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Cloud and the Future of Business: From Costs to Innovation

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Part One: Promise

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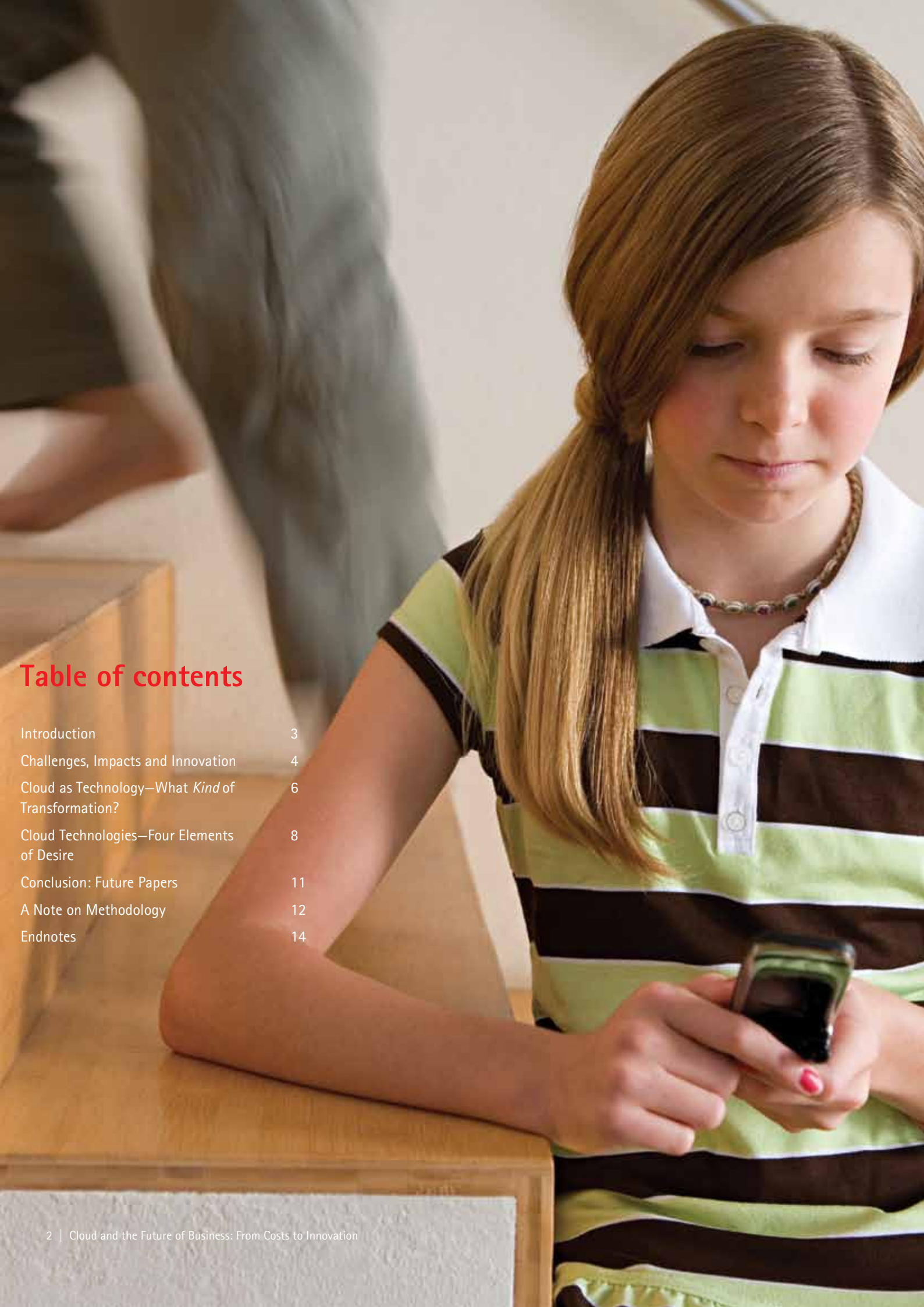

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Introduction

With cloud computing becoming an increasingly important element of the IT function of most organisations, this five-part report presents a state-of-the art review of the key features of cloud computing and its likely near–term and longer–term development trends. It draws on research undertaken from late 2010 into 2011, including a survey of over 1035 business and IT executives and more than thirty-five interviews with key international players in the cloud computing ecosystem including cloud providers, system integrators and users of cloud services.

