MDA & Semantic Web Services
Integrating SWSF & OWL with ODM

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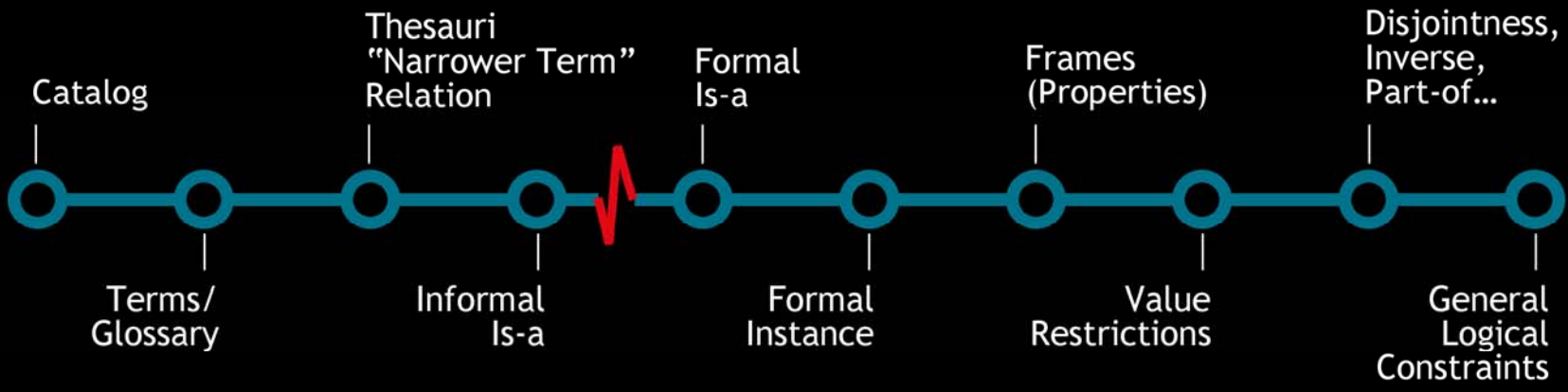
Level Setting

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*

MDA & Knowledge Representation

- 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

MOF and KR Together

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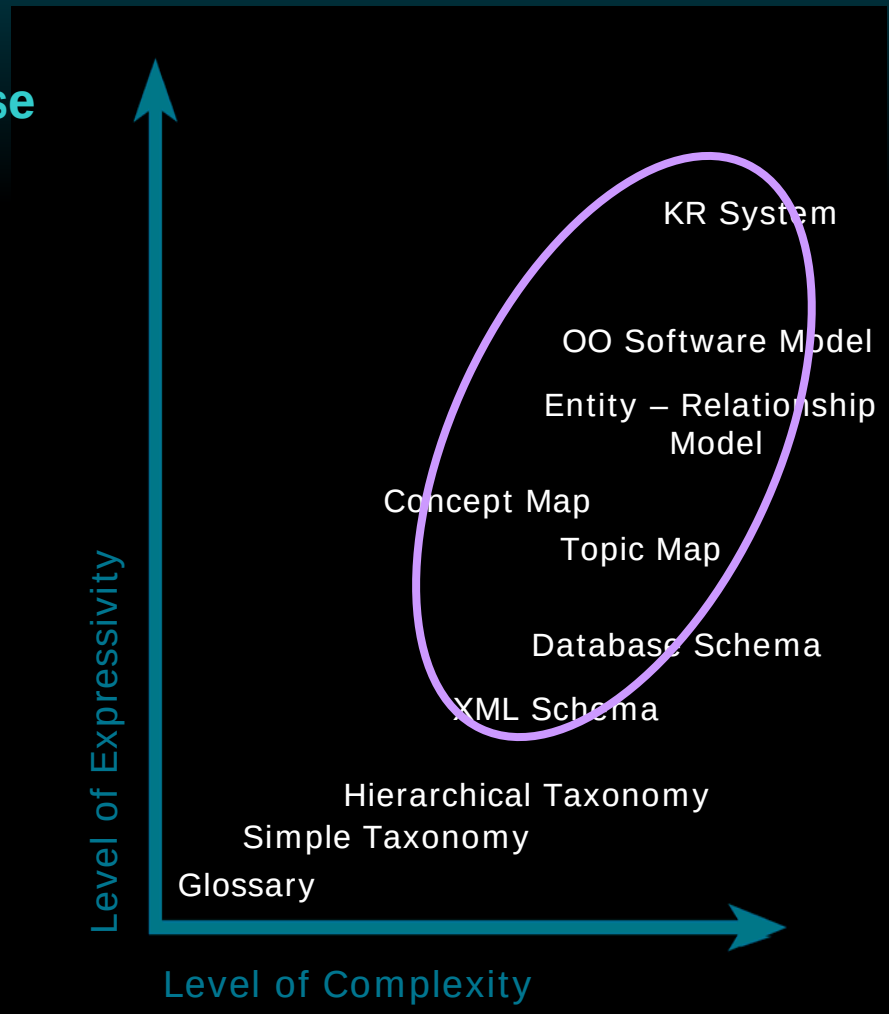
Coverage Goals

