BUSINESS VALUE OF SEMANTIC TECHNOLOGY

SICOP Status Report

SICOP Quarterly Meeting
Mitre Corporation
September 14, 2005

Mills Davis
Managing Director
Project10X
202-667-6400
mdavis@project10x.com

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

- *Quick facts:*
  - Semantic technologies
  - Technology providers
  - Early adoption
  - Business value
  - Opportunity
- *Semantic execution value paradigms:*
  - Operational enterprise architecture
  - Composite applications
  - Smart content
  - Knowledge computing

1. SEMANTIC TECHNOLOGIES ARE ABOUT PUTTING ONTOLOGIES TO WORK...

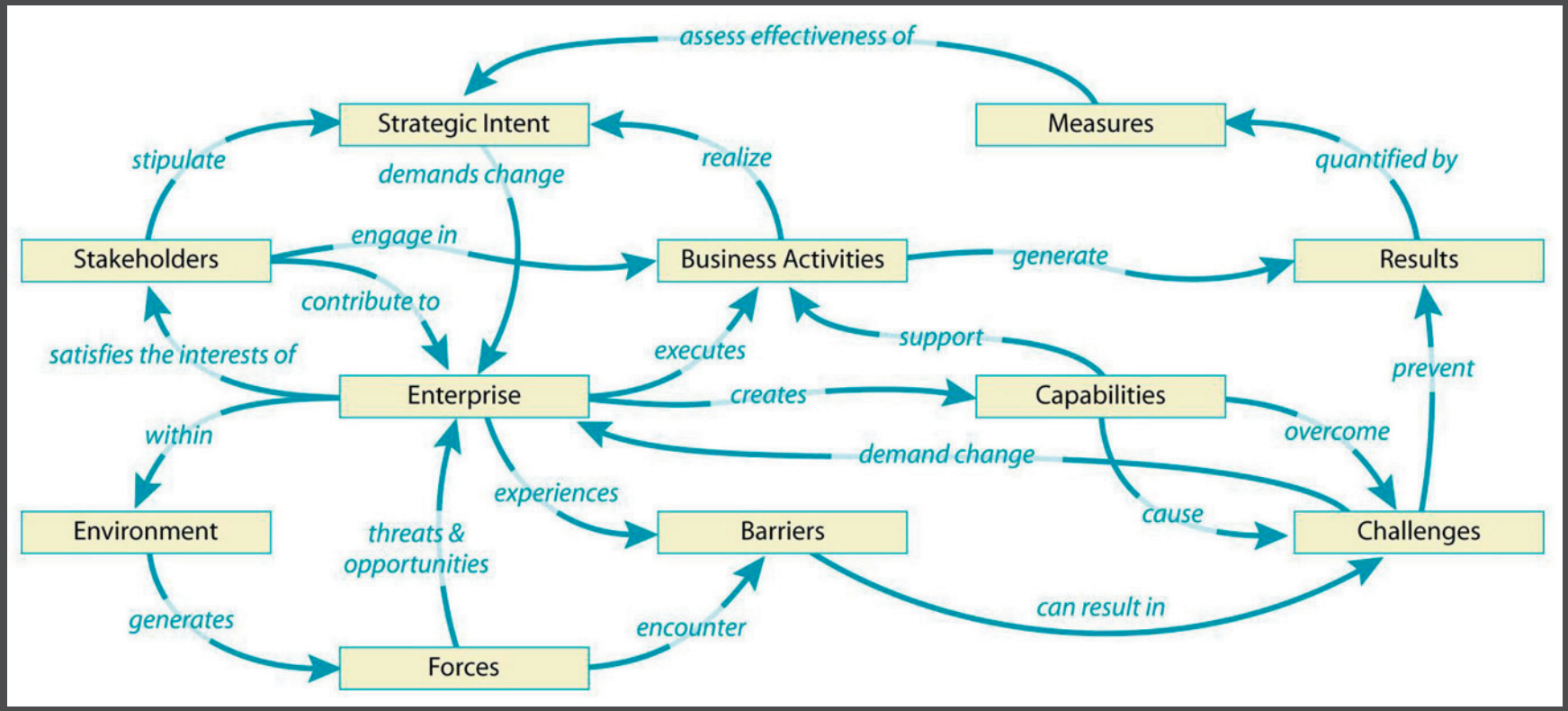
- Semantic technologies represent meanings, associations, and know-how about the uses of things separately from data and program code.
- This knowledge representation is called an **ontology** — a run-time model of information, defined using constructs for:

  – 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.

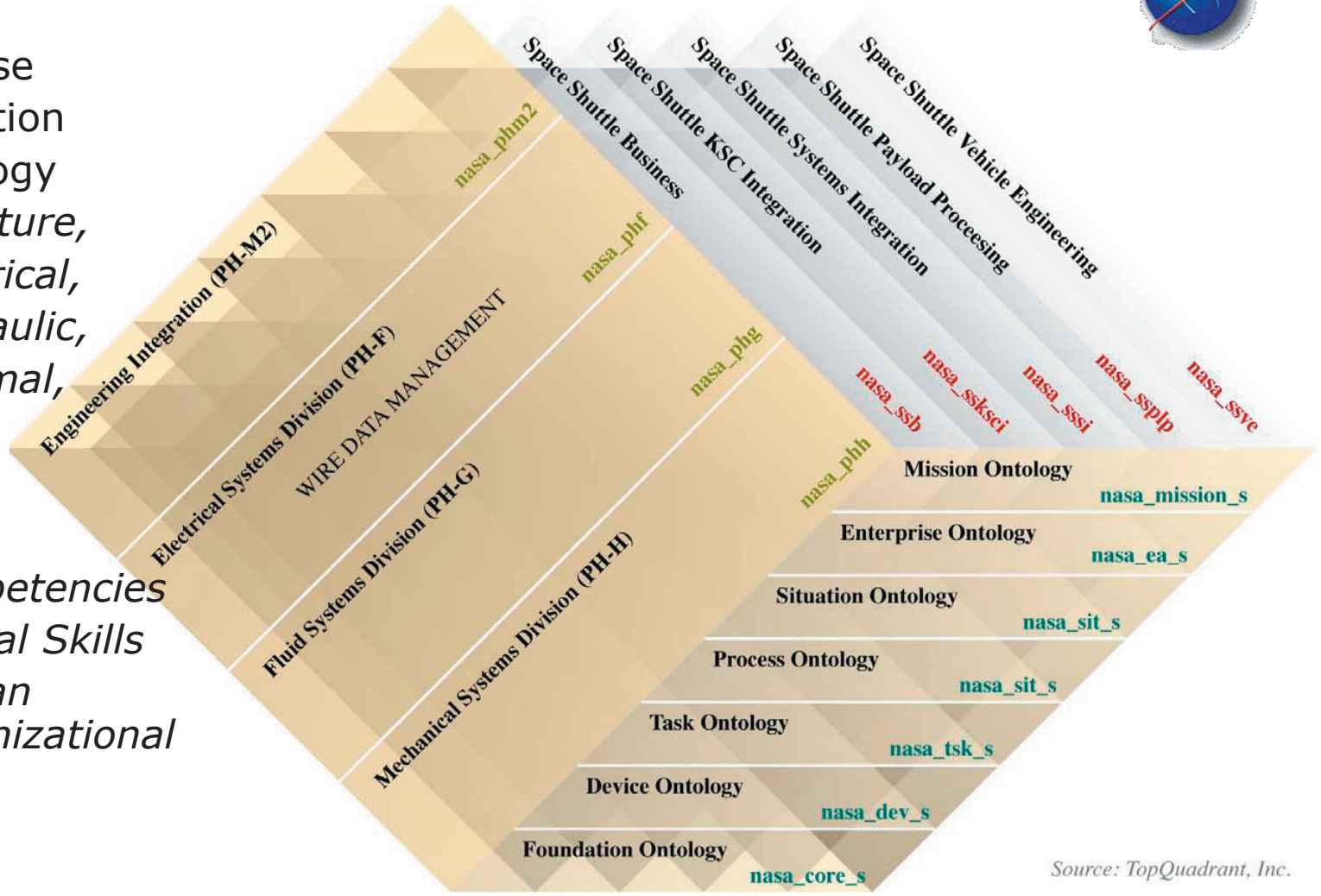
THIS IS A BUSINESS ONTOLOGY...