While the subject of cloud is everywhere being discussed, there is a lack of substantive, objective research into not just technological trajectories but into the potentially more far reaching business implications of cloud. Hence this report. It is important not to buy too heavily into the language of 'all change' and radical transformation, and crucial to avoid the related response to business hype and fashions which one book dubbed rather acerbically as 'fad surfing in the boardroom.' Cloud must be seen in the context of previous so-called "revolutions"—particularly in technology and in service outsourcing. Indeed from one perspective cloud can be portrayed as a "back to the future" phenomenon—for example, there are resonances of application services provision, shared data centres, and even Systems Network Architecture (SNA), with its data and application "bunkers" feeding multiple devices. Is cloud really just a more open SNA architecture on steroids?[1] However, one must point out some significant differences from what has gone before—not least more powerful computing/processing capabilities, fatter transport pipes, broadband wireless access, more open and flexible protocols (IP), to mention just a few. Our report finds that cloud is in many ways (finally) delivering on the promises of the **past**—into an environment that appears more prepared to put these capabilities to work due to dynamic changes in internal and external factors—competition, innovation, globalisation, user demographics, management readiness, and supplier ecosystems. Moreover, cloud has real consequences, not all of which are fully or well understood, and we are finding that expectations are running very high, particularly amongst business users. Organisations and CIOs need to be anticipating and planning the journey now for major changes that will begin over the next 3-5 years, and which will fully have realised their potential by 2020. Cloud computing is taken as the consequence of the evolution of two distinct strands: technological innovation—based around virtualisation and shared computing provision—and a distinct service based perspective on computing. Cloud computing changes the risk profile and status of many IT developments and offers the opportunity to experiment with, seed and grow innovative business services. In this introductory paper we focus on the kind of transformation cloud is going to represent, and we provide a perspective on the direction of travel of cloud technologies.

Cloud has real consequences, not all of which are fully or well understood...expectations are running very high, particularly amongst business users.

