The Semantic Web: A New Paradigm for Integrating Healthcare Information

The healthcare industry faces a crucial challenge: Information is everywhere, but so much of it is disconnected, trapped in different databases and systems, and hard to piece together in ways that generate value. As a result, the potential for exploiting information to drive innovation and transform medical care remains largely untapped. In this paper, we explore several strategies for integrating healthcare information systems and highlight how next-generation Semantic Web technologies can help organizations build integrations with greater speed, flexibility, and cost-effectiveness.

TAMING COMPLEXITY

Despite pouring billions of dollars into information technology over the last two decades, the U.S. healthcare industry still struggles to harness the vast quantities of data scattered across applications and databases used by doctors, scientists, and business decision-makers everyday. It's a growing challenge because the industry's dependence on data continues to expand, fueled by the data-intensity of new sciences like genomics and bioinformatics, and new regulations that required providers to track every aspect of a patient's diagnosis and treatment.

The data explosion has led to growing complexity. Most organizations now maintain multiple, independent data repositories and systems. Poor integration between these systems can have severe side effects, creating bottlenecks that sap productivity, raise costs, and block organizations from creating value. It also makes it hard to comply with new regulations, such as those issued by the European Medicines Agency (EMA) and HIPAA, both of which require the establishment of national standards for electronic healthcare transactions and paperless records.

In healthcare and pharma workplaces, scientists and medical providers are spending more time trying to find and manage data, and less time doing science and caregiving. According to Atrium Research, more than 95% of healthcare industry scientists cite data management as a significant workplace challenge.

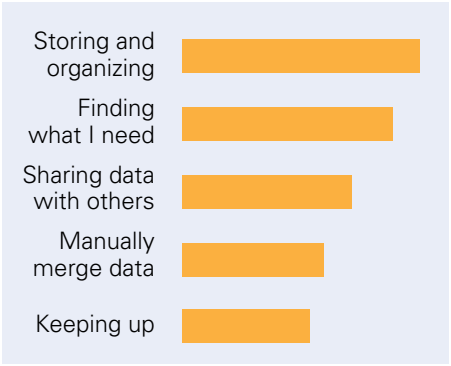
In healthcare and pharma workplaces, scientists and medical providers are spending more time trying to find and manage data, and less time doing science and caregiving. According to Atrium Research, more than 95% of healthcare industry scientists cite data management as a significant workplace challenge. Separate studies of medicinal chemists and biologists showed that nearly half of their workday is consumed by data and information tasks, and between 16% and 24% is spent with administrative tasks, meetings, and the like. That leaves only 33–36% left for really valuable activities, like experiment design and execution.

For pharmaceutical companies, the integration challenge is broad and the potential payoff huge. Pharma companies seek to speed drug development by integrating and connecting information

For more information on HCL's Semantic Web solutions, contact Somanth Mukherjee, Head—Lab Informatics and Manufacturing Practice, HCL, at somnath.mukherjee@hcl.com.

Data Management Overload

Over 95% of scientists report data management as a challenge



2004 Medicinal Chemist Study

	Percentage of day spent on task
Data and information tasks:	45%
Exp design and execution:	33%
Admin/meetings/other:	24%

2004 Medicinal Chemist Study

	Percentage of day spent on task
Data and information tasks:	45%
Exp design and execution:	33%
Admin/meetings/other:	24%

across its "value chain"—from its laboratory and clinical trial management systems to its manufacturing, distribution, and marketing systems.

More broadly across the healthcare complex, new regulations that mandate the use of electronic health records (EHRs) are putting pressure on providers and payers alike to build sophisticated database integrations. To date, nearly 200,000 providers have adopted EHRs, but its potential for improving patient health remains largely untapped.

The ability of healthcare organizations to address these information integration challenges isn't trivial. It can spell the difference between success and failure. According to Atrium Research, "Data and information have exploded—only organizations that can effectively manage, analyze and use it to their advantage will survive."

