Evolution of Cloud Computing

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Abstract - Theme of this paper is to explain the cloud features, its evolution, and various applications on cloud. The challenges faced in cloud implementation and finally various techniques and devices introduced to improve the performance of cloud architecture. Cloud vendors apply control measures between mobile users and cloud based services to provide secured service. Use of FPGA adds to the advantages of cloud computing promising secured cloud architecture. The reconfigurable hardware improves scalability, flexibility and reliability. Multimedia processing includes computation intensive and complex operations, these applications demand optimized solution in terms of speed and power. Use of reconfigurable hardware in cloud computing for multimedia applications improves the performance due to virtualization of platform and infrastructure.
Keywords – Cloud platform, FPGA, Evolution

I. INTRODUCTION

Modernization of IT industries demand increased computation capacity and providing large applications at lower investments. If these services and infrastructure are provided dynamically and virtually, user located geographically anywhere can extract the services. User need not invest for purchase of new setup. Even trained personnel are not required for maintaining the infrastructure. Thus with less investment the sharing of computation resources made the resources available for distance access. The technology of providing computing resources in the form of virtual data centers through internet is called cloud computing. It is a technology which offers centralized computing power, data or applications to customers on demand basis. Cloud computing is globalization of various applications (telecom, computer services, e-business, hardware and software tools etc) of Information Technology (IT) industries through internet.

Interoperation and collaboration of various IT industries, networks and devices are the mile stones of telecommunication industry. Due to these developments various applications are introduced in cloud computing and IT based applications. Continuous innovations in telecommunications, lead to regular research for the development of various devices, tools and protocols for the cloud computing. The relevance of IT ensure smooth run of manufacturing, human resources, security and finance departments. The information exchange across the globe by the people and IT industries is made easier. The collaboration of Internet Protocol (IP) services makes global market developments available at door step. IP services over the cloud computing connect customers from diversified work environment.

Basic components of cloud computing are service providers, clients and internet. The Cloud Service Providers (CSPs) are companies that provide cloud computing resources in the form of infrastructure, network services and business applications etc.

Individuals or companies access cloud services by connecting to the data centre where cloud services are hosted using internet connection. Larger servers with many Tera Bytes (TBs) are used for Web sites, data processing applications, businesses by enterprises and biggest enterprises. Clients purchase the services from cloud service providers, use services on shared basis. These services are delivered to client through internet.

Clients are end users of cloud computing services. They connect to the cloud through device with internet access and manage their data. The clients are classified into mobile, thick and thin type based on the device they use to connect to the cloud. Mobile clients use portable devices like smart phones and PDAs and work on internet. Thick clients are desktop computer users. Using web browser like internet explorer, Opera get connected to the cloud. These devices ensure lower IT and hardware cost, lesser noise and power consumption and secure. Thin clients are thin computer users without internal hard drives. Server perform all the process and only information is displayed on their screen.

The work space consists of various hardware and software tools. The customer operates different range of devices (desktop PC, laptop, smart-phones etc) to connect to cloud. Network connections and various protocols are required to unify the customer devices. The specifications of the hardware devices of customers differ from specifications of cloud devices and also the routing devices. Hence the networks need to adapt the customer device data with network device and cloud device parameters.

Key features

Cloud computing model connects the customers located anywhere with internet connected device of their choice to the cloud enabled systems. The cloud service provider owns the services and renders the services to the consumers on demand. Consumers can be client organizations, small businesses and individuals for personnel use. This centralization of resources reduces the investment cost of infrastructure. The cost to setup and maintain and operate an application is shared by many users, so that burden of infrastructure cost on single user is reduced to great extent. In order to improve the service availability and resource utilization, different tenants share the same service called multitenancy.

The virtualization of server and other resources of cloud increase efficiency of system because the system is not idle for lack of use. The system is continuously under monitor of expert technicians. Any failure of system will be rectified or substituted easily. So the cloud computing system is reliable.

Scalability is essential for computer centered applications because the hardware and software trends changes frequently. Centralized service provider upgrades the cloud setup without having to change the entire model. Addition or the deletion of hardware or software can be achieved with less effort. So cloud infrastructure provides flexibility of resource modification. Large potential of consumers getting attracted by cloud computing, which will be meaningful only when customer resources and sensitive data is highly secured. Cloud providers strive hard to escalate security by broadening investment on the maintenance staff. The cloud service provider adopts techniques and algorithms for efficient implementation and utilization of infrastructure and uplifting the system sustainability.

