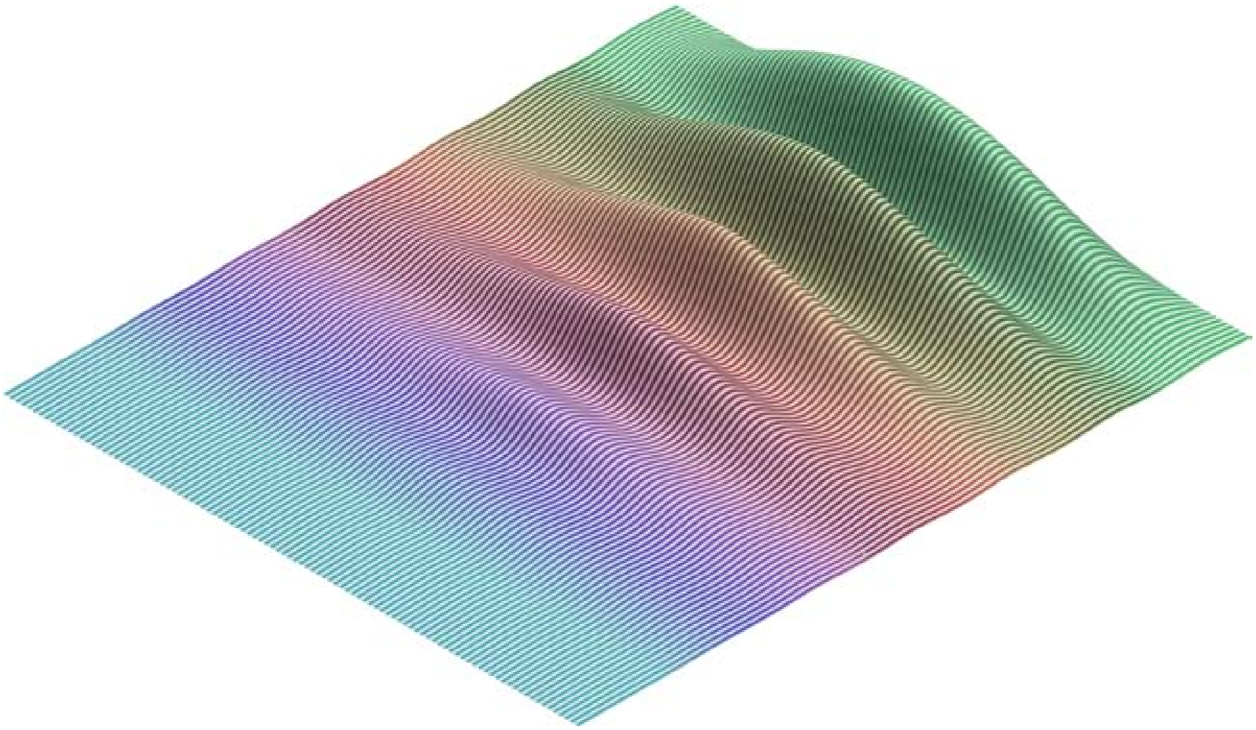

Project10X's

Semantic Wave 2008 Report: Industry Roadmap to Web 3.0 & Multibillion Dollar Market Opportunities

EXECUTIVE SUMMARY
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Project10X's

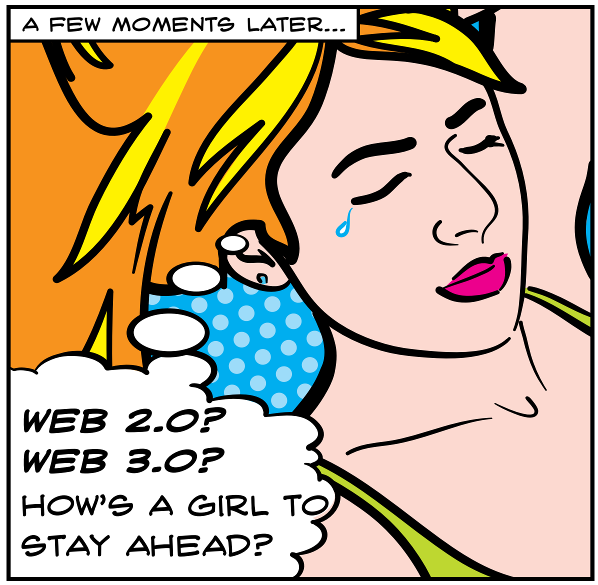
Semantic Wave 2008 Report:

Industry Roadmap to Web 3.0 and Multibillion Dollar Market Opportunities

Dear reader,

Project10X is pleased to announce publication of a comprehensive, groundbreaking 400-page study of semantic technologies and their market impact entitled *Semantic Wave 2008: Industry Roadmap to Web 3.0 and Multibillion Dollar Market Opportunities.* This report charts the evolution of the internet from Web 2.0 to Web 3.0, the emergence of semantic technologies for consumer and enterprise applications, and the growth of multi-billion dollar markets for Web 3.0 products and services. It is must reading for investors, technology developers, and enterprises in the public and private sector who want to better understand semantic technologies, the business opportunities they present, and the ways Web 3.0 will change how we use and experience the internet for pleasure and profit. Enjoy this free summary of Project10X's Semantic Wave 2008 Report, and be sure to...*Order your copy of the Semantic Wave 2008 Report.* *See ordering information on page 27!*

Then, if you'd like to take your exploration of these topics a step further, and meet the people and companies that are already bringing semantic technology to life, then you should strongly consider attending SemTech 2008 — the fourth annual conference on Semantic Technology — taking place in San Jose, California on May 18-22, 2008 at the Fairmont Hotel. We'd love to see you at SemTech — I hope you can make it.



Mills Davis
Washington, DC USA

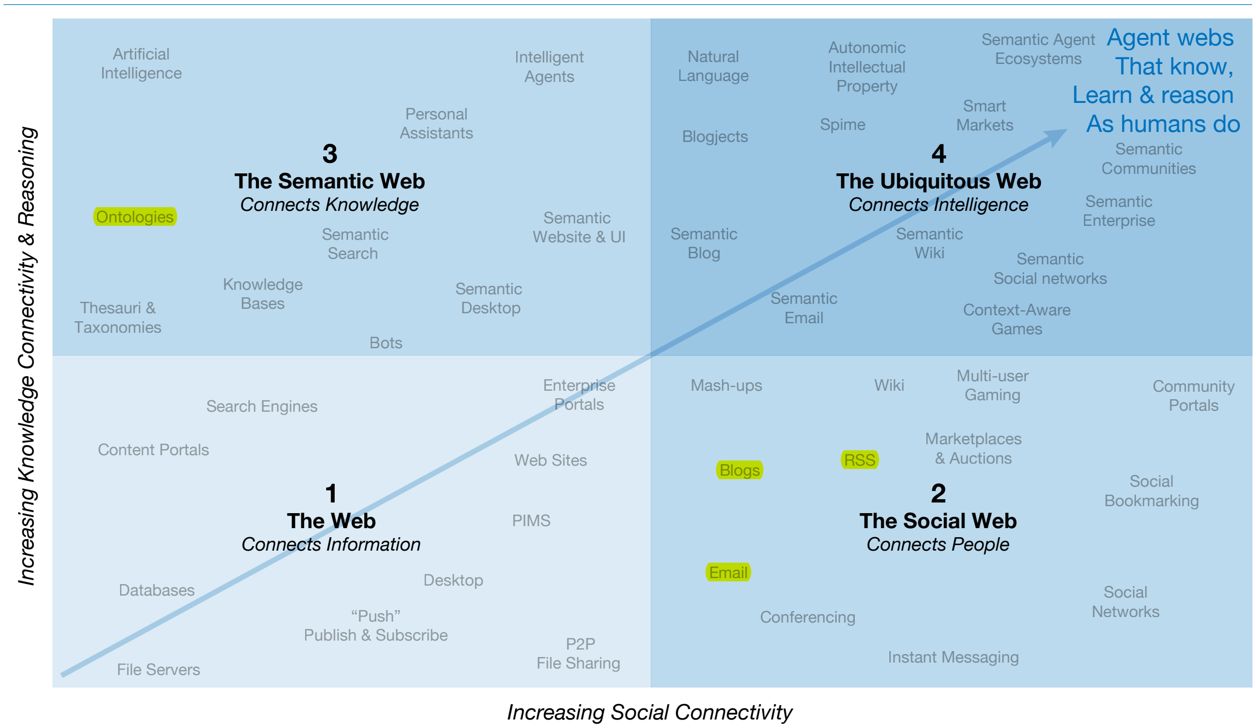
What is the semantic wave?

A tidal wave of four Internet growth stages.

The semantic wave embraces four stages of internet growth. The first stage, *Web 1.0,* was about connecting information and getting on the net. *Web 2.0* is about connecting people — putting the "I" in user interface, and the "we" into Webs of social participation. The next stage, *Web 3.0,* is starting now. It is about representing meanings, connecting knowledge, and putting these to work in ways that make our experience of internet more relevant, useful, and enjoyable. *Web 4.0* will come later. It is about connecting intelligences in a ubiquitous Web where both people and things reason and communicate together.

Project10X's Semantic Wave 2008 Report tells the story of Web 3.0. Over the next decade, Web 3.0 will spawn multi-billion dollar technology markets that will drive trillion dollar global economic expansions to transform industries as well as our experience of the internet. The Semantic Wave 2008 report examines drivers and market forces for adoption of semantic technologies in Web 3.0 and maps opportunities for investors, technology developers, and public and private enterprises.

Below:
What is the Evolution of the Internet to 2020?



Source: Nova Spivak, Radar Networks; John Breslin, DERI; & Mills Davis, Project10X

How is Web 3.0 different from previous stages of internet evolution?

