THE UTILITY OF CLOUD COMPUTING AS A NEW PRICING – AND CONSUMPTION - MODEL FOR INFORMATION TECHNOLOGY

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ABSTRACT

This paper provides the reader with a look at the cloud computing concept and its likely impact on information technology. It begins with a look at how cloud computing has rapidly evolved, examining what cloud computing is – and is not, seeing how the cloud has quickly taken hold as part of our everyday lives and how it is poised to become a major part of IT strategies for all organizations. We examine the notion of computing being "on demand," following in line with other services, such as electricity and telephony, that have become "utilities." We then examine how cloud computing challenges traditional models for pricing and procuring information technology. In the conclusion, we look at how the cloud model will ultimately serve to transform – in a big way – the information technology industry, as the shift from procuring IT "stuff" to buying IT services will be transformational across the landscape.

KEYWORDS

Cloud computing, Information technology, Utility, Procurement, Pricing, Strategy

1. INTRODUCTION

In the world of computing, clouds have always served a metaphorical – almost mystical role. They have been used traditionally to represent the Internet in a networked environment in diagramming and mapping operations [1] (Hartig, 2009). As Knorr and Gruman [2] opined: "As a metaphor for the Internet, 'the cloud' is a familiar cliché, but when combined with 'computing,' the meaning gets bigger and fuzzier."

Today, there is a new development - "cloud computing." The cloud model represents nothing less than a fundamental change to the economics of computing and the location of computing resources [3]. With the growth in Internet usage, the proliferation of mobile devices, and the need for energy and processing efficiency, the stage has been set for a different computing model – the idea of computing as a utility. This article explores the concept of computing as a utility resource, and the implications for pricing - and contracting for - information technology.

2. DEFINING THE CLOUD

What is the cloud? There has been a suggestion to define the concept using the name "cloud" as an acronym, standing for computing that is: "Common, Location-independent, Online, Utility

that is available on-Demand" [4]. As can be seen in Table 1, the cloud can take on various forms, including: SaaS (Software as a Service), PaaS (Platform as a Service), and IaaS (Infrastructure as a Service)

Table 1. Variants of Cloud Computing.

Level	Label	Description
User Level	SaaS "Software as a Service"	Companies host applications in the cloud that many users access through Internet connections. The service being sold or offered is a complete end-user application.
Developer Level	PaaS "Platform as a Service"	Developers can design, build, and test applications that run on the cloud provider's infrastructure and then deliver those applications to end-users from the provider's servers.
IT Level	IaaS "Infrastructure as a Service"	System administrators obtain general processing, storage, database management and other resources and applications through the network and pay only for gets used.

Source: Adapted from Rayport and Heyward [5].

The basic idea behind cloud computing is that *anything* that could be done in computing – whether on an individual PC or in a corporate data center – from storing data to communicating via email to collaborating on documents or crunching numbers on large data sets - can be shifted to the cloud. Certainly, one of the hallmarks of cloud computing is that it enables users to interact with systems, data, and each other in a manner "that minimizes the necessary interaction with the underlying layers of the technology stack" [6](Langley, 2008, n.p.). According to the *Cloud Computing Manifesto*, "The key characteristics of the cloud are the ability to scale and provision computing power dynamically in a cost efficient way and the ability of the consumer (end user, organization or IT staff) to make the most of that power without having to manage the underlying complexity of the technology" [7].

Certainly, cloud computing enables a new, platform and location independent perspective on how we communicate, collaborate and work. So long as one can access the Web, you are able to work when and where you wish [8]. On the flip-side, from a provider perspective, cloud computing dramatically shifts what Hayes [9] terms "the geography of computation," from the machine in front of you to a scale perhaps literally spanning the globe. This is because with fast, reliable Internet connectivity and computer power, it does not matter where the document, the email, the data the user sees on his or her screen comes from, enabling providers to use distant data centers for cloud computing.

3. USING THE CLOUD

Think of what you do on the Web on a daily basis. You check your email. You do your "social networking" – checking Facebook once, twice,…ten times a day and now Twittering. You post and view photos. You store files online, and yes, there can be real work done as well, creating documents, spreadsheets and presentations entirely online. You have entered the realm of cloud computing, and like most Americans, perhaps not even known it! Indeed, technology futurist

and Stanford University Visiting Scholar Paul Saffo recently remarked, "a lot of people are in the cloud and don't even realize it" [10].

What we see today - on campuses, in coffee shops, in train stations, and in the park – is that we are increasingly communicating, storing, interacting and working via cloud-based services. People today are indisputably showing a willingness to put more and more of their lives and the information online, "sacrificing privacy to save time and money" [11]. Thus, it is a personal calculus that we all make as to how much we engage in cloud computing offerings for our personal lives, trading privacy for ubiquitous, "easier" computing.

