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Present and Future of Cloud Computing: A Collaborated Survey Report

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Abstract*: Cloud computing is one of the most discussed IT trends of this decade, and rightly so. This paper provides an executive summary of cloud computing over the past few years and expected ratio of cloud usage in the next five years. The results are collated from responses of several individuals as to their usage and preferences for infrastructure, virtualization, cloud investments and other cloud computing technologies. What differentiates this paper is its focus on analyzing and quantifying the effects of the migration of application workloads to cloud environments. This measurement enables us to estimate better the magnitude and longevity of cloud impacts and to understand the derivative impacts on existing technologies. We introduce the paper with the report showing the deployment of cloud computing in the world. Then the factors influencing and affecting the adoption of cloud computing are discussed. We also discuss the impact of cloud computing on IT manageability and cloud investments. The purpose of this study is to get firsthand accounts of companies' use of cloud computing and to quantify the potential, financial and environmental benefits that can be attained from this technology.

***Index Terms*: Cloud, Drivers, Hybrid, Infrastructure, Inhibitors, Platform, Private, Public, Security, Virtualization**

I. INTRODUCTION

Cloud computing is a collection of Internet-based or private-network services providing users with scalable, abstracted IT capabilities, including software, development platforms and virtualized servers and storage. Although not new as a concept, Cloud computing is new in its generalized application to all IT services and is the next step in the relentless journey of corporate IT. Given its profound impact, Cloud computing cannot be ignored. To those who have embraced Cloud computing, it is powerful and is already embedded within their professional and personal lives. To others, it is immature, hyped, and distant, yet intrinsically compelling. Such conflicting descriptions are to be expected in any nascent industry, all the more so in one that is still searching for a clear definition to encapsulate a profound but subtle technological evolution.

Over the past five years, cloud computing has become one of the defining secular trends within technology [1], and we believe the effects are just beginning to be felt across the industry. As the ecosystem around cloud computing develops, it is important to understand what factors influence cloud computing adoption, so that the members of that ecosystem can adapt to the needs of cloud computing users.

II. WHAT WE DID AND WHY

The methodology used in this report aligns with the assessment methodology established by various companies which are leading ICT companies and non-governmental organizations committed to achieving sustainability objectives through innovative technology. The basis for our analysis is a global survey of 309 IT decisions makers on where application workloads are currently run, where they expect workloads to run going forward, and what the spending impacts from the migration of workloads to cloud environments might be. Few organizations out of those were cloud.com [2], GoGrid [6], 451 Group, CIO [3], Avanade [5], Bitnami, North Bridge [11], Gartner [10], Symantec [12], Morgan Stanley [1]. Our report is generated from the survey data collected by the above companies and sites in the year 2011. Their research methodology was based on:

- In-depth case studies with many multi-national corporations, across a broad spectrum of industries, who have invested in cloud computing
- In-depth interviews with experts from three global cloud computing service providers.
- The survey was also conducted via pop-up, email and social media invitations in the year 2011.
- A broad range of industries are represented including high tech, telecom, services, government and nonprofits and healthcare.

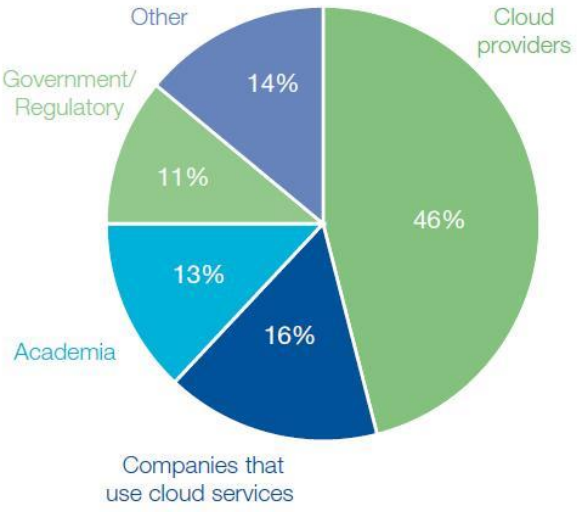

Figure 1. Respondents by organization type

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Respondents were divided into two categories based on the organization type and geography. People from academic institutions, government, companies using cloud services and cloud providers are the various respondents from different organizations. Majority of respondents were cloud providers (Fig 1). People from various parts of the world were involved in survey process. Respondents from North America hold the major part in geography (Fig 2).

