

EXPLORING THE FUTURE OF CLOUD COMPUTING: RIDING THE NEXT WAVE OF TECHNOLOGY-DRIVEN TRANSFORMATION



About this report

This World Economic Forum report was developed by the Forum's IT Industry Partnership in collaboration with Accenture and with the input from a group of experts and Future of Cloud Computing Steering Board members.

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About the Future of Cloud Computing Steering Board

Guidance was provided by an actively involved Steering Board of Experts which included:

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The views expressed in this publication do not necessarily reflect those of the World Economic Forum, Accenture, the Future of Cloud Computing Steering Board members or the Industry Partner companies. Without their dedication, guidance and support, we would not be able to successfully develop this report.

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Executive Summary

Cloud computing is seen by many as the next wave of information technology for individuals, companies and governments. The abundant supply of information technology capabilities at a low cost offers many enticing opportunities. In addition to reducing operational costs, cloud technologies have become the basis for radical business innovation and new business models, and for significant improvements in the effectiveness of anyone using information technology – which, these days, increasingly means most of the world.

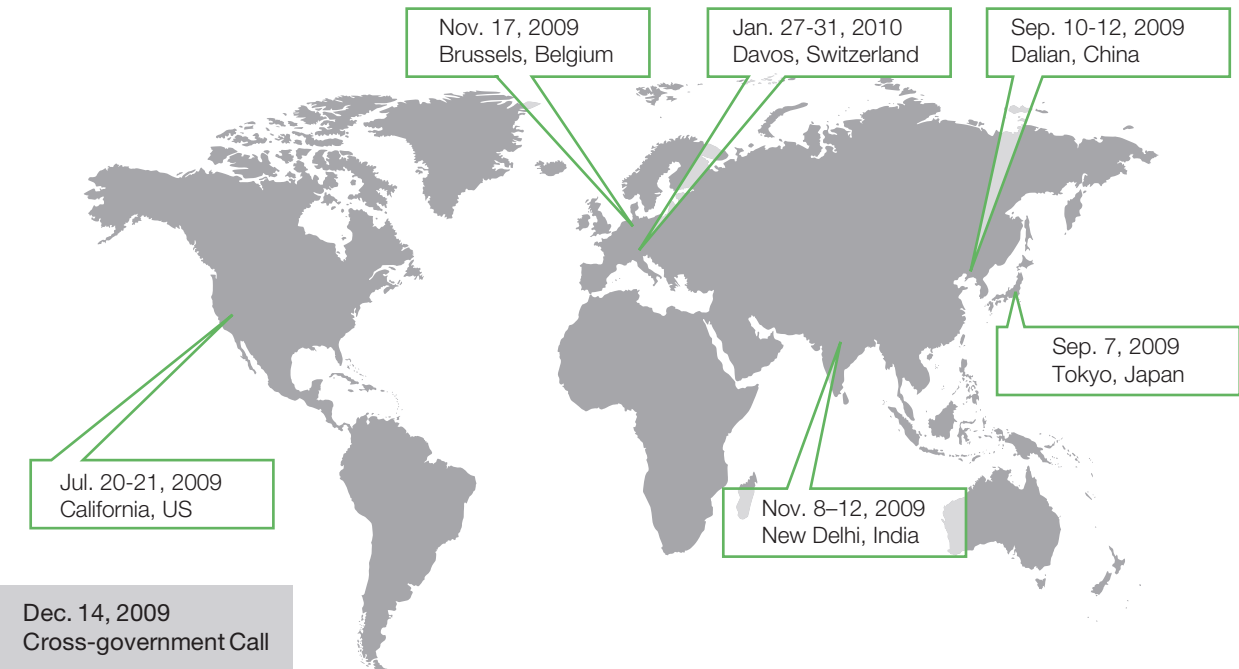
Like any new technology advancement, cloud computing also creates disruptive possibilities and potential risks. The fact that cloud computing involves the aggregation of computing power, and more importantly, information, has become a source of increasing concern. Users, providers and government policy-makers are asking many questions about the current use and future evolutionary path of cloud computing. These include:

What are cloud computing's most important current and potential future benefits for industry, governments, and society? What might derail cloud computing's progress? And are the overall benefits worth the risks?

The World Economic Forum and Accenture recently completed the first part of a two-year research initiative through surveys, focus group discussions and global workshops to address these questions (Figure 1.1 & 1.2). The project was mandated in 2009 by the IT Governors at the World Economic Forum meeting. The objectives of the project were to develop a set of collaborative actions and identify policy and industry recommendations that could steer the healthy development of cloud computing.

The research findings provide some surprising and useful insights into what current and potential users see as the most important benefits of cloud technologies; which industries, societal, and other stakeholder groups might most benefit from cloud computing; why governments are adopting cloud services at a higher than expected rate; and what users, providers, and policy-makers fear may disrupt the adoption of cloud services and thus potentially diminish their value.

Figure 1.1. Project Approach - Global Workshops



The experts who participated in the research generally believe that business, government organizations, and countries have seen only the tip of the iceberg with regard to the benefits that cloud computing will deliver in the next ten years. They predict that companies of all sizes and government institutions in both established and emerging economies will achieve new levels of productivity and innovation. They believe the cloud industry will be a key source of new jobs. And they see cloud computing helping nations make great gains through addressing major healthcare, education, and other societal issues.

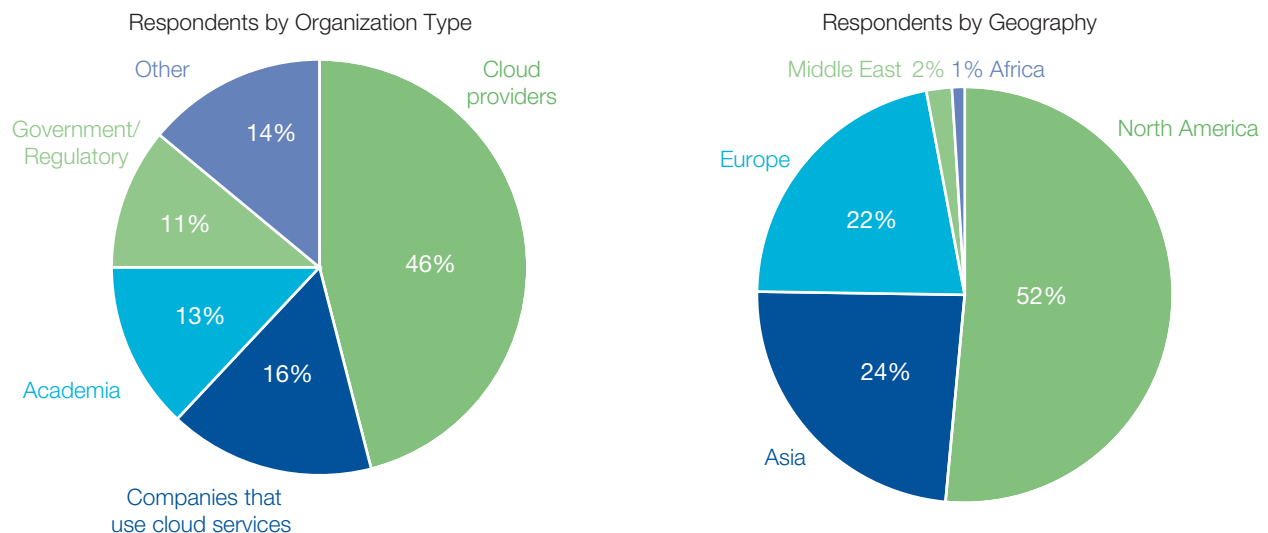
This optimism, however, is tempered by a realistic perspective on the significant barriers to the widespread adoption of cloud services. The challenges include keeping consumer, business, and government data and systems secure; maintaining the privacy of people and organizations; avoiding being locked into one cloud provider; and creating the right regulatory balance

between customer protection and business efficiency.

