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Competing in the Clouds: A Strategic Challenge for ITSP Ltd.

Christoph Riedl

Information Systems, Technische Universität München (TUM), Germany, riedlc@in.tum.de

Stefanie Leimeister

Fortiss—Research Institute at Technische Universität München (TUM), Germany

Markus Böhm

Information Systems, Technische Universität München (TUM), Germany

Phillip Yetton

Australian School of Business, University of New South Wales, Sydney, Australia

Helmut Krcmar

Information Systems, Technische Universität München (TUM), Germany

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Communications of the Association for Information Systems



Competing in the Clouds: A Strategic Challenge for ITSP Ltd.

Christoph Riedl

*Information Systems, Technische Universität München (TUM), Germany
riedlc@in.tum.de*

Stefanie Leimeister

Fortiss—Research Institute at Technische Universität München (TUM), Germany

Markus Böhm

Information Systems, Technische Universität München (TUM), Germany

Phillip Yetton

Australian School of Business, University of New South Wales, Sydney, Australia

Helmut Krcmar

Information Systems, Technische Universität München (TUM), Germany

Abstract:

By 2010, cloud computing had become established as a new model of IT provisioning for service providers. New market players and businesses emerged, threatening the business models of established market players. This teaching case explores the challenges arising through the impact of the new cloud computing technology on an established, multinational IT service provider called ITSP. Should the incumbent vendors adopt cloud computing offerings? And, if so, what form should those offerings take? The teaching case focuses on the strategic dimensions of technological developments, their threats and opportunities. It requires strategic decision making and forecasting under high uncertainty. The critical question is whether cloud computing is a disruptive technology or simply an alternative channel to supply computing resources over the Internet. The case challenges students to assess this new technology and plan ITSP's responses.

Keywords: teaching case, cloud computing, strategic decision making, disruptive innovation, education

Editor's Note: A teaching note for this case can be obtained from riedlc@in.tum.de. Only active MIS faculty who are currently listed in the AIS Faculty Directory are eligible to receive the teaching note.

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A TEACHING CASE ON DISRUPTIVE TECHNOLOGY

CONTEXT

John Lane is troubled. He has just returned from ITSP's annual fiscal review meeting. Not only has it been a long day discussing the previous year's results, but a disturbing news item has just been brought to his attention.

John Lane is the head of Portfolio and Innovation Management at ITSP Ltd, an IT service provider for information technology solutions and services. ITSP, which is headquartered in Munich, Germany, services the complete IT value chain—from consulting to systems integration, and IT infrastructure management, to industry-specific IT solutions and outsourcing. John is responsible for the entire range of IT products and services offered by ITSP to its business clients.

He has arranged to meet Markus Johnson, head of ITSP Sales, to discuss the news item.

LOCATION: A BEER GARDEN IN MUNICH AFTER WORK

As Markus sits down, John slides a press clipping across the table.

Markus: How was the meeting? Too bad I couldn't attend it.

John: Oh, the numbers were OK. No reason to complain, although we could have done better last year. But there is something else I'd like to discuss.

CONTEXT

John points to the press clipping.

Markus skims the text and frowns.

Markus: So, Amazon has done it! I read about their initial ideas and beta versions on the Amazon blog a couple of years ago (see Exhibit 1) but I didn't think they would continue developing it to a professional level. It looks like we have a new competitor—and they bring a new service to the table!

CONTEXT

Amazon has recently announced the official release of their Amazon Web Service EC2 for Windows (see Exhibit 2). Elastic Compute Cloud (EC2) is a service of Amazon.com's subsidiary, Amazon Web Services. It provides flexible and resizable computing power and capacity over the Internet.

Markus: I have to admit that their idea is very clever and quite intriguing. It addresses precisely the flexibility needs of our customers. Sometimes they need a lot of processing power and sometimes they need only a little.

CONTEXT

Pause.

Markus: Our home shopping television client comes to my mind. We run their data center and IT infrastructure. They don't always need the full capacity of their data center, but right before Christmas, for example, when their customers go into a buying frenzy—ordering presents on TV—they have a massive peak load on their system. I've had several conversations with their CIO who complains that he needs that capacity only twice a year. He keeps saying: "*What a waste, with all these resources sitting idle!*"

Now, Amazon promises that they can match his needs. He can access additional capacity when he needs it and only then—and he certainly won't care where it comes from. It's "somewhere out in the Internet universe." That's why they call it cloud computing.

John: This is a real threat to our portfolio of offerings. So far, we have had to focus only on competitors like ourselves—IBM, EDS, T-Systems, and maybe a new Asian player, such as Tata Consulting Services. But this is a new type of competitor. I thought Amazon was just selling books over the Internet. Now, they are using their large-scale computing resources to enter our market—our IT service provider market—and they have a new business model.

CONTEXT

Pause.

Markus: You're right. It's a serious problem. Recently, some of my clients have asked me what cloud services we offer and why they have to buy the whole application or IT infrastructure instead of specific bits when they want them. And they don't want to buy at a fixed price any longer. They want to be charged on a pay-per-use basis. Oh—and now that we're talking about it—I think Google has also started a cloud service!

John: So what should we do? I've seen the price list for the EC2 services. They're far cheaper than we could offer for the same service (see Exhibit 3 for EC2 price lists). In any case, I don't want us to be a copycat and offer the same service. We would always be second. But we must recognize that our IT services portfolio no longer matches our customers' needs. We should think about innovative services—not just being Amazon's little brother. I could even imagine working with Amazon's offerings, integrating them in a service we offer. That might be better than having them as a competitor.

CONTEXT

The two executives agree to take the topic to ITSP's strategy forum in a few months' time. Now they need to put the discussion on a more solid basis and sell it to the CEO. Markus volunteers to conduct some research on cloud computing, to obtain an in-depth understanding.

What he finds is a myriad of terms, concepts, and approaches. He comes to the conclusion that the term cloud computing is often misused to sell existing service products with a new and fancy name. Markus particularly likes the quote from Larry Ellison, Oracle's President: "We've redefined cloud computing to include everything that we already do. I can't think of anything that isn't cloud computing, with all of these announcements. The computer industry is the only industry that is more fashion-driven than women's fashion. Maybe I'm an idiot, but I have no idea what anyone is talking about. What is it? It's complete gibberish. It's insane. When is this idiocy going to stop?" [Fowler and Worthen, 2009]. This perception is supported by the market analysts at Gartner, who place cloud computing on the rising branch of their Hype Cycle (see Exhibit 4).

