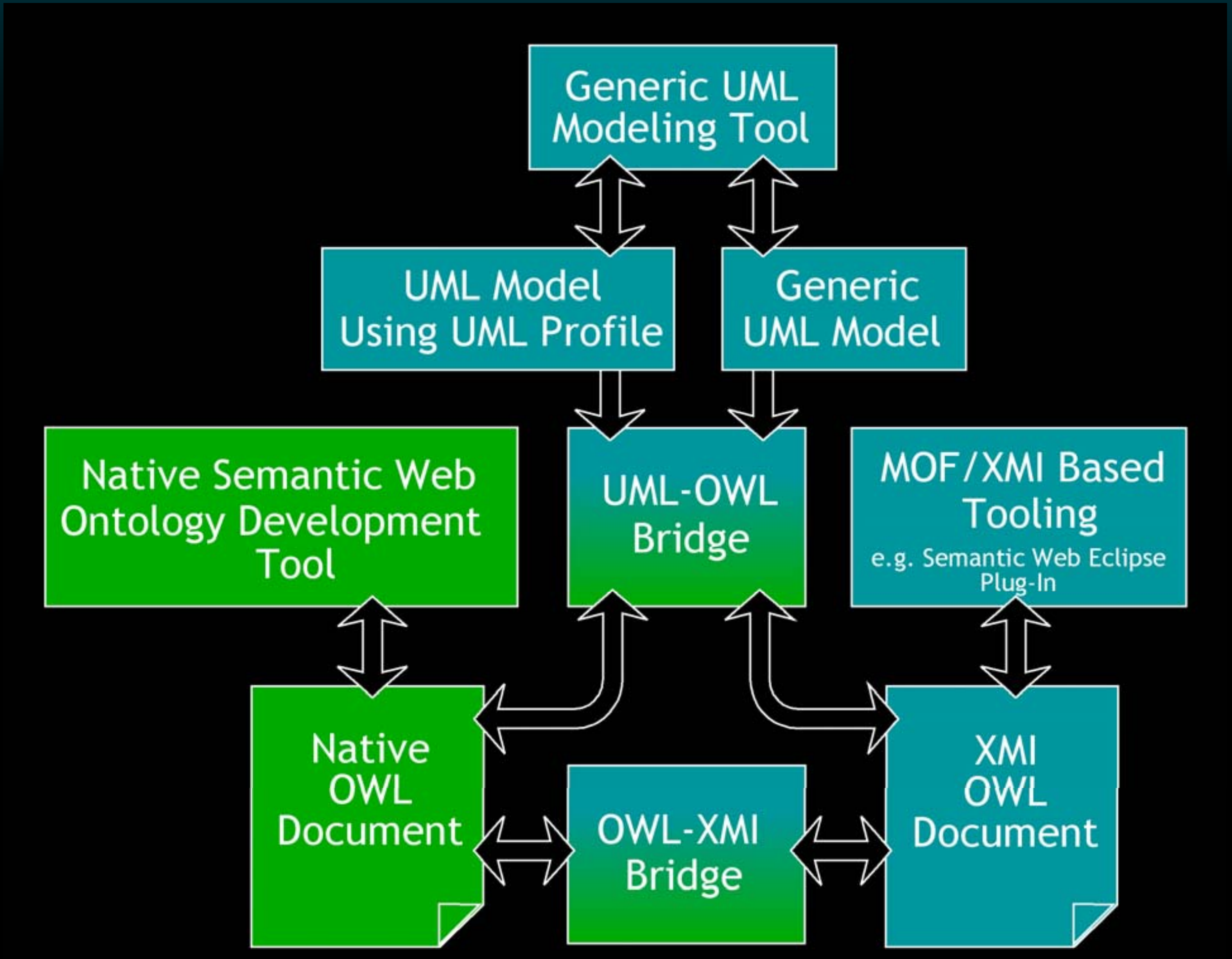
- Five EMOF platform independent metamodels (PIMs), four normative
- Mappings (MOF QVT)
- UML2 Profiles
  - RDFS & OWL
  - TM
- Collateral
  - XMI
  - Java APIs
  - Proof-of-concepts
- Conformance
  - RDFS & OWL
  - Multiple Options
  - TM, CL Optional
  - Informative Mappings