THE ROAD TO INTEGRATION

The good news is that healthcare organizations have been making significant strides toward improving data and systems integration. This trend is enabling new levels of process automation and efficiency and is helping healthcare companies get control over the data monster. As a result, companies are wielding new power to boost efficiencies, control costs, accelerate decision-making, and speed products to market.

New and evolving technologies are at the center of this transformation. In pharma laboratories, for example, the latest generation of informatics tools and solutions emphasize integration and interoperability. Former "islands" of functionality—such as laboratory information management systems, electronic lab notebooks, chromatography data systems, scientific data management systems—are now talking to each other.

New regulations that mandate the use of electronic health records (EHRs) are putting pressure on providers and payers alike to build sophisticated database integrations.

Better integration between applications allows for seamless workflows that can automate key tasks such as sample testing and management. More lab informatics applications are being equipped with middleware, interfaces and Web services that are making it easier to connect the lab to other parts of the business, including the manufacturing line.

These connections go in two directions: "downwards" to lab instruments and "upwards" to enterprise systems like ERP applications, manufacturing execution systems (MES), and process control systems. No longer cut off from the business, pharma labs have become an integral part of the enterprise. According to Atrium, this development is part of a long-term trend toward the "convergence" of lab informatics solutions in general, as vendors move from supplying discrete lab tools to broader solutions that cut across traditional functional boundaries.

NEW STRATEGIES

While the trend toward convergence is real, it is unlikely that any single application will ever perform all the information- and process-management functions needed by modern pharma and healthcare enterprises. Nor is that goal even advisable. For the foreseeable future, various lab, healthcare and business applications will continue to talk to each other through interfaces and integrations. Fortunately, new IT architectures and Web technologies are making it easier for healthcare organizations to achieve impressive levels of data integration of data throughout the enterprise.

A key advancement is the emergence of Service-Oriented Architecture (SOA) technologies, which enables organizations to link applications and share data using flexible XML-based Web services. With SOA and Web services, application modules can be "loosely coupled" and reused rather than hard coded. Such modularity accelerates the building of integrated IT environments and allows for flexible (and future-proof) pullout and plug-in configurability.

When SOA-based integrations in healthcare organizations are done properly, they have the potential to give key stakeholders—everyone from scientists to healthcare providers to business executives—instant access to all the information they need, all from a single interface. According to Atrium: "The adoption of service-oriented integration frameworks will enable the 'scientist desktop' metaphor to become are reality."

A NEW VISION: THE SEMANTIC WEB

While the SOA-based integration approach offers promise, it is not without its limitations. Even with the architectural efficiencies provided by SOA and Web services, these integrations can take a lot of time and effort to build and maintain. And they're not easy to modify if you want to create new connections or access new sets of information. You still have to depend on IT department to build new interfaces or design new database schemas to exploit fresh information sources.

What if there was a way to achieve data integration without building physical interfaces? What if you could get the information you needed by sending an intelligent agent to search through your applications and data stores? That is precisely the vision of the Semantic Web and it is rapidly emerging as a powerful technology platform that promises to bring vast new efficiencies to healthcare and pharma IT.

When SOA-based integrations in healthcare organizations are done properly, they have the potential to give key stakeholders—everyone from scientists to healthcare providers to business executives—instant access to all the information they need, all from a single interface.

With the Semantic Web, companies can create a "virtual entity" that connects all the data sources that are relevant to the business—from the lab to the manufacturing line. It allows researchers—as well as business managers—to reason over concepts and pose complex queries that weren't possible before.

An offshoot of the ubiquitous HTML-based Web with standards managed by the same organization (the World Wide Web Consortium or "W3C"), the Semantic Web provides a common framework that allows data to be shared and reused across multiple applications, enterprises, and communities. It is a system that enables machines to "understand" and respond to complex human requests based on their meaning.

Such an understanding requires that the relevant information sources are semantically structured. Fortunately, Semantic Web technology provides the language and tools to build those meaning-rich structures—also known as ontologies—that describe sets of data and allow them to be easily searchable.