Eventually Markus finds a definition that captures the core characteristics of cloud computing. To provide a common understanding for their discussions, he e-mails a summary to John.

E-mail from Markus to John **Topic Cloud computing—Definition and Issues**

John,
Here is a definition for cloud computing and an outline of its core characteristics:

Cloud computing is an IT deployment model, based on virtualization, where resources, in terms of infrastructure, applications, and data are deployed via the Internet as a distributed service by one or several service providers. These services are scalable on demand and can be priced on a pay-per-use basis [Böhm et al., 2009].

Its core characteristics are:

- ▶ *demand elasticity of virtualized computing resources*
- ▶ *consumption-based pricing model*
- ▶ *elimination of up-front investments for customers*
- ▶ *low maintenance costs for customers*
- ▶ *provision of services over the Internet*

Looking at these characteristics, the cloud computing model appears to have great appeal for both our private and business customers. However, it is not the solution to all their needs. Major obstacles and problems [Armbrust et al., 2009] include:

- ▶ *availability of service*
- ▶ *data lock-in*
- ▶ *data confidentiality and audit transparency*
- ▶ *data transfer bottlenecks*
- ▶ *unpredictable performance*
- ▶ *scalable storage*
- ▶ *bugs in large-scale distributed systems*
- ▶ *instant scaling*
- ▶ *reputation effects*
- ▶ *software licenses.*

I have cleared my diary for this Tuesday afternoon and will see you, as agreed on the phone, in Conference Room 1 at 2.30 p.m.

(Signed) Markus

LOCATION: CONFERENCE ROOM 1

Markus: I now have a good overview of what cloud computing is and what problems it faces. But I am still a bit uncertain about how it really differs from existing concepts like Software as a Service (SaaS). I think that it would be a good starting point to look at it from an historical perspective.

When pulling together this brief history of computing (see Exhibit 5), I concluded that the development follows a certain pattern. You can easily see the different streams from local calculating machines, to central mainframes, via personal computers and handheld devices, to the new quasi-centralization trend evident in cloud computing. What the timesharing models of computing were for the mainframe era, cloud computing appears to be today.

However, cloud computing is more elaborate and, importantly, provides the basis for different sorts of services. Youseff et al. [2008] describe this as a layered model of services (see Exhibit 6). The backbone of cloud computing is the hardware and the software kernels needed to virtualize those resources. On top of this, cloud computing infrastructure services are layered—for example, Amazon’s Elastic Compute Cloud (EC2) or its Simple Storage Service (S3). The next level of abstraction is platform services. These services provide a development and runtime environment for applications that automatically assigns computing resources on demand. For example, Google is establishing a platform called App Engine.

On top of the platform layer, various applications are offered as a service. Thus, the SaaS concept is inherent in cloud computing, accompanied by new service offerings, including Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). Even Hardware as a Service (HaaS) could be included at the base of the layered model.

John: Perhaps, we could look at cloud computing from a different point of view.

Let’s consider it from an IT provisioning perspective. There, it has the potential to revolutionize the mode of computing resource and application deployment, breaking up traditional value chains, and making room for new business models.

Many providers like Amazon, Google, IBM, Microsoft, Salesforce, and Sun could position themselves as infrastructure and platform providers in the cloud computing market. Other providers would build their own applications or consulting services on those infrastructure and platform services.

This would probably lead to a whole ecosystem of service providers, offering specialized services on different levels of the layered model. You could surmise that other new players would emerge, including aggregators, who bundle existing services into new products, or integrators, who align an individual company's on-premises computing with cloud services. It seems highly likely that we would also see the emergence of consulting companies specializing in cloud computing.

Markus: When I was researching this topic, I found such a diversity of estimates that it was difficult for me to judge the actual or potential size of the cloud computing market. A major factor, of course, is the fuzzy definition of cloud computing services. Estimates of the market size, measured in worldwide revenues for 2008, vary between \$16 billion (IDC) [Gens, 2008] and \$46 billion (Gartner) [Petty and Stevens, 2009]. The market analysts at IDC forecast a compound annual growth in cloud computing revenue of 26 percent compared to 4 percent for on-premises IT, up to 2013. This would result in revenue of \$44 billion from their estimated base, equal to 10 percent of worldwide IT spending [Gens, 2009]. Using the Gartner forecasts, cloud computing revenues could reach \$150 billion in 2013 [Petty and Stevens, 2009]. Although these numbers vary significantly, one fact is clear: Cloud computing is a fast growing market, and it will reach a significant proportion of the IT services market.

CONTEXT

Exhibit 8 provides more information on IDC's market forecasts for cloud computing.

John: Let's consider each of the characteristics that you identified in your e-mail before trying to link them....

CONTEXT

Two hours later.

John: We have made a lot of progress. Now, we need to open it up for discussion. I will get the boss on-side and then ask Peter (Group Executive for Strategy) to circulate a short briefing paper for the strategy forum outlining ITSP's business model. Would you please forward your e-mail to the team, and I will circulate an agenda for the planning session and ask the participants to do some homework. This is going to be a major challenge.

Thank you for getting us started.

CONTEXT

BRIEFING NOTE ON ITSP'S BUSINESS MODEL

ITSP's Business Model

ITSP began as an internal IT service provider for its holding company, Delta Group, a global corporation in electronics, engineering, energy and healthcare. Over the years, ITSP has developed into a major business area that now also serves external clients, although Delta Group is still its largest customer. One of five core business areas of Delta Group, ITSP's 2008/09 worldwide sales revenue was €5.3 billion. Employing some 41,000 people, its strong home base is Germany and Europe, with 85 percent of revenue generated in Europe, but it has a presence in forty-four countries.

The business model of ITSP is simple and traditional: "Provide all IT-related services that our customers want." ITSP thus offers "one-stop shopping for the complete IT service chain" (see Figure 1).