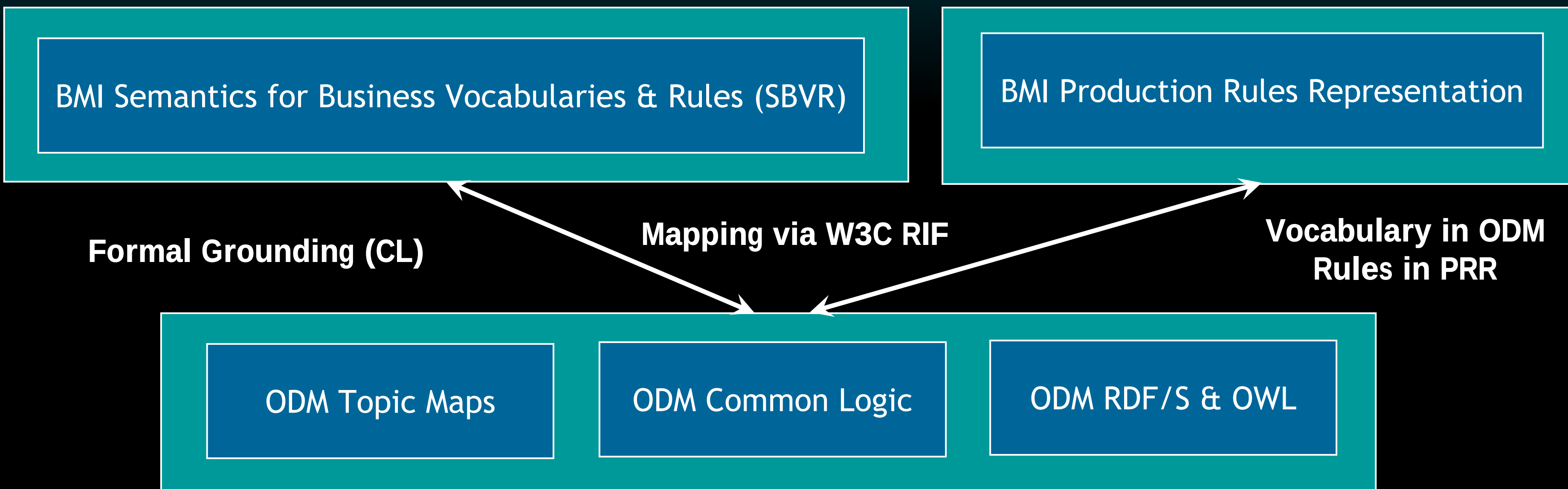
ODM Status

- Several revision cycles on the specification
- Informative discussions of Usage Scenarios, differences between UML & OWL
- Platform Independent Metamodels (PIMs) include
  - Resource Description Framework and Web Ontology Language (abstract syntax, constraints for OWL DL & OWL Full)
  - Common Logic (CL), based on ISO FCD 24707
  - Topic Maps (TM), based on ISO FCD 13250-2
  - DL Core – high-level, relatively unconstrained Description Logics based metamodel (non-normative, informational)
- Latest revised submission posted 11/14 to the OMG web site *(http://www.omg.org/docs/ad/05-09-08.pdf)*
- Update to include minor metamodel changes, QVT mappings, revised profile for St. Louis Meeting (4/23/06), plan to vote for adoption in ADTF

