IBM Institute for Business Value

The wisdom of the cloud

Cloud computing in the life sciences industry

By Stuart Henderson, Salima Lin, Maurice Solomon and Chris Hines

Cloud computing provides companies with a more efficient way of purchasing computing power. In addition, cloud computing facilitates the development of standard business processes, thereby enabling companies to outsource transactional processes and focus on those that genuinely add value. But the ultimate benefit for a research-intensive industry such as life sciences lies in the fact that cloud computing aids innovation. It provides a platform for collaborating with other organizations and facilitates the development of totally new business models.

Most of the literature on cloud computing focuses on how it can help organizations save money and mobilize rapidly. Instead of building its own IT infrastructure, a company hands the task to a third party. The "tenant" company has access to its data and software over the Internet and pays only for what it uses. It can then scale up or down as it needs, without having to invest in expensive hardware and software or worry about maintenance.

While all this is true, a key point is missing: The real value of cloud computing to a research-intensive industry like life sciences is that cloud computing can facilitate innovation. It provides a platform for collaborating with other organizations. It also enables companies to harmonize transactional processes, delegate those processes to a third party and concentrate on differentiating activities themselves. In other words, cloud computing goes far beyond utility computing. *It is not just a more efficient way of purchasing computing power but, rather, a way of facilitating new, more efficient business models* (see Figure 1).

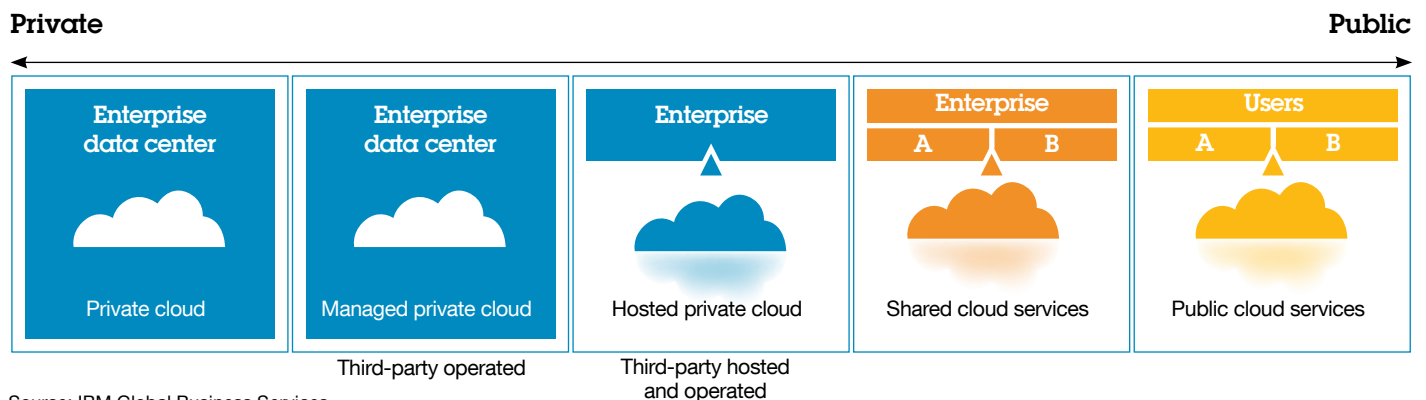| Capabilities	From...	....To
Business processes and standard operating procedures	Company specific	Consistent, shared process
Sourcing	Limited ability to ramp business resources within tight timelines	Flexible business resource ramping
Business collaborations	One-offs	Common platform for flexible collaboration
Relationship with partners	Multichannel, varied experiences, duplicative	Consistent and credentialed once
Flexibility	Slow on-boarding – training on unique processes	Rapid on-boarding using standard processes
Integration with healthcare environment	Pilot efforts by numerous sponsors	Collective effort
Flexibility to support business ventures	Limited	Flexible
Management of information systems capacity	Limited ability to ramp IT within tight timelines	Flexible IT ramping – ability to trade off cost for time
Technology	Applications and infrastructure	Services
Data	Company standards, sparse industry standards	Defined and adopted industry standards

Source: IBM Global Business Services.