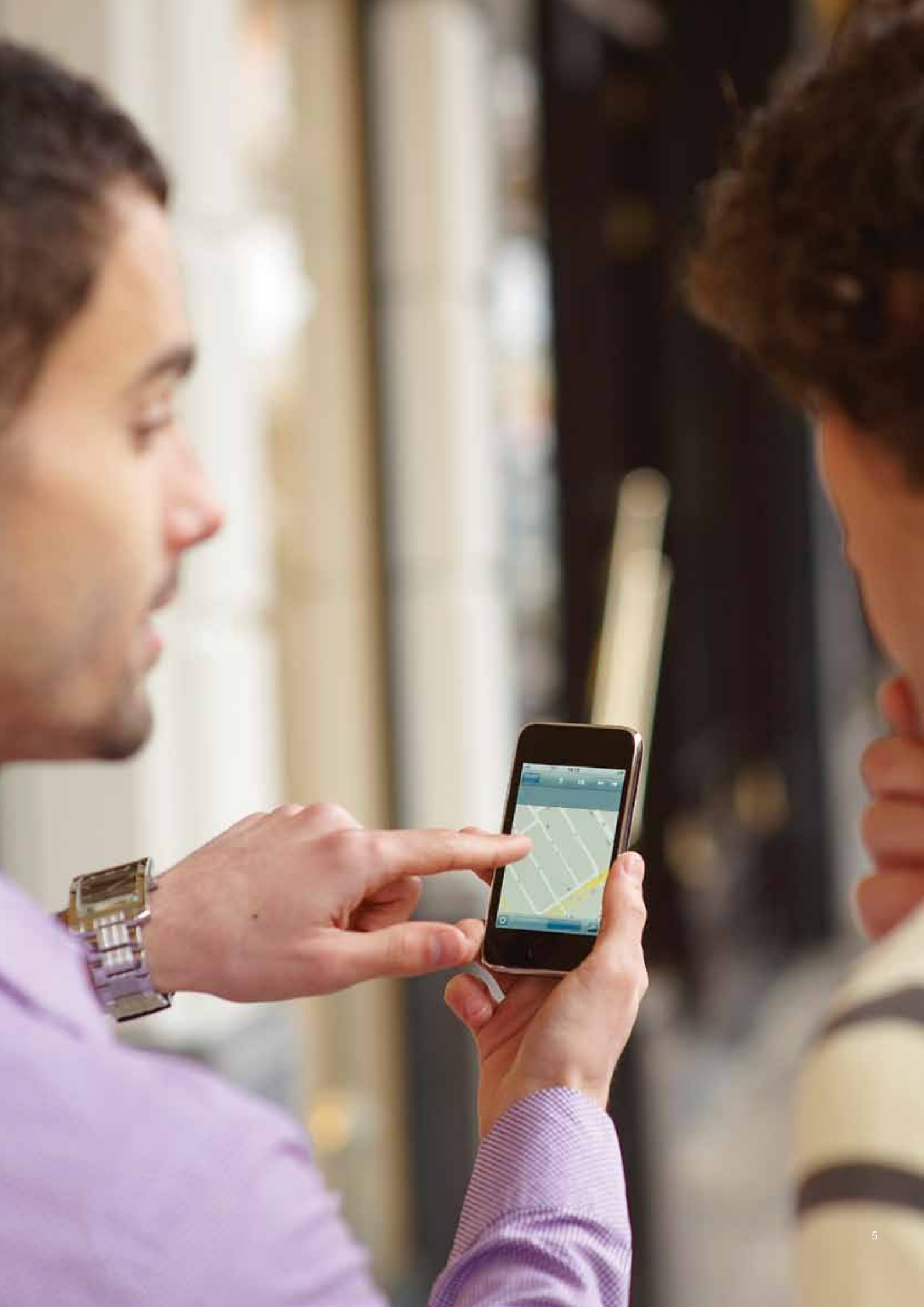
Challenges, Impacts and Innovation

In the near term, cloud computing faces a number of challenges clearly identified by our research. These include legal and regulatory compliance considerations, managing the contractual relationship between client and cloud provider, including lock–in and dependency, as well as managing the very flexibility that cloud provides. Nevertheless, many of these types of challenges have been faced previously and effective solutions have evolved. For example, safe harbour provisions address legal and regulatory issues about transferring data abroad, and over twenty years of IT outsourcing has resulted in a skill base that is capable of managing contractual relationships with key partners. End–user computing, whether in the form of desktop computers or, increasingly, smart phones has become effectively integrated within the IT infrastructure of the organisation. Cloud computing can, and should, learn from these experiences if it is to achieve its full potential.

We see it as important to differentiate the short-term from the long-term possible impacts of cloud technologies, and not to conflate the two into too immediate a timeline. Our respondents, especially those working closely with existing systems and technological infrastructures, invariably warned us against assuming that full cloud functionality would be delivered very quickly. Business executives, on the other hand, understandably wanted the significant benefits that cloud could bring within much shorter time horizons—a familiar story. The impact of major innovation, especially technological innovation, has frequently been delayed. On past experiences some have offered the rule of 10/10. This means it takes ten years to develop fully the technology set and another ten for it to be implemented, accepted, institutionalised and exploited in a society. Recently social networking has perhaps broken this rule dramatically, but cloud, as a convergence of a range of technologies, in our view looks more like a 10/10 transformation (though this does not mean we are starting from the beginning—many aspects of cloud computing are already quite progressed along this timeline). The reasons for this, as we will argue in later papers relate to the challenges cloud presents, the major impacts that will have to be worked through, and the management, organisational and sectoral changes that will need to occur if the more dramatic innovations in service, business operations and the way business compete and government agencies run themselves, are to be realised within the next ten years.

In this first paper we provide a commentary on the likely size and direction of the technological changes implicated by cloud. From this base, we then outline the subsequent four papers that describe in detail our assessment of cloud's implications for the future of business, and how business needs to respond to the challenges if it is to achieve the sorts of dramatic payoffs being touted, not just in terms of cost, but also in terms of business innovation.

Business executives... understandably wanted the significant benefits that cloud could bring within much shorter time horizons.



Cloud as Technology—What *Kind* of Transformation?

Microsoft's CEO Steve Ballmer recently stated that Microsoft's move to the cloud reflects a **"transformation that's going on in the computing world"[2].** This sense of the potentially transformative effect of cloud computing is also reflected in our own empirical research undertaken in late 2010 and early 2011 including a survey of more than 1035 business and IT executives[3] and more than thirty-five interviews with key players in the cloud computing ecosystem including cloud providers, system integrators and users of cloud services[4].