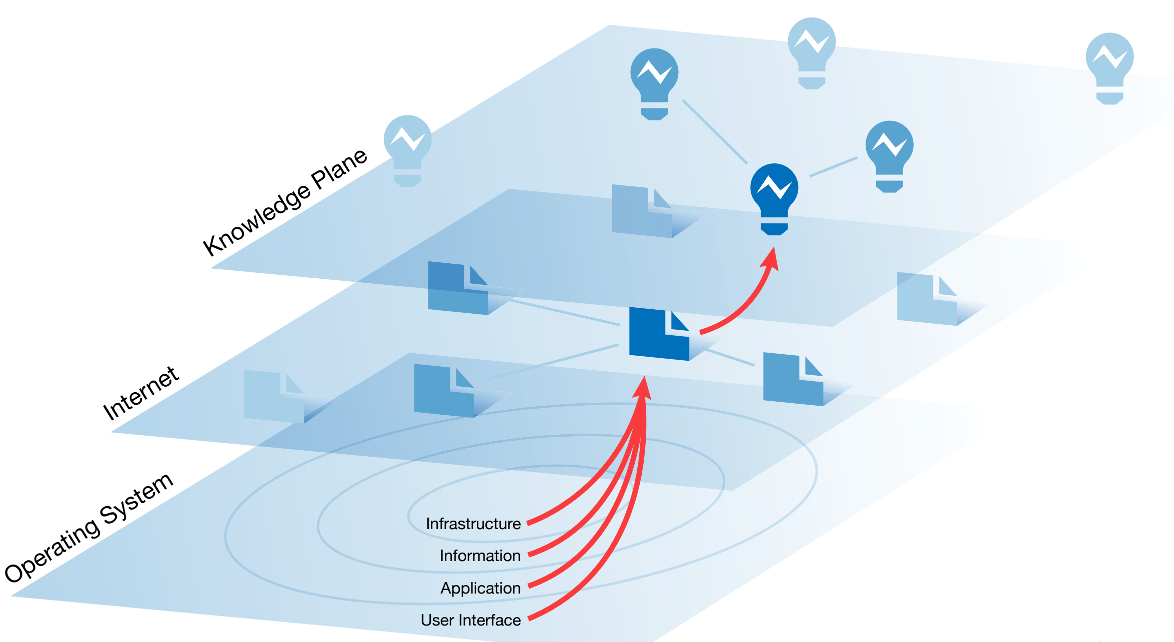
Knowledge computing drives new value creation and solves problems of scale and complexity.

The basic shift occurring in Web 3.0 is from information-centric to knowledge-centric patterns of computing. Web 3.0 will enable people and machines to connect, evolve, share, and use knowledge on an unprecedented scale and in new ways that make our experience of the internet better.

Web growth continues to accelerate. Dimensions of net expansion include communications bandwidth, numbers of people connected, numbers and kinds of devices that are IP-aware, numbers of systems and applications, quantities of information, and types of media. As the internet expands, needs world-wide are outstripping the capacities and capabilities of current information and communications technologies (ICT) and architectures. Information-centric patterns of computing have reached the limit of what they can provide to cope with problems of scale, complexity, security, mobility, rich media interaction, and autonomic behavior.

Web 3.0 will solve these problems and lay a foundation for the coming ubiquitous Web of connected intelligences. The Web 3.0 solution, simply put, is to give the internet a knowledge space. In the following topics we identify key characteristics of this knowledge space, sketch out how its semantic computing works, and examine how Web 3.0 knowledge-centric patterns of computing drive new value creation.

Below:
Web 3.0 — The Internet Grows a Knowledge Plane



Source: Project10X

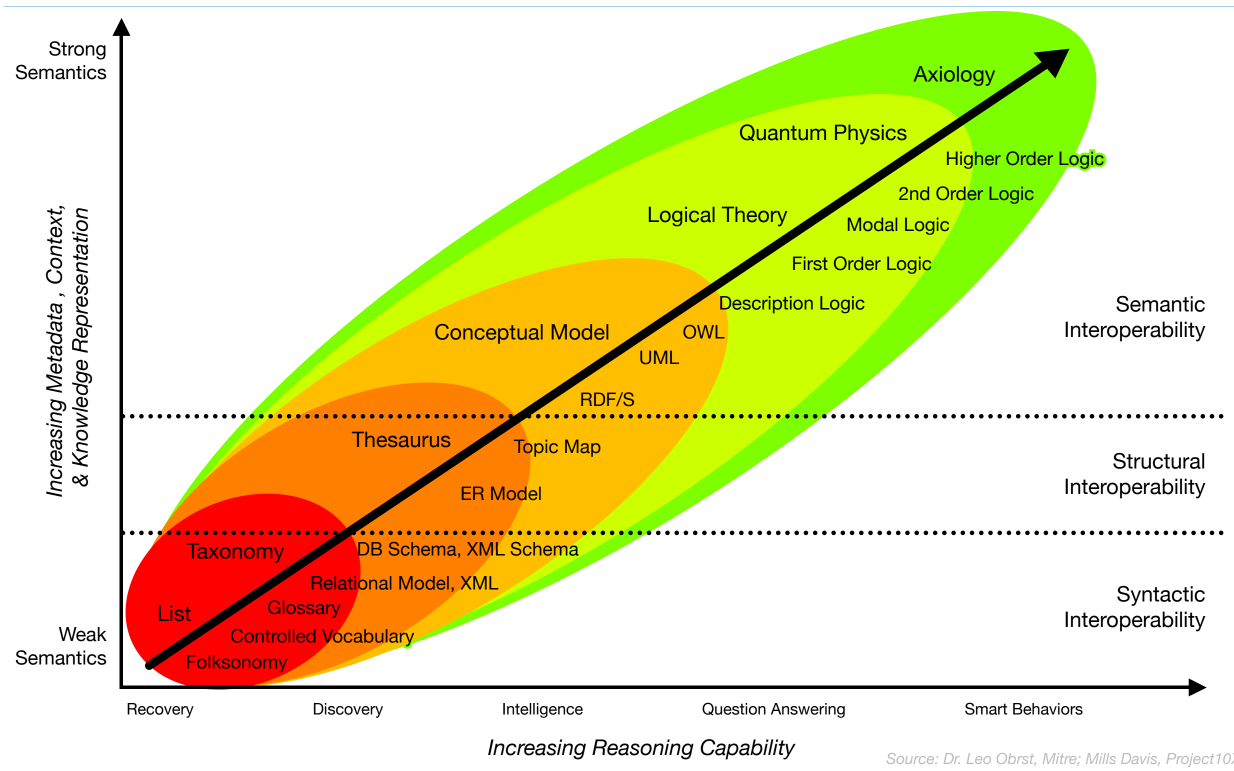
What semantic technologies wil power Web 3.0?

Digital tools that represent and reason about meanings, theories, and know-how separately from documents, data, and program code.

The key notion of semantic technology is to represent meanings and knowledge (e.g., knowledge of something, knowledge about something, and knowledge how to do something, etc.) separately from content or behavior artifacts, in a digital form that both people and machines can access and interpret. As a platform, Web 3.0 will embrace all semantic technologies and open standards that can be applied on top of the current Web. It is not restricted just to current Semantic Web standards.

Web 3.0 will encompass a broad range of knowledge representation and reasoning capabilities including pattern detection, deep linguistics, ontology and model based inferencing, analogy and reasoning with uncertainties, conflicts, causality, and values. The figure below depicts a spectrum of progressively more capable forms of knowledge representation that spans tag collections (or folksonomies); to dictionaries, taxonomies and thesauri; to schemas and conceptual models; to ontologies and theory-based logics, to axiologies (value-based reasoning), and entirely new uses barely tapped. Reasoning requires knowledge representation. We choose more powerful forms of representation to enable more powerful kinds of reasoning and problem solving. The integration of social Web and semantic technologies in Web 3.0 allows new synergy that lowers the cost of data and knowledge creation, and raises the computational value of gathering it.

Below:
From Searching to Knowing — Spectrum of Knowledge Representation and Reasoning Capabilities



Source: Dr. Leo Obrst, Mitre; Mills Davis, Project10X

How will Web 3.0 systems connect data, services and applications?

First, they'll integrate knowledge about these applications, content sources, and process flows. Then they'll execute it.

In order to connect systems, integrate information, and make processes interoperable, the first step is to integrate the knowledge about these systems, content sources, and process flows. Today, people do this offline, manually. This approach does not scale. In Web 3.0 both people and applications will connect knowledge in real time using automated and semi-automated methods. Web 3.0 approaches will scale.

Semantically modeled, machine executable knowledge lets us connect information about people, events, locations, times — in fact, any concept that we want to — across different content sources and application processes. Instead of disparate data and applications on the Web, we get a Web of interrelated data and interoperable applications. Recombinant knowledge is represented as concepts, relationships and theories that are sharable and language neutral. Semantic technologies provide the means to unlock knowledge from localized environments, data stores, and proprietary formats so that resources can be readily accessed, shared, and combined across the Web.

In today's Web, each device has an operating system (OS) that provides walled access to its content through a hierarchical file system. Limitations of OS platforms are spurring development of semantic desktops to provide meaning-based, concept-level search, navigation, and integration across varied content sources and applications found on PCs and other devices.

Applications running on OS platforms provide access to the information they have knowledge of, but do not combine easily with others, unless such link-ups have been planned and agreed to in advance by developers. The need to overcome these limitations of OS platforms including the need for human labor to research and code interfaces is fueling interest in:

Web-tops — platforms spanning multiple OSs connected over the internet,

Mash-ups — two or more data sources or works combined to become a new data source or work,

Context-aware mobility — dynamic composition and personalization of services across devices, networks, locations, and user circumstances, and

Semantic service-oriented architectures — using machine-interpretable descriptions of policies and services to automate discovery, negotiation, adaptation, composition, invocation, and monitoring of Web services.

In Web 3.0, these sorts of capabilities will become intrinsic features of the knowledge space's semantic fabric, and no longer mere one-off hacks or the result of mutually exclusive platform and service plays.