Figure 1: **Cloud computing supports the shift to more streamlined, collaborative business models.**

The key features of cloud computing

At its most basic level, cloud computing is the provision of an IT infrastructure for a group of users in different locations that allows them to share resources, software and information via the "cloud" that supports them. In a public cloud, IT activities or functions are provided as a service over the Internet. In a private cloud, IT capabilities are provided as a service over an intranet and protected behind a firewall (see Figure 2). Hybrid clouds bridge the gap, permitting two or more clouds (public or private) to share data and applications while preserving their separate identities.

Private   **Public**

Enterprise data center	Enterprise data center	Enterprise	Enterprise A / B	Users A / B
Private cloud	Managed private cloud	Hosted private cloud	Shared cloud services	Public cloud services

Third-party operated

Third-party hosted and operated

Source: IBM Global Business Services.

Figure 2: **Clouds come in a number of forms, ranging from the completely private to the completely public.**

However, cloud computing is much more than a way of linking people across the miles. It is also a means of managing the "workloads" – i.e., the computing activities (typically, computation, memory, networking and storage) – required to execute crucial processes and deliver industry-specific solutions. In the life sciences value chain, it can be used to perform modeling and simulation, computational biology, high throughput screening and medical imaging. Similarly, it can be used to analyze supply chain data, safety data, outcomes data, and sales and promotional data; track and trace products in the supply chain; support collaborations with external partners; monitor patients remotely in real time; and provide complementary healthcare services (see Figure 3).

The advantages of using cloud computing to manage the workloads associated with these processes vary, depending on the particular workload. For example, using a cloud for complex analytical tasks – which usually require intensive computing resources for brief periods of time – lets organizations dispense with otherwise underutilized server farms, whereas using a cloud for development and testing makes it easier to streamline the system development process, thereby reducing lead times and costs. But, in essence, all clouds enable the users to **engage** with each other, **operate** and **innovate** in smarter ways.

Workloads	Industry solutions	
Analytics	• Modeling and simulation • Translational medicine applications • Clinical trial analytics	• Sales analytics • Biomarker/outcomes pathways • Marketing and campaign analytics
Development and test	• Multiple validated and qualified environments • Large system stress testing	• User acceptance testing • System integration testing
Infrastructure storage	• High throughput screening • Clinical and pre-clinical imaging	• High-resolution promotional content
Desktop and devices	• Provisioning of validated environments • Provisioning of virtual desktops to contractors and partners	
Infrastructure compute	• Computational biology • Biostatistics	• Supply chain monitoring • Realtime device-based monitoring
Collaboration	• Rapidly provisioned research partnering • Rapidly provisioned clinical trial partnering • Joint sales and marketing programs	
Business services	• Safety processing • Clinical data management/programming • Sales analytics	• Contract management • Healthcare connection services

Source: IBM Global Business Services.

Figure 3: **Cloud computing can support specific industry solutions across a wide variety of critical workloads.**

Engaging in smarter ways

Cloud computing offers a simple, effective means of collaborating with a network of partners – and most life sciences organizations now recognize the importance of working together rather than trying to do everything alone. Through cloud computing, users can share information and applications reliably and rapidly in a communal workspace, with the various participants splitting the financing costs, resources, risks and rewards among themselves. And they create value by interacting as a group rather than through a series of one-to-one transactions.

Cloud computing facilitates these new, multi-nodal business models by providing a collaborative information infrastructure – or "infostructure," as we call it – that enables the partners to orchestrate and coordinate their activities smoothly and rapidly. It supplies the right users with the right information flows and tools and manages data security, risk and compliance across the entire network.

Different clouds can also be integrated to let the members of one cloud access data from another cloud at the point at which the information originates. A cloud designed to support the provision of collaborative care has already been launched in the United States, for example (see sidebar, **Care cloud helps doctors more effectively treat patients**).[1] But that same cloud – or others like it – could be linked to a life sciences cloud to give biopharmaceutical companies direct access to a blinded version of the electronic medical records for the purposes of research and development.

Care cloud helps doctors more effectively treat patients

ActiveHealth Management, a subsidiary of leading U.S. health insurer Aetna, is already leveraging cloud computing to help hospitals improve the care they deliver by making better use of electronic records and other digital data. The cloud will provide various services, including a feature that enables doctors to access patients' health data – such as previous medical records, claims and laboratory tests – from multiple sources and quickly analyze what might be the best treatment. It will also flag overdue check-ups and alert doctors as to which patients in their wards require the most immediate attention, as well as enable hospitals to measure their performance against national standards more easily.

