Executive's Quick Start Guide to Web 3.0 and the Semantic Web

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This QuickStart Guide explores the business value of Web 3.0 and the Semantic web. It's written for executives to help your business plan ways to benefit from adopting these technologies. This report addresses three key questions:

Where are we headed?
As we enter the third decade of the web, the Internet has already become essential to how we live and do business. Internet growth is exploding further. In addition to more people and more information, order of magnitude growth will be driven by a mobile internet of things, services, cloud computing, and semantics. These key trends and driving forces are building to shape the evolution of the Internet over the coming decade.

Web 3.0 and the semantic web is a web of meanings and knowledge that both humans and machines can interpret and put to work. There are four ways we can think about the semantic web, namely, as a:

- Web of data that we can search and query like it was a database;
- Massive [but messy] knowledgebase that we can reason with, discover connections, make inferences, and draw conclusions from;
- Core system technology for dealing with issues of exploding scale, complexity, and dynamism in time for the next internet of things and ubiquitous services; and
- Way to make our experience of the web smarter, better, more helpful, and more enjoyable.

What does it mean?
The semantic web will drive value for in multiple areas. Semantic technologies have the potential to drive 2 times to 3 orders of magnitude improvements in capabilities, performance, life cycle economics, and user experience of business and consumer solutions through cost reductions, improved efficiencies, gains in effectiveness, and new functionalities that were not possible or economically feasible before now.

Web 3.0 and semantic web approaches are being applied and delivering value in four broad areas:

- Semantic informatics
- Enterprise semantic web, and
- Social semantic web
- Consumer smart applications

While the semantic web is still a work in progress, case examples exist that demonstrate the maturity of development methodologies and technologies. Also, a significant community exists of companies developing products, services, and solutions. The value being delivered is encouraging. Moreover, some of these semantic applications will be game changers for business.

Bottom line: Ignore Web 3.0 and the semantic web at your peril.

What should we do about it?

Businesses and governments should be seeking ways to exploit semantic technologies and semantic web enabled opportunities. This report includes an executive action plan for jumpstarting benefits from semantically enabled information, applications, and processes within 90 days. .

Where Are We Headed?

Key Trends and Driving Forces Reshaping the Evolution of Internet to 2020

It's sometimes hard to remember that the World Wide Web is only two decades old. By the time the Web enters its fourth decade in 2020, we will be in an era of ubiquitous computing. Computing will be everywhere — in people, places, and things. Computing and communications will be always on, in the background, embedded, networked, and situated. It will be part of dedicated tools and devices ("made for purpose").

The emerging pervasive/ubiquitous computing landscape will be a network of connected "things," agents, and services with invisible processors, lightweight, small, cheap, low/no power in almost all everyday objects, wirelessly interconnected, continuously "online."

Beyond PCs and smart phones, user interfaces will mirror the context and task at hand, featuring ambient intelligence and multi-modal input and output (pen, touch, voice, gesture) that is user-centric and designed to provide a close fit with the real needs of users.

The next Internet is a Web of semantic agents. Both people and things contribute to co-evolving social dialog. Services will be seamless across all usage contexts. Boundaries between the virtual and the real will be porous. We will be living in a display landscape with ambient information and contexts that shift continuously and must be designed for a semantic user experience.

The next Internet will be a post-PC, post-IP era. Object orientation, stacks, and inflexible architectures will be jettisoned except for very local use. The need to process at massive scale dynamically means that interaction, coordination, security, and integrity can no longer be organized centrally.

Intellectual property will be autonomic. Whether we are speaking of a content paragraph, picture, model, software service, sensor, product or other physical entity, all will be self-organizing, context-aware, self-describing, self-configuring, pervasively adaptive, and communicating autonomously.