This report explores the potential benefits and barriers in more detail. It also highlights actions that the IT industry and governments should consider. These include educating customers about the benefits of cloud, creating standards and policies that enable easy switching among cloud providers, and providing clear information about where data is actually stored. Additionally, given the role of information technology and the structural changes that may be generated by cloud technologies, the report also highlights the potential to look at lessons from other more mature “infrastructure” industries, such as banking and transportation, to help shape our approaches towards cloud technologies.

Figure 1.2. Project Approach - Global Survey

Survey period: August - November 2009



Research Findings

The impact of cloud computing

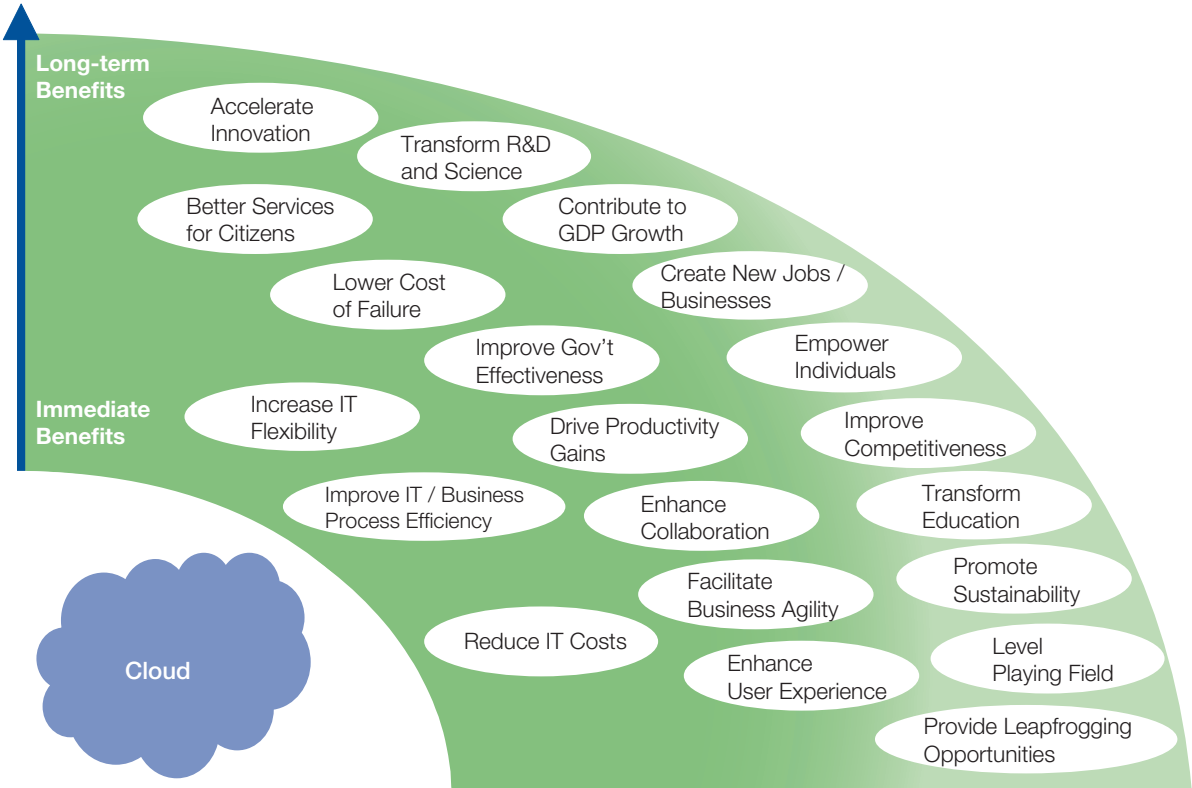
The concept of cloud computing has spread rapidly through the information technology industry. The ability of organizations to tap into computer applications and other software via the cloud and thus free themselves from building and managing their own technology infrastructure seems potentially irresistible. And in fact, some companies providing cloud services have been growing at double-digit rates despite the recent economic downturn.

Already numerous organizations can point to significant benefits from cloud computing, according to the 2009 research programme conducted by Accenture and the World Economic Forum (see "About the Research", Page 19). Part of that research included a global survey of professionals from companies supplying and using cloud services, government institutions, universities, and other organizations. As expected, survey participants said a major benefit of cloud computing is reducing IT costs—a large and often increasing expense in every company but especially information-intensive organizations such as financial services and media. Other benefits often cited were greater IT flexibility and more efficient business processes.

However, the experts we convened as part of our research believe such benefits are just scratching the surface of cloud's potential (Figure 2). Our study found that cloud computing has the potential to benefit organizations, whole industries, and even entire economies by:

- Dramatically accelerating the way companies create new products and services, in part through enabling product development professionals around the world to collaborate more effectively and access more powerful and economical computer resources
- Increasing the ability of organizations to mine their data for important trend information, such as customers' changing needs and competitors moves in the marketplace
- Leveling the playing field between large and small companies by giving companies of all sizes access to information technology that previously was affordable for only the largest of companies
- Helping emerging economies leapfrog to higher levels of technological development by providing more immediate and affordable access to next-generation applications, tools, and infrastructure

Figure 2. Examples of Benefits of Cloud



Workshop Highlights – Brussels, Belgium, 17 November, 2009

- Participants found the most important barriers to cloud adoption in Europe were privacy concerns, jurisdiction complexity, data protection and trustworthiness of data
- Building trust between and within the public and private sectors is essential for healthy development of cloud computing
- Some suggestions made by the workshop participants:
 - Improve transparency and provide clarification, e.g. government to prepare guidelines for existing legislation and data exchange; industry to provide clarity on how meta data is structured
 - Work on harmonization and clarity of privacy and data processing regulations
 - Increase investment in R&D on security- and privacy-enhancing technologies
 - Educate citizens on the implications, benefits and risks of cloud computing

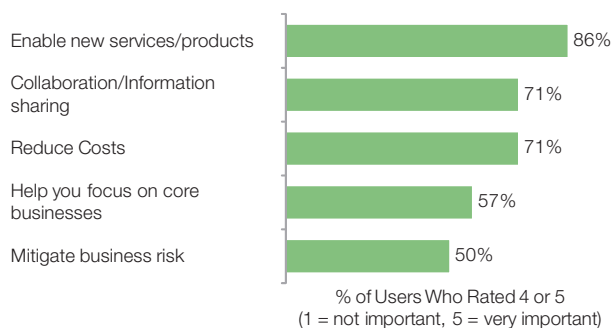
In fact, our research found that organizations using or planning to use cloud computing technologies do not view cost reduction as the most important potential benefit. While they are, indeed, lowering costs by accessing less-expensive computer resources over the Internet, corporate and government executives say the biggest advantage of cloud computing is better support for creating new products and services, and innovation in general (Figure 3).

As to the magnitude of expected impact of cloud computing, our research suggests that many believe

that cloud technologies could have a more substantial impact than mobile technologies in a number of areas, including allowing emerging economies to leapfrog in economic development, creating new businesses and jobs, and improving educational systems (Figure 4).

