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Beginning Semantic Solutions

TECHNOLOGY FOR THE ENTERPRISE

Lockheed Martin ITTC 2006
February 2006

CEREBRA, INC.
A CEREBRA UNIVERSITY WORKSHOP PRESENTATION

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This presentation is a slim version of the one-day Cerebra University course CU-001, "Beginning Semantic Solutions." Intended to provide a gentle introduction to Semantic Technology, W3C Semantic Web Standards, and the benefits of using Ontology and Reasoning as part of the Enterprise Software solution stack. The special emphasis for this presentation will be on enterprise use of the technology, and assumes some familiarity with concepts such as: Data Warehousing, Service-Oriented Architecture, Application Integration, Java, and .NET technology.

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Speaker Profile

- Jeff Pollock
  - Architect: VP Technology, Cerebra
  - Author: "Adaptive Information"
    - John Wiley and Sons: Business and Systems Management Series. Wiley Interscience
  - Consultant: Fortune 500 Clients & Government Agencies
    - Enterprise Middleware and Architecture
    - Banking and Finance Applications
    - E-Commerce and ERP Applications
    - Software Engineering Process & Methodology
    - Information Intelligence and Security
  - Software Engineering:
    - CTO, Modulant. Principal Engineer, Modem Media. Senior Consultant, Ernst & Young CTE, Software Engineer, Amgen
    - Engineering Instructor for UC Berkeley Extension

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Prelude

- **Presentation Goals**
  - Straight Talk; No Hype!
  - Education – what, why, how…
  - Explain Value-drivers & ROI
- **Presentation Takeaways**
  - Information outlives software.
  - You CAN unlock data from code.
  - Standards, and technology, are mature (enough).
  - Semantic technologies are different than _____.
  - Performance/scale is sufficient.
  - There are no silver bullets.

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The key takeaway from this presentation is that this technology base is
(a) here today,
(b) standards-based, and
(c) a powerful new way of getting control over large quantities of enterprise information.

Take the time to learn how these technologies can improve your job.

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Agenda

	*audience
Semantic Backgrounder	beginner
Enterprise Semantic Web	beginner
Cerebra 360° Product Suite	beginner
Business Use Cases	intermediate
Capability (Use) Cases	intermediate
Grid Service Utilities	intermediate
Semantic Engine Patterns	advanced
Logical Architecture	advanced
Performance and Scalability	advanced
Getting Started	beginner
Conclusions	beginner

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Semantics Backgrounder

Data is the Network

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The first section addresses several background questions about what semantics are, how inferencing operates, and why these technologies are different. We will use this section to define key words such as: ontology, semantics, inference, taxonomy, and schema.

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Core Tenets of Change

- Information is power
  - As always, for nations and businesses
- A change is required
  - Collection rate outstrips understanding
- The change must be fundamental
  - OO, Java, RDB, XML, EAI (etc) aren't enough
- Business own information, not vendors
  - Implement a strategy that keeps it that way (not vendor or SI ownership)

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There are big things going on here. Historically, information has always been power – both for nation-states and commercial businesses. But our ways of managing information are stone-age in comparison to the rate at which we acquire new data. Something significant and fundamental must change. XML and Java based systems are not the end-state of technology. While W3C standards are not perfect, they offer the most viable path toward a fundamentally better way of managing information.

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Graphs and Ontology

Q: How can the Semantic Web help?

- "Small Pieces Loosely Joined"
  - Small Pieces: RDF Triples – data graphs
  - Loosely Joined: OWL Models – concept collections **defined with precision**
- Fundamentally Different Than…
  - XML – taxonomic tree structures
  - Java – object structures (frames)
  - RDB – two-dimensional/tabular structures
- From "Trees to Piles of Leafs"
  - RDF Triples, collections of atomic data
  - Ontologies are "views" into the whole
  - "Strict" trees (XML) are not required
    - Ontologies are multi-dimensional, with formal, logically-sound, data semantics

Some Definitions

Semantics
Taxonomy
Schema
Ontology
Inference

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So what's different about semantic approaches? The W3C standards RDF and OWL have two foundational characteristics that differentiate themselves from other technical approaches: (1) they are based on graph data systems and (2) they can leverage "true" ontology formats with formal, logically sound, semantics. Taken together, these languages fundamentally improve the way meta/data relate to and evolve with IT systems.

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A Little Ironic…

Q: What are semantics?

BACK



"I don't know what you mean by 'glory,'" Alice said.

Humpty Dumpty smiled contemptuously. "Of course you don't—till I tell you. I meant 'there's a nice knock-down argument for you!'"

"But 'glory' doesn't mean 'a nice knock-down argument,'" objected Alice.

"When I use a word," Humpty Dumpty said, in a rather scornful tone, "**it means just what I chose it to mean—neither more nor less.**"

Lewis Carroll, Through The Looking-Glass

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In an industry obsessed with meaning, there is some small irony in the multi-faceted ways that people use the term "semantics." At this conference alone, you will probably hear dozens of definitions.