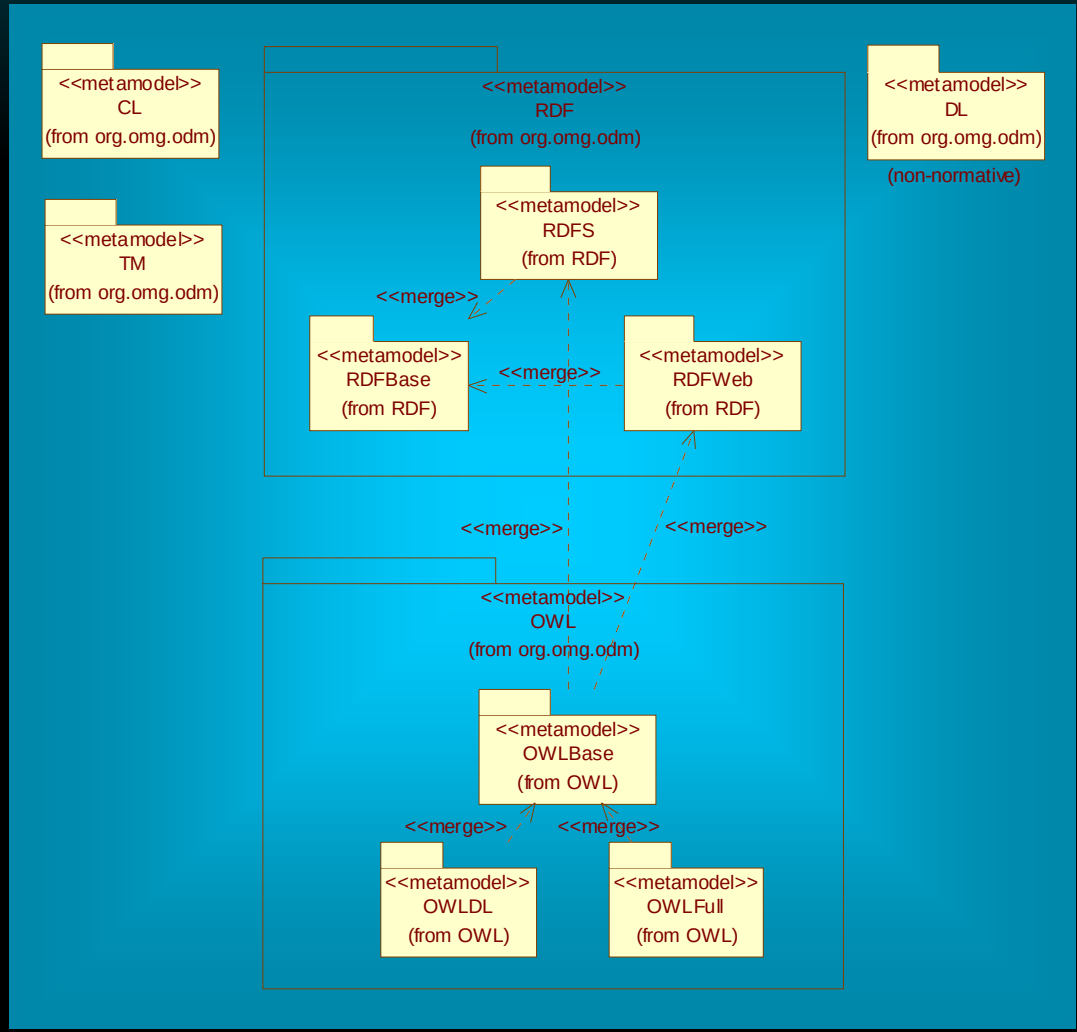
Classification techniques are as diverse as conceptual models; and generally include understanding