Bridging KR and MDA



Relationship to Other OMG Standards



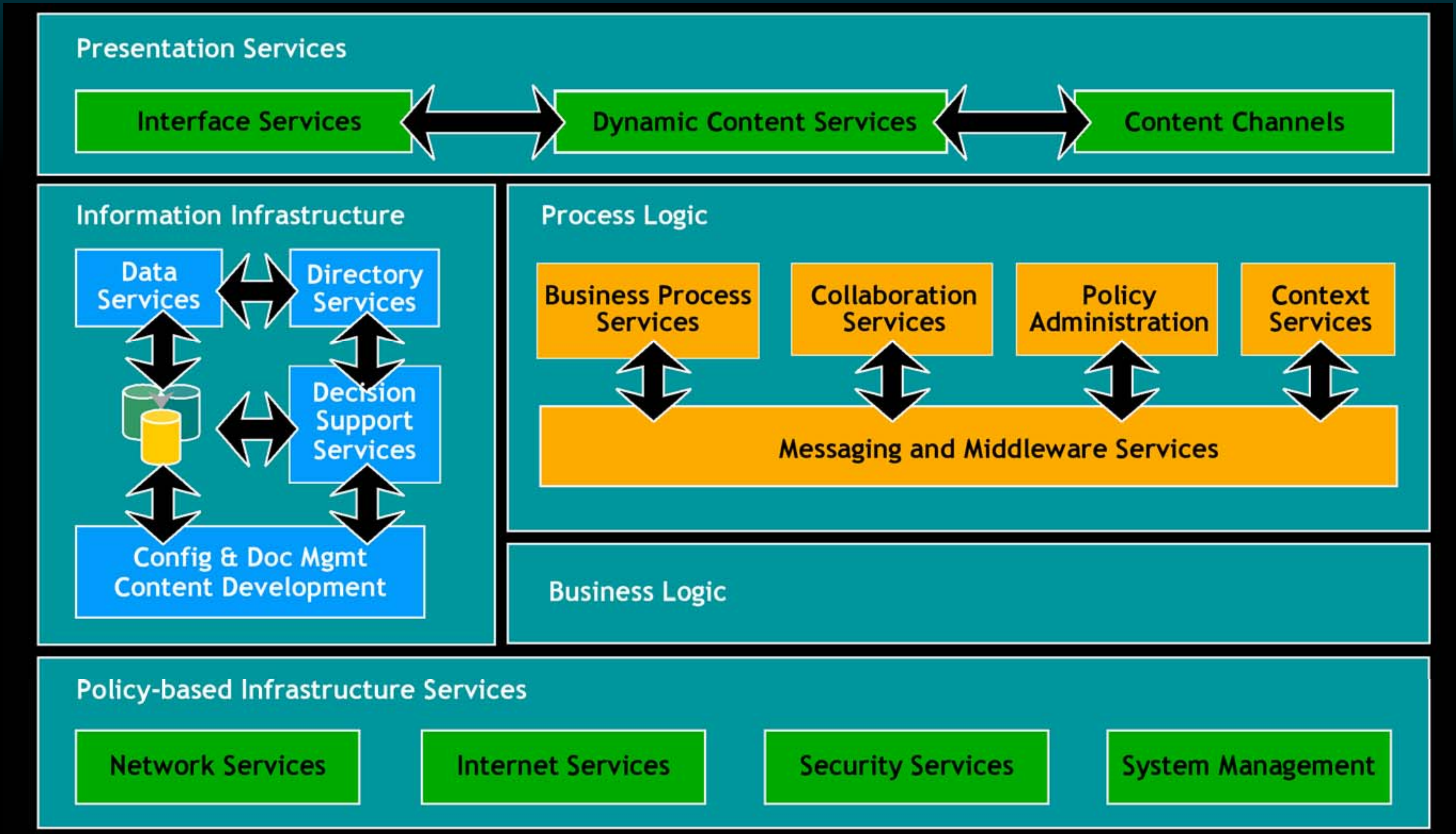
ODM extensions planned

- **Mapping from CL to RDF/S & OWL**
- **Support for Semantic Web Services Language, with bindings to WSDL & SOAP**
- **Mappings for W3C Rule Interchange Format (RIF) (*i.e.* vocab/ontology → rules)**