The experts who participated in the research generally believe that business, government organizations, and countries have seen only the tip of the iceberg with regard to the benefits that cloud computing will deliver in the next ten years.

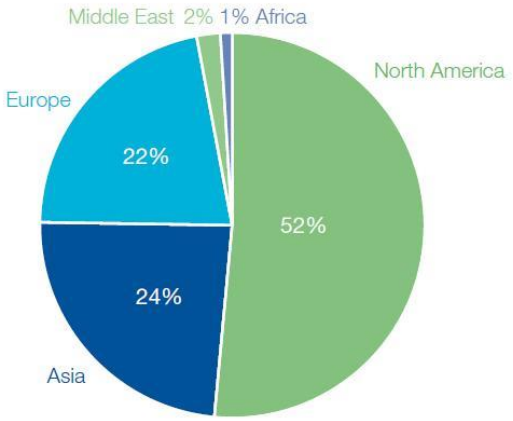

Figure 2. Respondents by geography

III. CLOUD COMPUTING PREFERENCES

The report was designed to collect information on the use of cloud computing technologies based on the surveys among and to help inform the evolution of cloud computing technologies and services. The following section deals with cloud computing preferences in 2011.

A. How do customers characterize their approach to using cloud computing today?

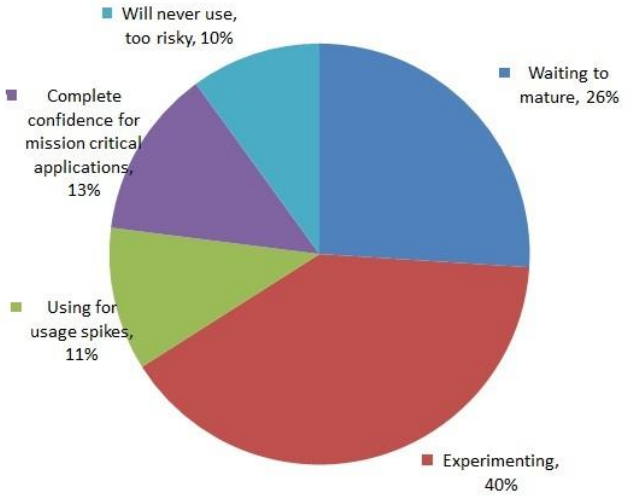

Figure 3. Customer Opinion

Fig 3. shows the chart representing how the customers characterize their approach to using cloud computing today. 40% say that they are experimenting the usage of cloud computing and 26% are waiting for the cloud technology to mature.

B. How serious is the issue of "lack of understanding of cloud computing"?

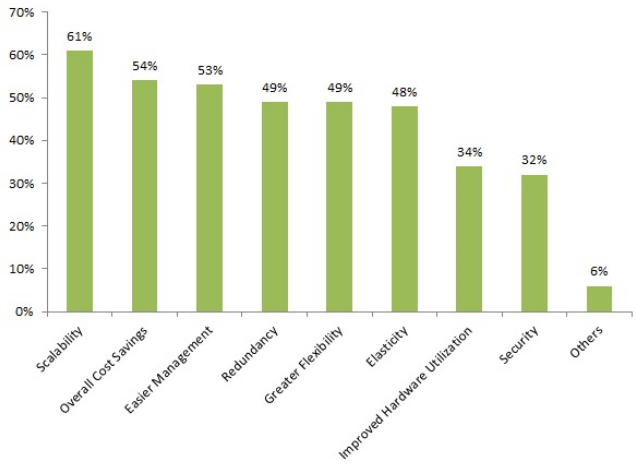

Figure 4. View of lack of understanding

Fig 4. brings the customers view about their understanding of cloud computing strategy. 46 % people are aware of cloud concepts and 18 % people are not bothered about the cloud computing technology. 36 % of people are somewhat serious about the cloud.