Where do the shared meanings and knowledge in Web 3.0 come from?

From both people and machines. And, to start with, from the Web itself.

Knowledge exists in many forms in todays Web. All computing processes represent some type of knowledge in some way in order to process information, for example: knowledge about how information is organized in order to search it; rules that tell a computer program how to make a decision; or action steps to take to complete a task.

The problem is that existing knowledge on the Web is fragmented and difficult to connect. It is locked in data silos and operating system file system formats. Knowledge is hidden in object-oriented black boxes and layers of stack architecture. It is embedded in program code and squirreled away in proprietary algorithms.

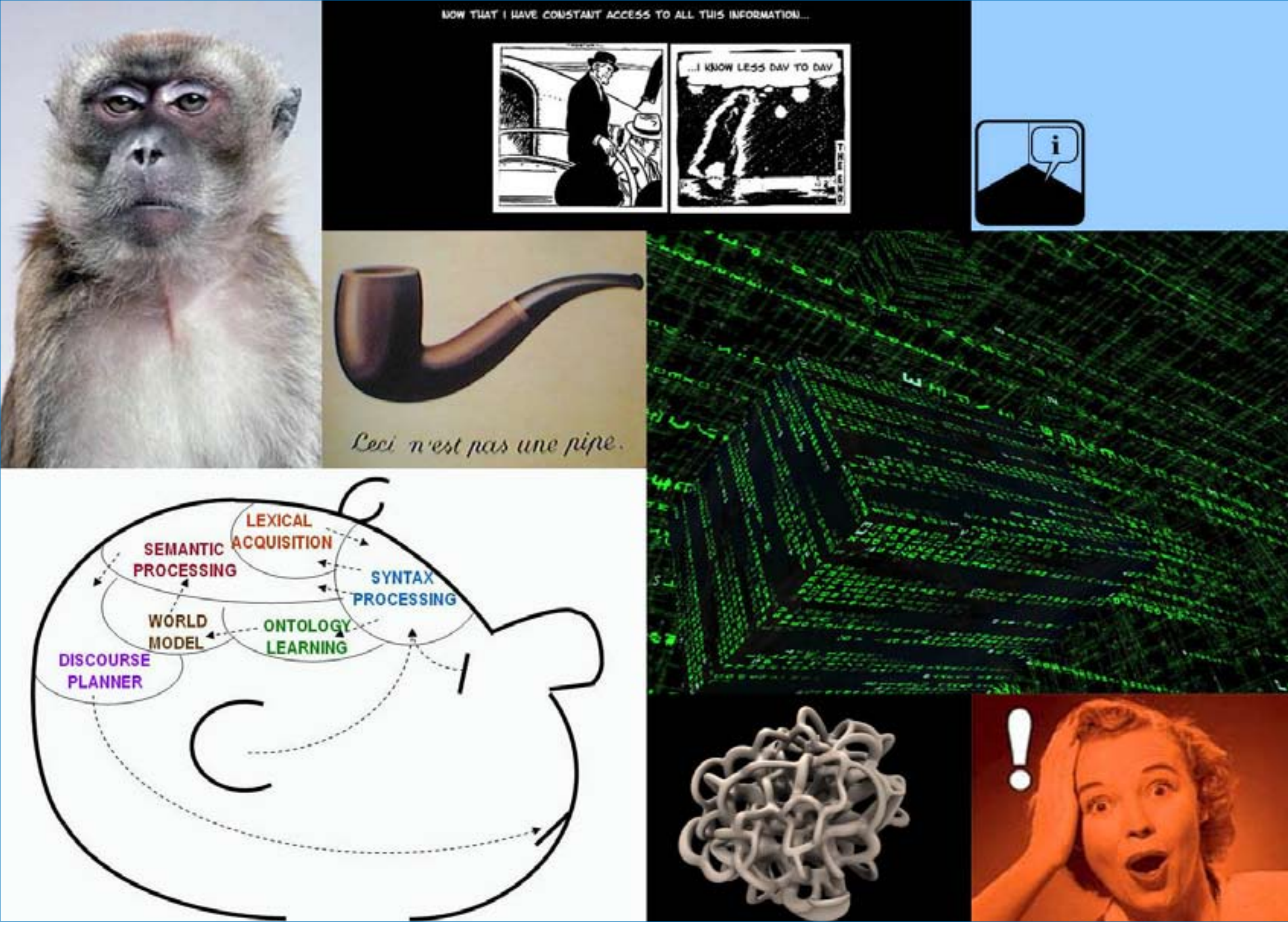
Web 3.0 changes this. The convergence of pattern discovery, deep linguistics, and ontological symbolic reasoning technologies make it feasible to automatically extract embedded and intrinsic knowledge from todays Web. Evolution of semantic social computing will enable communities to create, curate, and share knowledge in human readable and machine executable forms.

The diagram below contrasts knowledge-centric and information-centric patterns of computing. In Web 3.0, end-user development will increase as computers help generate intelligent services and manage application functionality, security, versioning and changes autonomically.

Below:
What Are Knowledge-centric Patterns of Computing?

Pattern	Information-centric	Knowledge-centric
Who develops software behaviors, knowledge structures, and content?	Producers and enterprises are developers.	Prosumers (consumers) and peer-to-peer producers (groups, communities) do it themselves.
How are different expressions of knowledge handled?	Separate technologies for documents (data, content), models, and behaviors. Closed semantics, hardwired.	Unified platforms handle documents, models & behaviors interchangeably, including pictures & natural language. Massive open local semantics, available everywhere.
Where do knowledge & logic in the system come from?	At design time, from people. At new release, from people. No run-time learning.	At design time, from people. At run time, from user input and from system learning.
What are the patterns for system learning?	No system learning. No autonomics. New knowledge requires new version of code.	System learns and evolves from use by people. Machine observes & learns from environment. Autonomics — self* learning and adaptation.
What are the patterns for knowledge representation and computation?	Process-centric, cycle time intensive. Directional algorithms and procedures. Embedded knowledge — logic, structure locked in code. Relational operators. First-order logic.	Data-centric, storage-intensive. Semantic operators. Sequence neutral graph reasoning. External declarative knowledge structures. Semantic and value-based reasoning with full spectrum of logic.
What are the patterns for underlying infrastructure?	Predefined configurations. Black-box objects. Stacks. Single processors. Local stores.	Adaptive, self-optimizing configurations. Ubiquitous semantic Webs, meshes & grids. Transparent semantic agents. Multi-core, multi-threaded processors. Federated stores and processes. Semantic ecosystems and social autopoeisis (self-organization, planning, etc.).
What are the patterns for security?	Separate role-based security for each system. Black boxes, lack of transparency, and human intervention make network security problematic.	Autonomic identity and security with concept level granularity across all IP entities, relationships, services, etc. Building block transparency = security by design.
What are patterns for versioning and change management?	Manual change management and versioning. Human architected. Central planning. Brittle.	Automated change management & versioning. Autonomic intellectual property, emergent behaviors, self-managed. Robust.

Source: Project10X



What new capabilities will Web 3.0 knowledge-centric computing enable?

Systems that know, learn, and can reason as humans do.

When knowledge is encoded in a semantic form, it becomes transparent and accessible at any time to a variety of reasoning engines.

Previously, if knowledge was in a document or set of documents, then it was fixed when published in a form only humans could read. Or, if knowledge was encoded in a computer program, then it was opaque and hidden in objects or in procedures that were fixed at design time, and hence a "black box" so that the logic is not visible to any other process that had not been pre-programmed with common knowledge.

In Web 3.0, knowledge lives, evolves and is stored transparently (as "glass boxes"). It can be used, validated, added to, combined with other knowledge at run time by multiple systems. This enables a system to "learn" to do things that the system designer did not anticipate. This is an important shift from IT as it has been practiced until now.

Web 3.0 systems will be designed so that they get better with use and scale. Their architectures will enable learning. One way is that their users can evolve them by adding knowledge and capabilities to them. Another way is that systems may learn by themselves how to respond to changes in their environments.

How will Web 3.0 overcome the fragmentation of information, processes, and application functionality?

By interrelating the myriad forms of language that people and machines used to encode thoughts, share meanings, and connect knowledge.

Until now, knowledge on the Web has been expressed in separate forms such as documents, imagery, patterns, structural models, and program code. Computers that produced these artifacts mostly have been used as electronic pencils, with little (if any) understanding of what the writing meant, and no ability to interpret other ways of expressing the same idea (such as through graphics, images, video, computer languages, formal languages, and other natural languages, etc.).

In Web 3.0, the myriad forms of language in which knowledge is expressed begin to get interrelated, connected, and made interchangeable with each other, for example: combining knowledge from one or more sources, or from one or more formats, or from one time and place with other contexts.

To illustrate, policies are typically written out as documents. But, this same knowledge can be modeled as a data structure or as decision rules. Also, policies can be hard coded into software objects and procedures. Using semantic technologies we can represent, connect, and manage the knowledge from all of these different forms at the level of concepts, and maintain each artifact. This sort of "transemantic" or multi-lingual capability leads to computer systems that can:

Capture knowledge from different sources such as sensors, documents, pictures, graphics, and other data and knowledge resources,

Interpret and interrelate these different ways of expressing ideas with each other,

Share what they know with people and machines, and

Re-express, and communicate what they know in different contexts, information formats, and media.

Below:
How Do Humans Encode Thoughts and Share Knowledge and Meaning?

Natural language	Documents, speech, stories
Visual language	Tables, graphics, charts, maps, illustrations, images
Formal language	Models, schema, logic, mathematics, professional and scientific notations
Behavior language	Software code, declarative specifications, functions, algorithms
Sensory language	User experience, human-computer interface

Source: Project10X

How does Web 3.0 tap new sources of value?

By modeling knowledge, adding intelligence, and enabling learning.