Relationship to ISO Standards

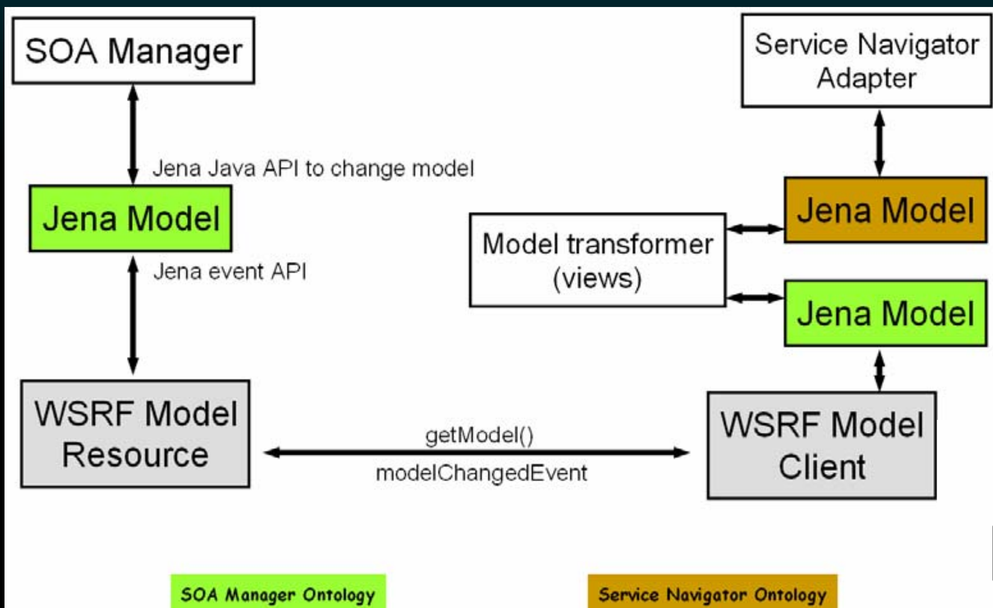
- CL Metamodel is included in ISO FCD 24707
- High degree of synergy between ODM and Topic Maps ISO FCD 13250-2 working group
- All ODM metamodels are referenced and used in ISO CD 19763 (MMF – Metamodel Framework, Model Registry specification)
- All ODM metamodels inform latest modifications proposed in ISO draft 11179 Metadata Registration specification
- ODM team is working with DoD XMDR team to promote interoperability among ODM, 19763, 11179 efforts
- Current work in OMG to develop a metamodel for ISO Express will include mappings to ODM
- Sandpiper team provides standards liaison for emerging DoD Semantic Service Oriented Architecture (SSOA) framework development