Remote-based email (whether it be Gmail, Yahoo Mail, Hotmail, MSN Mail, AOL Mail, or any similar service) may be the easiest way to understand the basics of how cloud computing works. In fact, analysts have pointed to the fact that our knowledge of how cloud computing works can be best understood through our own personal use of Google's Gmail and GoogleApps [12]. When using a service such as Gmail, your mail is stored on a Google server, rather than on your own machine's hard drive. Thanks to this, you can access your email from any device that has a Web browser and an Internet connection. Thus, anyone with a web-based e-mail account is already taking advantage of cloud computing.

We see this again and again in our Web 2.0 world, as anyone storing files or photos online is a cloud user, as are all participants on any of social networking sites or blog creators (and the many more who read them). Thus, most of us are indeed already in the clouds, whether we know it or not. In all of these instances, both the data and the application behind it are stored on a remote server, rather than on your own PC, laptop, or other computing device. As more and more us are today using these cloud computing resources for not just our personal lives, but for our work as well, cloud computing has now become "shadow apps" [13] for all of us – and our organizations.

4. MOVING FROM A DEVICE TO AN INFORMATION OR APPLICATION-CENTRIC WORLD

Certainly, cloud computing promotes – and is made possible by - an age of mobility and interactivity. Building on the ideas of Web 2.0, we are progressing toward an age of "anywhere computing" – with data, communications and applications anywhere we might need them, so long as we have connectivity. And today, the Internet is all around us. Wireless access options are growing in homes, in the workplace, in public areas and venues, and in commercial establishments - from restaurants and hotels to even truck stops [14].

We now have an assortment – a wealth – of digital devices in our lives, from our desktops and laptop computers to handheld devices, smart phones, and now, small netbooks. Yet, each has heretofore been "an island of capabilities—applications, communications, and content." Today however, for the first time, we see the prospect of connecting these formerly independent devices. With cloud computing, "information is not stranded on individual machines; it is combined into one digital 'cloud' available at the touch of a finger from many different devices" [15].

Indeed, one of the principal drivers toward cloud computing is the unmistakable megatrend that is the surge in both Internet users and the number and types of devices connected to the Web. Much of the surge has been caused by a sharp rise in the use of wireless gadgets and gizmos in lieu of – or in addition to – traditional PCs [14]. And this wireless wonder is not just an American, Asian, European or even the developed world phenomenon. It is truly worldwide.

According to market analyst IDC [16], the number of devices accessing the Internet worldwide will grow to more than 3 billion by 2012 – doubling from the 1.5 billion Internet-connected devices in 2008. Half of these device accessing the Web will be mobile – laptops, netbooks, PDAs, and increasingly, cell phones. IDC forecasts that the number of Internet users accessing the Web via mobile devices will nearly triple from the levels seen in 2008 to surpass 1.5 billion globally by 2012.

The Economist [17] captured the meaning of this trend in stating: "The plethora of devices wirelessly connected to the Internet will speed up a shift that is already under way: from a 'device-centric' to an 'information-centric' world….(and) as wireless technology gets better and cheaper, more and more different kinds of objects will connect directly to the cloud." Technology guru Clay Shirky perhaps put it best when he said: "What is driving this shift is a change in perspective from seeing the computer as a box to seeing the computer as a door" [5]. The emerging cloud computing paradigm is thus based on a "user-centric interface that makes the cloud infrastructure supporting the applications transparent to user" [18]. Some have speculated that the functionality of cloud computing "could even render the personal computer obsolete" [19], as we move to what has been described as an "application-centric" world [20].

5. COMPUTING – THE FIFTH UTILITY?

It is one of those proverbial "big ideas." What if we could just plug in the computer and it would go, just as we plug a cord into an outlet for electricity, turn on the tap for water, or hit "send" on our cell phones. What if computing became a *utility*? In fact, it has been suggested that the move to the cloud model could make computing the fifth utility (along with water, electricity, gas, and telephone) [21]. This may well be a trend that takes decades – perhaps even a century – to fully unfold [22]. But many believe that we are in the midst of a fundamental transformation toward a more centralized, utility model of computing.

While various authors have addressed the notion of computing becoming a utility, the concept crystallized in the work of Nicholas Carr. Carr [23] first advanced the concept in 2005 in his *Sloan Management Review* article, "The End of Corporate Computing." Carr continued developing and discussing his ideas on the subject over the next three years, leading to the release in 2008 of his book on the subject, *The Big Switch: Rewiring the World, From Edison to Google* [24]. All of this is not new however, as companies whose business model was to "sell computing instead of computers" dates back to pioneers such as payroll processor ADP and to Ross Perot, who left IBM in 1962 to found EDS (Electronic Data Systems) [22].