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



Ontology Definition Metamodel

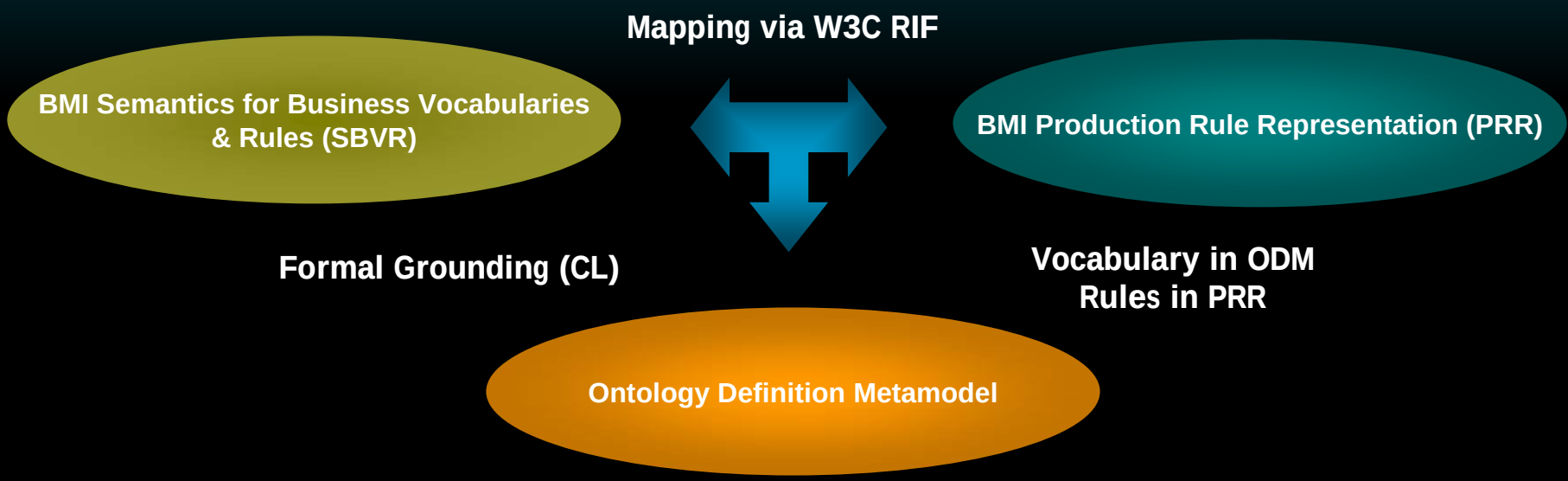
- Five EMOF platform independent metamodels (PIMs), four normative
- Mappings (MOF QVT)
- UML2 Profiles
  - RDFS & OWL
  - TM
- Collateral
  - XMI
  - Java APIs
  - Proof-of-concepts
- Conformance
  - RDFS & OWL
  - Multiple Options
  - TM, CL Optional
  - Informative Mappings



ODM Status

- Several revision cycles on the specification
- Informative discussions of Usage Scenarios, differences between UML & OWL
- Platform Independent (Normative) Metamodels (PIMs) include
  - RDF & OWL – abstract syntax, constraints for OWL DL & OWL Full, several compliance options
  - ISO Common Logic (CL)
  - ISO Topic Maps (TM)
- Informative Models
  - DL Core – high-level, relatively unconstrained Description Logics based metamodel (non-normative, informational)
  - Identifier (keys) model extension to UML for ER
- Latest revised submission will be posted 4/3 to the OMG web site *(http://www.omg.org/docs/ad/06-01-01.pdf)*
- Update includes minor metamodel changes, new QVT mappings, revised RDF & OWL profile for St. Louis OMG Meeting (4/23/06)

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)
- Mappings for Emerging OMG Information Management Metamodel (CWM2)
- New requirements from SOA ABSIG anticipated

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 (IMM) to develop a metamodel for ISO Express will include mappings to ODM