Technology Architecture



Example Management Application Integration Framework

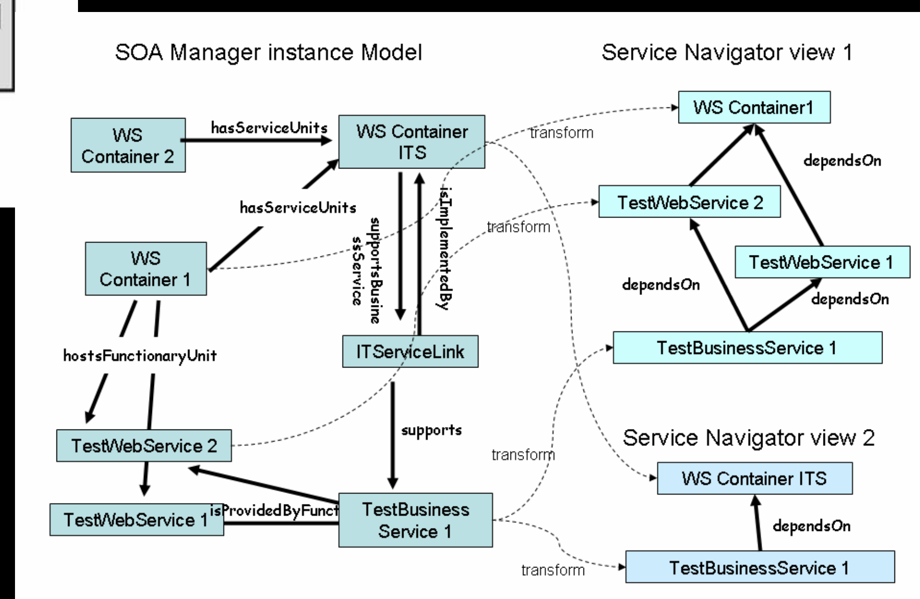
sandpiper software



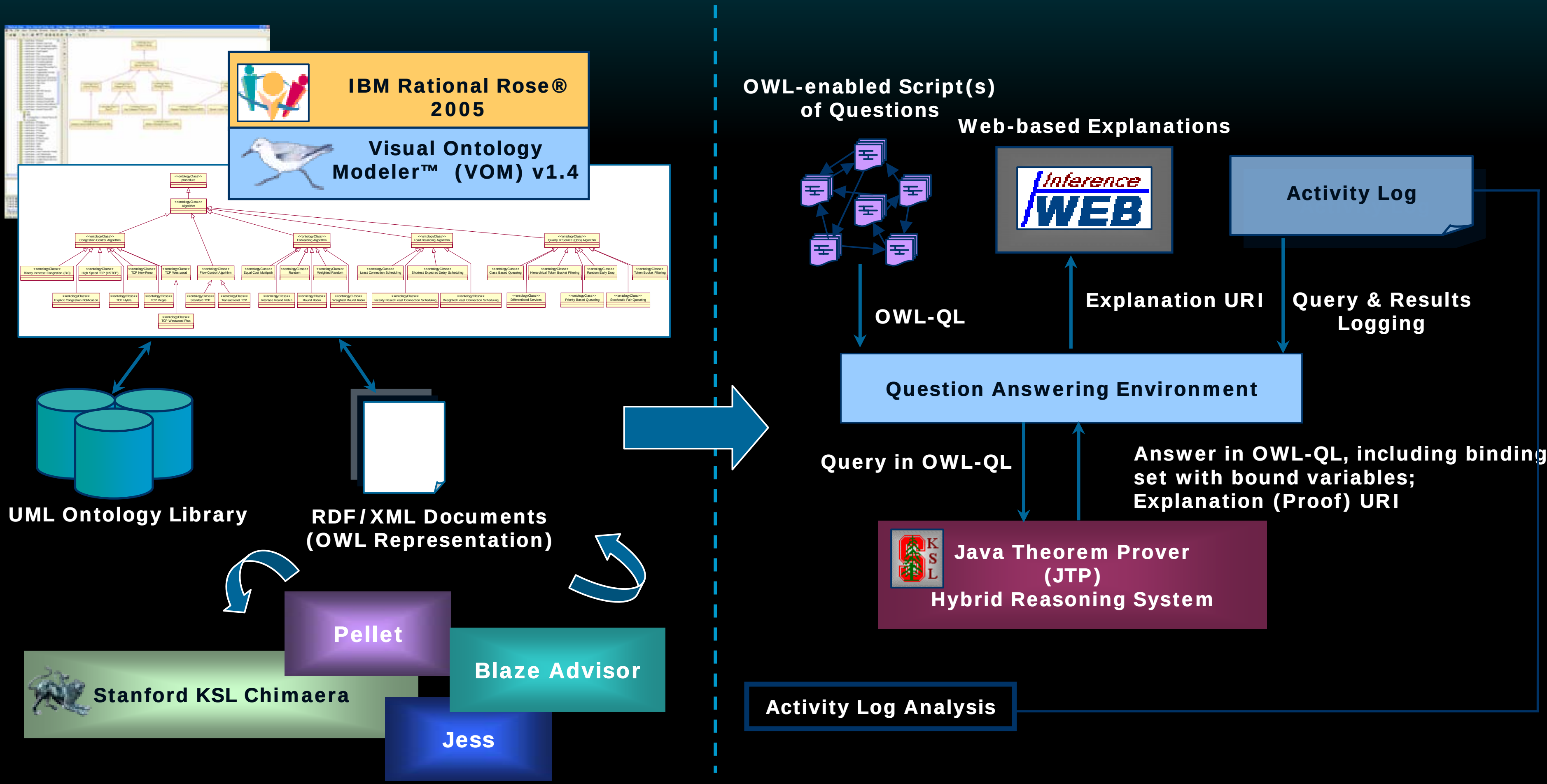
Synchronization of model repositories using RDF/S & OWL based representation & transformations provides new integration capabilities for HP OpenView