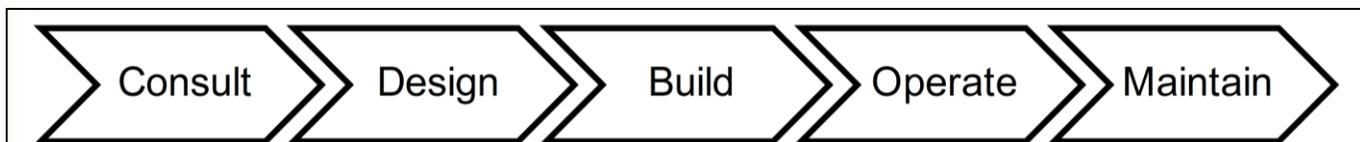


Figure 1. ITSP's Portfolio of Business Activities

The business model is mainly project-based, selling customer-specific solutions. These solutions generally cover more than one link in the IT value chain, but rarely incorporate the whole process from consulting and design, through to long-term maintenance. Projects are usually priced by time and effort. Sometimes a fixed price contract will be agreed. Very recently, due to customers' increased expectations and output focus, some risk-sharing models have been added to the portfolio.

ITSP is able to offer fully integrated, industry-specific IT solutions to its customers. This, by definition, implies a high degree of customization and low standardization, which drives costs up. In a typical ITSP project, considerable amounts of time and budget are expended on the requirement analysis and offering process alone. In these projects, ITSP offers comprehensive and wide-ranging IT solutions and software expertise to deliver sector-specific IT solutions and software developments. One of ITSP's main strengths in this business is their commitment to quality, reliability, and security. These terms appear frequently in ITSP's external communications. The size and scale of ITSP's operations engender high confidence in the business and customers typically sign long-term contracts with support periods for ITSP products lasting up to ten years.

ITSP's portfolio of business activities includes a broad range of services, divided into cross-industry and industry-specific services.

Cross-Industry Services

Services in this category are predominantly generic and require limited customization to a given customer domain. These services include:

- ▶ *Application management*
- ▶ *Customer relationship management (CRM)*
- ▶ *Enterprise resource planning (ERP)*
- ▶ *Human resource management*
- ▶ *Identity management*
- ▶ *Data centers*
- ▶ *Desktop services*
- ▶ *Network services (such as Voice-over IP)*
- ▶ *Other IT outsourcing services*

Industry-Specific Services

ITSP's main strengths are their industry-specific services, covering fourteen major industries:

- | | |
|--|----------------------------------|
| ▶ <i>Airports and Aviation</i> | ▶ <i>Healthcare</i> |
| ▶ <i>Automotive</i> | ▶ <i>Insurance</i> |
| ▶ <i>Banking</i> | ▶ <i>Media and Entertainment</i> |
| ▶ <i>Chemicals and Pharmaceuticals</i> | ▶ <i>Public Sector</i> |
| ▶ <i>Discrete Manufacturing</i> | ▶ <i>Pulp and Paper</i> |
| ▶ <i>Energy</i> | ▶ <i>Telecommunications</i> |
| ▶ <i>Food and Beverages</i> | ▶ <i>Transport and Logistics</i> |

In these industries, also serviced by the ITSP parent group, ITSP has acquired a substantial set of domain and industry-specific knowledge, which is highly valued by their customers. Thus, they are able to deliver fully integrated, industry-specific IT solutions.

CONTEXT

Several weeks before the ITSP bi-annual strategy forum, John Lane and Markus Johnson meet again in Conference Room 1 to agree on the strategy challenges to be addressed.

John: From what you explained at our last meeting, Markus, cloud computing looks to me like a disruptive technology. We have to act now if we don't want to be left behind. But it's not that easy. Even if we knew which cloud computing services to offer, we would still have to develop the capabilities to deliver them. Just as a start, we need to develop the capability to sell a server for a month, or a day, or even an hour—not for

three years. Right now, we can't do that. Our resource utilization and billing mechanisms just couldn't handle it. And there are other issues involved as well.... I don't even want to think about the legal aspects.

Markus: I see several needs and possible courses of action. I think we agree that we need to respond to Amazon and Google's offerings. But, rather than rushing in and acting like headless chickens, we need to understand what our customers want and how they could benefit from cloud computing offerings. I believe that we have a unique selling proposition that Amazon can't match. We should analyze our company's strengths to see what we can offer or where we should develop new services. We shouldn't just copy existing offerings that others are better at delivering. Those were your words, John, when we met last time.

John: I think that we also need to understand how the cloud computing paradigm could really hurt us if we don't respond to the market needs. We should ask: "What will the IT world look like in five years?" before we ask: "How could we be part of it?"

Markus: What I really want to discover are some powerful scenarios for those cloud computing offerings. I'm looking for a real-life, killer application. Let's think about different customers, including private consumers. We should always think first about the customer.

CONTEXT

One and a half hours later.

John: OK. We have five specific questions for the participants in the forum to address and a general strategy question, which requires that we integrate the answers to those earlier questions. Let's see what they come up with.

LOCATION: STRATEGY FORUM

John: Thank you for coming. I know that each of you is aware, from the briefing note, e-mails and your own research, that ITSP faces perhaps the greatest challenge of its history. Certainly, I've seen no greater challenge in the four years since I became Head of Portfolio and Innovation Management.

In your folder, you will find details of the process that we will follow today. First, you have been assigned to a team to address one of five questions. Your team has one hour to formulate a response to the question allocated to you.

Each of you is then assigned to a new group to answer a general strategy question directed to ITSP's strategic future. The teams in the second round will have members who have worked on each of the five questions. So the newly formed groups addressing the general strategy question can draw on the insights gained from the analysis of the five questions from the first round. You have two hours for the second task before presenting your ideas in a plenary session after lunch. Each team will select a team leader to present. We have provided you with background information on the cloud computing market to help you prepare your answers (see Exhibits 7 and 8).

The questions for the first round are:

1. What is the existing industry value chain?
2. What is the source of ITSP's competitive advantage?
3. What is the source of Amazon's and Google's potential competitive advantage?
4. What is the timeframe for the emergent cloud computing-based market?
5. What is ITSP's short-term defensive strategy?

The **general strategy question** for the second round is: What is ITSP's long-term strategy to create value by restructuring the industry value chain and capturing "its share" of the value created?

Markus will answer any questions that you have before we begin work.



EXHIBIT 1: AUGUST 2006, AMAZON WEB SERVICES BLOG ENTRY FROM JEFF BARR, WEB SERVICES EVANGELIST [BARR, 2006]

Note: Amazon had offered Web Services since 2002.