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*



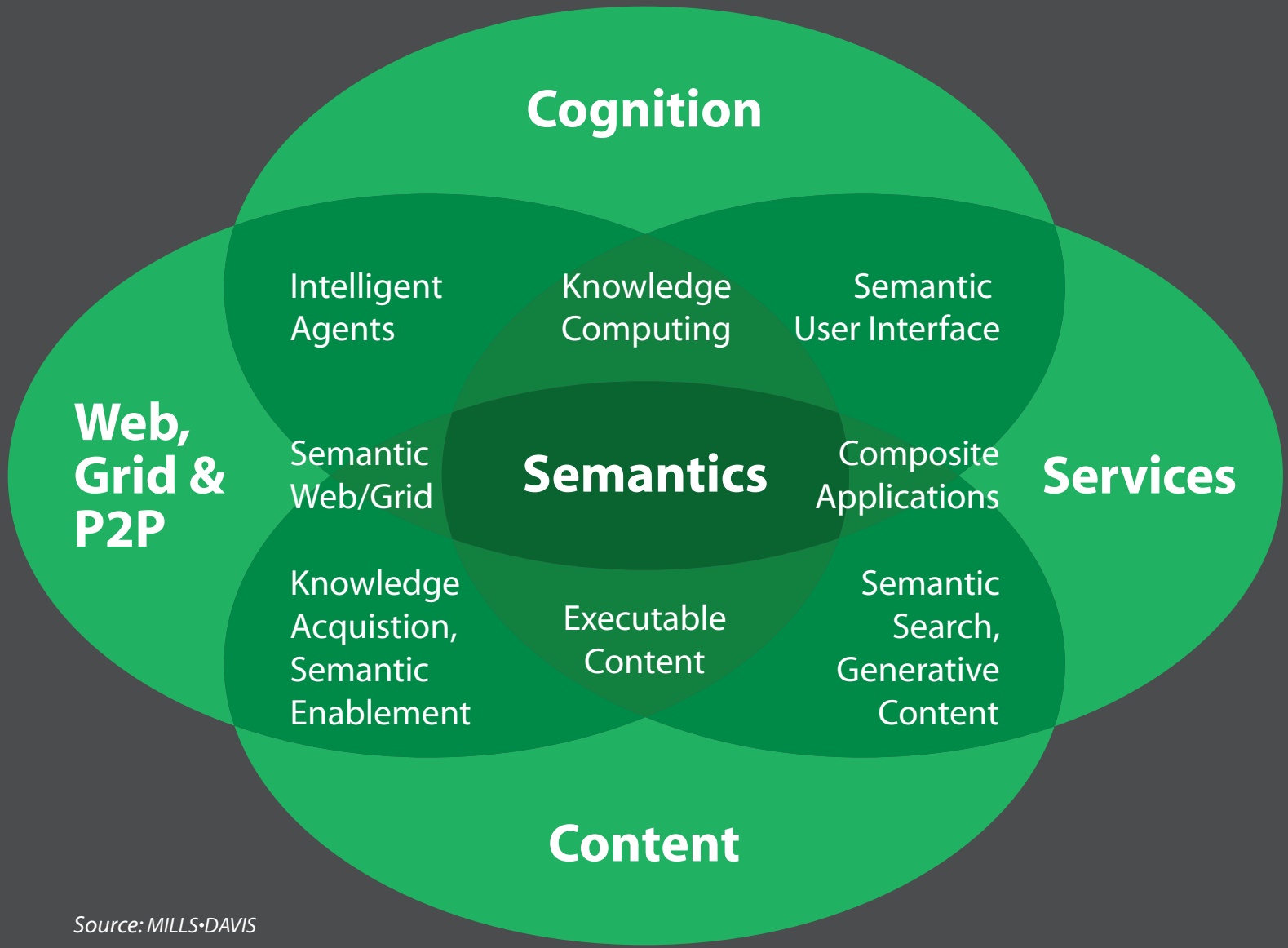
2. NEARLY 200 SEMANTIC TECHNOLOGY R&D, PRODUCT & SOLUTION PROVIDERS

Technology Providers Developing Semantic Solutions

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

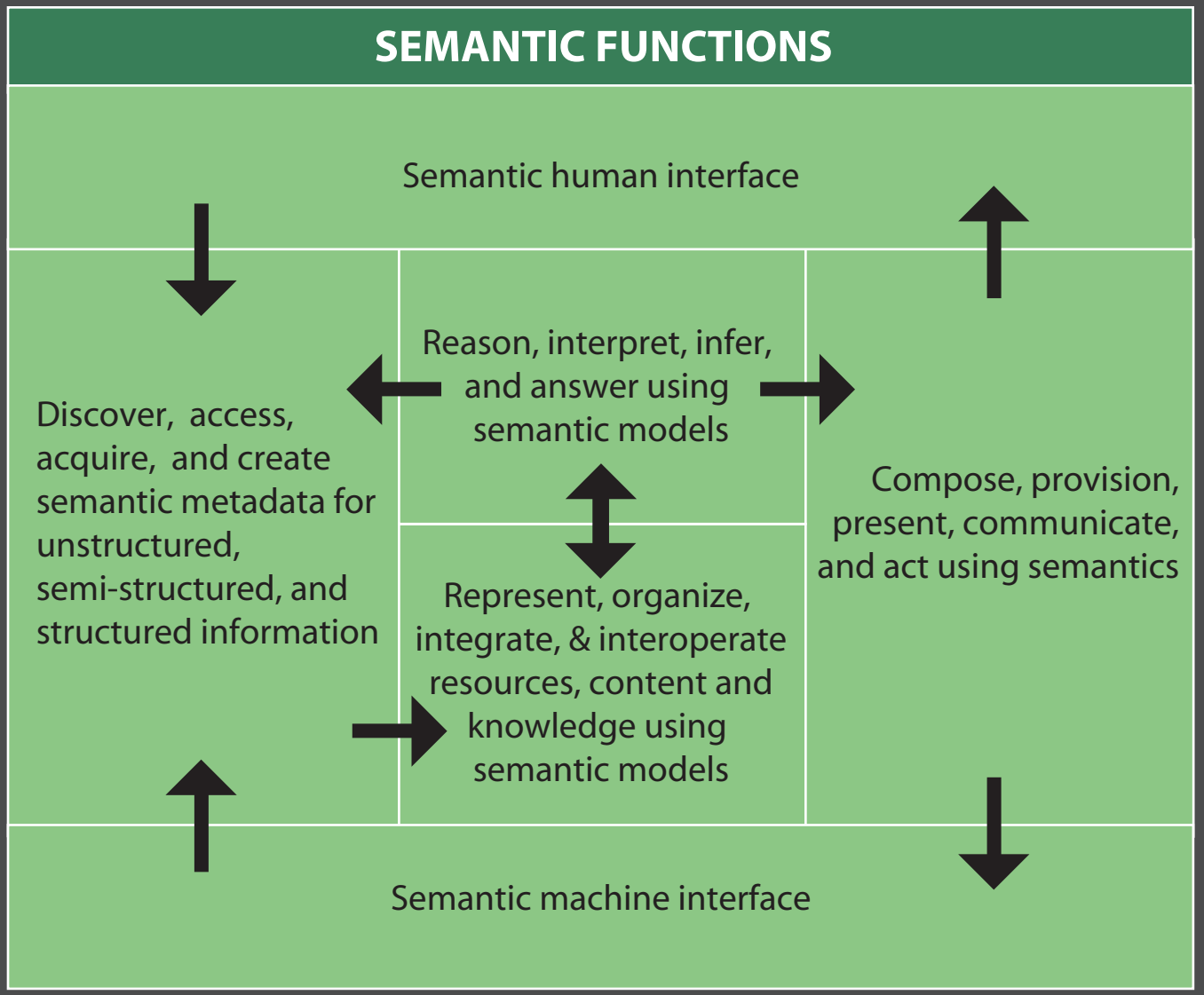
Source: MILLS•DAVIS

SEMANTIC TECHNOLOGY R&D THEMES



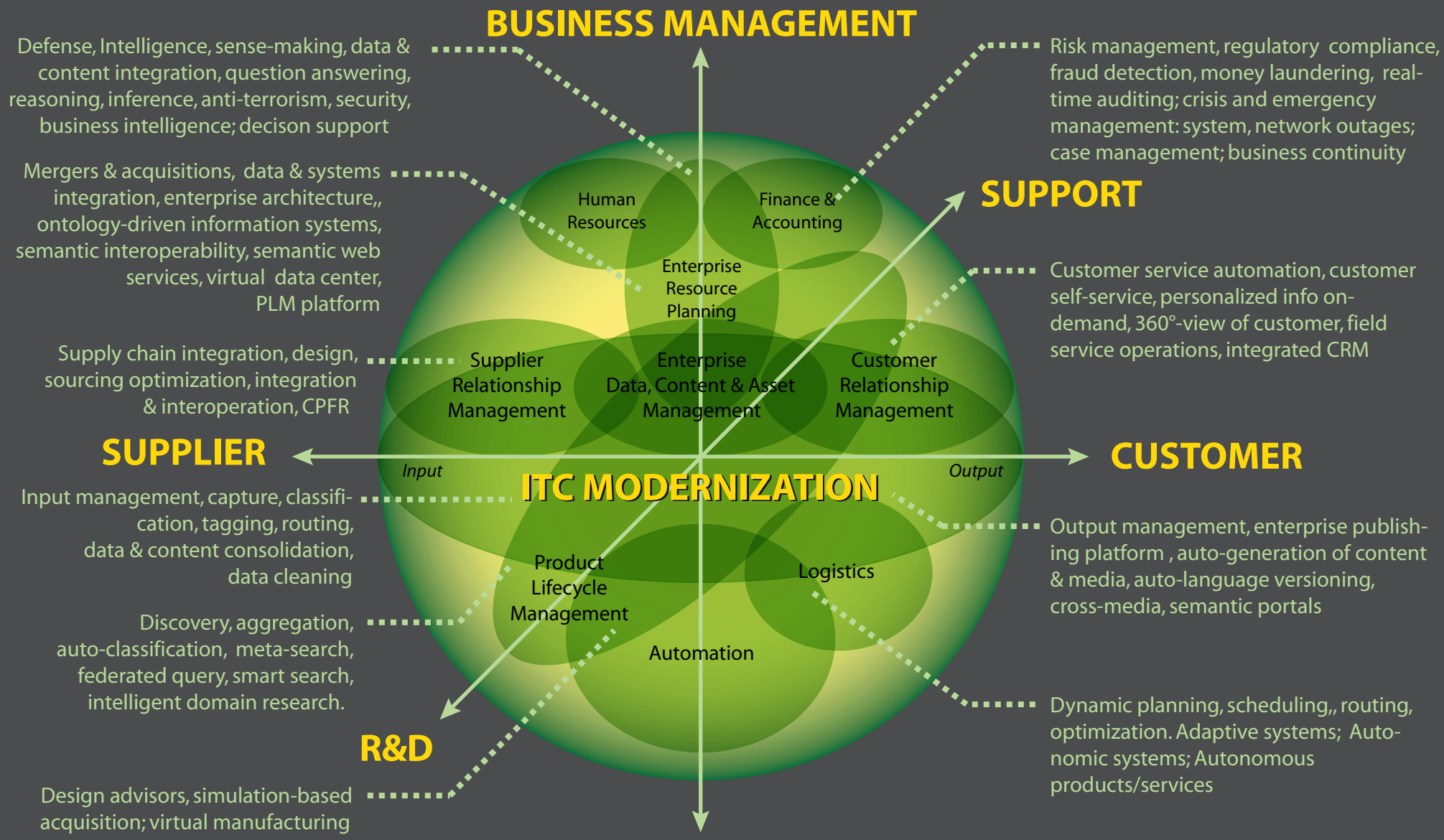
Source: MILLS•DAVIS

FUNCTIONS OF SEMANTIC TECHNOLOGIES



Source: MILLS•DAVIS

3. MORE THAN 100 SEMANTIC TECHNOLOGY EARLY ADOPTER BUSINESS CASES



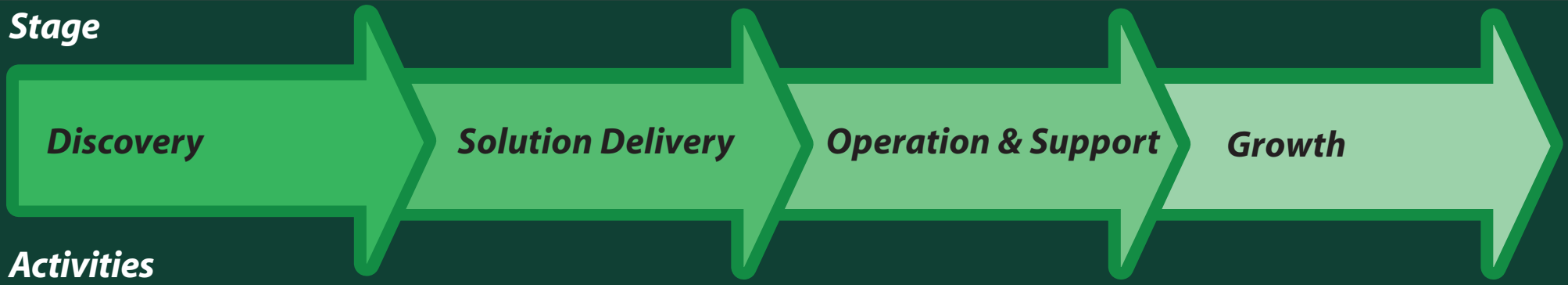
