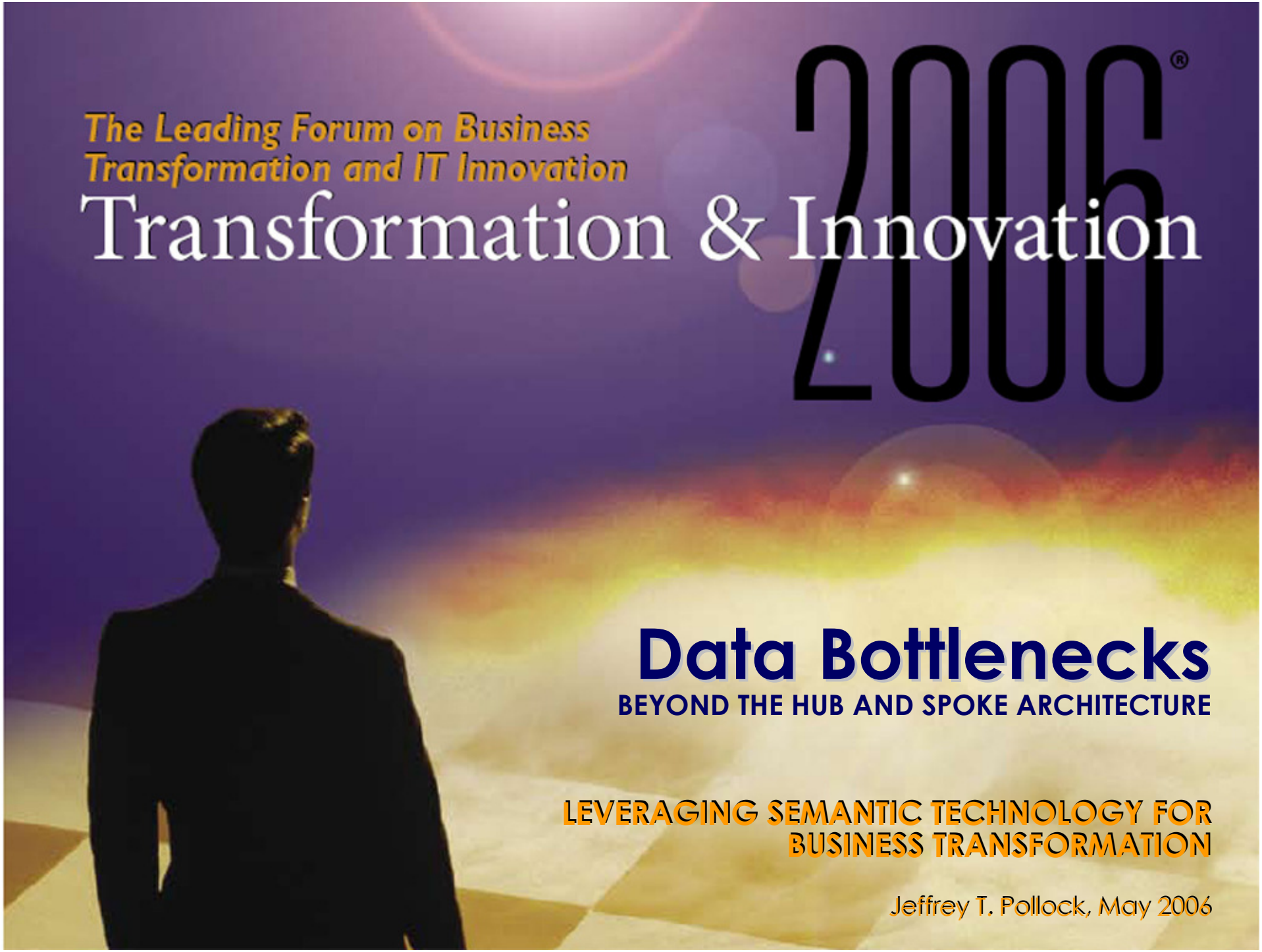

The Leading Forum on Business
Transformation and IT Innovation
Transformation & Innovation
2006®
Data Bottlenecks
BEYOND THE HUB AND SPOKE ARCHITECTURE
LEVERAGING SEMANTIC TECHNOLOGY FOR
BUSINESS TRANSFORMATION
Jeffrey T. Pollock, May 2006

Prelude

- Key Takeaways:
  - Hub and Spoke for data architecture is a bottleneck
  - Semantic Web can unlock the data bottleneck
  - Industry and vendor use cases can show you how
  - Invest in programs where mission data will be "long-lived," not stovepiped

- Agenda:
  - Why Are We Here?
  - Babies, Truth, and Other Sacred Cows
  - The Semantic Web
  - Shared Information Service Architectures
    - Data Policy, Governance, and Common Formats
  - Example Use Cases
  - No Free Lunch!
  - Final Thoughts: The Semantic Web "fit to task" for BTA Transformation

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Why Are We Here?

- BTA Mission Statement:
  Transform business operations to achieve improved warfighter support while enabling financial accountability across the Department of Defense

- Enterprise Integration
  - Best practices for DoD ERP deployments
  - Rapid adoption of information and process standards
  - Operational awareness of tactical impact of information, process, and data standards

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…and then "Reality" sets in:



(Hint: Rapid transformation is HARD because systems don't interoperate)

EAI?

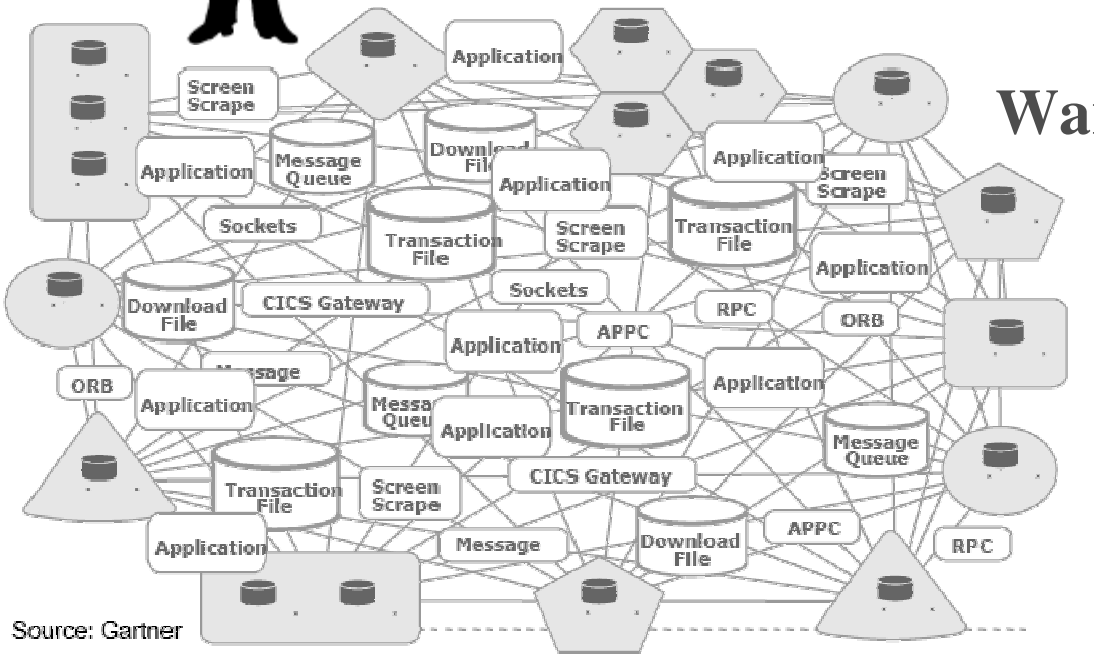
<XML>?

BAM?

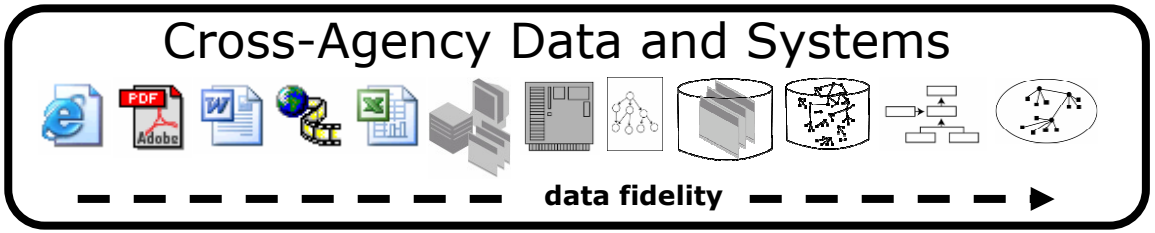
Warehouse?

ETL?

EII?



Source: Gartner



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Getting People on the Same Page

IN ORDER TO TRANSFORM, YOU HAVE TO KNOW WHERE YOU ARE NOW, WHERE YOU ARE GOING, AND THE STEPS TO GET THERE – HOW WILL TECH KEEP PACE?