The nature of this potential transformation was eloquently stated by one of our respondents, Tim Barker, of SalesForce.com: "Cloud computing in its best form lowers the barrier to actually getting the business what they want"[5], that is, through the use of cloud computing the IT department ceases to be part of the "business prevention unit" and instead delivers tangible business benefits. This was supported by our survey where over 50 percent of business respondents believed that cloud would "enable us to focus on transforming our business and not our IT". Even amongst IT executives nearly 50 percent recognised that cloud could enable far quicker implementation of business applications.

As arises with most emerging markets and new technologies, there are countless definitions of what a new technology is or may be. Cloud computing is no different, with some vendors providing innovative new services and others seeking to re-badge their existing provision to use the latest buzz words. Instead of worrying about words, we find it most helpful to consider cloud computing as the maturing and convergence of two distinct technological streams.

The first stream relates to the maturing of the technological infrastructure. That is, over the past ten years there have been significant technological developments that enable cloud computing[6]. These include far more reliable internet services, with higher throughput and resilience coupled with virtualisation techniques that enable computing facilities to be replicated and reproduced easily. One consequence of this move to virtualisation is that it is no longer necessary to have in–house computing infrastructures. Instead, in an echo of the outsourcing movement, it is possible to shift computing and storage capabilities "into the cloud" where they offer economies of scale including in terms of IT support, energy consumption and speed.

> "Cloud computing in its best form lowers the barrier to actually getting the business what they want."
>
> **Tim Barker, SalesForce.com**

In and of itself, however, developments in computing infrastructure do not result in the opportunities that cloud computing can provide.

In and of itself, however, developments in computing infrastructure do not result in the opportunities that cloud computing can provide. For that to happen, the second stream also needs to have matured. This stream is a service perspective on computing[7]. This focuses on providing computing capability as a service that is consumed as and when required rather than as a one–off, one size must–fit–all capability. The resulting change of management mind-set for both IT and business directors is marked, as Jimmy Harris of Accenture observed:

"When you start to understand that you're going to be buying things that used to be products, i.e., applications software, now as a service then you understand that you're going to be required to manage those services as you do outsourcing services today and you're going to understand that you will be required to integrate those services just as you integrate services from various outsourced companies today"[8].

The unique proposition that is cloud computing comes about when both streams are relatively mature. That is, the service perspective of offering computing resources as and when they are needed is coupled with the technological capability of using more or fewer virtualised servers over the internet. To illustrate this combination of the two streams we can consider the case of the media agency RAPP. They utilise the technological capabilities of cloud computing such as virtualisation to address the unknown processing demand associated with providing video streaming services for movie launches. If the movie launch is particularly successful, with many thousands of people wanting to stream the movie trailer, they are able to scale their operations rapidly; if the movie bombs, then the service element of cloud computing means that they are not paying for unused infrastructure. That is, because their cloud providers can offer and manage computing resources as a service, RAPP are able to purchase as many, or as few, cloud services as they require.

To date, most discussions of cloud have focused on the benefits that cloud can offer in terms of flexibility in the technological infrastructure. However, cloud computing is unlikely to result in the kinds of transformation signaled by Ballmer and Barker if it is understood solely in terms of cost savings arising from data centre consolidation and virtualisation. Indeed, there is a direct parallel here with the earliest stages of IT outsourcing, which we have studied for the past twenty years, and from which many lessons for cloud can be learned.

The earliest stages of IT outsourcing also highlighted the potential cost savings that outsourcing could offer and this resulted in many companies moving to what can be called contract or supplier management—establishing performance terms and then managing to these terms[9]. With hindsight, however, it is apparent that such an approach is fraught with problems: even managing contracts in terms of a single variable (for example, cost) is tricky if there is no real in-house capability to manage such contracts. Moreover, there is growing evidence[10] that relationships based on cost minimisation are unlikely to provide sustainable competitive advantage and will rarely lead to innovation. Instead, the most effective forms of long-term outsourcing tend to have a perspective that is diametrically opposed to concerns about cost–minimisation, focusing instead on risk–sharing and collaboration[11]. We therefore approach the question of cloud computing cognizant of the challenges and experiences of IT outsourcing and draw our analysis in terms of these insights.

Cloud Technologies—Four Elements of Desire

While the idea of providing computing as a service through networks dates back to the 1960s[12], and was the driving force behind the early development of the Internet[13], it was the dot-com boom, and the associated explosion in fibre-optic networking, which allowed internet companies to provide services which are equivalent to running a LAN based service. This change allowed the much promised "Application Service Provision" and NetSourcing[14] to become commercial realities—now termed cloud computing.