Source: MILLS•DAVIS

4. BUSINESS PERFORMANCE IMPROVES 2-10X

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

Source: MILLS•DAVIS

VALUE AMPLIFIES ACROSS THE LIFECYCLE



Activities

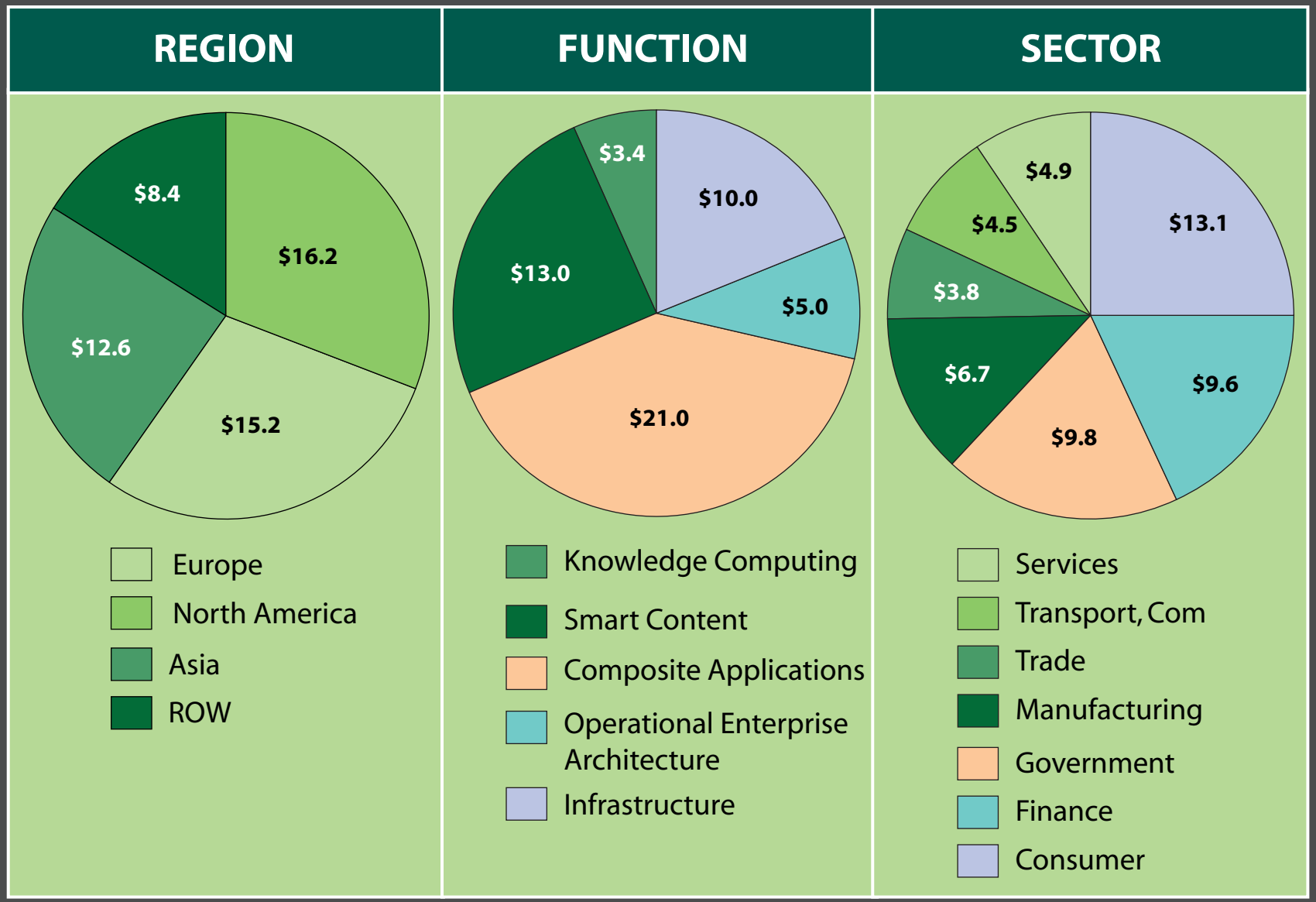
Discovery	Solution Delivery	Operation & Support	Growth
Diagnose problem	*Design semantic apps*	*Use, operate solution*	*Analyze new needs*
Envision solution	*Build business ontology*	*Monitor, measure performance*	*Add capabilities*
Map ontology	*Connect resources*	*Maintain & support*	*Upgrade solution*
Make business case	*Integrate & test*		*Optimize performance*
	Deploy		