- **Meetings and Memos**
  - Issue: while this can work to get people on the same page, it does little for the IT systems which move our data
- **Adopt the Same ERP Packages**
  - Issue: we've tried this since the mid-1990's → even if we succeed at using the same ERP, the business operations always dictate different manual customizations per community
- **Build Huge Data Warehouses**
  - Issue: operationally this is difficult due to data ownership concerns, but the larger technical issue may be time/effort for creating homogenized data models
- **Enforce Same Integration Technology**
  - Issue: vast investments have already been made for EAI, EII, SOA, and other integration infrastructure technology across various agencies – we know that communities want choice
- **Use the Same Data Models**
  - Issue: Community approaches to data structure and meaning are fraught with organizational and political problems. By definition, the result is the lowest common denominator

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Is This Just Unsolvable at any Price?

WE KNOW THAT OUR MISSION IS TO ENABLE RAPID TRANSFORMATION, FINANCIAL ACCOUNTABILITY, AND IMPROVED WARFIGHTER SUPPORT – BUT WE ALSO KNOW THAT OUR CURRENT TECHNOLOGY BASE IS RIGID, EXPENSIVE AND SLOW TO CHANGE – HOW CAN WE RECONCILE?

- **Not Working:**
  - Meetings and memos alone don't cut it
  - Adopting the same ERP packages has already failed
  - Building huge data warehouses never meets expectations
  - Enforcing same integration technology is a non-starter
  - Using the same data models takes forever and rarely works

- **Last Hope?**
  - Manpower, manpower, manpower – huge projects, lots of bodies. Get's the job done (sometimes) but still very expensive and slow to change. "Solvable at an enormous price."
  - New technology? Never mind price, is this problem simply: "Unsolvable with decades old technology?" Is there new technology that can help?

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We Tried Throwing Out the Bathwater!

SINCE 1986 – 20 YEARS AGO – WE'VE SEEN TECHNOLOGY CHANGE BY LEAPS AND BOUNDS. NEWER TECHNOLOGY HAS PROMISED TRANSFORMATIVE CAPABILITIES, BUT HAS IT MADE TRANSFORMATION FASTER OR CHEAPER?

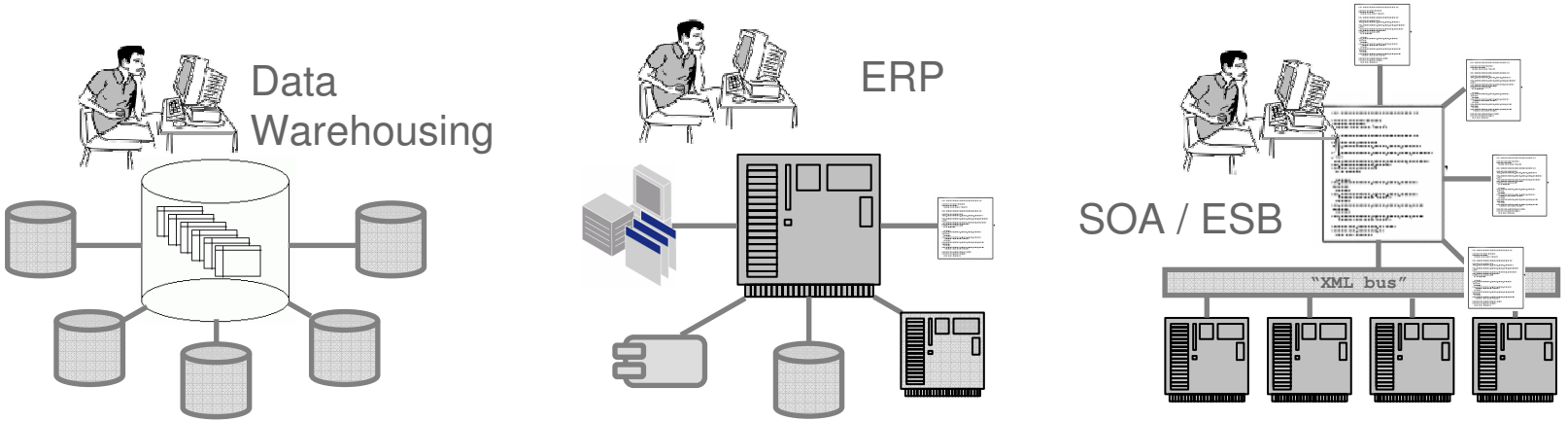
- New Bathwater:
  - ~1989 – Message-Oriented Middleware (MOM)
  - ~1993 – Data Warehousing (DW) & Business Intelligence (BI)
  - ~1997 – Enterprise Resource Planning (ERP)
  - ~2000 – Portals (AKA: the intranet and Internet B2B communities)
  - ~2003 – Service-Oriented Architecture (AKA: MOM + standards)

- What if the Problem is not the Bathwater; what if the Problem is the Baby?
  - Baby = "Hub and Spoke Data Architecture"
    - As each new watershed technology has emerged, the basic pattern for data alignment and reconciliation has remained the same – vendors have been focused on (a) Functions, (b) Persistence, and (c) Movement – but not Interoperability

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Babies, Truth, and Other Sacred Cows…

OUR PERPETUAL BELIEF THAT THERE CAN BE A "SINGLE SOURCE OF TRUTH" HAS RESULTED IN HUB-AND-SPOKE DATA ARCHITECTURES AGAIN AND AGAIN.



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Tightly-Coupled Data = Bottleneck (duh!)

HUB AND SPOKE ARCHITECTURES STILL REQUIRE A TIGHT-COUPLING OF DATA FOR DATA EXCHANGE – BECAUSE OF EXCESSIVE MAN-IN-THE-LOOP CODING

- **Don't be Fooled by "code free integration" Claims!**
  - Issue: many vendors provide adequate tooling for defining data transformations in a graphical environment, but no vendor can automate rapid changes to data and process that originate outside their "hub"
- **Learn the Basics About Traditional Data Structures**
  - Relational: tabular formats for data are most prevalent in database systems, and operate best for storage and persistence
  - Hierarchical: tree-like formats (including XML) are most prevalent in document models, and operate best in messaging systems (including SOA)
  - Object: frame systems like Java and C# combine behavior with data encapsulation, and operate best for compiled software programs
- **Know Why Traditional Structures are Tightly-Coupled**
  - **Issue: not enough metadata to substantially automate data transformation into numerous unpredictable formats required by consumers**
- **Understand How to Make Data Loosely-Coupled**
  - Hint: enrich your data with best-in-class metadata

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Punch Line: The Semantic Web

BEST-IN-CLASS METADATA PROVIDED BY STANDARD SEMANTIC WEB FORMATS CAN HELP YOU MAKE YOUR DATA LOOSELY-COUPLED. WHY BOTHER?

Technical



Business

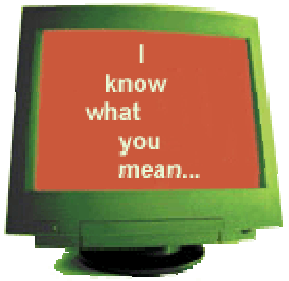
- **Better Metadata**
  - Modern, based on logic and math, web-ready, AI capable
- **Inference-Driven Systems**
  - Works with explicit and implicit knowledge, more declarative
- **Automation**
  - Impacts; know how a local change ripples to other communities
- **Centralized Policies**
  - Get a handle on governance, compliance, SLA's and security
- **IT Service Capabilities**
  - Distribute query, xform, lookup, and search utilities to the edge
- **Business Transformation Enabler**
  - Gain confidence in consistency and faster process support for organizational change initiatives – reuse data to new tasks

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But What is the Semantic Web?

A SET OF W3C METADATA STANDARDS BUILT ON TOP OF COMMONLY ADOPTED FORMATS LIKE UNICODE AND XML

- The Movement
  - Too much hype!
  - Broad-based, all of computing
  - Consumer applications
    - Web 2.0
    - Semantic Wiki
    - Social Nets
    - RSS, etc.



- vs. The Enabling Technology
  - Data Interoperability
  - Policies, Proof and Trust
  - Data Sharing Framework
  - Federated Query
  - Web-Based Artificial Intelligence

- Today:
  - RDF – Resource Description Framework
  - OWL – Web Ontology Language

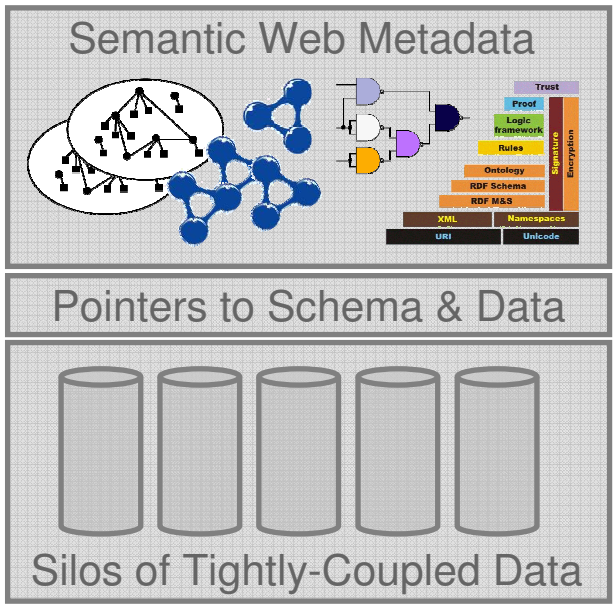
- Soon:
  - SPARQL – query language
  - Business Rules – SWRL or other…

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Semantic Web = Loosely-Coupled Data

FOUNDATIONALLY, AND FOR THE PURPOSES OF BUSINESS TRANSFORMATION, THE SEMANTIC WEB PROVIDES FOR A HIGHLY ADAPTIVE, FLEXIBLE, AND DYNAMIC FRAMEWORK OF METADATA ON TOP OF LEGACY DATA SOURCES

- **Semantic Web Key Enablers:**
  - **URI**
    - Everything is uniquely addressable
    - Everything is inherently distributable
    - New to AI technology!
  - **Triples**
    - Core data structure
    - Subject, Object, Predicate
  - **Inference**
    - Description Logic Reasoning
  - **Business Rules**
    - Math, Time, and Spatial calculations
    - …and other non-monotonic inference techniques

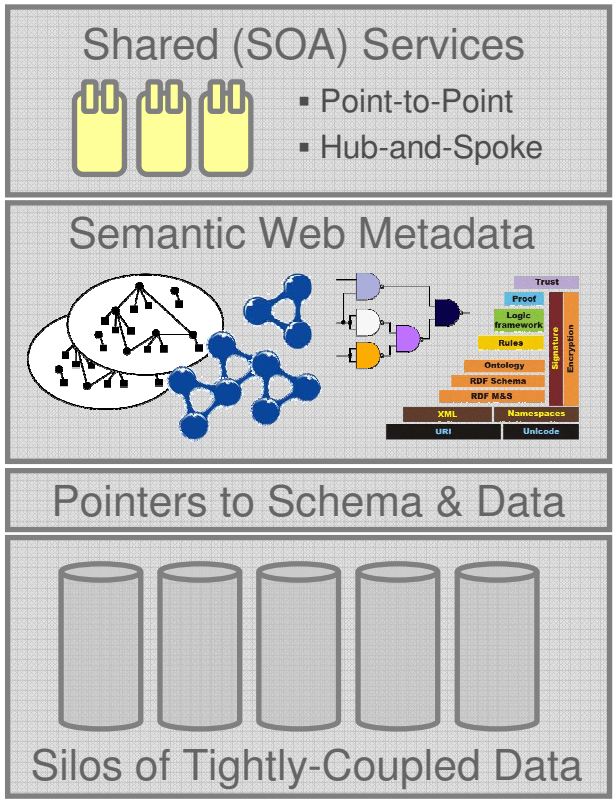


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Shared Services / Edge Computing

THE SEMANTIC WEB IS JUST DATA AND DOCUMENTS – THERE ARE NO TOOLS. JUST LIKE HTML IS A STANDARD, BUT BROWSERS ARE NOT. HOWEVER, THE SEMANTIC WEB ENABLES A TRUE SHARED SERVICES ARCHITECTURE.

- **Core Services:**
  - **Directory**
    - "I need to find a person, service, system, document, or piece of data – where is it?"
    - Key concept: extend UDDI, LDAP, Active Directory with standard, shared metadata
  - **Mediator**
    - "get me all data that relates to my query and give it to me in a format I understand"
    - Key concept: let the machine do the hard data transformations for you
  - **Policy Engine**
    - "protect and govern my sensitive data and follow my business policies correctly"
    - Key Concept: once the data is everywhere, policing it becomes critical path
  - **Repository**
    - "let me put my data asset somewhere where I can easily relate it to other assets"
    - Key concept: putting an asset somewhere is only the first step; it has to be linked to other things for other people to find it

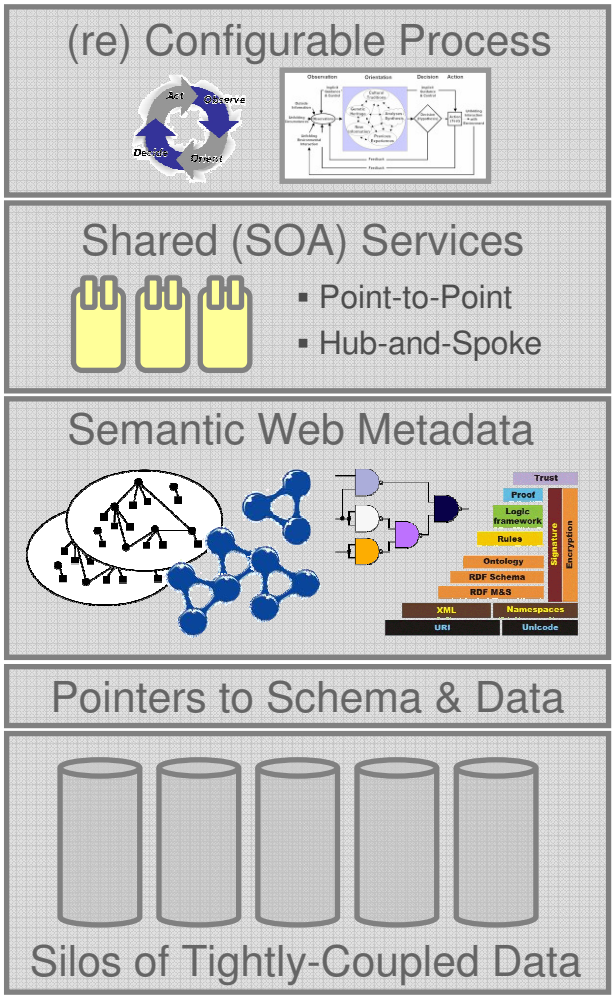


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…to Enable Rapid Business Transformation

MISSION: "OPERATIONAL AWARENESS OF TACTICAL IMPACT OF INFORMATION, PROCESS, AND DATA"

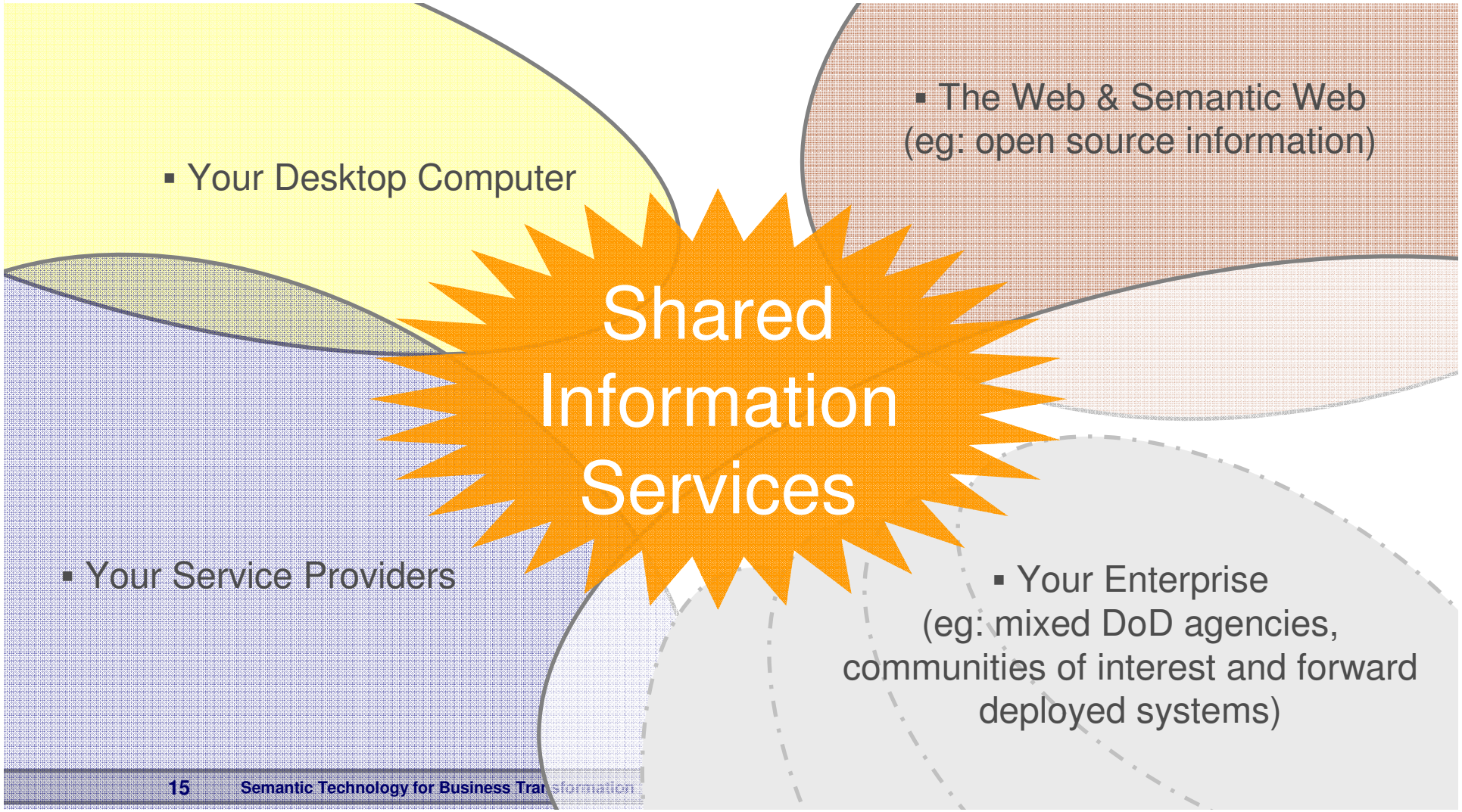
- **Business Transformation**
  - Warfighter support
  - Financial accountability
  - Integration best practices
  - Reduce redundancy
- **OODA Loop**
  - Observe – Signals / Intelligence
  - Orient – Understand in context
  - Decide – Policies and judgment
  - Act – Effect change
- **Feedback**
  - …at every step
  - …with impact analysis
  - …to test hypothesis
  - …for compliance with policies
  - …to monitor and govern actions



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Connect (and rearrange) the Dots

DATA FOR DoD DECISION MAKING CAN (AND SHOULD) COME FROM A WIDE VARIETY OF SOURCES: 3RD PARTY, OPEN SOURCE, INTERNAL SIGINT, ETC.



Conceptually Speaking…how?

LAYERED SOFTWARE ARCHITECTURES MUST RESOLVE THE FACT THAT DATA FROM SOME PLACES IS SIMPLY IRRECONCILABLE; AND THAT YOUR "TRUTH" IS ONLY A "VIEW" TO OTHERS



Your Version of Truth
(The Data You See)

Browsers or Applications

Single (logical) Entry Point

Web Service API's

Shared Services (local or remote)

Java/C# API's

Semantic Web Infrastructure Tools

JDBC/ODBC API's

Semantic Web Metadata

EII/EAI Infrastructure Tools

Many Versions of Truth
(Semantic Web Models)

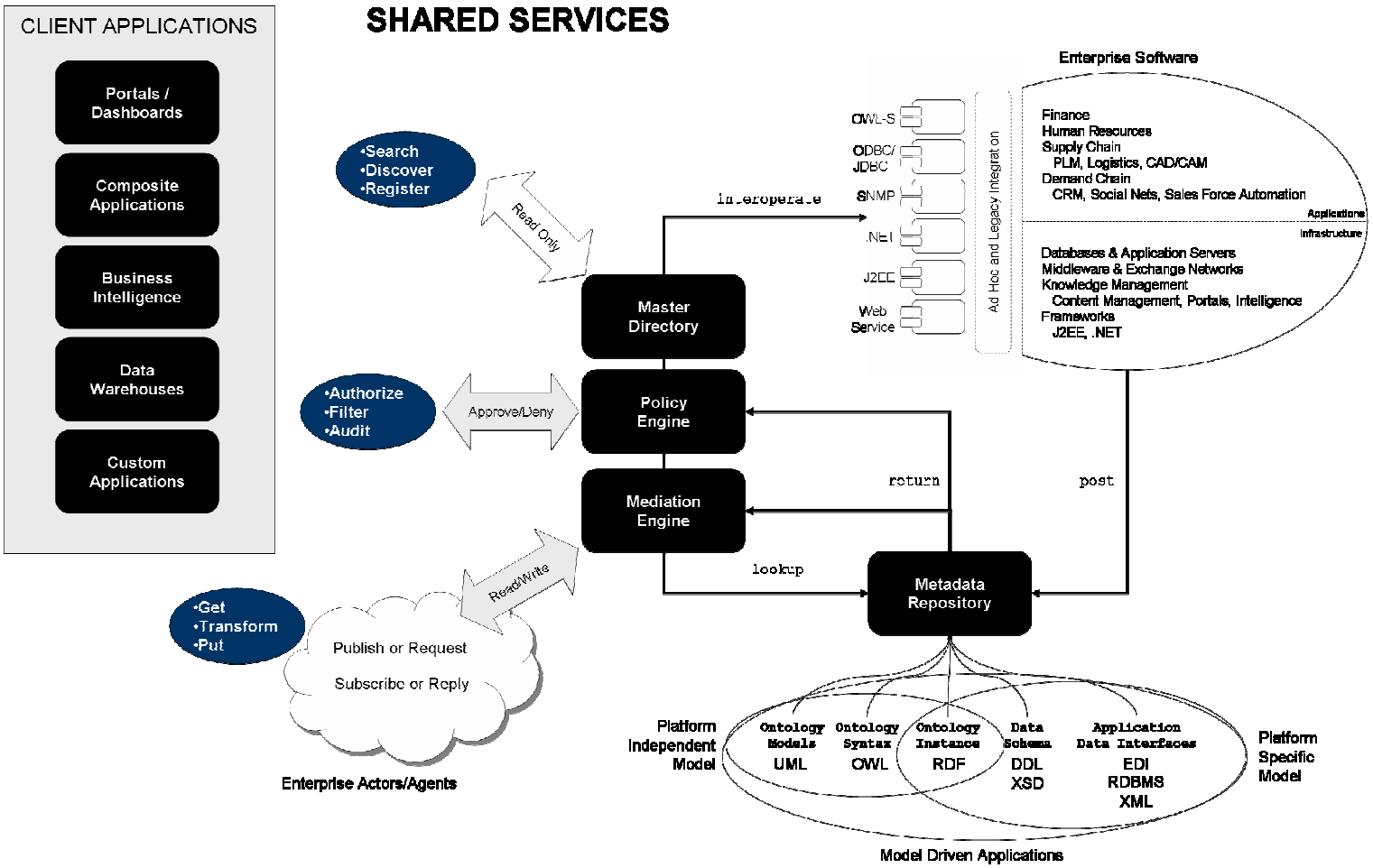
Adaptors

Irreconcilable Versions of Truth
(Native Enterprise Data Sources)

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Architecturally Speaking…how?

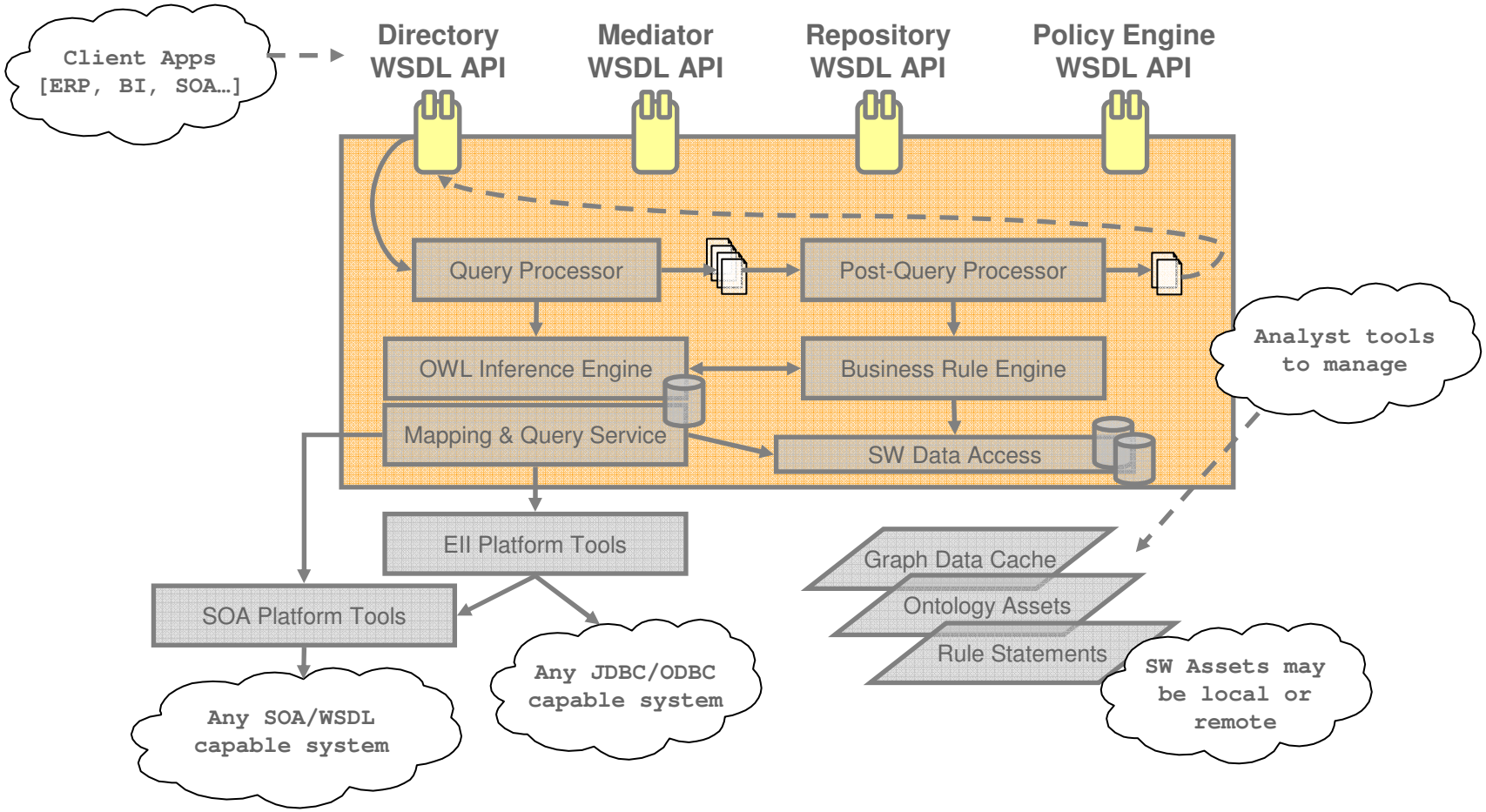
CLIENT APPLICATIONS AND ENTERPRISE SOFTWARE MUST REMAIN AS UNTOUCHED AS POSSIBLE – USE CORE SERVICES/METADATA AS "FACADES"



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Core Services; Common Components

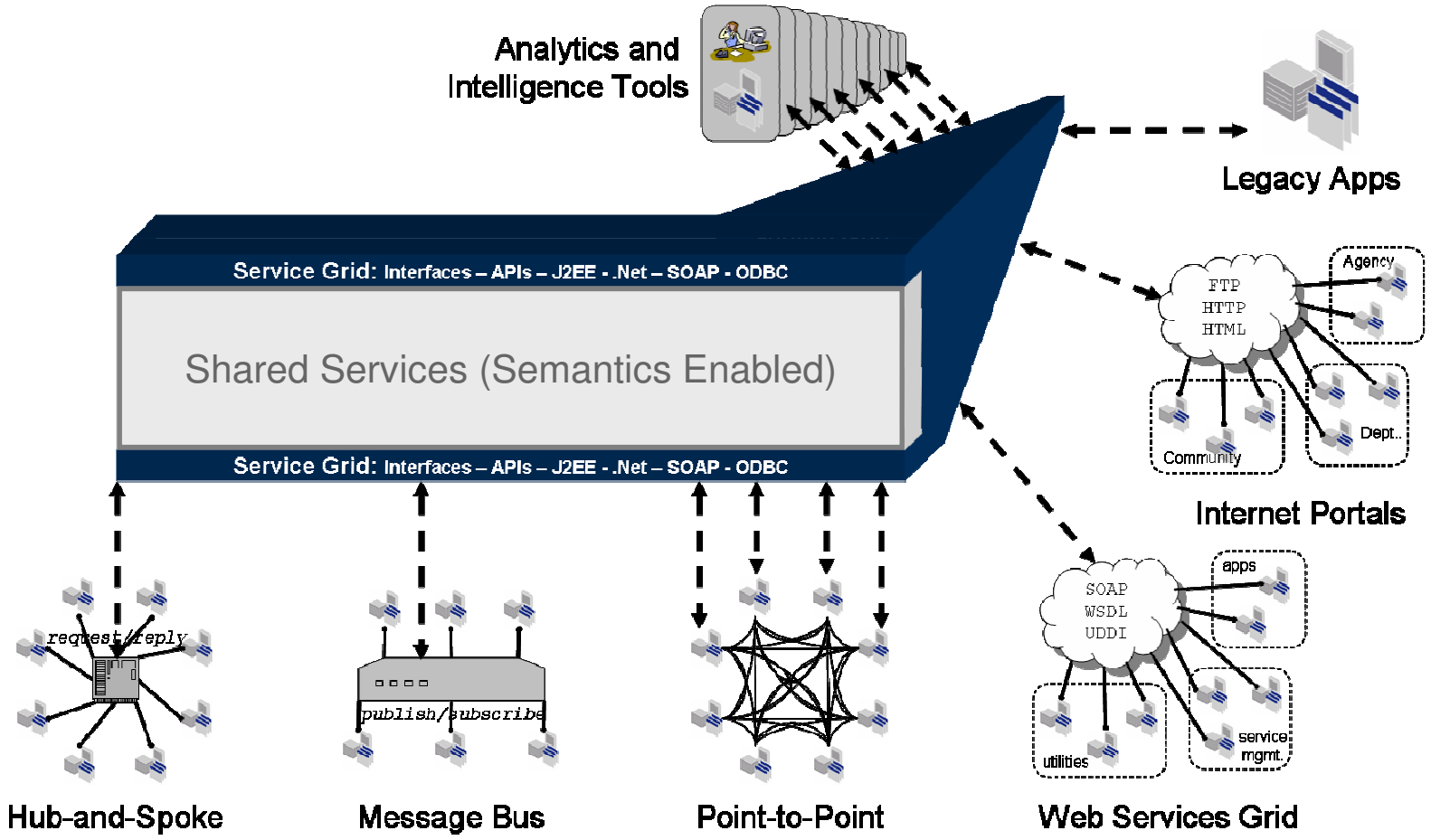
SHARED SERVICES CAN PROVIDE DIFFERENT CAPABILITIES YET STILL SHARE COMMON COMPONENTS. EACH SERVICE SHOULD BE SEMANTIC WEB READY AND WILL REQUIRE COMMON SEMANTIC TOOLING COMPONENTS



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Local, Edge, Hub or Point to Point

A KEY REQUIREMENT OF A SUCCESSFUL DATA STRATEGY WILL BE TO ENSURE CROSS PLATFORM ACCESSIBILITY TO DIFFERING ARCHITECTURES

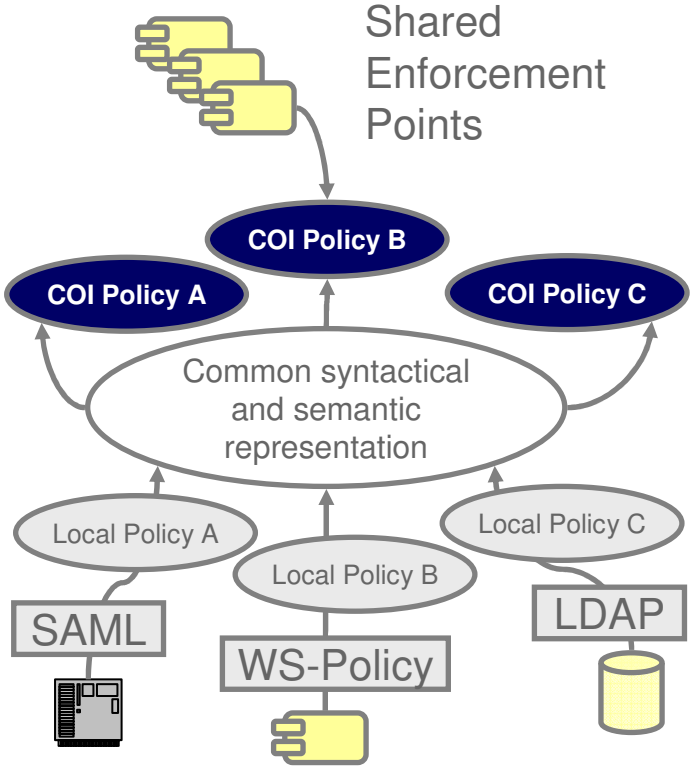


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That Little Matter of Data Security…

"70% OF SEMANTIC INTEGRATION CHALLENGES HAVE SECURITY ANALOGS, SEMANTIC INTEGRATION SEEMS TO PRECEDE SECURITY INTEGRATION"*

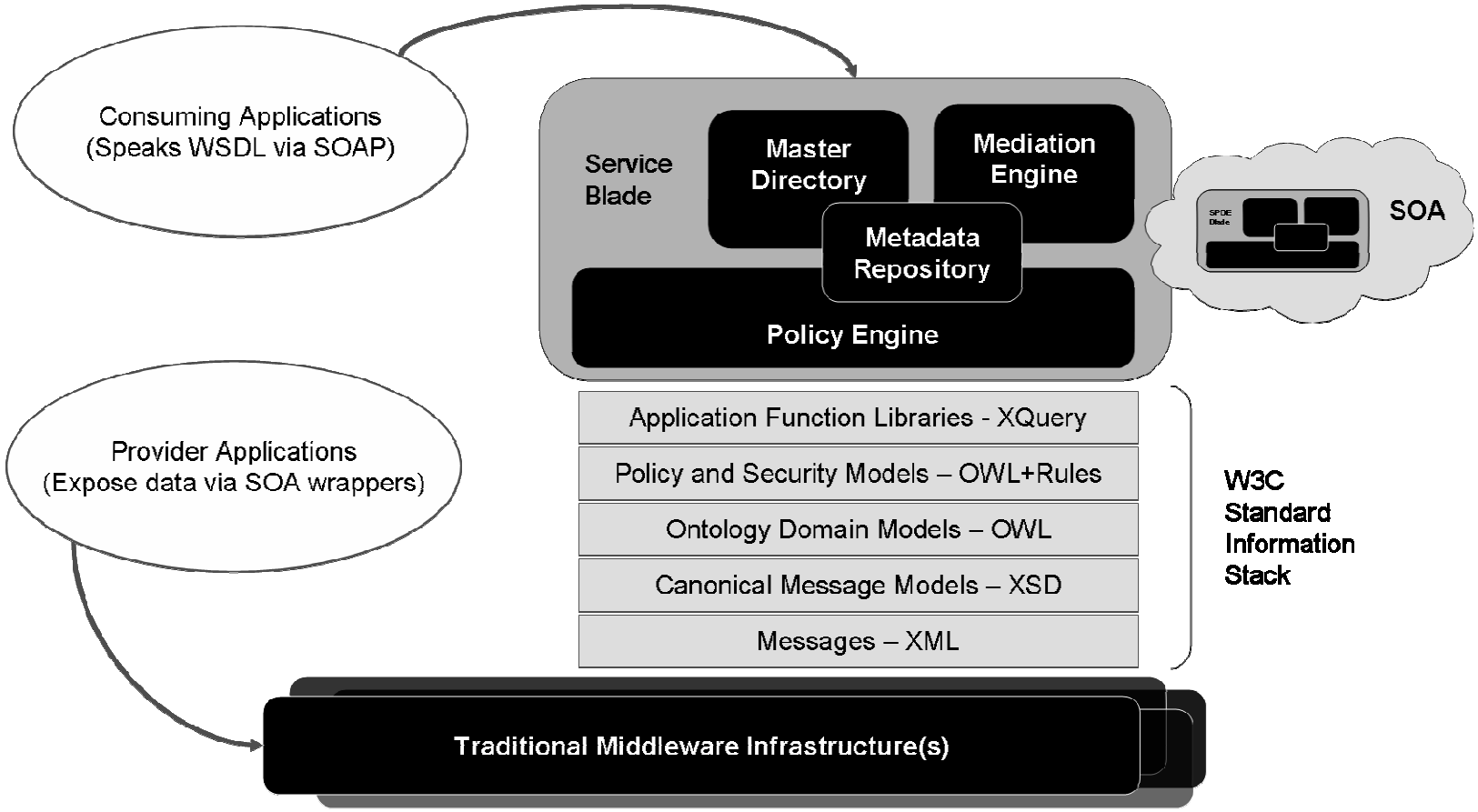
- **Federation Makes it Harder**
  - Widespread adoption of SOA will make life very hard for the security folks on your team – data that didn't used to be accessible now is…how shall it be governed?
- **Centralized Policy Management**
  - With all the security and policy standards out there, how do you interoperate when you are asking for data from each of them?
    - Most policy languages have no formal semantics
  - Prototypes show that a substantial portion of legacy policy declarations can be expressed in an OWL format
    - OWL's consistency checking is provable
- **OWL Common Policy Layer, over:**
  - SAML – mapping to/from OWL possible
  - WS-Policy – Mapping to/from OWL possible
  - JAAS – OWL generated JAAS possible
  - LDAP – mapping to/from OWL possible



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*mitre

Logical Schema and Data Layers…how?

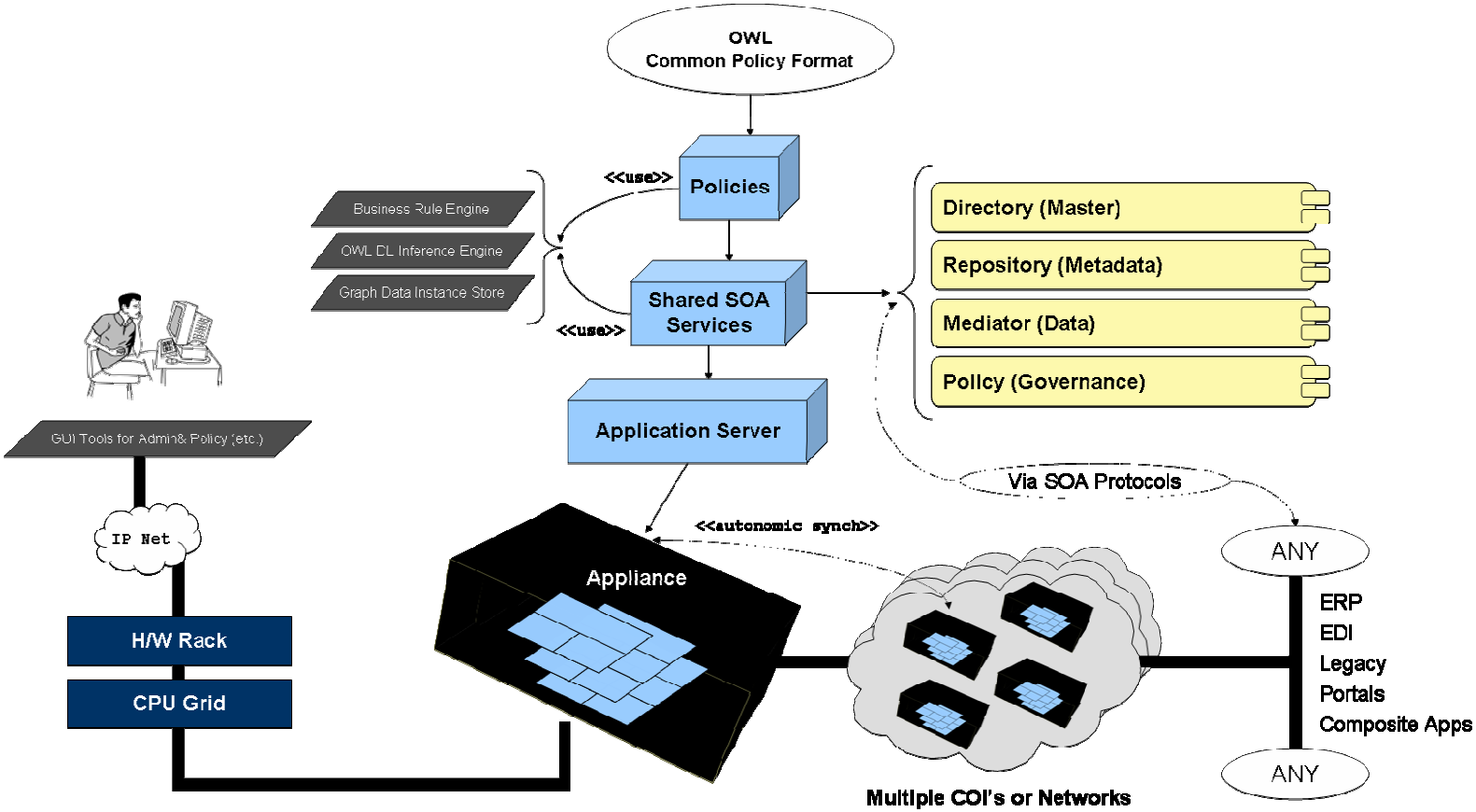
THE LOGICAL ARCHITECTURE CONSISTS OF XML, XSD, OWL, RULES, AND XQUERY FUNCTIONS – RUNTIME SERVICES HANDLE IMPORT/EXPORT



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Deployment: Must be Forward-Deployable

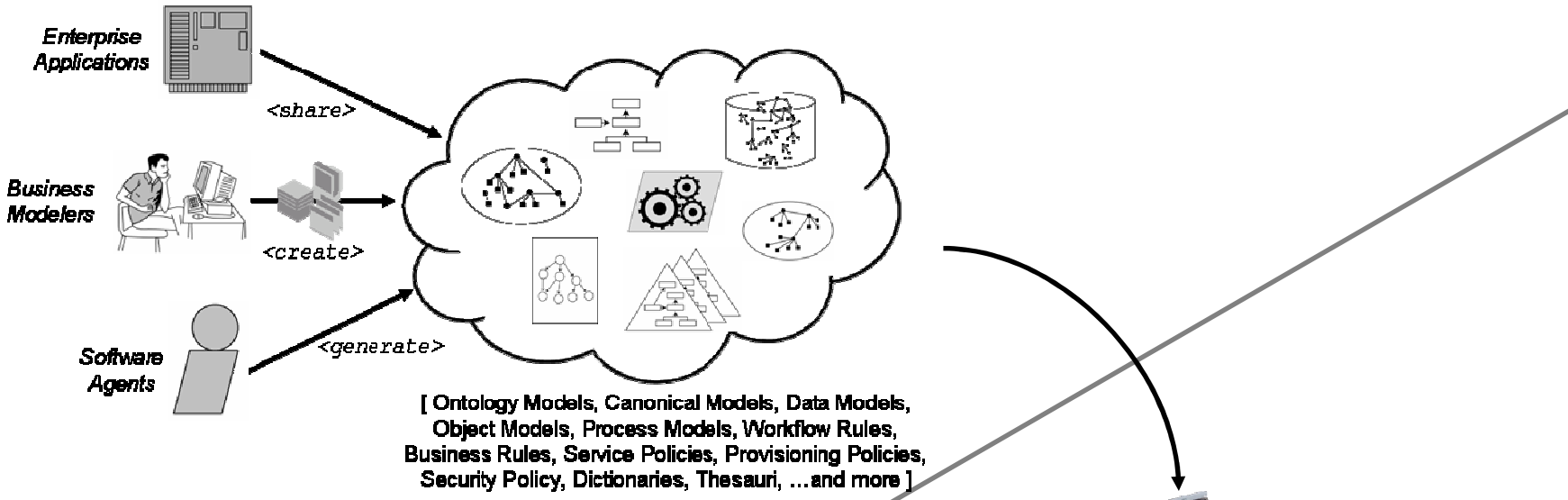
A DEPLOYMENT ARCHITECTURE FOR SEMANTIC WEB INFRASTRUCTURE COMPONENTS CAN BE LAYERED AND DEPLOYED AS CLUSTERED ENTERPRISE SOFTWARE



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Ultra-Simple View

DESIGN-TIME TOOLS ENABLE ANALYSTS TO MANAGE THE LIFECYCLE OF METADATA; RUN-TIME CAN BE PRE-LOADED AND FORWARD-DEPLOYED





Design-Time

Run-Time

"the blinky light means it's working"

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Supporting Scenarios & Use Cases

TRUE, THE SEMANTIC WEB IS STILL NEW AND CONTINUES TO EVOLVE.
TODAY, THESE POWERFUL USE CASES DEMONSTRATE ADVANCED CAPABILITIES

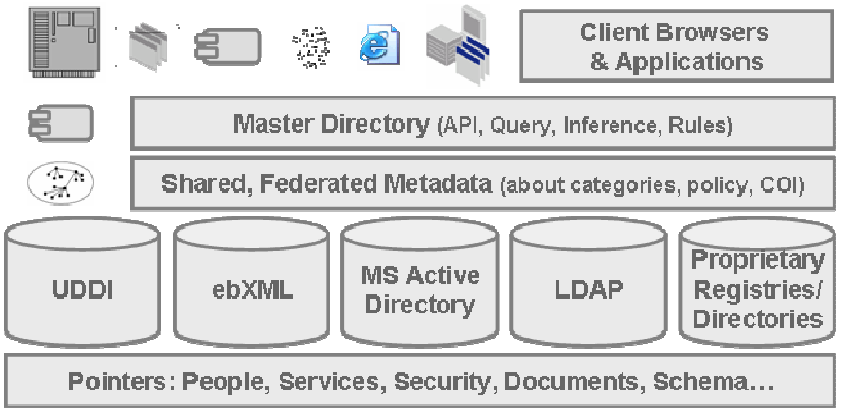
- **Department of Defense**
  - Directory Services – a number of DoD projects have explored this area
  - Mediation Services – beyond DISA/NCES, several have used RDF/OWL
- **US Intelligence Community**
  - Text Mining – operational systems now generate OWL/RDF from news stories
  - Social Networks – small scale systems use RDF for "graph walking" relationships
- **Life Sciences**
  - Mapping Biological Networks – connecting genes, proteins, metabolites and pathways
  - Decision Support Systems – targets, leads, biomarkers and hypothesis capture/tracking
- **Financial Services**
  - Compliance – slow to move to production, R&D work heavily leverages OWL
  - General Ledger – mediation capabilities applied to financial data
- **Manufacturing & Logistics**
  - Business Intelligence – generating vocabulary views based on reporting needs
  - Enterprise Content Management – categorizing distributed documents

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Scenario: Master Directory Service

DIRECTORY SERVICES CAN LEVERAGE THE SEMANTIC WEB AS A COMMON METADATA FORMAT TO SHARE AND RESOLVE CATEGORY LISTINGS

conceptual architecture:



operational capabilities:

- Discover People Info & IT Assets
  - Inference & Logic (not UDDI style)
- Align Metadata/Categories
  - From Different Registries etc.
- Apply Consistent Policy & Governance
  - Across Communities of Interest

proposed technical approach:

- Open Source Technical Approach
  - OWL/RDF Models | Domain Info
  - Pellet/KAON Reasoner | Query KB
  - SOA using SCA patterns | Utility API
- Custom Tooling
  - Category Management GUI (+policy)
  - Import/Export to OWL/RDF

order of magnitude:

SWAG Estimates; complete SDLC

Phase 1: ~18 man-months*

- Assuming ~3 sources & ~3 COI's

References:

OWL aware ebXML, SD Supercomputer Center, webMethods UDDI/RDF paper, Software AG, Fujitsu Centera Registry

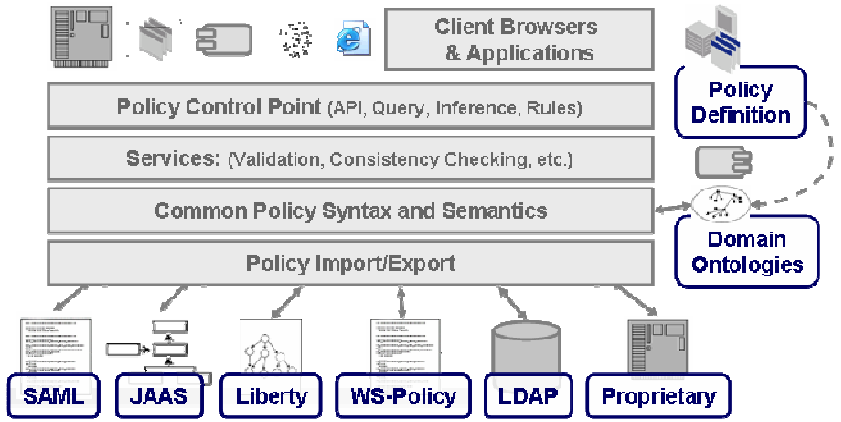
* to operational prototype

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Scenario: Governance, Policy, Compliance

POLICIES ARE EVERYWHERE: CODE, XML, SCHEMA – POLICY STANDARDS OVERLAP AND TARGET DIFFERENT TECH LAYERS – HOW TO KEEP TRACK?

conceptual architecture:



operational capabilities:

- Unified Policy & Compliance Visibility
  - One place to view and change
- Central Governance Checkpoint
  - Validate semantic/structural consistency
- Automated Impact Analysis (on change)
  - Reasoners and rules automate tasks

proposed technical approach:

- Open Source Technical Approach
  - OWL+Rules | General Policy Formats
  - Pellet/KAON Reasoner | Query KB
  - SOA using SCA patterns | Utility API
- Custom Tooling
  - Design: Policy Definition and Mapping
  - Runtime: Import/Export to OWL/RDF

order of magnitude:

SWAG Estimates; complete SDLC

Phase 1: ~36 man-months*

- Assuming low level of spec maturity

References:

University of Maryland Mindlab, European Union Research, OntoGrid & University Manchester, KAON and Ontoprise

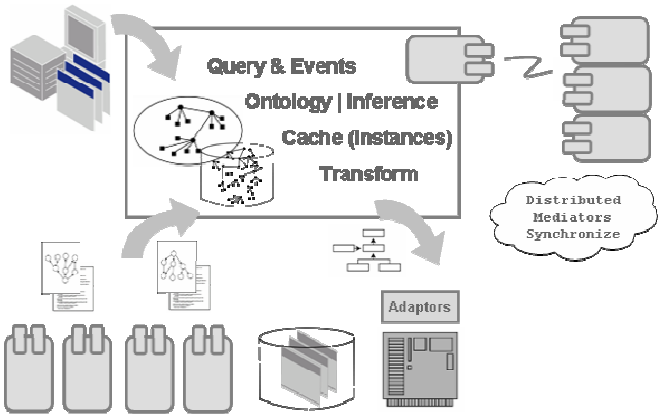
* to operational prototype

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Scenario: Data Mediation

DATA TRANSFORMATION IS EXPENSIVE, ERROR-PRONE, AND TAKES TOO MUCH TIME TO DEFINE AND PROPERLY SECURE; USE INFERENCE FOR AUTOMATION

conceptual architecture:



operational capabilities:

- Automatic Transforms for New Data
  - When ontology mapping available
- Unified Query & Function Interface
  - Not a "federated db" EII approach
- Event (pub/sub) and Monitoring Svc
  - Reasoners and rules automate tasks

proposed technical approach:

- Open Source Technical Approach
  - OWL/RDF | Domain Models
  - Pellet/KAON Reasoner | Query KB
  - (?) Tucana | Instance Store& Mapping
  - SOA using SCA patterns | Utility API
- Custom Tooling
  - Ontology bridging (axioms++) heuristic
  - Runtime: Leverage EII or EAI for query and messaging – don't reinvent wheel

order of magnitude:

SWAG Estimates; complete SDLC

Phase 1: ~48 man-months*

- Main issue: instance store scale

References:

Adaptive Information book, IEEE BAH Mediator Results, SEEK University of Manchester LS results, AFEI Transformation…

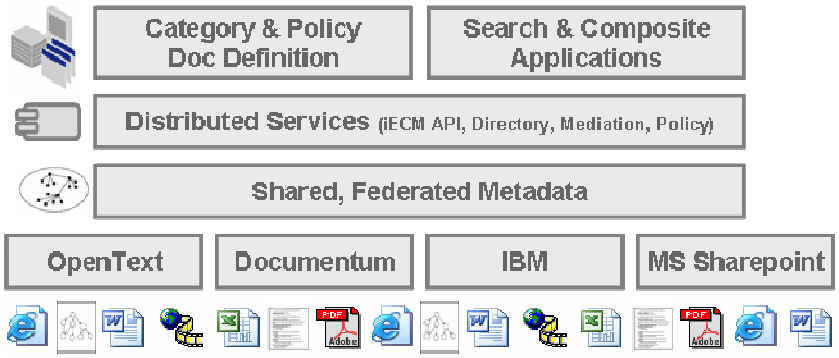
* to operational prototype

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Scenario: Enterprise Content Integration

METADATA ABOUT DOCUMENTS, MEDIA, WEB CONTENT AND OTHER ASSETS FROM SILOED CMS'S OR ECM'S CAN BE EXTRACTED, SHARED AND SEARCHED

conceptual architecture:



operational capabilities:

- Automatic Classification of Content
  - Based on document text/attributes
- Discovered Content in Local Views
  - Local context for new document content
- Unified Interface to Disparate CMS/ECM
  - iECM API in front of semantic technology

proposed technical approach:

- Note: subset of data mediator approach
- Open Source Technical Approach
  - OWL/RDF | Domain Models
  - Pellet/KAON Reasoner | Query KB
  - (?) Tucana | Instance Store& Mapping
  - SOA using SCA patterns | Utility API
- Custom Tooling
  - Ontology bridging (axioms++) heuristic
  - Runtime: ECM adapters and pointer system

order of magnitude:

SWAG Estimates; complete SDLC

Phase 1: ~36 man-months*

- Main issue: adaptors & instances

References:

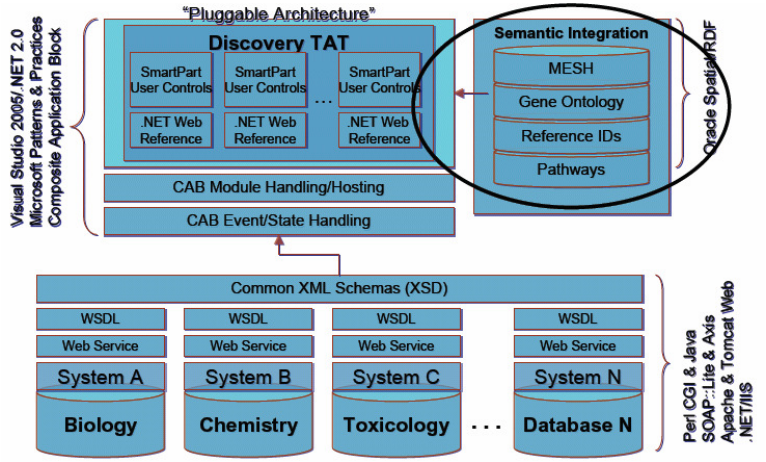
Interoperable Enterprise Content Management (iECM) group, Cerebra Inc. use cases (ST06), Eduworks Research

* to operational prototype

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Use Case: Drug Discovery at Eli Lily

THE LIFE SCIENCES COMMUNITY IS AWASH IN DATA, GETTING INFORMATION FROM ALL THAT DATA IS A USE CASE WHERE THE SEMANTIC WEB HELPS



operational capabilities:

- Pull Risk Forward
  - Save $$$ by spotting risk early in lifecycle
- Drug Target Validation
  - Connect dots in heterogeneous data
- Simplify XML & RDBMS Data Sharing
  - Accommodate fluid and changing data

proposed technical approach:

- Technical Approach
  - OWL/RDF/LSID | Domain Models
  - Jena API and Reasoner
  - Oracle 10g Spatial with RDF+rule support
  - Oracle data loaders and export tools
- End User Tooling
  - Data visualization and mapping desktop
  - Runtime: ECM adapters and pointer system

order of magnitude:

SWAG Estimates; complete SDLC

Phase 1: ~48 man-months*

- Main issue: analyst tooling* & scale

References:

University of Manchester MyGRID/Taverna, BioDASH and Haystack, UniProt RDF Extensions, Language and Computing…

* Not from Eli Lily

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Semantic Web Adoption

SINCE 1997 THE UPTAKE OF SEMANTIC WEB TECHNOLOGY HAS GRADUALLY INCREASED; IN 2005-2006 THE INDUSTRY IS SEEING EXPONENTIAL GROWTH

- Commercial
  - Audi, General Motors, Cisco Systems, Fed-Ex, France Telecom, Nokia, Fujitsu, Hitachi, NEC, Unisys, Pfizer, General Electric, Thomson, Genentech, Eli Lily, Ford…
- Federal
  - Federal CIO, SICoP, Navy, Army, DLA, EPA, NCI, DHS, CBP, NGA, MoD, NATO + other foreign federal
- Vendors/Systems Integrators
  - Oracle, IBM, Microsoft, Adobe, Altova, Hewlett Packard, WebMethods, CGEY, BearingPoint, SAIC, Lockheed Martin, SRI, MITRE, Booz Allen Hamilton, Accenture, Mantech…
- Standards Bodies
  - W3C, OMG (MDA), OASIS (DCML, ebXML), ISO

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No Free Lunch!

THE SEMANTIC WEB IS A NEW (META) DATA PARADIGM, ALTHOUGH BASED ON PROVEN GRAPH SYSTEMS, ANALYSTS WILL NEED TO BE TRAINED

- BAD NEWS: YOUR PEOPLE NEED TRAINING!
  - Semantic Arts – general semantic web and SOA training
  - TopQuadrant – general semantic web training
  - Cerebra University – general semantic web and tool training
  - Sandpiper Software – semantic web and UML/MOF training
  - Oracle – tool training with Oracle Spatial RDF
- GOOD NEWS: YOU ALREADY HAVE EXPERTS ON STAFF!
  - Taxonomists – already the bridge between business user vocabularies and the IT systems that work with them
  - Database Administrators – experienced with how to use logic when structuring knowledge, schemas, and data relationships
  - Object-Oriented Analysts – experts at thinking conceptually and modeling domain problems, business rules, and schema

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Business Transformation Requirements

FOR A SEMANTIC WEB DATA STRATEGY TO BE SUCCESSFUL WITHIN THE DoD, WE MUST ACCEPT THE DIVERSITY AND "MULTIPLE TRUTHS" ACROSS AGENCIES

- Leave SOA and DB vendor selection to Agencies, also leave open the definition of local vocabularies
  - Minimum requirements to provide a DB, EDI, API, or Web Service view into legacy
  - Minimum requirement to support a mapping to chosen domain ontologies via views and/or XML canonicals
- Loose-coupling of physical AND logical data
- Dynamic application of cross-agency governance policies
- Contextualized data views with applied security protections
  - Protect against multi-level security effects of shared data
- Maximizes best-of-breed data management platforms
- Known, mature, steps to adoption
  - Can be accomplished in parallel with concurrent PoCs
- Accomplish a "Single Point of Entry"
  - And single point of data management, with a thin architecture
  - In lieu of a "single version of the truth," a system that can accommodate multiple views while evolving with changing business demands
  - Unlock the data bottlenecks inherent within hub and spoke architectures

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In Conclusion…

TO BE SERIOUS ABOUT BUSINESS TRANSFORMATION IS TO BE SERIOUS ABOUT MAKING DATA EASIER TO USE AND RE-USE – YOU CAN CHOOSE THE OLD WAYS [EAI, EII, WAREHOUSING, ETL, etc.] OR A NEW WAY – THE SEMANTIC WEB.

- Hub and Spoke for data is a bottleneck
- Semantic Web uses smarter metadata to challenge the hub and spoke paradigm
- Industry adoption, vendor tools and use case proof points are available now
- Invest in training and programs that use best-in-class technology and data architectures

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Mr. Pollock is a technology leader and author of "Adaptive Information: Improving Business Through Semantic Interoperability, Grid Computing, and Enterprise Integration." (John Wiley & Sons) An independent consultant, Mr. Pollock was formerly Vice President of Technology at Cerebra and Chief Technology Officer of Modulant, developing semantic middleware platforms and inference-driven SOA platforms from 2001 to 2006. Throughout his career, he has architected, designed, and built application server/middleware solutions for Fortune 500 and US Government clients. Prior to Modulant, Mr. Pollock was a Principal Engineer with Modem Media and Senior Architect with Ernst & Young's Center for Technology Enablement. He is also a frequent speaker at industry conferences, author for industry journals, active member of W3C and OASIS, and formerly an engineering instructor with University of California at Berkeley's Extension on the subjects of object-oriented systems, software development process and enterprise systems architecture.