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BACK

Semantics? (OWL Formal)

Constructor	DL Syntax	Example
intersectionOf	$C_1 \sqcap \ldots \sqcap C_n$	Human ⊓ Male
unionOf	$C_1 \sqcup \ldots \sqcup C_n$	Doctor ⊔ Lawyer
complementOf	$\neg C$	¬Male
oneOf	$\{x_1 \ldots x_n\}$	{john, mary}
allValuesFrom	$\forall P.C$	∀hasChild.Doctor
someValuesFro		
maxCardinality		
minCardinality		

CLASS CONSTRUCTORS

AXIOMS

Axiom	DL Syntax	Example
subClassOf	$C_1 \sqsubseteq C_2$	Human ⊑ Animal ⊓ Biped
equivalentClass	$C_1 \equiv C_2$	Man ≡ Human ⊓ Male
disjointWith	$C_1 \sqsubseteq \neg C_2$	Male ⊑ ¬Female
sameIndividualAs	$\{x_1\} \equiv \{x_2\}$	{President_Bush} ≡ {G_W_Bush}
differentFrom	$\{x_1\} \sqsubseteq \neg\{x_2\}$	{john} ⊑ ¬{peter}
subPropertyOf	$P_1 \sqsubseteq P_2$	hasDaughter ⊑ hasChild
equivalentProperty	$P_1 \equiv P_2$	cost ≡ price
inverseOf	$P_1 \equiv P_2^-$	hasChild ≡ hasParent$^-$
transitiveProperty	$P^+ \sqsubseteq P$	ancestor$^+$ ⊑ ancestor
functionalProperty	$\top \sqsubseteq \leqslant 1P$	$\top \sqsubseteq \leqslant 1$hasMother
inverseFunctionalProperty	$\top \sqsubseteq \leqslant 1P^-$	$\top \sqsubseteq \leqslant 1$hasSSN$^-$

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In the context of OWL, the term “semantics” actually has a formal meaning – semantics are the allowable, and formal, relationships you can build between concepts, data, and relationships. This chart shows the foundational class constructors and axioms that comprise OWL semantics.

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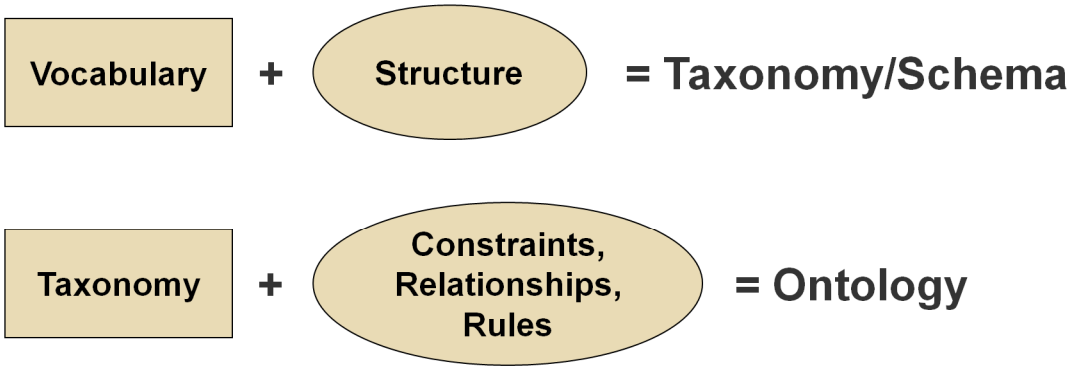
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Ontology?

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- Many definitions:
  - Vague – "a specification of a conceptualization"
  - Narrow – "the explicit meaning of terms in a vocabulary and relations between those terms"



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Ontology – in the context of this presentation – is just data structure plus constraints, relationships, and rules.

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Inference?
Logic With Less Code

BACK

Deduce **implicit facts** on explicit data at runtime. Get more application knowledge with **less coding.** Keep your business knowledge in **models, not algorithms.** Maybe learn a few new things too…

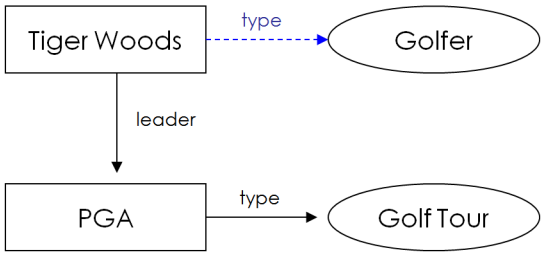
```
<owl:Property rdf:ID="leader">
  <rdfs:subPropertyOf
        rdf:resource="member" />
</owl:Property>

<owl:Class rdf:ID="Golfer">
 <owl:equivalentClass>
   <owl:Restriction>
     <owl:onProperty
           rdf:resource="member" />
     <owl:someValuesFrom
           rdf:resource="Golf Tour" />
   </owl:Restriction>
  </owl:equivalentClass>
</owl:Class>
```

The **leader** of a **tour** is also a **member** of it

A **member** of a **golf tour** is a **golfer**

Therefore, the **leader** of a **golf tour** is a **golfer**



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Inference can be used to mean many things in software, for this presentation we are discussing a particular kind of inference that focuses on drawing conclusions and implications based on stated data model relationships.