Source: Ando, Ritsuko. "IBM and Aetna tie up to offer clinical support service." Reuters. August 5, 2010.

Cloud computing supplies the right users with the right information and tools.

Operating in smarter ways

Cloud computing allows organizations to operate more efficiently by cutting their IT costs and accelerating the deployment of new technologies and processes. Sharing an IT platform with other entities means an organization can utilize computing resources more efficiently and reduce the amount of data it needs to store because the data only needs to be stored in one place (see Figure 4). The organization can also access the platform from any place at any time, use as many or as few resources as it requires and pay as it goes. In fact, IBM's research suggests that many life sciences organizations could save as much as 25 percent of their annual operating expenditures on clinical IT systems by using cloud computing – money they could then redirect to the development of new medicines and related healthcare services.[2]

Without cloud computing

Company A workloads:	Company B workloads:
• Software	• Software
• Hardware	• Hardware
• Storage	• Storage
• Networking	• Networking
Service management	*Service management*

With cloud computing

Company A	Company B	Company C
	• Software	
	• Hardware	
	• Storage	
	• Networking	
	Service management	

Source: IBM Global Business Services.

Figure 4: **Cloud computing lowers an organization's IT costs by enabling it to share resources.**

The ability to create new alliances and get trial sites up and running more quickly, as well as analyze data more rapidly because it is standardized and centralized, could likewise yield substantial financial advantages. Reducing time to market by a month for a product that generates annual sales of US$300 million could deliver US$25 million in extra sales, for example.

However, cloud computing has the potential to do even more. Common data, common standards *and* common processes could help harmonize the entire life sciences ecosystem. Process variations between interacting organizations cause complexity, generate large training costs and make compliance difficult to manage. Conversely, open, shared processes reduce complexity and lower the costs and efforts involved in conducting ongoing updates to conform to new rules and interpretations (see sidebar on page 6, **Trial and improvement**).

Process variations are particularly prevalent in the life sciences industry, where many companies still focus on creating "unique" processes, either because they perceive such processes as a source of competitive differentiation or simply due to cultural inertia. These customized processes, in turn, require customized software, although it is often easier and cheaper to deal manually with infrequent exceptions. Using standardized industrywide processes would thus enable life sciences organizations to reduce the costs they incur both internally and in collaboration with external partners.

Equally important, such common processes would allow them to delegate the performance of common transactional tasks to a third party and focus on truly differentiating activities.

Trial and improvement

One obvious area where harmonized standards and cloud computing could deliver benefits is clinical trial management. At present, trial investigators have to use different processes (and sometimes even different computers) when dealing with different companies. Common processes and platforms would reduce the amount of training required – which might, in turn, encourage more doctors to participate in clinical trials.

The sponsoring companies would have much to gain, too. Closer collaboration with investigators and other partners would help them save time designing trial protocols, selecting and equipping trial sites, and getting regulatory clearance to proceed. Similarly, standardized processes and shared platforms would improve the quality and timeliness of the data they collect, while flexible access to computing power would enable them to analyze the data more rapidly and comprehensively, as well as reduce the amount of time required to generate reports, making it easier to respond to regulatory queries.
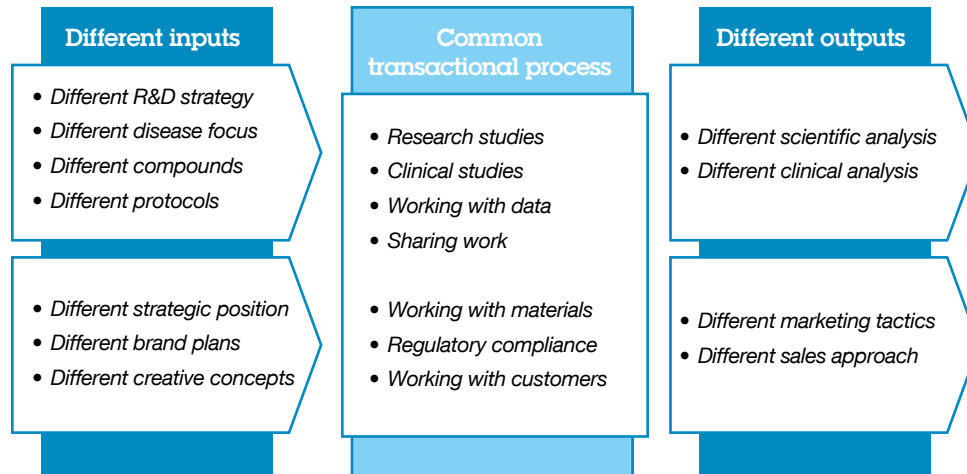
Rather than spending time, money and effort on basic administration, clinical study operations and data management, for example, life sciences organizations could concentrate on creating distinctive R&D strategies, sourcing novel compounds and developing different protocols – activities that would, in turn, produce different scientific and clinical results that help distinguish them from their competitors (see Figure 5).