Benefits

Explicit business case	*Business ontology speeds*	*Faster, better decision-making*	*Faster time to enhance*
Knowedge needs modeled	*data, process integration*	*Cycle time, productivity improved*	*Greater agility, flexibility*
Interrelated data, system sources	*Composite applications give*	*Higher service levels*	*Less capital re-investment*
Value of legacy preserved	*total picture, unified UI*	*Improved quality & reliability*	*Real-time optimization*
Make, buy, rent, share options	*Capital outlay reduced*	*Less training and support*	*Faster time to deploy*
Flexible, federated architecture	*Less time/cost to solution*	*Simplified maintenance*	*Reduced development risk*
Less time/cost to prototype	*Faster time-to-market*	*Reduced operating cost*	*Enhanced ROI*
	Faster return on investment	*Reduced total cost of ownership*	
	Reduced development risk		

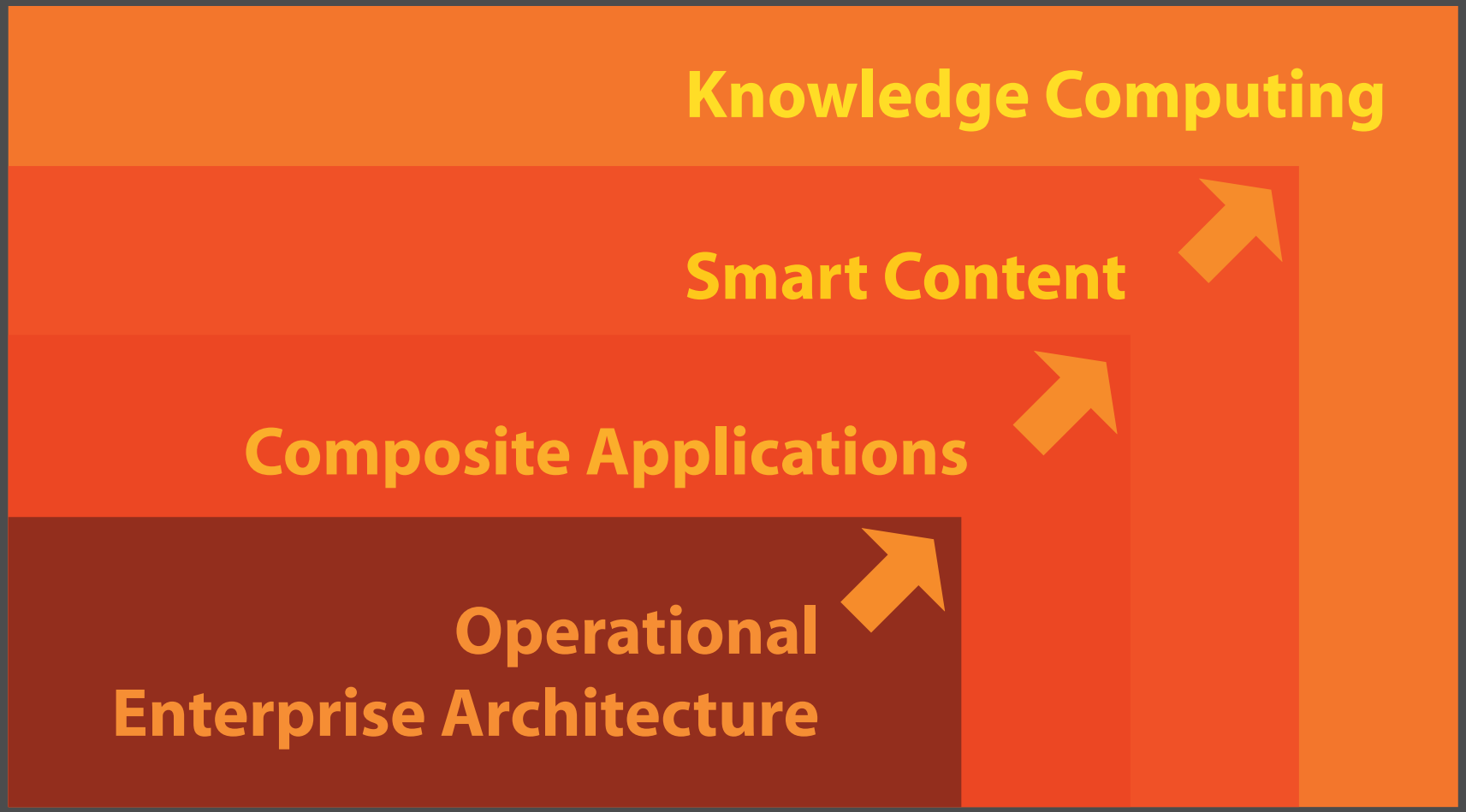
Source: MILLS•DAVIS

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



Source: MILLS•DAVIS

SEMANTIC EXECUTION VALUE PARADIGMS



OPERATIONAL ENTERPRISE ARCHITECTURE

SEMANTIC OPPORTUNITY

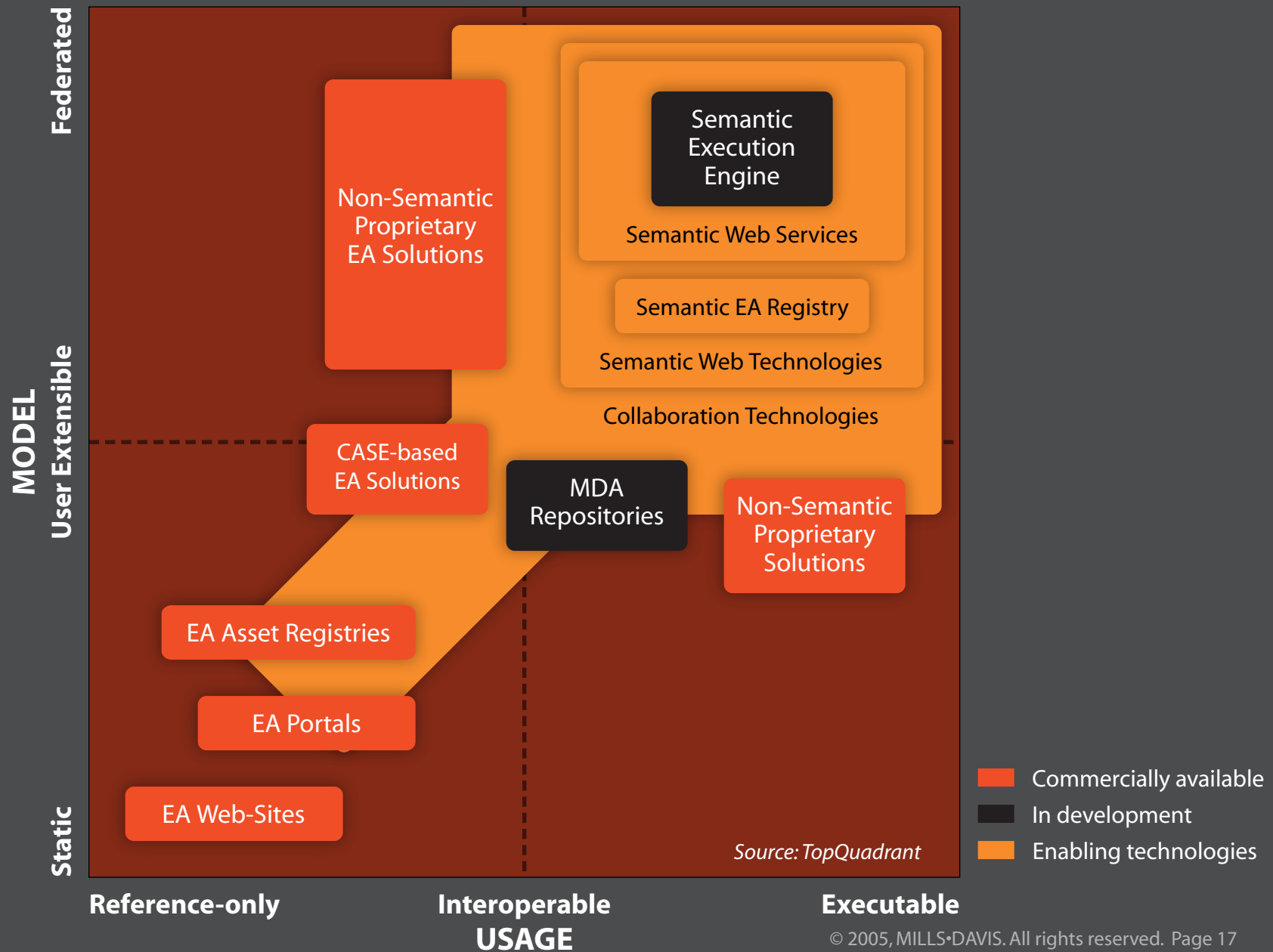
- ***Opportunity*** — $5B
- ***R&D Themes*** — Executable enterprise architecture, enterprise integration, semantic interoperability
- ***Problem*** — Hundreds of millions spent to date to develop enterprise architecture as a basis for IT modernization; remains largely a manual compliance exercise, producing 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