The value drivers for Web 3.0 are huge. The table below highlights five categories of challenges, semantic capabilities that address these needs, and the value drivers associated with these semantic capabilities. Semantic technologies have the potential to drive 2-3 order of magnitude improvements in capabilities and life cycle economics through cost reductions, improved efficiencies, gains in effectiveness, and new functionalities that were not possible or economically feasible before now. New sources of value include:

1. Value from knowledge modeling — Semantic models are sharable, recombinant, and executable. To model first, then execute the knowledge reduces time, risk, and cost to develop and evolve services and capabilities. Semantic model-based approaches achieve added development economies through use of (a) shared knowledge models as building blocks, (b) autonomic software techniques (goal-oriented software with self-diagnostic and self-management capabilities such as self-configuration, self-adaptation, self-optimization, etc.), and (c) end-user and do-it-yourself life-cycle development methodologies (rather than requiring intervention by IT professionals). Knowledge that is sharable, revisable, and executable is key applications where facts, concepts, circumstances, and context are changing and dynamic.

2. Value from adding intelligence — A working definition of intelligence is the ability to acquire, through experience, knowledge and models of the world (including other entities and self), and use them productively to solve novel problems and deal successfully with unanticipated circumstances. A key new source of value is adding intelligence to the user interface, to applications,

Below:
How Do Semantic Technologies Drive Value?

Challenges	Semantic Capabilities	Value Drivers
1. Development: Complexity, labor-intensity, solution time, cost, risk	Semantic automation of *"business need-to-capability-to-simulate-to-test-to-deploy-to-execute"* development paradigm	Semantic modeling is business rather than IT centric, flexible, less resource intense, and handles complex development faster.
2. Infrastructure: Net-centricity, scalability; resource, device, system, information source, communication intensity	Semantic enablement and orchestration of transport, storage, and computing resources; IPv6, SOA, WS, BPM, EAI, EII, Grid, P2P, security, mobility, system-of-systems	In the semantic wave, infrastructure scale, complexity, and security become unmanageable without semantic solutions.
3. Information: Semantic interoperability ofinformation formats, sources, processes, and standards; search relevance, use context	Composite applications (information & applications in context powered by semantic models), semantic search, semantic collaboration, semantic portals	Semantic interoperability, semantic search, semantic social computing, and composite applications & collaborative knowledge management become "killer apps."
4. Knowledge: Knowledge automation, complex reasoning, knowledge commerce	Executable domain knowlege-enabled authoring, research, simulation, science, design, logistics, engineering, virtual manufacturing, policy and decision support	Executable knowledge assets enable new concepts of operation, super-productive knowledge work, enterprise knowledge superiority, and new intellectual property.
5. Behavior: Systems that know what they're doing	Robust adaptive, autonomic, autonomoussystem behaviors, cognitive agents, robots, games, devices, and systems that know, learn, and reason as humans do	Semantic wave systems learn and reason as humans do, using large knowledgebases, and reasoning with uncertainty and values as well as logic.

Source: Project10X

and to infrastructure. An intelligent system or agent is a software program that learns, cooperates, and acts autonomously. It is autonomic and capable of flexible, purposeful reasoning action in pursuit of one of more goals. An intelligent user interface (UI) knows about a variety of things such as system functionality, tasks users might want to do, ways information might be presented or provisioned. Intelligent UIs know about the user (via user models), which enables tailoring system behavior and communications. Adding intelligence helps users perform tasks, while making working with the computer more helpful, and as invisible as possible. As a result, systems do more for the user, yield more relevant results with less effort, provide more helpful information and interaction, and deliver a more enjoyable user experience. Adding intelligence can produce ten-fold gains in communication effectiveness, service delivery, user productivity, and user satisfaction.

3. Value from learning — Machine learning is the ability of computers to acquire new knowledge from past cases, experience, exploration, and user input. Systems that learn increase in value during their lifetime. Their performance improves. They get better with use, and with scale. In addition to new or improved capabilities, systems that learn during operation may improve system lifecycle economics by (a) requiring less frequent upgrading or replacement of core software components, and (b) enabling new incremental extensions to revenue models through add-on knowledgeware and software-as-a-service.

4. Value from semantic ecosystem — An ecosystem is a self-sustaining system whose members benefit from each other's participation via symbiotic relationships (positive sum relationships). Principle drivers for semantic infrastructure and ecosystem include the economics of mobility, scale, complexity, security, interoperability, and dynamic change across networks, systems, and information sources. These problems are intractable at Web scale without semantics. The corollary is the need to minimize human labor needed to build, configure, and maintain ultra-scale, dynamic infrastructure.

Semantic ecosystems that emerge in Web 3.0 will consist of dynamic, evolve-able systems consisting of ensembles (societies) of smart artifacts. This means a shift in design focus from static, performance-driven design to: (a) design for robustness & resilience; (b) design for uncertainties; (c) design for distributed, autonomous pervasive adaptation; (d) design for organically growing systems; and (e) design for creating self-evolving services.

Current systems including the internet are designed to operate with predefined parameters. Change spells trouble. Mobility is a problem. Semantic ecosystems will be future-proof, able to grow dynamically, evolve, adapt, self-organize, and self-protect. Web 3.0 will lay the foundations for ubiquitous Web including autonomic intellectual property, Web-scale security and identity management, and global micro-commerce in knowledge-based assets. The value vector for semantic infrastructure is 2-4 orders of magnitude gains in capability, performance, and lifecycle economics at Web scale.

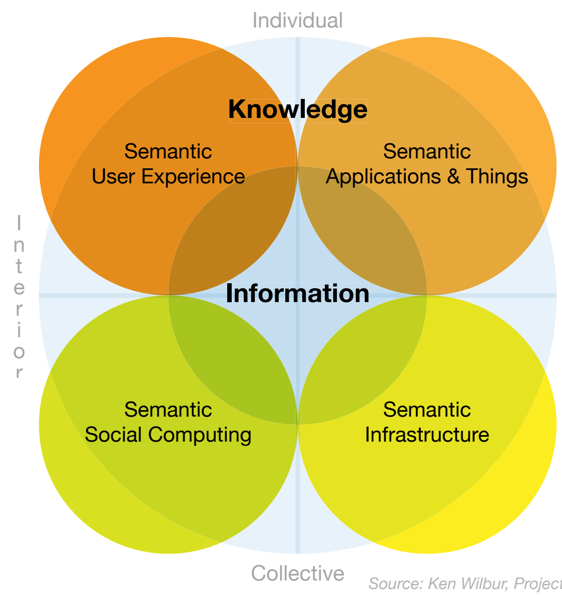
Semantic Wave Technology Trends

The Semantic Wave 2008 Report examines over 100 application categories & more than 270 companies pursuing semantic products and services.

A broad range of semantic technologies will power Web 3.0. The technology section of Project10X's Semantic Wave 2008 Report examines Web 3.0 technology themes from multiple perspectives. It shows how innovations in each area will drive development of new categories of products, services, and solution capabilities. Technology perspectives include:

> *Semantic user experience* — concerns how I experience things, demands on my attention, my personal values.
>
> *Semantic social computing* — concerns our lived culture, intersubjective shared values, & how we collaborate and communicate.
>
> *Semantic applications, and things* — concerns objective things such as product structure & behavior viewed empirically.
>
> *Semantic infrastructure* — concerns interobjective network-centric systems and ecosystems.
>
> *Semantic development* — concerns Webs of meanings, systems that know and can share what they know, and architectures of learning, whidh make semantic solutions different.

Semantic Wave 2008 spotlights trends in each of these areas and examines role of semantic technologies in over 100 application categories. An addendum to the report surveys more than 270 companies that are currently researching and developing semantic wave technology products and services.



Source: Ken Wilbur, Project10X

Above:
Semantic Technology Perspectives

Technology Trend 1—Semantic User Experience

Intelligent user interfaces drive gains in user productivity & satisfaction.

The Semantic Wave 2008 Report explores the impact of semantic technologies on user experience. User experience is the sum of interactions and overall satisfaction that a person has when using a product or system. Semantic user experience is the addition intelligence and context-awareness to make the user interface more adaptive, dynamic, advisory, proactive, autonomic, and autonomous, and the resulting experience easier, more useful, and more enjoyable.

Attention is the limited resource on the internet — not disk capacity, processor speed or bandwidth. Values shape user experience. Simplicity, versatility and pleasurability are the new watchwords. Context is king. Mobility, wireless, and video are the new desktop. Seamless services anytime, any where. Users are prosumers, creating content, participating in peer production, taking control of consumption. Trends in user interface (UI) are towards personal avatars; context-aware, immersive 3D interaction; and reality browsing, and augmented reality.

Identity is information used to prove the individuality of a person as a persisting entity. The trend is towards semantic avatars that enable individuals to manage and control their personal information, where ever it is across the net. Context is information that characterizes a situation of an entity, person, object, event, etc. Context-awareness is using this knowledge to sense, predict, interpret, and respond to a situation.

Web 3.0 browsers will understand semantics of data, will broker information, and automatically interpret metadata. The emerging display landscape (depicted above) will be semantically connected and contextually aware. It will unify displaying and interacting, and will personalize experience. Reality browsing is querying the physical world live and up close from anywhere. Augmented reality is bringing the power of the Web to the point of decision, by combining real world and computer generated data. Semantic rich internet applications will exploit higher bandwidth content dimensionality, context sensitivity, and expanded reasoning power for dynamic visualization and interaction in the UI.

Technology Trend 2 — Semantic Social Computing

Collective knowledge systems become the next “killer app.”

The Semantic Wave 2008 Report explores the role of semantic technologies in the evolution of social computing. Social computing is software and services that support group interaction. Semantic social computing adds an underlying knowledge representation to data, processes, services, and software functionality.