Most scientific processes comprise a combination of differentiating and transactional activities. Medical image management is a case in point. Some tasks – such as the design of trial protocols and image analysis – are potential sources of competitive value. Others – such as the acquisition, transfer, archiving and management of the images – are routine tasks that could easily be standardized and managed via a cloud.

Innovating in smarter ways

Cloud computing enables organizations to manage and analyze data much more rapidly and efficiently. This is especially important in the life sciences industry, where the volume and complexity of the scientific and commercial data that must be handled are increasing exponentially with the advent of new instruments (e.g., high throughput screening tools and sophisticated remote monitoring devices), new types of data, and more sophisticated methods for capturing marketing and sales data. The problem has already become so acute that 62 percent of the life sciences executives participating in one recent study firmly believed their organizations had more data than they knew how to use effectively.[3]

Cloud computing allows the members of a cloud to combine data from multiple sources, using simplified data structures and ontologies and common formats that make for more effective data sharing and collaboration. It also provides the flexibility with which to support a wide range of analytical technologies, including emerging open source tools for mining the data.

Different inputs	Common transactional process	Different outputs
• Different R&D strategy • Different disease focus • Different compounds • Different protocols	• Research studies • Clinical studies • Working with data • Sharing work	• Different scientific analysis • Different clinical analysis
• Different strategic position • Different brand plans • Different creative concepts	• Working with materials • Regulatory compliance • Working with customers	• Different marketing tactics • Different sales approach

Source: IBM Global Business Services.

Figure 5: **With harmonization, organizations can hand over common transactional processes to a third party and focus on differentiating activities.**

In short, cloud computing helps separate organizations realize the full value of their data by pooling it to obtain new insights, develop new products or services and respond to new regulations or evidence. Such seamless connectivity is a prerequisite for any form of open innovation, but it will become even more crucial as biopharmaceutical R&D becomes increasingly networked – with the creation of complex scientific and commercial ecosystems.[4]

Cloud computing enables innovation among life sciences organizations.

The value of cloud computing throughout the life sciences value chain

A number of life sciences organizations are now beginning to explore the potential of cloud computing throughout the life sciences value chain. These early adopters are pioneering various forms of process harmonization and collaboration – and though some hurdles still exist, we believe cloud solutions will focus on four main areas: research, development, supply chain and commercial.

Research clouds

In modern biopharmaceutical research, scientists must work with huge amounts of data from a wide variety of data sets, share the data with multiple partners and analyze them using a rapidly expanding range of analytical technologies – a process that requires a very flexible IT infrastructure. New high-throughput instruments for genomic transcription and proteomic characterization and for structural and cellular biology are producing vast volumes of data, for example. So, too, are DNA sequencers, mass spectrometers, electron microscopes and other such instruments.

A research analytics cloud would provide scalable, economic storage for increasingly large data sets, together with an easy means of sharing both the data sets and the computing power needed to analyze them. This would enable scientists in different locations to collaborate more closely and concentrate on their own research, as distinct from managing the infrastructure itself.

A protein modeling cloud would offer similar benefits. Protein structure prediction is an extremely difficult task. But with cloud computing, it is possible to create virtual, scalable protein models without making a huge investment in hardware or software. Researchers could analyze proteomic data in the cloud, using advanced analytical technologies and extensive computing resources, thereby accelerating the speed with which they perform the analysis and dramatically reducing the cost of an otherwise very expensive process.