BUSINESS VALUE

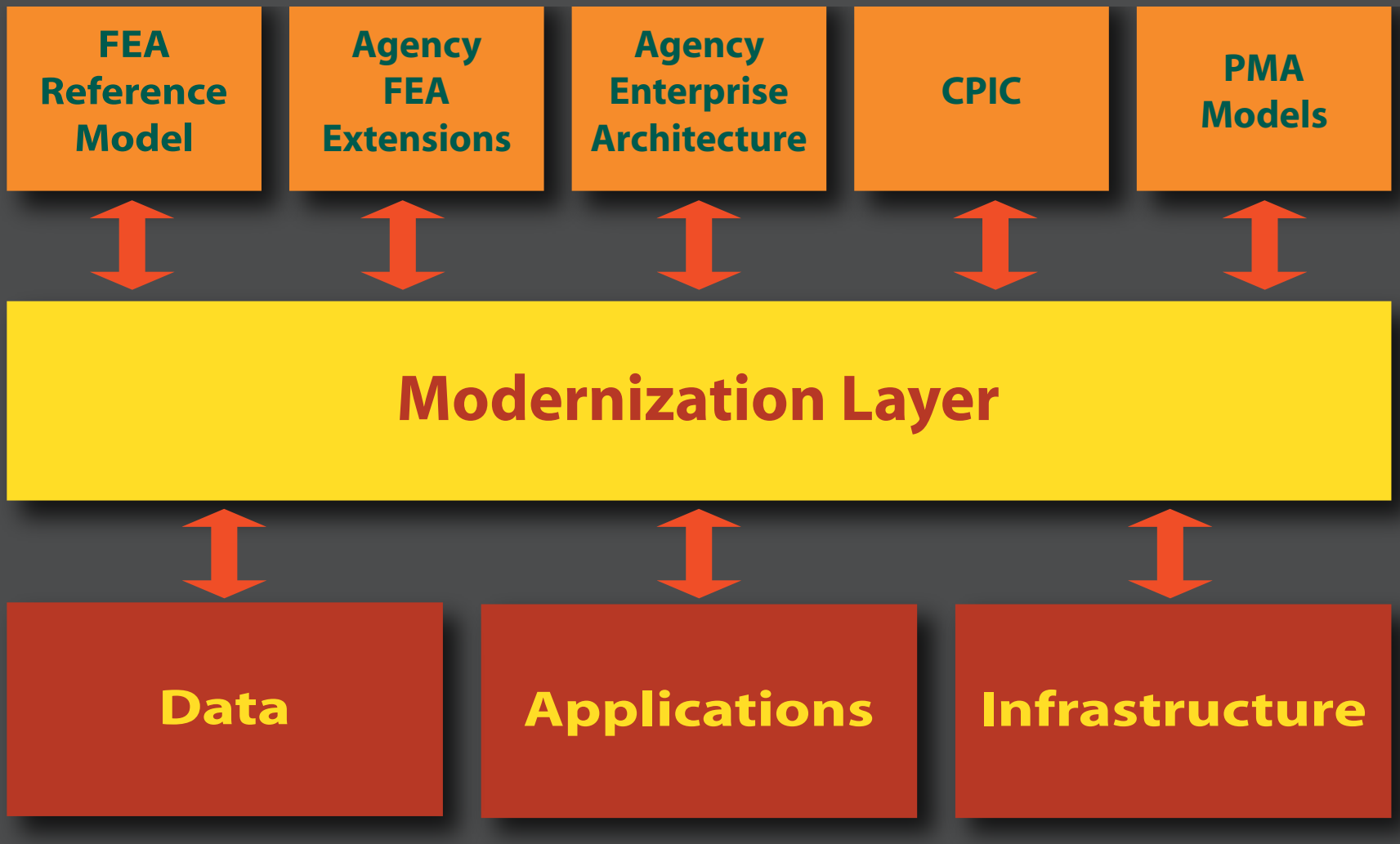
- ***Efficiency gain*** — Semantic auto-discovery of IT artifacts and documentation gives visibility, eliminates 1/5 to 1/3 of cost of as-is modeling, compliance auditing, and steady-state maintenance projects.
- ***Effectiveness gain*** — Enterprise knowledgebase enables line-of-sight analyses, analytics, 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.

Source: MILLS•DAVIS

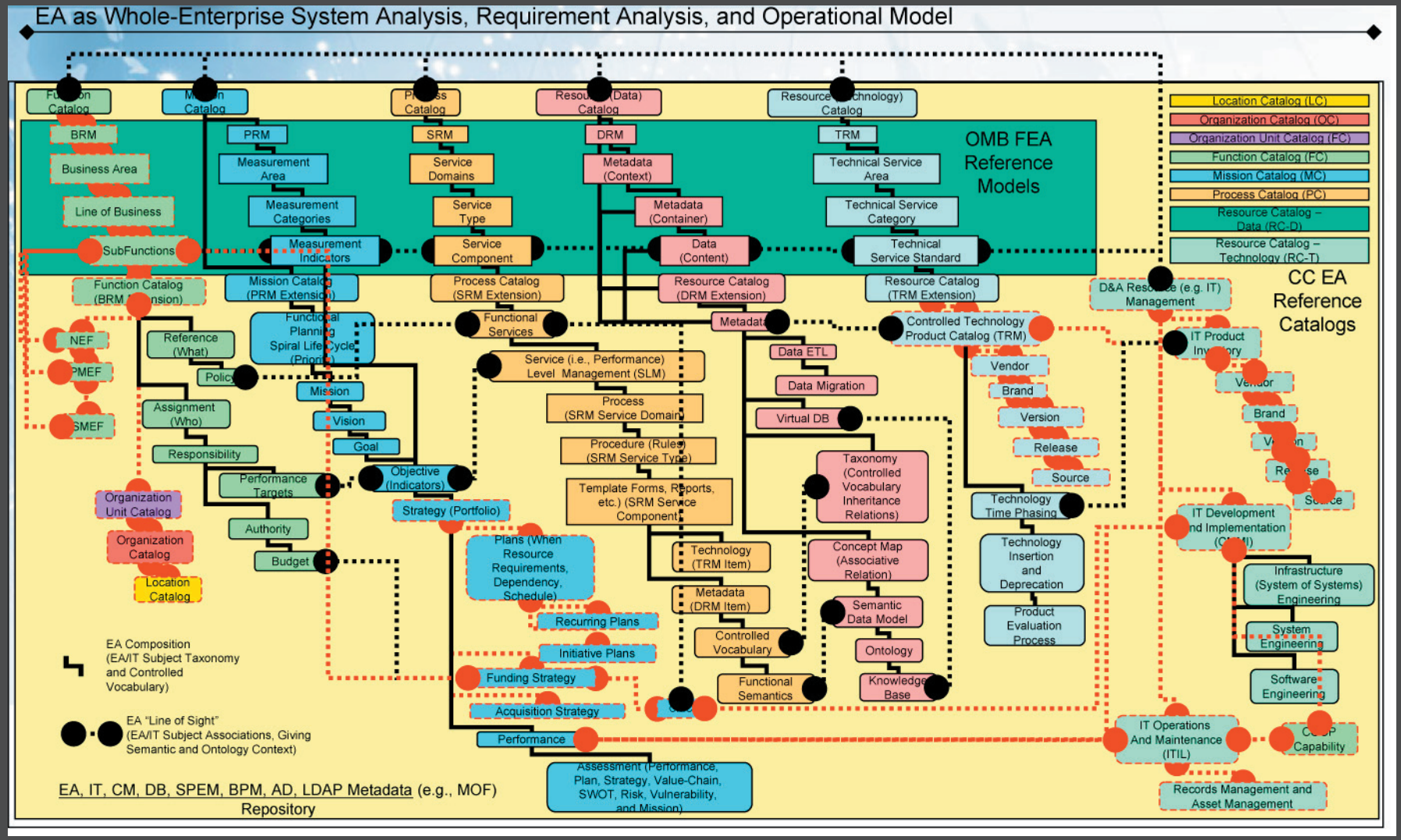
OPERATIONAL ENTERPRISE ARCHITECTURE: SOLUTION SPACE



OPERATIONAL ENTERPRISE ARCHITECTURE: MODERNIZATION LAYER



OPERATIONAL ENTERPRISE ARCHITECTURE: ENTERPRISE MANAGEMENT



Source: CommIT Enterprises

OPERATIONAL ENTERPRISE ARCHITECTURE: IMPLICATIONS FOR THE DRM

- On-the-fly semantic discovery of "as-is" software artifacts, data structures, and documentation poses new registry requirements.
- Operational architecture demands interchange of enterprise semantic models and knowledgebases.

