International Journal of Research in Social Sciences
Vol. 9 Issue 4, April 2019,
ISSN: 2249-2496 Impact Factor: 7.081
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

AN EXPLORATORY LITERATURE REVIEW ON ADVANCEMENTS IN APPLICATIONS OF CLOUD AND BI ;A TECHNO-BUSINESS LEADERSHIP PERSPECTIVE

Prof Dr.C.Karthikeyan[*]

AsstProfKrishna[**]

Ms Anna Benjamin[***]

Abstract; The origin of the term *cloud computing* is unclear. The word "cloud" is commonly used in science to describe a large agglomeration of objects that visually appear from a distance as a cloud and describes any set of things whose details are not further inspected in a given context. Another explanation is that the old programs that drew network schematics surrounded the icons for servers with a circle, and a cluster of servers in a network diagram had several overlapping circles, which resembled a cloud. In analogy to the above usage, the word *cloud* was used as a metaphor for the Internet and a standardized cloud-like shape was used to denote a network on telephony schematics. Later it was used to depict the Internet in computer network diagrams. With this simplification, the implication is that the specifics of how the end points of a network are connected are not relevant for the purposes of understanding the diagram. **Cloud computing metaphor**: For a user, the network elements representing the provider-rendered services are invisible, as if obscured by a cloud.

Key Words: Cloud; Computing; Application, Platform, Infrastructure, Service Oriented Architechture; SaaS;

[*] Director and Professor, Management Studies, T.John College, Bangalore, Affiliated to Bangalore University, Bangalore, Karnataka, and Accredited by NAAC "A", and Approved by AICTE, New Delhi

[**] Asst Professor, Management Studies,T.John College, Bangalore, Affiliated to Bangalore University,Bangalore, Karnataka, and Accredited by NAAC "A", and Approved by AICTE, New Delhi

[***] Asst Prof, T.John Institute of Management Science, Bangalore, Affiliated to Bangalore University,Approved by AICTE, New Delhi.

Objectives; (i) To know the basics of Cloud Applications.

(ii) To learn on the progress of Cloud from its Primitives

(iii) To learn about the service models on Cloud Computing applied in real life.

(iv) To educate on the applications and advancements in Cloud and BI

Methodology; Literature Study with secondary data from previous studies across the world

Data Used: Secondary Data

Review of Related Literature:

Mavodza,(2013) " libraries are using the cloud for putting together user resources, i.e. using Software as a Service (SaaS), such as in library catalogues, WorldCat, Googledocs, and the aggregated subject gateways like SUMMON, and others; the web Platform as a Service (PaaS) as in the use of GoogleApp Engine; or Infrastructure as a Service (IaaS) as in the use of D-Space, FEDORA, and others. The cloud is confirmed as a facilitator in storing and accessing information in addition to providing a unified web presence with reduced local storage capacity challenges" Few research studies has been made on cloud computing.

Yuvraj (2013) made a survey to find, how librarians in Indian Central Universities are using Cloud Computing tools into their daily library services and works. Result show that librarians are heavily dependent on cloud computing tools and majority of them are using various devices and want to imply the same to improve library services. Again, economics, delivery models and service layers and the user`s preference of cloud computing are the core drivers for using those applications in library, but majority of the librarians showed their concern over the security.

Abid M.H. et.al (2012) made a survey in 4 different universities of Faisalabad, Pakistan to find, the perception and what sort of issue, the IT administrators can face while using cloud computing. Findings show that most of the participants are familiar with cloud computing but unfortunately some of them are not much clear due to lack of resources. 91% participants replied that using of cloud computing is a highly security risk.

Mahalakshmi & Ally (2012) conducted a study to identify the awareness and applications of cloud computing by librarians of engineering colleges of coimbatore district and found that most of the respondents (98.2%) are aware of the term cloud computing and 87.7% of the respondents are aware of the application of cloud computing in libraries. Half of the respondents (52.6%) are of the opinion that it is feasible to apply cloud computing in libraries in Indian context. Many studies have examined the overall concept of Cloud Computing. However, research on librarian`s usage and acceptance level of Cloud Computing is not very significant. Again no study has been made before to find awareness and usage of cloud Computing among the library professionals in Odisha.

Jaeger Cloud computing is a group of computer resources that placed in a large data center and is able to dynamically provide computing resources to address a wide range of needs, in almost in all fields. Cloud computing is a revolution in the internet field and it offers computing resources as and when required such as electricity.

Chinyao, the high-tech industries are benefited by the adoption of cloud computing by certain factors. It reveals that significant effect on the adoption of cloud computing in top management support, firm size, etc. Aymerich, report that Cloud Computing is becoming popular and widely accepted. It is expected to enable companies involved in spreading this technology to open the doors to Web 3.0. The new features introduced by the cloud service will slowly replace many types of computational resources currently used.

Dong noted that e-learning systems are facing challenges of optimizing resource allocations, dealing with dynamic concurrency demands, handling rapid storage growth requirements and cost controlling. Hence, to overcome these problems, they proposed an e-learning framework based on CC called as BlueSky cloud framework. They explained the architecture and core components and claimed that it can be combined with traditional middleware functions (such as load balancing and data caching) to serve the requirements of e-learning systems as a general architecture.

Noor proposed the architecture of CC for education sector. They described how user 23 interface happens, the internal configuration of CC, etc., apart from presenting a comparative analysis of their proposed CC architecture with the existing one to demonstrate the advantages. They noted that CC has real advantage in terms of data portability, economic feasibility, etc., specifically with respect to higher education in Bangladesh.

Pocatilu attempted to measure the impact of using CC architectures upon e-learning solutions development. The proposed a set of CC efficiency metrics for enhanced e-learning implementation process control such as service availability, degree of security, ratio of planned budget to actual cost, etc.

Sultan provided adequate answers to those questioning the feasibility of implementing CC by discussing how the main users of IT services in a typical university can be migrated to the use of CC environment. He noted that students, lecturers, administrators can use SaaS and IaaS, while developers can use PaaS. Furthermore, he also dealt with the economics behind the existing IT support and highlighted about the flexibility and cost reduction that can be obtained by migrating to CC. He demonstrated the same using the case of University of Westminster, UK.

Alabbadi proposed a conceptual framework called “Education and Learning as a Service” (ELaaS) to highlight the utility of CC within education sector. The IT activities in the educational and learning organizations were classified with respect to the two criteria: mission criticality and sensitivity. Each class is then mapped into the appropriate position in the proposed Complete Cloud Computing Formations (C3F) resulting in a conceptual framework for ELaaS.

Behrend examined the factors that lead to technology adoption in a higher education setting. In particular, they attempted to understand the range of predictors and outcomes relating to the acceptance of a CC platform in rural and urban community colleges by conducting a survey among 750 community college students 24 enrolled in basic computing skills courses. They found that student’s ability to travel to campus; ease of use, level of instructor support, etc., are some of the important factors.

Alshuwaier not only described about some current CC-based educational and research products, but also evaluated the successful applications of CC models at educational institutions. Based on these, they suggested different ways to implement CC especially the CC-based education applications and education infrastructures for academic use.

Ercan too highlighted that the use of CC technology is more in the areas of finance and business (accounting for about 22 per cent), while it is very low in the education sector such as schools and education services (accounting for just 4 per cent).

Keahey enumerated the technologies utilized for establishing “science clouds” apart from highlighting a summary of the experiences of using these clouds. They discussed about the technical aspects in development of a science cloud named “Nimbus” by University of Chicago and the other science cloud developed by University of Florida with respect to the number of nodes, specifications, use of Internet Protocol (IP) address, virtualization etc. They discussed about its utilization and demonstrated how it helped in distributing the resources to create seamless platform for bio informatics applications. They also explained the obstacles and barriers faced during its use.

Khmelevsky evaluated the successful implementations of CC models at educational institutions and developed a research and 25 education prototype of a CC model. They demonstrated a real-life prototype of CC infrastructure which was developed for effective sharing and utilization of computing resources available with King’s University College and Okanagan College, Kelowna, Canada.

Doelitzscher enumerated in detail the building and working of the Hochschule Furtwangen University (HFU)’s own PRC infrastructure, called Cloud Infrastructure and Application (CloudIA). They explained how their cloud perform in each of the cloud service models, i.e. IaaS, PaaS and SaaS, to address the requirements and needs of e-learning and collaboration in an university environment.

Tan demonstrated how “Google Docs”, an application that is enabled by CC technology is utilized by the group of students pursuing a higher degree on Master of Business Administration (MBA) in a University at North Eastern US for carrying out their project needs. They found that it was really helpful for the students, who expressed they would be willing to these technologies quite often in the future too.

Stein discussed how CC can help K-12 education's academic mission by providing remote access to advanced learning tools, in a cost effective manner, especially to school systems struggling with reductions in local and state funding. They presented a case study, where an educational Cloud, the Virtual Computing Lab (VCL) developed by North Carolina State University (NCSU) in 2004 and available as Open Source from the Apache Foundation is used to provide dynamic visualization and simulation mathematics software to rural North Carolina high school ninth and tenth grade geometry and algebra classes.

Manro attempted to answer whether the services of CC are significant in the education sector – especially in the Indian scenario and concluded both the private and public educational institute can adopt the same. They noted that the educational institutes thus can outsource non-core services (i.e. the IT services) and better concentrate on offering students, teachers, faculty and staff the essential tools to help them succeed.

Gupta addressed the design and implementation of an academic cloud service christened "Baadal", which they claim to bridge the gap between a PRC and the requirements of an institution where request patterns and infrastructure are quite different from commercial settings. In particular, this cloud was developed to meet the requirements of researchers who run simulations requiring hundreds of virtual machines (VMs).

Chandra claimed that CC is a recurring expenditure model and hence it is accounted as standard Operating Expense (OpEx). They believed that OpEx is highly beneficial as it gives the flexibility to terminate costs at will, while a purchase of the server or software would result in the capital being fully committed to regardless of whether it is being utilized or not. Hence, they compared the costs of Total Cost of Ownership (TCO) Vs Cost per User per Month (CUM) model for an educational institute of 30 users for a period of three years. They also performed another analysis for replacing five PCs for an office environment in the education system by shifting to CC for an analysis period of 3 years and found that the cost savings as well as other benefits are very impressive apart from relieving from the burden of maintenance of computing infrastructure, etc. 27 Most importantly, studies documenting applications of CC in educational sector are reported from the developed countries in the west such as USA, UK, etc. The utilization of such technology is very rare specifically in educational institutes located in developing countries such as India.

Arijit Ukil, Debasish Jana and Ajanta De Sarkar, the problem of security in cloud computing has been analyzed. This paper gives security architecture and necessary support techniques for making our cloud computing infrastructure secured. Rabi Prasad Padhy, Manas Ranjan Patra , and Suresh Chandra Satapathy [3]: All the Security issues of cloud computing are highlighted in this paper, because of the complexity which users found in the cloud, it will be difficult to achieve end-to-end security. New security techniques need to be developed and older security techniques needed to be changed or improved. Kashif Munir and Prof Dr. Sellapan Palaniappan [4]: In this study, we reviewed the literature for security challenges in cloud computing and proposed a security model and framework to make cloud computing environment secure.

Introduction; Cloud computing is a type of Internet-based computing that provides shared computer processing resources and data to computers and other devices on demand. It is a model for enabling ubiquitous, on-demand access to a shared pool of configurable computing resources (e.g., computer networks, servers, storage, applications and services), which can be rapidly provisioned and released with minimal management effort. Cloud computing and storage solutions provide users and enterprises with various capabilities to store and process their data in either privately owned, or third-party data centers that may be located far from the user–ranging in distance from across a city to across the world. Cloud computing relies on sharing of resources to achieve coherence and economy of scale, similar to a utility (like the electricity grid) over an electricity network. Advocates claim that cloud computing allows companies to avoid up-front infrastructure costs (e.g., purchasing servers). As well, it enables organizations to focus on their core businesses instead of spending time and money on computer infrastructure. Proponents also claim that cloud computing allows enterprises to get their applications up and running faster, with improved manageability and less maintenance, and enables information technology (IT) teams to more rapidly adjust resources to meet fluctuating and unpredictable business demand. Cloud providers typically use a "pay as you go" model. This will lead to unexpectedly high charges if administrators do not adapt to the cloud pricing model. In 2009, the availability of high-capacity networks, low-cost computers and storage devices as well as the widespread adoption ofhardware virtualization, service-oriented architecture, and autonomic and utility computing led to a growth in cloud computing. Companies can scale up as computing needs increase and then scale down again as demands decrease. In 2013, it was reported that cloud computing had become a highly demanded service or utility due to the advantages of high computing power, cheap cost of services, high performance, scalability, accessibility as well as availability. Some cloud vendors are experiencing growth rates of 50% per year, but being still in a stage of infancy, it has pitfalls that need to be addressed to make cloud computing services more reliable and user friendly. **The BI on the cloud story in India;** Business Intelligence on the cloud is a mix that few enterprises can resist. A Redwood Capital report predicts the global outreach of cloud-based BI will increase from less than a billion dollars in 2013 to almost $ 3 billion in 2018. And according to Srikanth Karnakota, Director of Microsoft India's Server and Cloud Business, the cloud business in India has been growing at a '*disproportionately high'* rate.The BI or Big Data components are doing great on the cloud platform in India too. Srikanth adds that people are'opening up their minds, and realizing that the cloud is a platform that offers the best BI solutions, no matter what the size of a business may be. While large enterprises try to find the link between the data they already have as well as the amorphous data at hand, midsized enterprises are looking for enhanced functionality from their existing hardware. In the same scenario, small businesses have the liberty to move licenses and run operations across hybrid environments. So irrespective of the size of business, BI on the cloud surely offers a win-win situation for all!. **Cloud service providers in India;** India has never been late to an IT party and the same headway is being registered on the cloud platform too. The list of top cloud service providers in India is impressive, and the names suggest that the segment is indeed in strong hands. Ranging from names like Tata Consultancy Services, Infosys, Wipro and Zenith Infotech to others like Synapse India, CtrlS, Ozonotel Systems and App Point, every major IT player in the country has jumped on to the cloud bandwagon already. Add to this the commitment that international biggies like IBM and Microsoft are promising the Indian market and the going is not only good, but also great!At Tata Business Support Services Limited, our 'Let's Simplify' mantra applies to Business Intelligence in the Cloud environment too. Our BI analytics and research service offerings help our clients overcome key business and technical challenges.Knowing more about your business and market—and knowing it faster and sooner than others—is the best way to gain a competitive edge. But to get there, you need business analytics from enterprise-class business intelligence (BI) solutions.Many organizations want to modernize their BI infrastructures and practices — including information management, data quality and data integration—to improve agility and efficiency, but don't know where to start.At Mindtree, we believe a successful BI services strategy is not just about delivering the correct information, it is about delivering the right information to the right people at the right time.

Objective (i) : **To know the basics of Cloud Applications**

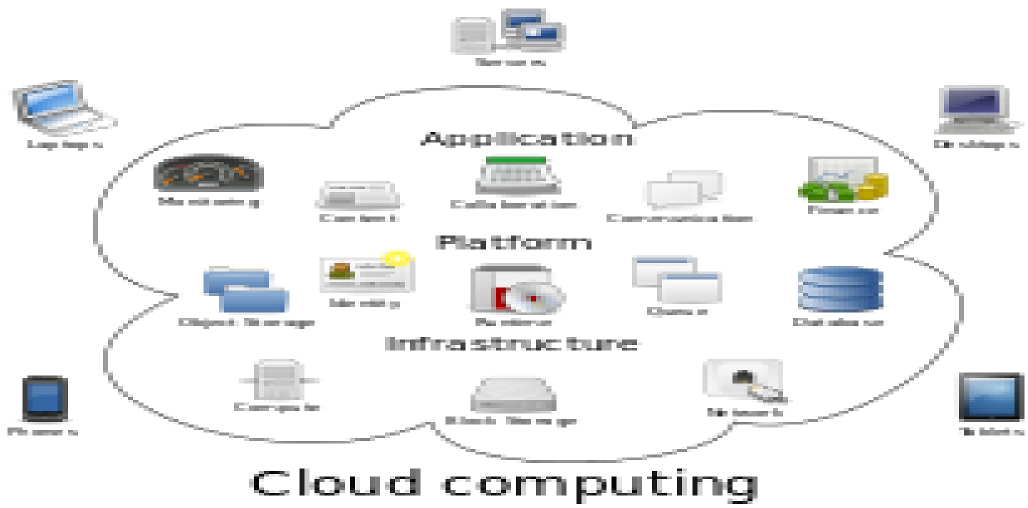


Figure: 1: Cloud Computing Technology Process; Source; Wikipedia.org

The cloud symbol was used to represent networks of computing equipment in the original ARPANET by as early as 1977, and the CSNET by 1981 both predecessors to the Internet itself. The term *cloud* has been used to refer to platforms for distributed computing. In *Wired's* April 1994 feature "Bill and Andy's Excellent Adventure II" on the Apple spin-off General Magic, Andy Hertzfeld commented on General Magic's distributed programming language Telescript that:"The beauty of Telescript ... is that now, instead of just having a device to program, we now have the entire Cloud out there, where a single program can go and travel to many different sources of information and create sort of a virtual service. No one had conceived that before. The example Jim White [the designer of Telescript, X.400 and ASN.1] uses now is a date-arranging service where a software agent goes to the flower store and orders flowers and then goes to the ticket shop and gets the tickets for the show, and everything is communicated to both parties."References to "cloud computing" in its modern sense appeared as early as 1996, with the earliest known mention in a Compaq internal document. The popularization of the term can be traced to 2006 when Amazon.com introduced its Elastic Compute Cloud.

1970s

During the 1960s, the initial concepts of time-sharing became popularized via RJE (Remote Job Entry);[22] this terminology was mostly associated with large vendors such as IBMand DEC. Full time-sharing solutions were available by the early 1970s on such platforms as Multics (on GE hardware), Cambridge CTSS, and the earliest UNIX ports (on DEC hardware). Yet, the "data center" model where users submitted jobs to operators to run on IBM mainframes was overwhelmingly predominant.

1990s

In the 1990s, telecommunications companies, who previously offered primarily dedicated point-to-point data circuits, began offering virtual private network (VPN) services with comparable quality of service, but at a lower cost. By switching traffic as they saw fit to balance server use, they could use overall network bandwidth more effectively. They began to use the cloud symbol to denote the demarcation point between what the provider was responsible for and what users were responsible for. Cloud computing extended this boundary to cover all servers as well as the network infrastructure. As computers became more diffused, scientists and technologists explored ways to make large-scale computing power available to more users through time-sharing. They experimented with algorithms to optimize the infrastructure, platform, and applications to prioritize CPUs and increase efficiency for end users.

2000s

Since 2000, cloud computing has come into existence. In early 2008, NASA's OpenNebula, enhanced in the RESERVOIR European Commission-funded project, became the first open-source software for deploying private and hybrid clouds, and for the federation of clouds. In the same year, efforts were focused on providing quality of serviceguarantees (as required by real-time interactive applications) to cloud-based infrastructures, in the framework of the IRMOS

European Commission-funded project, resulting in a real-time cloud environment. By mid-2008, Gartner saw an opportunity for cloud computing "to shape the relationship among consumers of IT services, those who use IT services and those who sell them" and observed that "organizations are switching from company-owned hardware and software assets to per-use service-based models" so that the "projected shift to computing ... will result in dramatic growth in IT products in some areas and significant reductions in other areas." In August 2006 Amazon introduced its Elastic Compute Cloud. Microsoft Azure was announced as "Azure" in October 2008 and was released on 1 February 2010 as Windows Azure, before being renamed to Microsoft Azure on 25 March 2014. For a time, Azure was on the TOP500 supercomputer list, before it dropped off it.[31] In July 2010,Rackspace Hosting and NASA jointly launched an open-source cloud-software initiative known as OpenStack. The OpenStack project intended to help organizations offering cloud-computing services running on standard hardware. The early code came from NASA's Nebula platform as well as from Rackspace's Cloud Files platform. On March 1, 2011, IBM announced the IBM SmartCloud framework to support Smarter Planet. Among the various components of the Smarter Computing foundation, cloud computing is a critical part. On June 7, 2012, Oracle announced the Oracle Cloud.[33] While aspects of the Oracle Cloud are still in development, this cloud offering is poised to be the first to provide users with access to an integrated set of IT solutions, including the Applications (SaaS), Platform (PaaS), and Infrastructure (IaaS) layers. In April of 2008, Google released Google App Engine in beta.[37] In May of 2012, Google Compute Engine was released in preview, before being rolled out into General Availability in December of 2013.

Objective (ii) To learn on the progress of Cloud from its Primitives

Similar concepts; Cloud computing is the result of the evolution and adoption of existing technologies and paradigms. The goal of cloud computing is to allow users to take benefit from all of these technologies, without the need for deep knowledge about or expertise with each one of them. The cloud aims to cut costs, and helps the users focus on their core business instead of being impeded by IT obstacles.[39] The main enabling technology for cloud computing is virtualization. Virtualization software separates a physical computing device into one or more "virtual" devices, each of which can be easily used and managed to perform computing tasks. With operating system–level virtualization essentially creating a scalable system of multiple independent computing devices, idle computing resources can be allocated and used more efficiently. Virtualization provides the agility required to speed up IT operations, and reduces cost by increasing infrastructure utilization. Autonomic computing automates the process through which the user can provision resourceson-demand. By minimizing user involvement, automation speeds up the process, reduces labor costs and reduces the possibility of human errors.[39] Users routinely face difficult business problems. Cloud computing adopts concepts from Service-oriented Architecture (SOA) that can help the user break these problems into services that can be integrated to provide a solution. Cloud computing provides all of its resources as services, and makes use of the well-established standards and best practices gained in the domain of SOA to allow global and easy access to cloud services in a standardized way.Cloud computing also leverages concepts from utility computing to provide metrics for the services used. Such metrics are at the core of the public cloud pay-per-use models. In addition, measured services are an essential part of the feedback loop in autonomic computing, allowing services to scale on-demand and to perform automatic failure recovery. Cloud computing is a kind of grid computing; it has evolved by addressing the QoS (quality of service) and reliability problems. Cloud computing provides the tools and technologies to build data/compute intensive parallel applications with much more affordable prices compared to traditional parallel computing techniques.

Cloud computing shares characteristics with: Client–server model—*Client–server computing* refers broadly to any distributed application that distinguishes between service providers (servers) and service requestors (clients). Computer bureau—A service bureau providing computer services, particularly from the 1960s to 1980s. Grid computing—"A form of distributed and parallel computing, whereby a 'super and virtual computer' is composed of a cluster of networked, loosely coupled computers acting in concert to perform very large tasks."Fog computing—Distributed computing paradigm that provides data, compute, storage and application services closer to client or near-user edge devices, such as network routers. Furthermore, fog computing handles data at the network level, on smart devices and on the end-user client side (e.g. mobile devices), instead of sending data to a remote location for processing. Dew computing—In the existing computing hierarchy, the Dew computing is positioned as the ground level for the cloud and fog computing paradigms. Compared to fog computing, which supports emerging IoT applications that demand real-time and predictable latency and the dynamic network reconfigurability, Dew computing pushes the frontiers to computing applications, data, and low level services away from centralized virtual nodes to the end users. Mainframe computer—Powerful computers used mainly by large organizations for critical applications, typically bulk data processing such as: census; industry and consumer statistics; police and secret intelligence services; enterprise resource planning; and financial transaction processing. Utility computing—The "packaging of computing resources, such as computation and storage, as a metered service similar to a traditional public utility, such as electricity." Peer-to-peer—A distributed architecture without the need for central coordination. Participants are both suppliers and consumers of resources (in contrast to the traditional client–server model). Cloud sandbox—A live, isolated computer environment in which a program, code or file can run without affecting the application in which it runs.

Characteristics of Cloud computing exhibits the following key characteristics: Agility for organizations may be improved, as cloud computing may increase users' flexibility with re-provisioning, adding, or expanding technological infrastructure resources. Cost reductions are claimed by cloud providers. A public-cloud delivery model converts capital expenditures (e.g., buying servers) to operational expenditure. This purportedly lowers barriers to entry, as infrastructure is typically provided by a third party and need not be purchased for one-time or infrequent intensive computing tasks. Pricing on a utility computing basis is "fine-grained", with usage-based billing options. As well, less in-house IT skills are required for implementation of projects that use cloud computing.[45] The e-FISCAL project's state-of-the-art repository contains several articles looking into cost aspects in more detail, most of them concluding that costs savings depend on the type of activities supported and the type of infrastructure available in-house. Device and location independence enable users to access systems using a web browser regardless of their location or what device they use (e.g., PC, mobile phone). As infrastructure is off-site (typically provided by a third-party) and accessed via the Internet, users can connect to it from anywhere. Maintenance of cloud computing applications is easier, because they do not need to be installed on each user's computer and can be accessed from different places (e.g., different work locations, while travelling, etc.). Multitenancy enables sharing of resources and costs across a large pool of users thus allowing for: Centralization of infrastructure in locations with lower costs (such as real estate, electricity, etc.). Peak-load capacity increases (users need not engineer and pay for the resources and equipment to meet their highest possible load-levels). Utilisation and efficiency improvements for systems that are often only 10–20% utilised. Performance is monitored by IT experts from the service provider, and consistent and loosely coupled architectures are constructed using web services as the system interface. Productivity may be increased when multiple users can work on the same data simultaneously, rather than waiting for it to be saved and emailed. Time may be saved as information does not need to be re-entered when fields are matched, nor do users need to install application software upgrades to their computer. Reliability improves with the use of multiple redundant sites, which makes well-designed cloud computing suitable for business continuity and disaster recovery. Scalability and elasticity via dynamic ("on-demand") provisioning of resources on a fine-grained, self-service basis in near real-time (Note, the VM startup time varies by VM type, location, OS and cloud providers), without users having to engineer for peak loads. This gives the ability to scale up when the usage need increases or down if resources are not being used. Security can improve due to centralization of data, increased security-focused resources, etc., but concerns can persist about loss of control over certain sensitive data, and the lack of security for stored kernels. Security is often as good as or better than other traditional systems, in part because service providers are able to devote resources to solving security issues that many customers cannot afford to tackle or which they lack the technical skills to address. However, the complexity of security is greatly increased when data is distributed over a wider area or over a greater number of devices, as well as in multi-tenant systems shared by unrelated users. In addition, user access to security audit logs may be difficult or impossible. Private cloud installations are in part motivated by users' desire to retain control over the infrastructure and avoid losing control of information security.

The National Institute of Standards and Technology's definition of cloud computing identifies "five essential characteristics":*On-demand self-service.* A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider. *Broad network access.* Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations). *Resource pooling.* The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. *Rapid elasticity*. Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear unlimited and can be appropriated in any quantity at any time. *Measured service.* Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

Objective : (iii) To learn about the service models on Cloud Computing applied in real life.

Service models; Though service-oriented architecture advocates "everything as a service" (with the acronyms EaaS or XaaS or simply aas), cloud-computing providers offer their "services" according to different models, of which the three standard models per NIST are Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). These models offer increasing abstraction; they are thus often portrayed as a *layers* in a stack: infrastructure-, platform- and software-as-a-service, but these need not be related. For example, one can provide SaaS implemented on physical machines (bare metal), without using underlying PaaS or IaaS layers, and conversely one can run a program on IaaS and access it directly, without wrapping it as SaaS.

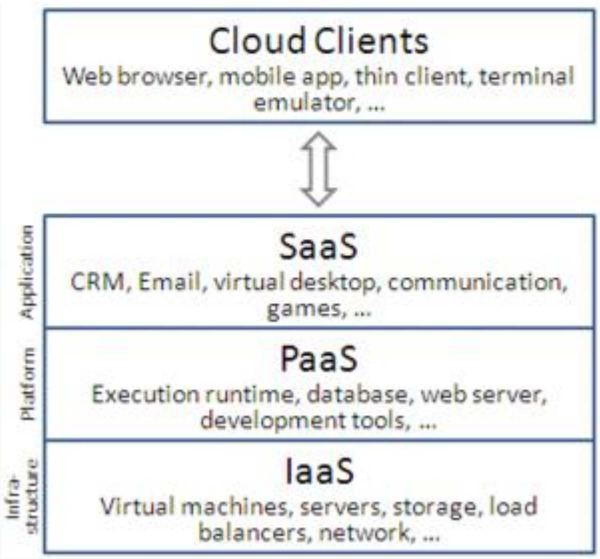


Figure: 2: Cloud computing service models arranged as layers in a stack ; Source ; wikipedia.org

The **NIST's** definition of cloud computing defines the service models as follows: *Software as a Service (SaaS).* The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.*Platform as a Service (PaaS).* The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment. *Infrastructure as a Service (IaaS).* The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls).

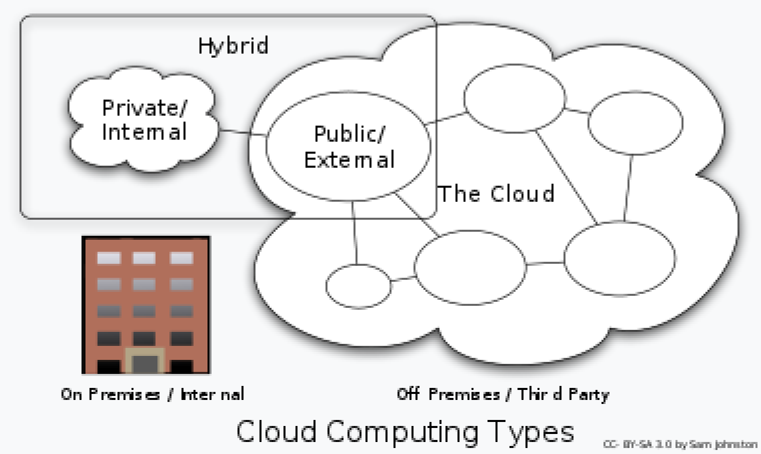
Infrastructure as a service (IaaS) ;According to the Internet Engineering Task Force (IETF), the most basic cloud-service model is that of providers offering computing infrastructure – virtual machines and other resources – as a service to subscribers. Infrastructure as a service (IaaS) refers to online services that abstract the user from the details of infrastructure like physical computing resources, location, data partitioning, scaling, security, backup etc. A hypervisor, such as Xen, Oracle VirtualBox, Oracle VM, KVM, VMware ESX/ESXi, or Hyper-V, runs the virtual machines as guests. Pools of hypervisors within the cloud operational system can support large numbers of virtual machines and the ability to scale services up and down according to customers' varying requirements. Linux containers run in isolated partitions of a single Linux kernel running directly on the physical hardware. Linuxcgroups and namespaces are the underlying Linux kernel technologies used to isolate, secure and manage the containers. Containerisation offers higher performance than virtualization, because there is no hypervisor overhead. Also, container capacity auto-scales dynamically with computing load, which eliminates the problem of over-provisioning and enables usage-based billing. IaaS clouds often offer additional resources such as a virtual-machine disk-image library, raw block storage, file or object storage, firewalls, load balancers, IP addresses, virtual local area networks (VLANs), and software bundles.]IaaS-cloud providers supply these resources on-demand from their large pools of equipment installed in data centers. For wide-area connectivity, customers can use either the Internet or carrier clouds (dedicated virtual private networks). To deploy their applications, cloud users install operating-system images and their application software on the cloud infrastructure. In this model, the cloud user patches and maintains the operating systems and the application software. Cloud providers typically bill IaaS services on a utility computing basis: cost reflects the amount of resources allocated and consumed.

Platform as a service (PaaS); PaaS vendors offer a development environment to application developers. The provider typically develops toolkit and standards for development and channels for distribution and payment. In the PaaS models, cloud providers deliver a computing platform, typically including operating system, programming-language execution environment, database, and web server. Application developers can develop and run their software solutions on a cloud platform without the cost and complexity of buying and managing the underlying hardware and software layers. With some PaaS offers like Microsoft Azure and Google App Engine, the underlying computer and storage resources scale automatically to match application demand so that the cloud user does not have to allocate resources manually. The latter has also been proposed by an architecture aiming to facilitate real-time in cloud environments. Even more specific application types can be provided via PaaS, such as media encoding as provided by services like bitcodin.com or media.io. Some integration and data management providers have also embraced specialized applications of PaaS as delivery models for data solutions. Examples include iPaaS (Integration Platform as a Service) and dPaaS (Data Platform as a Service). iPaaS enables customers to develop, execute and govern integration flows. Under the iPaaS integration model, customers drive the development and deployment of integrations without installing or managing any hardware or middleware. dPaaS delivers integration—and data-management—

products as a fully managed service.[75] Under the dPaaS model, the PaaS provider, not the customer, manages the development and execution of data solutions by building tailored data applications for the customer. dPaaS users retain transparency and control over data through data-visualization tools. Platform as a Service (PaaS) consumers do not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but have control over the deployed applications and possibly configuration settings for the application-hosting environment. A recent specialized PaaS is the Blockchain as a Service (BaaS), that some vendors such as Microsoft Azure have already included in their PaaS offering. Software as a service (SaaS)he software as a service (SaaS) model, users gain access to application software and databases. Cloud providers manage the infrastructure and platforms that run the applications. SaaS is sometimes referred to as "on-demand software" and is usually priced on a pay-per-use basis or using a subscription fee. In the SaaS model, cloud providers install and operate application software in the cloud and cloud users access the software from cloud clients. Cloud users do not manage the cloud infrastructure and platform where the application runs. This eliminates the need to install and run the application on the cloud user's own computers, which simplifies maintenance and support. Cloud applications differ from other applications in their scalability—which can be achieved by cloning tasks onto multiple virtual machines at run-time to meet changing work demand.[79] Load balancers distribute the work over the set of virtual machines. This process is transparent to the cloud user, who sees only a single access-point. To accommodate a large number of cloud users, cloud applications can be *multitenant*, meaning that any machine may serve more than one cloud-user organization. The pricing model for SaaS applications is typically a monthly or yearly flat fee per user, so prices become scalable and adjustable if users are added or removed at any point. Proponents claim that SaaS gives a business the potential to reduce IT operational costs by outsourcing hardware and software maintenance and support to the cloud provider. This enables the business to reallocate IT operations costs away from hardware/software spending and from personnel expenses, towards meeting other goals. In addition, with applications hosted centrally, updates can be released without the need for users to install new software. One drawback of SaaS comes with storing the users' data on the cloud provider's server. As a result, there could be unauthorized access to the data. For this reason, users are increasingly[adopting intelligent third-party key-management systems to help secure their data.

Mobile "backend" as a service (MbaaS*)*; In the mobile "backend" as a service (m) model, also known as backend as a service (BaaS), web app and mobile app developers are provided with a way to link their applications to cloud storage and cloud computing services with application programming interfaces (APIs) exposed to their applications and custom software development kits(SDKs). Services include user management, push notifications, integration with social networking services and more. This is a relatively recent model in cloud computing, with most BaaS startups dating from 2011 or later but trends indicate that these services are gaining significant mainstream traction with enterprise consumers. Serverless computing ; Serverless computing is a cloud computing code execution model in which the cloud provider fully manages starting and stopping virtual machines as necessary to serve requests, and requests are billed by an abstract measure of the resources required to satisfy the request, rather than per virtual machine, per hour. Despite the name, it does not actually involve running code without servers. Serverless computing is so named because the business or person that owns the system does not have to purchase, rent or provision servers or virtual machines for the back-end code to run. **Cloud clients;** Users access cloud computing using networked client devices, such as desktop computers, laptops, tablets and smartphones and any Ethernet enabled device such as Home Automation Gadgets. Some of these devices—*cloud clients*—rely on cloud computing for all or a majority of their applications so as to be essentially useless without it. Examples are thin clients and the browser-based Chromebook. Many cloud applications do not require specific software on the client and instead use a web browser to interact with the cloud application. With Ajax and HTML5 these Web user interfaces can achieve a similar, or even better, look and feel to native applications. Some cloud applications, however, support specific client software dedicated to these applications (e.g., virtual desktop clients and most email clients). Some legacy applications (line of business applications that until now have been prevalent in thin client computing) are delivered via a screen-sharing technology.

Deployment models



Figure; 3:Cloud computing types: Source; Wikipedia.org

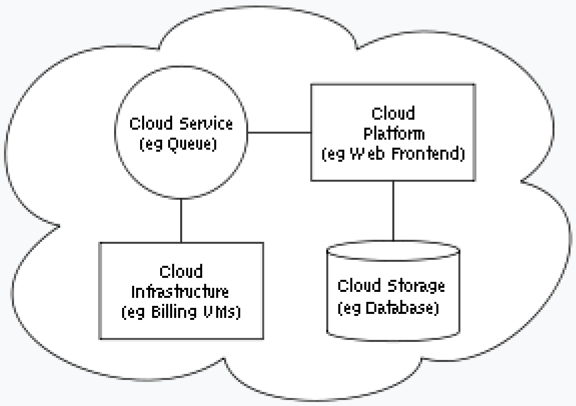
Objective; (iv) To educate on the applications and advancements in Cloud and BI.

Private cloud; Private cloud is cloud infrastructure operated solely for a single organization, whether managed internally or by a third-party, and hosted either internally or externally. Undertaking a private cloud project requires a significant level and degree of engagement to virtualize the business environment, and requires the organization to reevaluate decisions about existing resources. When done right, it can improve business, but every step in the project raises security issues that must be addressed to prevent serious vulnerabilities. Self-run data centers are generally capital intensive. They have a significant physical footprint, requiring allocations of space, hardware, and environmental controls. These assets have to be refreshed periodically, resulting in additional capital expenditures. They have attracted criticism because users "still have to buy, build, and manage them" and thus do not benefit from less hands-on management, essentially "the economic model that makes cloud computing such an intriguing concept". **Public cloud;** A cloud is called a "public cloud" when the services are rendered over a network that is open for public use. Public cloud services may be free. Technically there may be little or no difference between public and private cloud architecture, however, security consideration may be substantially different for services (applications, storage, and other resources) that are made available by a service provider for a public audience and when communication is effected over a non-trusted network. Generally, public cloud service providers like Amazon Web Services (AWS), Microsoft and Google own and operate the infrastructure at their data center and access is generally via the Internet. AWS and Microsoft also offer direct connect services called "AWS Direct Connect" and "Azure

ExpressRoute" respectively, such connections require customers to purchase or lease a private connection to a peering point offered by the cloud provider. **Hybrid cloud**; Hybrid cloud is a composition of two or more clouds (private, community or public) that remain distinct entities but are bound together, offering the benefits of multiple deployment models. Hybrid cloud can also mean the ability to connect collocation, managed and/or dedicated services with cloud resources. Gartner, Inc. defines a hybrid cloud service as a cloud computing service that is composed of some combination of private, public and community cloud services, from different service providers. A hybrid cloud service crosses isolation and provider boundaries so that it can't be simply put in one category of private, public, or community cloud service. It allows one to extend either the capacity or the capability of a cloud service, by aggregation, integration or customization with another cloud service. Varied use cases for hybrid cloud composition exist. For example, an organization may store sensitive client data in house on a private cloud application, but interconnect that application to a business intelligence application provided on a public cloud as a software service. This example of hybrid cloud extends the capabilities of the enterprise to deliver a specific business service through the addition of externally available public cloud services. Hybrid cloud adoption depends on a number of factors such as data security and compliance requirements, level of control needed over data, and the applications an organization uses.[96]Another example of hybrid cloud is one where IT organizations use public cloud computing resources to meet temporary capacity needs that can not be met by the private cloud.[97] This capability enables hybrid clouds to employ cloud bursting for scaling across clouds.[2] Cloud bursting is an application deployment model in which an application runs in a private cloud or data center and "bursts" to a public cloud when the demand for computing capacity increases. A primary advantage of cloud bursting and a hybrid cloud model is that an organization pays for extra compute resources only when they are needed. Cloud bursting enables data centers to create an in-house IT infrastructure that supports average workloads, and use cloud resources from public or private clouds, during spikes in processing demands. The specialized model of hybrid cloud, which is built atop heterogeneous hardware, is called "Cross-platform Hybrid Cloud". A cross-platform hybrid cloud is usually powered by different CPU architectures, for example, x86-64 and ARM, underneath. Users can transparently deploy and scale applications without knowledge of the cloud's hardware diversity. This kind of cloud emerges from the raise of ARM-based system-on-chip for server-class computing. **Community**

cloud; Community cloud shares infrastructure between several organizations from a specific community with common concerns (security, compliance, jurisdiction, etc.), whether managed internally or by a third-party, and either hosted internally or externally. The costs are spread over fewer users than a public cloud (but more than a private cloud), so only some of the cost savings potential of cloud computing are realized. **Distributed cloud;** A cloud computing platform can be assembled from a distributed set of machines in different locations, connected to a single network or hub service. It is possible to distinguish between two types of distributed clouds: public-resource computing and volunteer cloud. Public-resource computing—This type of distributed cloud results from an expansive definition of cloud computing, because they are more akin to distributed computing than cloud computing. Nonetheless, it is considered a sub-class of cloud computing, and some examples include distributed computing platforms such as BOINC andFolding@Home. Volunteer cloud—Volunteer cloud computing is characterized as the intersection of public-resource computing and cloud computing, where a cloud computing infrastructure is built using volunteered resources. Many challenges arise from this type of infrastructure, because of the volatility of the resources used to built it and the dynamic environment it operates in. It can also be called peer-to-peer clouds, or ad-hoc clouds. An interesting effort in such direction is Cloud@Home, it aims to implement a cloud computing infrastructure using volunteered resources providing a business-model to incentivize contributions through financial restitution. Intercloud; The Intercloud is an interconnected global "cloud of clouds" and an extension of the Internet "network of networks" on which it is based. The focus is on directinteroperability between public cloud service providers, more so than between providers and consumers (as is the case for hybrid- and multi-cloud). Multicloud; Multicloud is the use of multiple cloud computing services in a single heterogeneous architecture to reduce reliance on single vendors, increase flexibility through choice, mitigate against disasters, etc. It differs from hybrid cloud in that it refers to **multiple cloud services, rather than multiple deployment modes (public, private, legacy).**

Cloud Architecture



Figure; 4:Cloud computing sample architecture; Source : Wikipedia.org

Cloud architecture the systems architecture of the software systems involved in the delivery of cloud computing, typically involves multiple *cloud components* communicating with each other over a loose coupling mechanism such as a messaging queue. Elastic provision implies intelligence in the use of tight or loose coupling as applied to mechanisms such as these and others. **Cloud engineering;** Cloud engineering is the application of engineering disciplines to cloud computing. It brings a systematic approach to the high-level concerns of commercialization, standardization, and governance in conceiving, developing, operating and maintaining cloud computing systems. It is a multidisciplinary method encompassing contributions from diverse areas such as systems, software, web, performance, information, security, platform, risk, and quality engineering. Cloud computing poses privacy concerns because the service provider can access the data that is in the cloud at any time. It could accidentally or deliberately alter or even delete information.[112] Many cloud providers can share information with third parties if necessary for purposes of law and order even without a warrant. That is permitted in their privacy policies, which users must agree to before they start using cloud services. Solutions to privacy include policy and legislation as well as end users' choices for how data is stored. Users can encrypt data that is processed or stored within the cloud to prevent unauthorized access.According to the Cloud Security Alliance, the top three threats in the cloud are *Insecure Interfaces and API's*, *Data Loss & Leakage*, and *Hardware Failure*—which accounted for 29%, 25% and 10% of all cloud security outages respectively. Together, these form shared technology vulnerabilities. In a cloud provider platform being shared by different users there may be a possibility that information belonging to different customers resides on same data server.

Therefore, Information leakage may arise by mistake when information for one customer is given to other. Additionally, Eugene Schultz, chief technology officer at Emagined Security, said that hackers are spending substantial time and effort looking for ways to penetrate the cloud. "There are some real Achilles' heels in the cloud infrastructure that are making big holes for the bad guys to get into". Because data from hundreds or thousands of companies can be stored on large cloud servers, hackers can theoretically gain control of huge stores of information through a single attack—a process he called "hyperjacking". Some examples of this include the Dropbox security breach, and iCloud 2014 leak.[114] Dropbox had been breached in October 2014, having over 7 million of its users passwords stolen by hackers in an effort to get monetary value from it by Bitcoins (BTC). By having these passwords, they are able to read private data as well as have this data be indexed by search engines (making the information public). There is the problem of legal ownership of the data (If a user stores some data in the cloud, can the cloud provider profit from it?). Many Terms of Service agreements are silent on the question of ownership. Physical control of the computer equipment (private cloud) is more secure than having the equipment off site and under someone else's control (public cloud). This delivers great incentive to public cloud computing service providers to prioritize building and maintaining strong management of secure services.[116] Some small businesses that don't have expertise in IT security could find that it's more secure for them to use a public cloud. There is the risk that end users do not understand the issues involved when signing on to a cloud service (persons sometimes don't read the many pages of the terms of service agreement, and just click "Accept" without reading). This is important now that cloud computing is becoming popular and required for some services to work, for example for an intelligent personal assistant (Apple's Siri or Google Now). Fundamentally, private cloud is seen as more secure with higher levels of control for the owner, however public cloud is seen to be more flexible and requires less time and money investment from the user.

Findings and Conclusions:

Emerging trends; Cloud computing is still a subject of research. A driving factor in the evolution of cloud computing has been Chief technology officers seeking to minimize risk of internal outages and mitigate the complexity of housing network and computing hardware in-house. Major cloud technology companies invest billions of dollars per year in cloudResearch and Development. For example, in 2011 Microsoft committed 90 percent of its $9.6 billion R&D budget to its cloud. Research by investment bank Centaur Partners in late 2015 forecasted that SaaS revenue would grow from $13.5 billion in 2011 to $32.8 billion in 2016. **Cloud computing architecture;** Cloud computing architecture refers to the components and subcomponents required for cloud computing. These components typically consist of a front end platform (fat client, thin client, mobile device), back end platforms (servers, storage), a cloud based delivery, and a network (Internet, Intranet, Intercloud). Combined, these components make up cloud computing architecture**. Cloud client platforms:** Cloud computing architectures consist of front-end platforms called clients or cloud clients. These clients are servers, fat (or thick) clients, thin clients, zero clients, tablets and mobile devices. These client platforms interact with the cloud data storage via an application (middleware), via a web browser, or through a virtual session. **The zero client;** The zero or ultra-thin client initializes the network to gather required configuration files that then tell it where its OS binaries are stored. The entire zero client device runs via the network. This creates a single point of failure, in that, if the network goes down, the device is rendered useless. **Cloud storage;**An online network storage where data is stored and accessible to multiple clients. Cloud storage is generally deployed in the following configurations: public cloud, private cloud,community cloud, or some combination of the three also known as hybrid cloud. In order to be effective, the cloud storage needs to be agile, flexible, scalable, multi-tenancy, and secure. **Cloud based delivery; Software as a service (SaaS);** The software-as-a-service (SaaS) service-model involves the cloud provider installing and maintaining software in the cloud and users running the software from their cloud clients over the Internet (or Intranet). The users' client machines require no installation of any application-specific software - cloud applications run on the server (in the cloud). SaaS is scalable, and system administrators may load the applications on several servers. In the past, each customer would purchase and load their own copy of the application to each of their own servers, but with the SaaS the customer can access the application without installing the software locally. SaaS typically involves a monthly or annual fee. Software as a service provides the equivalent of installed applications in the traditional (non-cloud computing) delivery of applications. **Development as a service (DaaS);** Development as a service is web based, community shared development tools. This is the equivalent to locally installed development tools in the traditional (non-cloud computing) delivery of development tools.**Data as a service (DaaS):** Data as a service is web based design construct where by cloud data is accessed through some defined API layer. DaaS services are often considered as a specialized subset of a Software as a service offering. **Platform as a service (PaaS);** Platform as a service is cloud computing service which provides the users with application platforms and databases as a service.[3] This is equivalent to middleware in the traditional (non-cloud computing) delivery of application platforms and databases.[6] We can take on example for this as Microsoft Azure provides platform as services for multilple language,if we use .net platform then we can build products using .net framework which will be provided by Microsoft Azure.

Infrastructure as a service (IaaS); Infrastructure as a service is taking the physical hardware and going completely virtual (e.g. all servers, networks, storage, and system management all existing in the cloud). This is the equivalent to infrastructure and hardware in the traditional (non-cloud computing) method running in the cloud. In other words, businesses pay a fee (monthly or annually) to run virtual servers, networks, storage from the cloud. This will mitigate the need for a data center, heating, cooling, and maintaining hardware at the local level.**Cloud networking;** Generally, the cloud network layer should offer:High bandwidth (low latency)Allowing users to have uninterrupted access to their data and applications.Agile network; On-demand access to resources requires the ability to move quickly and efficiently between servers and possibly even clouds.Network security; Security is always important, but when you are dealing with multi-tenancy, it becomes much more important because you're dealing with segregating multiple customers. Experience BI in the Cloud; Venturing into the cloud can be a challenging task. There's more to consider than just migrating applications or data. Yet many companies are moving their entire networks into the cloud making it a mainstream IT model. Not only does it make technology sense, but there's a strong business case for the move as well, regardless of company size. But how do you navigate the vast array of cloud choices?. **SAP BusinessObjects Cloud;**SAP BusinessObjects Cloud helps you bring powerful, real-time analytics to everyone in one centralised place. Rely on our expertise to guide you through the process of connecting your data to the HANA Cloud Platform, and performing all of the administration and security tasks required to keep you moving ahead. **SAP HANA Cloud**

Platform; SAP HANA Cloud is a low cost, subscription based option that has the full breadth of HANA features in a single interface. You can build customised solutions for core SAP applications, tailoring to your business needs. Let us guide you through the process of transitioning your data into the cloud and modelling it into a format customised for you.

SAP HANA Enterprise Cloud; SAP HANA Enterprise Cloud (HEC) offers HANA customers another way to access and harness the power of real-time data without the financial risk. This managed cloud environment through SAP, gives HANA customers more choices and more control over their database of choice.The Cloud Computing wave has transformed the information technology sector and in 2014, India is no different. With several valid reasons thrown out by experts, the hype seems to be well justified. In India, the cloud is changing the IT landscape, with companies reserving a large chunk of their investments for upgrades and innovations in the cloud. In fact, most in the industry will tell you that if a business is not moving to the cloud, it is committing a great error! So how big is the cloud computing in India?; In India, cloud computing is set to launch itself into the skies and stay there for a long time to come. If this seems like an exaggeration, here are some numbers. IDC, a tech research firm, sees the cloud segment in India clocking a whopping $3.5 billion by the year 2016, five times more than the $688 million it clocked in 2012. 20-25% of large outsourcing deals in India already involve the cloud.Investments of cloud services providers in the country are growing phenomenally, with stories like IBM's cloud investment program worth $1.2 billion spilling over into India too, in the form of a cloud data center.A Gartner report suggests that 2014 will see India registering a growth of 30% in the cloud segment, touching a total value of around $550 million.Apart from these numbers, the euphoria surrounding the crowd in the IT sector simply cannot be undermined. IBM's commitment as a cloud services provider in the country alone boasts of services to Indian majors such as Luminous, Airtel, HCL, Thermax and Tata Motors. Add to the mix, other cloud service providers who will be catering to the millions of small businesses in India. Considering that these small and midsized businesses have even more compelling reasons (minimum investment, pay-as-you use) to get on to the cloud, what we have on hand here is a sure performer.

References

1. Reese, G. (2009). Cloud Application Architectures: Building Applications and Infrastructure in the Cloud. Sebastopol, CA: O'Reilly Media, Inc. (2009).

2. Rhoton, J. and Haukioja, R. (2011). Cloud Computing Architected: Solution Design Handbook. Recursive Limited, 2011. ISBN 0-9563556-1-7.

3. Shroff, Dr. Gautam. Enterprise Cloud Computing: Technology, Architecture, Applications.

4. Wolfram, Stephen. Scientific Bug Hunting in the Cloud: An Unexpected CEO Adventure.

5. Madden, B. (May 19, 2012) (2010-05-19). "Wyse hopes to shake up the thin client industry with a new zero client platform. Will it work?". Retrieved 2012-05-27.

6. Segal, I. ""When Is Zero Client Not Zero Client?", SysGen, Inc" (PDF).

7. Mell, P.; Grance, T. (September 2011). "The NIST Definition of Cloud Computing. NIST Special Publication 800-145 (September 2011). National Institute of Standards and Technology, U.S. Department of Commerce" (PDF). Retrieved 2012-05-20.

8. Sherbak, T.; Sweere, N. & Belapurkar, V. "Virtualized Enterprise Storage for Flexible, Scalable Private Clouds. Reprinted from Dell Power Solutions, 2012 Issue 1" (PDF). Retrieved2012-05-27.

9. Chou, Timothy. Introduction to Cloud Computing: Business & Technology.

10. Wang, R. "Tuesday's Tip: Understanding The Many Flavors of Cloud Computing and SaaS". Retrieved 2012-05-27.

11. "Understanding the Flex Tenancy Architecture by CITRIX". Retrieved 2012-05-27.

12. Greaves, J. (of Carpathia Hosting) and Potti, S. (of Citrix). Uploaded by CarpathiaHosting on Feb 22, 2010. "Flex-Tenancy: Secure Multi-Tenancy Network Environments". Retrieved2012-05-27.

13. Hassan, Qusay (2011). "Demystifying Cloud Computing" (PDF). The Journal of Defense Software Engineering. CrossTalk. **2011** (Jan/Feb): 16–21. Retrieved 11 December2014.

14. Peter Mell and Timothy Grance (September 2011). The NIST Definition of Cloud Computing (Technical report). National Institute of Standards and Technology: U.S. Department of Commerce. doi:10.6028/NIST.SP.800-145. Special publication 800-145.

15. M. Haghighat, S. Zonouz, & M. Abdel-Mottaleb (2015). CloudID: Trustworthy Cloud-based and Cross-Enterprise Biometric Identification. Expert Systems with Applications, 42(21), 7905–7916.

16. "What is Cloud Computing?". Amazon Web Services. 2013-03-19. Retrieved2013-03-20.

17. Baburajan, Rajani (2011-08-24). "The Rising Cloud Storage Market Opportunity Strengthens Vendors". It.tmcnet.com. Retrieved 2011-12-02.

18. Oestreich, Ken, (2010-11-15). "Converged Infrastructure". CTO Forum. Thectoforum.com. Retrieved 2011-12-02.

19. "Where's The Rub: Cloud Computing's Hidden Costs". 2014-02-27. Retrieved2014-07-14.

20. "Cloud Computing: Clash of the clouds". The Economist. 2009-10-15. Retrieved2009-11-03.

21. "Gartner Says Cloud Computing Will Be As Influential As E-business". Gartner. Retrieved 2010-08-22.

22. Gruman, Galen (2008-04-07). "What cloud computing really means". InfoWorld. Retrieved 2009-06-02.

23. Dealey, C. "Cloud Computing Working Group", Network Centric Operations Industry Consortium - NCOIC, 2013

24. "The economy is flat so why are financials Cloud vendors growing at more than 90 percent per annum?". FSN. March 5, 2013.

25. "Realization of Interoperability & Portability Among Open Clouds by Using Agent's Mobility & Intelligence - TechRepublic". TechRepublic. Retrieved 2015-10-24.

26. "Interoperability and Portability among Open Clouds Using FIPA Agent / 978-3-659-24863-4 / 9783659248634 / 3659248630". www.lap-publishing.com. Retrieved2015-10-24.

27. Hassan, Qusay F.; Riad, laa M.; Hassan, Ahmed E. (2012). "Software reuse in the emerging cloud computing era". In Yang, Hongji; Liu, Xiaodong. Understanding Cloud Computing (PDF). Hershey, PA: Information Science Reference. pp. 204–227.doi:10.4018/978-1-4666-0897-9.ch009. ISBN 978-1-4666-0897-9. Retrieved11 December 2014.

28. Schmidt, Eric; Rosenberg, Jonathan (2014). How Google Works. Grand Central Publishing. p. 11. ISBN 978-1-4555-6059-2.

29. "Internet History 1977".

30. "National Science Foundation, "Diagram of CSNET," 1981".

31. Steven Levy (April 1994). "Bill and Andy's Excellent Adventure II". Wired.

32. Antonio Regalado (31 October 2011). "Who Coined 'Cloud Computing'?". Technology Review. MIT. Retrieved 31 July 2013.

33. "Announcing Amazon Elastic Compute Cloud (Amazon EC2) - beta". Amazon.com. 2006-08-24. Retrieved 2014-05-31.

34. White, J.E. "Network Specifications for Remote Job Entry and Remote Job Output Retrieval at UCSB". tools.ietf.org. Retrieved 2016-03-21.

35. "July, 1993 meeting report from the IP over ATM working group of the IETF". CH: Switch. Retrieved 2010-08-22.

36. Corbató, Fernando J. "An Experimental Time-Sharing System". SJCC Proceedings. MIT. Retrieved 3 July 2012.

37. Rochwerger, B.; Breitgand, D.; Levy, E.; Galis, A.; Nagin, K.; Llorente, I. M.; Montero, R.; Wolfsthal, Y.; Elmroth, E.; Caceres, J.; Ben-Yehuda, M.; Emmerich, W.; Galan, F. "The Reservoir model and architecture for open federated cloud computing". IBM Journal of Research and Development. **53** (4): 4:1–4:11. doi:10.1147/JRD.2009.5429058.

38. Kyriazis, D; A Menychtas; G Kousiouris; K Oberle; T Voith; M Boniface; E Oliveros; T Cucinotta; S Berger (November 2010). "A Real-time Service Oriented Infrastructure".International Conference on Real-Time and Embedded Systems (RTES 2010). Singapore.

39. Gogouvitis, Spyridon; Konstanteli, Kleopatra; Waldschmidt, Stefan; Kousiouris, George; Katsaros, Gregory; Menychtas, Andreas; Kyriazis, Dimosthenis; Varvarigou, Theodora (2012). "Workflow management for soft real-time interactive applications in virtualized environments". Future Generation Computer Systems. **28** (1): 193–209.doi:10.1016/j.future.2011.05.017. ISSN 0167-739X.

40. Keep an eye on cloud computing, Amy Schurr, Network World, 2008-07-08, citing theGartner report, "Cloud Computing Confusion Leads to Opportunity". Retrieved 2009-09-11.

41. Gartner (2008-08-18). "Gartner Says Worldwide IT Spending On Pace to Surpass Trillion in 2008".

42. "Windows Azure General Availability". The Official Microsoft Blog. Microsoft. 2010-02-01. Retrieved 2015-05-03.

43. "Faenov - Cluster Platform SL230s Gen8, Xeon E5-2670 8C 2.600GHz, Infiniband QDR - TOP500 Supercomputer Sites".

44. "Launch of IBM Smarter Computing". Retrieved 1 March 2011.

45. "Launch of Oracle Cloud". Retrieved 28 February 2014.

46. "Oracle Cloud, Enterprise-Grade Cloud Solutions: SaaS, PaaS, and IaaS". Retrieved12 October 2014.

47. "Larry Ellison Doesn't Get the Cloud: The Dumbest Idea of 2013". Forbes.com. Retrieved 12 October 2014.

48. "Oracle Disrupts Cloud Industry with End-to-End Approach". Forbes.com. Retrieved12 October 2014.

49. "Introducing Google App Engine + our new blog". Google Developer Blog. 2008-04-07. Retrieved 2017-03-07.

50. "Google Compute Engine is now Generally Available with expanded OS support, transparent maintenance, and lower prices". Google Developers Blog. 2013-12-02. Retrieved 2017-03-07.

51. HAMDAQA, Mohammad (2012). Cloud Computing Uncovered: A Research Landscape (PDF). Elsevier Press. pp. 41–85. ISBN 0-12-396535-7.

52. "Distributed Application Architecture" (PDF). Sun Microsystem. Retrieved 2009-06-16.

53. Skala, Karolj; Davidović, Davor; Afgan, Enis; Sović, Ivan; Šojat, Zorislav (2015-12-31)."Scalable Distributed Computing Hierarchy: Cloud, Fog and Dew Computing". Open Journal of Cloud Computing. RobPub. **2** (1): 16–24. ISSN 2199-1987.

54. "It's probable that you've misunderstood 'Cloud Computing' until now". TechPluto. Retrieved 2010-09-14.

55. Danielson, Krissi (2008-03-26). "Distinguishing Cloud Computing from Utility Computing". Ebizq.net. Retrieved 2010-08-22.

56. "Recession Is Good For Cloud Computing – Microsoft Agrees". CloudAve. Retrieved2010-08-22.

57. "Defining 'Cloud Services' and "Cloud Computing"". IDC. 2008-09-23. Retrieved2010-08-22.

58. "e-FISCAL project state of the art repository".

59. Farber, Dan (2008-06-25). "The new geek chic: Data centers". CNET News. Retrieved2010-08-22.

60. "Jeff Bezos' Risky Bet". Business Week.

61. He, Sijin; Guo, L.; Guo, Y.; Ghanem, M. "Improving Resource Utilisation in the Cloud Environment Using Multivariate Probabilistic Models". 2012 2012 IEEE 5th International Conference on Cloud Computing (CLOUD): 574–581. doi:10.1109/CLOUD.2012.66.ISBN 978-1-4673-2892-0.

62. He, Qiang, et al. "Formulating Cost-Effective Monitoring Strategies for Service-based Systems." (2013): 1-1.

63. A Self-adaptive hierarchical monitoring mechanism for Clouds Elsevier.com

64. Heather Smith (23 May 2013). Xero For Dummies. John Wiley & Sons. pp. 37–.ISBN 978-1-118-57252-8.

65. King, Rachael (2008-08-04). "Cloud Computing: Small Companies Take Flight".Bloomberg BusinessWeek. Retrieved 2010-08-22.

66. Mao, Ming; M. Humphrey (2012). "A Performance Study on the VM Startup Time in the Cloud". Proceedings of 2012 IEEE 5th International Conference on Cloud Computing (Cloud2012): 423. doi:10.1109/CLOUD.2012.103. ISBN 978-1-4673-2892-0.

67. Dario Bruneo, Salvatore Distefano, Francesco Longo, Antonio Puliafito, Marco Scarpa:Workload-Based Software Rejuvenation in Cloud Systems. IEEE Trans. Computers 62(6): 1072–1085 (2013)

68. "Defining and Measuring Cloud Elasticity". KIT Software Quality Departement. Retrieved 13 August 2011.

69. "Economies of Cloud Scale Infrastructure". Cloud Slam 2011. Retrieved 13 May 2011.

70. He, Sijin; L. Guo; Y. Guo; C. Wu; M. Ghanem; R. Han. "Elastic Application Container: A Lightweight Approach for Cloud Resource Provisioning". 2012 IEEE 26th International Conference on Advanced Information Networking and Applications (AINA): 15–22.doi:10.1109/AINA.2012.74. ISBN 978-1-4673-0714-7.

71. Marston, Sean; Li, Zhi; Bandyopadhyay, Subhajyoti; Zhang, Juheng; Ghalsasi, Anand (2011-04-01). "Cloud computing — The business perspective". Decision Support Systems. **51** (1): 176–189. doi:10.1016/j.dss.2010.12.006.

72. Mills, Elinor (2009-01-27). "Cloud computing security forecast: Clear skies". CNET News. Retrieved 2010-08-22. Kurdi, Heba; Li, Maozhen; Al-Raweshidy, H. S. (2010). "Taxonomy of Grid Systems". In Antonopoulos, Nick. Handbook of Research on P2P and Grid Systems for Service-Oriented Computing: Models, Methodologies and Applications. IGI Global research collection. IGI Global. p. 34. ISBN 978-1-61520-687-2. Retrieved 2015-07-29. Nowadays Service-Oriented Architecture (SOA) has become as [sic] the main architectural model of many IT initiatives including grid, cloud and everything as a service (Essa\XaaS\aas) computing.

73. Alcaraz Calero, Jose M.; König, Benjamin; Kirschnick, Johannes (2012). "Cross-Layer Monitoring in Cloud Computing". In Rashvand, Habib F.; Kavian, Yousef S. Using Cross-Layer Techniques for Communication Systems. Premier reference source. IGI Global. p. 329. ISBN 978-1-4666-0961-7. Retrieved 2015-07-29. Cloud Computing provides services on a stack composed of three service layers (Hurwitz, Bloor, Kaufman, & Halper, 2009): Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).

74. "ElasticHosts Blog". Elastichosts. 2014-04-01. Retrieved 2016-06-02.

75. Amies, Alex; Sluiman, Harm; Tong, Qiang Guo; Liu, Guo Ning (July 2012). "Infrastructure as a Service Cloud Concepts". **Developing and Hosting Applications on the Cloud**. IBM Press. ISBN 978-0-13-306684-5.

76. Ananich, Anthony (February 20, 2016). "What is IaaS?". ananich.pro. Retrieved2016-02-20.

77. "Amazon EC2 Pricing". aws.amazon.com. Retrieved 7 July 2014.

78. "Compute Engine Pricing". cloud.google.com. Retrieved 7 July 2014.

79. "Microsoft Azure Virtual Machines Pricing Details". azure.microsoft.com. Retrieved7 July 2014.

80. "cloud.ca".

81. Boniface, M.; et al. (2010), Platform-as-a-Service Architecture for Real-Time Quality of Service Management in Clouds, 5th International Conference on Internet and Web Applications and Services (ICIW), Barcelona, Spain: IEEE, pp. 155–160,doi:10.1109/ICIW.2010.91

82. "bitcodin – cloud based transcoding and streaming". Retrieved 22 April 2015.

83. media.io

84. Gartner. "Gartner IT Glossary". Retrieved 6 July 2015.

85. Gartner; Massimo Pezzini; Paolo Malinverno; Eric Thoo. "Gartner Reference Model for Integration PaaS". Retrieved 16 January 2013.

86. Loraine Lawson. "IT Business Edge". Retrieved 6 July 2015.

87. Enterprise CIO Forum; Gabriel Lowy. "The Value of Data Platform-as-a-Service (dPaaS)". Retrieved 6 July 2015.

88. "Blockchain as a Service (BaaS) | Microsoft Azure". azure.microsoft.com. Retrieved2016-08-22.

89. Hamdaqa, Mohammad. A Reference Model for Developing Cloud Applications (PDF).

90. Chou, Timothy. Introduction to Cloud Computing: Business & Technology.

91. "HVD: the cloud's silver lining" (PDF). Intrinsic Technology. Retrieved 30 August 2012.

92. Carney, Michael. "AnyPresence partners with Heroku to beef up its enterprise mBaaS offering". PandoDaily. Retrieved 24 June 2013.

93. Alex Williams (11 October 2012). "Kii Cloud Opens Doors For Mobile Developer Platform With 25 Million End Users". TechCrunch. Retrieved 16 October 2012.

94. Aaron Tan (30 September 2012). "FatFractal ups the ante in backend-as-a-service market". Techgoondu.com. Retrieved 16 October 2012.

95. Dan Rowinski (9 November 2011). "Mobile Backend As A Service Parse Raises $5.5 Million in Series A Funding". ReadWrite. Retrieved 23 October 2012.

96. Pankaj Mishra (7 January 2014). "MobStac Raises $2 Million In Series B To Help Brands Leverage Mobile Commerce". TechCrunch. Retrieved 22 May 2014.

97. "built.io Is Building an Enterprise MBaas Platform for IoT". programmableweb. Retrieved 3 March 2014.

98. Miller, Ron (24 Nov 2015). "AWS Lambda Makes Serverless Applications A Reality".TechCrunch. Retrieved 10 July 2016.

99. "Self-Run Private Cloud Computing Solution — GovConnection". govconnection.com. 2014. Retrieved April 15, 2014.

100. Foley, John. "Private Clouds Take Shape". InformationWeek. Retrieved 2010-08-22.

101. Haff, Gordon (2009-01-27). "Just don't call them private clouds". CNET News. Retrieved 2010-08-22.

102. "There's No Such Thing As A Private Cloud". InformationWeek. 2010-06-30. Retrieved2010-08-22.

103. Rouse, Margaret. "What is public cloud?". Definition from Whatis.com. Retrieved12 October 2014.

104. "Mind the Gap: Here Comes Hybrid Cloud – Thomas Bittman". Thomas Bittman. Retrieved 22 April 2015.

105. "Business Intelligence Takes to Cloud for Small Businesses". CIO.com. 2014-06-04. Retrieved 2014-06-04.

106. Désiré Athow. "Hybrid cloud: is it right for your business?". TechRadar. Retrieved22 April 2015.

107. Metzler, Jim; Taylor, Steve. (2010-08-23) "Cloud computing: Reality vs. fiction", Network World.

108. Rouse, Margaret. "Definition: Cloudbursting", May 2011. SearchCloudComputing.com.

109. "How Cloudbursting "Rightsizes" the Data Center".

110. Kaewkasi, Chanwit (3 May 2015). "Cross-Platform Hybrid Cloud with Docker".

111. Vincenzo D. Cunsolo, Salvatore Distefano, Antonio Puliafito, Marco Scarpa: Volunteer Computing and Desktop Cloud: The Cloud@Home Paradigm. IEEE International Symposium on Network Computing and Applications, NCA 2009, pp 134–139

112. Bernstein, David; Ludvigson, Erik; Sankar, Krishna; Diamond, Steve; Morrow, Monique (2009-05-24). "Blueprint for the Intercloud – Protocols and Formats for Cloud Computing Interoperability". IEEE Computer Society: 328–336. doi:10.1109/ICIW.2009.55.ISBN 978-1-4244-3851-8.

113. "Kevin Kelly: A Cloudbook for the Cloud". Kk.org. Retrieved 2010-08-22.

114. "Intercloud is a global cloud of clouds". Samj.net. 2009-06-22. Retrieved 2010-08-22.

115. "Vint Cerf: Despite Its Age, The Internet is Still Filled with Problems". Readwriteweb.com. Retrieved 2010-08-22.

116. "SP360: Service Provider: From India to Intercloud". Blogs.cisco.com. Retrieved2010-08-22.

117. Canada (2007-11-29). "Head in the clouds? Welcome to the future". The Globe and Mail. Toronto. Retrieved 2010-08-22.

118. Rouse, Margaret. "What is a multi-cloud strategy". SearchCloudApplications. Retrieved3 July 2014.

119. King, Rachel. "Pivotal's head of products: We're moving to a multi-cloud world". ZDnet. Retrieved 3 July 2014.

120. Multcloud manage multiple cloud accounts. Retrieved on 06 August 2014

121. "Building GrepTheWeb in the Cloud, Part 1: Cloud Architectures". Developer.amazonwebservices.com. Retrieved 2010-08-22.

122. "Cloud Computing Privacy Concerns on Our Doorstep".

123. Chhibber, A (2013). "SECURITY ANALYSIS OF CLOUD COMPUTING" (PDF).International Journal of Advanced Research in Engineering and Applied Sciences. **2** (3): 2278–6252. Retrieved 27 February 2015.

124. "Google Drive, Dropbox, Box and iCloud Reach the Top 5 Cloud Storage Security Breaches List". psg.hitachi-solutions.com. Retrieved 2015-11-22.

125. Maltais, Michelle (26 April 2012). "Who owns your stuff in the cloud?". Los Angeles Times. Retrieved 2012-12-14.

126. "Security of virtualization, cloud computing divides IT and security pros". Network World. 2010-02-22. Retrieved 2010-08-22.

127. "The Bumpy Road to Private Clouds". Retrieved 2014-10-08.

128. "Should Companies Do Most of Their Computing in the Cloud? (Part 1) - Schneier on Security". www.schneier.com. Retrieved 2016-02-28.

129. "Disadvantages of Cloud Computing (Part 1) - Limited control and flexibility".www.cloudacademy.com. Retrieved 2016-11-03.

130. "The real limits of cloud computing". www.itworld.com. Retrieved 2016-11-03.

131. "The real limits of cloud computing". www.itworld.com. Retrieved 2016-11-03.

132. Karra, Maria. "Cloud solutions for translation, yes or no?". IAPTI.org. Retrieved23 February 2017.

133. Smith, David Mitchell. "Hype Cycle for Cloud Computing, 2013". Gartner. Retrieved3 July 2014.

134. "The evolution of Cloud Computing". Retrieved 22 April 2015.

135. "Microsoft Says to Spend 90% of R&D on Cloud Strategy". Retrieved 22 April 2015.

136. "Roundup Of Cloud Computing Forecasts And Market Estimates, 2014". Forbes. Retrieved 2015-11-22.