In order to understand the technological direction of cloud computing, and thus to evaluate differing technology options, it is necessary to understand the distinct dimensions by which the various offerings differ from existing solutions. We therefore define a set of dimensions which enable easy comparison between offerings—and enable the evaluation of new offerings against old. Crucially however our **"Desires Framework"** strips out the "value-added" benefits of cloud—the stuff of marketing hype—and allows organisations to focus on the specific differences, and thus make decisions on such differences alongside the promised benefits. Our framework consists of four desired dimensions of the different offerings—Equivalence, Abstraction, Automation, and Tailoring (see Table 1).

Table 1. Cloud 'Desires' Framework (source: authors)

Equivalence	The desire to provide services which are at least equivalent in quality to that experienced by a locally running service on a PC or server.
Abstraction	The desire to hide unnecessary complexity of the lower levels of the application stack.
Automation	The desire to automatically manage the running of a service.
Tailoring	The desire to tailor the provided service for specific enterprise needs.

By considering these dimensions we can evaluate the four key types of cloud computing offering—SaaS, PaaS, IaaS and Hosted Services. A summary is shown in Table 2.

SaaS—Software as a Service

This is the highest level of abstraction in which complexity is hidden at the application level. The cloud provider runs all elements of the service with the user presented with a complete application—usually through their browser. Equivalence is achieved if the application meets users' functional requirements—if the application does what they need it to do. Examples include SalesForce.com but also complete "desktop" applications such as Google Apps. Automation is high since the user is not required to consider the management of the service. The tailoring of the service to specific needs is limited by its author—who remains in control of the applications development path.

Table 2. Four Types of Cloud Computing Offerings (source: authors)

	Equivalence	Abstraction	Automation	Tailoring
SaaS	Defined by functional requirements	At the level of the application	High degree of automation	Limited by application
PaaS	If aligned to existing development practices	To the level of integrating components	Core management tasks automated	Through assembly of "lego" components
IaaS	Close to that of a server	At the hardware level	Limited to hardware management	Complete application stack without networking
Hosted Services	Equivalent to server ownership	No abstraction	Limited management	Complete application stack

PaaS—Platform as a Service

Abstraction occurs at the development-environment level—with the underlying computing resource hidden but with developers given the freedom to tailor components in order to develop specific services. Described as like Lego[15] the tailoring is constrained by the building blocks provided by the vendor. Automation is relatively high—as all basic management of the underlying hardware is handled by the platform, but with management of the application left to the user. Examples include Microsoft Azure, Google App Engine and Force.com. Such services can achieve high equivalence if they capitalise on existing software development practices. Microsoft Azure for example is closely equivalent to existing Microsoft development practices.

IaaS—Infrastructure as a Service

Here abstraction occurs at the hardware level—with only a simulation of underlying hardware provided to the user (based on virtualisation[16]). Automation is limited to ensuring the virtual machine runs—with users required to run the operating system and management services such as backup, monitoring and networking. Equivalence is close to that of owning a local server, as is tailoring. Examples include Amazon's Elastic Compute Cloud and RackSpace.

In each of the above examples the physical hardware is abstracted from the user. This allows multi-tenancy in which a number of users' services are consolidated onto shared hardware. Traditionally most servers run below capacity as they needed to be provisioned for peak demand rather than average usage. Multi-tenancy thus enables vast reductions in the costs of processing, power and cooling. Further statistical multiplexing (selecting the "tenants" of the server such that their demand for processing complement each other) ensures high utilisation of the processors at all times.

Hosted Services

Hosting servers in outsourced data centres predates the "cloud" term and is often ignored from cloud debates—however it should be included in the mix when considering some intensive business applications which are inappropriate for virtualisation. Here no abstraction occurs—a physical machine is hosted in the cloud providers' data centre, and is managed remotely by the user. Automation is minimal, but equivalence is only limited by network latency, and tailoring is closely equivalent to a locally hosted server. As there is a direct equivalence of hardware no benefit in cost reduction is achieved through multi-tenancy or statistical multiplexing.

Having defined the basic concepts we discuss the direction cloud computing technology is moving in the near future.