C. What is "cloud" and what does it encompass?

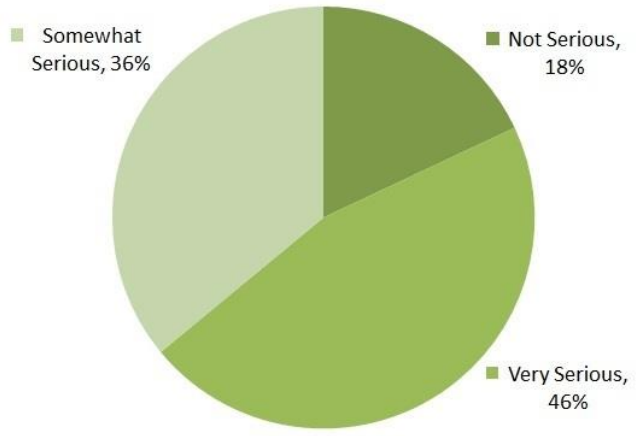

Figure 5. Cloud computing services

Once a cloud is established, how its cloud computing services are deployed in terms of business models can differ depending on requirements. The primary service models being deployed (see Fig. 5) are commonly known as SaaS (Software as a Service), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service). The above figure was obtained based on multiple answers received which added up to more than 100%.

D. What is the strategy of cloud customers today?

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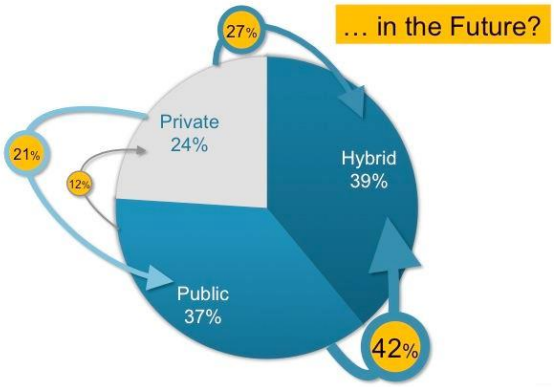

Figure 6. Cloud deployment models

The above figure shows the strategy of cloud customers today and how does it gets transformed in the future. The value enclosed inside the yellow area represents the change in the upcoming years.

E. Which of the following aspects of cloud computing is of most interest?

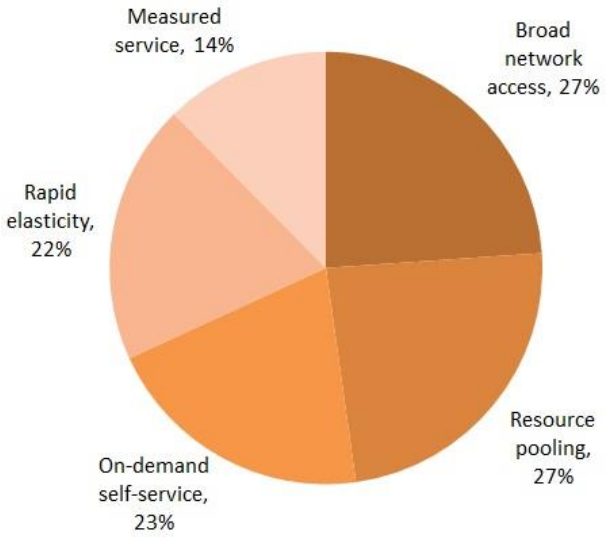

Figure 7. Customer interest towards cloud benefits

Broad network access and Resource pooling are the major attributes that distinguish cloud computing from conventional computing. On-demand self service, Rapid elasticity and measured services are the other important attributes of cloud computing.

IV. DRIVERS FOR CLOUD ADOPTION

Cloud computing exhibits obvious advantages linked to its characteristics. The pay-as-you-go model and multi-tenancy lead to increased ROI with quicker payback and lower upfront investment. High abstraction and immediate scalability lead to accelerated deployment, greater flexibility, and greater focus on core competencies. The following graph shows the factors which are influencing the choice to use cloud computing.

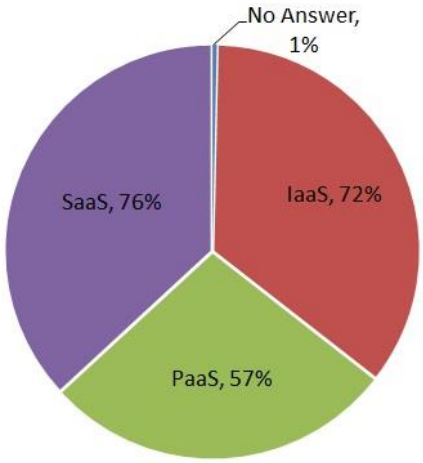

Figure 8. Cloud adoption drivers

The factors which influenced the cloud computing adoption [15] are Scalability, Cost savings, Easier management, Flexibility, Elasticity and many more. Scalability and cost savings sits at the top of drivers of cloud adoption. Fig 8. shows the average percentage of various drivers.