Semantic technologies will enrich many categories social applications including instant messaging, email, bookmarking, blogging, social networking, wikis, user driven “communitainment”, and do-it-yourself applications and services. For example, semantic technologies will enable social computing applications to provide concept-based rather than language-based search and navigation across most standard applications, document types, and file formats, regardless where these resources reside on the net, be it a desktop, mobile device or server, etc.

A key trend in Web 3.0 is toward collective knowledge systems where users collaborate to add content, semantics, models, and behaviors, and where systems learn and get better with use. Collective knowledge systems combine the strengths of social Web participation with semantic Web integration of structure from many sources. Key features of Web 3.0 social computing environments include (a) user generated content, (b) human-machine synergy; (c) increasing returns with scale; and (d) emergent knowledge. Incorporating new knowledge as the system runs is what enables Web 3.0 systems to get smarter.

Technology Trend 3 — Semantic Applications

New capabilities, concepts of operation, & improved lifecycle economics.

The Semantic Wave 2008 Report examines the emerging role of semantic technologies in more than 100 consumer and enterprise application categories. Semantic applications put knowledge to work. Areas covered in the report include: (a) semantics in commercial off the shelf software such as ERP, CRM, SCM, PLM, and HR; (b) ontology-driven discovery in law, medicine, science, defense, intelligence, research, investigation, and real-time document analysis; (c) risk, compliance and policy-driven processes such as situation assessment, exceptions, fraud, case management, and emergency response; (d) knowledge-intensive processes such as modeling & simulation, acquisition, design, engineering, and virtual manufacturing; (e) network & process management such as diagnostics, logistics, planning, scheduling, security, and event-driven processes; (f) adaptive, autonomic, & autonomous processes such as robotics and intelligent systems; and (g) systems that know, learn & reason as people do such as e-learning, tutors, advisors, cognitive agents, and games

Key trends toward semantic applications are:

From knowledge in paper documents, to digital documents, to knowledge (semantic models), to semantic agents;

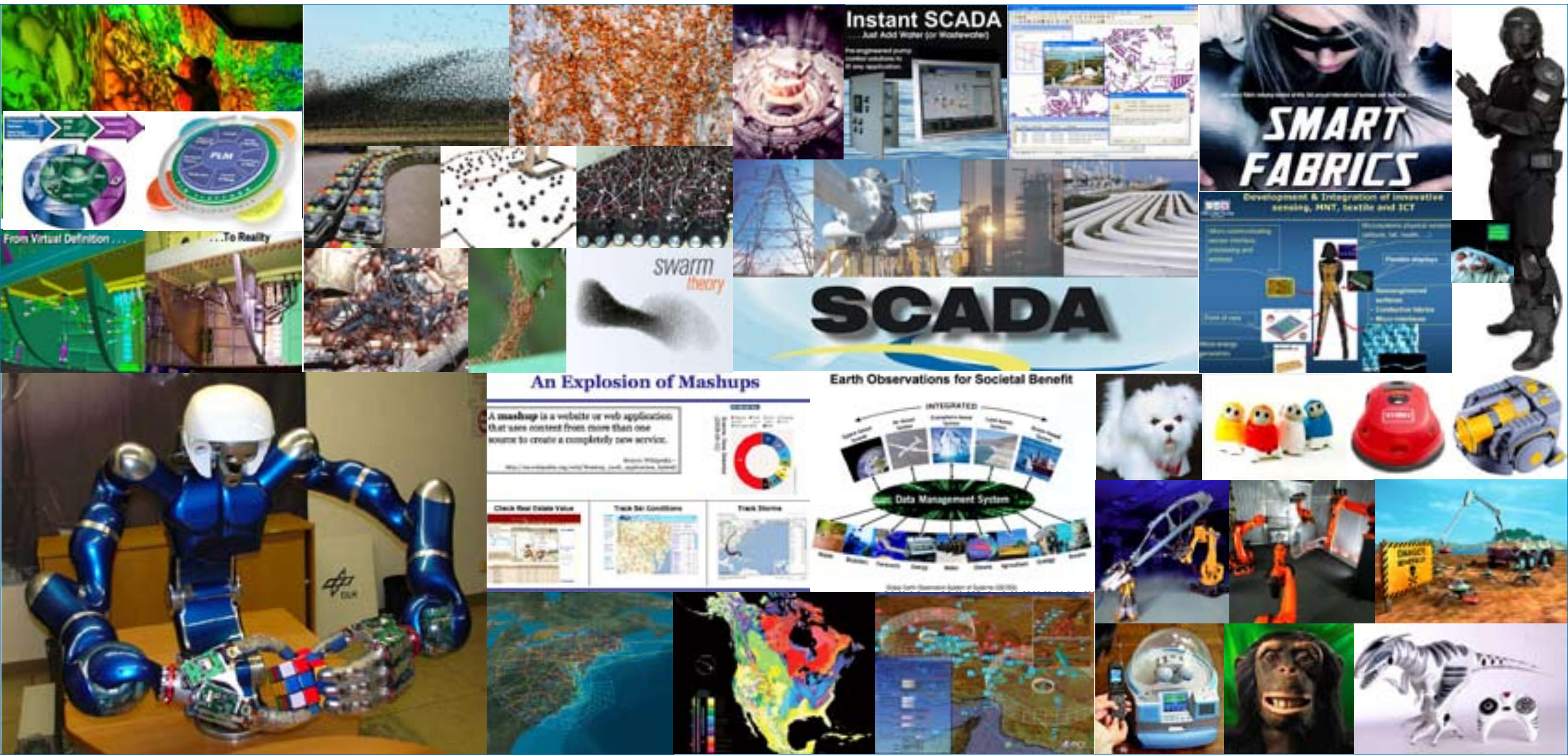
From static and passive functional processes, to active, adaptive, and dynamic processes, to autonomic to autonomous processes;

From programmer encoded interpretations of meaning and logic at design time, to computer interpretation of meaning and logic at run time;

From smart program code to smart data;

From search to knowing; and

From reasoning with SQL to first order logic, to complex reasoning with uncertainty, conflict, causality, and values for the purposes of discovery, analysis, design, simulation, and decision-making.



Technology Trend 4 — Semantic Infrastructure

A knowledge space solves problems of scale, complexity and security.

The Semantic Wave 2008 Report examines the role of semantic technologies in infrastructure. Infrastructure is the basic features of a system such as networks, facilities, services, and installations that are needed for the functioning of internet-based communities. By adding a knowledge dimension to this underlying structure, semantic infrastructures provide solutions to problems of Integration, interoperability, parallelism, mobility, ubiquity/pervasiveness, scale, complexity, speed, power, cost, performance, autonomics, automation, intelligence, identity, security, ease of programming, and ease of use.

Information and communications technology (ICT) has reached the limits of what it can do with stack architecture, object orientation, first-order logic, and fixed, embedded knowledge (i.e., in code) with no learning, or with architected development versus emergent solutions. Semantic technologies provide the first path forward to overcome the limitations of these existing approaches.

Trends toward semantic infrastructure include:

> Computing diverges into declarative (brain) and procedural (sensory organs) lines of development.
>
> Storage moves from flat files, to centralized "bases" with relational operators, to federated "spaces" with native semantic operators. The trend is toward high-performance semantic processing at scale and representations that support nearly unlimited forms of reasoning.
>
> Transport moves from dial-up, to broad band, to video bandwidth. Mobility is the new platform, and semantic technologies are needed to deliver seamless, customizable, context aware services, any time, any where.
>
> Processor technology goes parallel, multi-core, multi-threaded, and specialized.
>
> Displays become a landscape of interoperable devices of differing characteristics, sizes and capabilities. Boundaries between virtual and real dissolve in planned and unplanned ways. The trend is towards immersive experience and reality browsing.

Longer term, the trend is towards every thing becoming connected, somewhat intelligent, somewhat self-aware, socially autopoeitic, and autonomically capable of solving problems of complexity, scale, security, trust, and change management.

Technology Trend 5 — Semantic Development

Semantic modeling reduces time, risk, and cost to develop solutions.

The Semantic Wave 2008 Report explores trends in methodology and practices for semantic software and solution development.

A development life cycle is a conceptual model used in project management that describes the stages involved in a system or application development project, typically involving a discovery, feasibility, and planning stage through maintenance of the completed application. Conventional development methodologies include the waterfall model; rapid application development (RAD); the fountain model; the spiral model; build and fix; and synchronize-and-stabilize, etc.

Semantic solution development departs from conventional development. It deals with: (a) Webs of meanings and knowledge from diverse provenance, (b) systems that know and can share what they know, and (c) architectures of learning.

Semantic solutions emerge from a techno-social collaboration that also supports do-it-yourself development. The process is business and user driven versus IT and developer driven. The collective knowledge developed is both human and machine interpretable. Some different skills are required including domain experts, semantic modelers, and semantic user experience designers.

Knowledge is extracted and modeled separately from documents, schemas, or program code so it can be managed across these different forms of expression, shared between applications, aligned and harmonized across boundaries, and evolved. For example, requirements, policies, and solution patterns are expressed as semantic models that execute directly and can be updated with new knowledge as the application runs.

The semantic solution development process is model-driven and knowledge-centric and rather than procedural and document based. Semantic solutions may have zero code. Build cycles are fast, iterative, non-invasive. Semantic solution development typically entails less time, cost, and risk to deploy, maintain, and upgrade.