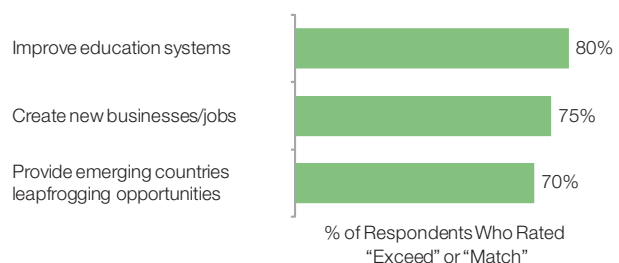
The question then becomes this: Why is cloud computing expected to have such a dramatic impact? And in what sectors of the economy is it expected to have the greatest impact?

Figure 3. Which benefit is the most important for current and potential cloud users?



Source: Cloud Computing Survey 2009, World Economic Forum and Accenture

Figure 4. Where will the impact of cloud technologies match or exceed that of mobile technologies?



Source: Cloud Computing Survey 2009, World Economic Forum and Accenture

Beyond cost reduction to structural change

Clearly, cloud computing is already having a profound impact on the IT and telecommunications industries. As an example, this research participants said they expect technology start-ups to continue to proliferate as cloud computing enables them to avoid the substantial costs of selling and distributing software around the world. In fact, the venture capitalists we interviewed as part of this study were reluctant to fund any IT start-up that did not plan to operate from the cloud.

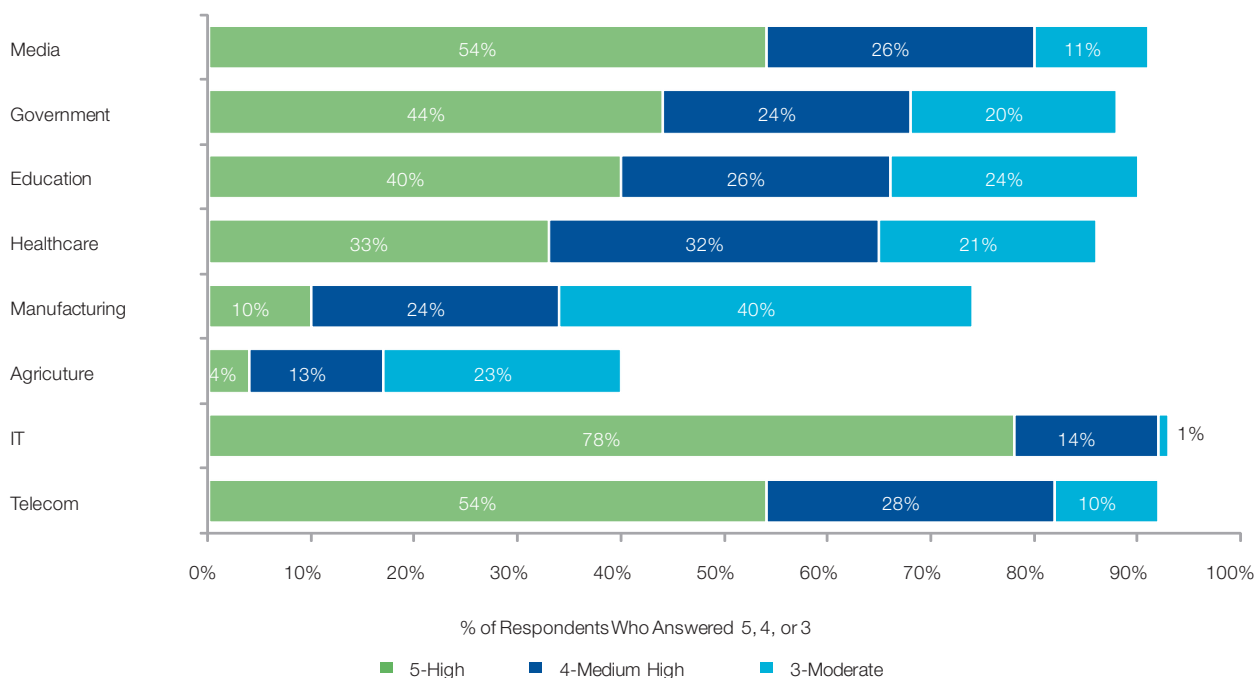
However, this research found that cloud computing is expected to have a substantial impact on a broad swath of industries outside of IT and telecom. The survey respondents believe that beyond the IT and telecom industries, cloud computing will have the greatest impact on media, government, education and health care (Figure 5).

The pharmaceutical industry offers some good examples of the power of using computing in the cloud. Recently, scientists at a drug company used Amazon's cloud services to dramatically shrink the time to analyse data and determine how to treat diseases. They cut the time to analyse a large data set from 140 days (on a desktop computer) to six days (in the cloud).¹ Another example comes from the manufacturing sector, where cloud computing is viewed as a superior tool to link factory information systems to those of suppliers, distributors and customers, resulting in fewer supply chain disruptions (Figure 6). And media companies imagine cloud computing opening up vast new distribution channels – new outlets for movies, newspapers, magazines, music and other forms of information and entertainment that can be digitized and delivered through the cloud.

"We no longer fund companies based on PowerPoint proposals. We fund them based on live, working solutions hosted in the cloud."

Venture Capitalist, 2009

Figure 5. Which industries are most likely to be impacted by cloud computing?



Source: Cloud Computing Survey 2009, World Economic Forum and Accenture

“Cloud computing enables higher level of innovation and discoveries by dismantling data silos and providing greater capabilities in data mining and data analytics.”

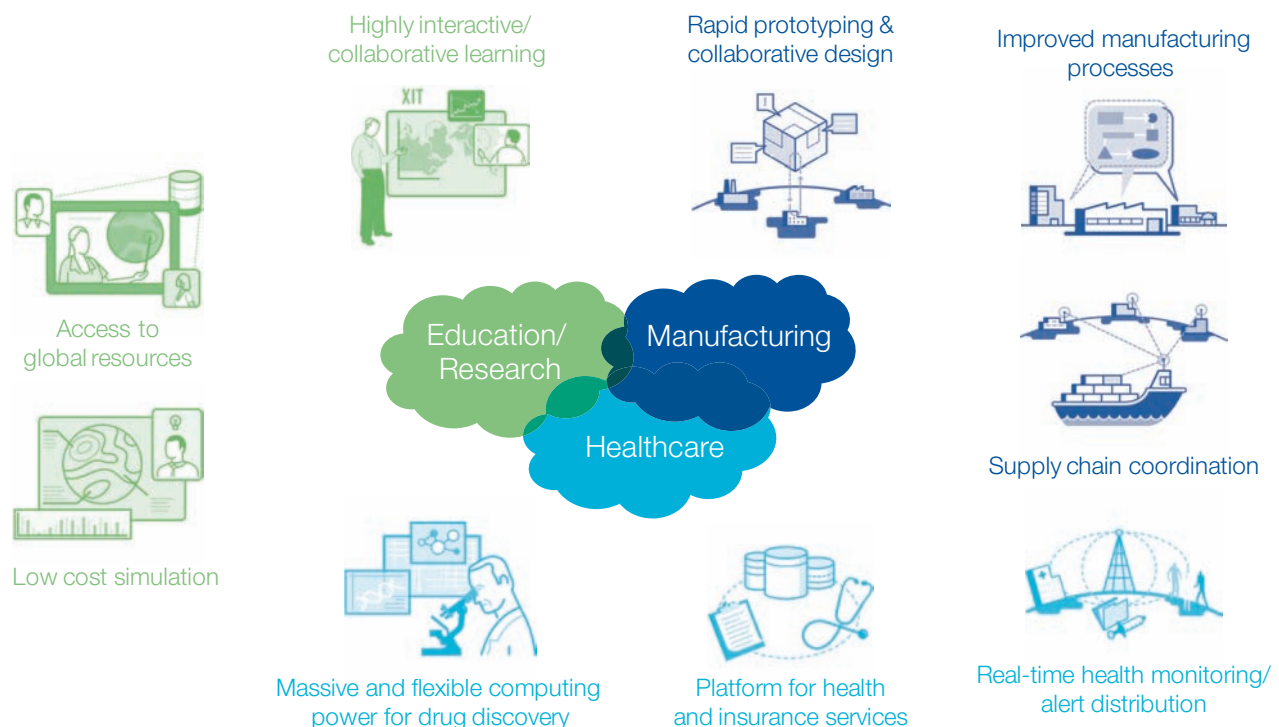
Participant, Cloud Computing Session, World Economic Forum Annual Meeting 2010, Davos