Cloud Ecosystems

Once equivalence is achieved between the local data centre and the cloud it is possible to create enterprise services by "mashing up" the services from a variety of cloud providers to create what has been termed a cloud ecosystem. This integration allows the tailoring of services to specific business needs using a mixture of SaaS, PaaS and IaaS —though considerable technical skill is required to integrate such services. Further the resultant ecosystem is limited by the service quality of the weakest component. Such ecosystems have been termed **"BPaaS"—Business Process as a Service**—reflecting the focus on business specific services.

As equivalence is achieved between existing internal data centre computers and cloud-provided services so it is possible to use a hybrid mix of internal machines and cloud-provided machines within a business process. This so-called **hybrid cloud** allows parts of the process to be run internally (e.g. handling sensitive data), when other parts of the process run at low cost externally. Further **"cloud bursting"** can occur where services are run internally but 'burst' to the cloud when internal capacity is insufficient to meet demand.

For many enterprises who already operate large-scale data centres the economy-of-scale benefits of IaaS and PaaS are limited (particularly if they already operate multi-tenanted servers)—whereas the risks of outsourcing to the cloud are perceived to be high. In response software vendors have created software to operate existing enterprise data centres as though they were a pay-as-you-go (PAYG) cloud provider (albeit to one customer—the enterprise[17]). Such private clouds benefit from the automation and abstraction of service provision from business needs and allow billing of IT service usage to business units. In response some IaaS and PaaS providers are offering equivalent **virtual private clouds**[18]—in which a cloud-provider dedicates (and separates) part of their data centre wholly to one enterprise as though it were their own private cloud accessed by secure virtual networking. In such cases automation is provided—but with a high degree of resource tailoring.

Another interesting technology relevant to cloud computing is the Container Data Centre. Some enterprises are unable to exploit the public cloud but demand data centre renewal or expansion. The shipping-container-based **modular data centre** responds by providing a complete data centre within a shipping container (or some form of modular box). All elements of a data centre are pre-configured and all that is required is power, water (for cooling) and network connectivity. Such facilities allow the rapid creation of relatively automated data centres which could themselves be used for hosting private or public clouds at relatively low cost where network equivalence is not achievable. Examples include financial services (where latency is a key issue), military uses (where connectively is generally poor), or where legislation demands hosting in particular locations (e.g. data protection laws require data to remain inside a country).

Finally, though, it is worth reflecting on the trajectory of computing in general. Gordon Moore's[19] famous "law" of microprocessors continues apace and this will impact upon the cloud providers,[20] dynamically changing their cost and profit models. The attraction of moving to the cloud must thus be compared with the speed by which the service being rented PAYG becomes cheaper to purchase. Modern multi-core processors are designed to support the running of many virtual machines per server[21]. In a few years it may be possible to purchase processors capable of running entire 2010-equivalent data centres on one server. As a result we note that long-term cost benefit modelling for cloud computing is immature and demands much further attention.

Cloud must be seen in the context of previous so-called "revolutions" —particularly in technology and in service outsourcing.

Conclusion: Future Papers

During 2011 we will be producing four further articles that elaborate on the very rich findings from our research work on Cloud. A combined report will be updated and produced at the end of 2011.

The next papers organise our findings into a series of four further areas that emerge from the research as highly significant. These are:

Part 2 – Challenges

Part 3 – Impacts

Part 4 - Innovations

Part 5 - Management

In the next, second paper we look at the perceived and real **challenges** cloud represents for business, IT and supplier executives. We find different stakeholders weighting the risks and challenges differently, and provide a detailed assessment of what are the significant challenges, and what can be done about these. The emerging challenges include security and legal risks, defining the relationship, the lock-in dilemma, and managing in the cloud.

In the third paper, we detail the meaning of cloud for IT suppliers, IT functions and businesses, and separate out near- and long-term **impacts.** We document the drivers of near-term developments. We assess the significance of these and long-term impacts for a range of sectors, the supply industry and customers and users of cloud. A particular focus will be on three areas of impact: service performance, cloud as a business service, and radical changes in the supply industry. Our research uncovered the initial appeal of cloud lying with potentially dramatic cost reduction. At the same time respondents were clear that the technologies provided massive potential not just for transformation of the technology platforms on which they operated, and also the financial and service relationships with suppliers, but also for major business **innovation.**

Our fourth paper describes these potential innovations, including a detailed picture of moves we are already witnessing towards a cloud-enabled agile, 'ambidextrous' organisational form—what we call the cloud corporation.