Amazon EC2 Beta

Innovation never takes a break, and neither do I. From the steaming hot beaches of Cabo San Lucas I would like to tell you about the Amazon Elastic Compute Cloud, or Amazon EC2, now open for limited beta testing, with more beta slots to open soon.

Amazon EC2 gives you access to a virtual computing environment. Your applications run on a “virtual CPU,” the equivalent of a 1.7 GHz Xeon processor, 1.75 GB of RAM, 160 GB of local disk and 250 Mb/second of network bandwidth. You pay just 10 cents per clock hour (billed to your Amazon Web Services account), and you can get as many virtual CPUs as you need. You can learn more on the EC2 Detail Page. We built Amazon EC2 using a virtual machine monitor by the name of Xen. Amazon EC2 works in terms of AMIs, or Amazon Machine Images. Each AMI is a pre-configured boot disk—just a packaged-up operating system stored as an Amazon S3 object. There are Web service calls to create images, and to assign them to virtual CPUs to run your application....

In a previous post, Sometimes You Need Just a Little..., I alluded to the new world of scalable, on-demand Web services. In that post I talked about the fact that sometimes a little bit of storage is all you need. Sometimes you need a lot of processing power, and sometimes you need just a little. Sometimes you need a lot, but you only need it for a limited amount of time. Perhaps you are doing some number crunching, some in-depth text processing, some scientific research, or your end-of-month accounting. Or perhaps you want to experiment with some radical new parallel processing algorithm for a week or two. In any of these situations, acquiring sufficient hardware to accommodate the high-water mark of your usage would definitely not be economical....

Before the advent of Amazon EC2, you had to buy or rent sufficient servers to cover your present needs, and you also had to be able to anticipate, forecast, and pay (in advance) for enough hardware, storage, and network bandwidth to accommodate organic growth as well as bursts of traffic brought upon by popular sites such as Digg or Slashdot. If you are too generous with your planning, hardware sits idle. Too frugal, and your chance at fame and fortune may very well pass, as thousands of would-be users are greeted with a “site too busy” message. With Amazon EC2, you don’t need to acquire hardware in advance of your needs. Instead, you simply turn up the dial, spawning more virtual CPUs, as your processing needs grow. During the beta you can run up to 20 virtual servers per account, or more by special arrangement....

[Also] consider what you can do to help other developers use Amazon EC2. What about building specialized AMIs and then selling them to other developers? Preload an AMI with a popular open source stack (being careful to respect any and all redistribution prohibitions in the software licenses). What about an advanced monitoring system that spools up additional machine images in times of heavy load, then safely winds them down after the load goes away? There are a lot of ways that you can add value on top of what’s already there....

EXHIBIT 2: AMAZON'S PRESS RELEASE ON THE ELASTIC COMPUTE CLOUD (EC2)

Amazon Web Services Launches Amazon EC2 for Windows [Excerpt]

SEATTLE—(BUSINESS WIRE) Amazon Web Services LLC (AWS), a subsidiary of Amazon.com Inc. (NASDAQ: AMZN), today launched a public beta of Amazon Elastic Compute Cloud (Amazon EC2) running Microsoft Windows Server and Microsoft SQL Server, providing even greater flexibility for deploying solutions in the AWS cloud. Additionally, AWS today announced that Amazon EC2 is now Generally Available, having successfully exited its beta period and now offers a Service Level Agreement (SLA). Launched in beta in August of 2006, Amazon EC2 is the popular AWS service that provides resizable compute capacity in the cloud for businesses and developers. To sign up for Amazon EC2 and other AWS services, go to <http://aws.amazon.com>.

“When we launched Amazon EC2 over two years ago, the idea of accessing computing power over the web was still a novel idea. Today a diverse array of businesses drawn by the benefits of cloud computing—cost savings without giving up speed, reliability, flexibility, and performance—are running EC2 for all types of applications,” said Peter De Santis, General Manager of Amazon EC2. “We’ve listened closely to our customers for the past two years and worked backward from their requirements, adding important new features such as those we are announcing today—Windows support and a Service Level Agreement.”...

With over two years of operation and many highly-requested features added, Amazon EC2 is today exiting its beta into general availability and offering customers a Service Level Agreement (SLA). The Amazon EC2 SLA guarantees 99.95% availability of the service within a Region over a trailing 365 day period, or customers are eligible to receive service credits back. The new Amazon EC2 SLA is designed to give customers additional confidence that even the most demanding applications will run dependably in the AWS cloud.

New Features for Amazon EC2 in 2009: To help customers better plan their future hardware and software investments, AWS today announced plans to release several new features in 2009 that will make managing cloud-based applications even easier. Thousands of customers employ the massive compute power of Amazon EC2 to build highly scalable and reliable solutions. AWS will deliver additional features that automate customer usage of Amazon EC2 for more cost-efficient consumption of compute power and provide greater visibility into the operational health of an application running in the AWS cloud. These features include:

- ▶ *Load Balancing*—Enables customers to balance incoming requests and distribute traffic across multiple Amazon EC2 compute instances.
- ▶ *Auto-Scaling*—Automatically grows and shrinks usage of Amazon EC2 compute capacity based on application requirements.
- ▶ *Monitoring*—Enables customers to monitor operational metrics of Amazon EC2, providing even better visibility into usage of the AWS cloud.
- ▶ *Management Console*—Provides a simple, point-and-click web interface that lets customers manage and access their AWS cloud resources....



EXHIBIT 3: AMAZON'S EUROPEAN PRICES [2010]

Table 1: Computing Units

Standard On-Demand Instances	Linux/UNIX Usage	Windows Usage
Small (Default)	\$0.095 per hour	\$0.12 per hour
Large	\$0.38 per hour	\$0.48 per hour
Extra Large	\$0.76 per hour	\$0.96 per hour
High-CPU Medium	\$0.19 per hour	\$0.29 per hour
High-CPU Extra Large	\$0.76 per hour	\$1.16 per hour

Table 2: Storage

Amazon Elastic Block Storage Volumes
\$0.11 per GB-month of provisioned storage
\$0.11 per 1 million I/O requests

Table 3: Data Transfer

Volume per Month	First 10 TB	Next 40 TB	Next 100 TB	Over 150 TB
Data Transfer In	\$0.10 per GB	\$0.10 per GB	\$0.10 per GB	\$0.10 per GB
Data Transfer Out	\$0.15 per GB	\$0.11 per GB	\$0.09 per GB	\$0.08 per GB

Source: <http://aws.amazon.com/ec2/> (current Sept. 1, 2010)

Explanation: Standard instances are offered in three performance classes, Small, Large, and Extra Large. A small Instance, for example, has 1.7 GB of memory, 1 EC2 Compute Unit (1 virtual core with 1 EC2 Compute Unit), 160 GB of instance storage (32-bit platform). Extra Large Instances offer 15 GB of memory, 8 EC2 Compute Units (4 virtual cores with 2 EC2 Compute Units each) and 1690 GB of instance storage (64-bit platform).