Semantic Wave Markets

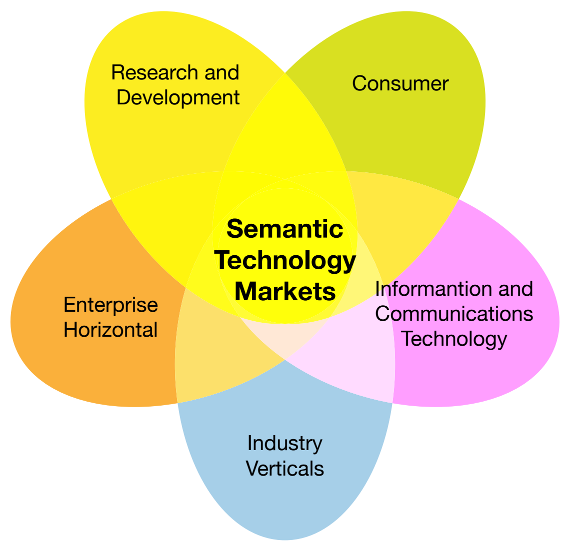
The Semantic Wave 2008 Report sizes markets and presents 150 case studies in 14 horizontal and vertical market sectors.

The market section of Project10X's Semantic Wave 2008 Report examines the growth of supply and demand for products, services and solutions based on semantic technologies. Specifically, the report segments and discusses semantic wave markets from horizontal and vertical perspectives:

> *Horizontal* market sectors include: Research and development; Information and communication technologies; Consumer internet; and Enterprise horizontal.
>
> *Vertical* market sectors include: Advertising, content, entertainment; Defense, intelligence, security; Civilian agencies, state & local government; Education, training; Energy, utilities; Financial services; Health, medical, pharma, life sciences; Information & communications technology; Manufacturing; Professional services; Transportation, logistics; and other services.

Horizontal and vertical market sectors each present multi-billion dollar opportunities in the near- to mid-term. The study sizes markets. It presents 150 case studies in 14 horizontal and vertical sectors that illustrate the scope of current market adoption.

Semantic technologies are spreading out and penetrating into all areas of information and communications technology, all economic sectors, and most categories of application. There are powerful economic drivers. Development and adoption is already global in scope. Market momentum is building. The sweet spot for cross-over and market acceleration is only about a year out.



Source: Project10X

Above:
What Are Semantic Wave Markets?

Market Trend 1—Research & Development

Semantic technologies are a significant and growing focus in global R&D.

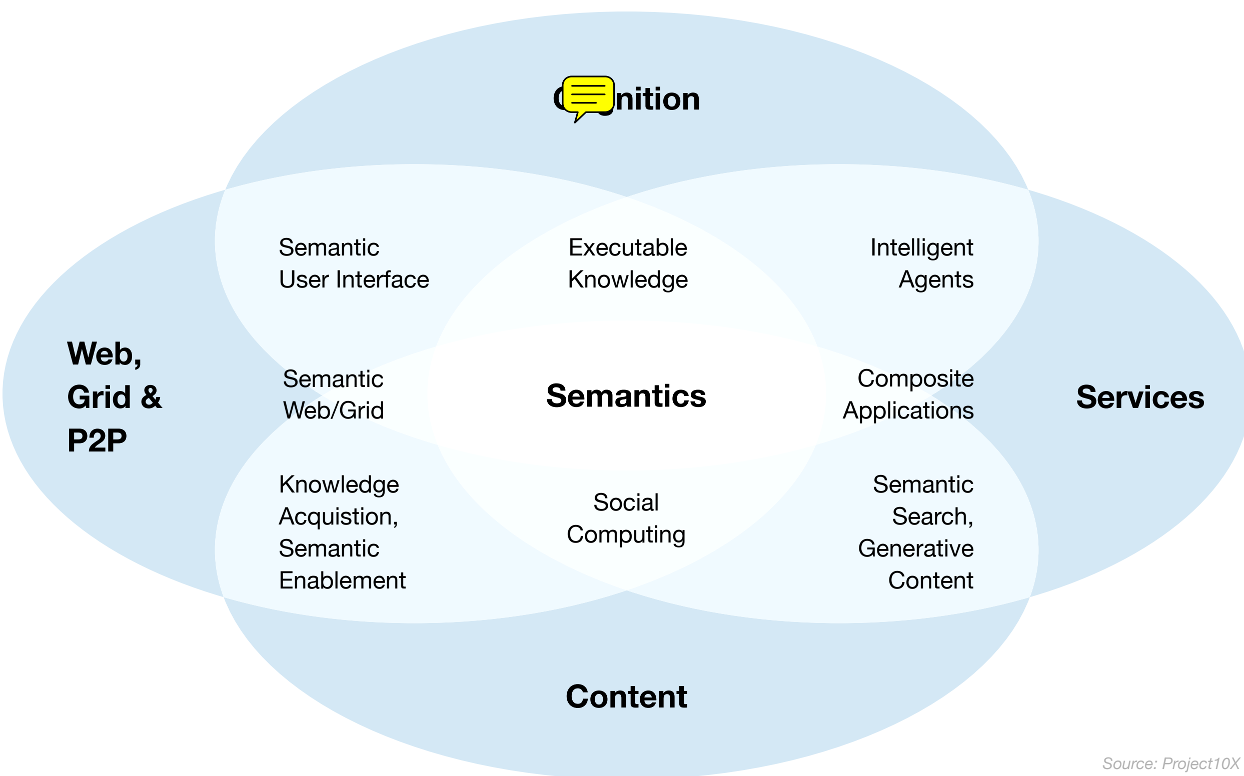
The maturation of R&D investments made in the public and private sectors over the past decade is one reasons why semantic technologies and Web 3.0 are entering mainstream markets. The diagram below highlights semantic technology areas which are receiving international R&D funding estimated to be more than $2B per year through the end of the decade.

Public sector investment has been significant and is growing in North America, Europe, and Asia. Countries recognize the strategic importance of semantic technologies in the emerging global knowledge economy and are seeking competitive advantage through public sector investments. Historically, it is worth noting that public sector investment to develop ICT technologies has a strong track record, having spawned $-billion industries repeatedly over the past 40 years.

The Semantic Wave 2008 Report provides summarized examples of public sector R&D programs from organizations such as: DARPA, Air Force Research Laboratories, NASA, and NSF.

Private sector firms accelerate semantic technology R&D. Commercial investment is now global. Private sector motivations for R&D are nearer-term and focus on return on investment. Semantic Wave 2008 predicts that both consumer-internet and enterprise-oriented investments in semantic technology will increase significantly through the end of the decade.

Below:
What Are Semantic R&D Trends?



Source: Project10X

Market Trend 2—Information & Communication Technology

ICT semantic technology markets will exceed $50 billion in 2010.

The global ICT market is $3.5 Trillion and will be $4.3 Trillion by 2010. Growth in the E7 countries (China, Brazil, Korea, India, Russia, Mexico, and Taiwan) is currently around 20-percent per year. The market for semantic technologies is currently a tiny fraction of global ICT spending. But, growth is accelerating.

Semantic Wave 2008 profiles more than 270 companies that provide semantic technology R&D, services and products. Most are small, boutique firms, or start-ups. But, a significant number of established ICT companies have entered the semantic space. Overall, we estimate markets for semantic technologies in ICT exceed $50 B in 2010.

Below:
Who Are the Semantic Technology Suppliers?

42 Objects
Above All Software
Abrevity
Access Innovations
Active Navigation
Adaptive Blue
Adobe Systems
Aduna
Agent Logic
Agent Software
Agilense
Altova
Amblit Technologies
Apelon
Arisem
Articulate Software
AskMe
AskMeNow
Aspasia
Astoria Software
AT&T Research
ATG
Attensity
Autonomy
Axontologic
BAE Systems
BBN Technologies
BEA Systems
Biowisdom
Boeing Phantom Works
Bouvet
Bravo Solution
Business Semantics
Celcorp
Celtx
CheckMI
Cisco Systems
Clarabridge
ClearForest
Cogito
CognIT a.s
Cognition Technologies
Cognium Systems
Cohereweb
Collarity
Collexis
Composite Software, Inc.
Computas AS
Computer Associates
Connotate
Content Analyst
Contextware
Contivo
Convera
Copernic
Correlate
Cougaar Software
Coveo
Crystal Semantics
CureHunter
Cycorp
Dassault Systemes
Data-Grid
Day Software
Deepa Mehta
Design Power
DERI
Design Power
DFKI
DiCom Group
Digital Harbor
Digital Reasoning Sys.
Discovery Machine
DreamFactory Software
EasyAsk
Effective Soft
Ektron
EMC Corporation
Empolis
ENDECA
Enigmatec
Enterra Solutions
Entrieva
Epistemics
Expert System
ExpertMaker
Factiva
Fair Isaac
Fast Search & Transfer
Fortent
FourthCodex
Franz Inc.
Fujitsu Laboratories
General Dynamics IT
Generate
GeoReference Online
Global 360
Google
Graphisoft
Groxis
Gruppometa
H5
hakia
HBS Consulting
Hewlett-Packard
i2
IAC Search & Media
IBM
ILOG
Image Matters
Imindi
iMorph
Infolution
Informatica
Information Extraction Sys.
InforSense
InfoSys
Innodata Isogen
Intellidimension
Intelligent Automation
Intellisemantic
Intellisophic
Interwoven
Invention Machine
Iona Technologies
Irion Technologies
Iron Mountain
iSOCO
ISYS Search Software
Janya
JARG Corporation
JustSystems
K2
Kalido
Kapow Technologies
Kennen Technologies
Kirix
Knewco
Knova Software
Knowledge Based Sys.
Knowledge Computing
Knowledge Concepts
Knowledge Foundations
Knowledge Media Inst.
Knowledge Systems, AI Lab
Kroll Ontrack
Kyield
Language and Computing
Language Computer Corp.
LEGO Americas
Leximancer
Lexxe
Liminal Systems
Linguamatics
LinkSpace
Lockheed Martin
LogicLibrary
Lymba Corporation
Magenta Technology
Makna Semantic Wiki
Mandriva
Mark Logic
MatchMine
McDonald Bradley
MetaCarta
MetaIntegration
Metallect
Metatomix
Metaview 360
MetaWeb Technologies
Métier
Microsoft Corporation
Mind-Alliance Systems
Mindful Data
Miosoft
Modulant
Modus Operandi
Molecular
Mondeca
Moresophy
Motorola Labs
mSpace
Nervana
Netezza
NetMap Analytics
NeurokSoft
Nielsen BuzzMetrics
Noetix
Nokia
Northrop Grumman
nStein
NuTech Solutions
Ontology Online
Ontology Works
Ontomantics
ontoprise
Ontos
OntoSolutions
Open Text
Oracle
PhraseTrain
Polymeta
Powerset
Pragatic
Profium
Progress Software
Project10X
Proximic
PTC
Quigo
Radar Networks
Raytheon
Readware
Rearden Commerce
Recommind
Red Hat
Reengineering
Reinvent Technology
Revelytix
RuleBurst
SAIC
SaltLux
Sandpiper Software
SAP
SAS Institute
SchemaLogic
Semandex Networks
Semansys Technologies
Semantic Arts
Semantic Discovery
Semantic Insights
Semantic IQ
Semantic Knowledge
Semantic Light
Semantic Research
Semantic Search
Semantic Solutions
Semantic System
Semantra
Semaview
SemperWiki
SERENA Software
SiberLogic
Siderean Software
Sierra Nevada Corp
SilkRoad Technology
Sirma Group — Ontotext
Smart Desktop
SmartLogic
Soar Technology
Software AG
Sony
Spock
SRA International
SRI International
Sun Microsystems
SunGard
Sybase
Synomos
SYS Technologies
System One
TACIT
Talis
Taxonomy Strategies
TÉMIS Group
Teradata
Teragram
TextDigger
Textwise
The Brain Technologies
The METADATA Co.
Thetus
Thinkmap
Thomson Corporation
ThoughtExpress
TopQuadrant
TripIt
Troux Technologies
True Knowledge
Ultimus
Ultralingua
Versatile Info Systems
Vignette
Vitria
Vivísimo
Vivomind Intelligence
WAND
WebLayers
WiredReach
Wordmap
XSB
Yahoo!
Zepheira
ZoomInfo
Zotero
ZyLAB