Further research in the series will support our already rich vein of findings on the **management** issues raised by cloud. Cloud technologies, we are finding, have far-reaching implications for client and supplier skills sets and capabilities, and also for the roles of senior executives and business managers in harnessing the potential of cloud for future business advantage. In the fifth paper, we conclude our report with a detailed assessment of the management capabilities required to give meaning to the radical possibilities inherent in further developments in cloud technologies.

A Note on Methodology

This paper, and four subsequent papers, draw on four main sources—an interview base, industry and academic reports, the LSE Outsourcing Unit 1,600 organisation database, and a large-scale survey. We undertook thirty-five initial interviews with leading industry players across the cloud supply chain. These will be added to during 2011, following the same procedures outlined below and the additional insights will inform the remaining papers. We interviewed providers of cloud infrastructures and services, system integrators and users of cloud services. In terms of roles, we spoke to CEOs, CIOs, marketing managers and service directors. Interviews were normally undertaken by one person and were held over the phone. They typically lasted at least one hour, with some running to over two hours.

Each interview was then transcribed and the transcripts shared amongst the research team. Each interview was then coded by one member of the team. Initially codes were used to simply classify each element ("quotations") of the interview. For example, some parts of the interviews related to "hybrid clouds" others to "lock–in" or "pay–as–you–drink models". As the interviews were being coded, a parallel process of consolidation took place.

The first step towards consolidating codes into analytically distinct segments that can be examined together both within and between interviews involved tidying up the initial codes, for example by combining codes that covered the same concept but were labeled slightly differently. For example, codes initially labeled as "pay–as–you drink" and "pay–per–drink" models were merged. This process of analysis was also based on, and contrasted with, themes from the cloud and outsourcing literatures[22]. The process involved an iterative reading, coding and cycling through the codes. The validity of the coding and analysis was constantly checked by searching for counter examples and nuances in the text and codes.

The resulting codes and associated quotations were then shared with the remainder of the project team. This resulted in further insights and themes to explore.

Finally, a selection of the coded quotations was selected for presentation in the current report[23]. The selection process was guided by the need for a coherent narrative flow in the paper.

In addition to reviewing the academic literature and associated industry reports, a distinctive feature of the work reported is the inclusion of results from a large–scale survey of IT industry practitioners. The survey was undertaken by HfS Research[24] in conjunction with the LSE Outsourcing Unit. HfS Research is the foremost research analyst firm and social–networking community that is focused on helping enterprises make complex decisions with their global sourcing strategies. It has 120,000 monthly visitors and over 50,000 subscribers and leverages this community of sourcing professionals to deliver rapid insights on the global sourcing industry.

The survey ran between October and November 2010. Many of the key results from the survey are presented in this "Cloud and the Future of Business" report. Other views on the data are available on the HfS site[25]. The survey was conducted online and disseminated across a broad number of networks and media to collect a random sample of 1. business executives (non-IT executives), 2. IT executives and 3. technology vendors, advisors/consultants and service providers of cloud-based services. The survey was sent in a number of outgoing emails and was also available live on a number of popular websites and blogs. Three separate question sets were developed that were tailored to these three groupings. Each question set was completed via a 12-minute web-based questionnaire. IP addresses were collected to ensure duplicate responses were deleted. Networks were spread across multiple technology blogs and media, largely ZDNet blogs, Global Services Media, Shared Services & Outsourcing Network and the HfS Research subscriber-base (accounting for 75 percent of respondents). 1035 responses were collected, 214 from IT executives, 414 from business executives 407 from technology vendors, advisors/consultants and service providers of cloud-based services.

Contributing organisations

The Cabinet Office, UK
Glasshouse
RAPP
SpiritMedia
VMWare
GridPP
SAP
Microsoft
Accenture
EMC
Salesforce
Cable & Wireless
CERN
PA Consulting
Logica
Royal Sun Alliance
RightNow
Fujitsu

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Endnotes

1 SNA is IBM's proprietary networking architecture. Created in 1974 it is a complete protocol stack for interconnecting computers and their resources. SNA describes the protocol and is, in itself, not actually a program. The implementation of SNA takes the form of various communications packages, most notably Virtual telecommunications access method (VTAM) which is the mainframe package for SNA communications. SNA is still used extensively in banks and other financial transaction networks, as well as in many government agencies.