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

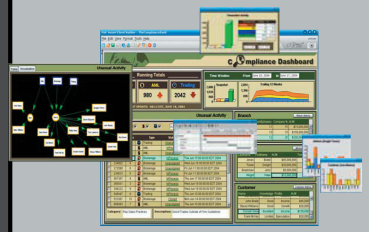
- ***Efficiency gain*** — 5X faster development. Lean teams. Reduced project risk.
- ***Effectiveness gain*** — Tactical, non-invasive, iterative solution for strategic modernization empowers IT. Composite applications links information in context, empowering users.
- ***Mission edge*** — New categories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

Source: MILLS•DAVIS

COMPOSITE APPLICATIONS: KNOWLEDGE WORKER REQUIREMENTS

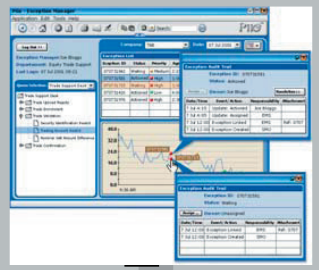
Many knowledge applications have a similar lifecycle…

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.



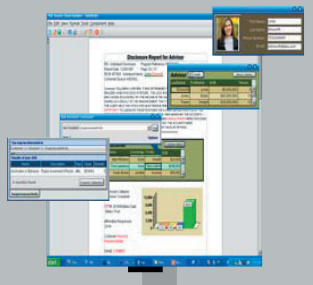
Event Capture

- –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

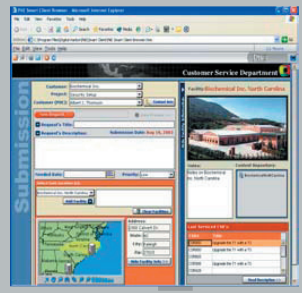


Case Management

- –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

COMPOSITE APPLICATIONS: ANATOMY OF A SEMANTIC SOLUTION

Anatomy of a solution: Apply semantics at 3 levels...

(1) Composite UI

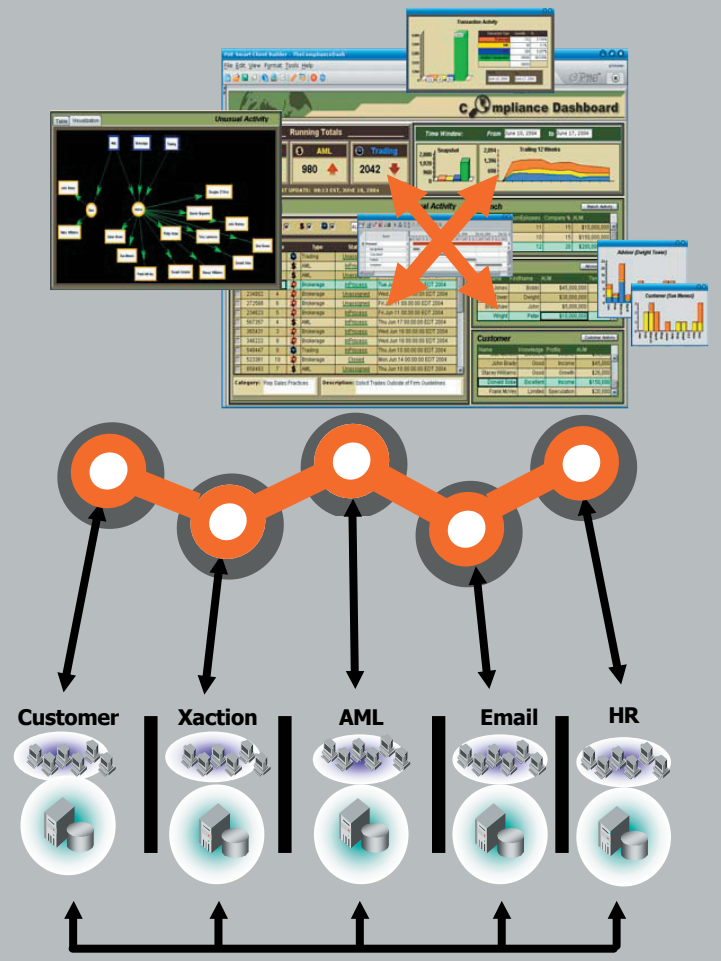
UI must model user context, persist, and expose semantics such that users can interact with meaningful objects

(2) Composite schema (business ontology)

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

(3) Composite queries (EII)

Logically maps multiple databases, applications, or web services as if they came from a single source