Development clouds

The quantity and complexity of the data generated during clinical trials – and the corresponding effort and expense required – are likewise growing very rapidly. Moreover, many life sciences organizations are experimenting with new business models that require greater collaboration, decentralization and flexibility in an effort both to become more efficient and stimulate innovation. For example, GlaxoSmithKline has divided its research function into "discovery performance units" of 20 to 60 people, each focusing on a different disease or technology.[5]

Again, cloud computing offers various advantages. With a clinical development cloud, for example, multiple tenants could use common business processes and applications, thus making the experience much simpler both for the investigators participating in the trials and for two or more sponsors collaborating on the co-development of a compound. Similarly, with a safety cloud, the originating companies could coordinate safety surveillance with their development and marketing partners more effectively. With a regulatory cloud, they could share data from multiple filings with multiple partners. And if the regulatory agencies also participated directly in such a cloud, enormous efficiencies could be realized.

Through cloud computing, scientists in different locations can more effectively collaborate.

Supply chain clouds

The management of the life sciences supply chain presents other challenges. The non-stop nature of biopharmaceutical manufacturing and distribution requires a very high degree of reliability and security. Many companies are also trying to shorten the production lifecycle and reduce costs by outsourcing work to overseas contract manufacturers and carriers and closely collaborating with them. This means they must share data with numerous suppliers – and they must share the right data with the right suppliers in the right ways to create as much value as possible. A supply chain cloud that brings all the partners together using a common set of processes would enable the industry to work more efficiently. It would provide realtime data on every process and computing power that could be adjusted as needed.

The manufacturing and distribution of biologics poses particular difficulties. Because such products must be made and transported at carefully controlled temperatures without being subject to vibration or other potentially damaging environmental factors, they must be tracked at every stage throughout the supply chain. A cold-chain cloud with industrywide standards would enable all the distributors and transport carriers in the supply chain to measure and monitor the products and issue alerts where necessary. It would also provide scalable resources for analyzing the data for both reporting and predictive purposes, as well as significantly reduce the incidence of product complaints.

Commercial clouds

Cloud computing has potential in the commercial sphere, too. The traditional method of marketing medicines is changing, as the cost of employing an army of sales representatives escalates while the digital channels created by the Internet become increasingly crowded. Many life sciences companies are therefore trying to reduce their marketing and sales costs without diminishing their market presence. To do this, they need to reach the "right" customers by capturing more extensive data on all their customers, targeting customers more accurately – using techniques such as closed-loop marketing – and measuring their return on investment.

Cloud computing has numerous uses in this regard. A cloud dedicated to customer relationship management would, for example, enable companies to share data selectively, analyze their customer bases using complex marketing analytics tools, tailor their marketing investments to suit specific circumstances and benchmark their performance against that of their peers. Similarly, a cloud designed to support enterprise content management would enable brand teams, marketing agencies and content providers to collaborate more easily and simplify rights management so that companies could share and re-use marketing materials more frequently. It could also provide a seamless link with the regulators whose responsibility it is to vet many of those materials and even, perhaps, support the co-development of training resources for quality initiatives in hospitals or other such assets.

Post-marketing surveillance is yet another area in which cloud computing could prove invaluable. It provides an ideal platform for synthesizing and analyzing massive quantities of data from remote sensors to monitor the safety of existing medicines, identify new applications, develop new formulations and deliver supporting healthcare services such as compliance management.

Overcoming barriers to adoption

Several obstacles to widespread adoption of cloud computing still remain, including concerns about data security, privacy and ownership; the absence of global industrywide standards; and protection of the interests of competing cloud users. However, early adopters are actively engaged in resolving each of these difficulties.