Our experts also told us that another set of major benefits for companies and government institutions is the ability to aggregate previously disparate databases, pore through massive amounts of information, and identify patterns. That kind of computation-for-hire is already transforming the way emergency room doctors work. A company called the Schumacher Group that manages emergency rooms in more than 20 states in the US provides information on emergency room performance through the cloud.² The ability to

aggregate and analyze data from multiple sources leads a number of experts to believe that cloud computing will soon generate breakthroughs in fields as diverse as weather forecasting, agriculture, and threat prediction.

Beyond its impact on various discrete industries and sectors, cloud computing is also expected to have a potentially significant impact on the pace of economic development in emerging economies. Institutions in Western economies take for granted data centre offerings that have long existed, including their ability to own their computer rooms, install complex systems, and access other services that make a company proficient at IT. But as cloud services develop, emerging economies can gain access to world-class IT infrastructure for the first time – without having to build it all on their soil. Assuming they can install sufficient communications infrastructure (admittedly, a big assumption in some parts of the world), developing countries could leapfrog a technological generation and rapidly become more efficient, much the same way they skipped the landline phase of telephony and moved directly to mobile communications. Indeed, some new cloud-based services, such as providing advice to rural doctors, are set up to require only mobile connectivity.

Figure 6. Potential Use of Cloud Computing in Different Industries



Source: Cloud Computing Survey 2009, World Economic Forum and Accenture

“Cloud computing could create between 300,000 and 1.5 million new jobs in five years in Europe alone.”

Professor Federico Etro,
University of Milan, 2009

Many of the experts in our study were quick to point out broader macroeconomic benefits. Some European economists see cloud computing promoting the growth of thousands of new small and medium-sized companies through making IT support much more accessible. One European economist and professor,

Federico Etro, estimates that new and existing companies using cloud services could create between 300,000 and 1.5 million new jobs in Europe in the next five years. If so, that could reduce Europe’s unemployment rate from 0.3% to 0.6% and boost GDP growth by 0.1 - 0.3%.³

Governments everywhere are also anxious to leverage the cloud to make public information accessible to citizens at a low cost. Examples include providing information about land ownership and allowing companies to generate customized applications using that data. In the UK, for example, cloud-based applications are used to inform governments about the need to repair potholes.⁴

This kind of analysis has led high-ranking government officials to highlight the need for their countries or regions to embrace cloud computing. A Singapore government official, for example, described cloud computing as a “major source of economic development.”⁵

The US government’s chief information officer, Vivek Kundra, said cloud computing “allows us to create a government that is more transparent – so that government is not practiced behind closed doors, but in the public square.”⁶

But despite such enthusiasm in high places across industry and government, many organizations are hesitant to embrace cloud computing. Our survey and discussions with executives around the world shed light on why.

“Thanks to cloud computing, public services will have the chance to be provided anywhere, anytime and anyhow and to anybody.”

Viviane Reding,
EU Commissioner for Information Society and Media, 2009

Examples of Government Embracing/Investing in Cloud

European Commission

- Cloud computing facilitates public procurement among different member states’ administrations and enables small & medium enterprises to gain access to public services

Japan

- A nation-wide "Kasumigaseki Cloud" is being developed to enable various ministries to collaborate
- At the local level, the "Jichitai Cloud" is being built to provide interoperability among local governments

Singapore

- Cloud Computing is viewed as a major source of economic development

Source: Cross-government call on cloud computing, *The World Economic Forum*, December 2009

Workshop Highlights – Dalian, People's Republic of China, 10-12 September, 2009

- Meeting attendees believed cloud computing will greatly impact innovation, bringing about new business models and new software applications. It will help bridge the digital divide, especially in emerging economies
- Participants expressed concerns about data security (e.g. theft, misuse or accidental leakage of data), interoperability, governance issues over taxation, data ownership, and privacy
- Participants suggested the IT industry collaborate to develop common standards or guidelines for data sharing and usage, and better demonstrate the cost/value of cloud and how it will evolve



Roadblocks: What's holding cloud computing back?

According to this research, the barriers to adopting cloud computing vary both by region of the world (North America, Europe and Asia Pacific) and by "stakeholder" group (users, government, and IT vendors) (Figure 7).

"The fundamental cloud security challenges include the lack of a global identity and inability to remove compromised machines."

Participant, Cloud Computing Session, World Economic Forum Annual Meeting, Davos, 2010

In North America, the biggest barriers to adoption today are data security, privacy issues, and compliance. In Europe, privacy and security are cited as significant issues as well. But unlike their North American counterparts, they fear vendor lock-in even more. For their part, Asia-Pacific organizations are held back most frequently by compliance issues, followed by privacy and governance matters.

This research found that the key concerns of IT vendors, government, and current and potential purchasers of cloud services also differed, sometimes greatly. For customers of cloud computing, the biggest concerns were security and data privacy (Figure 8, p.10). Putting private

records in "public" clouds increases the risk that unauthorized parties gain access to sensitive data.

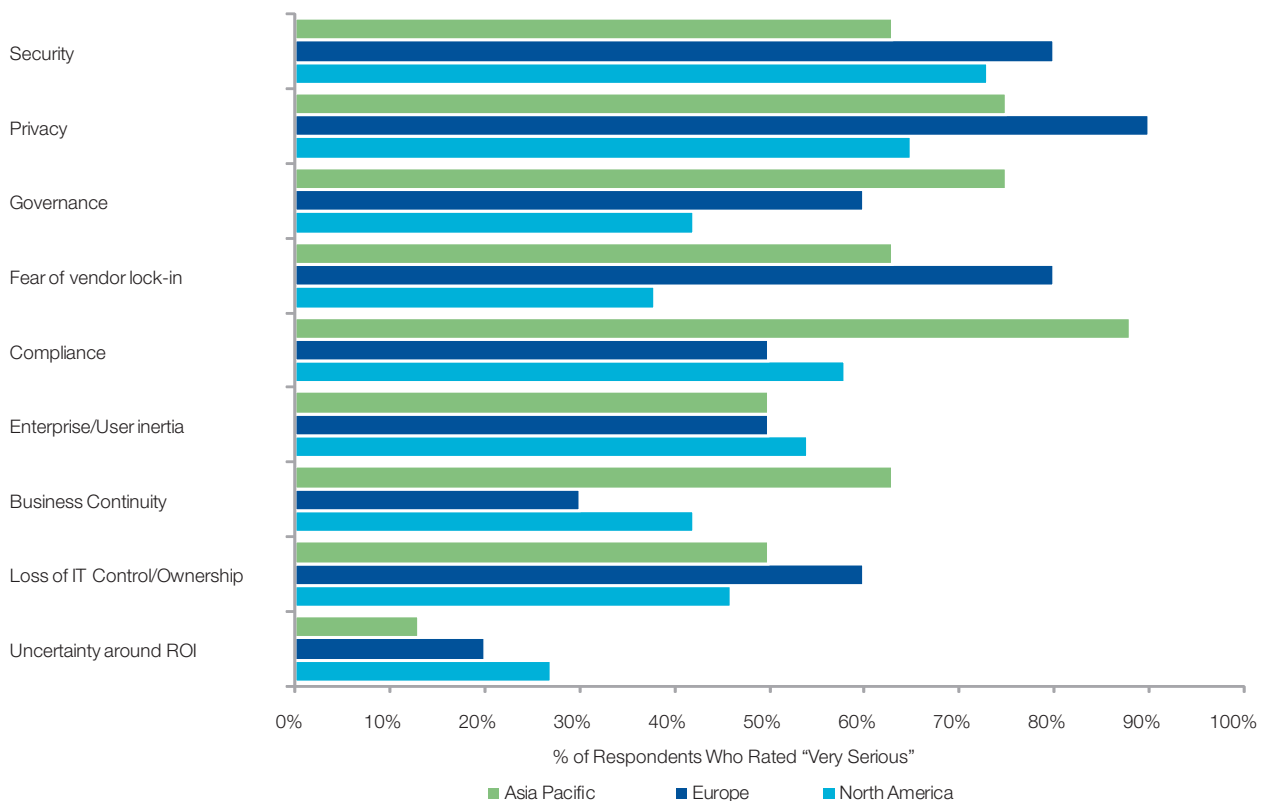
The financial losses to retailers, banks and others from hacking have been well-publicized – although most of these are examples of intrusion in "non-cloud" computers and by putting such data in the cloud, the risks can increase measurably. A participant from the session in Davos warned that the lack of a global identity system and an inability to remove compromised machines make it challenging to solve Internet and cloud security issues.