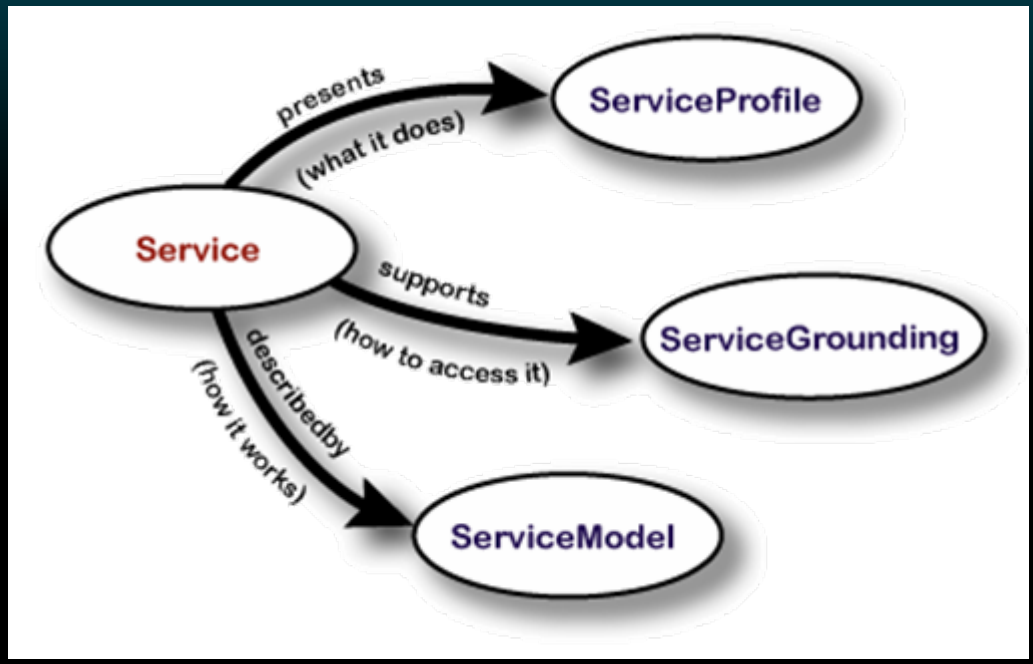
Why Semantics for Web Services

- Ontologies provide a common vocabulary and definition of rules for use by independently developed services
- Companies and organizations sharing common services can declaratively specify the *behaviors*, *policies* and *agreements* relevant to their usage
- Automation of service use by software agents
  - Goal/vision: dynamic discovery & use of new services, previously unknown, to complete task
  - Reasoning about services: support on-the-fly composition
  - Integrated use with other information resources: ultimate, fully-automated customized, user experience
- Composition, mapping and vocabulary brokering for independently developed resources and services – enables information sharing & process enactment consistently, accurately, and dynamically
- OWL-S complements WSDL by providing an abstract or application level description lacking in WSDL

OWL-S: Enabling Infrastructure for Web Services

- Based on research from the DARPA/DAML program in DAML-S (2000/2001 – SRI, Stanford, CMU)
- OWL-S – an ontology that sits at the application level, above WSDL, and describes *what* is being exchanged and *why*, not just the *how*
- OWL-S enables
  - *discovery* – of services that meet particular requirements and adhere to specified constraints
  - *invocation* – and execution by agents or other services
  - *interoperation* – through specification of the appropriate vocabularies (semantics) and message parameter translation as required based on service specifications
  - *composition* – automated service composition and interoperation to provide new services
  - *verification* – of service properties
  - *execution monitoring* – tracking of execution of complex services and transactions