Ontology was developed using an ODM-based development environment;

Jena Rules support model transformations



Ontology & KB Analysis, Management & Evolution Framework



Authoring and Analysis | **Question Answering**

Business Integration Summary

- Semantic Web Services standards are converging (OWL-S and SWSL)
- OMG RFP forthcoming for extensions to ODM to support W3C Semantic Web Services, ISO EXPRESS, eventually W3C RIF
- OMG BMI DTF Semantics for Business Vocabularies & Rules (SBVR) is logically grounded in Common Logic / ODM CL Metamodel
- Planned mapping to forthcoming Production Rule Representation (PRR) specification
- Leverage mapping from UML for BPEL to ODM extensions
- Strategy:
  - Link business process models through MOF environment
  - Generate OWL for the linkage
  - Use linkage as basis for mediating business process semantics

A Framework for Next Generation Interoperability

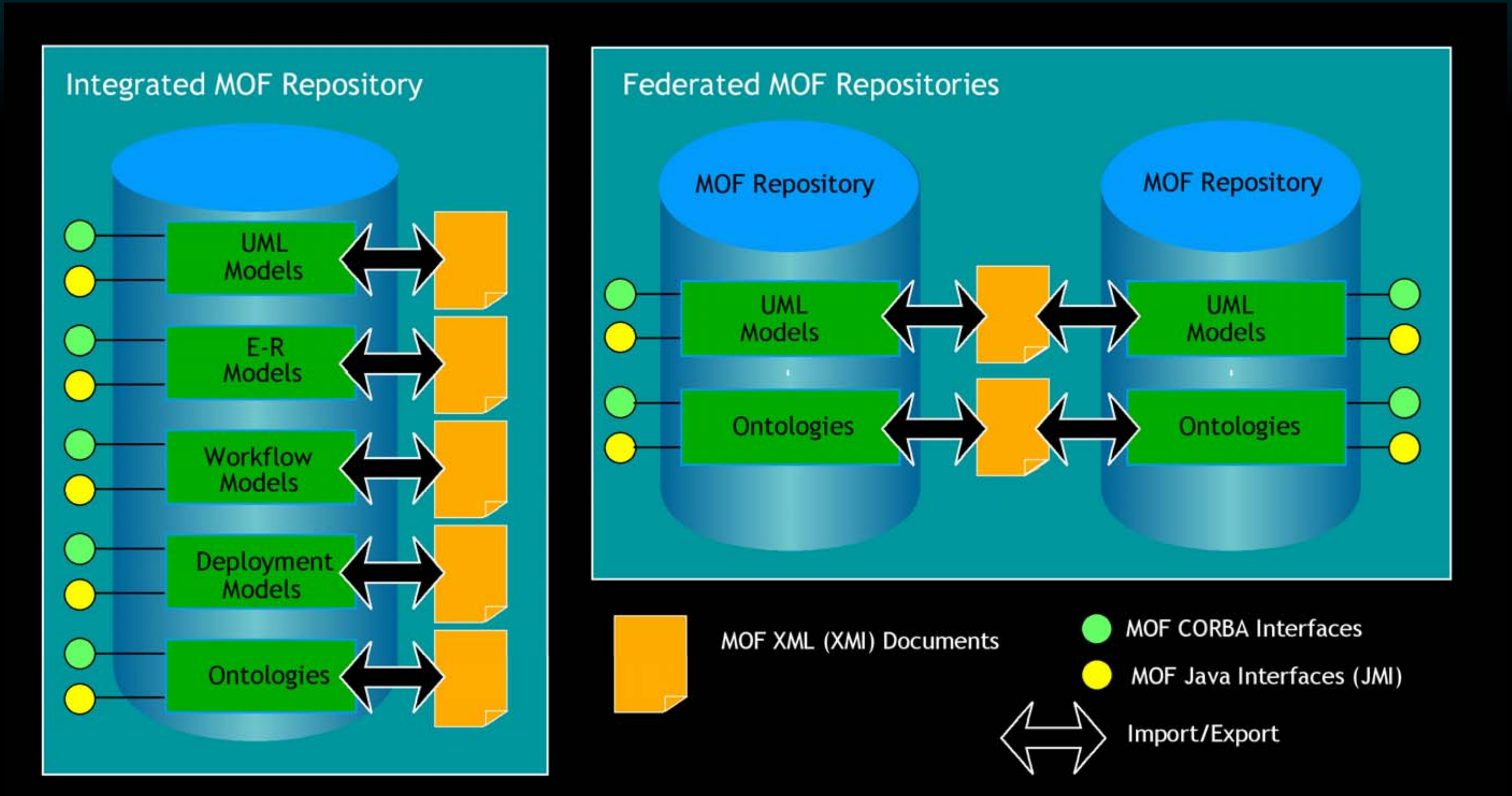
- MOF's model management facilities and KR capabilities for machine interpretable semantics and reasoning are separate, complementary concerns
- The ability of reasoners to find discrepancies in invariant rules, preconditions, and post conditions, can add scalability to MDA's use of Design-by-Contract (DBC)
- UML profiles can serve as graphical notations for Semantic Web languages, dramatically increasing ease of use
- The combination of MDA and SW technologies promises to
  - Address the missing link in business process automation
  - Enable true information interoperability and continuity
  - Support next generation policy-based applications development

The Model-Driven Semantic Web

- Knowledge acquisition, developing the semantics is the bottleneck