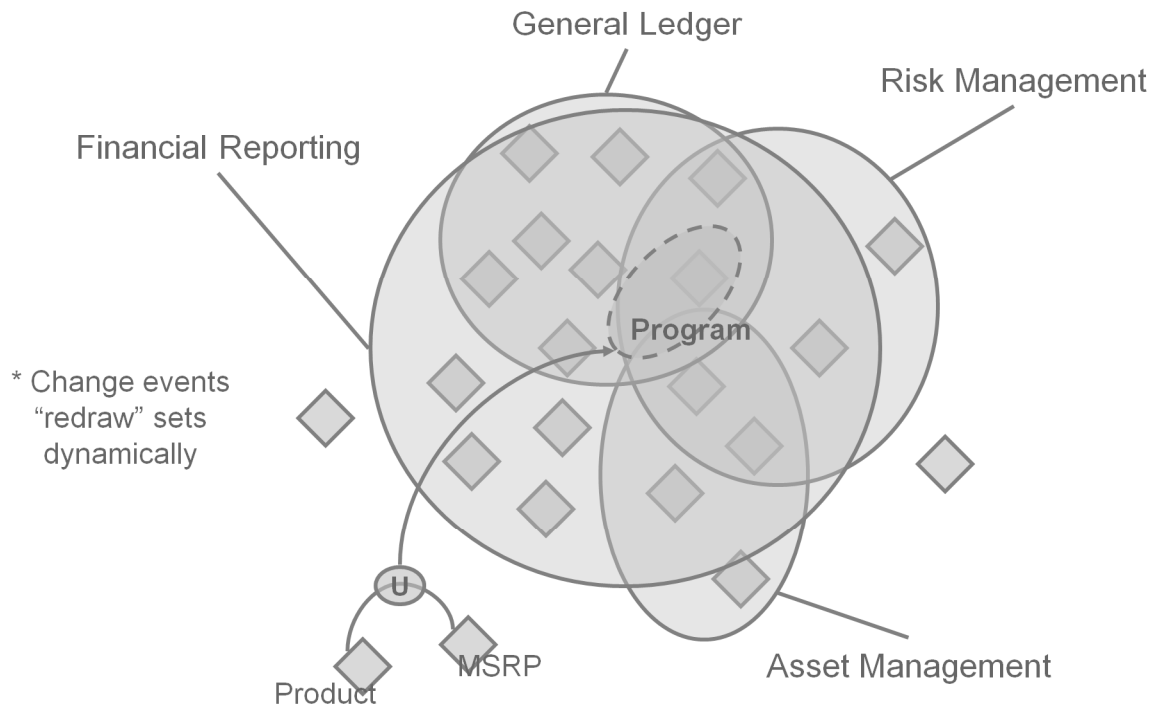
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Inference (2)

BACK



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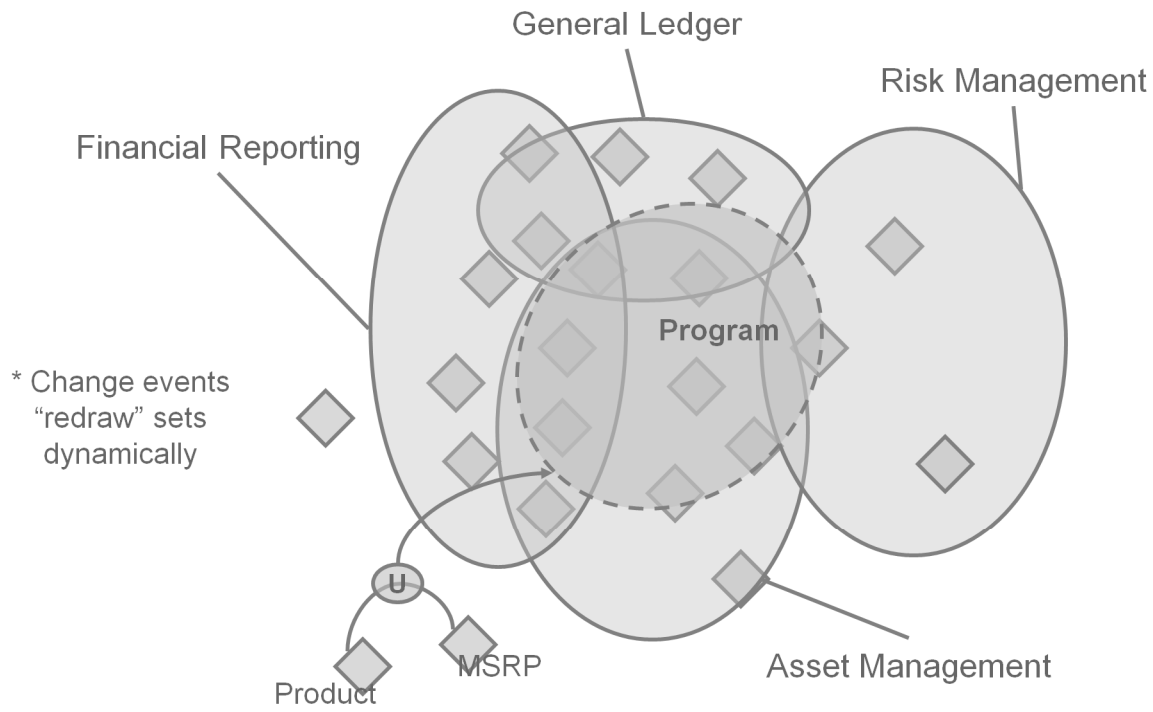
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Inference (3)

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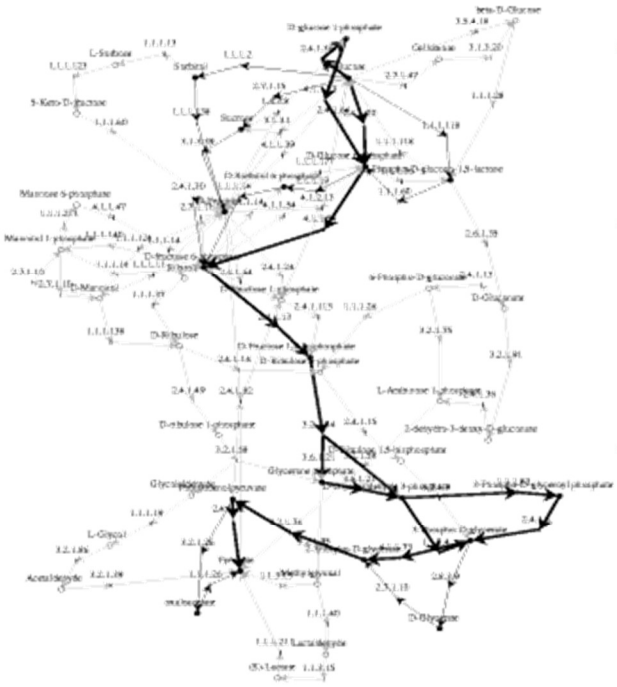
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"Web-Effect" + Standards

Q: Isn't "Semantic Web" just AI all over again?