Instead of HTML, developers of Semantic Web applications use RDF (Resource Description Framework) and other languages and syntaxes, such as OWL, to represent information in sentence-like "triplets" that include a subject, predicate and object. For example, in Pharma R&D, one of these statements might include a specific compound and a functional relationship of that compound to a specific cellular receptor.

With the Semantic Web, companies can create a "virtual entity" that connects all the data sources that are relevant to the business—from the lab to the manufacturing line. It allows researchers—as well as business managers—to reason over concepts and pose complex queries that weren't possible before. For organizations seeking to track patients over time using electronic health records, the Semantic Web offers a powerful platform for efficiently tying together diagnoses, lab results, and treatments stretching across multiple systems, providers and episodes.

MAKING IT WORK

While the Semantic Web still encounters skeptics in the healthcare industry, its inherent efficiencies are swiftly pushing this approach into the mainstream and attracting a burgeoning number of advocates and developers. Semanticweb.com, for example, reports that companies across several healthcare markets are actively hiring "ontologists."[1]

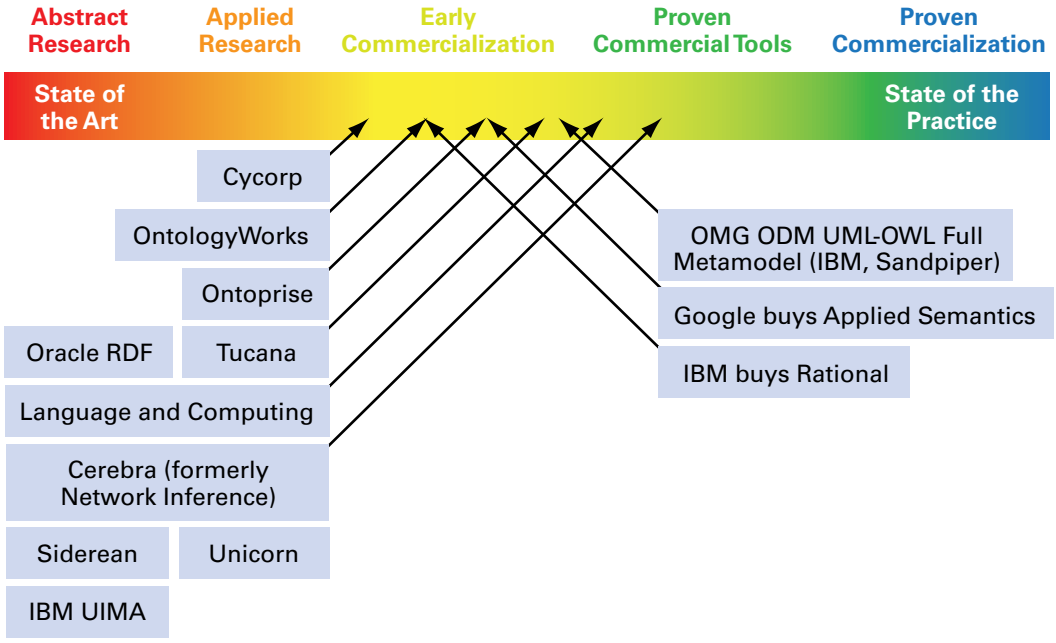
Semantic Web search technologies—much like the familiar search engines of the HTML Web—enable you to send "semantic agents" that crawl across systems, retrieving data that is relevant or similar in meaning. For healthcare IT organizations accustomed to building costly integrations for every new database and application, this represents a huge leap in time and resource efficiency. That's because the Semantic Web is extensible. There's no need to build hard-coded interfaces between systems.

To make it work, developers build a Web-based interactive layer describing data existing on different systems. In effect, developers create a Semantic Web layer on top of applications, allowing users to easily pull information and answer complex queries. Information residing in the Semantic Web is a virtual concept and new connections can be generated on the fly.