Rappa [25] categorized a number of services according to their business models (*see Table 2: Business Models of Utility Services*). Over the years, many services have evolved from "make your own" to utility models. Many compare what is happening today with similar circumstances surrounding electricity at the turn of the last century. Before the rise of the electric utility, businesses and individuals had to generate their own power to run their machines. However, when large electric producers began generating power and delivering it via transmission lines into factories, buildings, and homes, self-generation of power waned due to the cost-efficiency and convenience of having reliable electricity on-demand. At the turn of the century, for manufacturing plants and other large facilities to have electrical power, they had to generate their own electricity through small generators or be located near a water source that could operate a waterwheel [24]. Take for instance a brewery operating a hundred years ago. As Amazon CTO Werner Vogels famously put it: "They had to be experts in electricity to brew beer. Something is off there. These guys couldn't wait to dump their own generators and start to use electricity from other companies" [26].

Table 2. Business Models of Utility Services.

Type of Service	Business Models
Water	Periodic • Metered usage of service
Electricity	Periodic • Metered usage of service
Common Carrier Transportation	One-way or Roundtrip Service • Basic pay-as-you-go fare Commuter Service • Pay-as-you-go fare • Subscription (weekly or monthly pass)
Telephone	POTS ("Plain Old Telephone System" – or Land-Line Telephone Service) • Subscription for local service • Metered usage of long-distance service • Equipment is leased or purchased Cellular • Subscription with usage limits • Metered usage in excess of the subscription limit Equipment purchased or bundled with subscription
Radio and Television Broadcasting	Terrestrial • Advertiser-sponsored • Community-sponsored Satellite • Subscription with basic package and premium services • Lease or purchase equipment Cable • Subscription with basic package and premium services • Pay-per-view for special event programming and movie selections • Leased equipment is bundled with service
Internet Access:	Dial-up • Subscription for limited service or metered usage, based upon connection time; • Equipment is purchased DSL • Subscription for unlimited ("always on") service • Leased equipment is bundled with service Cable • Subscription for unlimited ("always on") service • Leased equipment is bundled with service

Source: Adapted from Rappa [25].

So just as turn of the century manufacturers had to produce all their electricity on site, akin to today's situation where organizations in the private and public sector have historically had to own all of their IT resources – until now.

However, like electricity, IT assets are not used equally or continuously. Overall, research has shown that as computing power has indeed grown far cheaper and more plentiful, utilization rates for IT resources have, in fact, plummeted. Carr [23] reports that overall, corporate servers typically use *less than a third* of their processing capacity (and much of the time, they are simply not being used). Likewise, much of a typical organization's storage capacity is either unused or being "wasted" (think unnecessary redundancy and all those music, video, and personal files that employees routinely save on their boss' computers). An IBM study showed that desktop computers in organizations were even less utilized – with an average utilization rate of just 5% [27]. Cramm [28] argues that this underutilization comes as a result of not properly using existing IT resources and unnecessary spending on new IT resources to ensure even more overcapacity *and* even greater underutilization, compounding the problem even more.

All of this adds-up to a great deal of waste – an overinvestment in IT resources – and all those dollars being tied-up in unnecessary hardware, software and the manpower it takes to monitor, maintain and constantly upgrade and update those resources – serve as a drain on not just individual firms, but the economy as a whole [23, 24]. As Baig [29] commented, this means "companies with static compute resources have to consistently grapple with the tradeoffs related to under and over provisioning of in-house compute capacity." For large organizations, these IT investments – both in capital costs and operating expenditures – represent a significant level of commitment to providing the computing resources necessary for operations. Yet, traditionally, IT has been viewed as a capital expense. With ready access to credit, the cost of acquiring technology could be written-off over a period of years. Today however, with shrinking budgets, companies are increasingly looking to cut their IT costs – not just the upfront infrastructure costs, but also the personnel, software and energy costs necessary to maintain and support that level of internal IT. Thus, many are increasingly looking at a pay-as-you-go approach [30]. This means not just a strategic change but a shift in the mindset of many - from viewing IT and its infrastructure as a fixed, capital expense to a variable cost. By only paying for the computing power they actually use, for most organizations, cloud computing can represent a significant – perhaps *very* significant – overall cost savings. And with managing data centers and managing massive numbers of electronic devices, the more organizations keep IT in-house, the more expensive – and difficult – they will find it to attract and retain qualified IT staff [31].

With all the unused computing capacity, the stage has been set for cloud computing to develop. Carr [23] stated that: "The history of commerce has repeatedly shown that redundant investment and fragmented capacity provide strong incentives for centralizing supply. And advances in computing and networking have allowed information technology to operate in an increasingly 'virtual' fashion, with ever greater distances between the site of the underlying technological assets and the point at which people access, interpret and manipulate the information. Given this trend, radical changes in corporate IT appear all but inevitable" (p. 73). Carr [24] believes that we will see the Web morph to become, in time, the "World Wide Computer" where we will go for all of our computing and communication needs in the era of cloud computing. Futurist George Gilder predicted in 2006 that we would see the growth of mammoth computing companies that would take advantage of the economies of scale for centralized computing operations, writing that:

> In the PC era, the winners were companies that dominated the microcosm of the silicon chip. The new age of petacomputing will be ruled by the masters of the remote data center – those who optimally manage processing power, electricity, bandwidth, storage, and location. They will leverage the Net to provide not only search, but also the panoply of applications formerly housed on the desktop. For

> the moment, at least, the dawning era favors scale in hardware rather than software applications, and centralized operations management rather than operating systems at the network's edge [32].

