Semantics for Service Oriented Architectures

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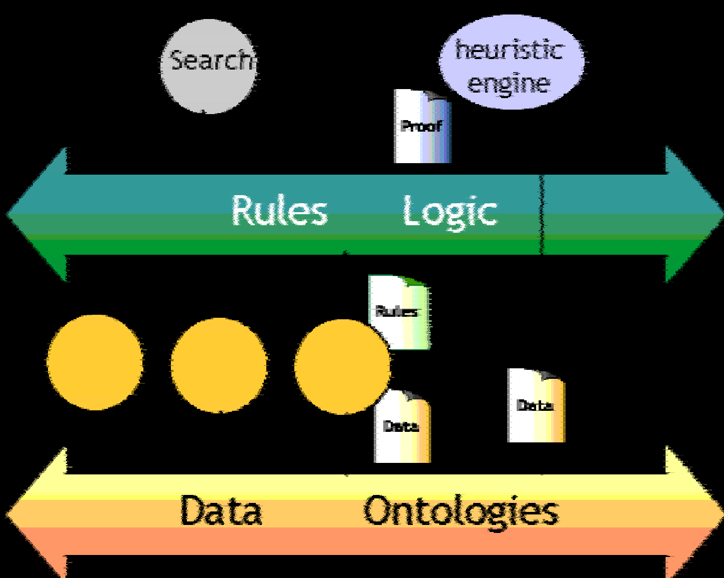
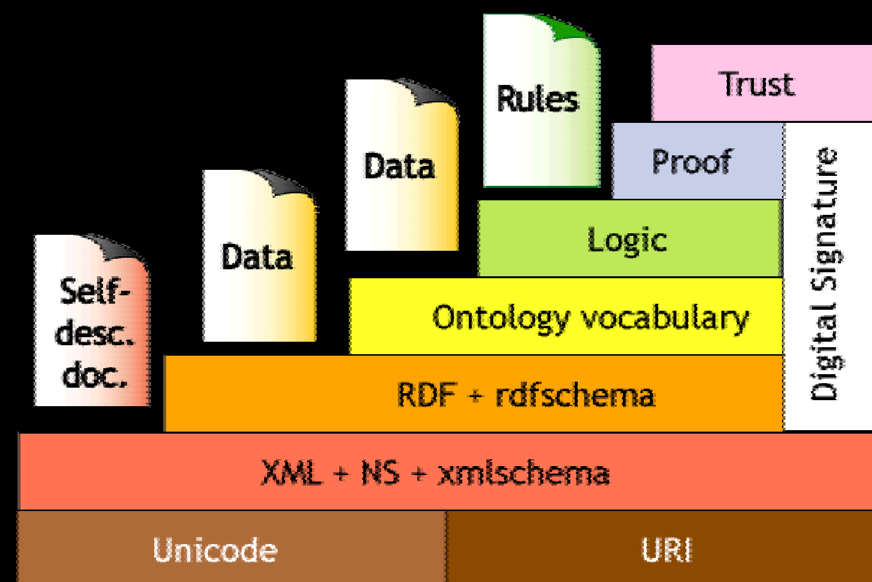
The Semantic Web

"The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation."

-- Tim Berners-Lee



"the bus"



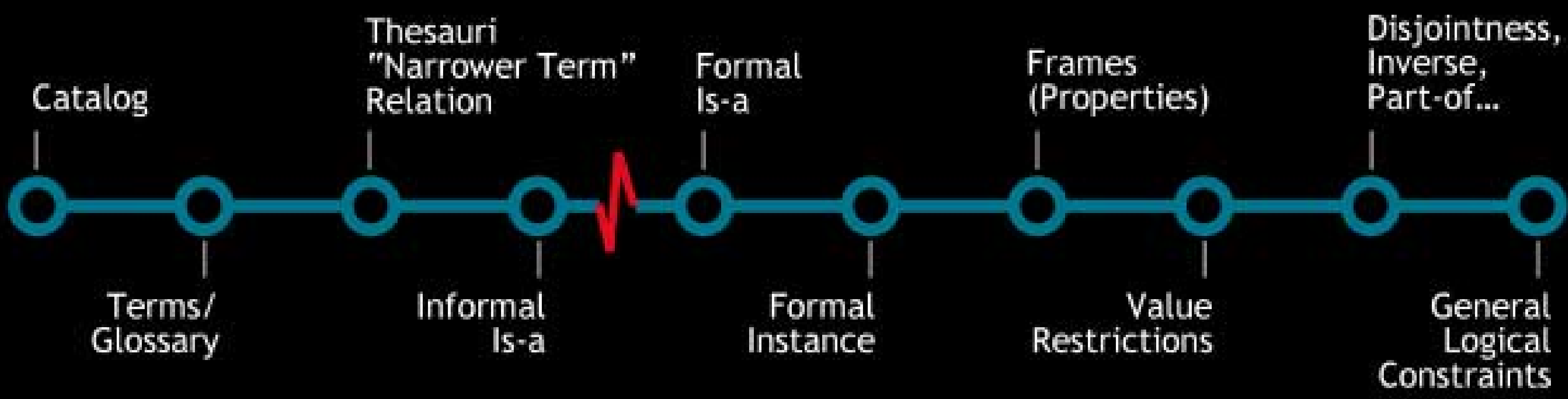
"the wedding cake"