"Many pharmaceutical companies are exploring the use of the Semantic Web," says Susie Stephens, director of biomedical informatics at Johnson and Johnson. "It's a more flexible approach to incorporate new data sets as you go

[1]http://semanticweb.com/semantic-web-jobs-report-2-ontology-jobs-in-healthcare_b581.

The Semantic Web: Gaining Traction with New Vendors and Commercial Indicators



along." Jim Hendler, a computer scientist from Rensselaer Polytechnic Institute and former chief scientist of the information systems office at the US Defense Advanced Research Projects Agency (DARPA), says that the Semantic Web is a "maturing" technology that can "sit on top of web infrastructure, is extensible, and oriented toward data-sharing."

In the Semantic Web, there are no boundaries between systems, so information flows freely across the enterprise and between healthcare databases. Lab data connects naturally with pharma manufacturing and distribution systems, becoming an integral part of the whole business. Healthcare plans build EHR solutions effortlessly through the integrative power of the Semantic Web.

SEMANTIC WEB IN ACTION

For organizations that exploit the power of Semantic Web technology to integrate and mine data, the opportunities for transforming drug development programs and EHR projects are potentially huge. For pharma companies, the value of semantic technologies extends throughout the lifecycle of products, from basic research and clinical trials to manufacturing and distribution.

During basic research and pre-clinical testing, Semantic Web applications can help researchers accelerate aggregation of discovery research, manage high-throughput screening (HTS) models and lead-target knowledge bases, and optimize pre-clinical testing. Semantic technologies are also well equipped to facilitate translational research, which requires an awareness of many data sources and the need to integrate, mine, and analyze data from different parts of the business and across industries.

During clinical trials, Semantic Web applications can speed the interchange of clinical and lab data to keep development projects on track. Pharma R&D organizations can also streamline regulatory submissions with Semantic

Among the most promising of the new approaches to integration is the Semantic Web, which deploys a knowledge-rich Web layer on top of applications that enables information to flow freely between databases and applications.

Web solutions that enable better management of regulatory documents. Related applications support FDA's Critical Path Initiative, a national strategy for transforming the way FDA-regulated medical products are developed, evaluated, and manufactured.

During the drug-manufacturing phase, when in process sampling and testing ensure product quality, Semantic Web solutions can accelerate raw materials management and inspections, enable fast in-process and in-reactor sampling, and streamline finished product sampling and inspection. And even after the drug leaves the factory floor, the Semantic Web can do the fast data integration necessary to uncover the root cause of a recall event.

CONCLUSION

Information overload has become a defining feature of the healthcare industry landscape. But the industry is responding with new strategies that cut through the complexity and enable comprehensive system integration without the overhead and inflexibility of costly, hard-coded IT interfaces.

Among the most promising of the new approaches to integration is the Semantic Web, which deploys a knowledge-rich Web layer on top of applications that enables information to flow freely between databases and applications. Semantic Web technologies are inherently extensible, allowing for easy and affordable incorporation of new databases and applications.

Empowered by system-spanning Semantic Web applications, healthcare and pharma organizations can sharpen their focus on what really matters: conducting innovative scientific research, developing cost-effective medicines, and delivering cutting-edge patient care.

HCL is committed to staying on the forefront of this promising technology area with initiatives, investments, and partnerships that help organizations thrive in the new healthcare ecosystem.

ABOUT HCL TECHNOLOGIES

HCL Technologies is a global technology services, consulting and outsourcing company, with more than 72,000 experienced professionals dedicated to creating value for clients in 30 countries. Recognized as a world leader in IT-driven business transformations, HCL offers services ranging from software solutions and infrastructure management to engineering, research and development, and business process outsourcing.

ABOUT HCL HEALTHCARE

HCL Healthcare is one of the fastest growing practices within HCL, helping leading healthcare providers, payers, and pharmaceutical companies thrive in today's global healthcare ecosystem. Powered by 5,000 skilled professionals, HCL Healthcare collaborates with the world's leading healthcare organizations to design and build future-ready technology, business process optimization, and compliance solutions. For more information, please visit www.hcltech.com/healthcare.

HCL