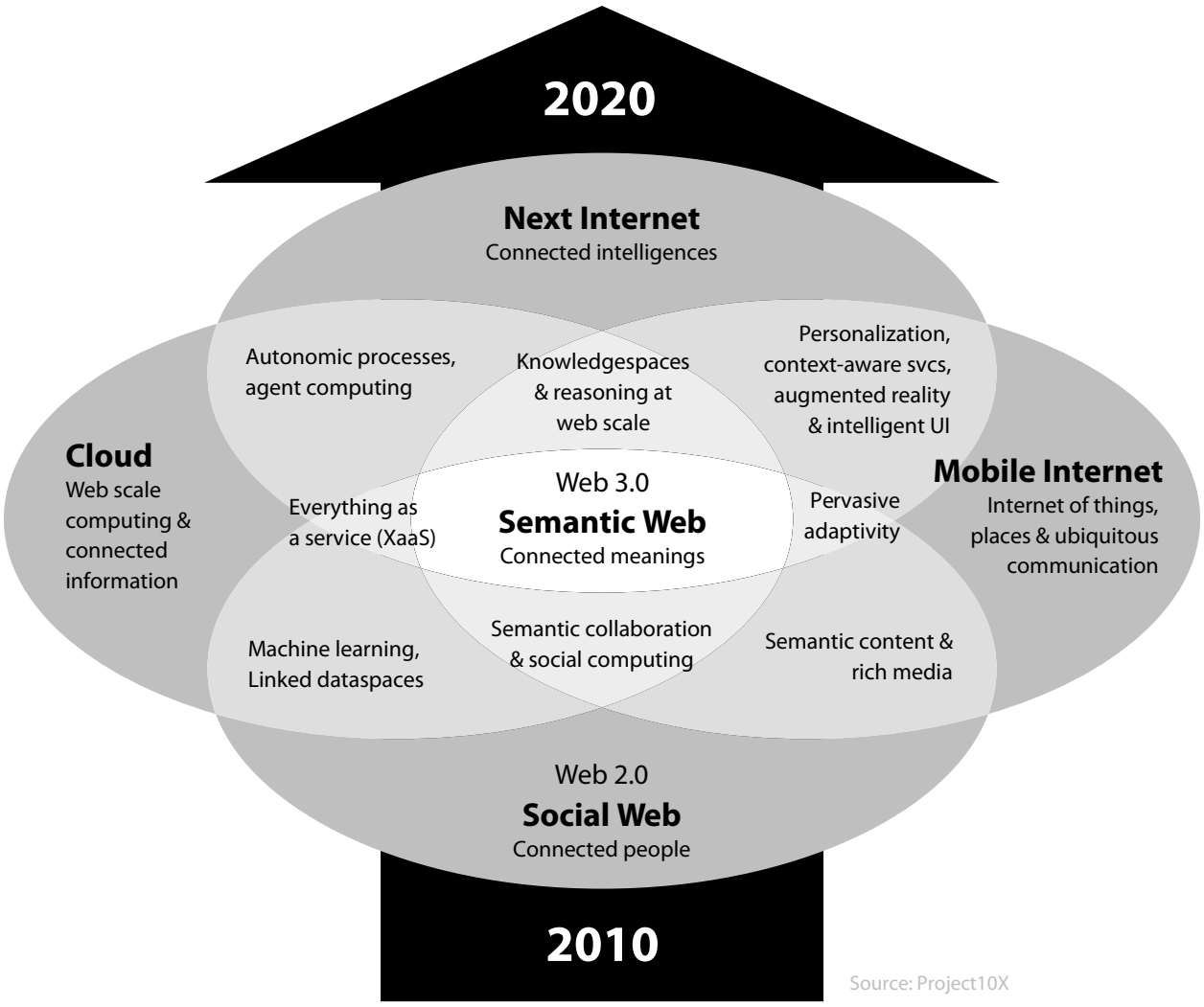

Figure-1: Evolution of the Internet to 2020

This figure depicts the convergence of technologies that are shaping the next stage of the Internet. Technology This report is a Quick Guide to the third decade of the web. Its focus is on the central role that the semantic web and semantic technologies will play in it and how businesses can benefit. drivers include the social Web, cloud computing, mobile Internet, and the Semantic Web. These technologies will combine to create advanced infrastructures, platforms, applications, and ecosystems delivering unprecedented capabilities, economy, scale, and dynamism.

What trends and drivings are shaping the next Internet?

The first 10 years of the Web were about getting on the Net and linking to information with our browser. The second decade of the Web has been about connecting people — putting the "I" in user interface, and the "we" into webs of social participation.

This report is a Quick Guide to the third decade of the Web. Its focus is on the central role that the Semantic web and semantic technologies will play in it and how businesses and government organizations can benefit.

First, what do we mean by the **semantic web**? The Semantic web is a web of meanings and connected knowledge where computers as well as people can understand concepts and put knowledge to work. The term "semantic web" refers most often to technologies based on open standards specifications developed by the W3C. In this report, the term semantic web encompasses both W3C specifications and other web-based knowledge representation and reasoning capabilities that currently are or will become part of the Internet during this decade.

Second, what are **semantic technologies**? Semantic technologies are tools and methods that represent meanings and knowledge and process them separately from documents, data, program code and other artifacts. A spectrum of technologies exists that provides differing semantic capabilities.

Semantic technology is not new. It's been a distinct research field for decades. For example: library science including classifications, thesauri and taxonomies (2,000+ years), symbolic logic (more than 100 years), knowledge representation systems in AI since the 1970s, also relational algebras and schemas in database systems since the '80s.

What's new is the semantic web. After two decades of growth, the information and other material needed to answer almost any question is out there somewhere on the web. Moreover, a massive infrastructure of data servers, protocols, authentication systems, presentation languages, and thin clients exists that can be leveraged.

So, how should we think about the semantic web? Here are four viewpoints.

1. Semantic Web is a "web of data."

One way to think about the semantic web is as a vast web of data. Adding semantic tagging and data mark-up provides a way to query vast sections of the Internet as if it were a database. And more, it provides a way link to someone else's data, augment it, and add to it. Unlike databases, the schema is not a set of tables whose relationships are fixed at design time, but rather is a flexible graph of entities and relationships that can grow and evolve dynamically.

2. Semantic Web is a massive knowledgebase.

Another way to think about the semantic web is as the largest formal knowledge base on earth — and also the messiest. It is massive, partial, participatory, logically weak, dynamic, and extremely powerful. It is a fully distributed publishing platform for formal knowledge (logical assertions), as well as pages. Semantic data doesn't have to be associated with an HTML web page (just a URI). There can be huge numbers of knowledge publishers. They can combine representations with simple RDF [Resource Description Framework] statements and owl:sameAs or SKOS:exactMatch links to connect concepts. It is a revolution in the way we think of data, crowds, and schemas. Creating and curating this knowledge becomes democratic, crowd-based, and scalable.

3. Semantic Web is a core system technology for dealing with issues of scale, complexity, dynamism, security, and user experience.

Another way to think about the web 3.0 and the semantic web is as an essential systems technology for building the next Internet and coping with issues of scale, complexity, change, security, and user experience. Figure-1 depicts technology aspects to be aware of, including:

Cloud computing

Cloud computing brings scalable, on-demand, click-and-run, pay-by-the-drink resources and services provisioned over the Internet. The cloud refers to virtualized infrastructure services where data and services reside in massively scalable data centers that can be accessed ubiquitously from any connected device over the Internet. It gives us flexible, Web scale processing power and connected information combined with compelling economics.

The intersection of cloud computing and semantic web technologies will be crucial to enabling multi-agent computing and autonomic processes at Web scale. Semantic

cloud computing will give us ways to provision not just infrastructures and computing resources, but just about everything-as-a-service (XaaS).

Semantic clouds will be organized as multi-dimensional meshes of concepts rather than fixed stacks so that they can apply goal-oriented computational mechanisms dynamically along any dimension, as well as across traditional layers. Ontology services will store and access conceptual / knowledge models. Reasoning services will support computational decision-making with those models on a Web scale. Provisioning services will use semantic models to link applications with semantic process and service entities. These semantic services will support dynamic creation, annotation, storage, update, removal and access of computing entities, metadata, and semantic bindings.

Mobile Internet

"Mobile Internet is largest market opportunity we've seen in the history of the technology sector."
-Morgan Stanley Mobile Internet Report, December 2009

The mobile Internet is the new desktop, only at least ten times larger. Users with access to the Internet will increase to more than 7 billion this decade. According to current studies, consumer adoption of mobile services and applications may be occurring at the fastest pace in history. For example, Apple reported selling 1 million iPad devices within the first month. The number of devices, sensors, and things connected to the Internet will explode (again) by more than a factor of 10. The mobile Internet will bring us an Internet of things, ubiquitous dynamic services, and augmented reality.