Top-Level of the Service Ontology

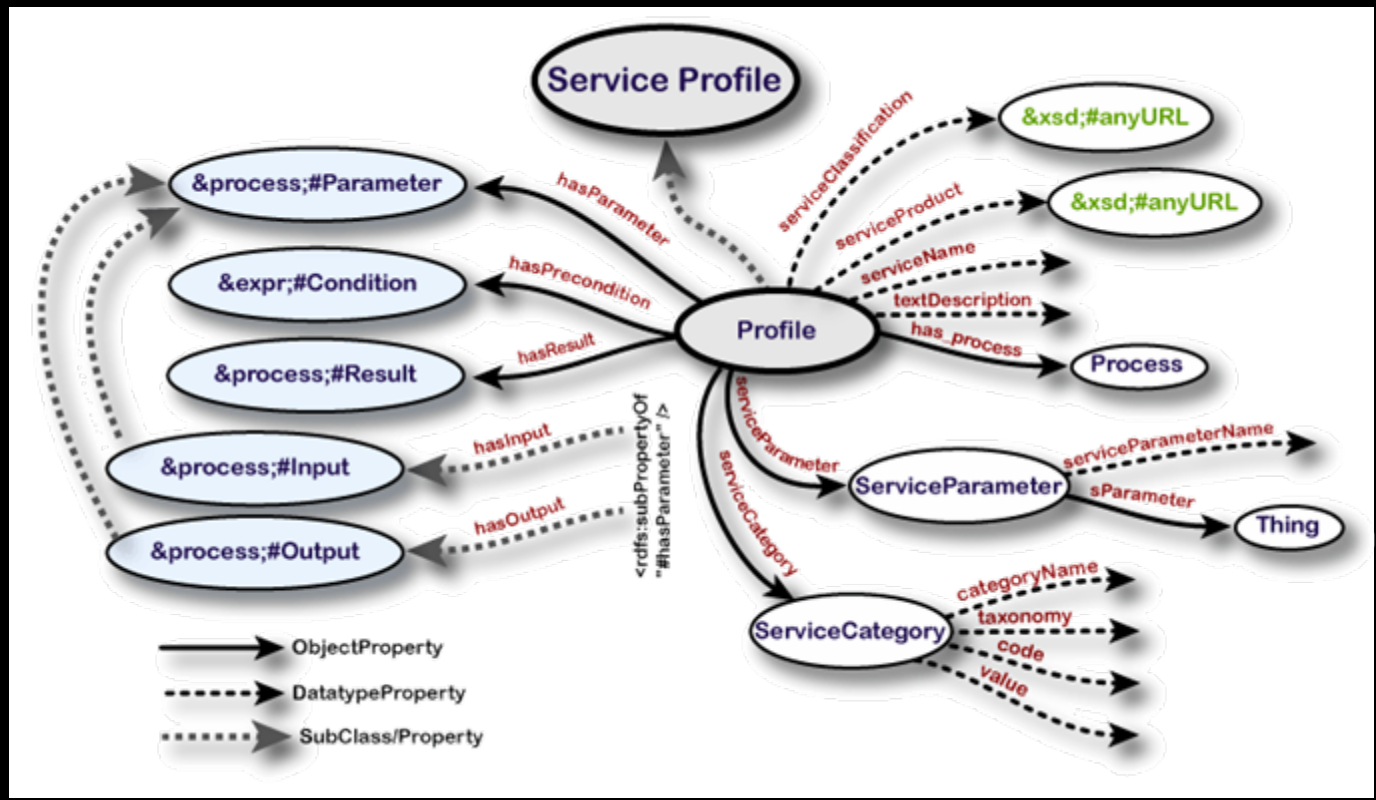


Three essential types of knowledge about services

- **The *what*, its capabilities and parameters, through a *ServiceProfile*, which can answer questions such as what does the service require of agents and provide for them**
- **The *how*, through a *ServiceModel* that describes the workflow and possible execution paths**
- **Accessibility and usage through a *ServiceGrounding***

OWL-S Structure

- Service profiles are used to request or advertise services with discovery services and capabilities registries, including
  - Descriptions of services and providers
  - Functional behavior & attributes



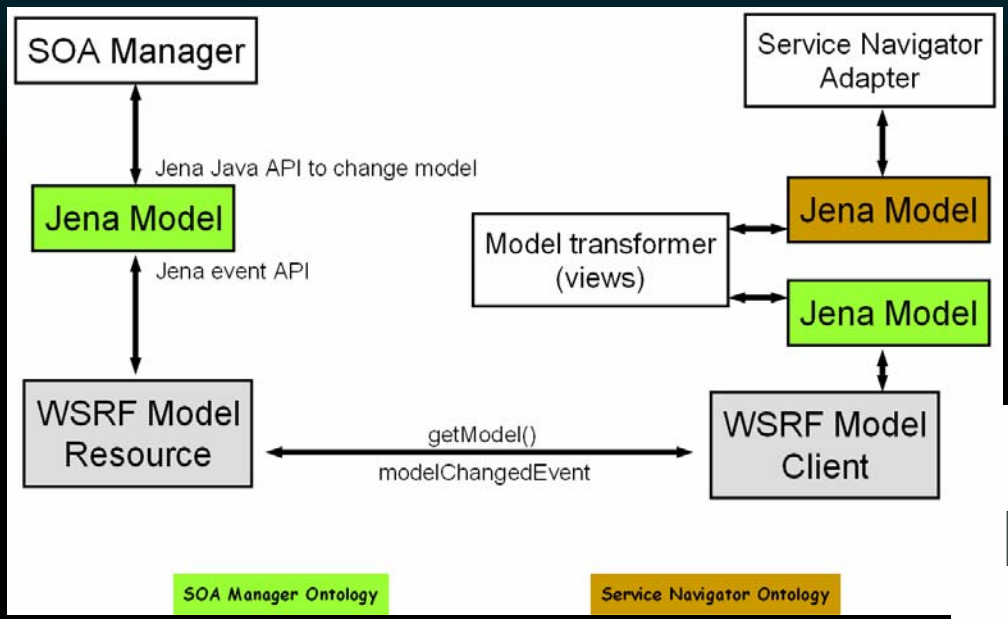
Semantic Web Services Framework (SWSF)