Another driver toward the technology possibility of computing as a utility – and cloud computing - is to be found in the trend toward what Gartner [33] labeled as the "industrialization" of information technology. There is no doubt that IT has become standardized today, with "commoditized" hardware that underpins the Internet and data centers today. IBM tech visionary Irving Wladawsky-Berger believes that this standardization is key, in that "for computing to reach a higher level", he says, "its cells had to be commoditised (sp)" [34]. There is also far more harmonization than at any point perhaps in the history of computing, with common software, file, and document formats that no longer present the "Mac vs. PC" incompatibility issues. Some have compared the possibilities that come from such standardization to that offered when Henry Ford mastered the art of assembly-line manufacturing to provide lower cost, standardized outputs that made cars and a whole hosts of products available at reasonable costs. Indeed, the concept of "modularity" and interchangeable parts has been around since the early days of computing, with common parts used in programming (through the use and reuse of subroutines) and standards constantly emerging [35]. In fact, it has been said each generation rediscovers the power of interchangeable parts, making cloud computing "a 21st century version of centralized mainframe computing" [36]. All organizations today need to look to simplicity as an anecdote to the complexity that has not just caused so many of the problems of the current economic crisis, but made it hard to find common platforms and common solutions [37].

Certainly, as with electricity, there are cost efficiencies to be gained from centralizing and industrializing IT – through better capacity utilization, economies of scale, and cost savings/sharing (akin to the cost differential of a plant having its own small electrical generator versus the giant, centralized generators operated by an electrical utility firm). Instead of buying, operating, and maintaining IT functions on their own internal servers and data centers, organizations can instead today opt to purchase this capacity and services from cloud providers – often at a far lower cost and perhaps with more capabilities than their own internal systems. They can buy these services over the Internet from companies specializing in IT — at a lower cost than running an in-house system.

Such industrialization of IT, built upon massive economies of scale, may well revolutionize the very structure of the computer industry and how IT resources are owned and housed. Traditionally, when it comes to software, IT managers had to decide whether to "build" or "buy" what was needed for operations. In contrast today, the choice is complicated by adding two new options – whether to build with open source or to "rent" through SaaS applications [38]. The move to cloud computing will ultimately be a sourcing decision, and for public and private sector organizations, there will be operations that are too critical – at the heart of one's core business – to outsource and place outside of one's controls [39]. As Nicholas Carr commented, "One of the key challenges for corporate IT departments, in fact, lies in making the right decisions about what to hold onto and what to let go" [40]. As outsourcing grows, more and more computing functions will be shifted to outside, often outsize providers. Indeed, Intel has projected that by 2012, a quarter of all its server chip sales will be for machines to be placed in such "mega-data centers" [41].

Jackson [20] noted that there has been a long-term pendulum swinging between centralized and personalized computing. In other words, we have seen periods where computing power, data, and programs have been held on a major, centralized platform, and we have also seen periods where that power has resided on one's desktop – or today, literally in the palm of your hand. We may well be heading – in a way – "back to the future" – as the pendulum swings again. We have

seen computing cycle from a highly vertical structure in the mainframe era of the 1960s and 1970s to an increasingly distributed, horizontal model of computing. This latter era began with the introduction of PCs in the 1980s through the next three decades with the explosion of the Web and the proliferation of mobile devices. In the horizontal model of computing, it was important to distinguish between hardware, software, networking and support services, and as such entire industries grew and proliferated around each element of computing. However, under the cloud model - where we tie into the cloud, there is a move back towards a more vertical model of computing. As such, as cloud computing features IT as a service, and thus, "in a world of services it often does not make sense to think of hardware and software separately" [42].

The utility analogy has been categorized as "an intriguing and big argument"[43], but one that ultimately will encounter a great deal of resistance from organizations and their IT departments that will want to – and have security and compliance issues – that will cause them to retain computing resources and functions in house. Besides those issues, there are also other trade-offs for treating computing as a utility and moving to a more centralized computing model. Certainly, under cloud computing, while IT gains from better efficiencies, utilization and manageability, that same centralization could inhibit the ability to innovate in the IT area by tying-in users to larger and larger, standardized systems [22].

Simply put then, when organizations can procure the same-level of computing power and like-power (and compatible) software applications from outside providers as from their in-house resources for less (and perhaps for free), then companies and even public sector agencies will turn to the utility model and obtain more and more of their computing from the cloud [44]. The cloud case can be summarized very succinctly in stating that, very simply, "it makes computing a heck of a lot less expensive" [45]. Thus, the stage has been set for cloud computing to emerge as a new model for delivering information technology to individuals, organizations and government agencies.