The intersection of mobile Internet and semantic web technologies will play a key role in managing the dynamics of service delivery to make user experience context-aware, seamless, and pervasively adaptive. Mobile semantic web will give us new ways to interact with the world. For example, reality browsing is querying the physical world live and up close from anywhere using semantically enabled web browsers, real-time sensors (e.g. GPS, camera), and linked data. Augmented reality, on the other hand, brings the power of the web to the point of decision by combining real world and computer-generated data. Unlike virtual reality, which creates immersible, computer-generated environments, augmented reality overlays (or embeds) graphics, sounds, haptic (touch) features, and smells on the natural world as it exists.

Semantic Web builds on W3C open standards — from HTML to XML to RDF to OWL.
These provide increasingly expressive options for web data markup and query.

What is RDF? RDF [Resource Description Framework]
RDF is web data language with web-friendly syntax

- All elements are either primitive values or URIs
- RDF defines entities and relations for an area of knowledge
- Assertions are triples of (resource, property, resource) or (resource, property, value)
- Assertions are precise enough to be interpreted according to set theory by machines
- Graphically RDF can be represented as a directed concept graph with typed links
- RDF semantics enable reuse of domain knowledge via class hierarchies
- RDF Schema extends RDF to add classes, domains, ranges, and inheritance of domains and ranges

What does OWL add to RDF?

- Description logic semantics for defining relations between classes, for example:
  + Equivalent class (e.g., USPresident and PrincipalResidentofWhiteHouse)
  + Disjoint class (e.g., Male and Female), subClassOf
  + Derived classes (intersectionOf, unionOf, complementOf)
  + Property characteristics (inverseOf, transitive, symmetric, subPropertyOf, equivProperty, etc.)
  + Range and Cardinality constraints (e.g. birthMother has exactly one value, which is a person)
- Ability to combine assertions into inferences according to the rules of the description logic

What is linked data?
The Semantic Web isn't just about putting data on the Web. It is about making links, so that a person or machine can explore the Web of data. Linked data follows four rules:

- Use URIs as names for things
- Use HTTP URIs so that people can look up those names
- When someone looks up a URI, provide useful information, using the standards (RDF, SPARQL)
- Include links to other URIs, so that they can discover more things

What is SPARQL?

- A language for querying Webs of linked data
- It's like SQL, but for data fabrics or graphs of connected information
- SPARQL enables querying combined RDF, OWL and RDBMS systems — potentially encompassing vast segments of the Internet as a Web of data.

Source: Mark Greaves, Vulcan; Tim Berners-Lee, W3C

4. Semantic web is a way to make our experience of the web "smarter".

Web 3.0 is not about re-inventing the Internet. It's about making the Internet more deeply connected, open, and intelligent. It's about making the internet more useful, and improving our experience of it.

The trend is for users to be served by systems that present personalized information; are context-aware; can link and share information in relevant ways; connect with relevant people; better organize the digital life; combine and integrate processes; arrange dates and tasks; and give meaningful answers instead of data in bulk.

Machine learning and data mining become important for extending, cleaning, and making semantic data more useful. Combined with collaboration technologies for engineering social consensus, they enable semantic systems to gain new knowledge and get better with use and with scale of adoption.

The semantic web will bring context-aware semantic browsing, intelligent user interfaces, and virtual assistants that complete tasks for people. What does this mean? Here are some ideas:

- Put the user in control.
- Do what he means.
- Find what she needs.
- Be aware of what s/he knows.
- Know what he's trying to do.
- Don't make him or her have to know, ahead of time, what sources to go to, how to access them, or how to combine the intermediate results.
- Capture and organize everything that s/he sees and hears.
- "Read" emerging content for her.
- Extract information.
- Handle languages for him, in all different kinds of formats including documents, tables, charts, diagrams, video, audio.
- Extract meanings.
- Give her a "spell-checker" for facts and knowledge.
- Answer questions.

Intelligent user interfaces will help users perform tasks, while making working with the computing device as intuitive, helpful, and invisible as possible. They know (are "intelligent") about a variety of things, such as system functionality, how to communicate with a user, tasks a user might want to do, and ways information might be presented or provisioned.

Intelligent interfaces and virtual assistants observe behavior, predict what a user wants to do, present information to the user with this prediction in mind, and adapt to improve performance based on experience. Also, they can learn about and be sensitive to a user's context, wants, and needs.

What Does It Mean?

Web 3.0 and the Semantic Web Drive Significant Business Value

To set the stage, let's talk for a moment about how semantic technologies add value. Over the next 10 years, semantic technologies have the potential to drive huge improvements in capabilities and life cycle economics of business solutions through cost reductions, improved efficiencies, gains in effectiveness, and new functionalities that were not possible or economically feasible before now. How big are we talking about? As much as 2-3 order of magnitude.

How do semantic technologies drive value? Several ways. Business value has three dimensions, or axes: capability, performance, and life cycle economics. Semantic technologies move the dial on all three dimensions.

1. New capabilities

Semantic technologies enable new capabilities that tap new sources of value. Sources of new value include:

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 improve development economics through use of:

- Shared knowledge models as building blocks,
- Autonomic software techniques (such as goal-oriented software with self-diagnostic and self-management capabilities including self-configuration, self-adaptation, self-optimization, etc.), and
- End-user and do-it-yourself life-cycle development methodologies (requiring less intervention by IT professionals).

Knowledge that is sharable, revisable, and executable is key for applications where facts, concepts, circumstances, and context are changing and dynamic.

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, 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 or more goals. An intelligent user interface (UI) knows about a variety of things such as system functionality, tasks users might want to do, and 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 tenfold gains in communication effectiveness, service delivery, user productivity, and user satisfaction.

Value from learning

Machine learning is the ability of computers to acquire new knowledge from past cases, experience, exploration, and user input. Systems that can learn will 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 life cycle 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 knowledge-ware and software-as-a-service.

To compete based on knowledge means organizing people, partners, processes, systems, communications, and value in order to consistently out-learn, out-adapt, out-execute, out-communicate, out-deliver, and out-grow competitors.