COMPOSITE APPLICATIONS: SEMANTIC COMMAND AND CONTROL

Knowledge Base

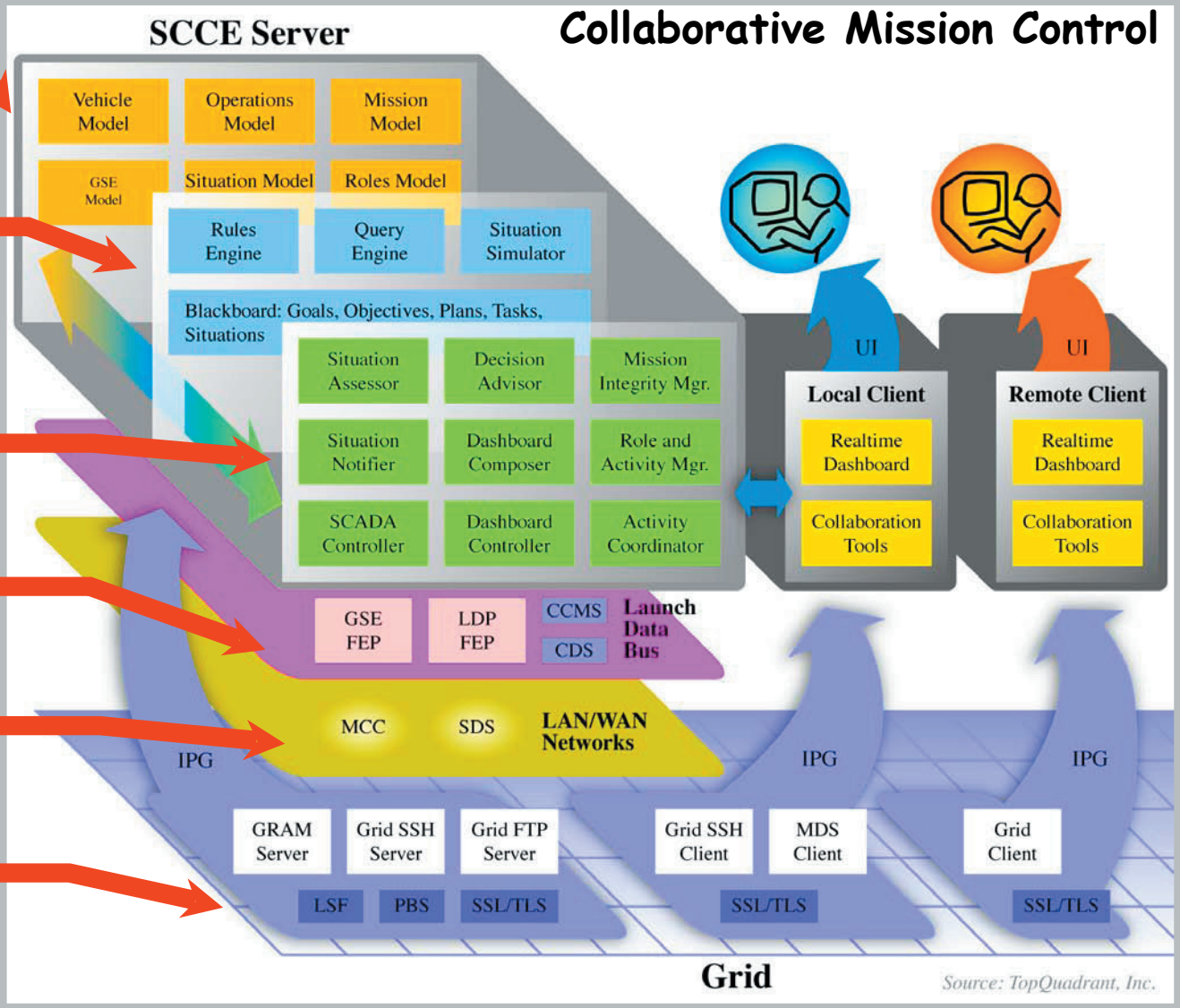
Semantic Engine

SCCE Capabilities

Launch Data Bus

NASA Networks

NASA Grid



COMPOSITE APPLICATIONS: IMPLICATIONS FOR THE DRM

- 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

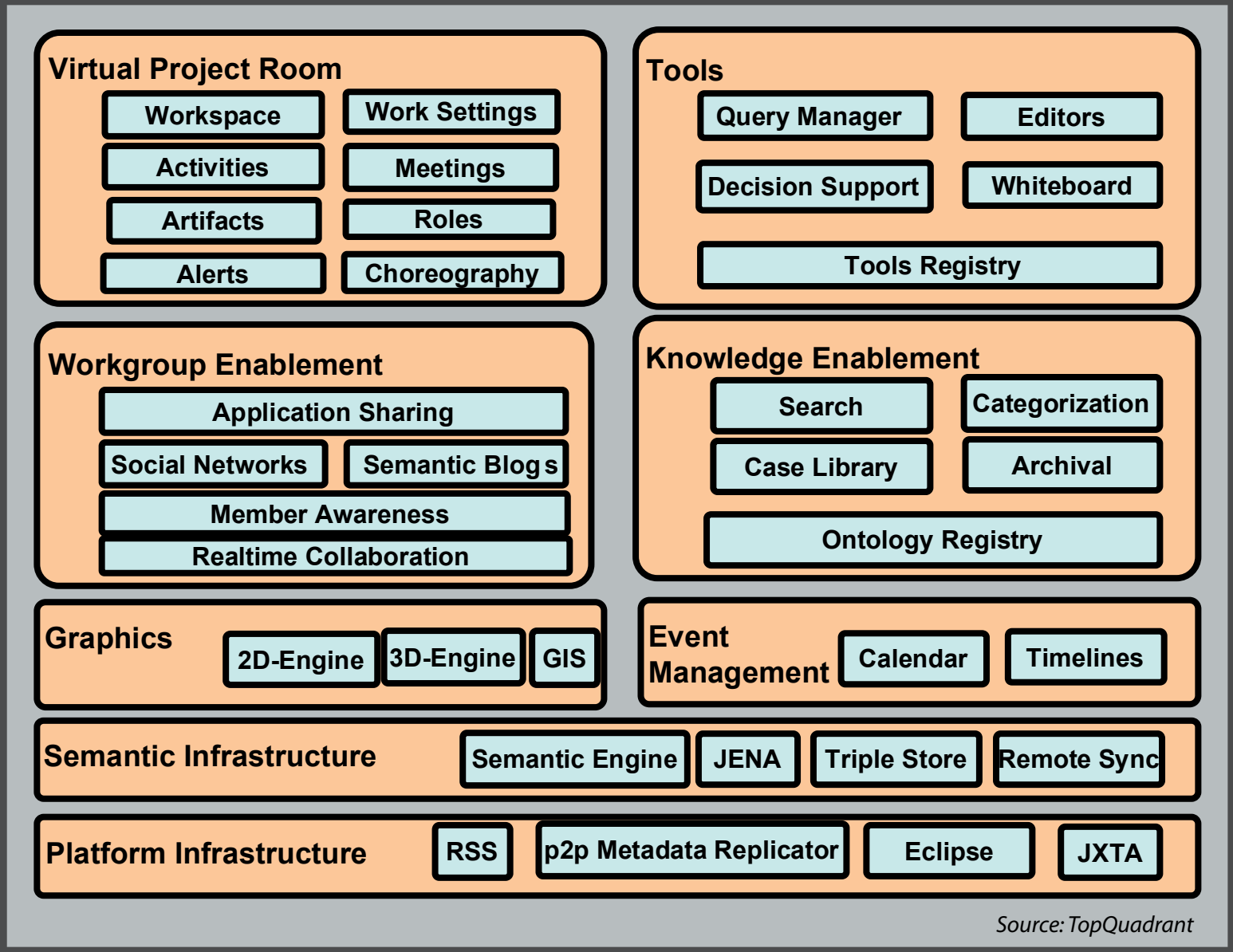
- ***Opportunity*** — $13B
- ***R& D Themes*** — Semantic discovery and sense making; authoring driven by semantic models; semantic modeling of meanings and knowledge contained in text, tables, graphics and other media; semantic search, semantic Q&A, content and media generation from models, intelligent 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.

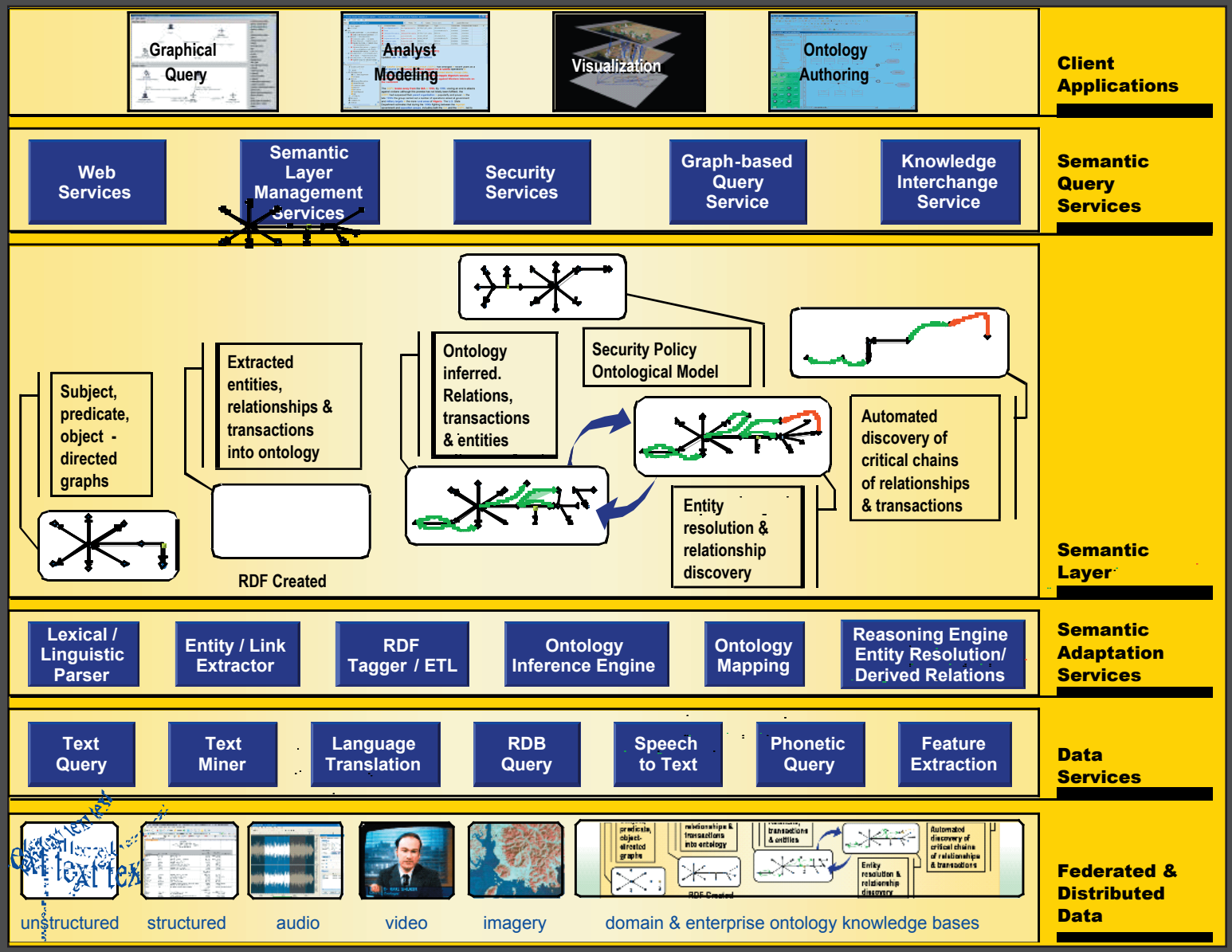
Source: MILLS•DAVIS

SMART CONTENT: SEMANTIC COLLABORATION



Source: TopQuadrant

SMART CONTENT:
IC SEMANTIC ARCHITECTURE



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

SMART CONTENT: IMPLICATIONS FOR THE DRM

- Tools that enable acquisition, editing, exchange, merging, integration, and lifecycle management of large-scale federated, distributed content ontologies, metadata registries, and knowledgebases, in the context of the intended end-use application.
- Sharing complex knowledge stacks (composite assemblages of semantically enabled content) well as security and provenance.