- Emerged from work in services composition
  - May require more expressivity than is available in OWL
  - Based on logic programming, first-order logic, policy research
- Considered smorgasbord of standards
  - Web Services Description Language (WSDL) – for input & output messaging, invocation (W3C)
  - Business Process Execution Language for Web Services (BPEL4WS) – workflows of basic services (OASIS)
  - Choreography Description Language (WS-Choreography) – more global view of information exchange from a transaction perspective (W3C)
  - UDDI – standard approach for service registration, discovery, & advertising
- Builds on DAML-S, OWL-S, WSMO
- Provides rich semantics for greater automation of discovery, selection & invocation, content transformation, composition, monitoring & recovery, verification

Semantic Web Services Framework
SWSL & SWSO

- Semantic Web Services Language (SWSL)
  - SWSL-FOL – first order language for ontology representation, builds on CL
  - SWSL-Rules – logic programming to enable ontology use in reasoning and execution environments
- Semantic Web Services Ontology (SWSO)
  - Conceptual model, complete axiomatization expressed in SWSL-FOL
  - Called FLOWS – First-Order Logic Ontology for Web Services
  - Includes model theoretic semantics
  - Ontology translated to SWSL-Rules is slightly more constrained,
  - Called ROWS – Rules Ontology for Web Services
- W3C Note & member submission
  - http://www.w3.org/Submission/SWSF/

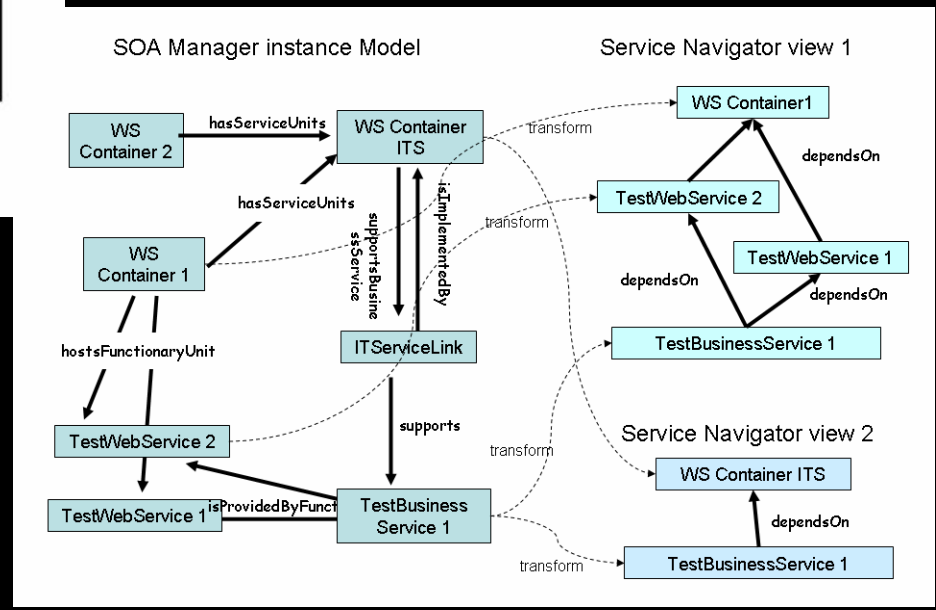
Management Application Integration (MAI)