Knowledge, and the ability to act on it rapidly, is a key differentiator that successful organizations use to out-position and out-perform competitors.

The value drivers for semantic technologies in business are strong, making a compelling case for the adoption of semantic technologies

Web 3.0 and semantic web approaches enable a business to marshal distributed collective knowledge systems, social computing, net-centric operations, and semantic technologies that increase the organization's reach and speed to discover, digest, and apply knowledge.

Machine learning-driven strategies call for knowledge assets that are interpretable by both humans and computers. The goal is to create systems that have the "Google Property:" that is, they get (much) better as they get bigger, just as Google PageRank™ yields better relevance judgments as it indexes more and more pages.

Value from semantic ecosystems

The Internet was designed to operate with predefined parameters. It was not designed for massive numbers of sensors and mobile devices with dynamically changing contexts. But, that is where our computing and communications ecosystem is going.

An ecosystem is a self-sustaining system whose members benefit from each other's participation via symbiotic relationships (positive sum relationships).

In the next internet, the 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. Why? Because these problems are intractable at Web scale without semantics. The corollary need is to minimize the human labor required to build, configure, and maintain ultra-scale, dynamic infrastructure.

Over the next decade, semantic ecosystems will become future-proof, able to grow dynamically, evolve, adapt, self-organize, and self-protect. Semantic ecosystems will consist of dynamic, evolvable systems consisting of ensembles (societies) of smart artifacts.

Semantic technologies will help lay the foundations for ubiquitous Web including autonomic intellectual property, Web-scale security and identity management, and global micro-commerce in knowledge-based assets.

This means a shift in focus from static, performance-driven design to include:

- Design for robustness and resilience;
- Design for uncertainties;
- Design for distributed, autonomous pervasive adaptation;
- Design for organically growing systems; and
- Design for creating self-evolving services.

The value drivers for moving towards semantic infrastructure and ecosystems is 2-3 orders of magnitude gains in capability, performance, and life cycle economics at Web scale. For businesses and governmental organizations of all sizes this also means new concepts-of-operation. The overall trend is towards more transparent, collaborative, and open process models that enable organizations to be more agile, flexible, and quick to respond.

The next stage of the Internet favors net-centric concepts of operations with an evolving network of developers, operational centers, and independent business entities across the internet. How do we get there? Semantic web approaches and Web 3.0 technology platforms provide practical ways to make significant use of networked infrastructure, distributed systems and tools that enable employees to connect, collaborate, communicate, engage, and orchestrate distributed operations.

2. New performance

The classic motivations for new investments in technology are: efficiency gain, effectiveness gain, and strategic edge. We call these the Three E's.

Efficiency gain

Increased efficiency means doing the same job faster, cheaper, or with fewer resources than it was done before. The key measurement is cost savings. Semantic technologies can have a dramatic impact on labor hours, cycle time, inventory levels, operating cost, and development time and expenses. Early adopter case examples documented by Project10X have showed 20-90 percent reductions in these measures.

Effectiveness gain

Improved effectiveness means doing a better job than the one you did before, making other resources more productive, and improving the attainment of mission. The key measurement is return on assets: Semantic technologies can drive dramatic improvements in quality, service levels, and productivity. Combined with process improvements, these can allow existing staff to handle a greater number (or higher complexity) of current projects, product releases, and units of work. Early adopter case examples documented by Project10X showed increases in effectiveness and return on assets from 2-50 times.

Strategic edge

Strategic edge means changing some aspect of what the business entity does, resulting in growth, new value capture, mitigation of business risk, or other strategic advantage. The key measurement is return on investment. The strategic value of semantic technologies comes from new capabilities that tap new sources of value, resulting in new advantages.

Early adopter case examples documented by Project10X demonstrate 2-10 times improvements in measures of performance. But, potential exists for gains of 2-3 orders of magnitude.

3. New life cycle economics

Semantic technologies improve economics and reduce risks across all stages of the solution life cycle.

Research and Development

Rapid, iterative development speeds time to solution and reduces risk. The first part of the solution life cycle is the innovation stage. Every project begins at zero, with nothing ventured and nothing gained or lost. The slope of the ROI curve during innovation is negative. Investments outweigh returns. This is the time of greatest risk and greatest exposure. A key ques-

tion in evaluating this stage of a project is: How deep into its pockets is the enterprise being asked to go? A semantic web approach impacts R&D stage ROI as follows:

- Knowledge capture and modeling allows early validation and iterative refinement of requirements, minimizing cost and risk.
- Semantic modeling of UI, data, and system interrelationships minimizes time/cost to prototype.
- Semantic modeling unlocks data and logic and facilitates switching between make, buy, rent, share options at least cost.
- Reduced coding (or elimination of coding) minimizes labor, time, and cost for interoperability, integration, federation.
- Semantic models and composite applications provide unified user interface across multiple legacy systems, services and data sources, to preserve legacy value, minimize disruption to operations, and reduce development, training, use, and maintenance costs.
- Fast, incremental, non-invasive development cycles accelerate time to value, reduce cost to solution and mitigate development risk.

Deployment and operations

Characteristics of semantic solutions in operation include rapid, flexible deployment, lower cost of operation, ease of maintenance, and robust security.

The second part of the solution lifecycle is the operations stage. Solution deployment and initial operations can overlap. The break-even point: when cumulative returns equal cumulative investments. If the time to break even takes too long, the project may be a bad risk. The curve continues to rise ("in the black") so long as benefits such as revenues exceed operating costs. Net present value analysis is used to compare the relative return on assets employed. Eventually, the benefit stream will slow. Eventually, requirements change, the curve flattens, and the project reaches a point of diminishing returns. Key questions in evaluating this stage of a project are: How long will the business have to wait for positive returns? What is the maximum positive benefit (or upside)?

A semantic web approach impacts deployment and operations-stage ROI as follows:

- Semantic solutions deploy rapidly, incrementally, iteratively, and flexibly, resulting in lower exposure and faster time to value. Semantic modeling of UI, data, and system interrelationships minimizes time/cost to prototype.
- During operation, the semantic model integrated solutions require the less overhead for staffing and support, which helps reduce total cost of ownership.
- Composite applications provide common context and access to underlying information and processes so that users do not have to learn multiple methods to search and navigate across them, which increases their productivity.
- Semantic model-driven solutions can be self-documenting and self-explaining, which reduces training and support costs, and helps mitigate risks from knowledge erosion when personnel change roles.
- Semantic models allow robust, policy-based, role and concept-level security that is comprehensive and much easier (and less expensive) to ensure for mission critical workflows.