It has been said that: "The early 21st century is like the early 20th century in that we are at the beginning of a new economic paradigm. This time, however, the engine of growth will not be manufacturing, but *information*" [46]. Yet, with this new age come new uncertainties. In her 2002 book, *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages*, Carlota Perez [47] described the "techno-economic" paradigm of technological innovation that has occurred historically. Once a major new technology emerges - be it trains, the telephone, or electrical power – eventually these disruptive innovations become thought of as "utilities" – becoming stabilizing forces for a new order for business and the economy. What is "different" about this time and the revolution in computing that is underway is that there will likely not be a stable period coming from the disruptively innovative technology forming the model of computing as a utility. Writing in the *Harvard Business Review,* Hagel, Brown, and Davison [48] commented that: "(The) historical pattern - disruption followed by stabilization - has itself been disrupted. A new kind of infrastructure is evolving, built on the sustained exponential pace of performance improvements in computing, storage, and bandwidth. Because the underlying technologies are developing continuously and rapidly, there is no prospect for stabilization….making equilibrium a distant memory."

As some commentators have pointed-out, past technological innovations have created far more jobs than those they have destroyed. However, as old media is being supplanted by new media, new media companies have remained very small, with many being "Mom and Pop" or even one person in nature [49]. And so, with more IT being shifted to the cloud – and more internal IT roles being outsourced to external providers – it is likely that we will see fewer IT jobs overall. However, there is a concern that from a public policy perspective, this IT revolution is failing to create middle-class jobs to replace the ones that will inevitably be taken away. Indeed, today's outsourcing IT could likely soon become offshoring IT for many cloud providers, thus taking

the jobs and revenue from cloud computing outside of the country entirely [3]. For certain areas of the United States however, like the Pacific Northwest, cloud computing may mean a veritable economic boom, as companies from Amazon to Google to Microsoft have moved to place their mammoth cloud data centers in areas with abundant water supplies and relatively inexpensive electrical utility costs [50]. Likewise, similarly situated areas around the globe may benefit from hosting the huge data storage facilities that will accompany the growth of cloud computing.

6. THE GROWTH OF THE CLOUD

Global IT spending hit $3.4 trillion in 2008, although the aggregate total is expected to decline for the first time since 2001 in the current year – and perhaps for 2010 as well [51]. Indeed, across the private sector, IT spending is under fire. In fact, due to the interrelated impacts of the recession and the credit crisis, capital budgeting and credit availability for large IT projects has declined significantly. Thus, the only areas of IT that are growing in the wake of the economic crisis are outsourced IT and IT services. Additionally, as new entrants, many of them tied to cloud services, enter the marketplace, the prices for outsourced IT are likely to decline over the next few years as competition intensifies between larger, entrenched competitors and these upstart firms [52].

IDC estimates that roughly ten percent of the approximately $64 billion spent on business applications worldwide in 2008 was spent on cloud computing applications – being those entirely delivered on a remote basis [53]. Many analysts project growth rates for cloud computing in excess of 20% to 30% or more for years to come, with analysts estimating that the global market for cloud computing services could reach $42 billion by 2012 [54]. Gartner sees the cloud computing marketplace as an even larger market, and it predicts that the market for cloud services already surpasses $40 billion today, and that it will grow to over $150 billion annually by 2013 [15].

Why cloud – and why now? According to the results of the 2009 Cloud Computing Survey, surveying over 500 IT decision-makers, the shift to cloud computing can be seen as organizations are increasingly “turning to new technologies to cut costs, rather than cutting back on their technology uptake” [55]. Cloud computing is also by no means an “all or nothing” proposition. Indeed, it has been seen in practice that cloud involvement often starts when organizations initially use cloud resources for part of their non-mission-critical applications or as resources for test projects [56].

7. PRICING THE CLOUD

New pricing models are fundamental to the growth of cloud computing. Popularly referred to as either the “consumption” or “pay by the drink" model [56]. For the organization using such cloud services, the idea is that you can dramatically lower the need for upfront investments in information technology and ongoing support/maintenance by simply paying only for the services/capacity/programs as they are used. Or, as technology futurist and Stanford University Visiting Scholar Paul Saffo characterized it, we are fast-moving to a world “where you're going to pay for everything by the slice rather than by the product…So instead of buying a software application, you're going to subscribe to it” [10].

The analogies have been numerous – from taking a taxi, rather than buying a car, or sending a package by mail or by a delivery service, rather than having your own truck [57]. And, the best part may be that some of these “drinks” may be free. *The Economist* described this shift as “a

fundamental change in the nature of software"[35]. This is due to the fact that software will increasingly be delivered online and as a combination of services delivered to meet the needs of the user, not a pre-packaged, shrink-wrapped amalgamation of all possible solutions to what the software maker sees as all possible user needs. The shift to cloud computing will also change how developers and programmers build programs and how they will be compensated for those efforts [58].