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 sandpiper software

MDA from the KR Perspective

- EII/ESB 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

Ontologies 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
- Through ontology composition, mapping and vocabulary brokering for participating resources and services, independently developed services can share information and processes consistently, accurately, and completely

OWL-S: Enabling Infrastructure for Web Services

- Emerging work 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

OWL-S Structure

- Two 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
- Service profiles are used to request or advertise services with discovery services and capabilities registries, including
  - Descriptions of services and providers
  - Functional behavior
  - Functional attributes
- Service models describe the operation of a web service through a process model of the control and data flow structure of the service
- OWL-S complements WSDL by providing an abstract or application level description lacking in WSDL
- Current specifications available at http://www.daml.org/services/

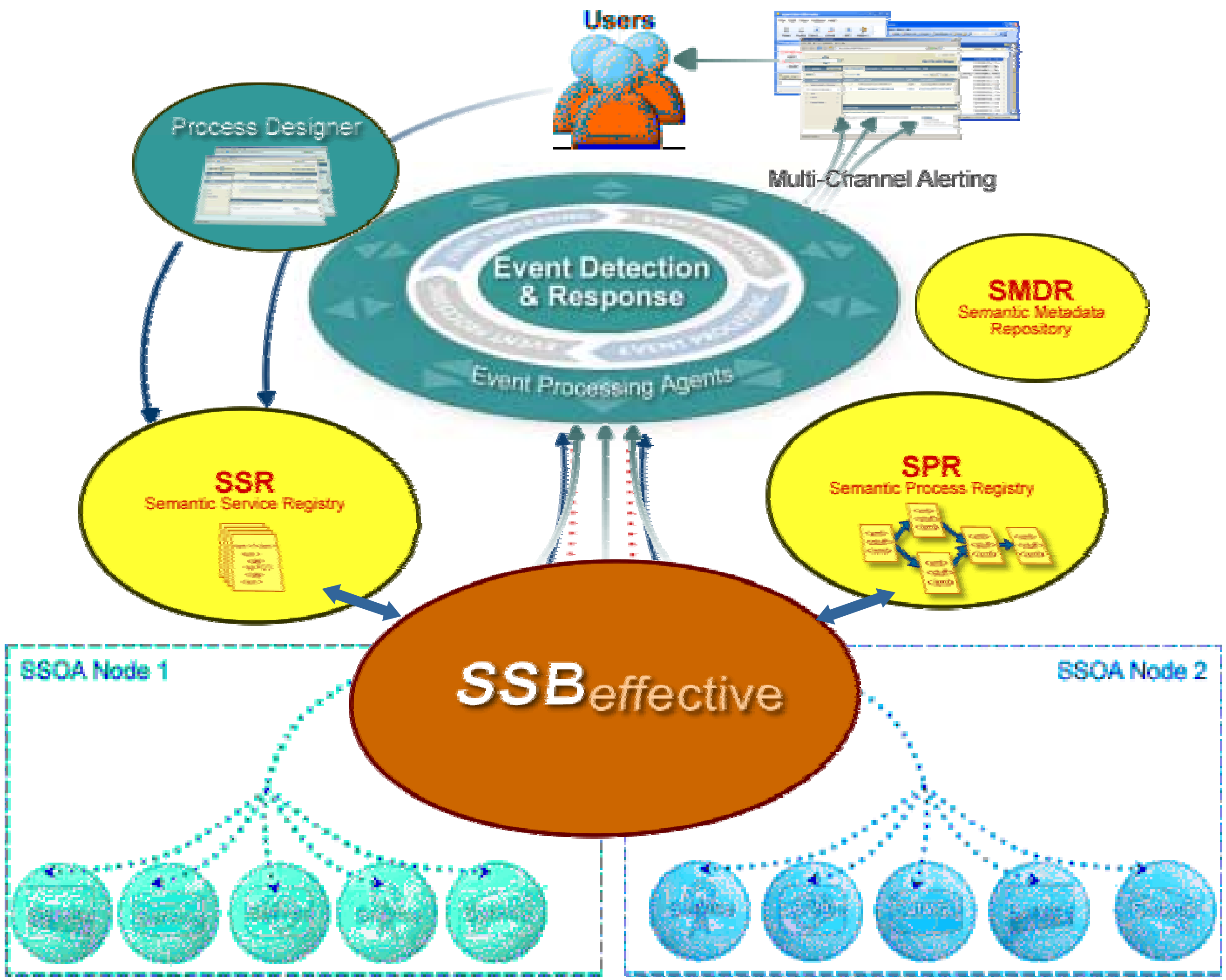
Semantic Web Services Framework

- Emerged from work in services composition
  - Requiring more expressivity than was available in OWL
  - First order logic approach
  - Based on significant work in logic programming, government funded policy work
- Considered the smorgasbord of relevant standards
  - Web Services Description Language (WSDL) - for specifying input & output message, invocation (W3C)
  - Business Process Execution Language for Web Services (BPEL4WS) - addresses specification of workflows of basic services (OASIS)
  - Choreography Description Language (WS-Choreography) - supports a more global view information exchange from a transaction perspective (W3C)
  - UDDI provides a standard approach for service registration, discovery, and advertizing
- Integrates notions from prior initiatives, builds on DAML-S, OWL-S, WSMO
- Provides rich semantics for greater automation of service discovery, selection and 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 (proposal for recommendation made recently), additional references available at
  - http://www.w3.org/Submission/SWSF/

Example Enterprise Framework (DoD)



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

Opportunity for OMG

- Potential for extensions to ODM to support
  - 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