II. LITERATURE SURVEY

Grid computing explained in [1], utility computing in [2] and now cloud computing are based on concept of on-demand computing. Web services in collaboration with cloud provide resizing of computing resources within short time. The cloud computing environment includes massive numbers of computers networked together with application specific software. The cloud based model evolution story includes unfolding of hardware, software and internet protocols. The advancements in the field of VLSI always aim for reducing the size of processors with increased circuit complexity. Further it has computerized the personnel and professional life. The rapid progress in field of VLSI has increased the power, memory and data storage capacities of computers by many orders of magnitude.

Author in [3] Cloud computing is widely used for mobile devices to provide database management, data storage for business enterprises, searching and multimedia applications for mobile devices using internet etc. Cloud computing adds enhanced features to adhoc networks by using the mobile devices as part of cloud computing network. But the application needs secured service. proposes mobile cloud secure data processing model. Algorithms are implemented to improve the authentication of data and attain mobile cloud trust management. Data security is the burning issue in remote data management, research is done to increase robustness of application, security monitoring, misuse detection.

Authors in [4][5] present Cloud computing system that provide supercomputing capacity to large pool of users at increased efficiency, it is becoming an active research project in IT industry. But the success story of cloud computing faces many challenges. To name some of the challenges the cloud computing company face are: reliability, data security, large bandwidth, and high speed of internet access. The computer and other resource specifications, the technical standards of networks of cloud setup are not standardized. But move is always to use new products with large data storage, high speed memory, application specific software and high speed internet access. The user gets connected to cloud computing system through internet. The system is tenable when high speed broadband connection is used for communication. So high speed broadband is one of biggest challenge in cloud computing. Mobile health services are used for distance health provision which evolved when internet evolved in IT industries. The working of mobile health services include multimedia computations and service platform. Multimedia processing and power supply are major issues to be dealt in mobile health service development. Security and reliability are the challenges in delivering mobile health services. These issues are sorted out easily by combining mobile devices with cloud computing. [6] Provide trust worthy mobile health application at cloud computing center, on mobile devices. The paper introduces issues in mobile computing platform. The cloud renders multimedia signal processing and security to user. Battery life is one of main limitation of mobile devices, which is solved by clod computing.

Implementation of the multimedia applications on cloud improves the performance of algorithms. [7] propose use cloud architecture for multimedia applications increases energy efficiency. Cloud computing services are given on rental basis. On service provider side the infrastructure and software tools and hardware tools are rendered to the users. The developments in technology bring and add new type of device users. The adaptability of the cloud infrastructure to new technology is a costlier move for the cloud enterprises. So the service provider need not adapt new techniques, as it can serve older version device users. when cloud computing enterprise adopt to new

technology, the customer devices and service rules remain unchanged. This fluid nature of cloud computing has increased its popularity. On users side the new hardware tools and software tools added to the user device find limitation to access to the existing featured cloud computing infrastructure. The situation demands user to connect to new cloud infrastructure with required infrastructure. Above all these possible changes, billing of the services is easier, as the user pay for what he uses.

III. EVOLUTION OF CLOUD COMPUTING

In 1960s the mainframe computers introduced in market were of large size and costly. So, small businesses and education institutes found investing on computers as expensive. Instead of owning the computer hardware and to be competitive in the market businesses, education institutes, government offices relied on using of computers on shared basis. Shared basis usage of computing resources minimized investment cost. Resource sharing is basic principle of cloud computing. The journey of SaaS in small scale and with area restriction started from then and continued in same status up to 1980 and early 1990s. In early 1990s computers were found cheaper than any time in history. Companies started using computers in large scale. Technology developments led to interconnection of computers to build Local Area Networks (LAN). In a LAN, secured data is stored on one computer called server and applications are hosted on client machines. SaaS was functioning similar to LAN and provided virtualization, scalability.

In late 90s when internet connected the computers across the globe, Information Technologies shifted from LAN to Application Service Providers (ASP) industry. The usage of application is maintained using subscription license model. ASPs failed due to customer dissatisfaction in terms of cost, deployment and remote operation. When web 2.0 was released in 2009, “Google Apps” were offered by Google as browser based application.