Security

Security is probably the single biggest source of anxiety but, as long as the right measures are in place, information stored in clouds is no less protected than it would be in any other kind of data repository. In fact, it is often more safeguarded because the security systems used to manage clouds are typically more robust than those used in traditionally hosted environments. With federated trust and identity management systems, users access a cloud through the Web, via a single sign-on system. And a biopharmaceutical industry standard – Secure Access For Everyone (SAFE) – has already been developed to verify and manage digital identities and use digital signatures safely.[6]

Meanwhile, Role-Based Access Control (RBAC) enables each tenant company to restrict access to authorized users. Permission to see particular data, use a particular application or perform a particular operation is assigned to specific roles, rather than specific employees. So it is a relatively simple matter to manage individual user rights by changing a user's role or department. Responsible hosts also use stringent infrastructure and operations security measures to protect the underlying network, servers and applications and to control access to sensitive or critical data. In other words, properly managed clouds provide a robust operating environment and pinpoint control over access to the data they contain.

Evolving industry standards

The standards required to support cloud computing have not yet been finalized, so unwary subscribers risk getting locked into proprietary systems – a risk that applies with early adoption of any new technology. Nevertheless, various efforts are underway to engage the emerging cloud computing community (both cloud users and cloud providers) in a dialogue that will result in a core set of principles. One such instance is the Open Cloud Manifesto, which starts from the premise that cloud computing should be based on open standards.[7] We believe this dialogue will result in the development of stringent security and data standards and assessment tools within the next four years.

Protection of the interests of competing cloud users

Concerns also exist about how best to ensure that the interests of competing cloud users are represented and supported. Who, for example, should determine the scope of the cloud? How should its direction be managed? And how should any conflicts of interest – either between the cloud provider and the tenants or between different tenants – be resolved? This is where cloud governance comes into play.

Cloud governance engages all the stakeholders, including the relevant regulatory bodies, in the decision-making process so that they can collectively develop new standards, harmonize their business processes and optimize the user experience. It also provides a neutral forum for defining the scope of the cloud and any modifications to the operating structure, such

Early cloud adopters are actively engaged in resolving obstacles to adoption.

as changes in validation policies, procedures or standards; developing new short- and long-term plans and priorities; discussing new technologies or strategic partnerships to improve functionality or address new needs; appointing sub-committees to secure proof of concept; and evaluating the performance of the cloud.

The evolution of cloud computing

So how is cloud computing likely to evolve in the life sciences industry? We think it will gain increasing acceptance as a means of sharing computer power and storing data over the next two or three years, but its use will primarily be restricted to mature business processes at the biggest companies. These first movers will enjoy some initial IT cost savings, as well as being able to pioneer new forms of collaboration.

However, by 2015, most large biopharmaceutical companies will use multi-tenanted clouds for many of their major business processes (see sidebar, **Moving to the cloud**). There may even be industrywide clouds for certain activities, possibly sponsored by key trade bodies or regulatory agencies. The true benefits of cloud computing will also be increasingly obvious, as it produces a paradigm shift in the way companies interact, delivering greater operational effectiveness and stimulating more open innovation.

Moving to the cloud

Most organizations have significant investments in existing IT infrastructure, applications and processes, as well as projects that are already underway. So it is difficult for them to make the switch to cloud computing. A transition period is usually required, where new projects are implemented via a cloud, while ongoing projects are completed on the existing systems. During the transition, user identity, data management and other functions must be maintained in tandem. However, there are various ways of moving data smoothly from one system to another and synchronizing data between systems.

Many cloud systems must also be integrated with legacy systems or other cloud systems. Again, there are a number of techniques for integrating data from disparate systems without loss of data quality. Finally, any organization that adopts cloud computing must provide the training and governance structures needed to support any systems transition. Fortunately, since cloud systems leverage common user interfaces and operations, such transitions are usually easier than those involving traditional systems.

Conclusion

Cloud computing enables companies to reduce their IT costs and call on additional computing power, new applications or advanced analytical tools as required. But this is only a tiny part of its true promise. A common "infostructure" facilitates the development of standard business processes, thereby enabling companies to outsource transactional processes and focus on those that genuinely add value. It also provides a foundation for greater collaboration, open innovation and the development of totally new business models.

Companies in other industries – including industries with heavily regulated markets like legal and financial services – are already starting to reap some of the benefits of cloud computing.[8] But it has huge potential in the life sciences industry, too – from the analysis of genomic, proteomic and clinical data to coordination of the supply chain, customer relationship management and safety surveillance. Those companies with the wisdom to see the true significance of cloud and seize the initiative will be in the strongest position to capitalize on the advantages it facilitates.

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