2 Microsoft CEO, Steve Ballmer, gave this speech at London School of Economics and Political Science on 5th October 2010—*Seizing the Opportunity of The Cloud: The Next Wave of Business Growth.* On www.lse.ac.uk—see media and events.

3 This survey was conducted in conjunction with HfS Research. See Note on Methodology.

4 Details of the interviews conducted and how they were analyzed are given in the Note on Methodology.

5 Telephone interview with Tim Barker 22 September 2010.

6 Early versions of these technological capabilities include Application Service Provision (ASP) and Netsourcing. For a detailed study see Kern, T., Lacity, M. and Willcocks, L. (2002) *Netsourcing; Renting applications, services and infrastructure over networks.* Prentice Hall, New York. See also Killalea, T. (2008). "Meet the Virts: Virtualisation technology isn't new, but it has matured a lot over the past 30 years." *ACM Queue* 6(1): 14-18.

7 As an illustration only, one early example of the service perspective is in the management of elevators—instead of annual contracts where they inspect an elevator, say, every January, they provide a constant monitoring service and send in the engineer whenever a problem is noted.

8 Interview with Jimmy Harris of Accenture.

9 See the following reviews which cover the major research studies of outsourcing 1992-2010, and show strongly these results: Lacity, M., Khan, J. and Willcocks, L. (2009) A Review of the IT Outsourcing Literature: Insights For Practice. *Journal of Strategic Information Systems*, 18, 130-146; Lacity, M. et al. (2010). A Review of the Empirical IT Outsourcing Literature and Future Research Directions. *Journal of Information Technology*, 25, 4, 395-433.

10 See Willcocks, L. and Craig, A. (2010) *Step-Change in Outsourcing.* LSE Outsourcing Unit Working Paper, LSE, London.

11 See Willcocks, L., Cullen, S. And Craig, A. (2011) *The Outsourcing Enterprise: From Cost Management To Collaborative Innovation.* Palgrave, London.

12 In 1969 Leonard Kleinrock from ARPANET said "As [computer networks] grow up and become sophisticated, we will probably see the spread of 'computing utilities' which, like present electric and telephone utilities, will service individual homes and offices across the country" Kleinrock, L. (2005) "A Vision for the Internet," *ST Journal of Research,* (2:1) pp 4-5.

13 Berman, F. and T. Hey (2004). *The Scientific Imperative. The Grid 2.* I. Foster and C. Kesselman. San Francisco, Morgan Kaufmann.

14 Kern, Lacity and Willcocks (2002), *Netsourcing Business Applications: Renting Business Applications and Services Over a Network.* London, Financial Times/Prentice Hall.

15 Knorr, E. and G. Gruman. (2010). "What cloud computing really means." Retrieved 20th December, 2010, from www.infoworld.com/d/cloud-computing/what-cloud-computing-really-means-031?page=0,1.

16 Virtualisation is providing a software simulation of computing hardware. Each simulation thus looks and acts like a physical machine and must run an operating system (e.g. Windows or Linux). Virtualisation allows a decoupling of hardware from the virtualised machines—for example, running multiple virtual machines on one physical machine, moving virtual machines between physical machines and even saving virtual machines to disk or tape. Virtual Machines are managed by virtualisation software (often called the hypervisor), of which VMWare is an example.

17 E.g. VMWare's V-Cloud director www.vmware.com/products/vcloud-director

18 E.g. http://aws.amazon.com/vpc/ or Google's secure data connection to its App Engine.

19 Moore, G. E. (1965). "Cramming more components onto integrated circuits." *Electronics*, 38(8).

20 As stated in a recent article concerning Cloud Computing: Brynjolfsson, E., P. Hofmann, et al. (2010). "Economic and Business Dimensions Cloud Computing and Electricity: Beyond the Utility Model." Communications of the ACM 53(5): 32-34.

21 Underdahl, B., M. Lewis, et al. (2010). Cloud Computing Clusters for Dummies—AMD Special Edition. Hobeken, NJ, Wiley Publishing Inc.

22 Eisenhardt KM (1989) Building theories from case study research. *Academy of Management Review*, 14(4), 532-550.

23 Golden-Biddle K and Locke K (1993) Appealing work: An investigation of how ethnographic texts convince. *Organization Science*, 4(4), 595-616.

24 www.horsesforsources.com/research-services

25 Link to HfS blog is www.horsesforsources.com/

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