Maintenance and evolution

The third part of the solution lifecycle is secondary and tertiary maintenance and enhancement projects that build off of the solution established by the primary project. The measure of performance that is relevant here is the ratio of added value to added cost and risk. A good ROI curve would enable these projects to begin in a timely manner, and be funded by positive returns from the base project. A key question in evaluating this stage of a project is: What is the total upside for related projects that can be funded from the proceeds of this project?

A semantic web approach impacts maintenance and evolution stage ROI as follows:

- Knowledge capture and modeling allows early validation and iterative refinement of requirements, minimizing cost and risk.

- Semantically modeled solutions are easier to scale up and scale out — adding new capabilities, users, locations, security or capacity.

- Semantic models and open standards (knowledge plane) insulate components to minimize impact of changes. This facilitates best-of-breed substitutions, integration of new capabilities, and extension to embrace legacy applications. Enhancements happen faster and at lower switching costs.

- Semantic models provide leverage to accelerate secondary and tertiary ROIs. There is relatively less capital re-investment, and lower development risks.

Category	Example Semantic Application Capabilities	Semantic Solution Providers
Semantic Informatics	• Information and knowledge extraction from speech, text, graphics, imagery, sensor data, links, and reference knowledge • Machine learning using pattern reasoning, deep linguistics, domain knowledge, and symbolic inference • Semantic dataspace management — semantic search and navigation, linked data, reasoning engines, querying the Web as a massive database • Semantic reasoning at scale — semantic platforms; semantic dataspaces; semantic mobility, semantic cloud computing; semantic micro-commerce; semantic rights management; semantic security • Semantic discovery, relationship analytics, question answering	BBN, Connotate, Crystal Semantics, Cycoep, DBPedia, ENDECA, Evri, Exalead, Expert Systems, Franz, Freebase, Google hakia, HP, IARPA, IBM, KBSI, LarKC, LCC, Metallect, Microsoft, Nervana, Netbreeze, Ontos, Oracle, Semantic Insights, Semantic System, Siderean Software, SmartLogic, TÉMIS Group, Teragram, Textwise, Thomson Reuters, TrueKnowledge, Wand, Yahoo
Enterprise Semantic Web	• Semantic data fabrics — integration and sharing of information across data and content sources, as well as system, organization and jurisdictional boundaries; semantic master data management • Semantic core applications — ERP, CRM, SCM, PLM, project management • Semantic business process management; semantic Web services, policy-based computing, composite applications, model-driven applications, semantic service oriented computing, semantic event processing, semantic technical information • Smart applications and decision support — semantic e-discovery, semantic marketing, semantic advertising, semantic e-commerce, field service and customer care, semantic logistics, governance-risk-&-compliance, knowledge-based engineering, e-research and science, semantic simulation and testing, multi-agent applications and processes.	7 Degrees, Aduna, Agent Logic, Alitora, Apelon, BeInformed, CheckMI, Computas AS, Cougaar Software, CureHunter, Dassault Systemes, Digital Harbor, Empolis, JustSystems, KBSI, KFI, Matrixware, Mendix, Metatomix, Mondeca, Mondeca, Ontos, Oracle, Peer39, SAP, SAS, Semantic System, SPSS, Thetus, zAgile
Semantic Social Computing	• Semantic desktop, webtop and mobile — semantic content and media authoring, knowledge modeling, semantic integration of diverse data types, spreadsheets, databases, applications and external information sources • Do-it-yourself mash-ups of data, gadgets, applications, and services • Semantic social and interest networking, collaboration, publishing, entertainment, engagement • Intelligent user interface, context-aware services, personalization, virtual assistants, and augmented reality	Adaptive Blue, Adobe Systems, Altova, Cambridge Semantics, Celtx, Drupal, Insilico Discovery, Kirix, Semantic Media Wiki, Siri, Talis, Twine, Zemanta, Zotero

Figure-2: Areas where semantic technologies are being applied in business and government

This figure overviews three broad areas where semantic technologies are delivering new capabilities, levels of performance, and life cycle economic advantages. These areas include: Semantic informatics, Enterprise Semantic Web, and Semantic Social Computing. For each area, the table lists key semantic capabilities and applications and provides examples of companies that provide semantic-technology based products, services and solutions in the space.

What Does It Mean?

Semantic Technologies Can Benefit Many Areas of Business and Government

The following topics overview three broad areas where web 3.0 and semantic web approaches are being applied today.

- Semantic web informatics
- Enterprise semantic web
- Semantic social computing

In each area, semantic web standards and methodologies apply across a range of applications and infrastructure needs. Figure-2 highlights some of the capbilities provided and companies providing them. The results to date are encouraging, and merit close consideration by business and government executives and IT professionals.

Semantic Informatics

Informatics are the sciences concerned with gathering, manipulating, storing, retrieving, and classifying recorded information. Web 3.0 and semantic web technologies are going beyond search to teach computers to link data across the Internet, discover concepts, and understand meanings. This will be a game-changer for business and government.

Semantic informatics capabilities

- Information and knowledge extraction from speech, text, graphics, imagery, sensory data, links, and reference knowledge
- Machine learning using pattern reasoning, deep linguistics, domain knowledge, and symbolic inference
- Semantic search and navigation, linked data, querying the Web as a massive database
- Semantic reasoning at Web scale — semantic platforms; semantic data spaces; semantic cloud computing
- Semantic discovery, relationship analytics, question answering, and search engine optimization

Knowledge representation and machine learning

Humans encode thoughts, represent knowledge, and share meanings using varied forms of language: spoken, written, visual, gestural, formal, etc.

Computers are learning to identify concepts and relationships in digital information by combining pattern discovery and statistics; linguistics and natural language processing; and domain knowledge and symbolic inferring. Machine learning now spans Web scale data spaces that combine myriad languages, media formats, data structures, and standards.

From search to knowing

Semantics are a keystone technology for both unstructured and structured information retrieval across the Internet. More comprehensive and expressive knowledge representation enables more powerful reasoning.