V. INHIBITORS FOR CLOUD ADOPTION

A number of inhibitors are consistently cited in the discussion of Cloud computing adoption. However, their perceived impact often differs from the actual impact.

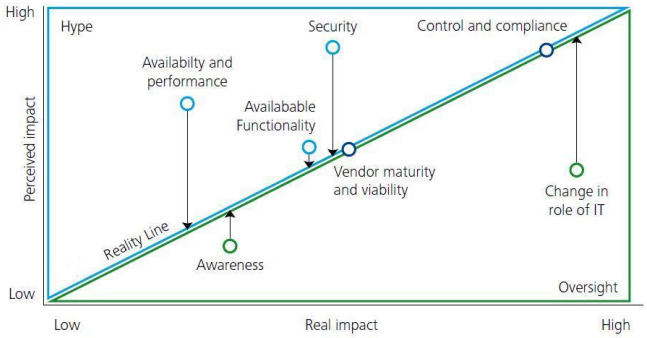

Figure 9. Real and perceived impact

The above diagram shows that inhibiting concerns, such as security, availability and performance, and control and compliance are perceived as more important than they should be, while Cloud awareness and resistance to change in IT are typically underestimated. Security is far and away the leading concern of IT leaders when they consider the implementation of cloud computing technologies.

Figure 10 shows the list of inhibitors [15] responsible during cloud adoption. Security is the top inhibitor in adopting clouds. Interoperability, vendor lock-in, compliance, reliability, complexity, privacy have equal impact in adopting cloud computing.

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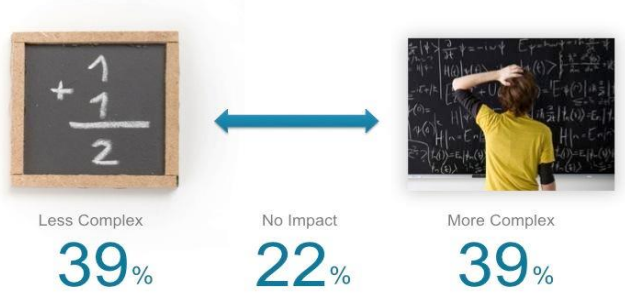

Figure 10. Cloud adoption inhibitors

VI. IMPACT OF CLOUD COMPUTING ON IT MANAGEABILITY

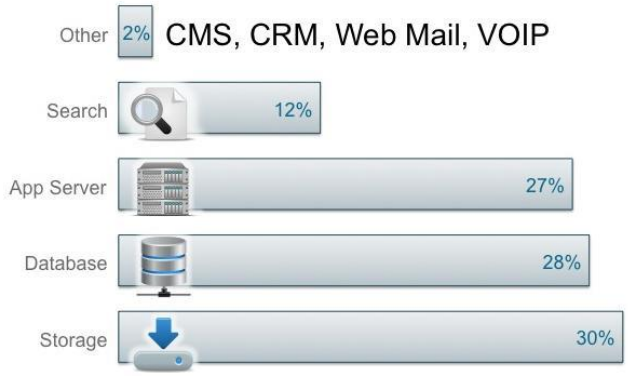

Figure 11. Impact of cloud on IT

Figure 11 shows the impact of cloud computing on IT manageability. 39% of people say that impact will be less complex and another 39% say that it will be more complex. Whereas 22% say that there will be no impact of cloud computing implementation.

VII. CLOUD BASED SOLUTIONS ARE A TOP INVESTMENT PRIORITY

On average, respondents plan to invest around $1.2M in cloud-based solutions in the next 12 months. This figure increases significantly for enterprise organizations ($2.2M). Top areas of cloud computing (rated as a high or moderate investment priority) over the next 12 months (Figure 15):

- Software-as-a-Service (62 percent)
- Storage-as-a-Service (44 percent)
- Infrastructure-as-a-Service (39 percent)

It should be noted that expected investment in Platform-as-a-Service (PaaS) (31 percent high/moderate priority overall) is significantly higher among enterprise organizations (39 percent) than small- to mid-sized organizations (23 percent). Similarly, expected investment in Data-as-a-Service (DaaS) (23 percent high/moderate priority overall) is significantly higher among enterprise organizations (29 percent) than small-to mid-sized organizations (18 percent) and expected investment in Network-as-a-Service (NaaS) (25 percent high/moderate priority overall) is significantly higher among enterprise organizations (30 percent) than small-to mid-sized organizations (19 percent).

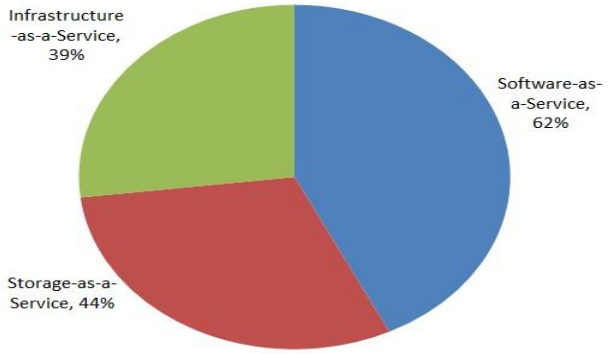

Figure 12. Investment options

VIII. VENDORS AND CLOUD COMPUTING

The following set of questions was raised to vendors about their cloud services and results were drawn with the help of charts as shown below. It describes about the way through which vendors use cloud services and their primary revenue sources. 30% of vendors say that they use cloud services through the storage and 28% say that they do by means of database and application server. Few people have those by means of CMS, CRM, web mail, VOIP, etc.,

A. How vendors use cloud services?

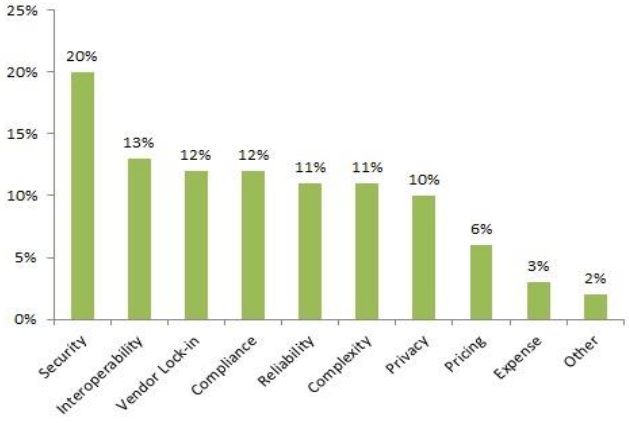

Figure 13. Vendors usage of cloud services

B. What are the vendor's primary revenue resources?

Figure 14. Vendor's revenue resources

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The above figure represents the various revenue resources of vendors when concerned with cloud computing. Figure 14 denotes that the major revenue comes from the SaaS subscription fees.

C. Who are the vendors gaining most benefits from adoption of cloud?

Several vendors with cloud offerings stand to benefit from this trend. Many of these vendors—Amazon, IBM, Microsoft— have established cloud products and have been active in this space for a number of years.

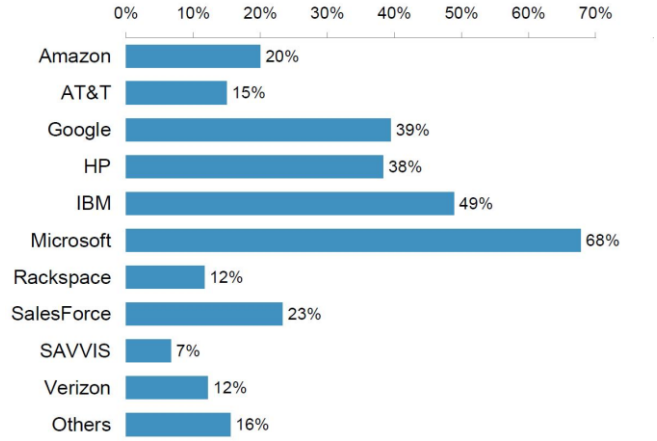

Figure 15. Major vendors

We note that although several vendors stand to benefit from this trend, Microsoft is likely to gain most from a broader adoption of the cloud. Of all respondents, 68% of all respondents who expect to move workloads or provision new ones to the cloud environment mention Microsoft as their preferred vendor of choice—a surprisingly high number. This is consistent across regions and company size.

IX. TOP UP AND COMING CLOUD COMPANIES

In this section we have identified the top up-and-coming cloud companies [18, 19] that are helping customers do everything from keeping their cloud costs low to implementing their own private clouds to meeting security and regulatory needs. By now we are familiar with the big names in the cloud computing industry, such as Amazon, Rackspace, and VMware. With publicly-traded giants like Amazon, Google, VMware, Microsoft, Cisco and Salesforce lurching around with new and improved services that can help businesses with cost and efficiency gains, sometimes it's easy to miss the hot players that are up-and-coming. We have assembled a list of private cloud companies such as cloudera, nasuni, Eucalyptus, Assistly that we think are particularly intriguing – they're focused on massive opportunities and leading the disruption in the sector they're targeting.

A. Amazon

Amazon is one of the true innovators in Web-based computing, offering pay-as-you-go access to virtual servers and data storage space. In addition to these core offerings, Amazon offers the SimpleDB (a database Web service); the CloudFront (a Web service for content delivery); and the Simple Queue Service (a hosted service for storing messages as they travel between computers). By launching the Elastic Compute Cloud in 2006, well before most of its competitors, Amazon has become almost synonymous with "cloud computing". But criticisms are starting to pop up regarding Amazon's reliability and service-level agreements.

B. Google

Google Apps, a set of online office productivity tools including e-mail, calendaring, word processing and a simple Web site creation tool; Postini, a set of e-mail and Web security services; and the Google App Engine, a platform-as-a-service offering that lets developers build applications and host them on Google's infrastructure. No one knows the Internet quite like Google. While the company's main focus is crawling the Web and delivering advertising-supported search results, Google's foray into software-as-a-service applications for businesses is hastening the industry's move from packaged software to Web-hosted services, and App Engine provides a credible alternative in the platform-as-a-service market.

C. Microsoft

Azure, a Windows-as-a-service platform consisting of the operating system and developer services that can be used to build and enhance Web-hosted applications. Azure is in beta until the second half of 2009. We are watching it now because this is Microsoft's first big foray into the cloud. But for all of Microsoft's might, it is still a new player in the cloud market and has questions to answer. For example, will it be easy to move existing applications onto the Azure platform, and will Microsoft avoid the tendency toward vendor lock-in – which is bad for users but has been tremendously profitable for Microsoft in the world of packaged software.

D. Rackspace

The Rackspace Cloud, also known as "Mosso", consists of three major services: Cloud sites, a platform for building Web sites; Cloud Files, a storage service; and Cloud Servers, an Amazon EC2-like service that provides access to virtualized server instances. Rackspace has a long history of offering hosted data center services and is a trusted name in the enterprise. With Mosso, Rackspace is taking aim at the platform-as-a-service and infrastructure-as-a-service markets, the two key areas for customers looking to build Web-hosted applications.

E. VMware

Virtualization is the essential catalyst for cloud computing. As the virtualization leader, VMware builds on this solid foundation with platforms and solutions to power the cloud infrastructure, build and run robust cloud applications, and supply end-user computing as a cloud-based service. Their approach is comprehensive, but unlike other cloud offerings, it's not one-cloud-fits-all. To deliver competitive advantage, cloud computing must be flexibly tailored and aligned to the individual needs. For an enterprise, that could mean a cloud that's internal and private, one that leverages external services, or a hybrid cloud that combines both. VMware offers a complete solution stack for building and managing it, plus a broad partner ecosystem to ensure that everything in it works seamlessly and securely. The result is not just any cloud, but your cloud—where accelerated IT delivers accelerated results for the business.

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Figure 16. Hot cloud companies

F. Eucalyptus

Eucalyptus enables the creation of on-premise Infrastructure as a Service clouds, with no requirements for retooling the organization's existing IT infrastructure or for introducing any specialized hardware. The Eucalyptus Infrastructure as a Service (IaaS) platform maintains high fidelity with the Amazon Web Services (AWS) API, allowing support for both on-premise and hybrid IaaS clouds. This compatibility allows any Eucalyptus cloud to be turned into a hybrid IaaS deployment, capable of moving workloads between AWS and on-premise data centers. Eucalyptus is compatible with a wealth of tools and applications that also adhere to the de facto AWS API standards.

G. Cloudera

Cloudera, the commercial Hadoop company, develops and distributes Hadoop, the open source software that powers the data processing engines of the world's largest and most popular web sites. Founded by leading experts on big data from Facebook, Google, Oracle and Yahoo, Cloudera's mission is to bring the power of Hadoop, MapReduce, and distributed storage to companies of all sizes in the enterprise, Internet and government sectors. Headquartered in Silicon Valley, Cloudera has financial backing from Accel Partners, Greylock Partners and angel investors who include Diane Greene (former CEO of VMware), Marten Mickos (former CEO of MySQL), and Jeff Weiner (CEO of LinkedIn).

H. Acquia

Acquia Hosting (based on Drupal workflow process) is serving 2.2 billion page views a month for several hundred customers and growing rapidly. Like Acquia Hosting, the new single-server offering will come with an optimized stack for Drupal, including Varnish, Nginx, APC and Memcache, as well as all the tools to manage the lifecycle of your website. This new hosting offering will be called Acquia Dev Cloud. It will be great for people that want to build Drupal sites without the need for high-availability or help from Acquia to help scale and maintain their site. In many ways, Dev Cloud is the logical next step for Acquia Hosting, and helps us close the chasm between Drupal Gardens and Acquia Hosting.

I. Nasuni

Nasuni - The Gateway to Cloud Storage™ is a cost-saving SaaS solution that will allow IT organizations to harness all of the benefits of cloud storage (inexpensive, offsite, scale, capacity, etc.) with "in house" levels of security, performance and disaster recovery. Nasuni creates a secure, high-performance link to cloud storage. The technology offers an alternative to present-day IT headaches through virtually unlimited file storage capacity, automatic provisioning, periodic snapshots, fast restore of old files, high-performance caching, and end-to-end encryption of both data and metadata. The technology encompasses the Nasuni Filer, a downloadable, easy-to-use virtual appliance, and Nasuni.com, which includes a broad set of controls and monitoring services that set up and track the links to cloud storage providers.

X. IMPACT OF CLOUD COMPUTING

The concept of cloud computing has spread rapidly through the information technology industry. The ability of organizations to tap into computer applications and other software via the cloud and thus free themselves from building and managing their own technology infrastructure seems potentially irresistible. In fact, some companies providing cloud services have been growing at double- digit rates despite the recent economic downturn. A major benefit of cloud computing is reducing IT costs—a large and often increasing expense in every company but especially information-intensive organizations such as financial services and media.

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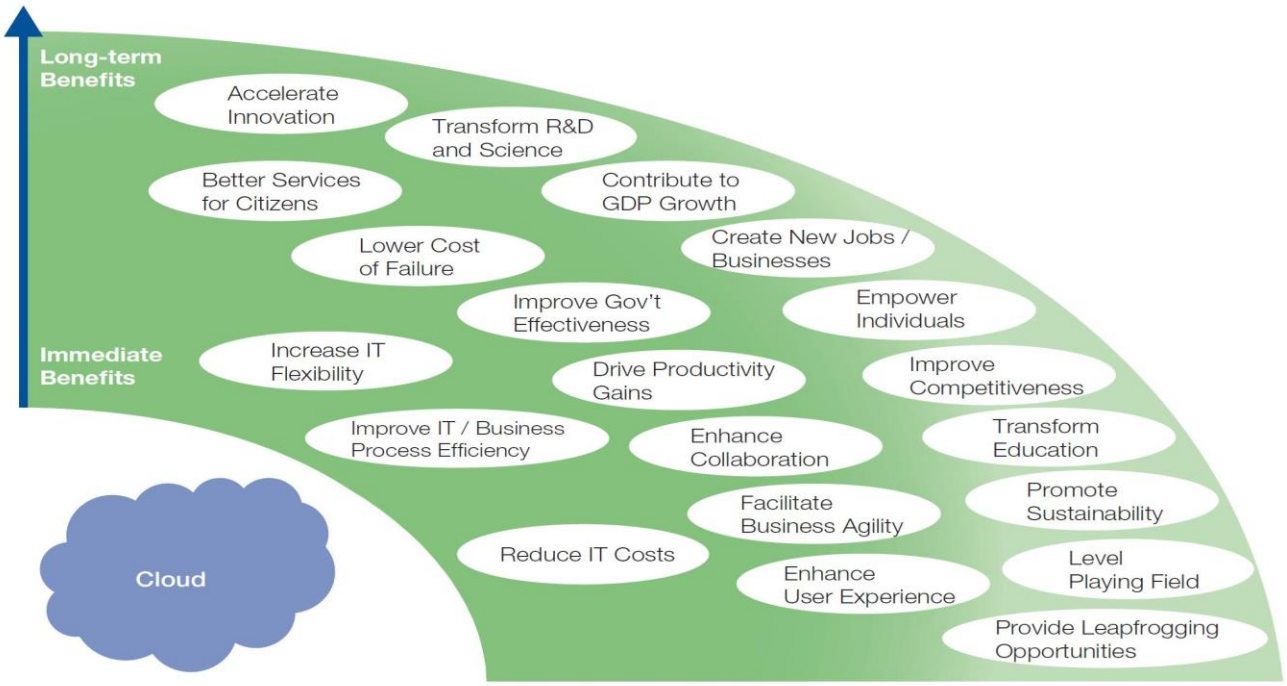

Figure 17. Examples of benefits of cloud

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

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

XI. EXECUTIVE SUMMARY

Cloud computing is seen by many as the next wave of information technology for individuals, companies and governments. This consolidated survey report was created with a goal of gaining a better understanding of key cloud computing trends taking place today and the effect these trends are having on organization. Although there are most certainly business advantages to deploying cloud-base solutions, there are also challenges and barriers of implementation. We present our summary of this report with the following points:

- Cloud computing brings business efficiency savings
- Respondents are heavily involved in the purchase process for cloud technology
- Hardware savings was cited as the most popular reason for using cloud-based storage
- Data residing in the cloud is expected to grow quickly
- The top factor influencing the use of cloud computing is scalability
- The biggest management challenge for cloud computing users was security.
- Building trust between and within the public and private sectors is essential for healthy development of cloud computing
- Most it professionals prefer to deploy their infrastructure using virtualization
- Cloud already makes up an impressive portion of it budgets, and is expected to increase
- Cloud-based solutions are a top investment priority
- Vendors will be judged on a number of factors
- Cloud computing can avoid millions of metric tons of CO_2
- The cloud is viewed as a supplement to it operations as opposed to a replacement

As expected, survey participants said a major benefit of cloud computing is reducing IT costs—a large and often increasing expense in every company but especially information intensive organizations such as financial services and media. Other benefits often cited were greater IT flexibility and more efficient business processes. However, we convened as part of our research believes such benefits are just scratching the surface of cloud's potential. Our study found that cloud computing has the potential to benefit organizations, whole industries, and even entire economies.

XII. CONCLUSION

Cloud computing has tremendous potential to benefit businesses, industries, and entire economies, but substantial challenges stand in the way.

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The study has defined potential actions for industry and governments to consider in order accelerate cloud adoption and generating benefits for all stakeholders – individuals, businesses, governments, and society as a whole.

The report shows that cloud computing is rising in terms of adoption, and that more organizations are looking at implementing cloud computing. While cloud computing still poses some challenges stopping a minority not to implement or consider cloud computing, it has definitely progressed and is now becoming mainstream. The anticipated business benefits in terms of business case, financial value, strategic direction and flexibility provided are appreciated by organizations worldwide and the current adoption curve confirms that cloud computing is here to stay and has a potential to transform business and IT.

While cloud computing has been a hot topic in IT the last couple of years, it has now also caught the attention of the business as they are ever more involved in the discussion, the decision on using cloud computing and the implementation of the solutions.

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Dr. R. Manickachezian (05/06/1965) received his M.Sc Applied Science from PSG College of Technology, Coimbatore, India in 1987. He completed his M.S. degree in Software Systems from Birla Institute of Technology and Science, Pilani, Rajasthan, India and Ph.D degree in Computer Science from School of Computer Science and Engineering, Bharathiar University, Coimbatore. He served as a Faculty of Maths and Computer Applications at P.S.G College of Technology, Coimbatore from 1987 to 1989. Presently, he is working as an Associate Professor of Computer Science in NGM College (Autonomous), Pollachi. He has published 45 papers in various International Journals and Conferences. He is a recipient of many awards like Desha Mithra Award and Best paper awards. His research focuses on Network Databases, Data Mining, Network Security, Bio-Informatics and Distributed Computing.

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