Source: Project10X

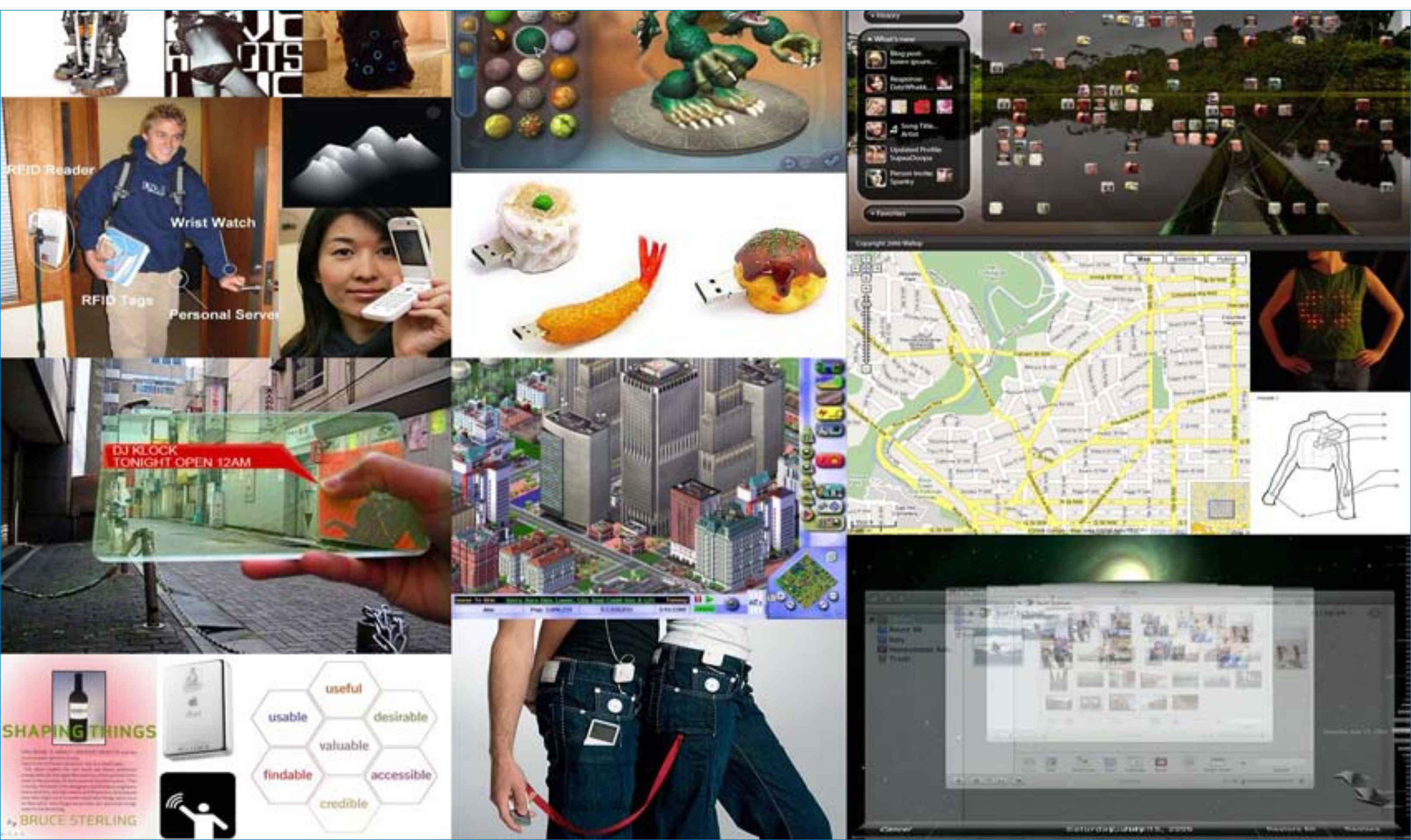
Market Trend 3—Consumer Internet

Consumer content, entertainment & advertising dollars will build Web 3.0.

Semantic Wave 2008 examines the growth of internet and mobile advertising, content and entertainment to 2012, as well as the growth of internet based commerce and consumer electronics. Driving forces in consumer internet markets are huge. The increasing the flow of advertising dollars, content, entertainment, and commerce to the internet will fuel the build-out of Web 3.0.

Consumers account for 25 percent of global ICT spending. One billion people around the globe now have access to the internet. Nearly 50 percent of all U.S. Internet access is via always-on broadband connections. Mobile devices outnumber desktop computers by a factor of two. By 2017, telecom industry projects are that there will be 5 billion mobile internet users and more than 7 billion internet-enabled devices. The internet is now a mass medium for content, entertainment, and advertising as well as knowledge exchange and business efficiency. It is growing rapidly and it is taking market share (i.e., money) away from other media.

Semantic technologies are strategic for consumer internet markets as enabling technology, and as a means for competitive differentiation. We're in the midst of a "user revolution." Context, social nets, & relationships are king. Consumers are prosumers. They create content, engage in peer production, participate in usites (sites with user created content), enjoy themselves with communitainment (users simultaneously communicating and participating in entertainment activities with each other as part of social networks. The "long tail" makes semantic advertising into a killer app — a better way to target, match and bring together buyer and seller.



Market Trend 4—Enterprise Horizontal

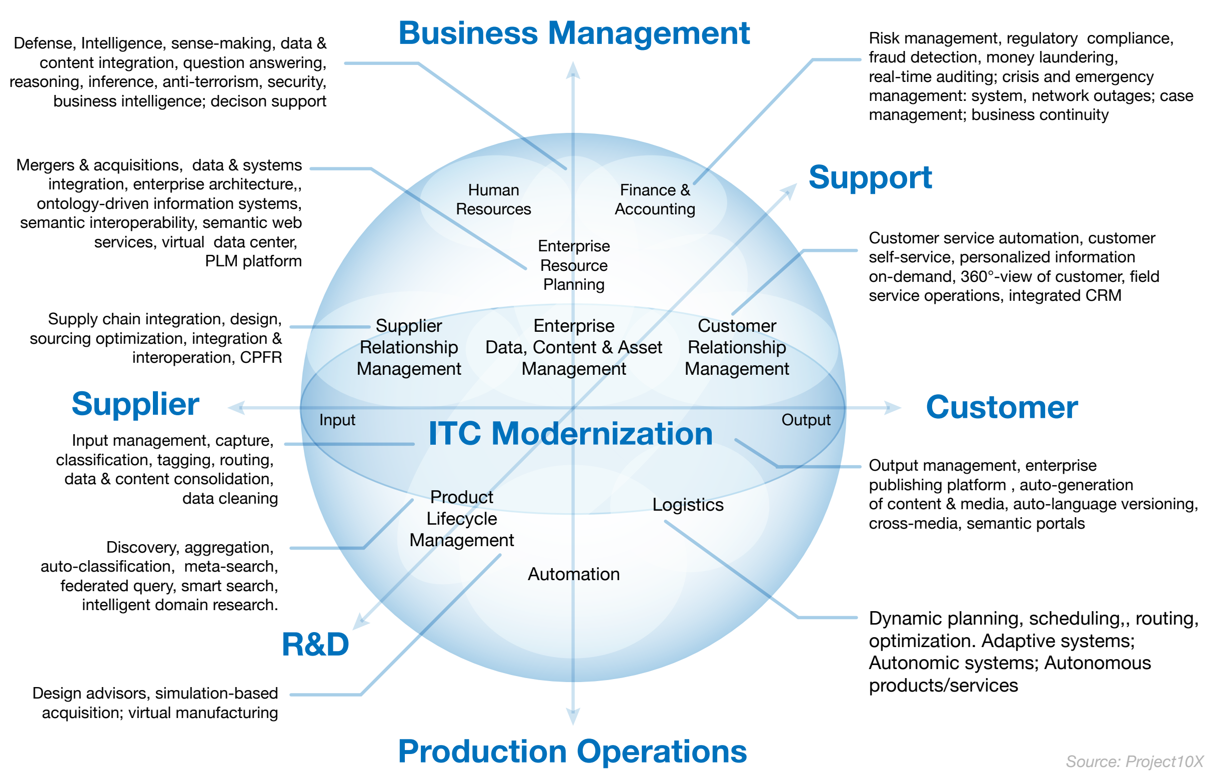
Middleware, services, processes, search, and collaboration go semantic.