The trend is:

- from recovery or basic retrieval of matching patterns;
- to more relevant organization of responses through clustering, faceted navigation, and concept-based search;
- to discovery of new concepts and relationships through latent semantic analysis and other machine learning techniques;
- to intelligence and analytics that fuse structured and unstructured information, put it into context, and detect meaningful patterns and relationships;
- to question-answering rather than giving mere lists of sources; and
- to progressively smarter behaviors and assistance driven by goals, knowledge, experience, and machine learning.

Examples of semantic search and query include Yahoo! SearchMonkey and Google Rich Snippets. The technique is to add semantics and information structure to HTML pages using microformats and linked data expressed in RDFa.

One implication, depending on the type of data that is semantically enabled and linked, is that a browser can format a more engaging display of information, for example pulling in other linked information from somewhere else on the web.

Another implication is that if the information on the web page is linked to underlying reference knowledge, then a search engine can use this meta-information and knowledge to optimize its search ranking.

An example of using semantically-enabled linked data for search engine optimization in e-commerce is the "Good Relations" ontology. This is a shared vocabulary for conveying product information and expressing offers, which is now supported by Yahoo!, Google, and Microsoft search engines. As reported by Best Buy, describing their product offerings to Web search engine using the Good Relations ontology provided better matching and increased the rankings of their product offerings by up to 30 percent in some cases, which should translate into benefits such as increased sales.

Reasoning at web scale is another trend that will impact business, government, and consumer applications.

At web scale, information is vast and ever changing. For example: every minute, there are 100 edits in Wikipedia (144K/day), 200 tags in Delicious (288K/day), 270 image uploads to Flickr (388K/day), and 1,100 blog entries (1.6M/day). Also, the same concepts may be expressed with different symbols, words or spellings, or by using different formats and forms of information.

At web scale, meanings are similarly dynamic. This means that there is no "right ontology" or universal knowledge model for the semantic web of linked data. Each vocabulary, graph of information, or knowledge model is an abstraction. Different applications and implementations lead to different ontologies. For example, Google Base already has more than 250K schemas. Freebase has more than 10 million tagged concepts and relationships culled from linked open data sources. DBpedia and the linked open data cloud now encompass billions of assertions and counting.

What does the trend towards semantic informatics mean for businesses and governments? It means that you ignore web 3.0 and the semantic web at your peril.

Value drivers for semantic web informatics include new capabilities for linking, making sense of, and reasoning with information of all kinds at web scale, and up to ten-fold improvements in the economics of digital information when it is semantically enabled.

The explosive growth of linked data gives the semantic web the "Google property" we talked about earlier. That is, the value of connected information from many sources across the web is more than simple aggregation.

However, it also demands community attention as well as computational methods to clean-up data, and curate the fabric of knowledge about this information so that diverse information sources can be meaningfully connected as well as linked.

Enterprise Semantic Web

What happens when we apply web 3.0 and semantic web technologies in the enterprise? We integrate information, connect processes, and put knowledge to work in ways that deliver new levels of capability, performance, and life cycle value.

Enterprise semantic web capabilities

- Semantic data fabrics – Semantic EII, connecting, integrating and sharing of information across data and content sources as well as system, organization and jurisdictional boundaries; semantic master data management

- Semantic core applications — ERP, CRM, SCM, PLM, project management

- Semantic business process management; Semantic web services, policy-based computing, composite applications, model-driven applications, semantic service- oriented computing, semantic event processing, semantic technical information

- Smart applications and decision support — semantic e-discovery, semantic marketing, semantic advertising, semantic e-commerce, field service and customer care, semantic logistics, governance-risk-and-compliance, knowledge-based engineering, e-research and science, semantic simulation and testing, multi-agent applications and processes

- Semantic enterprise infrastructure; semantic rights management; semantic security; semantic micro-commerce

Semantic enterprise processes

Enterprise processes provide the core functionality to plan, operate and interrelate with customers, suppliers, and internal constituencies. Historically, enterprise applications have been monolithic and difficult to implement. Dependent on fixed formats, interfaces, and program logic, enterprise solutions have been inflexible and costly to modify and adapt as business circumstances change. Web 3.0 and semantic web technologies resolve these issues by phasing out hard-coded schemas, interfaces, and procedures in favor of shared executable semantic models.

Enterprise semantic applications

A broad range of enterprise semantic applications are emerging. This is not to say that every application is a prime candidate. Web 3.0 and semantic web technologies work best for applications where it is advantageous to process knowledge represented separately from documents, data, and program code. For example:

- Commercial-off-the-shelf software vendors are adopting semantic technologies for core enterprise processes involving middleware, ERP, CRM, SCM, HRM and PLM product lines. semantic web standards provide a way to link diverse information sets across product suites, automate Web services across application domains, and provide fine-grained, policy-based security and event processing.

- Business intelligence is evolving from retrospective data mining and analytics to real-time analysis of diverse operationally relevant structured and unstructured information coming from internal data, document, and messaging systems, as well as a vast number of sources accessible via the World- Wide Web. Semantic technologies enable flexible information fusion on a scale simply not possible with conventional database technology.

- Some other areas where semantic approaches are advantageous include governance, risk, compliance, fraud, exceptions, emergency response, and case management applications. Policies and events trigger these workflows. To resolve issues, knowledge workers correlate structured and unstructured information from multiple (often siloed) sources, apply applicable policies, interpret evidence, take actions, communicate in context, and track cases until resolved.

Semantic technologies enable mash-ups, relationship analytics, and system learning that are simply not practical otherwise.

- Some of the biggest gains in capability and performance come from changing work paradigms and resulting concepts of operation. A good example of this is using semantic technologies to put knowledge to work through knowledge-centric versus document-centric approaches. Projects working with semantically enabled content and computable knowledge models can achieve up to 5-10X faster cycle time, with up to 5-10X reductions in project costs. Some areas of application include research, design, engineering, simulation, e-science, professions, logistics, virtual manufacturing, and decision support.

Value drivers for enterprise semantic web approaches include the potential for up to ten-fold gains in performance through semantic integration of information, semantic service oriented computing and process management, knowledge-based computing, task automation, autonomics, labor substitutions, and high-yield concepts of operation.