There is much discussion about the whole concept of "free" pricing for many products and services today – and many of the email, storage, hosting, and applications that are at the forefront of cloud computing today are indeed free. The most notable of these are the product offerings of Google (Gmail, GoogleApps, GoogleDocs, and others). Much attention has been devoted to the concept of "freeconomics," most notable the recent book by Chris Anderson [59] entitled, *Free: The future of a radical price*. Most consumer-level cloud offerings would be labeled a "freemium," which is a free version that is supported by a paid, premium version. Such freemiums are becoming an emergent business model, as they are particularly popular among online service and software companies. And, when faced with competing against "free" alternatives, older, more established companies have seen users migrate to the gratis alternative. Indeed, some see an entire "Culture of free" emerging, where from music to entertainment to news to software, people are coming to expect that free is the price they should pay [60].

In the corporate computing market, as software, hardware and processing power, and storage capacity become more and more commoditized, cloud computing becomes a free – or lower cost – alternative to the way things have been done for decades. As DiMaio [61] remarked: "Why should I bother looking for an email client to replace Outlook and coexist with my newly installed OpenOffice, if I can get email and office suite as a service with somebody like Google at a fraction of the cost and - most importantly - giving up the IT management burden too? Why are we talking about moving servers from Windows to Linux when the real question is why do we need to have our own servers in the first place?"

8. CONSUMING AND CONTRACTING IT IN THE CLOUD

From the perspective of Willy Chiu, Vice President of IBM Cloud Labs: "Cloud computing is a new way of consuming IT" [62]. Thus, from an organizational standpoint, cloud computing simply represents "an architecture in which companies consume technology resources as an Internet service rather than as an owned system" [63]. There will also need to be vast changes in the not just the language and pricing - but the mindset - of negotiating and contracting for computing services. For while IT administrators look at capacity and systems, end users look to performance. As Jackson [64] recently put it, the key metric will now become: "When I sit down at that computer, do I see the functionality I need?"

Outsourcing has always been a part of any organization's IT decision-making, as by outsourcing non-core functions, this enables executives to more fully concentrate on strategic priorities and core competencies [65]. Tech-pioneer Geoffrey Moore [66] developed the concept of core versus context IT activities in organizations. According to Moore's typology, core functions help provide the organization's competitive differentiation and spanned the organization to connect to its external constituencies, while context functions are typically internal in nature and helped support the core activities. In an interview on the subject, Moore [67] quipped that if executives are "caught up in managing old context stuff and you don't find a way to get that stuff out of the company, you have trouble turning the boat," and thus, it is crucial to concentrate on the core functions to promote long-term success. We may thus, as Collett [38] predicts, be fast-moving into "a world where everything is provisioned" in computing. In the

realm of deciding what activities to keep internal and what to potentially shift to the cloud, [68] offered the following "rules of thumb," based on Moore's core versus context framework: "If the business practice is context and non-mission-critical, then always put it in the cloud. If it is context and mission-critical, it is likely you should make it cloud-enabled. However, if it is core and non-mission-critical, you may want to think about keeping it behind the firewall; if it is core and mission-critical, then definitely keep it behind the firewall."

How to price (and how to negotiate and evaluate) cloud computing contracts will become a huge issue over the next decade as more and more corporate and governmental computing shifts to cloud providers. Cloud pricing models that are based on usage (the "pay-by-the-drink" model) could be confusing - and even off-putting - to IT managers and organizational executives. As Allan Leinwand, who is a partner with Panorama Capital, recently commented that: "You're talking about units that people don't normally think about. CPU hours: that's not something I go buy. I buy a blade server, and the hours are infinite, they're mine. Even if an IT pro finds it easy to understand CPU hours, a CFO might not. Try to explain to your CFO how many CPU hours you're going to use in the cloud, and see if they care" [69]. Furthermore, those entering cloud computing contracts expecting considerable cost savings could experience the "sticker shock" that many of us do with our cell phone bills, as if utilization is far greater than anticipated, so too will be the tab for that computing power used from the cloud provider. In other words, metered pricing works well – but only if based on considerable planning, analysis, and understanding of the up- and down-sides of consumption-based cloud pricing models.

Some [70] have also criticized the current pricing models for cloud storage, insisting that it makes little sense to charge the same amount to store large amounts of data over a long-term basis. This is due to the fact that storage costs are likely to continue their steady, unabated decline into the future. They argue that unless cloud storage providers develop new pricing storage models to recognize the different needs clients have for the security and accessibility of their data, the attractiveness of cloud storage may pale versus the declining costs for in-house storage. There will also have to be efforts made to educate procurement staffers on consumption-based contracting and the need for sharing best practices and lessons learned as more experience is gained across the board in this area.