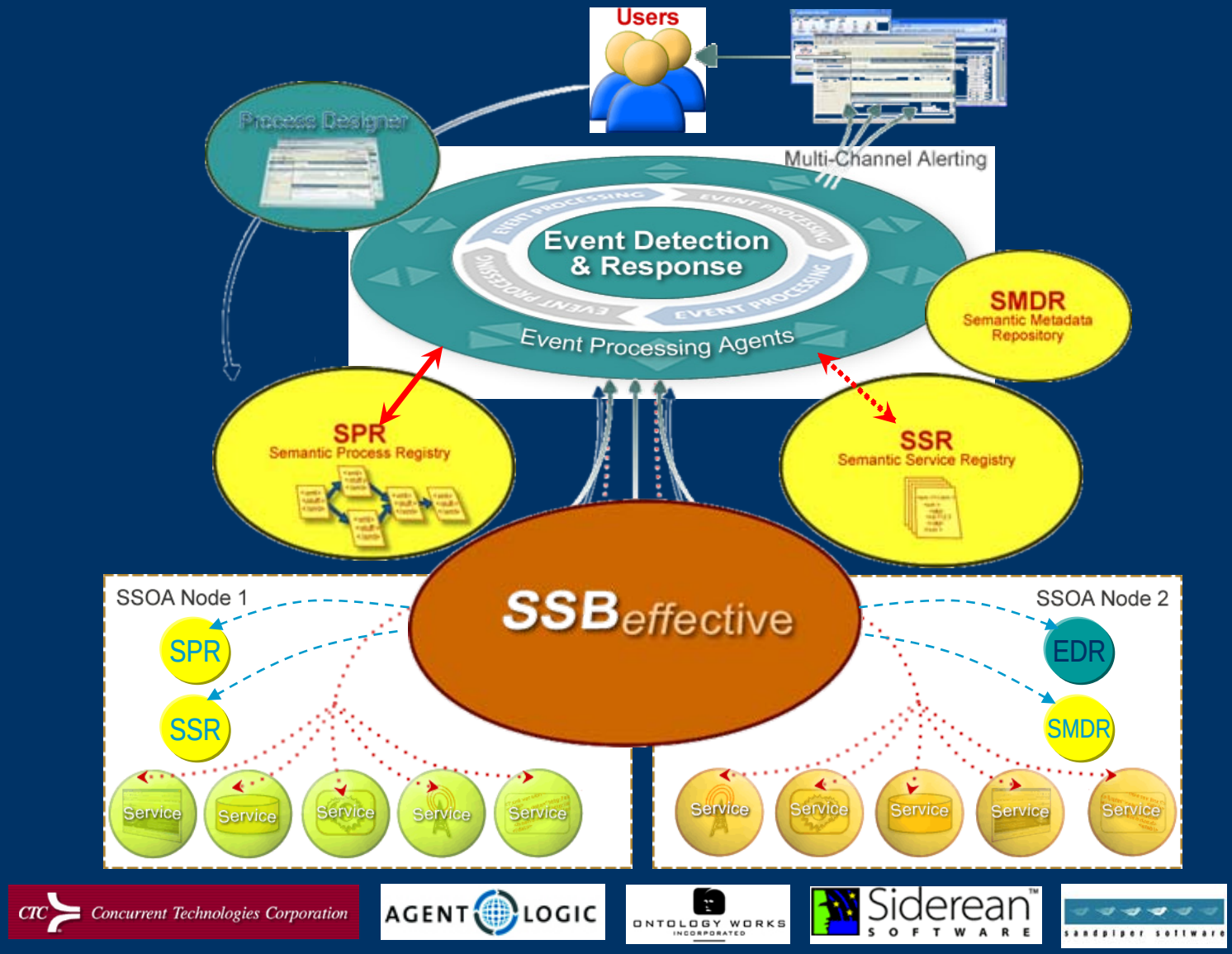
Synchronization of model repositories using RDF/S & OWL based representation & transformations provides new integration capabilities for HP OpenView

Ontology was developed using an ODM-based development environment;