Semantic Social Computing

In the following topics we highlight three aspects of social semantic web computing: collaboration, publishing, and engagement

- Semantic Collaboration — Adding an underlying knowledge representation to data, processes, services, and software functionality empowers teams and communities to connect, collaborate, communicate, link information, automate processes, and solve problems together very productively.

- Semantic Publishing — Embracing open standards, semantics, social media, and mobility helps organizations save money while increasing the accessibility, findability, relevance, utility, and value of their content and information resources to users.

- Semantic Engagement — Using semantic web platforms, open standards, Web data mining, audience modeling, social media, context-aware messaging, and intelligent user interfaces drives increasing yields for Internet-savvy organizations.

Semantic social computing capabilities

- Semantic desktop, webtop and mobile — semantic content and media authoring, knowledge modeling, semantic integration of diverse data types, spreadsheets, databases, applications and external information sources

- Do-it-yourself mash-ups of data, gadgets, applications, and services

- Semantic social and interest networking, collaboration, publishing, entertainment, recommendations

- Semantic Intelligent user interface, context-aware services, personalization, virtual assistants, and augmented reality

Semantic Collaboration

Semantic collaboration is the use of web 3.0 and semantic web technologies and knowledge-centric processes to enable people to work together to accomplish common goals.

"Historically, when social communication media grow in capability, pace, scope, or scale, then people use these media, communication techniques, and tools to construct more complex social arrangements and practices that increase human capacity to cooperate at larger and larger scales," according to "Technologies of Cooperation," a report from the Institue for the Future (IFTF). This pattern followed the introduction of printing presses. And today, as the World Wide Web enters its third decade, we see a global shift towards pervasive collaboration in all areas of business and social life.

Individuals collaborating across networks and organizational boundaries require tools to connect team members; research problems to be solved; read, write, edit, and communicate ideas; manage evolving knowledge; develop and document interim and final outcomes; and present, deploy and promote results of the effort. Also, projects need management tools to plan and coordinate activities through task assignments, time-management with deadlines, and shared calendars, etc.

A spectrum of gadgets, tools, and application suites exist to help people collaborate. These are usually separate capabilities. That is, each tool knows little or nothing about the information or functioning of other software programs.

Collaboration applications include functionality such as: e-mail, voice mail, online chat, instant messaging, videoconferencing, telephony, web conferencing, data conferencing, application sharing, wikis, charting, web publishing, document and data sharing, content management, revision and version control, and time and cost management.

Semantic collaboration applications add an underlying knowledge representation to data, processes, services, and software functionality that empowers teams and communities to connect, collaborate, communicate, link information, automate processes, and solve problems together very productively.

Semantic collaboration components include: semantic content tools; semantic wikis; semantic social media; semantic search, query, and navigation; ontology-driven applications; intelligent user interfaces; and web scale semantic computing.

What's new is that web 3.0 and semantic web knowledge representations orchestrate processes, connect information, and automate concept-level management of evolving team knowledge across all of the documents, team member communications, tools, and application processes. This enriches the collaborative experience, increases the productivity of team members, improves the manageability of the collaborative effort, and enhances the utility of its results.

Value drivers for semantic collaboration include up to tenfold gains in knowlege worker productivity, service delivery, and enjoyment through semantic enablement of information, processes, and user experience.

Semantic Publishing

Semantic publishing is the activity of making documents, information objects, and knowledge models available on the Web accompanied by semantic markup that enhances the meaning of the information; facilitates its automated discovery; enables its linking to semantically related information; provides access to data, models, visualizations, and other objects in actionable form; and facilitates integration data and information across published artifacts.

Semantic publishing is anything that enables computers to interpret the structure and even the meaning of the information in ways that make search, data integration, reasoning about it, and its presentation to users more efficient, relevant, and useful. In the coming decade, publishing will become threaded communication, information sharing, and exchanges of executable knowledge.

Semantic publishing solutions are essential building blocks for 21st century businesses. Web 3.0 and semantic web technologies tap sources of value based on openness, semantics, community collaboration, context-aware presentation, and rich media. These augment, but also undercut, previous sources of value that were based on content exclusivity, editorial control, proprietary copyright, and rights to restrict access and distribution.

In the coming era, investing in exclusive data and information that are shielded behind a firewall is simply not enough. Businesses will need to:

- Access and utilize open information and collaborate with the communities that create it.
- Exploit linked open data as a strategy for weaving extensive fabrics of semantics to form graphs combining structured and unstructured information that can be queried across the web as one vast, flexible database.
- Add semantics that improve the organization, accessibility, relevance, and utility of their information. That is, it is not enough to simply put enterprise information on the web.
- Build communities around their information, engage with them, and learn from them as they add value by contributing to it, by linking it with other data, and by using it.

Value drivers for semantic publishing include up to tenfold gains in communication effectiveness from exploiting bandwidth, semantics, and design in the UI to deliver user experience that is more connected, usable, findable, desirable, accessible, credible, and valuable.

Semantic Engagement

"The semantic web should allow people to have a better online experience" – Alex Iskold, AdaptiveBlue

Commerce in ideas, goods and services entails processes the purpose of which is to influence behaviors of external constituencies through activities such as research, advocacy, marketing, advertising, sales, and service.

Web 3.0 and semantic web technologies give us new ways to engage in multichannel conversations and processes that manage life cycle relationships with customers, suppliers, channels and other external constituencies so as to evolve and maximize relationship value through time.

For example:

- Research activities involve ongoing investigation of prospective markets and constituencies — typically multiple categories of external constituency including: higher authorities and regulators; sources of funding; channels for distribution of goods, services and information; suppliers; and customers. Web 3.0 and semantic web technologies enable harvesting diverse insights, building rich profiles, and using powerful analytic techniques that more fully exploit dynamic reference, news, opinion, and other information now available across the Web.

- Marketing activities are iterative and involve channels, contacts and information sharing directed toward campaigns that build awareness or mind share, then stimulate interest and subsequently develop understanding, leading to increasing engagement and preference for the intended course of action. Branding on the Internet is engagement and interaction with information.

  Semantically enabling information, context, and feedback enables Web 3.0 and semantic technologies to deliver new levels of relevance in search and navigation, utility in content presentation, and helpfulness in the user experience. In this sense, every organization is a publisher, engaged in multi-way social conversations involving multiple communities and a variety of channels and media.