- Ssshhhhhh!
  - OWL/RDF are a type of AI "Knowledge Representation"
- Traditional AI
  - "Silos" of knowledge
  - Incompatible algorithms
  - Inconsistent "expertise"
- What's Different?
  - Everything has a URI
    - Models, classes, data
  - Predictable semantics
    - Std. Triples & Axioms

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So, isn't all this just artificial intelligence with a new face? Not really. Two significant changes make these technologies truly disruptive. First, the introduction of the URI as the primary linking mechanism for the model, classes, relationships, and instances creates a "web effect" among your information – which is dramatically unlike any previous AI technology. Second, the standardization of formal semantics (the allowable relationships among data) means that common baseline can be put in place.

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Enterprise Semantic Web

Deployable Solutions Now

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Unified Information Access

Linking Diverse IT Assets into a Common, Managed, Searchable Framework

Fuse | Interpret | Automate

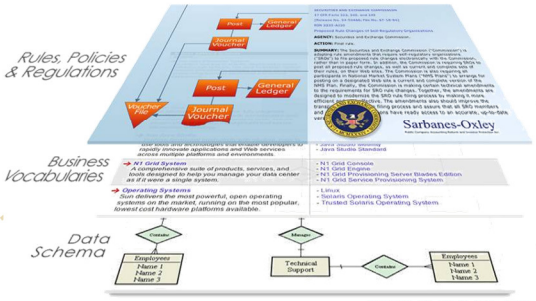
- Fuse information assets [data, metadata, rules, services and documents]
- Interpret the meaning of assets in the right context, securely, and within policy
- Automate business action based on explicit *and implicit* information assets

RDBMS/Marts/EII

B	A	-
X	C	Z
Y	-	-
-	-	-

Clear Text/Email/Documents

```
The X product was unveiled
today at the mega-conference
with a list price of C;
further extending Y with new
features that will drive
market forecasts for Z.
```



Java/.NET/MDA/Domain

```
Class myClassX {
  public String Z = 'NULL';
  public int A = 0;
  ... }
```

OWL/Master Data

This is the only technology that can tie together diverse corporate information assets into a logically coherent whole.

```
if{
  product=X
  or product=Y
  and type=W
} then {
  market=Z
}
```

XML/SOA/Grid/Services

```
<process>Billing</process>
<invoice><item id=123456>
<product name='A'>C</product>
<product name='B'>X</product>
</item><invoice>
```


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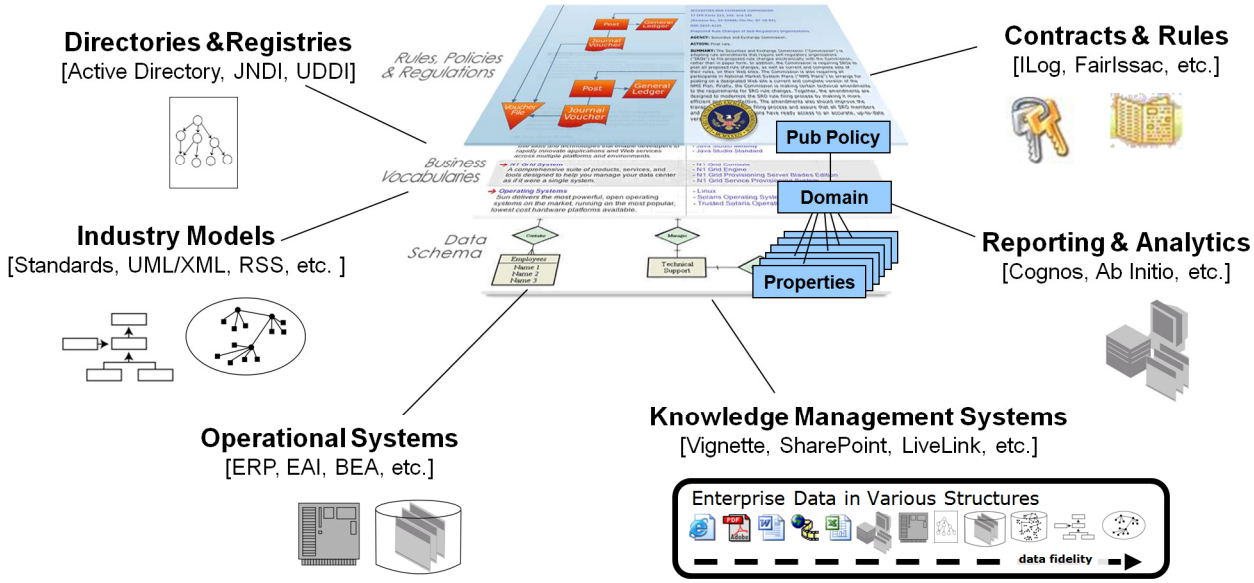
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Integration Points

Big Picture Goal: **Use metadata as the "logical glue" for cross-system assets**

- **Use a common, ontological model to unify data assets, reduce manpower needs, increase agility, apply policy and mitigate risks**