Certainly, one of the principal concerns for anyone using the cloud is the financial stability of their cloud provider. There is a vendor risk in the possibility that the cloud provider could cease operations – and then what is to happen? Whether it be an individual storing their pictures in the ether or an organization storing files with a cloud provider, if that firm goes bankrupt, their data may be irretrievable [10]. Thus, this is certainly a concern for public sector buyers of cloud services and storage. Yet, financial concerns are not the only eventuality that could proved troublesome or even fatal – what if a cloud provider stops operating for another reason - say the destruction of a data center by a natural disaster (without a redundant secondary back-up of their housed data). Likewise, some have expressed concern that for providers such as Amazon, their cloud operations are not part of their traditional, core business [71]. This is not to say that as the cloud model takes-off that the cloud portion of their operations will likely become a much more significant part of the cloud provider's revenue and business model. However, there is always a potential risk when dealing with a firm whose primary line of business is not the area that you are contracting to become dependent upon.

Finally, the shift to greater use of cloud computing may in fact make it possible to streamline and simplify compliance audits and analysis [72]. The greater automization and standardization embedded in cloud processes may also free-up many, many work hours of senior and mid-level IT managers from focusing on compliance issues to other, arguably more productive uses of their time [73].

9. THE ROI OF CLOUD COMPUTING

What is the ROI (return on investment) of cloud computing? Most analysts have projected that cloud computing can deliver cost savings by outsourcing IT operations – perhaps as much as three to five times cheaper than in-house data centers and hosted applications [74]. Analysts have found that organizations spend an astonishing $8 out of every $10 in their IT budgets on maintaining existing systems, rather than on innovative new technologies [40]. Recent estimates are that for every $1 organizations spend on PC's in the enterprise, another $8 is required for administrative support, maintenance and upgrades [75]. Based on anecdotal evidence from organizations, the ROI of cloud computing initiatives – from cloud storage and email to SaaS applications – can be significant. Indeed, costs savings have been demonstrated both from using hosted applications and from less need for internal IT resources and staffing [76].

An organization's cloud computing strategy should thus certainly not be an "all or nothing" gambit, with a sudden "we're in" or "we're staying out of it" decision. Instead, a cloud strategy should look to create "a portfolio of cloud resources," combing public, private, and hybrid cloud elements with the organization's legacy systems and resources [77]. Laurence Millar, the former CIO of the Government of New Zealand, recently framed the cost versus control trade-off of private versus public clouds in a very astute manner, commenting: "A private cloud is all very well, and at the moment it is probably worth paying a price premium for the control and security that it supposedly provides. But it is a risk versus cost equation. A private cloud will half the cost of computing. But the public cloud will half that cost again" [78]. Many observers believe that what will emerge are hybrid models, whereby organizations will combine using their own private in-house clouds for running their mission-critical operations and hosting sensitive data with and public clouds for routine work, operations, and storage. The key will be to develop decision rules to determine which applications and data should remain in-house and which are candidates for the cloud.

Finally, some argue that the most significant cost of not shifting to greater utilization of cloud computing is in the time and attention of senior IT and organizational leadership. As Golden [79] squarely framed the issue, "Every minute spent on reviewing an RFP for procuring another tranche of servers is a minute not devoted to how to use IT for competitive business advantage." Yet, one challenge facing cloud adoption is the simple fact that as organizations choose to move some of their data and applications to the cloud, rather than running a 100% internal IT operation, this will necessitate the development of a second management front – and additional time, training, and managerial attention – to managing cloud operations.

10. CONCLUSION

The cloud model will ultimately serve to transform – in a big way – the information technology landscape, as the shift from procuring IT "stuff" to buying IT services will be transformational. It will transform not just how organizations and people within them interact, compute, operate, communicate, and collaborate, it will greatly impact the companies that are involved in supplying a vast array of IT equipment, software, support and services. While a challenge to the existing computer hardware and software providers, new, whole "industries" will likely be birthed over the next decade by the shift to more cloud-based computing.

As we look out over the immediate horizon, one can well imagine that in five to ten years, we may not speak of the "cloud" or "cloud computing" anymore. This is because using what we now regard as cloud-based services – for applications, for storage, for email, etc. – may simply become "the way things are done." Just as today we no longer can tell if a phone call is from an

analog or a cell phone, in the very near future – sooner than most think – we may no longer be able to know – or care – whether the program we are using or the data we are accessing resides on our desktop, our laptop, our cell phone, or somewhere in the cloud (likely a data center in Oregon or Washington State – or in Bangalore or Tegucigalpa).

How will all of this unfold? How long will it take? Will cloud computing replace 10-20-50-75-80% of what we typically think of as the IT function in organizations? The best minds in the area believe that all of this will not be an overnight transformation. With the entrenched investments, people, and ways of in-house IT, as Dave Girouard, Google's President of Enterprise Computing, put it: "It will be a draining of the pond" [40]. There is however likely to be rapid growth in cloud computing. Yet, we must be mindful that, as Kurdi, Li, and Al-Raweshidy [80] reminded us, : "successful innovation is the result of a specific socioeconomic and technological constellation—the right product, in the right market, at the right time where specific requirements in terms of user needs, pricing, and standards, among others, must be met."