Globalization of computing resources dates back to as early as 1961. Professor John Mc Carthy proposed thought of computer resource sharing and selling of computing applications through utility computing. Public utility computing companies provided computation and storage resources. Grid computing is similar to cloud computing. It consists of networked or internetworked computers to execute heavy assignments. It is type of distributed computing.

On demand computing concept is in vogue in IT marketplace since from days of its infancy. On demand computing enterprises provide computing resources as per users requirement. The need of computing resources varies from time to time. The peak time load requirement can be easily met by on-demand model. The capacity planning is done by cloud provider allow users to be relieved of consequences faced with overbuy and overload capacity. Even the user can easily handle low computation requirements. Thus reducing cost of computing and pay for what he use. Application specific software, different OS, development of common internet protocols (TCP/IP) and its acceptance worldwide connected the devices to communicate.

The hardware and software evolution contributed for the growth of cloud computing. The hardware evolution is explained with evolutionary steps in computer processing technology. Always an efficient calculating machine is need of computation industries. The first generation modern computers were electromechanical programmable computers. These were built using hardwired circuits and vacuum tubes. Paper punch cards are the storage units. The invention of transistors paves the way for second generation computers. These computers were bulky. The third generation computers are mini computers, developed using integrated circuits. The fourth generation computers used microprocessors with sufficient memory and speed. From then, revolution and evolution took in IT industries and IT related applications. But "how to deploy these computation resources at any time irrespective of location" thinking gave way for networking of computation resources. The internet software evolution, explain the roadway of sharing the computation resources by large pool of users. Standard protocols were developed for worldwide acceptance.

of protocols. TCP/IP networking protocols connected users and made common interface to the internet. It began with development of web browser and web servers. Considerable development was observed when Microsoft developed World Wide Web (WWW) and released Windows 95 in the year 1995. Clustering of computation resources and rendering for service introduced grid computing.

Resource Grids try to make resources, such as computational devices and storage locally available in a fashion that is transparent to the user. The main focus there by lies on availability rather than scalability, in particular rather than dynamic scalability. The more resources are available, the more code instances are deployed and executed. Replication capabilities may be applied to ensure reliability, though this is not an intrinsic capability of in particular computational Grids. More important is the strong conceptual overlap between the issues addressed by Grid and Clouds which allows re-usage of concepts and architectures. E-Business Grids share the essential goals with Service Oriented Architecture, though the specific focus rests on integration of existing services so as to build up new functionalities, and to enhance these services with business specific capabilities. The e-Business (or here Virtual Organization) approach derives in particular from the distributed computing aspect of Grids, where parts of the overall logic are located in different sites. The typical Grid middleware thereby focus mostly on achieving reliability

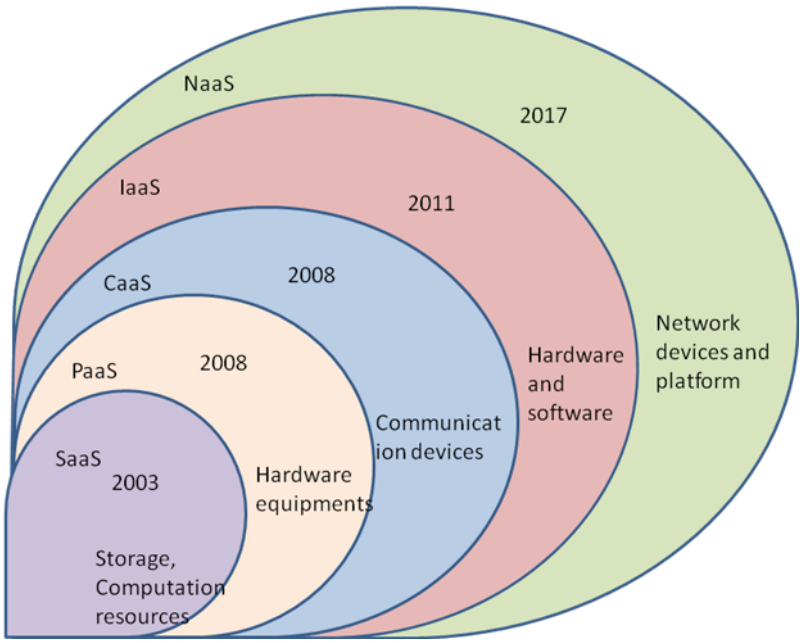
in the overall execution through on-the-fly replacement and (re)integration. But e-Business Grids also explore the specific requirements for commercial employment of service consumption and provisioning even though this is generally considered an aspect more related to Service Oriented Architectures than to Grids.
There is a strong relationship between the Grid and Service Oriented Architectures, often leading to confusions where the two terms either are used indistinguishably, or the one as building on top of the other. This arises mostly from the fact that both concepts tend to cover a comparatively wide scope of issues, i.e. the term being used a bit ambiguously.
Service Oriented Architecture however typically focuses predominantly on ways of developing, publishing and integrating application logic and / or resources as services. Aspects related to enhancing the provisioning model, e.g. through secure communication channels, QoS guaranteed maintenance of services etc. come in this definition. Again it must be stressed though that the aspects of eBusiness Grids and SOA are used almost interchangeably. Service Oriented Architectures are therefore of primary interest for a) the type of applications and services the user can build for and host on the cloud system and b) for providing additional high level services and capabilities with which to enhance the base cloud capabilities.