KNOWLEDGE COMPUTING

SEMANTIC OPPORTUNITY

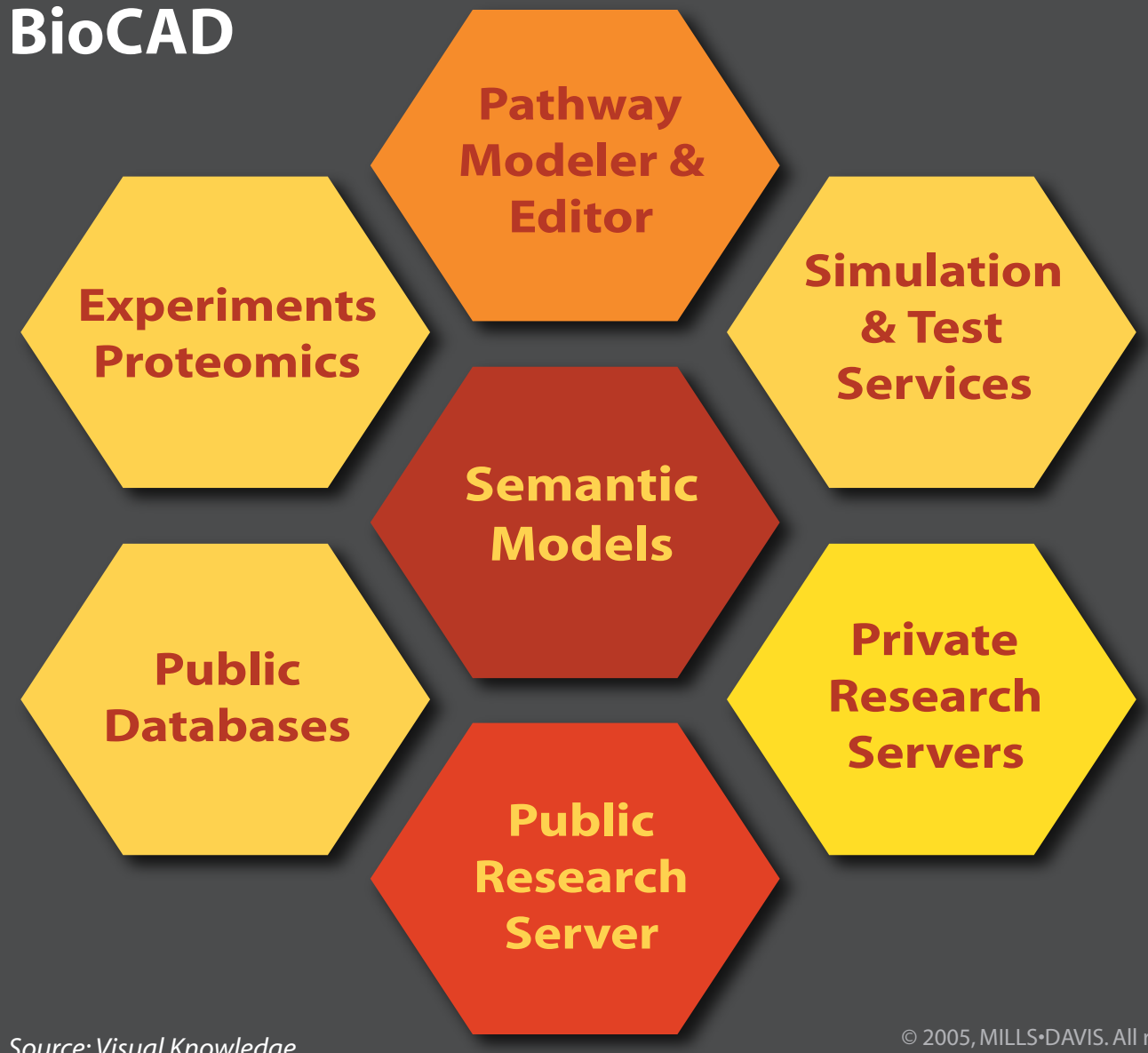
- ***Opportunity*** — $3.4B
- ***R& D Themes*** — Modeling all forms of knowledge. Massive knowledgebases. Intelligent agents. Cognitive systems (al a DARPA). Adaptive, autonomic, and autonomous human and robotic systems with massively scalable knowledgebase and reasoning performance.
- ***Problem*** — 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.

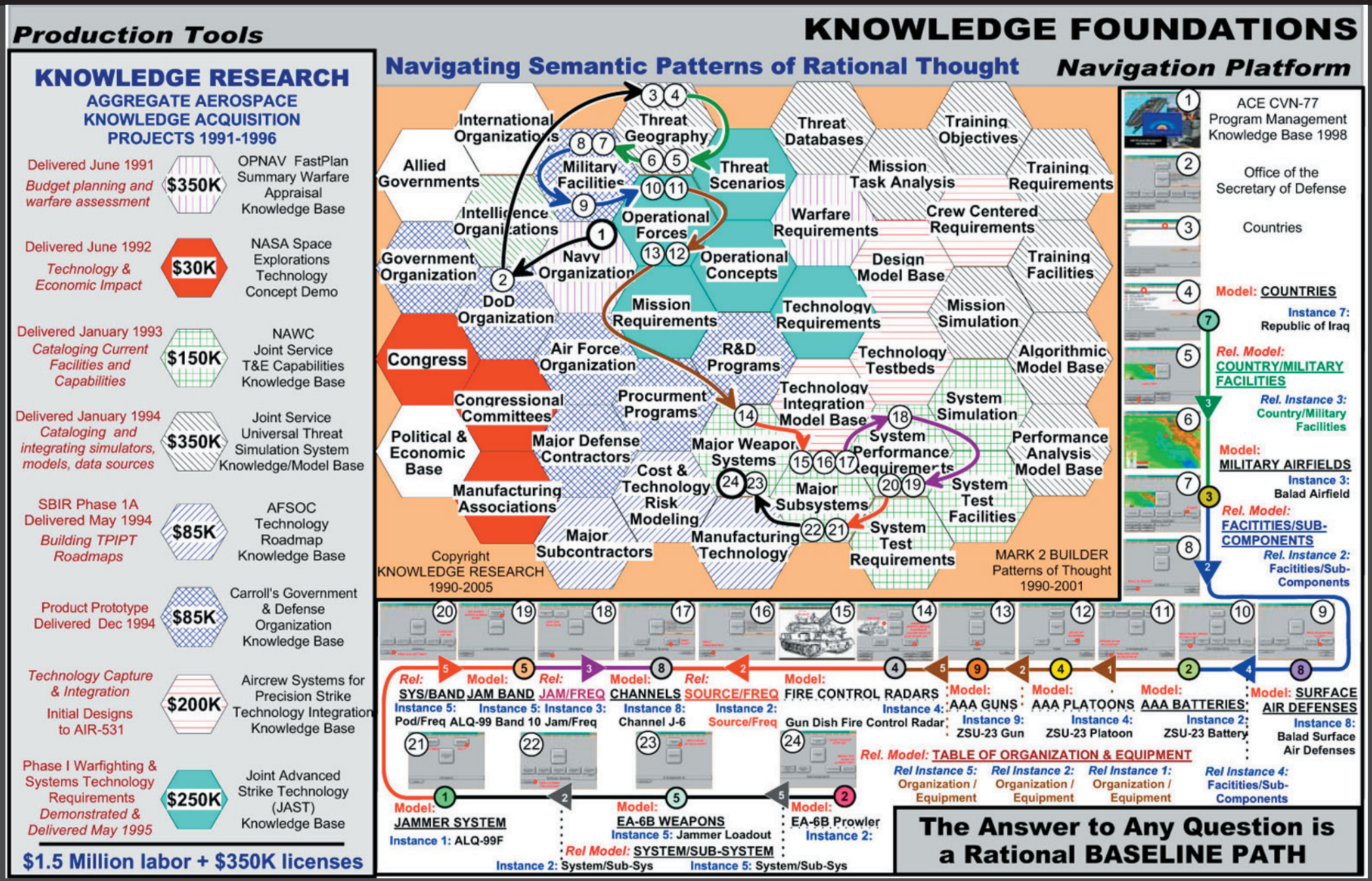
Source: MILLS•DAVIS

KNOWLEDGE COMPUTING: SEMANTIC APPLICATIONS



Source: Visual Knowledge

KNOWLEDGE COMPUTING: THEORY-BASED SEMANTIC WEBS



Source: Knowledge Foundations

SUMMARY

- Semantic technologies are about putting ontologies (semantic models) to work.
- Nearly 200 firms have semantic products and solution development underway. Nearly 100 have products.
- SICoP research has reviewed more than 100 government and industry business cases.
- Early adopter research documents 2 to 10 times improvements in key measures of performance across the solution lifecycle.
- Semantic solution, services & software markets will top $50B by 2010.
- Four semantic execution value paradigms will drive adoption: operational enterprise architecture, composite applications, smart content, & knowledge computing.