As shown in the diagram below, just about everywhere one can look in an enterprise, someone somewhere is applying semantic technologies to some problem. Drivers of enterprise business value are all strong— new capability, life cycle ROI, performance, and strategic edge.

Semantic Wave 2008 examines enterprise markets for semantic technologies including twelve categories of commercial-off-the-shelf software (COTS) packages that are estimated to represent a combined software product and service revenue of more than $160 billion in 2010. The report projects the transition of these market segments from conventional to semantic COTS technologies. Amongst the first tier of large ICT technology providers, areas that are being targeted first are related to the internal stack, or plumbing for suites of applications because these changes make few demands on customer while establishing a semantic application framework that developer can use as a foundation. Service oriented architecture becomes semantic SOA. Changes that impact application concept of operations, and user interface come next.

Also, enterprise software has a long tail. There are an estimated 56 million firms worldwide, including 1.5 million with more than 100 employees, and around 80,000 businesses with more than 1,000 employees. The transition to semantic software technologies will facilitate mass customization of commercial-off-the-shelf solutions enabling software vendors to address more levels of the market with sustainable solutions.

Below:
What Semantic Technologies Are Being Employed in Enterprise?



Source: Project10X

Market Trend 5—Industry Verticals

150 case studies make the case that semantic wave markets are here.

Semantic Wave 2008 examines semantic technology adoption in industry verticals. The report summarizes 150 case examples in fourteen industry sectors. The table below highlights some of the semantic application case examples in eight vertical industry sectors. Each industry has both horizontal and vertical needs. Applications are diverse. Nearly three-fourths of the case examples come from private industry. A little more than one-fourth are public sector. Collectively, they make a strong case that semantic wave markets are here and now.

Below:
What Are Industry Vertical Markets for Semantic Technologies?

MARKET SECTOR	EARLY ADOPTER ORGANIZATIONS	SEMANTIC APPLICATION CASE EXAMPLES
ADVERTISING, CONTENT & ENTERTAINMENT	BBC; Bertelsmann; Dentsu; Disney; Elsevier; Associated Press	Digital asset management; rich media interoperability; content mining; mapping of concepts across content libraries; accelerated creation of new derivative information products; identification and extraction of information types, such as chemical compounds and classes for science; rapid development of custom news feeds; skills curation and collaboration
EDUCATION & TRAINING	Industry; universities; governments	E-learning; simulation learning tools (“learning by doing”); semantic collaboration environments; digital library services; rapidly customized coursework content; automated scoring; publication streamlining
ENERGY & UTILITIES	Air Liquide America; Air Products; BP; GE Infrastructure Water & Process Technologies; Shell Oil; Statoil	Energy exploration; processing real-time remote sensor data; power distribution through “common information models”; multi-agent technologies; corporate portals across departments and disciplines; adaptive data warehousing; multi-format document access; knowledge-based service reporting; proposal management; integrating information across operating units; product and market segmentation; scenario validation
FINANCIAL SERVICES	Citigroup; Ameriprise Financial; Aon; Fireman’s Fund Insurance	Risk and compliance management; due diligence; security and surveillance; analytical dashboards and composite applications; case management; auditing transparency; trend analysis; regulation and policy management; document and contract analysis; business rules for investment strategies; sales and customer service; risk scoring; new business acquisition; policy-based computing and application monitoring; loan processing; analyst productivity suites
HEALTH, MEDICINE, PHARMA & LIFE SCIENCES	National Library of Medicine; Amgen; Biogen; Eli Lilly; GSK; Novartis; Pfizer; Healthline; Partners Clinical Informatics; University of Texas; Mayo Clinic; ImpactRX; Cleveland Clinic; Astrazeneca	Meta-searching and clustering; enterprise search; scientific discovery; translational medicine; clinical knowledge bases; reasoning and decision support; healthcare supply chain planning; in silico drug discovery; integrated biosurveillance; lexical standardization; market intelligence; patient records; drug development cost reduction
MANUFACTURING	Emerson Motors; General Dynamics; General Motors; BAE Systems; Rockwell Automation; Proctor & Gamble; EniTechnologies; Siemens	R&D; supply chain; customer support; product modeling; design and fabrication; design-to-order; document life cycle management; virtual manufacturing; international market and scenario simulation and visualization; robotics and autonomous systems; speech recognition; automobile telematics and automation; quality improvement; enterprise knowledge management; inventory optimization; maintenance and repair management; competitive intelligence; intellectual capital management; portfolio management; customer self-service
TRANSPORTATION & LOGISTICS	Tankers International; SouthWest Airlines	Cargo management; shipment tracking; contract review & management; logistics outsourcing management; logistics cycle emulation; network routing and scheduling
PUBLIC SECTOR	DoD Finance & Accounting Service; GSA; National Communications System Continuity Communications Working Group; FAA; OMB; National Geospatial Intelligence Agency; National Institutes of Health; National Cancer Institute; National Center for Biomedical Ontology; Dept. of Health and Human Services; Defense Information Systems Agency; Defense Logistics Agency; U.S. Army; XVIII Airborne Corps; Dept. of Education; Internal Revenue Service; National Biological Information Infrastructure; NSA; CIA; DIA; Dept. of Homeland Security	Semantic Service Oriented Architecture (SSOA); modeling IT environments; federated queries across databases; process management; geospatial information interoperability; predictive analytics; document parsing and entity extraction; mapping biological networks and biomarkers; unified medical ontologies; clinical care support; net-centric data services; knowledge navigation; speed of command; combat information distribution; nested networks; educational and training gateways; grant application processing; tax code navigation; expert systems; integrated defense information access; relationship analytics and social network analysis; pattern recognition; emergency management; immigration; infrastructure protection; international trade

Source: Project10X

About the Author

Mills Davis is founder and managing director of Project10X — a Washington, DC based research consultancy specializing in next wave semantic technologies and solutions. The firm's clients include technology manufacturers, global 2000 corporations, and government agencies.

Mills served as principal investigator for the Semantic Wave 2008 research program. A noted consultant and industry analyst, he has authored more than 100 reports, whitepapers, articles, and industry studies.

Mills is active in both government and industry-wide technology initiatives that are advancing semantic technologies. He serves as co-chair of the Federal Semantic Interoperability Community of Practice (SICoP). Mills is a founding member of the AIIM interoperable enterprise content management (iECM) working group, and a founding member of the National Center for Ontology Research (NCOR). Also, he serves on the advisory boards of several new ventures in the semantic space.

In addition to his research and consulting practice, Mills is currently directing development of community based collaborative semantic magazine that is dedicated to aggregating, linking, and making sense of all things Web 3.0.

Above:
Sample Pages from Semantic Wave 2008: Industry Roadmap to Web 3.0

Summary

In the preceding pages we introduced the thesis and have highlighted some findings and conclusions from our new research report — *Semantic Wave 2008: Industry Roadmap to Web 3.0.* We hope this brief overview will encourage you to read the full report. As you can see from the sample pages, Semantic Wave 2008 is no ordinary research report. It is written to be understood by a broad audience and contains a great many figures and illustrations.

Semantic Wave 2008 explains the new semantic technology and gives perspective on emerging patterns and keys to success. It gauges both technology and market readiness. By mapping the frontier, it shows where the tough problems are, and where to look for breakthroughs. But, most importantly, Semantic Wave 2008 profiles significant opportunities for executives, developers, designers, entrepreneurs, and investors. What to build and what to buy, and why. For this, SW2008 is simply the most comprehensive resource available anywhere at this crucial time.

The technology section of the report examines five strategic technology themes and shows how innovations in these areas are driving development of new categories of products, services, and solution capabilities. Themes include: executable knowledge, semantic user experience, semantic social computing, semantic applications, and semantic infrastructure. The study examines the role of semantic technologies in more than 100 application categories. An addendum to the report surveys more than 270 companies that are researching and developing semantic technology products and services.

The market section of the report examines the growth of supply and demand for products, services and solutions based on semantic technologies. Specifically, the report segments and discusses semantic wave markets from five perspectives: research and development, information and communication technology, consumer internet, enterprise horizontal, and industry verticals. Viewed as horizontal and vertical market sectors, each presents multi-billion dollar opportunities in the near- to mid-term. The study presents 150 case studies in 14 horizontal and vertical sectors that illustrate the scope of current market adoption.

In addition to the main report, there are two addenda: a supplier directory, and an annotated bibliography.

Specifications for the Semantic Wave 2008 report and a topic outline follow this page.

Semantic Wave 2008: Industry Roadmap to Web 3.0		
Report Specifications		*Report Outline*
Format	PDF — Color and B&W	**1 Introduction**
Pages	400	**2 Semantic Wave**
Figures	290	2.1 Strategic Vision
Vendors	270	2.2 Web 1.0
Applications	110	2.3 Web 2.0
Market sectors	14	2.4 Web 3.0
Case examples	150	2.5 Web 4.0
Price	$3495 USD	**3 Semantic Technologies**
Availability	Nov 1, 2007	3.1 Technology Themes & Perspectives
		3.2 Knowledge
		3.3 Semantic User Experience
		3.4 Semantic Social Computing
		3.5 Semantic Applications
		3.6 Semantic Infrastructure
		4 Semantic Markets
		4.1 Market View
		4.2 Research and Development
		4.3 Information & Communications Technology
		4.4 Consumer Internet
		4.5 Enterprise Horizontal
		4.6 Industry Verticals
		Addenda
		A Suppliers
		B Bibliography

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