Additionally, some of our experts told us that another major impediment is the lack of good mechanisms for certifying the "lineage" of data – ensuring that the data received by the user is in fact the same data that was put in the cloud originally. Unless clear policies are created, adopted, and enforced at each site in which data is stored, the risks can be substantial. The world has gradually become aware of the risks of using the Internet; these concerns are quickly amplified when coupling the Internet with cloud technologies.

"The word 'cloud computing' is too nebulous for the customers to understand cloud's true benefits and potential."

Participant, Cloud Session, Tokyo, Japan, 2009

Figure 7. Impediments to broader cloud computing adoption by region



Source: Cloud Computing Survey 2009, World Economic Forum and Accenture

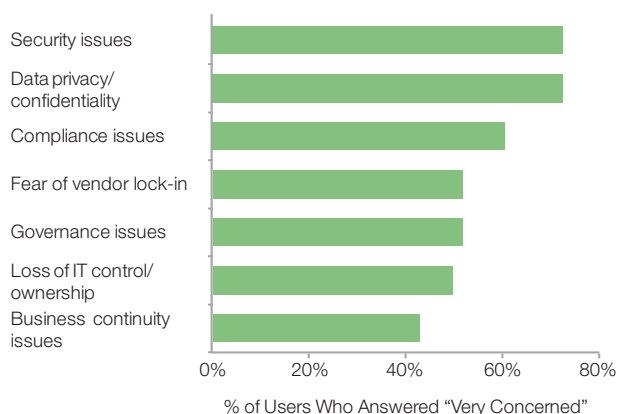
Workshop Highlights – New Delhi, India, 8-12 November, 2009

- The most significant benefits of cloud seen in India are scalability and lower upfront investment
- Emerging markets have their own unique enablers and barriers to cloud computing
 - Lack of connectivity is a major issue while privacy is not a real concern
 - Mobile access will be a key enabler to address the network access issue
- Some suggestions made by the meeting participants:
 - For the industry: better understand governments' needs and educate them about the benefits of cloud (e.g. using cloud to connect with their voters, solving problems in education and health services); develop cloud products/services tailored to emerging markets
 - For governments: provide better network infrastructure and make clear rules on privacy, data ownership, and liability

In addition to security and privacy concerns, cloud computing users were also very concerned about vendor lock-in – proprietary architectures or unique application/data models that might make it difficult to switch vendors and move into or out of a cloud vendor.

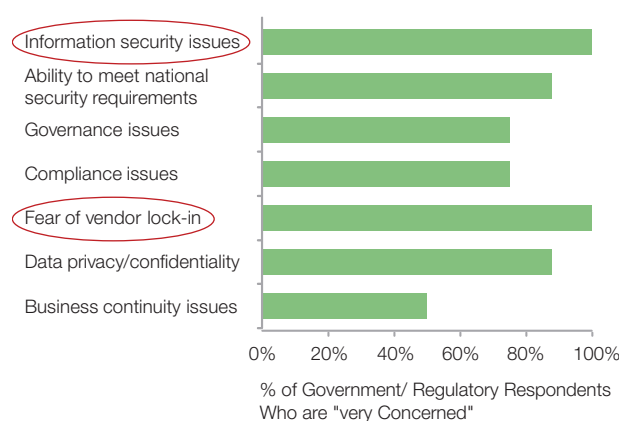
The fact that governments and regulators both (and even more intensely) cite this as a major concern is worth noting (Figure 9). Such concerns may not dissipate until standards are in place. We have seen several large cloud providers already making commitments to letting customers “exit their cloud” much easier.

Figure 8. What are users' major concerns when buying cloud services?



Source: Cloud Computing Survey 2009, World Economic Forum and Accenture

Figure 9. What are governments actually worried about?



Source: Cloud Computing Survey 2009, World Economic Forum and Accenture

“Rules are Byzantine and not fit for the Internet, so it is hardly surprising there are problems in governance.”

A major cloud provider, 2009

Although they stand to profit most immediately from cloud computing, providers of cloud services have their own set of worries (Figure 10). Based on our survey data as well our meetings, their concerns can be grouped into three categories: data governance,

outdated laws, and users’ lack of understanding of cloud computing. Under data governance, survey participants most commonly cited the burden of privacy requirements as a “very serious” issue.

Additionally, limitations to letting users’ data cross country or continental borders were another big cloud provider concern. The more regulations against cross-border data transfers, the more data centres a cloud vendor must build (and, consequently, the less economical the service becomes for the provider). Issues about data ownership were also found to be significant. As one participant from the session in Davos said: “There is very blurry definition of ownership. Does [ownership mean]

right to access? Right to download? Or right to own?”

Perhaps not surprisingly, the nascent cloud industry views government regulations as complex and inconsistent. There is little agreement on what kinds of regulations are necessary in general or especially across borders. For example,

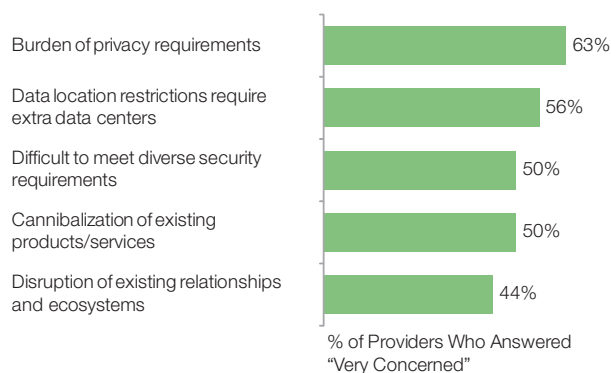
one EU regulator didn’t believe that regulations on data privacy need to be updated for cloud computing – a very different viewpoint from that of the industry.

The last group of significant concerns for cloud providers revolves around customer confusion. Our research participants time and again decried the lack of customer understanding of exactly what “cloud” means. In a focus group discussion, 46% of cloud providers said they believed a lack of understanding of cloud computing by customers is a “very serious” concern (Figure 11).

“In Europe, the regulatory frameworks such as data privacy are designed to be technology neutral. It is not necessary to regulate specifically for cloud computing.”