Amazon also offers Instances with proportionally more CPU resources than memory (RAM). High-CPU Extra Large Instances, for example, offer 7 GB of memory, 20 EC2 Compute Units (8 virtual cores with 2.5 EC2 Compute Units each) and 1690 GB of instance storage (64-bit platform).

An EC2 Compute Unit provides the equivalent computing power of a 1.0–1.2 GHz 2007 Xeon processor. Discount options are offered for users who may reserve an instance to receive lower hourly usage rates.

Reservation prices range from \$227.50 per year (Small; \$0.04 per hour of usage) to \$1820 per year (High-CPU Extra Large; \$0.32 per hour of usage). Different prices may apply due to licenses for software (e.g., databases, application or streaming servers, etc.), pre-installed in the Amazon Machine Images. Auto-scaling and load balancing between instances is charged separately. With the termination of an instance, data in its storage vanishes. Amazon Elastic Block Storage (EBS) offers persistent storage that is replicated. The option to create point-in-time consistent snapshots of volumes is also available.

EXHIBIT 4: GARTNER'S HYPE CYCLE FOR EMERGING TECHNOLOGIES [2008]

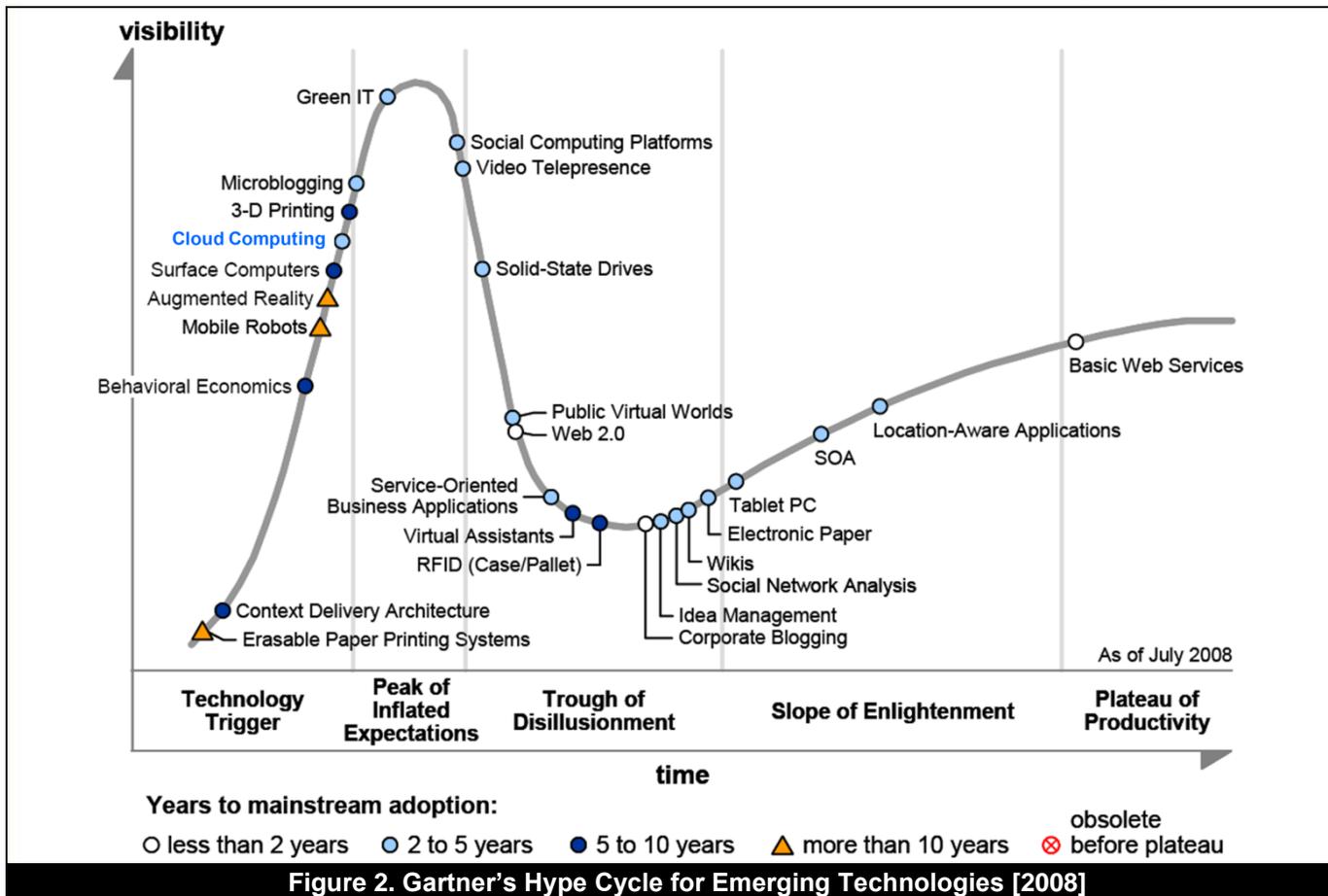


Figure 2. Gartner's Hype Cycle for Emerging Technologies [2008]

Source: Fenn et al. [2008]

Explanation: Gartner's Hype Cycle describes the relative maturity of technologies. The graphical depiction highlights overhyped areas against those that are in productive use. Gartner also estimates how long technologies and trends will take to reach maturity to provide a decision basis for organizations on when to adopt.

The Hype Cycle starts with the launch of an emerging technology or initial media interest, as a trigger. The technology then typically receives a lot of publicity, which generates over-enthusiasm and unrealistic expectations. There may be some examples that utilize the technology successfully but the majority of projects fail, leading to disillusionment, because expectations could not be met. Although the media lose interest in the topic, some companies could continue experimenting with the technology, gaining experience in its use and identifying benefits and practical application. If the technology is proven to be of use, it reaches the productivity phase.