Where does all of this "end?" Where does the growth of cloud computing take us? Some have speculated that ultimately, the concentration of resources and power in the cloud leads us down dangerous paths. As Jaeger, et.al. [81] (2009) observed:

> "Cloud computing represents centralization of information and computing resources — quite contrary to the imagery that the label evokes. Centralized resources, by their very nature, are easy to control, by corporations that own them and governments whose jurisdictions they are under. This less–discussed fact represents a 'darker' or 'stormier' side of cloud computing and presents a danger to open information–based societies if the issues are not carefully considered."

Some have forecast that we may be headed to a future where there are fewer and fewer megacomputers, or as Kelly [82] surmised, a single "Planetary Computer" that anyone around the world would be able to tap into from any device. Indeed, Nicholas Carr has surmised that we are indeed heading to a "World Wide Computer." In an interview with *Wired*, Carr was asked: "IBM founder Thomas J. Watson is quoted — possibly misquoted — as saying the world needs only five computers. Is it true?" He responded that: "The World Wide Web is becoming one vast, programmable machine…Watson was off by four" [11]. Carr believes that: "We'll probably see some kind of oligopoly, with standards that allow the movement of data among the utilities similar to the way current moves through the electric grid" [11]. In fact, O'Reilly [83] warned that due to the economies of scale and scope involved, cloud computing could lead to "a huge monopoly." However, he also cautioned that the ensuing competition in this area could make Windows versus Apple look like "kid's stuff." Thus, in the near-term, competition may well make cloud-based applications and storage even more attractive on a cost basis to potential enterprise customers. As such, this area needs to be monitored closely by governmental authorities to assure competition and choice among cloud providers.

Over the long-term, any such consolidation in the emerging cloud services industry could be harmful – even threatening – to the economy and as such, must be monitored by governmental interests. It is not just for the sake of preventing monopolization for public policy reasons, as more and more consumers and small businesses – and governments – will be dependent on the infrastructure offerings of large cloud providers, such as Apple, Amazon, Google – and on the horizon, certainly Microsoft [84]. Erickson [85] warns that some in the IT community have concerns that cloud computing could cause the rise to power of a new "Big Data" sector of the economy (comprised of firms such as Google, IBM, Amazon.com and Oracle).

Yet, cloud computing will likely invariably lead to a more vertically integrated structure to the computing industry. This has led legal and industry analysts to predict that just as in prior computing eras there were anti-trust concerns and actions brought by the Justice Department against Microsoft and IBM, similar concentration and market dominance could put Google – or another dominant market player that might emerge – at risk of anti-trust actions in the next decade [86].

However, in this fast-moving area, established regulatory models and practices may well need to be adapted to keep pace with the changing computing paradigm. As Nicholas Carr [87] observed:

> There's a danger of too much of this very important infrastructure falling into the hands of too few companies. It's critical that there continues to be competition both at the level of the utility and of component suppliers to the utility. Don't think hardware and software companies will go away; they'll just shift from supplying the user to supplying the utility company. So it's critical at the highest level to ensure strong competition between all those parties. Eventually, as with electricity, it may require the government moving in to ensure that there isn't too much consolidation.

Market mechanisms may also play a role in guarding against a true monopoly/oligopoly from developing in the cloud computing marketspace. For one thing, much of the cloud computing market (storage, simple SaaS, IaaS, PaaS, and email) may be in the areas that are commodity-like in nature and thus, low margin businesses. Also, because there will be many firms that will – of choice and necessity – operate private clouds, they will be operating largely independent of the market conditions in the public cloud marketplace for their internal operations. Further, as firms find they will likely have excess capacity that could be traded/sold through exchanges and brokerage-type operations. Such models are likely to develop in the very near future [88].

Finally, especially if mega-sized, market dominant cloud providers do emerge, there may be a need for additional regulation. Based on the banking regulation model, there will be a role for regulations to ensure that cloud providers have enough "reserve capacity" to meet their customers demands, even in times of extreme utilization (a natural disaster or other emergency could provoke the equivalent of a computing "run on the bank" for capacity). Likewise, as companies – and even agencies at the national governmental levels – are both users and providers of cloud services, there may need to be guidelines and oversight as to whose needs are met first – the provider's internal needs or those of their cloud customers? These are very good points that will most assuredly need to be addressed in the coming years as cloud oversight becomes a real issue. If not, we could well face the prospect of what Greenberg [89] terms a "cloud collapse" that could send the companies, national and local governments – and the economy – reeling in the event of a major cloud provider failure without adequate procedures in place to address user needs and concerns.

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