Jena Rules support model transformations



SSOA System View



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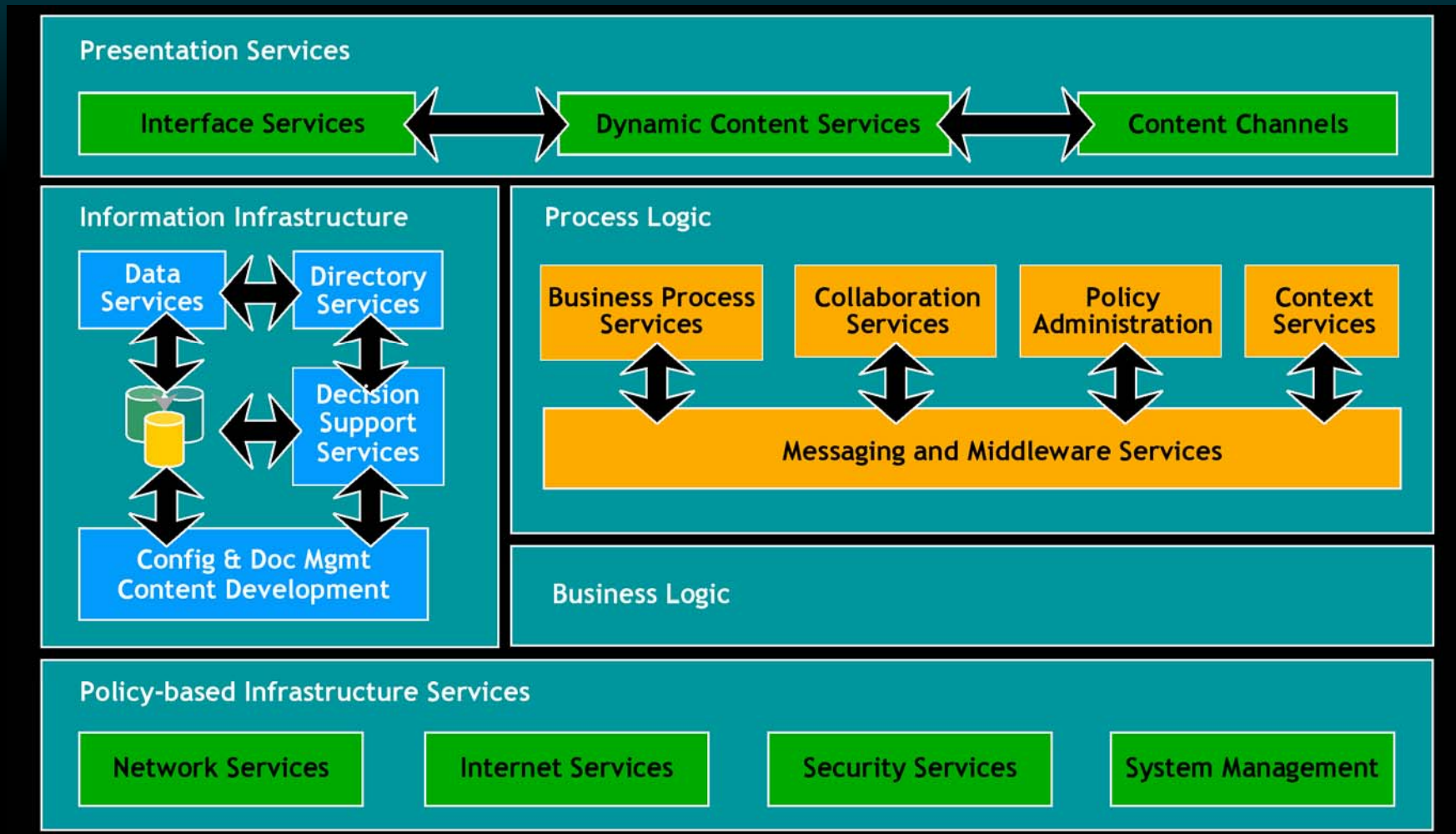
Policy Based Architecture



Current Status

- Several candidate standards recently submitted to W3C (OWL-S, SWSF, WSMO, WSDL-S)
- Workshop on creating a Semantic Web Services working group held Spring 2005
- Draft charter for working group currently under development
- Process is likely to move forward in early 2006, 2 year preliminary timeline to complete standards work

Summary

- Semantic Web Services standards are converging
- OMG RFP forthcoming for extensions to ODM to support W3C Semantic Web Services, ISO EXPRESS, eventually W3C RIF
  - OWL-S, building on the RDF & OWL metamodels
  - SWSF, building on the CL metamodel, with mappings to OWL-S
  - Mappings to standardize bindings to WSDL, SOAP
- 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
- Planned mappings to structured, semi-structured resources via IMM
- Leverage mapping from UML for BPEL to ODM extensions (*e.g.*, to the PSL component of SWSF)