The height of the plateau depends on the extent of application and use.

EXHIBIT 5: HISTORY OF COMPUTING

From a technological perspective, cloud computing is an advancement of computing, having its roots in the construction of the calculating machine in the early seventeenth century [von Freytag-Löringhoff and Seck, 2002].

Development continued with the invention of the analytical engine [1837], the logical engine [1885] and the tabulating machine [1890] [Babbage, 1864; Burack, 1949].

The history of modern computing began with the invention of the first computers (Z3 in 1941 and ENIAC in 1945) [Goldstine and Goldstine, 1946; Rojas, 1997]. Following that phase, the pace of progress increased. The 1960s and 1970s were the age of mainframe computing. Central computing resources were harnessed through terminals that provided the input and output devices to interact with the computer.

With the development of the first microprocessor (1969), hobbyists began to construct the first home computers, some years before mail-order kits such as the Altair 8800 were sold in 1975. Other computer manufacturers, such as Apple, Atari, and Commodore entered the market for computer home users, before IBM introduced its personal computer (PC) in 1981 [Freiberger and Swaine, 2000]. With that development, the pace increased rapidly, the diffusion of PCs spread significantly and an increasing miniaturization led to the development of laptop computers and mobile devices.

Another important technology that paved the way for cloud computing was the development of the ARPANet [1969], a communications network that evolved into today's Internet [Freiberger and Swaine, 2000]. By the 1990s, services such as e-mail and the World Wide Web, a hypertext-based information management system, gained popularity. Technologies such as Java, Ajax, WebServices, and many more supported the development of rich, interactive websites. Eventually, around 2000, whole applications could be deployed over the Internet, and were characterized as "Software-as-a-Service" [Bennet et al., 2000; Finch, 2006]. Analogous to the provision of software via the Web, computing resources could also be accessed via the Internet. For scientific purposes in particular, grid computing became popular in the early 1990s [Foster and Kesselman, 2003].

EXHIBIT 6: A LAYERED MODEL OF CLOUD COMPUTING

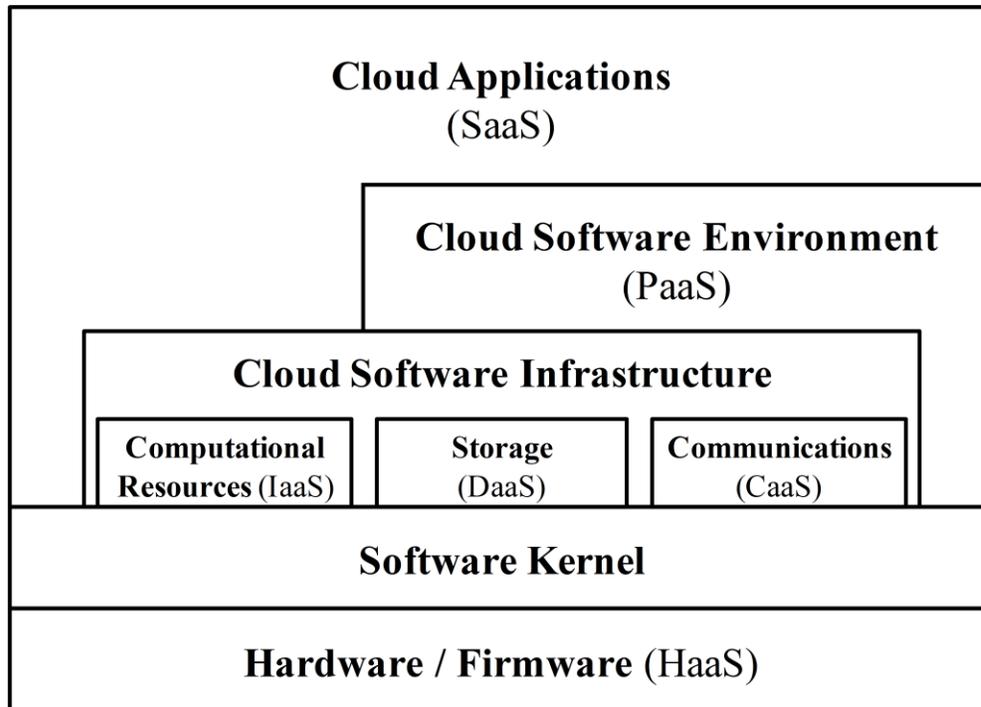


Figure 3. A Layered Model of Cloud Computing

Source: Youseff, Butrico, and Da Silva [2008]

Explanation: To develop a comprehensive understanding of cloud computing and its relevant components, Youseff et al. [2008] were among the first to suggest a unified ontology. According to their layered model, cloud computing systems fall into one of five layers: applications, software environment, software infrastructure, software kernel, and hardware. Each layer represents a level of abstraction, hiding all underlying components from the user and thus providing simplified access to the resources or functionality.

At the point of user interaction, the cloud application is the most visible layer for the end-customer. It is usually accessed through Web-portals and thus builds the front-end, with which the user interacts when using cloud services. A “Service” in the application layer may actually consist of a mesh of various other cloud services, but appears to the end-customer as a single service. This model of software provision, also referred to as *Software-as-a-Service (SaaS)*, appears an attractive option for many users. The cloud software environment layer (also called software platform layer) provides a programming-language environment for developers of cloud applications. It also offers a set of well-defined application programming interfaces (API) to utilize cloud services and interact with other cloud applications.

The cloud software infrastructure layer provides resources to other higher-level layers that are utilized by cloud applications and cloud software platforms. The services offered in this layer are commonly differentiated into computational resources, data storage, and communication. The backbone of each cloud computing service is formed by the physical hardware, which is managed through software kernels such as Hypervisor or Virtual Machine Monitors.

EXHIBIT 7: KEY PLAYERS IN THE CLOUD COMPUTING MARKET

The cloud computing market is cluttered with hundreds—even thousands—of small, entrepreneurial, innovative companies seeking to gain ground in this promising field. The market offerings range from infrastructure and platform services, to applications that run “in the cloud,” and extend even to related consulting services. The *CIO Magazine* has selected ten cloud computing companies to watch [Brodkin, 2009], based on their pioneer status, their potential to capture a significant market share or on their innovative offerings. A summary of the article is provided below, as a starting point for a market overview of key players in the cloud computing market.