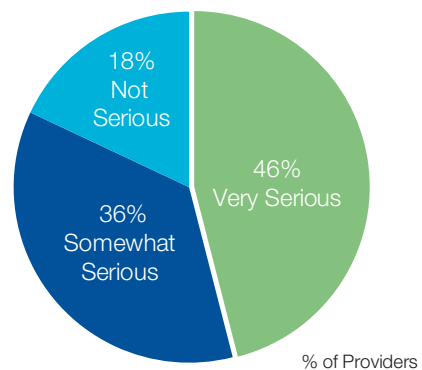
EU regulator, 2009

Figure 10. What are providers’ major concerns when deploying cloud services?



Source: Cloud Computing Survey 2009, World Economic Forum and Accenture

Figure 11. How serious is the issue of “lack of understanding of cloud computing”?



Source: Cloud Computing Survey 2009, World Economic Forum and Accenture



Potential Action Items and Areas for Further Study

Our Phase One research has shown interesting, and in some cases surprising, findings about the expected benefits and barriers to the development and adoption of cloud computing. What are the implications for industry members and policy-makers which have an interest in achieving the optimal level of benefits for all stakeholders?

As part of our surveys and workshops, we asked users, providers, academics, and public policy-makers for their preliminary recommendations on smoothing and accelerating the path of development and adoption of cloud computing.

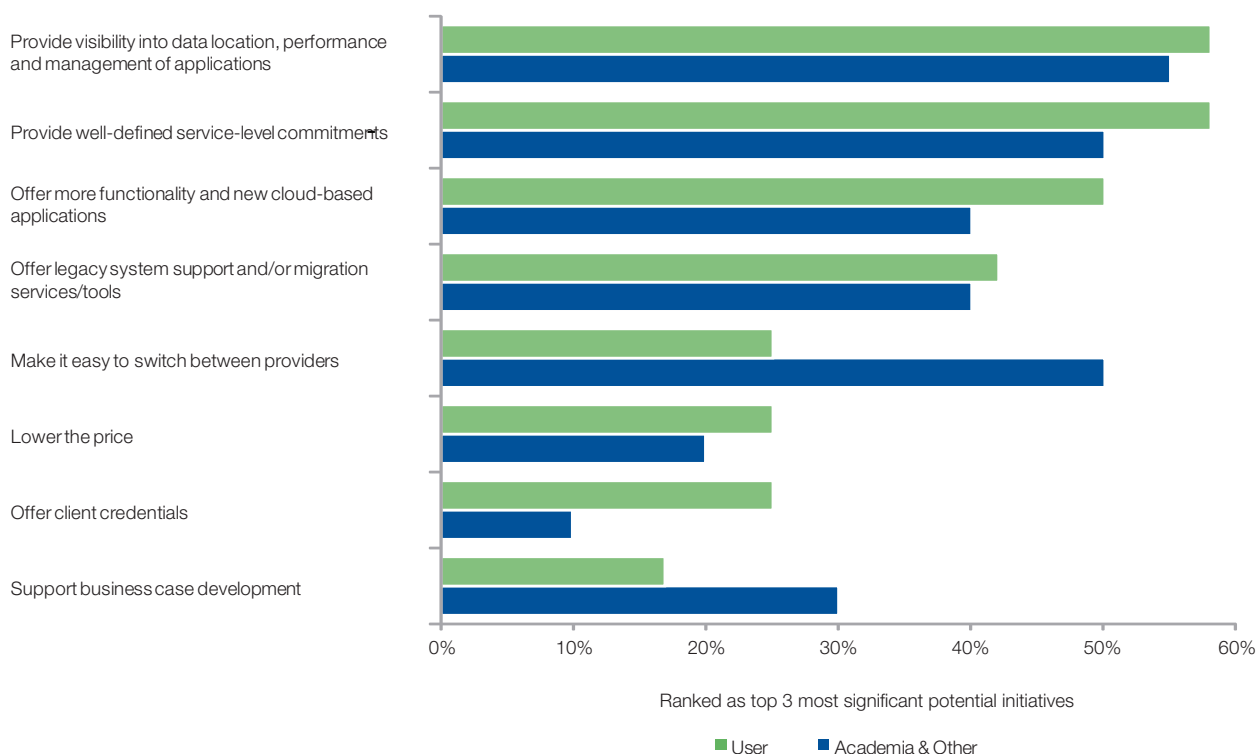
When asked, cloud users and academic experts frequently pointed to the following suggested actions (Figure 12):

- Provide visibility on where data is located, providers' performance, and ways to facilitate the management of software applications
- Make well-defined commitments on service levels (i.e. effective service-level agreements, or SLAs)

- Make it easy to switch providers, perhaps by establishing standards in metrics for determining the importing and exporting of data service quality, interfaces to cloud services, and minimum service requirements (in that order of importance). In fact, about half of the customers of cloud services that we surveyed wanted standards for import and export of cloud data within a year

The needs and desires of customers have obvious implications for the providers of cloud services. Based on what we learned from customers in our research, one area of possible action for the industry is to do much more to educate customers – businesses and governments – about the advantages of getting information services from the cloud rather than from their own computers. To reduce customer confusion, the IT industry might start to work together to clearly articulate the potential bottom-line benefits to corporations and government institutions. Creating a commonly accepted taxonomy of cloud services might also go a long way towards explaining an often fuzzy concept. Collecting and publishing case studies on companies that have increased innovation, grown revenue, reduced product development cycle times and achieved other quantifiable benefits beyond cost reduction may help accelerate adoption.

Figure 12. Potential initiatives for cloud providers to accelerate the adoption of cloud



Source: Cloud Computing Survey 2009, World Economic Forum and Accenture

Additionally, cloud providers could potentially reduce fears about security, privacy and vendor lock-in by offering concrete approaches to these issues, and providing more case examples of companies using cloud services successfully. Moreover, cloud vendors could discuss the advances they have achieved in these areas.

To reduce anxieties over vendor lock-in, research participants suggested that the IT industry should make it easy for users to move data in and out of the systems of different cloud providers. Supplying standard data import/export tools and interfaces would ease the fear of being held captive to a provider. In addition, cloud providers might allow more transparency about their operations “behind the cloud,” including where they store and process their data (i.e. in what countries) and what service levels they will guarantee.