- Leveraging existing assets breaks that bottleneck
- Correlation through reasoning provides the utility
  - Multi-dimensional, cross organizational tailored semantic views
  - “Virtual” repository approach enables elimination of redundancy
  - Reasoning supports quality initiatives through inconsistency discovery, model and content validation
- MDA and MOF coupled with semantic technologies are the key

Backup

Metadata Management Scenarios



Model Dynamics

Model centric perspectives characterize the ontologies themselves and are concerned with their structure, formalism and dynamics.

Perspective	*One Extreme*	*Other Extreme*
Level of Authoritativeness	Least authoritative, broader shallowly defined ontologies	Most authoritative, narrower, more deeply defined ontologies
Source of Structure	Passive (Transcendent) - Structure originates outside the system	Active (Immanent) - Structure emerges from data or behavior
Degree of Formality	Informal or primarily taxonomic	Formal, having rigorously defined types, relations, and theories or axioms
Model Dynamics	Read-only, ontologies are static	Volatile, ontologies are fluid and changing
Instance Dynamics	Read-only, resource instances are static	Volatile, resource instances change continuously

Application Characteristics

Application centric perspectives are concerned with how applications use and manipulate ontologies.

Perspective	*One Extreme*	*Other Extreme*
Control/Degree of Manageability	Externally focused, public (little or no control)	Internally focused, private (full control)
Application Changeability	Static (with periodic updates)	Dynamic
Coupling	Loosely-coupled	Tightly-coupled
Integration Focus	Information integration	Application integration
Lifecycle Usage	Design Time	Run Time