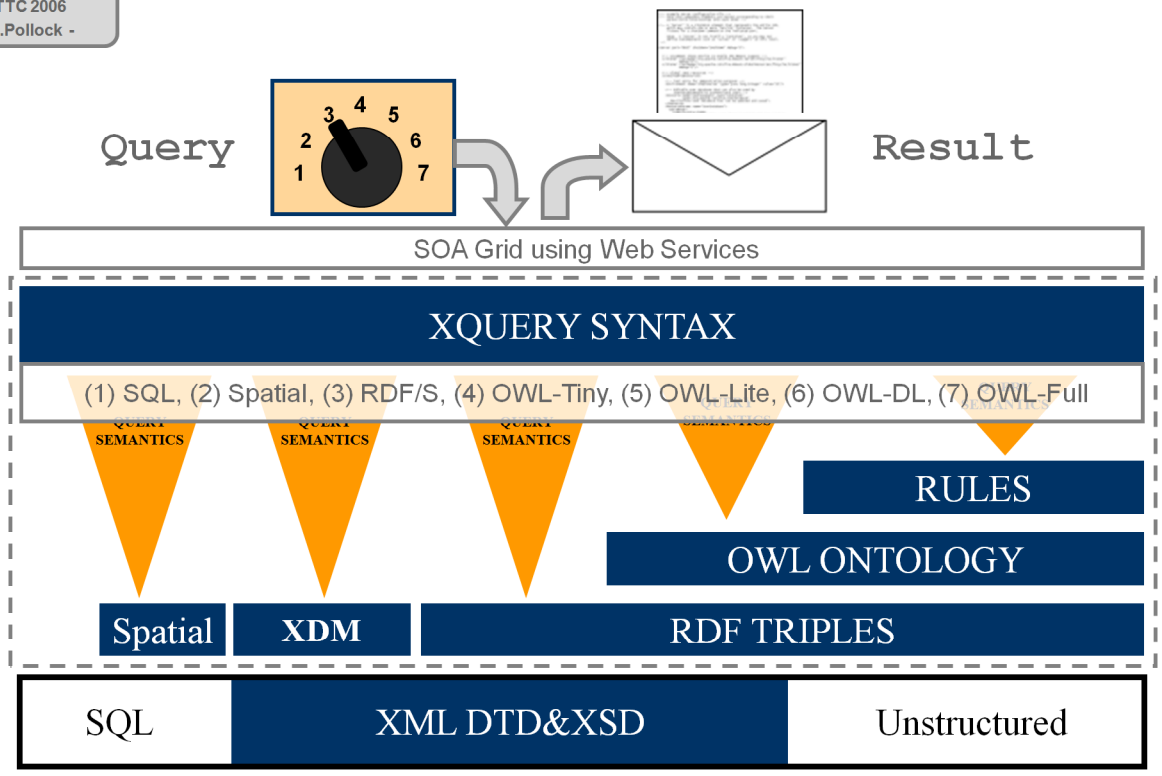
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Adjustable Search Clarity



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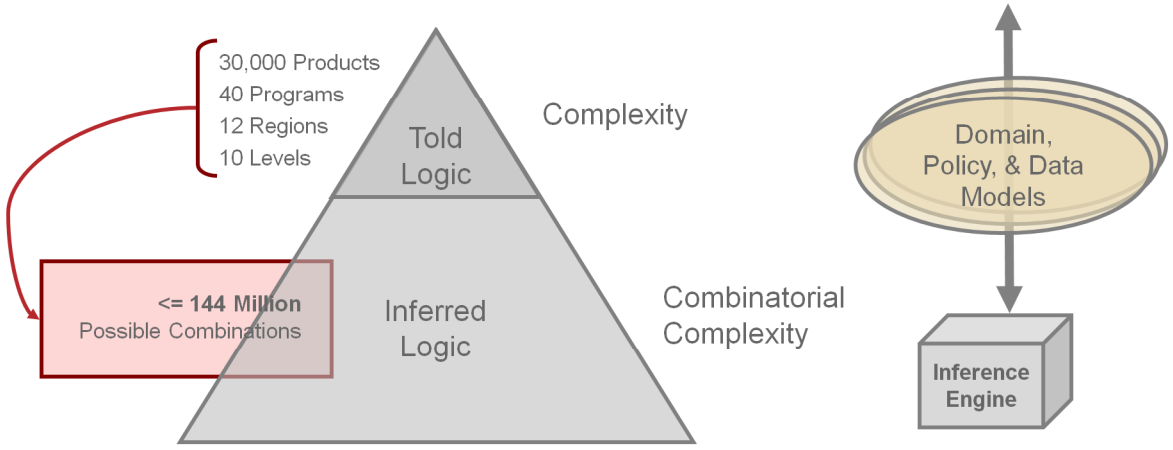
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Complexity Management

- Logical Inference
  - Infer the correct classification of data from models, rather than encode it in brittle algorithms



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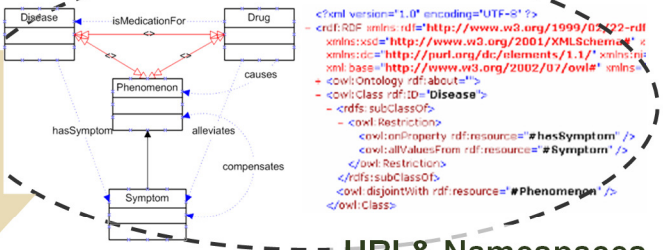
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Implement it Your Way

Top-down or Bottom-up



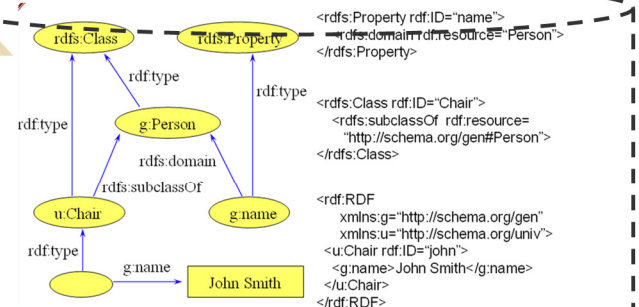
Model Ontologies



URI & Namespaces



Create RDF Triples



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Two general approaches are being taken towards adoption. Some people are starting "top-down" by creating ontologies to be connected to IT systems at a later point. Other people are working hard to convert legacy data of all types to a "triples" format; understanding that this gives them incredible flexibility down the road. It is where the two meet in the middle that 1+1 can = 3. Significant new information capabilities are at hand.