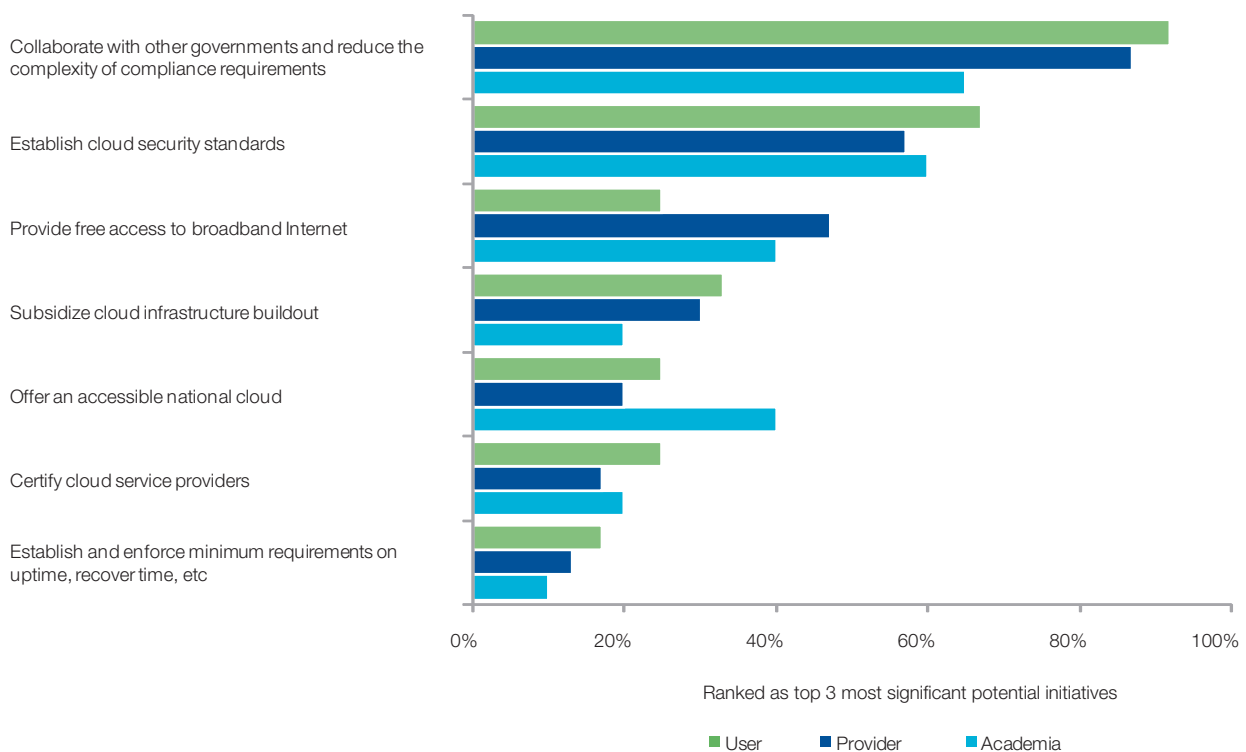
Given that cloud computing puts the computerized records and software applications of many organizations in fewer locations, customers and government rightly worry about what can happen if those facilities are attacked or fail. To ensure continuity of service when one provider’s cloud services go down, the IT industry might consider creating industry-wide “mutual aid” agreements that enable other providers to quickly come to the rescue, as suggested by a participant at the session in Davos.

Government, too, has an important role to play if it wants cloud computing to spur economic growth (Figure 13). Policy-makers, regulators and other government officials might consider providing better public access to national data – economic, agricultural, census, meteorological, and others. Opening up their treasure trove of data will spur the development of cloud services that can harvest that data, helping their countries address societal issues such as health and environmental sustainability.

Creating effective regulations for cloud computing will be critical. At the session in Davos, it was suggested that policy-makers can draw numerous lessons and safeguards from regulatory efforts in other more mature “infrastructure” industries such as banking and transportation.

Finally, our research participants recommended the IT industry and government increase collaboration to make all this happen. Business and government should continue investing in new methods for improving security, making cloud services interoperable, certifying cloud providers, and managing the systemic risk that comes with putting the world’s data and technology in fewer locations. They should work jointly to improve network

Figure 13. Potential initiatives for governments to accelerate the adoption of cloud



Source: Cloud Computing Survey 2009, World Economic Forum and Accenture

infrastructure, especially by extending the reach of broadband Internet networks. If they don't, potential customers will rightfully complain about the length of time it takes to get information from the cloud. Similar efforts need to be applied to Internet security, including the ability to quickly isolate sources of threats.

Different approaches are needed to accelerate cloud usage in emerging markets. Major investments need to be made in telecommunications infrastructure to provide access to major cloud data centers. As suggested in one of our focus groups, initiatives such as creating an International Government Cloud incubator that would allow governments around the world to share data and applications might be valuable.

The above survey and findings from our focus groups and Forum member meetings will serve as a strong basis for our next phase of work: identifying more specific action items for both industry members and public policy-makers to help mitigate the uncertainties and accelerate the benefits of cloud computing.

Examples of Potential Actions

IT Industry

- Educate customers about the benefits of cloud by making available case studies and reduce customer confusion by creating a common cloud services taxonomy
- Make it easy for users to move data into, out of, and between cloud service providers (e.g. create standard data import/export tools/interfaces)
- Increase focus on SLAs and provide transparency on where data is stored and processed
- Create industry-wide "mutual aid" agreements to ensure continuity of service in the event of a provider's failure

Government

- Adopt lessons and safeguards from regulatory efforts in other more mature "infrastructure" industries such as banking and transportation
- Provide better public access to national data (e.g. economic, census, agricultural, meteorological, etc.)

Industry-Government Collaboration

- Invest in new technologies that would enable improved security, increased interoperability between cloud services, and better management of systemic risks
- Improve network infrastructure and extend the reach and accessibility of broadband Internet
- Sponsor initiatives that would allow governments around the world to share data and applications

Conclusions

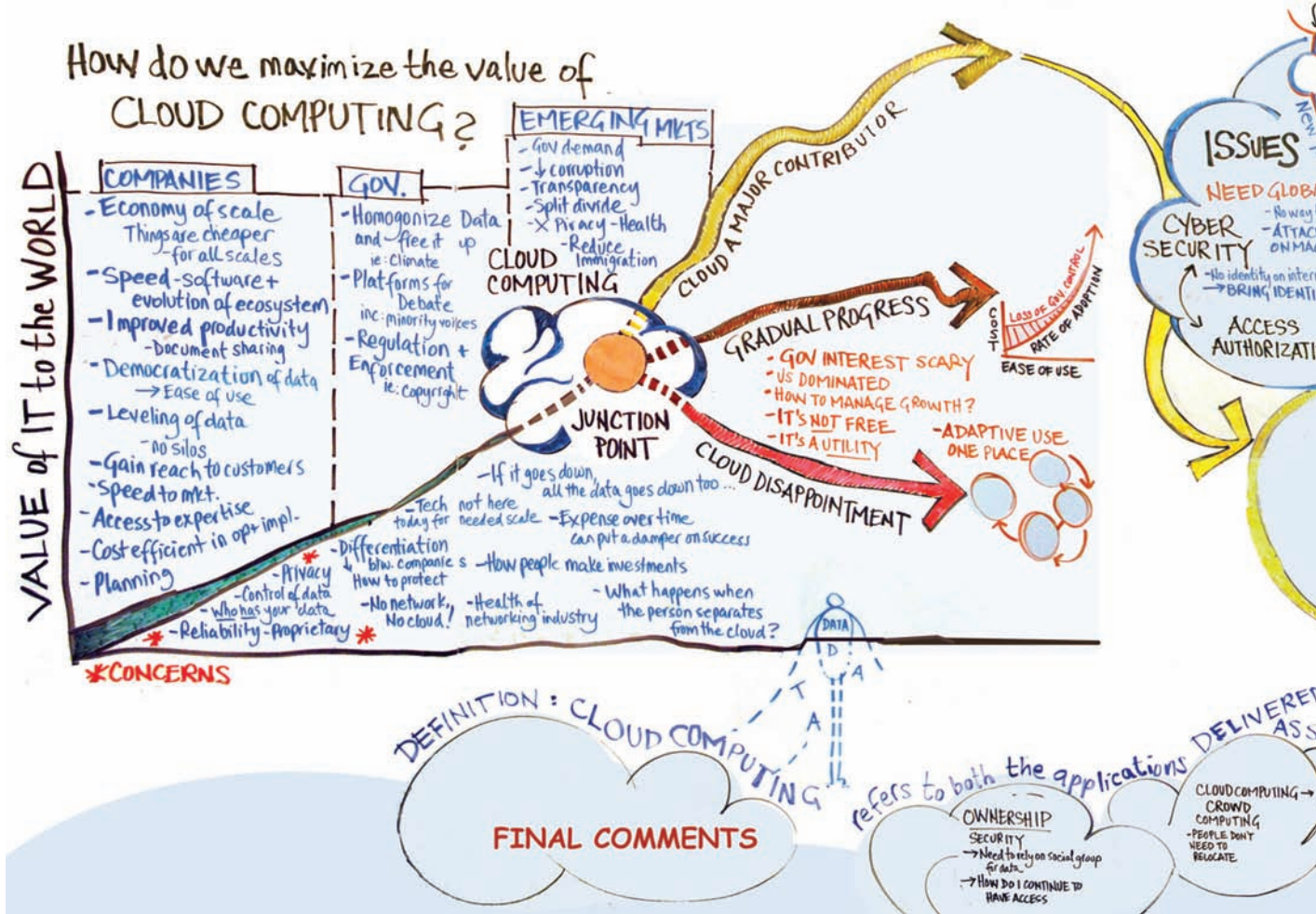
Cloud computing has tremendous potential to benefit businesses, industries, and entire economies, but substantial challenges stand in the way. Our study has taken the first step: defining potential actions for industry and governments to consider in order to accelerate cloud adoption and generate benefits for all stakeholders – individuals, businesses, governments, and society as a whole.