Amazon: Amazon (founded 1994) is among the leading vendors in the industry and has made a big contribution in the evolution of Web-based computing. It offers access to virtual servers and data storage space on a pay-per-use basis. The company offers a cloud service through Amazon Web Services including Elastic Compute Cloud (EC2) and Simple Storage Service (S3). Amazon’s entry to the cloud market was related to their main business, online shopping. They were already deploying a large scale computing environment for their own purposes and offered it to their customers. They needed only to extend their business to deliver their computing resources in a cloud format. As a pioneer of cloud business, they serve a wide variety of customers including the *New York Times* and the *Washington Post*.

AT&T: As a strong Telecommunications company, AT&T (founded 1983) had the advantage of an existing infrastructure. Entering the cloud computing business, they needed only customers, an objective they achieved through their acquisition of USinternetworking, an application service provider with customers in more than thirty countries. Having combined infrastructure strength with the expertise of the newly purchased company, their Cloud Service Synaptic is now serving large customers.

Enomaly: Enomaly (founded in 2004) differs from other players in that it does not offer cloud services through the Web. Enomaly develops software that is used to manage resources used both inside the business and by the cloud providers. Their Elastic Computing Platform (ECP) is used to orchestrate the enterprise data centers and commercial cloud computing offerings from a single console. Today Enomaly has a variety of prominent customers throughout the world.

Google: Google (founded 1998) is without doubt the king of the Internet world, and their application engine provides Platform-as-a-Service through which developers build applications. They also provide Application-as-a-Service through Google apps, a set of online office productivity tools including e-mail, calendaring, word processing, and a simple website creation tool. Google serves many small and larger businesses, along with colleges such as Arizona State University and Northwestern University.

GoGrid: Established in 2008 as a part of ServePath, GoGrid offers cloud infrastructure (particularly cloud storage and computing). Unlike their main competitor, Amazon, which offers only Windows Server 2003, GoGrid offers Windows Server 2008 with 100 percent SLA. GoGrid hosts both Linux and Windows virtual machines and specializes in serving start-up companies, along with more established customers.

Microsoft: Microsoft (founded 1975) is the largest company in the software industry but, in the cloud computing field, it has a tentative presence only at this stage. Microsoft’s cloud computing service, Azure, was in beta status until the end of 2009 and mainly provides Platform-as-a-Service. Users can develop Web-hosted applications using Azure. It is generally expected that Microsoft will deliver its Windows OS over the Internet.

Net Suite: Net Suite (founded 1998) is one of the most successful and competitive online business software providers. Through aggressive pricing, they are challenging Salesforce.com and other ERP providers. Oracle’s CEO, Larry Ellison, was a co-founder of Net Suite, and the two businesses retain ties.

Rackspace: A well-trusted player in the sector, Rackspace (founded 1998) primarily targets Platform-as-a-Service and Infrastructure-as-a-Service markets, areas that have primary roles in developing Web-based applications. Their cloud, Mosso, offers three major services: Cloud Sites, a platform for building websites; Cloud Files, for data storage; and Cloud Servers, providing access to virtualized server instances.

RightScale: RightScale (founded 2006) delivers Software-as-a-Service through their RightScale Platform. It facilitates the process of using the cloud model for customers, helping them to deploy new virtual servers, managing load balancing in case of changing needs, automating storage backups, and offering monitoring and error reporting. In summary, it prevents complications that can occur during the management of the cloud and helps maintain one of the cloud core values: simplicity. RightScale has many customers, particularly social networking vendors seeking to facilitate management of their cloud-based servers.

Salesforce.com: Salesforce.com (founded 1999) is one of the leaders of the Software-as-a-Service market, which is now considered to be a component of cloud computing. Their latest initiative is to enter the Platform-as-a-Service market that could fundamentally transform businesses. The major product is a set of CRM tools including Salesforce automation, analytics, marketing, and social networking tools, and Force.com, a platform for developing Web applications which are deployed on the Salesforce infrastructure. Salesforce.com has more than 50,000 customers in various industries such as communications and media, energy, healthcare, financial services, and retail.