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Some Use Cases

Fortune 100 Electronics Manufacturer
Fortune 100 Software Company
Financial Compliance Services Provider
Clinical Healthcare Services Provider
QinetiQ – UK MoD, Tactical Ground Picture
LMCO – US Customs and Border Protection
BearingPoint – US Dept. Homeland Sec.
SAIC – US Intelligence Community

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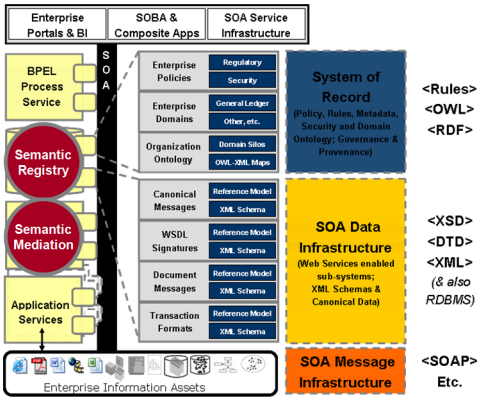
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Sample Use Case:

Dynamic Grid Services



Problem:

- Metadata for SOA is weak / hard to search
  - No concept search for XML / tags
- Registries poor / hard to find services
  - UDDI 3.0 enables minimal discovery
- Point-to-point data coding still required
  - Canonical XML masks the problem
- Securing data from various sources requires complex and multi-level access configurability
- Need native XML solutions

Products Used:

- Cerebra Server & Metadata Repository &
- Oracle Database 10g

Overlays 3rd Party Applications:

- (Any) SOAP client capable software application
  - Machine interfaces
  - Portal and search interfaces
  - Modeling and metadata management

Benefits:

- Easier to locate services and data sources
- Dynamic and automated services
  - Query brokering among services
  - Evolving metadata repository
- Actionable intelligence from live systems
- Better decisions and risk awareness
- Secure multi-level protections on information

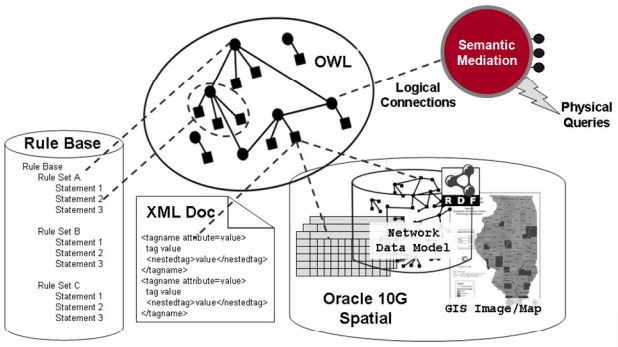
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Sample Use Case:
Geospatial Mediation



Problem:

- Mis-categorization of geo-objects
- Rigid, hard-coded descriptions of data
- Difficult manual process of merging data
- Inefficient sharing of data from different world-views – change responsiveness
- Minimal access to "implied data" from the native geospatial system

Products Used:

- Cerebra Server
- Oracle Spatial 10g

Overlays 3rd Party Applications:

- External Web Services

Benefits:

- Visibility into organizational data or services
- **Unification of various GIS capabilities:**
  - **Land and Property / Theaters**
  - **Utilities / Provisioning**
  - **Government / Intelligence**
  - **Transportation / Logistics**
  - **Wireless and Location-Based Services**

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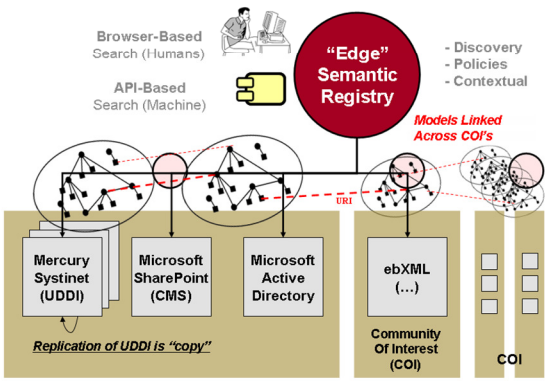
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Sample Use Case:

Unified Directories & Registry



Problem:

- FEDERATION: Top-down replication strategy. There is no concept of a federated inquiry, only data copies. This implies a global service taxonomy or psychic employees – neither of which is practical.
- DISCOVERY: Keyword search only, limited taxonomy category structure
- NAVIGATION: Difficult to view structure, navigate, and correlate data
- STANDARDIZATION: UDDI takes you only so far, proprietary (systinet) extensions fill some gaps, but that means vendor lock-in for the Fed.
- MAINTENANCE: UDDI replication (as copy) will incur massive costs globally

Products Required:

- Cerebra Server
- Cerebra Model Repository
- Relational Database

Overlays 3rd Party Applications (potential):

- Mercury / Systinet UDDI
- Microsoft Active Directory / LDAP
- Sun / ebXML

Benefits:

- FEDERATION: Inherently federated data models (OWL/RDF)
- DISCOVERY: Inference with query, graph + logic based models
- NAVIGATION: Ontology is a more natural way of structuring service categories (as graphs) rather than UDDI (as trees) and UI's may take advantage of simpler discovery and "browse" features.
- STANDARDIZATION: metadata is standard
- MAINTENANCE: easy change propagation

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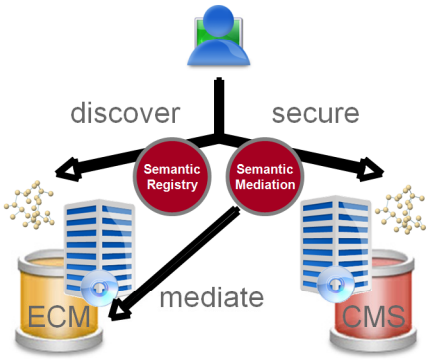
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Sample Use Case:

Interoperable Content



Problem:

- Distributed content repositories
- Need semantic search for precision retrieval based on corporate domain (Keyword & Google yields too many results)
- Need consistent role based security overlay
- Need policy enforcement based on corporate/legal directives (don't destroy, etc)
- Need automated action based on policy/role/semantic combination
- Need to compliment SOA architecture

Products Used:

- Cerebra Server & Metadata Repository &
- Oracle App Server 10g, BPEL Engine, Business Rules Engine, DB 10g

Overlays 3rd Party Applications:

- Sharepoint Services/Portal
- FileNet & EMC/Documentum ECM
- PlumTree/BEA Portal

Benefits:

- Provides extendible SOA framework to eventually overlay 10+ content repositories
- Replaces largely manual task to enforce corporate objectives (costly and error prone)
- Provides central user interaction access across multiple disparate systems, but fuses information in context
- Promise for corporate infrastructure to stretch out to partners with consistent security

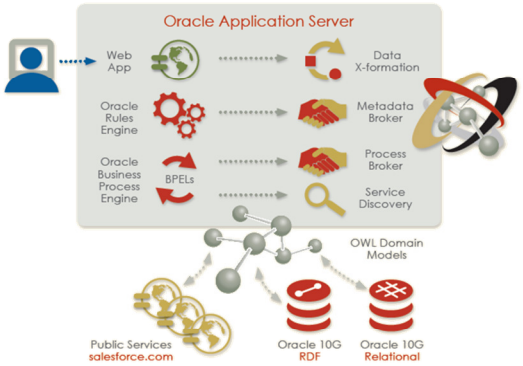
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Sample Use Case:
Horizontal Fusion



Problem:

- Finding the right information or service
- Costly, non-interoperable IT enterprise software applications, ERP, sensors, Web services and other content
- Inaccurate portal views and business reporting on cross-organizational data
- Out of context data for decision support and risk management business processes
- Difficulty interpreting incomplete data
- Compliment a SOA and XML architecture

Products Used:

- Cerebra Server & Metadata Repository &
- Oracle App Server 10g, BPEL Engine, Business Rules Engine, DB 10g

Overlays 3rd Party Applications:

- Machine interfaces – SOAP/Services
  - webMethods, IONA, sensor databases
- PlumTree/BEA Portal
- Systinet UDDI

Benefits:

- Visibility into organizational data or services
  - Common operational picture
  - Knowledge base systems
  - Registry of services and content
- Actionable intelligence from live systems
- Better decisions and risk awareness
- Secure multi-level protections on information

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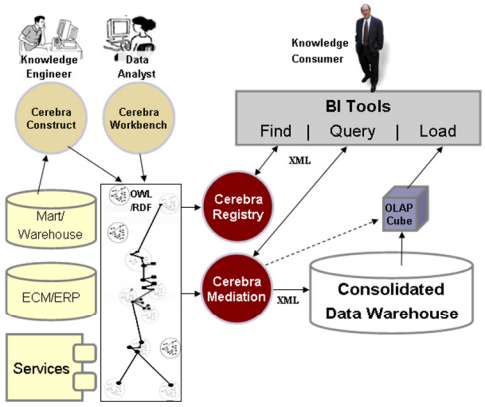
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Sample Use Case:

Business Intelligence Visibility



Problem:

- Can't enable business level users to perform ad-hoc query without technical resources
- Can't adequately explore content and data from federated source systems
- Can't define robust set of rules to pro-actively get information or reclassify existing data
- Can't contextualize information for different users, either during exploration or reporting
- Can't react fast to changing business needs, to monitor, build, and anticipate OLAP data
- Can't easily change the extraction processes from source systems to adjust to changing data

Products Required:

- Cerebra Server
- Cerebra Model Repository
- Relational Database

Overlays 3rd Party Applications (potential):

- MicroStrategy
- Custom Analytics and Data Marts
- Other COTS Business Intelligence

Benefits:

- FIND / DISCOVERY:
  - Select data sources for BI analysis using shared metadata
  - Support multiple versions of the truth
- QUERY / POLICY:
  - Get data from source with dynamic filters based on policy models
- LOAD / CONTEXT:
  - Put data into OLAP cube or into Data Warehouse (via XML)