  The best ways to build brands and influence constituencies are to give them information that helps them do what they want, and to listen well to what they have to say, then taking constructive action based on it.

- Advertising, promotion, and sales acquisition activities convert prospect interest and preference into agreements and commercial transactions. Semantic advertising analyzes page content, user context, and advertising message in order to make a more meaningful match between buyer and seller.

  Semantic analytics measure activity and interpret results in order to do better, based on experience. Semantic sales dashboards and collaboration environments use web 3.0 and semantic web technologies to facilitate combining information and processes from separate systems and services to orchestrate sales cycle activities and feedback from customers using composite dashboards.

- Service and support activities fulfill the transaction or contract, deliver the product or service, and provide ongoing support following the sale. Web 3.0 and semantic web technologies facilitate: understanding customer questions; marshalling all relevant knowledge to point of need; reasoning about course of action using related cases; orchestrating activities and resources to point of resolution; and analyzing feedback and activity metrics to continuously improve performance.

Value drivers for semantic engagement approaches include new capabilities for web scale dynamic social networking, context-aware personalization, social media, and relationship management, and up to ten-fold gains in performance in market-facing functional areas such as research, marketing, advertising, sales, service, and support.

What Should We Do About It?

Executive Action Plan For Benefitting From the Semantic Web

What to do on Monday:
The first thing to do is to examine the impact of social computing, cloud computing, mobility, and semantic technology on today's business functions, IT infrastructure, and applications.

Ask: What are we missing? Identify high value opportunities for your business. Make a list of most beneficial and most threatening potential impacts for your business or government organization. Identify low-hanging fruit — potential opportunities with real value that can be addressed relatively quickly and at relatively low cost and risk. Analyze what else your business needs in order to seize these opportunities.

In the next three months:
Now you're ready to get going. Use this "Executive's Quickstart Guide to Web 3.0 and the Semantic Web" and other reports and presentations in the Semantic Wave research series as input to your technology planning. Self-assess. Determine the knowledge, skills, practices, and resources your organization needs to take action.

Next, establish a *QuickStart Program*. The goals should be to build executive awareness and train your professionals to seize high-value opportunities that exploit semantic technologies. Tailor topics to meet specific needs of different audiences within the business.

The following is a sample QuickStart Program:

Semantic Business Opportunities: (2-4 hours)
This session is an executive briefing with slides and possibly some embedded video that would be delivered on site or as a Webinar. This high-level briefing would be for executives who direct the business, set strategy, commit resources, and manage risk and returns.

The purpose of this briefing is to build understanding of the practical near-to-mid-term business potential presented by semantic technologies. When planning new initiatives they need to consider economic conditions, market directions, business value, growth and profit opportunities, competitive strategy, capability development, and mission achievement.

Semantic Applications: (1/2 - 1 day)
This is a management-level briefing and solution envisioning workshop. This workshop would be for business strategists, IT management team, and line of business managers and business analysts concerned with realizing profitable business opportunities that deliver value to the market.

The purpose of this workshop is to build understanding of high-priority opportunities for semantic solutions; models for successful engagements; techniques for partnering with suppliers; and approaches for how to determine and communicate the business value of semantic solutions.

This session would help attendees consider which client problems and opportunities to address; what methodologies and solution patterns to apply; what mix of team skills are needed; what supplier building blocks to use; what to charge; and how to position the business value of a semantic solution relative to potential alternatives and competitors.

Semantic Solution Development: (1-5 days)
This QuickStart training session is for architects, developers and programmers. The session has three stages:

The purpose of the first part of this training program is to get developers up to speed, provide necessary background and level set. It presents semantic technology concepts, capabilities, standards, languages, reasoning methods, solution methodologies, development environments and tools, and solution building blocks. It features demos of tools, design techniques, and development methods, as well as practical case examples of semantic architecture, ontology development, semantic programming, and semantic solution integration.

The purpose of the second part(s) of the training program is to teach basic concepts, patterns, and best practices for utilizing web 3.0 approaches and semantic web standards (RDF, RDFS, OWL, SWRL and SPARQL) and related tools to build semantic applications with ontologies. Semantic application workshops would be hands-on and scenario-driven, and feature case examples, demos and practical problems. Also, sessions can draw on the solution expertise and customer case examples from users, experts, and vendors in specific market segments and applications being addressed.

QuickPilot
Now you are ready to undertake a "Quick Pilot." that implements a semantic solution and delivers value within 90 days. Select a project that represents "low-hanging fruit" and demonstrates near-term value to the business. Commit the team and select, conduct, complete and assess the initizl QuickPilot within 90 days.

In the next 12 months:
Next establish and follow through on an innovation strategy. Find, assess, prioritize, and take action on high-impact opportunities for the mid-to-longer term that deliver business value. Further empower internal teams through skills building, social networks and collaborative environments.

This completes the Executive Quick Guide to Web 3.0 and the Semantic Web report.

At the outset of the report we defined what we mean by web 3.0 and semantic web, and described trends and driving forces shaping the evolution of the Internet during the coming decade. Next, we discussed ways that semantic technologies drive value for businesses and governments. We examined three main areas where web 3.0 and semantic web approaches will impact businesses and some challenges that these developments will pose. Finally we set forth an executive action plan action plan for businesses seeking to seize semantic web opportunities.

Other reports in the Semantic Wave research series delve deeper into the application of web 3.0 and semantic web approaches to specific areas of business needs.

About the Author

Mills Davis is founder and managing director of Project10X — a Washington, DC.-based research consultancy specializing in next wave semantic technologies, solutions, and business models. The firm's clients include technology manufacturers, global 2000 corporations, government agencies, and Web 3.0 startups.

Mills serves as principal investigator for the Semantic Wave research program, which focuses on the business advantages of Web 3.0 and semantic web technologies.

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

Mills is active in a range of government and industry initiatives that are advancing semantic technologies. He co-chairs SemantiCommunity.net, and before that 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). Mills serves on the advisory board of several new ventures in the semantic space.

In addition to technology research and consulting, Mills is a partner of Reyes+Davis, a fine arts gallery in Washington, DC.