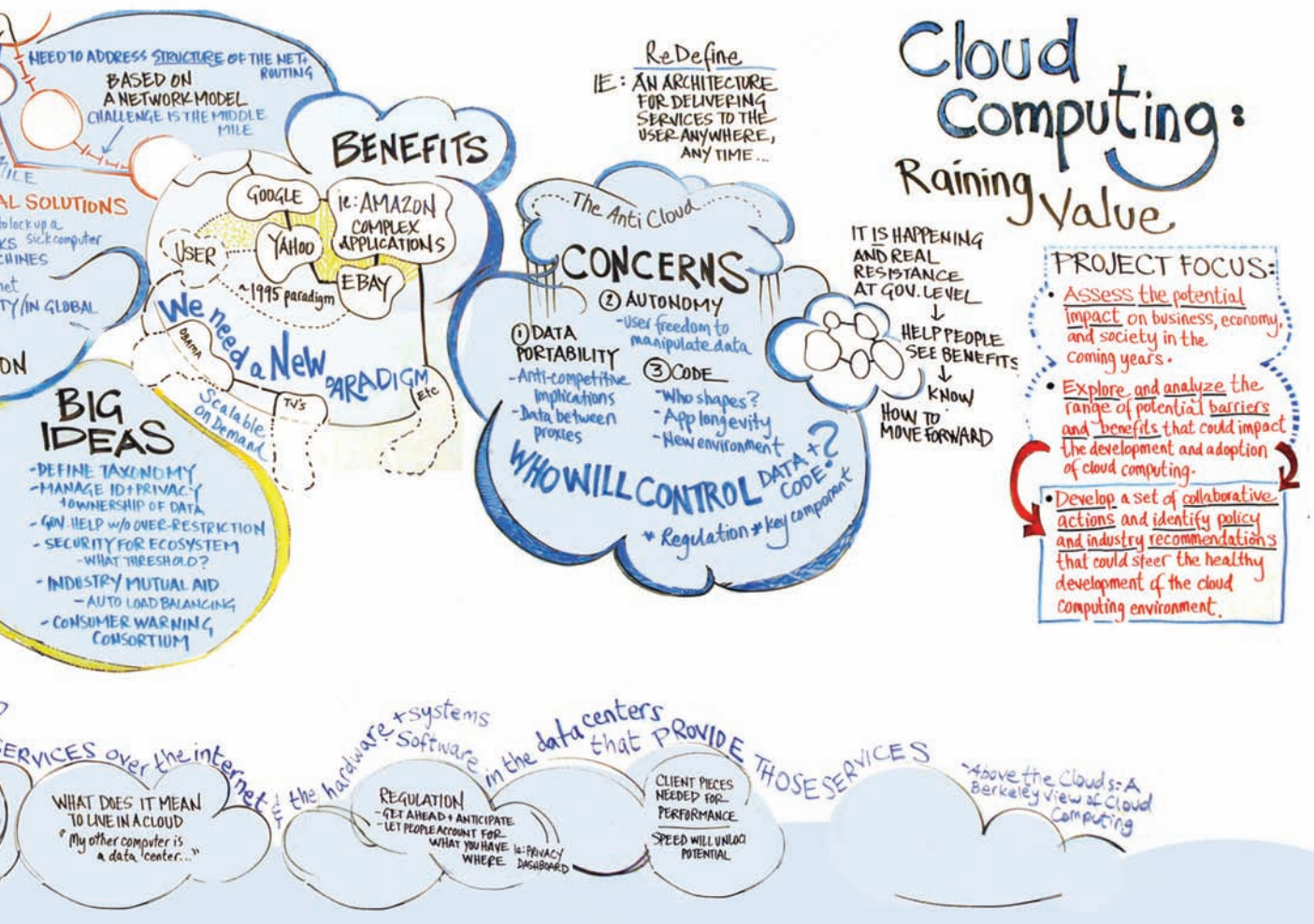
10X

"Cloud Computing may multiply the benefits of the Internet by a factor of 10... but we may also face 10 times the challenges"

Participant, Cloud Workshop, California, USA, 2009







About the Research

Project background

This report is part of the World Economic Forum's research study "Exploring the Future of Cloud Computing." It was mandated in 2009 by the IT Governors at the World Economic Forum Annual Meeting in Davos, Switzerland. Two objectives for the research were defined:

- Develop a set of collaborative actions that could steer the healthy development of both public and private cloud computing environments
- Develop a set of industry and public policy recommendations that could help mitigate the uncertainties and accelerate the benefits of cloud computing

The project was divided into two phases. The first phase focused on convening a wide range of relevant stakeholders (IT industry, corporate buyers of IT, government regulators, investors, academics, journalists and others) through workshops, surveys and interviews to generate their views on the potential impacts of cloud computing – on business, society, and the global economy. A key research tool was an extensive survey that Accenture designed and developed on cloud computing. Collecting a wide range of highly informed views enabled us to identify the key drivers, enablers, and barriers in cloud computing.

Based on the findings of this report, Phase Two (expected to be completed in 2011) will focus on developing actionable strategic options and policy recommendations.

Definition of Cloud Computing

There are probably as many definitions of cloud computing as there are opinions about its future. To date, there is no definition that is agreed upon in most quarters. The definition we used in this project came from the University of California at Berkeley: "Cloud computing refers to both the applications delivered as services over the Internet and the hardware and systems software in the data centers that provide those services."³

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References

- ¹ Cloud Computing Brings Cost of Protein Research Down to Earth, American Chemical Society, May 2009
- ² Case Study: Cast Iron Integration and Google Gadgets help Schumacher Group expose critical Emergency Room information, Google, 2009.
- ³ Prof. Federico Etro, "The Economic Impact of Cloud Computing on Business Creation, Employment and Output in Europe," Review of Business and Economics, June 2009, Vol. 54, 2, pp. 179-208.
- ⁴ Capital Ambition Project Initiation Document, www.londoncouncils.gov.uk
- ⁵ Cross-government call on cloud computing, The World Economic Forum, December 2009
- ⁶ "Cloud Computing – What is its potential value for your company?", February 2009, <http://www.cio.com/documents/whitepapers/WP3CloudComPotentialValue.pdf>. Kundra said this in an interview when he was chief technology officer for the District of Columbia.
- ⁷ From "Above the Clouds: A Berkeley View of Cloud Computing," February 10, 2009, authored by 11 members of UC Berkeley's division of Electrical Engineering and Computer Sciences.



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