EXHIBIT 8: THE CLOUD COMPUTING MARKET IN FIGURES

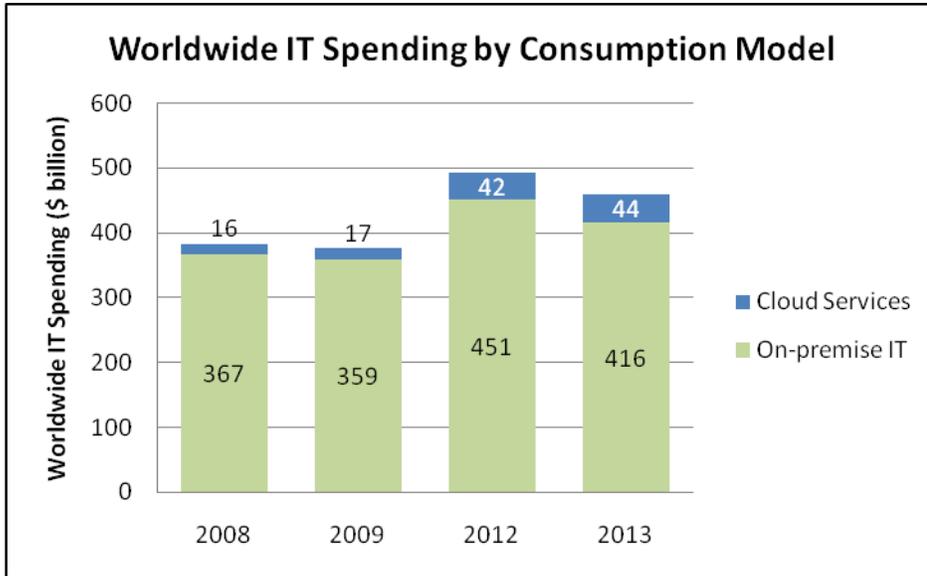


Figure 4. Worldwide IT Spending by Consumption Model

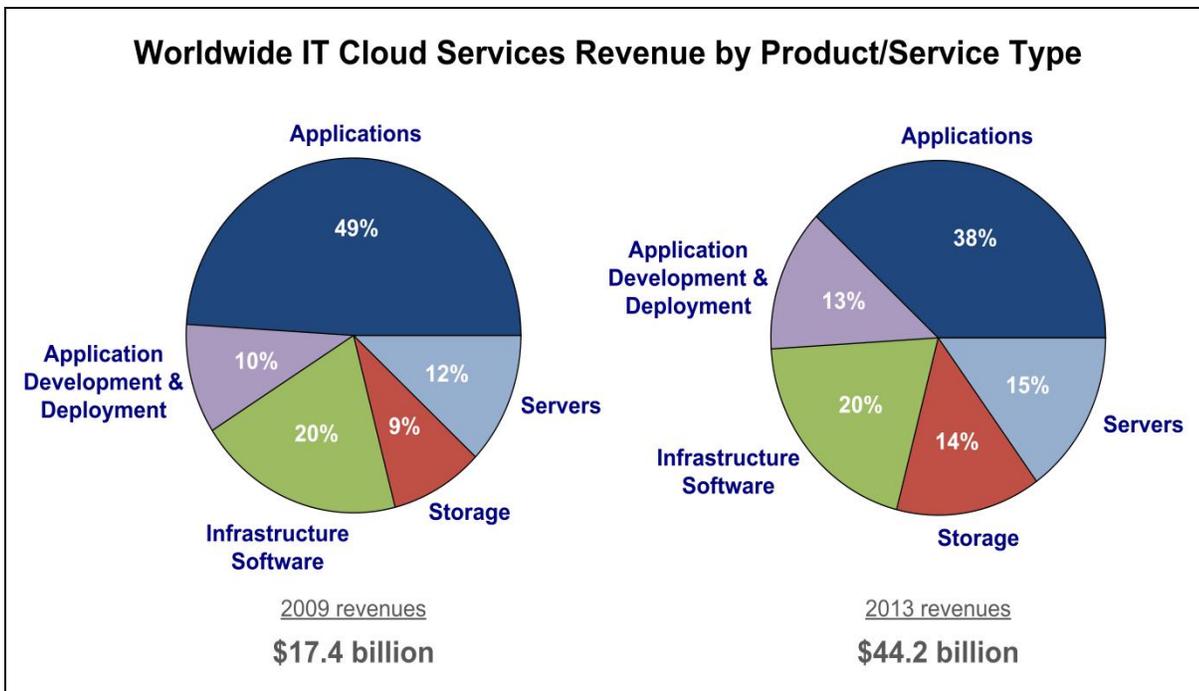


Figure 5. Worldwide IT Cloud Services Revenue by Product/Service Type

Source: IDC [Gens 2008; Gens 2009]



Explanation: The IDC forecasts are based on revenues for public cloud service offerings in the following five IT segments: Application Software, Application Development and Deployment, Infrastructure Software, Server, and Disk Storage capacity. Private cloud deployments are not included in these figures.

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Editor's Note: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the article on the Web, can gain direct access to these linked references. Readers are warned, however, that:

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ABOUT THE AUTHORS

Christoph Riedl is a research associate and Ph.D. student at the Chair for Information Systems at the Department of Informatics, Technische Universität München (TUM). He received a BSc in Computer Science from TUM in 2006 and an MSc in Information Systems in 2007. He studied and researched at the National University of Singapore (NUS) and at Queensland University of Technology (QUT). He has published his work in various international journals and conferences. His research interests include service science, IT-enabled value webs, open and service innovation, and Semantic Web and Web 2.0 technologies.

Stefanie Leimeister is a research group leader and Post-Doc in Information Systems at the research institute fortiss at Technische Universität München, Germany. She received her Ph.D. degree from Technische Universität München, Germany, and a master's degree in Communication Science from Hohenheim University, Germany, and spent an academic term at Central Connecticut State University, CT, USA. Her research focus is on IS Outsourcing, Relationship Management, IS Governance, Social Engineering, Enterprise Architecture Management (EAM), and IT Carve Outs. She has published her work in various international conferences and journals. In her dissertation, she empirically examined governance approaches of different outsourcing relationships.

Markus Böhm is a research associate and Ph.D. student at the Chair for Information Systems, Department of Informatics, Technische Universität München (TUM), Germany. From 2003 to 2008, he studied Information Systems at Friedrich-Alexander Universität Erlangen-Nürnberg (FAU), Germany, and at Jönköping International Business School (JIBS), Sweden. He focused on General Management, IT and Business Process Management, and Software Engineering. As an intern, he has worked for BMW, Bosch, ContentServ, and Siemens. Prior to his studies, he undertook an apprenticeship in business administration at Wolf GmbH, and worked also in Human Resources. His research interests include information management, IT-related challenges of mergers and carve-outs, and IT-enabled Value Webs.

Philip Yetton is AGSM Professorial Research Fellow and Commonwealth Bank of Australia Professor of Management at the Australian School of Business, University of New South Wales, Australia. He is the author of numerous articles in journals as varied as *MIS Quarterly*, *Journal of Management Information Systems*, *Information and Organization*, *Journal of Accounting Research*, *Accounting Organization and Society*, *Organizational Behavior and Human Decision Processes*, *Journal of Applied Psychology*, *Journal of Management Studies*, *Sloan Management Review*, and *IEEE Transactions in Software Engineering*. He is a member of a number of editorial boards. His major research interests are multidisciplinary, focusing on the management of information technology, project management, IT-based strategic change, strategic leadership, and decision making. Philip is a graduate of Cambridge, Liverpool, and Carnegie-Mellon Universities, a Visiting Professor at London School of Economics, Technische Universität München, and the Copenhagen Business School, and a Peter Moore Fellow at Oxford University.

Helmut Krcmar is a full professor of Information Systems and has held the Chair for Information Systems at the Department of Informatics, Technische Universität München (TUM), Germany since 2002. He worked as a Post Doctoral Fellow at the IBM Los Angeles Scientific Center, as Assistant Professor of Information Systems at the Leonard Stern School of Business, NYU, and at Baruch College, CUNY. From 1987 to 2002, he was Chair for Information Systems, Hohenheim University, Stuttgart. His research interests include Information and Knowledge Management, IT-enabled Value Webs, Service Management, Computer Supported Cooperative Work, and Information Systems in Health Care and eGovernment.

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