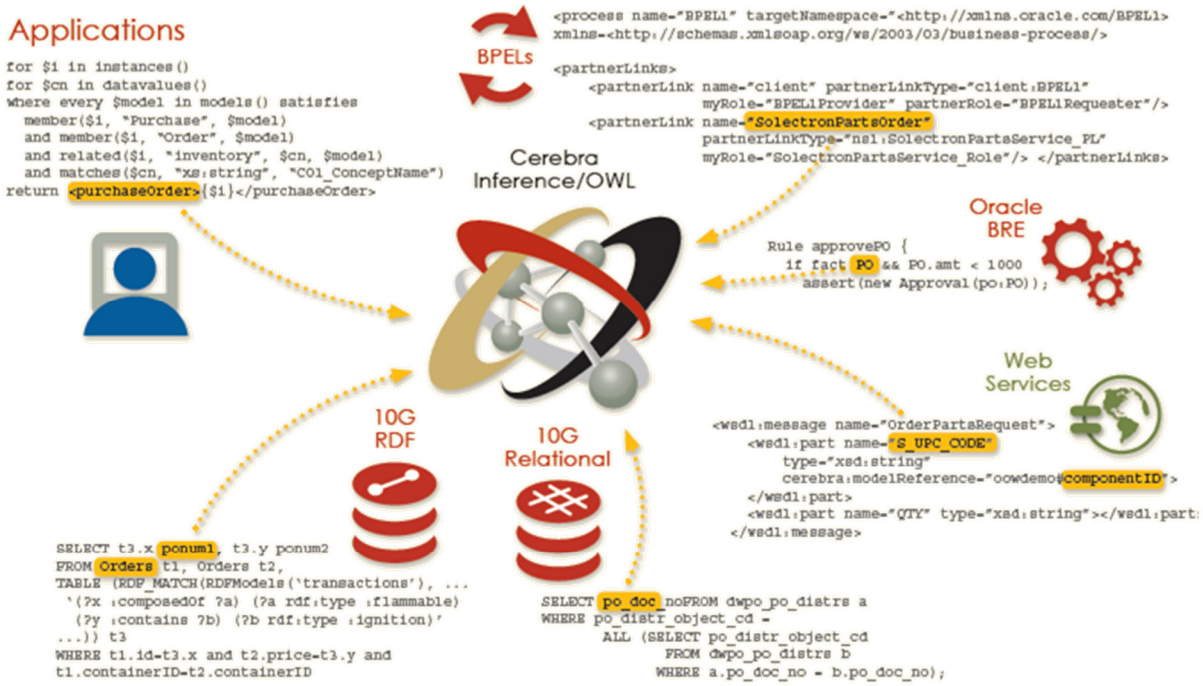
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Oracle Open World Demo



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No Free Lunch

THE BAD NEWS:

TRAIN YOUR PEOPLE!

THE GOOD NEWS:

DBA's may already know most of this stuff…
Object-Oriented analysts have a BIG head-start…

Tools are available:

Modeling – GUI driven, Visio-based, Rational-based, etc.
Inference – Java based, C++, App Server based, etc.
Rules – GUI driven, J2EE integration, .NET components, etc.
Database – RDF databases, open source, triples stores

Trainers are available:

Software Vendors (Cerebra, etc.)
Consultants (TopQudrant)

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It is important to understand that new technology does not come without cost. It will take training, tools and in-the-trenches experiences to fully leverage the benefits of semantic technology.

Student Notes:

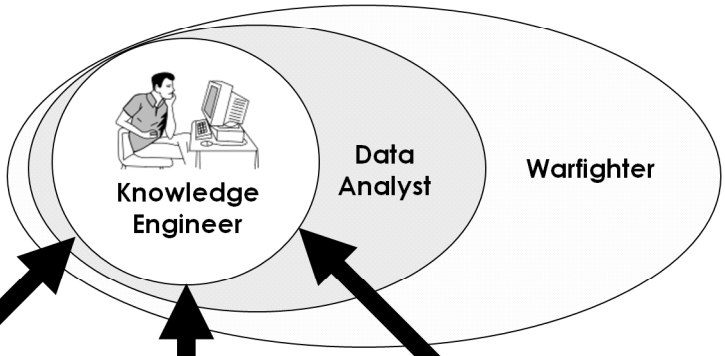
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WHAT SKILLS WOULD BE REQUIRED?

Existing Staff Provide the Baseline Skills, Training Covers the Gaps

"End" Users
Regular "Business Staff" and "Data Analysts" will require minimal to no additional training – *because they will be interacting with the same kinds of tools they are used to (eg: browser-based)*



SKILL GAPS:
Graph Data Modeling
Logic-Based Constraints
New Hierarchy Patterns

SKILL GAPS:
Graph Data Modeling
Advanced Relations
Programming Skills

SKILL GAPS:
Business Concept (focus)
Graph Data Modeling
Physical De-Coupling

Object-Oriented Analyst
- Focus on Behavior/Operations
- Use Unified Modeling Language
- Is-a and Part-of Relations
- Goal: Code Generation
- Strength: Abstraction ability

Taxonomy Designer
- Focus on Hierarchy
- Use (typical) XML
- (mostly) Is-a Relations
- Goal: Search/Navigation
- Strength: Business focus

Relational Modeler
- Focus on Entities
- Use ER Modeling
- Relational Integrity "Keys"
- Goal: Data Storage
- Strength: Query efficiency

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Postscript

- **Presentation Goals**
  - Straight Talk; No Hype!
  - Education – what, why, how…
  - Explain Value-drivers & ROI
- **Presentation Takeaways**
  - Information outlives software.
  - You CAN unlock data from code.
  - Standards, and technology, are mature (enough).
  - Semantic technologies are different than _____.
  - Performance/scale is sufficient.
  - There are no silver bullets.

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The key takeaway from this presentation is that this technology base is (a) here today, (b) standards-based, and (c) a powerful new way of getting control over large quantities of enterprise information. Take the time to learn how these technologies can improve your job.

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Questions?

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Please feel free to contact me with any follow-up questions or comments regarding this presentation.

Student Notes: