

# BUSINESS VALUE OF SEMANTIC TECHNOLOGY

Exploiting New Value Paradigms

**iECM Perspective**  
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# MILLS DAVIS



Mills Davis is Project10X's managing director for industry research and strategic programs. He consults with technology manufacturers, global 2000 corporations, and government agencies on next-wave semantic technologies and solutions.

Mills serves as lead for the Federal CIO Council's Semantic Interoperability Community of Practice (SICoP) research into the business value of semantic technologies.

A noted researcher and industry analyst, Mills has authored more than 100 reports, whitepapers, articles, and industry studies.



# TOPICS

## 1 *Opportunity*

- Stakeholder interests
- Common IT process
- Policy guidance
- CPIC
- EA 2.0

## 2 *What we're learning as SCoP...*

- Semantic technologies
- Technology providers
- Early adoption
- Business value
- Market size

## 3 *About semantic execution value paradigms...*

- Operational enterprise architecture
- Composite applications
- Smart content
- Knowledge computing

## 4 *And what this means for:*

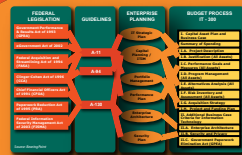
- IT management
- Enterprise architects
- Business line execs

## 5 *Pilot suggestion(s)*

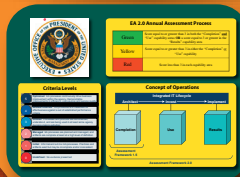


# THE OPPORTUNITY

**BUSINESS LINE  
EXECUTIVES**



**IT  
MANAGEMENT**

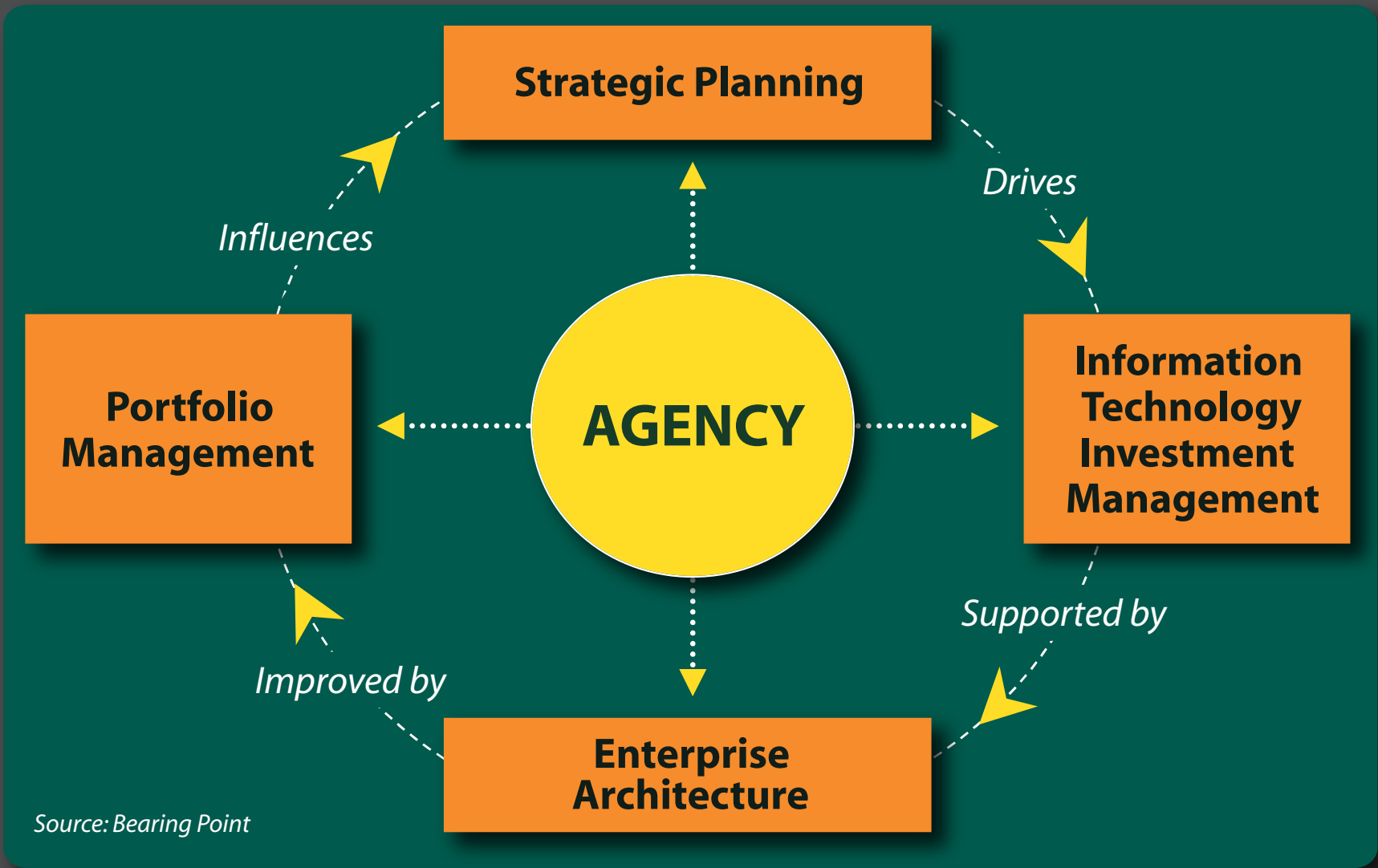


**ENTERPRISE  
ARCHITECTS**





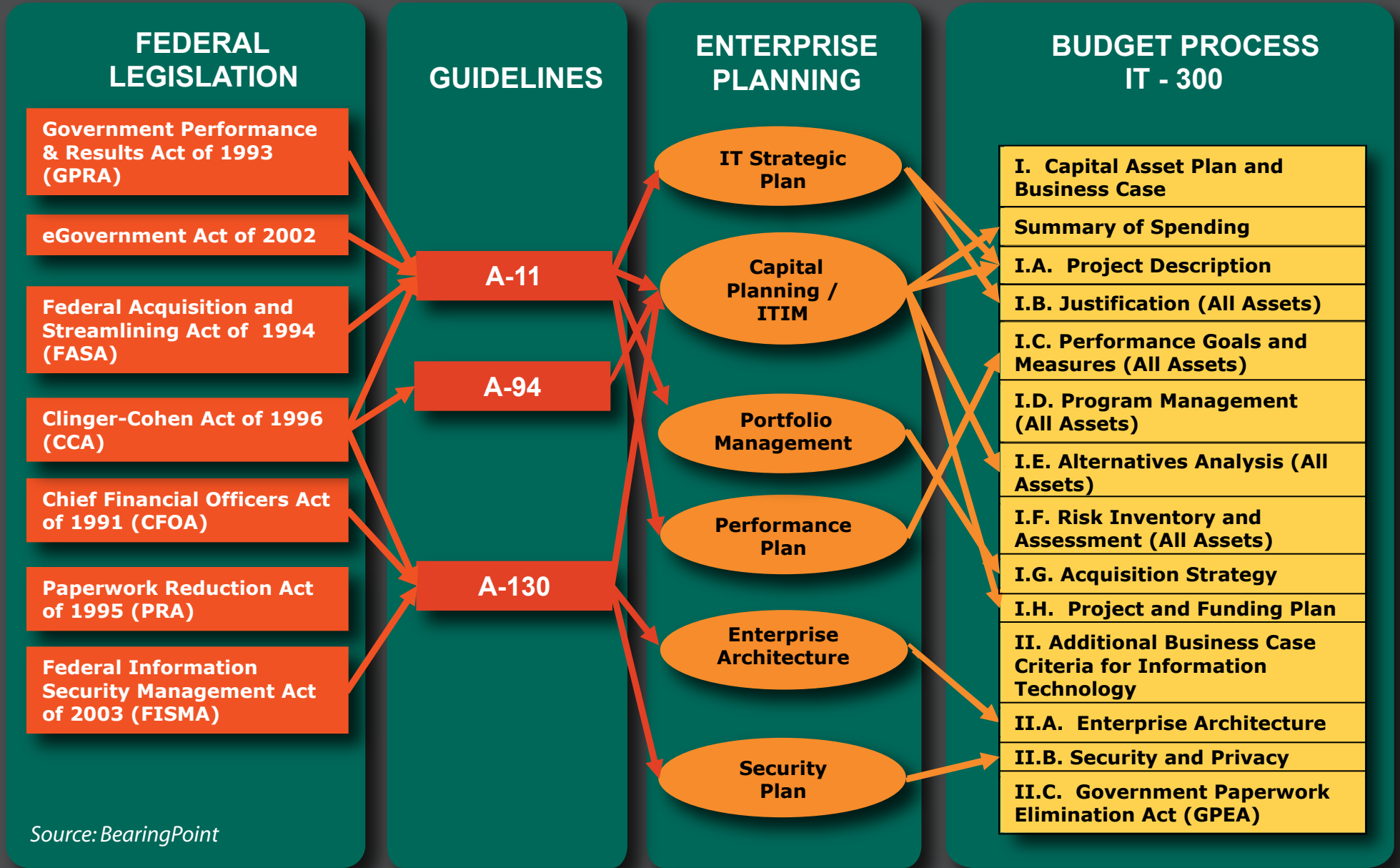
# THE BIG PICTURE



Source: Bearing Point



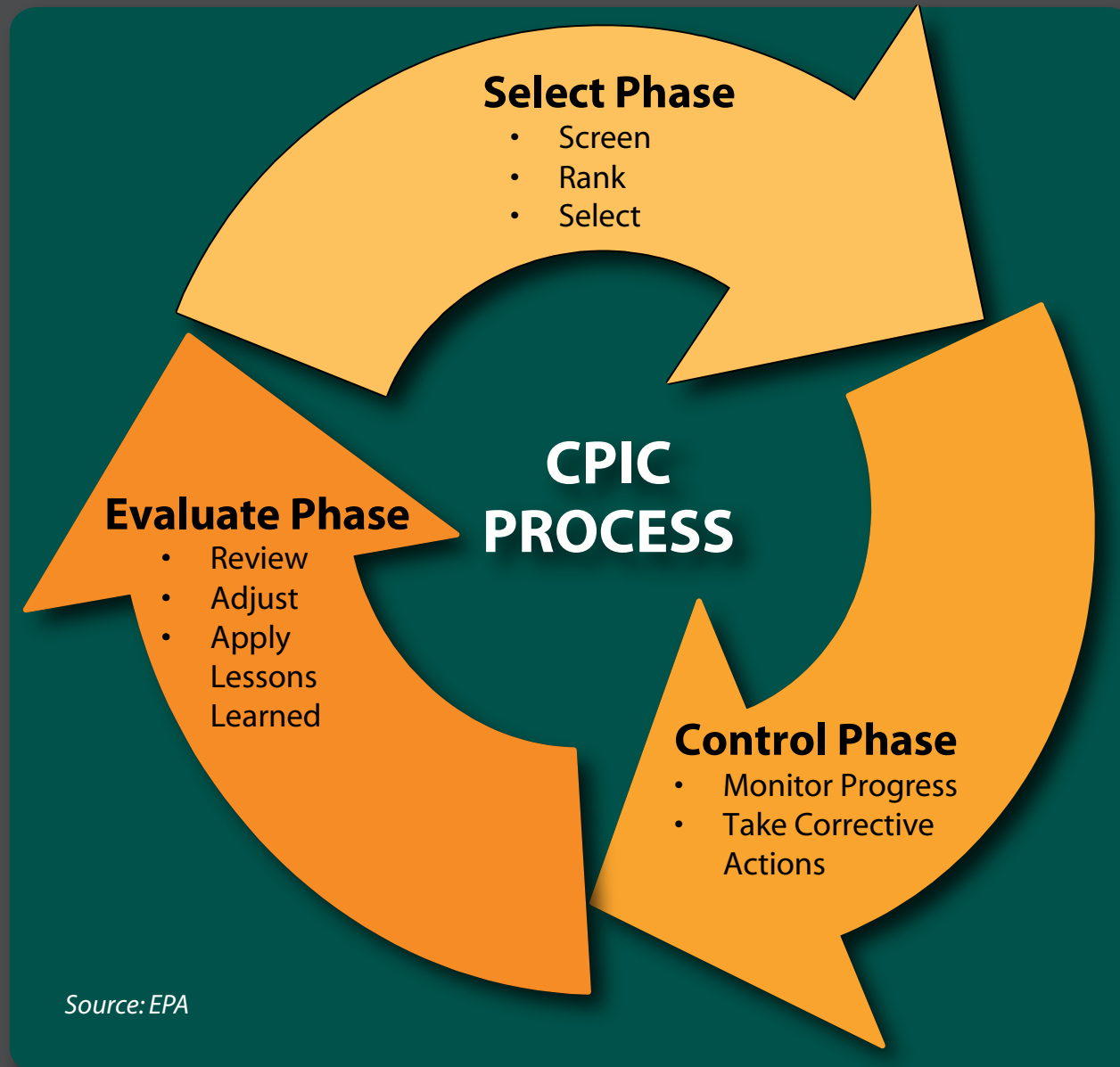
# IT LEGISLATION & POLICY GUIDANCE



Source: BearingPoint



# CPIC PROCESS



Source: EPA



# EA 2.0 ASSESSMENT



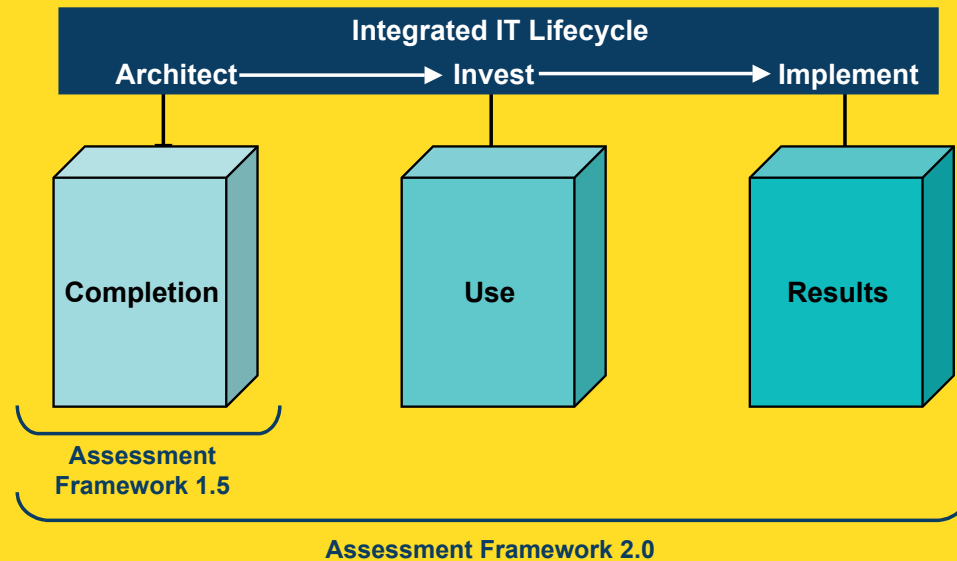
## EA 2.0 Annual Assessment Process

Green	Score equal to or greater than 3 in both the “Completion” <b>and</b> “Use” capability areas <b>OR</b> a score equal to 3 or greater in the “Results” capability area
Yellow	Score equal to or greater than 3 in either the “Completion” <u>or</u> “Use” capability
Red	Score less than 3 in each capability area

## Criteria Levels

5	<b>Optimized:</b> EA processes continuously drive business improvement within the agency. Demonstrable improvements in efficiency, cost savings and service quality.
4	<b>Results-Oriented:</b> EA processes are measured for effectiveness against a set of established performance criteria.
3	<b>Utilized:</b> Processes and products are documented, understood, and are being used in at least some agency decision-making activities
2	<b>Managed:</b> EA processes are planned and managed, and artifacts are complete at least at a high level of definition.
1	<b>Initial:</b> Informal and ad-hoc EA processes. Practices and artifacts exist but may be incomplete and/or inconsistent
0	<b>Undefined:</b> No evidence presented

## Concept of Operations





# PROBLEMS

## Typical business architectural problems

Problem	Govt	Private Sector
Custodial role of architects	●	
Perception of valueless by business	●	●
Communication problems: abstract language	●	●
Political barriers to IT's business involvement	●	●
Lack of integration of EA activities to business planning	●	●
Lack of detailed business planning	●	●
Lack of enterprise-wide view by any organizational unit other than EA	●	●

Source: Forrester

FORRESTER®



# WHAT WE'RE LEARNING AT SICOP...

## *Quick facts:*

- Semantic technologies
- Technology providers
- Early adoption
- Business value
- Market size



# 1. SEMANTIC TECHNOLOGIES ARE ABOUT PUTTING SEMANTIC MODELS TO WORK...

- Semantic technologies represent meanings, associations, and know-how about the uses of things separately from data and program code.
- This knowledge representation is called an **ontology** — a run-time semantic model of information, defined using constructs for:
  - Concepts – classes, things
  - Relationships – properties (object and data)
  - Rules – axioms and constraints
  - Instances of concepts – individuals (data, facts)



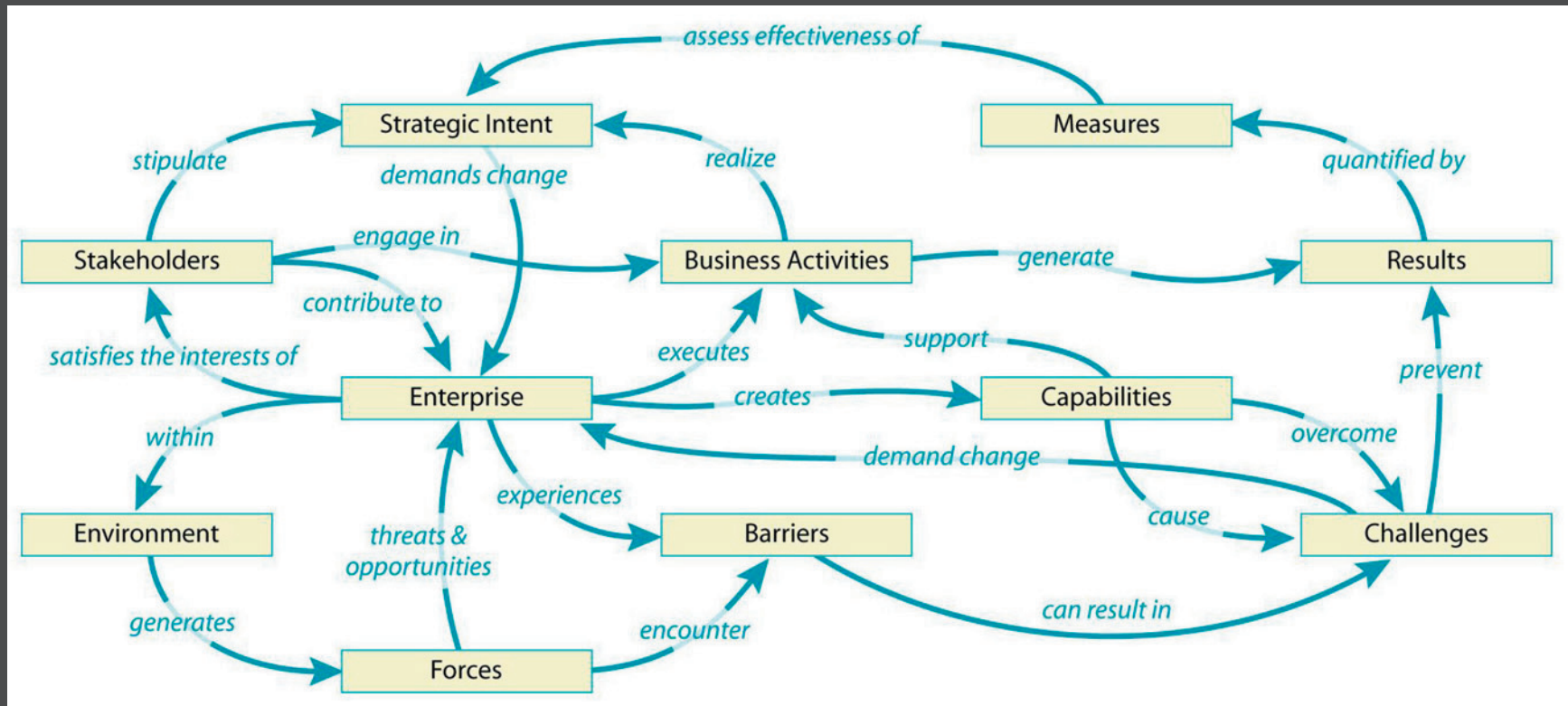
# SEMANTIC MODELS (AKA ONTOLOGIES) ARE LIKE AND UNLIKE OTHER IT MODELS

- Like **databases** ontologies are used by applications at run time (queried and reasoned over). Unlike databases, relationships are first-class constructs.
- Like **object models** ontologies describe classes and attributes (properties). Unlike object models, ontologies are set-based and dynamic.
- Like **business rules** they encode rules. Unlike business rules, ontologies organize rules using axioms.
- Like **XML schemas** they are native to the web (and are in fact serialized in XML). Unlike XML schemas, ontologies are graphs not trees, and used for reasoning.





# THIS IS A BUSINESS ONTOLOGY...



Source: Top Quadrant

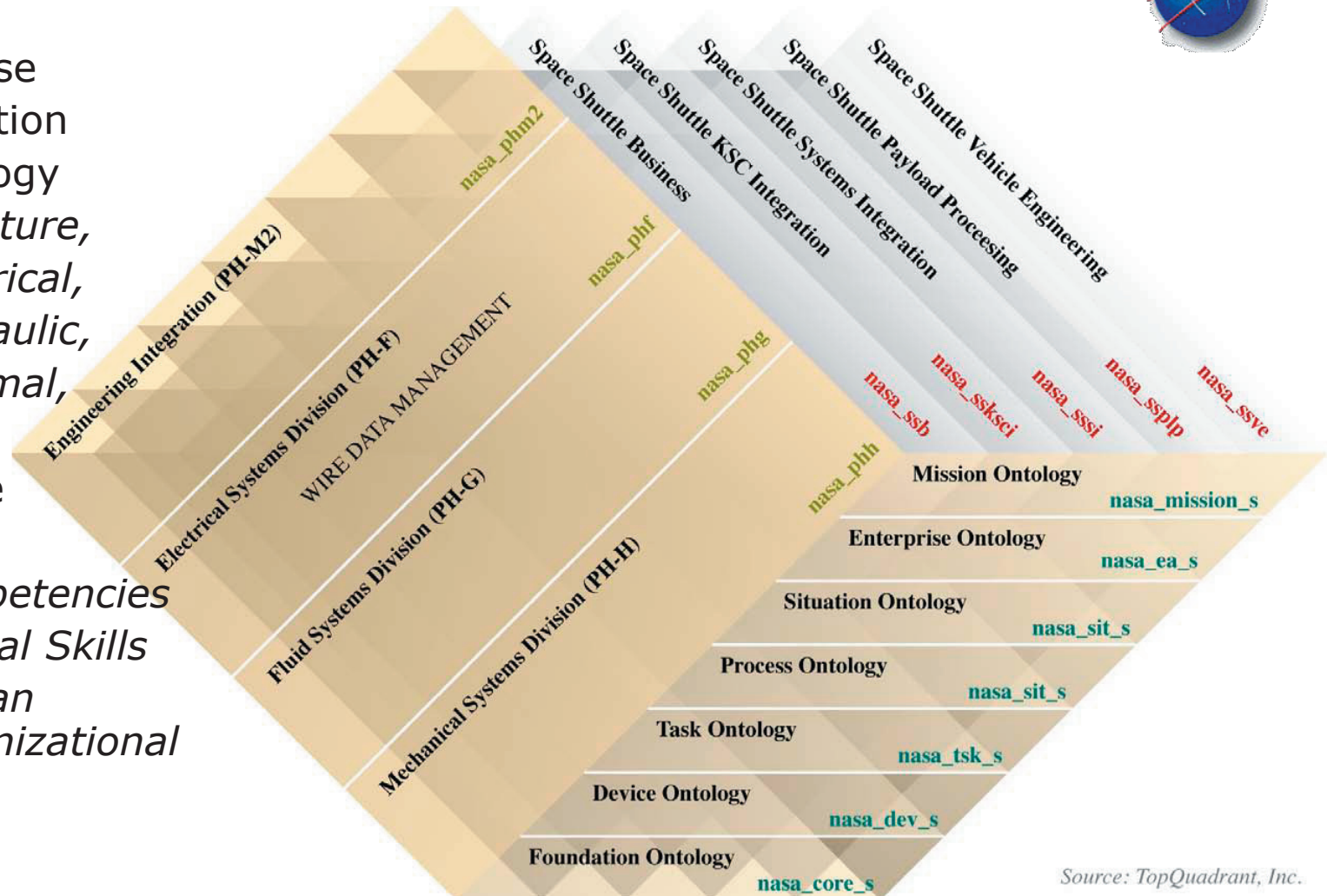


# THIS IS AN ENTERPRISE ONTOLOGY...

## Ontologies: Backplane of semantic enterprise



- Enterprise
- Information
- Technology
  - Structure,
  - Electrical,
  - Hydraulic,
  - Thermal,
  - ...
- Lifecycle
- Social
  - Competencies
  - Critical Skills
  - Human Organizational Risks



Source: TopQuadrant, Inc.



## 2. NEARLY 200 SEMANTIC TECHNOLOGY R&D, PRODUCT & SOLUTION PROVIDERS

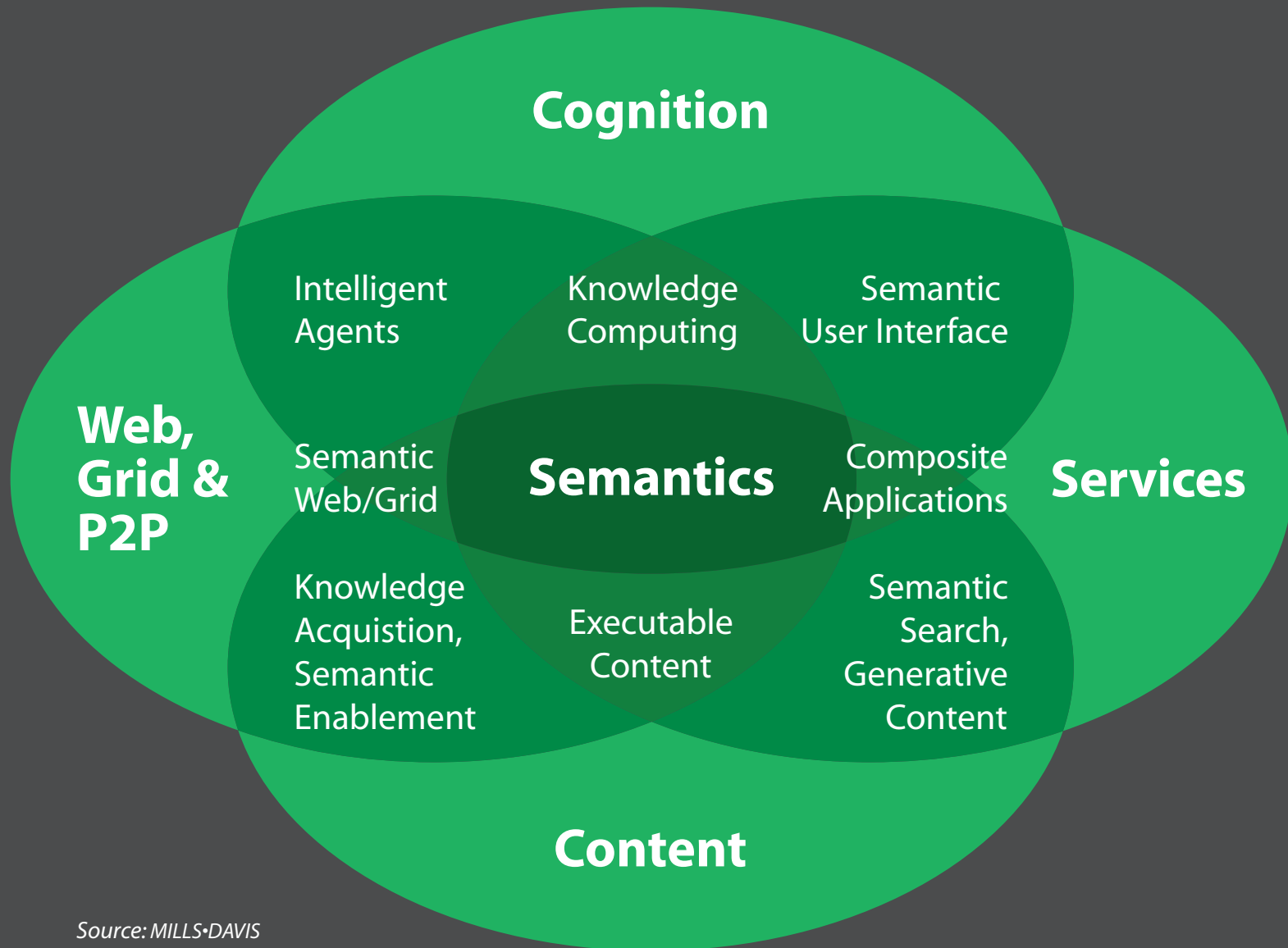
### Technology Providers Developing Semantic Solutions

Active Navigation	Cerebra	EMC/Documentum	Intellidimension	Neurok	Siderean
Adobe	CheckMi	Empolis	Intelliseek	Noetix	SilkRoad
Aduna	Cisco	Endeca	Intellisophic	Northrop Grumman	Software AG
Agilense	ClearForest	Engenium	Interwoven	nStein	Sony
AKT Triple Store	CoeTruman Technologies	Enigmatec	Inxight	NuTech	SRA International
Amblit Technologies	Cogito	EnLeague Systems	ISX Software	Ontologent	SRI International
Anteon	CognIT	Entopia	ISYS Search Software	Ontology Works	Stanford University
Apelon	Cognos	Entrieva	JARG	Ontopia	Stellent
APR Smartlogik	Composite	Epistemics Ltd.	Jayna	Ontoprise	Stratify
Arbortext	Compoze Software	Factiva	Kalido	OpenText	Sun Microsystems
Ask Jeeves	Computer Associates	Fair Isaac	Kanisa Software	Oracle	Sybase
AskMe	Conformative Systems	FAST	Knowledge Foundations	Profium	Synomos
Aspasia	Connecterra	FileNet	Knowledge Media Institute	Radar Networks	SYS Technologies
Astoria Software	Connotate	Fujitsu	Kofax	Raytheon	Tacit
AT&T	Content Analyst	GeoReference Online	Kowari	Readware	Taxonomywarehouse
ATG	Contextware	Global360	L&C	RuleBurst	TEMIS
Attensity	Contivo	Gnowsis	Lockheed Martin	Reed Elsevier	The Brain
Autonomy	Convera	Google	Logic Library	SAIC	Thetus
Axontologic	Copernic	Grand Central	Mark Logic	Sandpiper Software	Thomson
BBN	Correlate	Groxis	McDonald Bradley	SAP	Triple Hop
BEA	Cougaar Software	H5 Technology	Metacarta	SAS	Troux
BioWisdom	Coveo Solutions	Hewlett Packard	MetalIntegration	SchemaLogic	Ultimus
Black Pearl	Crystal Semantics	Hummingbird	Metallect	Semagix	Unicorn
Blue Oxide	Cycorp	Hyperion	Metamatrix	Semandex Networks	Verity
BrandSoft	Dassault Systems	i2 Inc	Metatomix	Semantic Light	Versatile Info Sys
Broadvision	DAY	IBM	Microsoft	Semantic Research	VerticalNet
Business Objects	Digital Harbor	iLog	Mind Alliance	Semantic Sciences	Vignette
C24 Solutions	Discovery Machine	Image Matters	Miosoft	Semansys	Visual Knowledge
Capraro Technologies	Dynamic Digital Media	Informatica	Modulant	Semaview	Vitria
Captiva	Dream Factory	InforSense	Mondeca	Semtation GmbH	Vivisimo
Celcorp	EasyAsk	Infosys	NCR Teradata	Serena	WiredReach
	Ektron	Innodata (ISOGEN)	NetMap Analytics	SiberLogic	XSB

Source: MILLS•DAVIS—10/01/2005



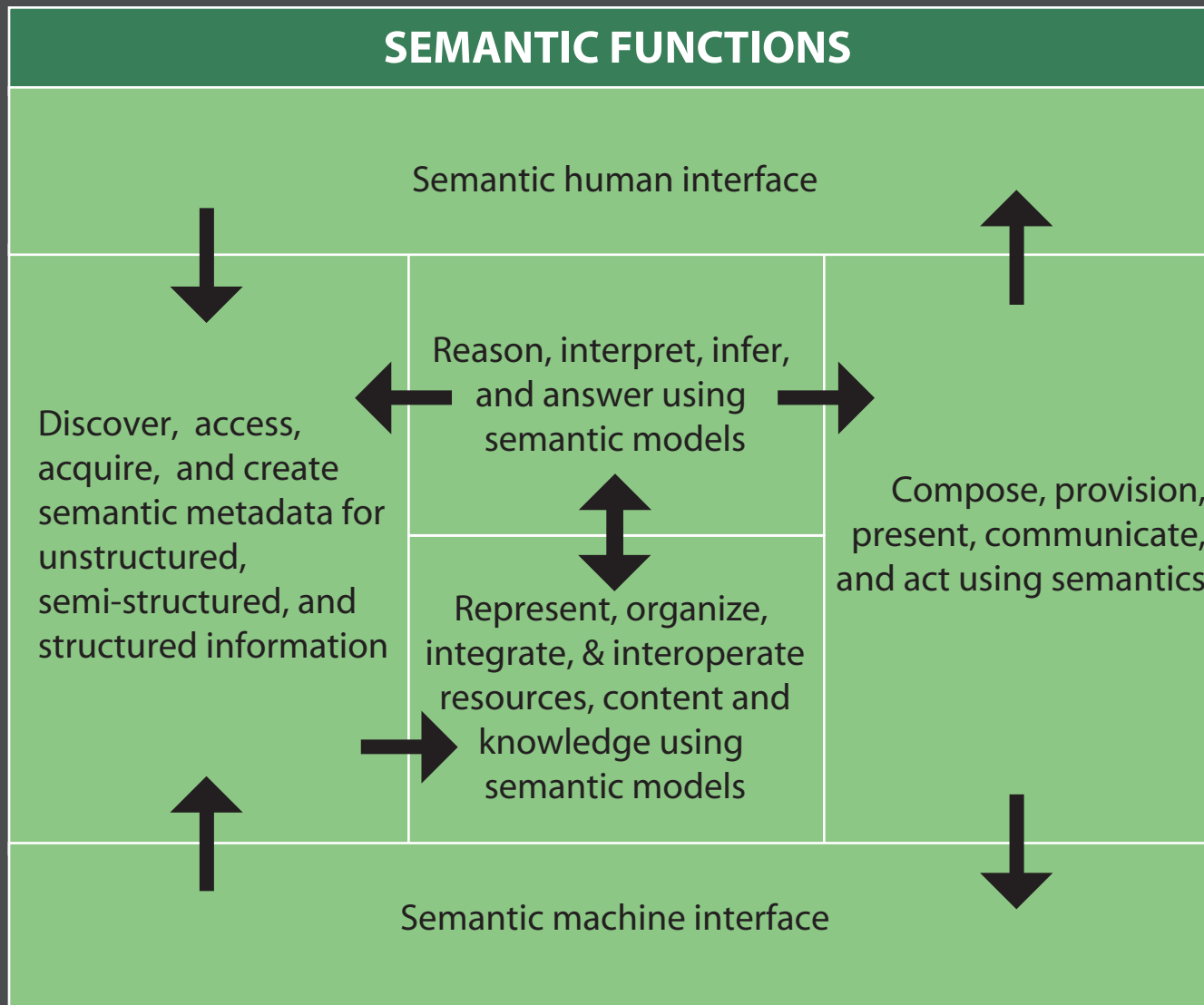
# SEMANTIC TECHNOLOGY R&D THEMES



Source: MILLS•DAVIS



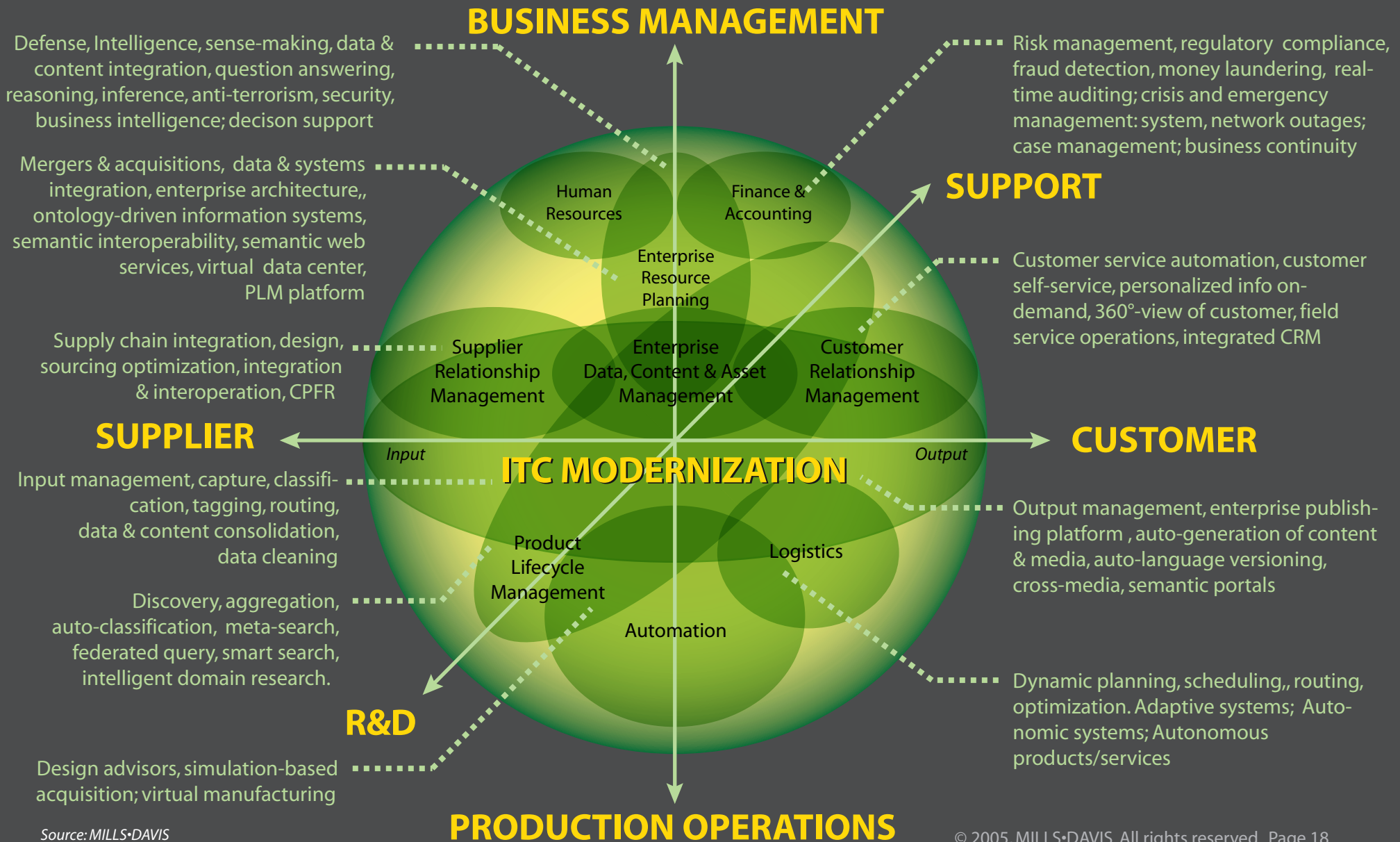
# FUNCTIONS OF SEMANTIC TECHNOLOGIES



Source: MILLS•DAVIS



# 3. MORE THAN 100 SEMANTIC TECHNOLOGY EARLY ADOPTER BUSINESS CASES





# 4. BUSINESS PERFORMANCE IMPROVES 2-10X

EFFICIENCY	EFFECTIVENESS	EDGE
<p><i>Cost savings</i></p> <p>Doing the same job faster, cheaper, or with fewer resources than it was done before</p>	<p><i>Return on assets</i></p> <p>Doing a better job than the one you did before, making other resources more productive and increasing their return on assets and attainment of mission</p>	<p><i>Return on investment</i></p> <p>Changing some aspect of what the business does, resulting in growth, new value capture, mitigation of business risk, or other strategic advantage</p>
IMPACT OF SEMANTIC TECHNOLOGIES		
20-80% less labor hours	50-500% quality gain	2-30X revenue growth
20-90% less cycle time	2-50X productivity gain	20-80% reduction in total cost of ownership
30-60% less inventory levels	2-10X greater number or complexity of concurrent projects, product releases & units of work handled	3-12 month positive return on investment
20-75% less operating cost	2-25X increased return on assets.	2-300X positive ROI over 3-years
25-80% less set-up & development time		
20-85% less development cost		

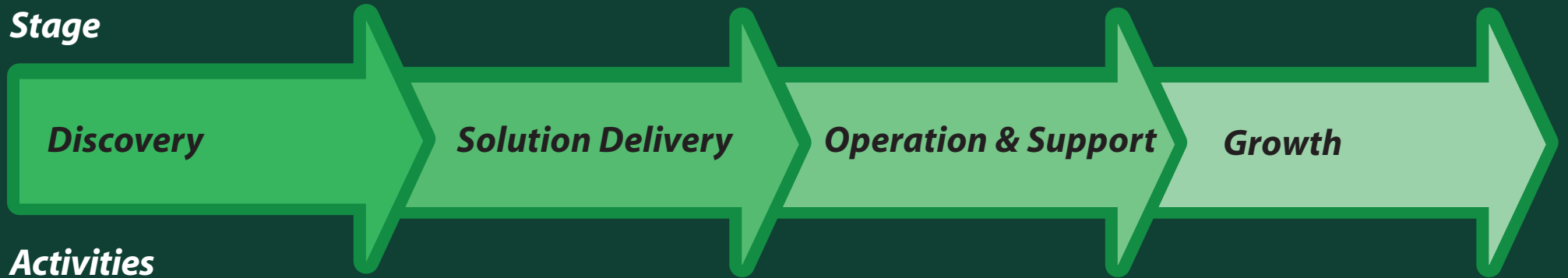
Source: MILLS•DAVIS





# VALUE AMPLIFIES ACROSS THE LIFECYCLE

## Stage



**Discovery**

**Solution Delivery**

**Operation & Support**

**Growth**

## Activities

*Diagnose problem  
Envision solution  
Map ontology  
Make business case*

*Design semantic apps  
Build business ontology  
Connect resources  
Integrate & test  
Deploy*

*Use, operate solution  
Monitor, measure performance  
Maintain & support*

*Analyze new needs  
Add capabilities  
Upgrade solution  
Optimize performance*

## Benefits

*Explicit business case  
Knowledge needs modeled  
Interrelated data, system sources  
Value of legacy preserved  
Make, buy, rent, share options  
Flexible, federated architecture  
Less time/cost to prototype*

*Business ontology speeds  
data, process integration  
Composite applications give  
total picture, unified UI  
Capital outlay reduced  
Less time/cost to solution  
Faster time-to-market  
Faster return on investment  
Reduced development risk*

*Faster, better decision-making  
Cycle time, productivity improved  
Higher service levels  
Improved quality & reliability  
Less training and support  
Simplified maintenance  
Reduced operating cost  
Reduced total cost of ownership*

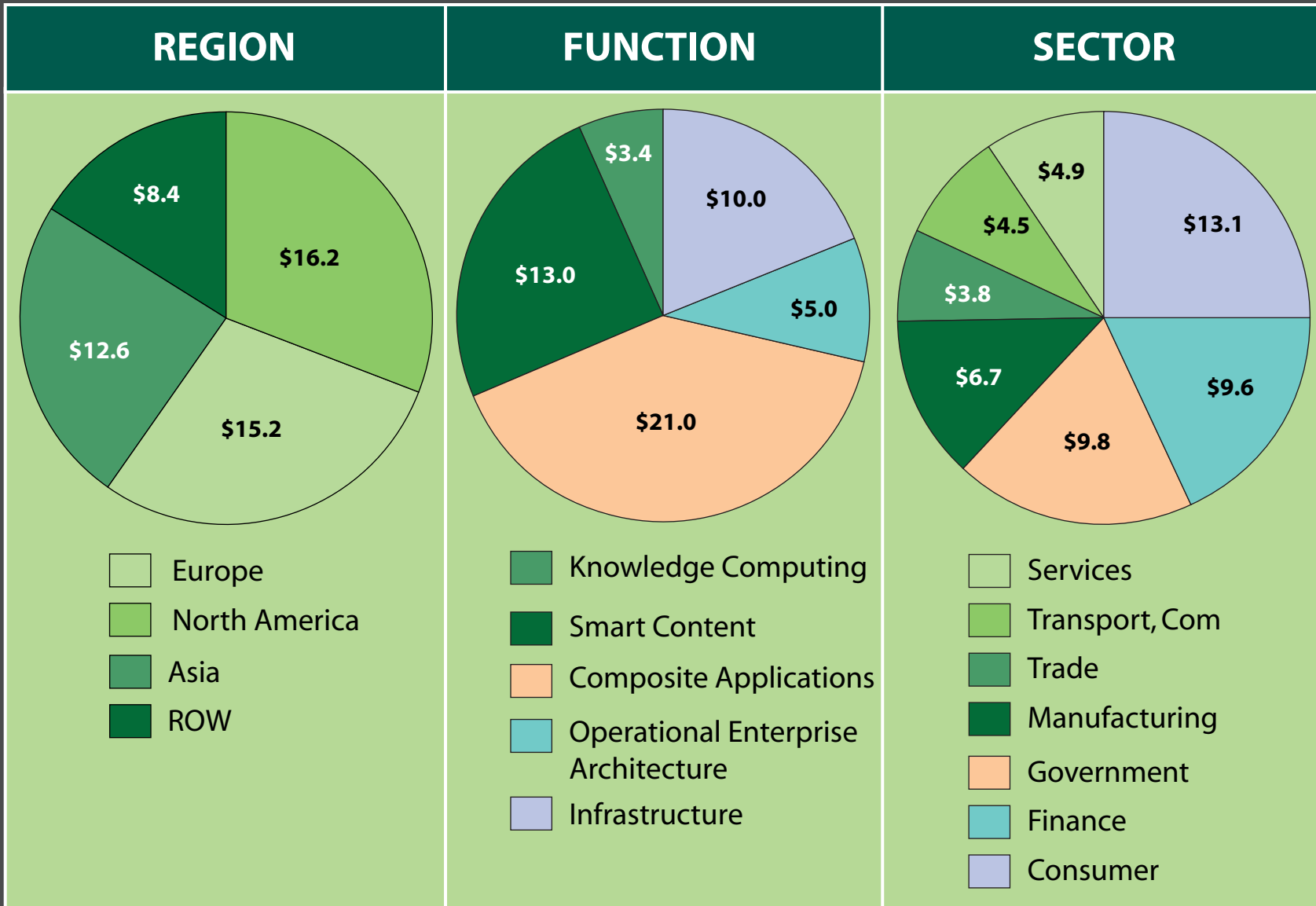
*Faster time to enhance  
Greater agility, flexibility  
Less capital re-investment  
Real-time optimization  
Faster time to deploy  
Reduced development risk  
Enhanced ROI*

Source: MILLS•DAVIS





# 5. SEMANTIC EXECUTION WORLD-WIDE MARKET WILL EXCEED TO \$50 BILLION BY 2010

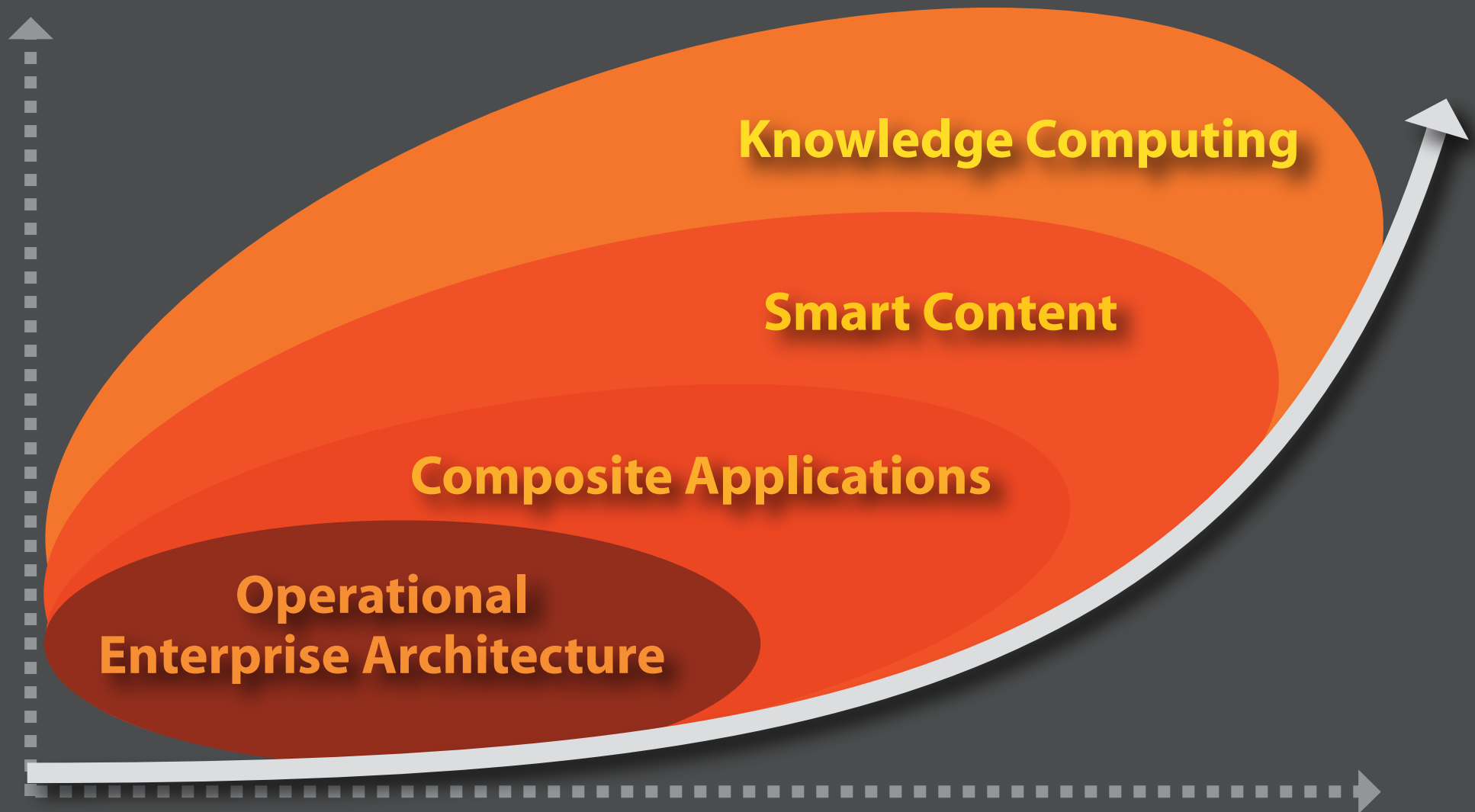


Source: MILLS•DAVIS



# WHAT WE'RE LEARNING AS SICOP...

*New semantic execution value paradigms!*





# OPERATIONAL ENTERPRISE ARCHITECTURE

## SEMANTIC OPPORTUNITY

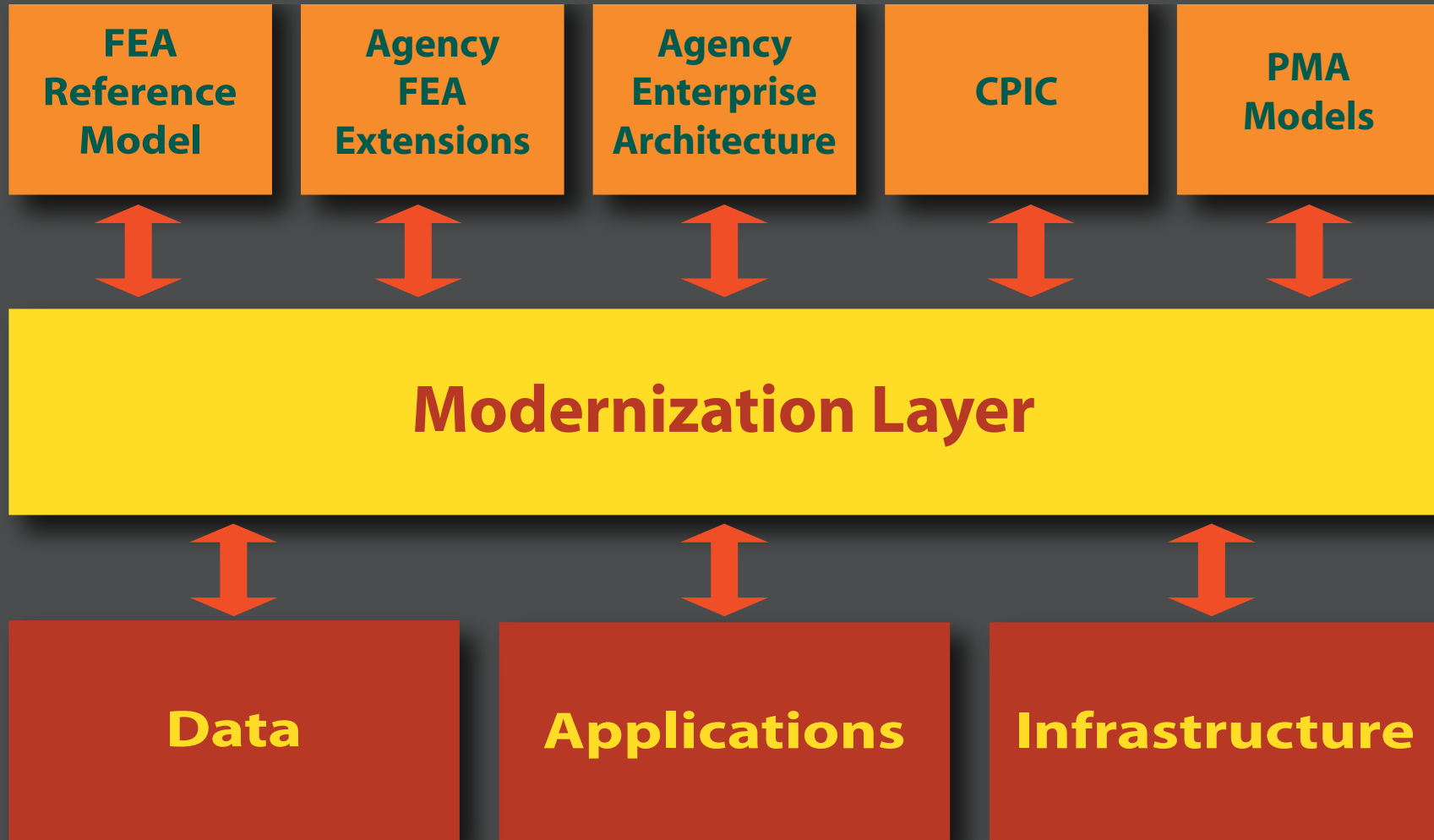
- **Opportunity** — \$5B
- **R&D Themes** — Executable enterprise architecture, enterprise integration, semantic interoperability
- **Problem** — Hundreds of millions spent to date to develop enterprise architecture as a basis for IT modernization; remains largely a manual compliance exercise, producing reference documentation, disconnected from operations and management systems.
- **Semantic solution** — Semantic enterprise architecture based on enterprise management metamodel, linked with FEA reference models, Agency FEA extensions, CPIC, and President's Management Agenda including E-Gov, Budget-Performance integration, Financial Services, and Human Resources.

## BUSINESS VALUE

- **Efficiency gain** — Semantic auto-discovery of IT artifacts and documentation gives visibility, eliminates 1/5 to 1/3 of cost of as-is modeling, compliance auditing, and steady-state maintenance projects.
- **Effectiveness gain** — Enterprise knowledgebase enables line-of-sight analyses, analytics, and automating of alignment and compliance with OMB, saving labor.
- **Mission edge** — Integrated, semantic model-based operational capability for cross-agency investment planning and control, IT portfolio management, and compliance with OMB and PMA directives.



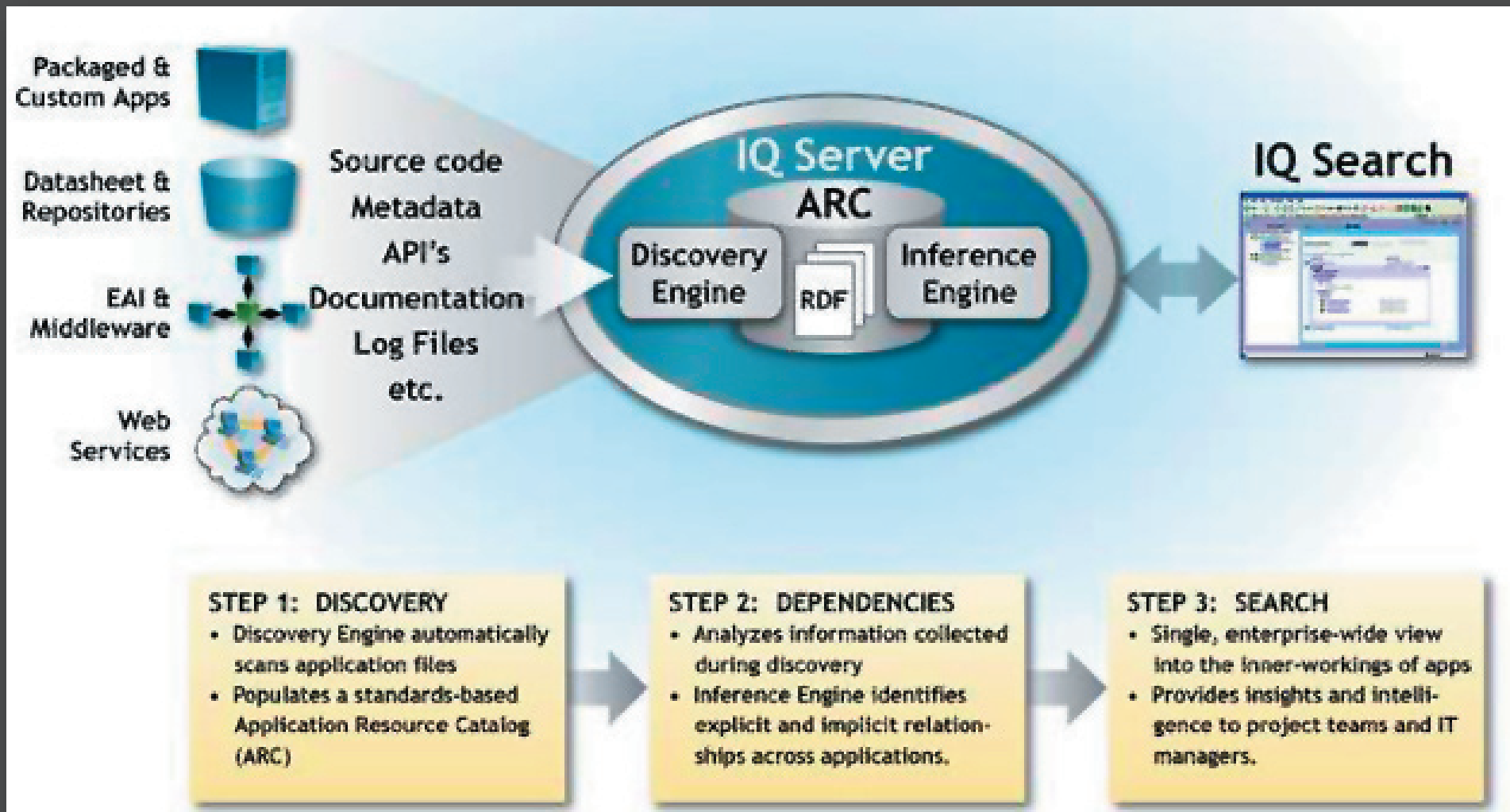
# OPERATIONAL ENTERPRISE ARCHITECTURE: MODERNIZATION LAYER





# OPERATIONAL ENTERPRISE ARCHITECTURE: SEMANTIC DISCOVERY OF THE "AS-IS"

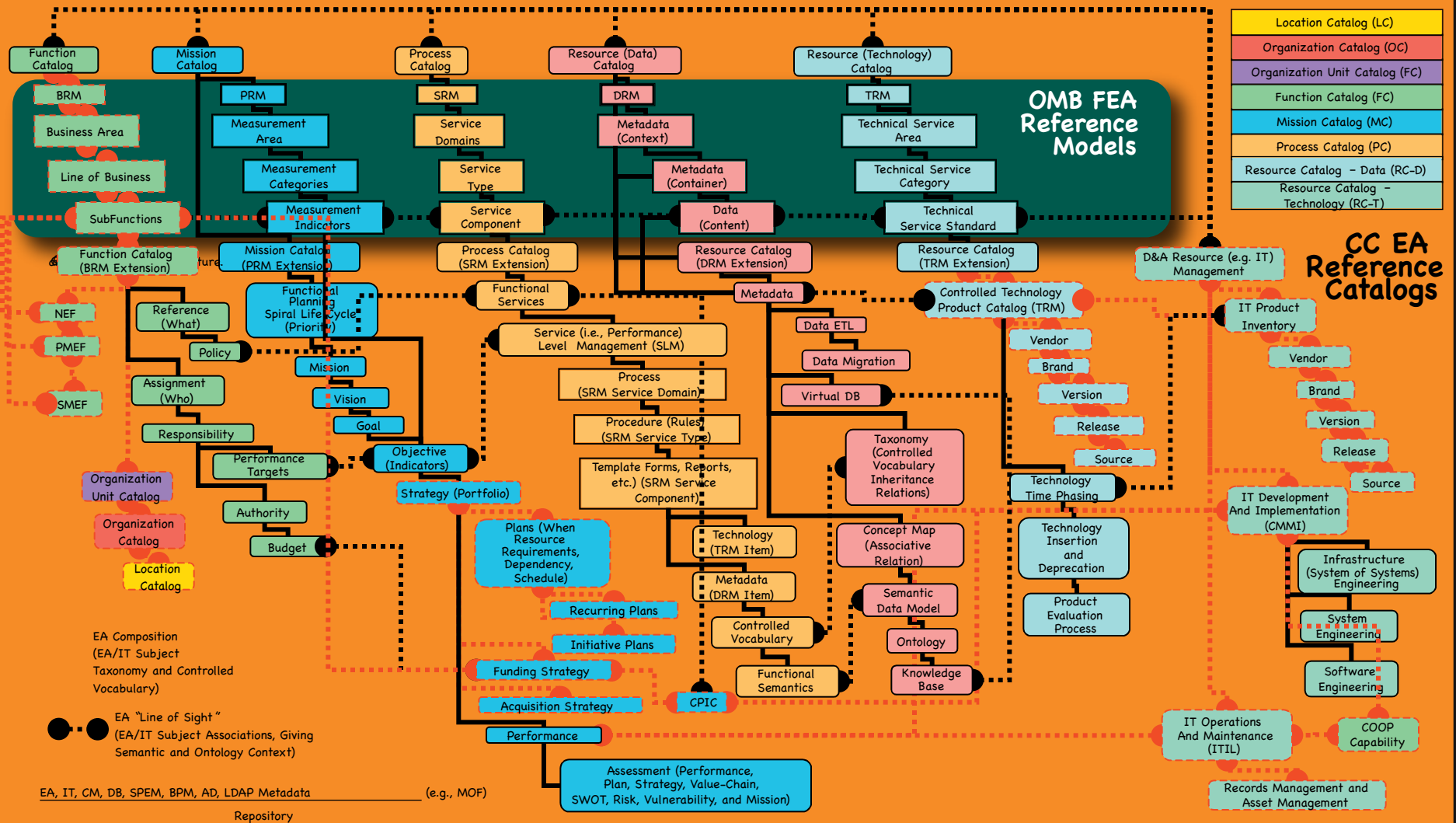
*"Google" for IT + latent semantic analysis = ongoing visibility*





# OPERATIONAL ENTERPRISE ARCHITECTURE: EXECUTABLE "TO-BE" SEMANTIC MODELS

## Federal Enterprise Architecture for managing continuity of communications

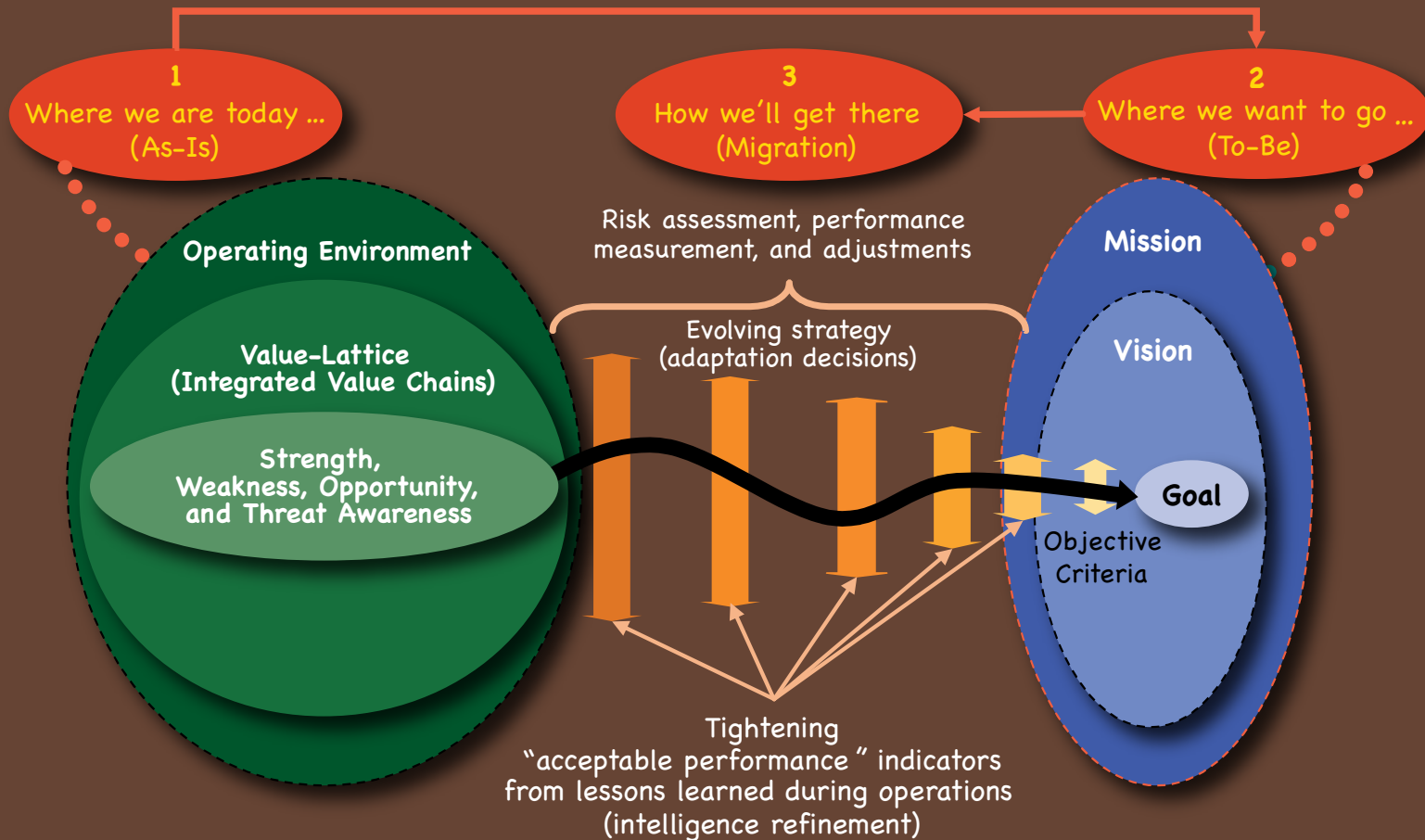




# OPERATIONAL ENTERPRISE ARCHITECTURE: INSTRUMENTING EXECUTIVE MANAGEMENT

## Executive Management Function—Migrating from As-Is to To-Be

Operational EA provides a procedure to move from problems to solutions.  
Operational EA enables accomplishment of architecture goals and objectives.



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# COMPOSITE APPLICATIONS

## SEMANTIC OPPORTUNITY

- **Opportunity** — \$21B
- **R&D Themes** — Semantic user interface, business ontologies (that model entities, attributes, relationships, processes, events and rules), and semantic query across distributed data, applications and services.
- **Problem** — Business users don't care about enterprise architecture. They want capabilities, that demand information integration, system-of-system interoperability and power-to-the-edge, but cannot define all requirements in advance. Need a way to deliver benefits directly to end-users that is fast, affordable, incremental, and non-invasive.
- **Semantic solution** — Composite application as killer application for semantic web.

## BUSINESS VALUE

- **Efficiency gain** — 5X faster development. Lean teams. Reduced project risk.
- **Effectiveness gain** — Tactical, non-invasive, iterative solution for strategic modernization empowers IT. Composite applications links information in context, empowering users.
- **Mission edge** — New categories of knowledge worker capabilities for: exception handling, emergency response, compliance, risk management, situation assessment, command and control.





# DIGITAL HARBOR: COMPOSITE APPLICATIONS POWERED BY SEMANTIC MODELS

- Next-Generation software platform for building and using composite applications
- Composite Application Solution: EII, SOA, and Portals
- 6 years and over \$50M in investment R&D and over \$100M in partner R&D
- Supports 22 industry standards including OWL
- Delivered 24 business templates over six domains
- Government customers include Navy, Air Force, NSA, DISA, DIA, NRO, NGA, CIFA, and DHS



# COMPOSITE APPLICATIONS: KNOWLEDGE WORKER REQUIREMENTS

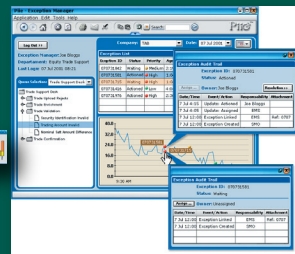
## Many knowledge applications have a similar lifecycle...

Lifecycle often begins with automated capture of events, followed by human monitoring and analysis of situation based on information from different sources in different formats (structured & unstructured). People need to keep the context, share the picture of the situation, and resolve it.



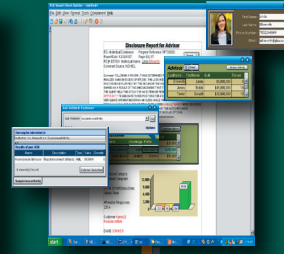
### Event Capture

- Dashboards
- Rich Visualization
- Thresholds & Highlights
- In-context navigation
- Live updates
- Ad Hoc Discovery
- Multiple Ops Systems



### Monitoring & Analysis

- Many types and sources of information
- Save as 'smartlets'
- Personalized view of common operating picture
- Optimized Data Access



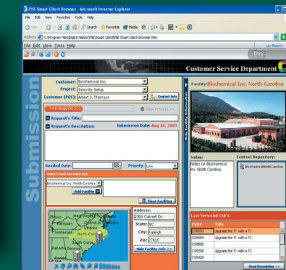
### Case Management

- Assemble the pieces
- Show the relationships
- Link different kinds of information (data with documents with internet with media)
- Keep live data



### Contextual Communication

- Reports with Context
- Live data in the report
- Reusable Smartlets
- Rapid Development
- Easy Distribution
- Common operating picture



### Event Resolution

- Action Oriented
- Dynamic Workflows
- Process UI for end users
- Process Monitoring
- Transactional

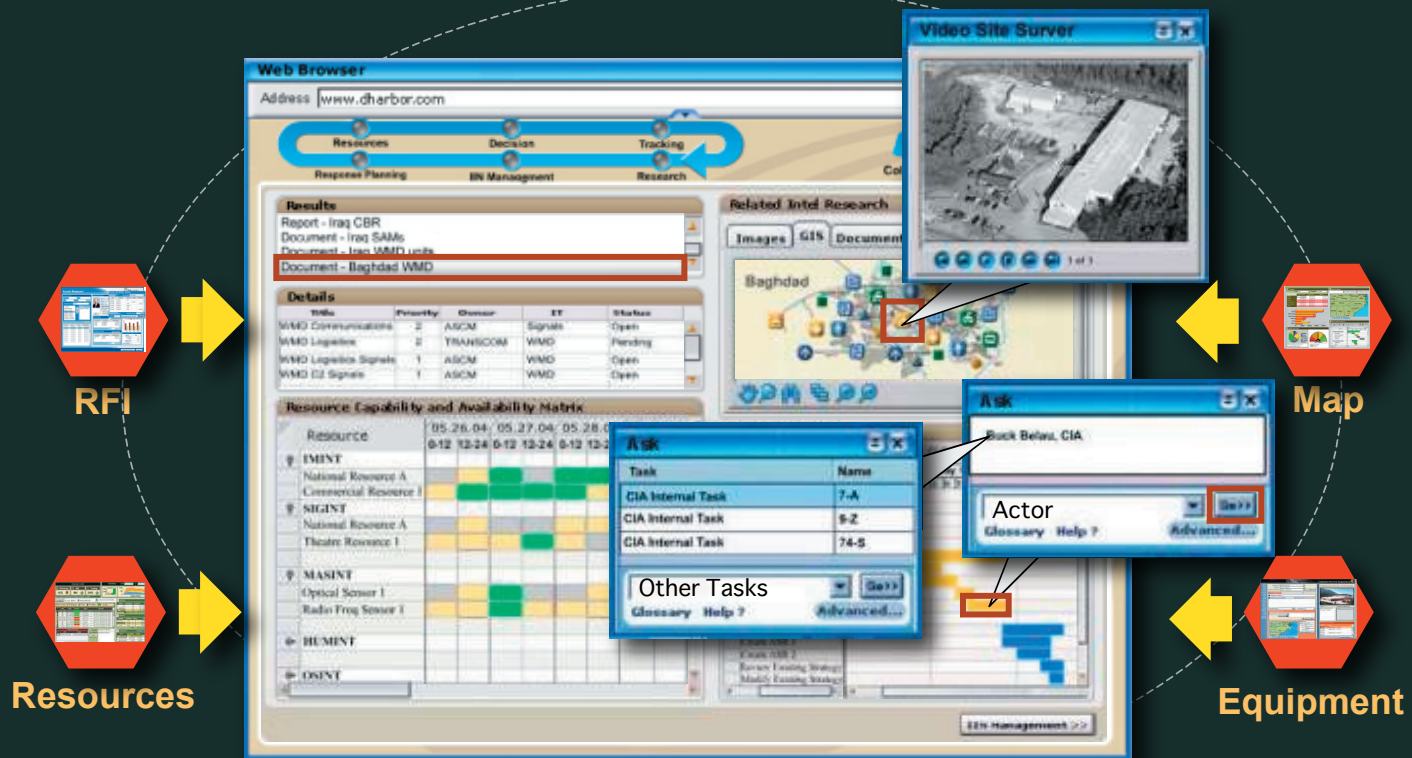
Source: Digital Harbor



# COMPOSITE APPLICATIONS: FUNCTIONAL CAPABILITIES

## Composite Application

1. **Fuse** services from multiple applications
2. **Correlate** information in context
3. Drill down in **Real-Time**
4. **Ask** questions across databases
5. **Infer** links across systems



Source: Digital Harbor



# COMPOSITE APPLICATIONS: ANATOMY OF A SOLUTION

## Anatomy of a composite application — Semantic technologies at 3 levels:

### (1) Composite User Interface

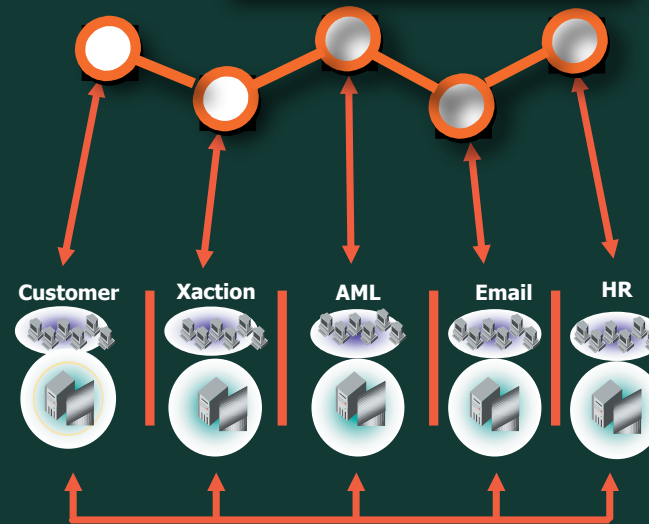
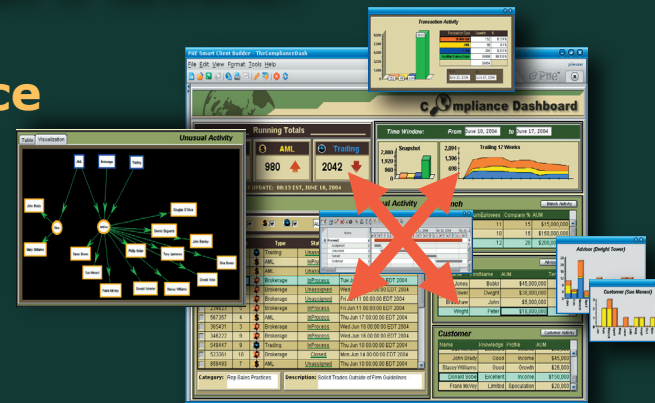
UI must persist and expose semantics such that users can interact with meaningful objects

### (2) Composite schema (business ontology)

A business ontology describes the semantics of data relationships, workflow, events, and business rules

### (3) Composite query (EII)

Logically map multiple databases, applications, and web services as if they came from a single source



Source: Digital Harbor



# COMPOSITE APPLICATIONS: IMPLICATIONS FOR DATA ARCHITECTURE

- Tools that enable exchange, compositing and harmonization of distributed data and metadata sources in the context of the intended end-use application.
- Sharing semantic models for composite applications that include: entities, attributes, relationships, processes, events, and rules as well as security and provenance.



# SMART CONTENT

## SEMANTIC OPPORTUNITY

- **Opportunity** — \$13B
- **R&D Themes** — Semantic discovery and sense making; authoring driven by semantic models; semantic modeling of meanings and knowledge contained in text, tables, graphics and other media; semantic search, semantic Q&A, content and media generation from models, intelligent advisors, semantic UI.
- **Problem** — Content lifecycle costs surge as information volume explodes. Issues include search quality, how to leverage knowledge worker content use, authoring cost, content interoperability and integration, & coping with overload.
- **Semantic solutions** — Knowledge portals, collaboration, intelligence help desk, personal information management, ambient intelligence.

## BUSINESS VALUE

- **Efficiency gain** — Up to 50% reduction in content authoring and support costs.
- **Effectiveness gain** — Knowledge-centered rather than document-based process can increase productivity by 5-10X, integrate executable content with composite applications and operational enterprise architecture
- **Mission edge** — Enables new categories of knowledge and content-intensive applications such as intelligence Q&A, just-in-time knowledge, intelligent tutoring and simulation, simulation-based acquisition, virtual manufacturing, and policy-based computing.



# SMART CONTENT: A WORKING DEFINITION

- Content is anything written, depicted, filmed, recorded, animated and stored in some media.
- Digital content is any content whose physical properties can be substituted by computer-processable descriptions. (E.g. a digital recording on a CD is a binary description of the sound.)
- “Smart” content is digital content whose primary information (e.g. music, video, text, etc.) is enhanced by secondary information about the content. This secondary information is called *metadata*.





# METADATA — MAKING CONTENT “SMART”

- 1 Knowledge extraction creates metadata that enables concepts and relationships in content to be interpreted by computer.
- 2 Domain knowledge provides metadata for understanding the meaning of the content from different perspectives.
- 3 Context of use modeling provides metadata that enables software to organize content to task, interest, or preference.
- 4 Media resource metadata enables packaging content for presentation across different media.
- 5 Behavioural knowledge allows the computer to sequence communications, manage dialogs, and orchestrate action.
- 6 Provenance and rights metadata is key to establishing trust, maintaining security, and enabling commerce.
- 8 Semantic models and metadata enable content integration, interoperability, and reasoning over content sources.



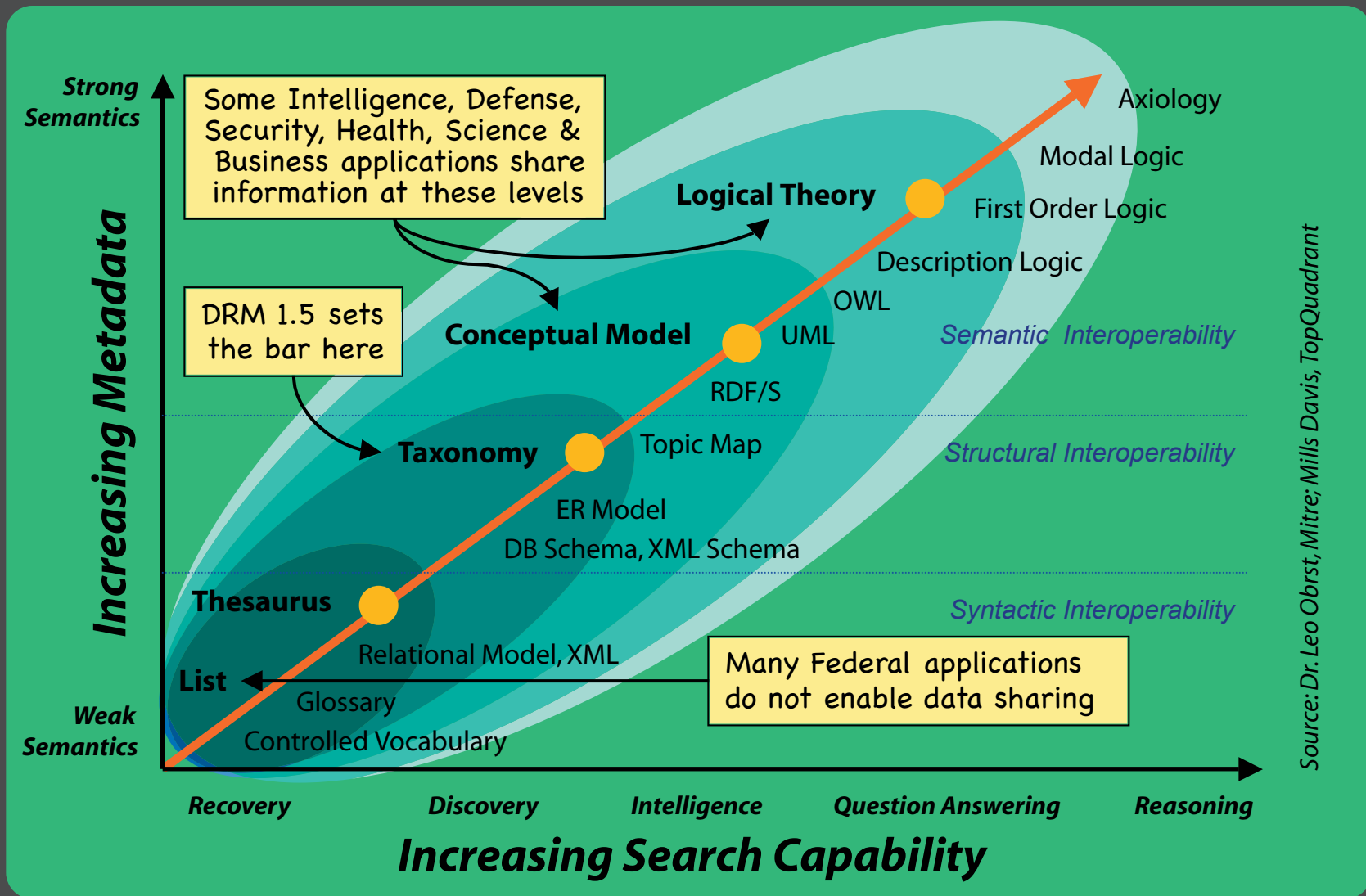


# WHY SMART CONTENT?

- Cope with information overload.
- Improve content accessibility and search quality.
- Reason over content and knowledge sources to answer questions and support decision making.
- Leverage knowledge worker content use in specific contexts.
- Improve the economics of authoring, provisioning, and distributing content.
- Mobilize and make sense of distributed content assets from diverse provenance.
- Achieve content interoperability and integration across diverse sources that have been classified and indexed by different communities.
- Ensure content from diverse provenance is trusted, and authoritative for its intended use.
- Achieve multiple returns on content investments.



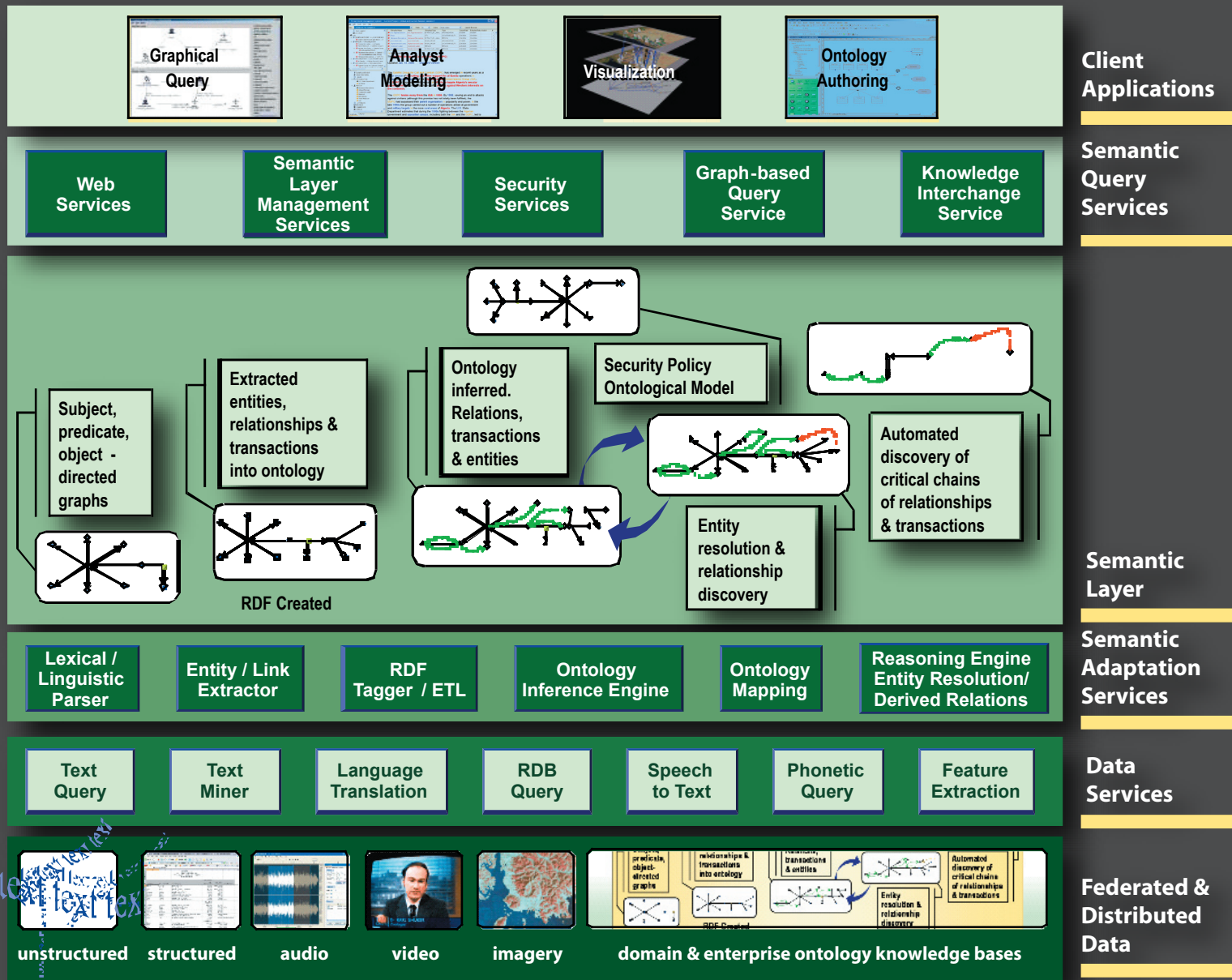
# SMART CONTENT CONTINUUM



Source: Dr. Leo Obrst, Mitre; Mills Davis, TopQuadrant



# SMART CONTENT: INTELLIGENCE COMMUNITY STACK





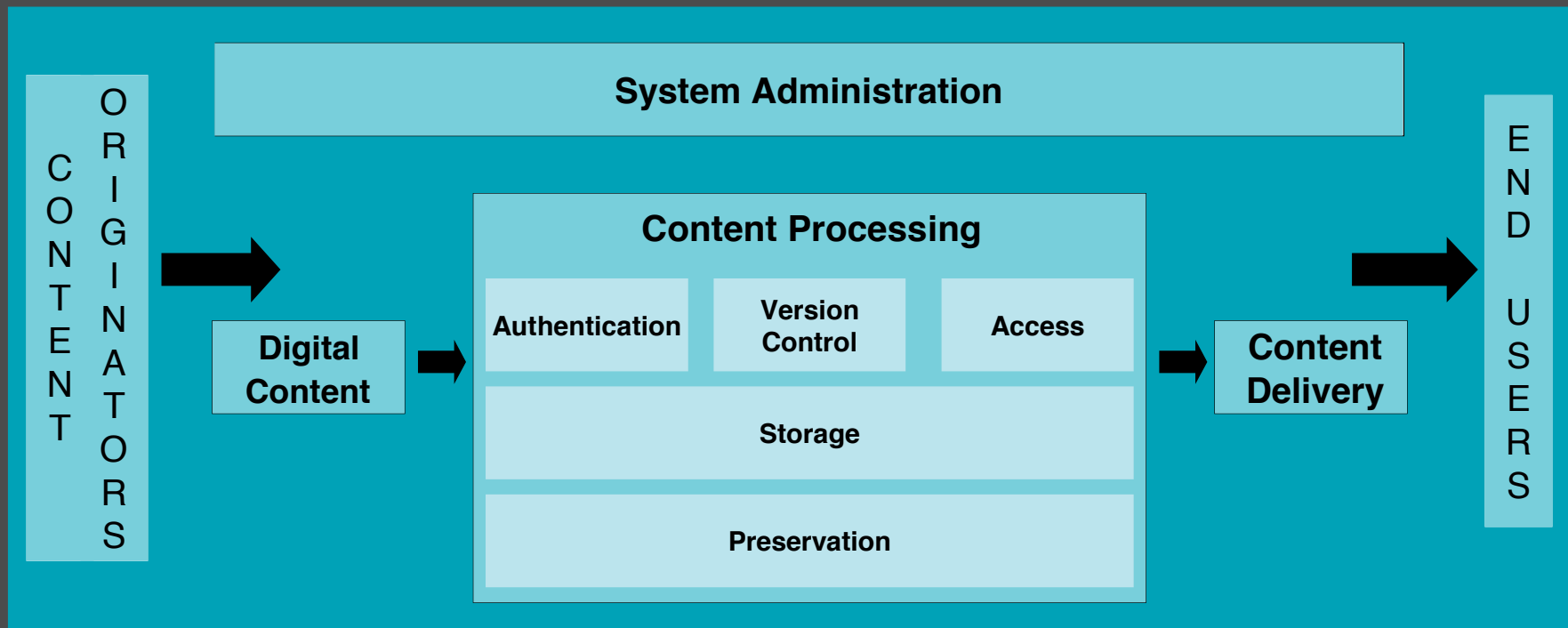
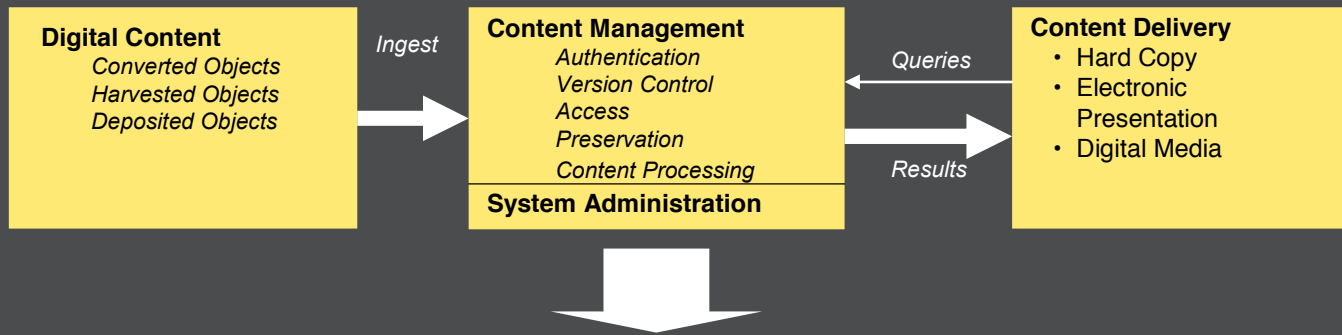
# SMART CONTENT: IC DATA MATURITY MODEL

Data Maturity	Data Fidelity	Metadata Type	Data Instance	Data Organization	Metadata Content	Tools	Data Autonomy
4 Optimized Semantics	High Fidelity	Multi-layer Markup	Ontology and automated reasoning	Ontology	Inferred Relationships	Semantic Web Agent Technology	Smart Data
3 Managed Relationships		Entity & Relationship Markup	Taxonomies and Documents with horizontal integration of domain vocabularies	Ontology Taxonomy	Named Relationships	Data Independent	
2 Defined Content		Entity Markup	XML Documents using vertical domain vocabularies	Taxonomy	Content Mission	Filtering, Clustering, Categorization	
1 Repeatable Structure		Structure Markup	Schemas & DTDs	Document Models	Security Resource Format	Database Tools	
0 Chaotic	Low Fidelity	Unstructured	Text Documents & Database Records	Proprietary Application	Proprietary Properties	Search Tools	Dependent Data

Source: Joel A. Gladding, SAIC



# SMART CONTENT: GPO'S OPEN ARCHIVAL MODEL



GPO's FDS is based on the Open Archival Information System reference model



# SMART CONTENT: GPO'S NEW SYSTEM WITH SEMANTICS

## COMPOSITE APPLICATIONS

**Ingest:**  
Harvest  
Deposit  
Convert

**Content mgmt:**  
Validate  
Authorize  
Version  
Storage

**Preservation:**  
Archival data  
management  
Archival storage

**Access:**  
Search  
Request  
Catalog  
Reference  
Interface  
User support

**Content delivery:**  
Retrieval  
E-presentation  
Digital media  
Physical media  
Composite apps  
Intelligent Q&A

**Administration:**  
Security  
Process mgmt  
Data mining  
Biz Intelligence

**Ongoing R&D:**  
Discovery  
Modeling  
Composite UI

## SEMANTIC LAYER UI Context Connectivity Content

**1. User interface:**  
Composite application(s) use semantic models to link content and data sources in real-time. encapsulate best of breed tools & applications in the UI

**2. Context:**  
Business ontology defines:

- Entities
- Attributes
- Relationships
- Process
- Events
- Rules

**3. Connectivity:**  
Semantic models orchestrate linking and interoperation across federated & distributed data sources via multiple mechanisms:

- APIs
- Web services
- RDB query
- Text query and mining
- Language translation
- Speech to text
- Phonetic query
- Feature extraction

**4. Content:**  
Semantic enablement services mine knowledge in unstructured and structured information as well as metadata, taxonomies, ontologies & knowledgebases using:

- Lexical and linguistics parsing
- Entity and relationship extraction
- Subject/predicate/object (RDF) tagging
- Latent semantic analysis
- Semantic metadata enhancement
- Ontology mapping, inferencing

## FEDERATED & DISTRIBUTED CONTENT

**Documents**  
Hard copy  
Digitized legacy  
Digital documents  
Web pages

**Digital Media:**  
Audio  
Video  
Imagery  
Graphics

**Structured data:**  
Files  
RDBs

**Enterprise metadata:**  
Enterprise Architecture  
Business ontologies  
Data reference models  
Composite app models  
Interoperability metadata

**Domain metadata:**  
Catalogs  
Controlled vocabularies  
Taxonomies  
Domain ontologies  
Registries

Source: MILLS•DAVIS



# KNOWLEDGE COMPUTING

## SEMANTIC OPPORTUNITY

- **Opportunity** — \$3.4B
- **R&D Themes** — Modeling all forms of knowledge. Massive knowledgebases. Intelligent agents. Cognitive systems (al a DARPA). Adaptive, autonomic, and autonomous human and robotic systems with massively scalable knowledgebase and reasoning performance.
- **Problem** — Large-scale knowledgebases, complex forms of situation assessment, and value-based modes of reasoning essential in many domains exceed the capabilities and performance capacity of current standards-based approaches.
- **Semantic solutions** — Semantic operating systems and UI, intelligent systems.

## BUSINESS VALUE

- **Efficiency gain** — Zero code, declarative application development. Tractable incremental costs of knowledge acquisition, life cycle management, and knowledge-commerce.
- **Effectiveness gain** — Capabilities for research, analysis, design, engineering, virtual manufacturing, logistics medicine, law, management, Advanced decision support.
- **Mission edge** — Systems that know, reason as humans do, and learn. Knowledge superiority, performance augmentation, labor transitions.

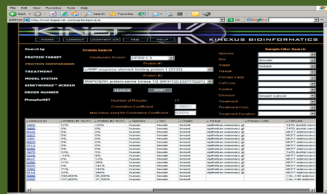




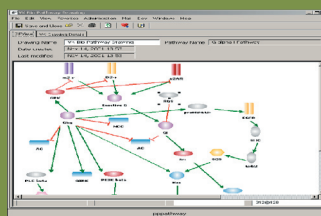
# KNOWLEDGE COMPUTING: SEMANTIC APPLICATIONS

## BioCAD

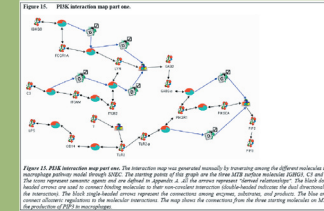
Helping scientists think together



Genomic/Proteomics  
Experiments

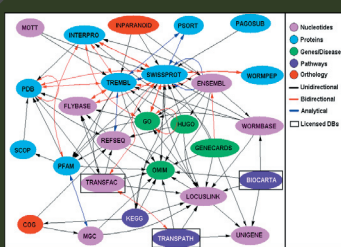
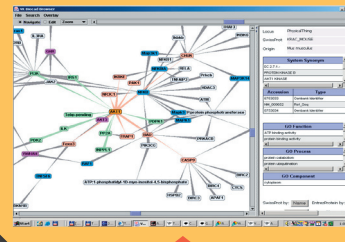


Pathway Modeler  
& Editor



Simulation & Test  
Services

Semantic Models



Public Databases



Private Research  
Servers



Publication  
Server

Source: Visual Knowledge



# KNOWLEDGE COMPUTING: THEORY-BASED SEMANTIC WEBS

## Production Tools

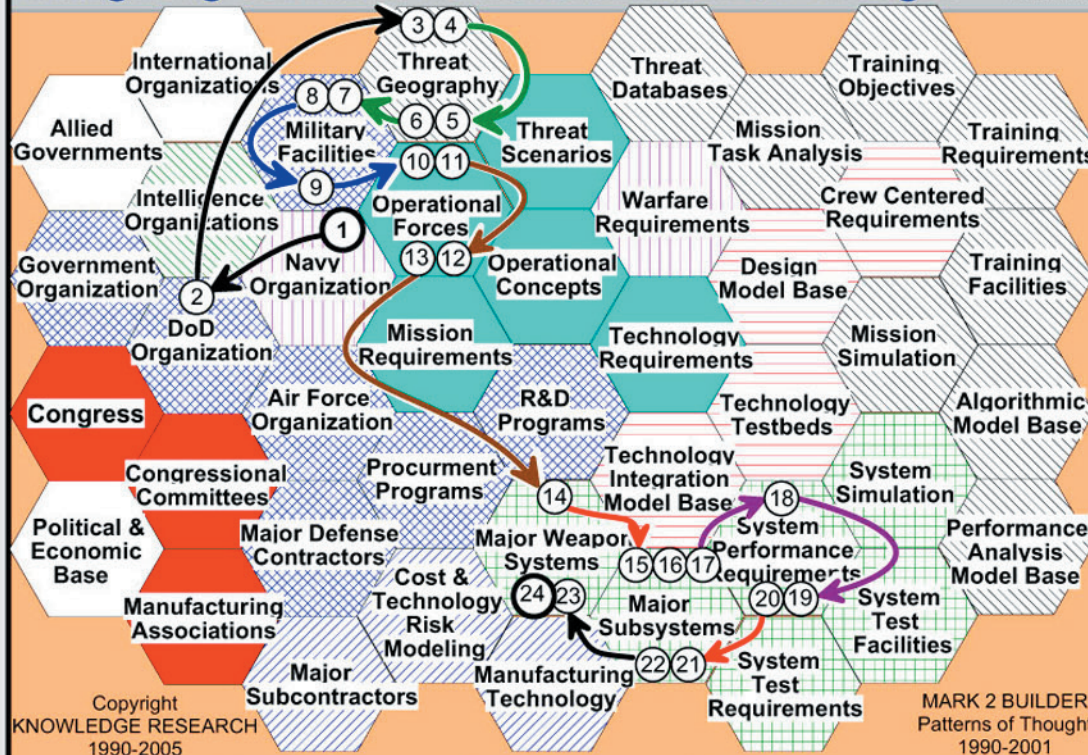
### KNOWLEDGE RESEARCH

#### AGGREGATE AEROSPACE KNOWLEDGE ACQUISITION PROJECTS 1991-1996

- Delivered June 1991  
*Budget planning and warfare assessment*  
\$350K  
OPNAV FastPlan Summary Warfare Appraisal Knowledge Base
- Delivered June 1992  
*Technology & Economic Impact*  
\$30K  
NASA Space Explorations Technology Concept Demo
- Delivered January 1993  
*Cataloging Current Facilities and Capabilities*  
\$150K  
NAWC Joint Service T&E Capabilities Knowledge Base
- Delivered January 1994  
*Cataloging and integrating simulators, models, data sources*  
\$350K  
Joint Service Universal Threat Simulation System Knowledge/Model Base
- SBIR Phase 1A  
Delivered May 1994  
*Building TPIPT Roadmaps*  
\$85K  
AFSOC Technology Roadmap Knowledge Base
- Product Prototype  
Delivered Dec 1994  
\$85K  
Carroll's Government & Defense Organization Knowledge Base
- Technology Capture & Integration  
*Initial Designs to AIR-531*  
\$200K  
Aircrew Systems for Precision Strike Technology Integration Knowledge Base
- Phase I Warfighting & Systems Technology Requirements  
*Demonstrated & Delivered May 1995*  
\$250K  
Joint Advanced Strike Technology (JAST) Knowledge Base

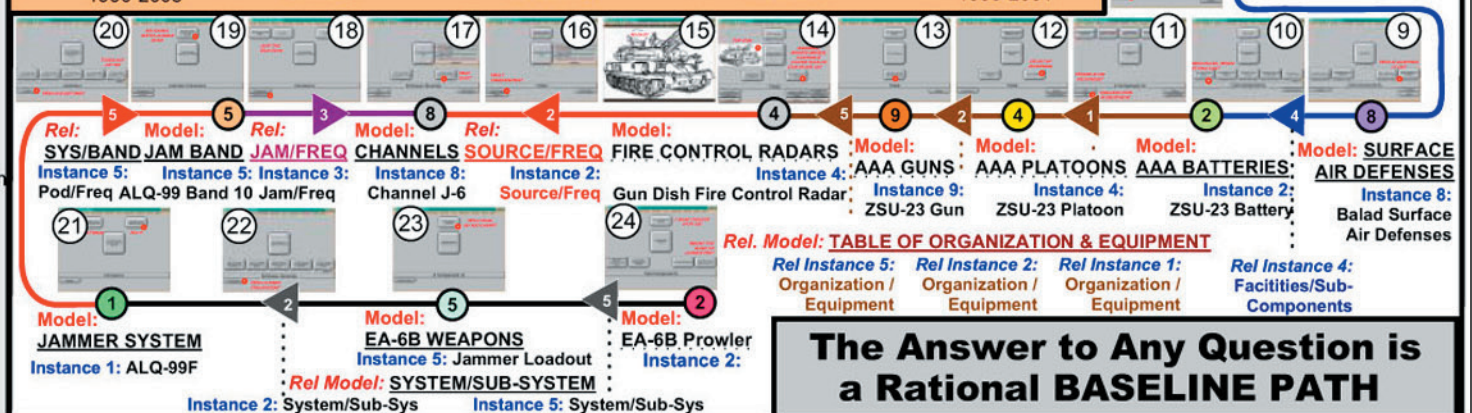
**\$1.5 Million labor + \$350K licenses**

## Navigating Semantic Patterns of Rational Thought



## KNOWLEDGE FOUNDATIONS

### Navigation Platform

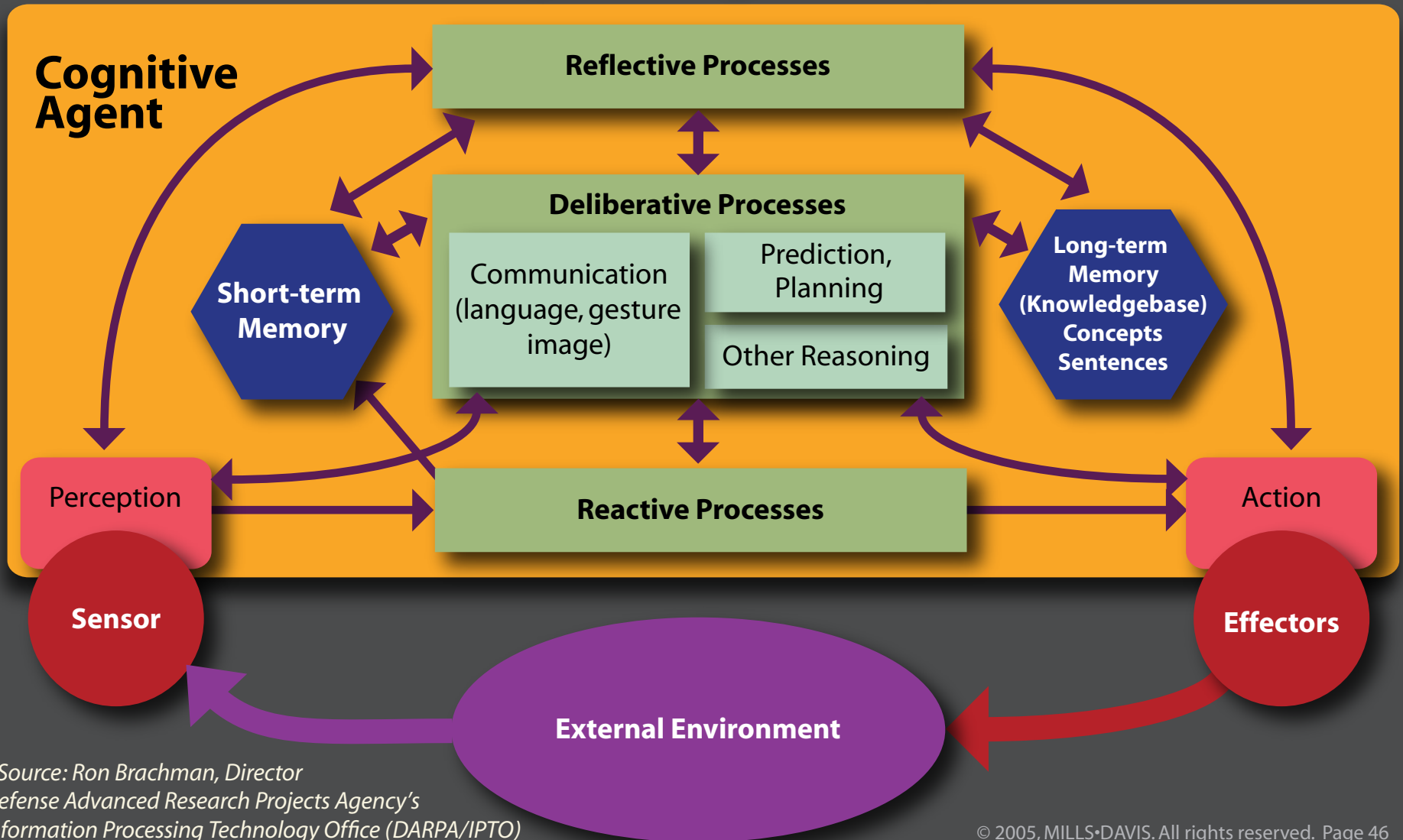


**The Answer to Any Question is  
a Rational BASELINE PATH**



# SYSTEMS THAT KNOW WHAT THEY'RE DOING\*

## Anatomy of a Cognitive System







# SYSTEMS THAT KNOW WHAT THEY'RE DOING\*

*A system that "knows what it's doing" can:*

- Reason, using substantial amounts of appropriately represented knowledge
- Learn from its experience so that it performs better tomorrow than it did today
- Explain itself and be told what to do
- Be aware of its own capabilities and reflect on its own behavior
- Respond robustly to surprise

*\* Source: Ron Brachman, Director  
Defense Advanced Research Projects Agency's  
Information Processing Technology Office (DARPA/IPTO)*



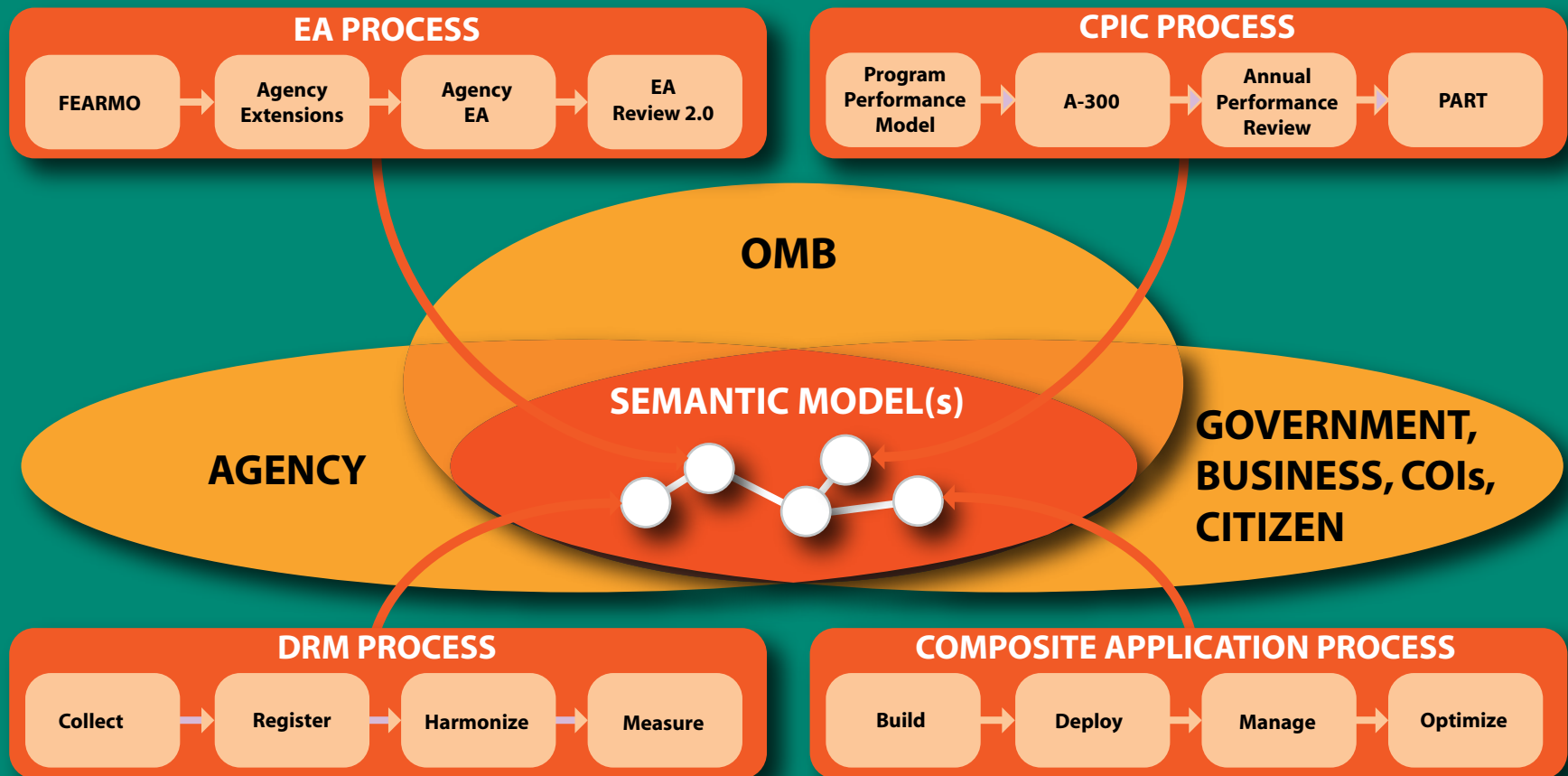
# WHAT DOES THIS MEAN FOR BUSINESS LINE EXECUTIVES, IT MANAGEMENT & ARCHITECTS?

- “Killer apps” to deliver capabilities and value directly to business line executives
- Rapid, non-invasive, hi-yield, incremental modernization
- Enterprise architecture becomes operational
- Integrated budget, performance and portfolio management
- Built-in visibility and line of sight for policy alignment and compliance
- 2-10X performance improvement



# PILOT CONCEPT

## Executable Integration of FEA & CPIC for DRM-based Information Sharing using Composite Applications



Source: TopQuadrant