3.1 Cloud configurations
The cloud computing is categorized as public cloud, private cloud, hybrid cloud based on the customers they serve. Public cloud is available for any industry and for personnel use. Most of the clients use cloud computing in the form of public cloud. The resources are provided by CSPs. CSPs own infrastructure, hardware and software and provide to users on shared basis. Amazon EC2, Google App Engine, Microsoft windows Azure, IBM smart cloud are examples of public cloud. When computing resources are owned by an organization or business it is called private cloud. The resources are restricted to one organization only. Usually government organizations and businesses with secured operations use private cloud. VMware, Eucalyptus are few private cloud companies. Hybrid cloud is mixture of two or more clouds. In order to provide flexibility in service deployment, hybrid clouds use both public and private clouds. Data move between private and public clouds. "Cloud bursting" is a method of handling overloads by CSPs. If the private cloud fails to meet the service demands, the organization connects to public cloud for computing resource requirements. VMware cloud, Windows Azure are hybrid cloud vendors.

3.2 Cloud service providers
The cloud service providers of India and the services they offer details are as follows:
IBM provides IaaS, PaaS, SaaS services to software vendors and developers. Cisco Systems is one of top cloud provider. It provides storage, virtualization, IaaS and cloud video delivery. VMware renders the resources required to build and operate IT manufacturers. Sify offers IaaS, PaaS and SaaS. Ctrls provide public and private cloud configurations. ESDS offers IaaS, Desktop as a Service, disaster recovery. SaaS India offers SaaS, IT infrastructure etc. orange Space is a leading PaaS cloud service providers. CSPs offer services based on "subscription based pricing". The customer purchases the services and subscribers are committed to receive the services for a month or year basis. Pay as you go is another method of payment for using of cloud services. The CSP provides flexibility of choosing resources and decides the payment for the time of resource usage.

IV. SERVICES DELIVERED BY CLOUD

The technology has drifted from on-premise model to the cloud computing. The services offered by the cloud changes rapidly and services are enhanced in their features. The table 1 lists the types of services offered by the cloud model and their features. Communication, infrastructure, and platforms are the key services provided by cloud computing along with Software as a Service (SaaS). Cloud delivers these services on the web, so the cloud users find fewer barriers to enter the cloud network.



4.1 Time line of Cloud Services

Server and storage virtualization are main features of cloud computing make reuse software and hardware. Virtualization has increased flexibility and performance of end users of cloud. Cloud virtual machines tend to be built for fixed resource environments, thus allowing instance replication better than changes in the resource structure. But future systems will have to show more flexibility with this respect to adapt better to requirements, capabilities. Cloud computing penetrated into large IT based applications like secured data storage, deploying computation resources for multimedia applications, rendering software for service etc. Cloud computing penetrated into large IT based applications like secured data storage, deploying computation resources for multimedia applications, rendering software for service etc. The data security is affected by the rate at which the cloud services and their features changes. The continuous up gradation of cloud architecture, add new features to it. The user connected to cloud, needs to verify the functionality and security of data. The user extracting the service from the cloud must constantly adapt to the changes in services to secure his data. Since cloud based services can be easily accessed by many mobile IT users without traversing through corporate sectors, there is threat of data security.

To enhance the security, Cloud vendors apply control measures between mobile users and cloud based services. Local machines and servers are connected in the cloud setup. Web applications and cloud users machines connect to cloud through internet protocols. When all these machines deploy same operating system, there is an increase in threat of attackers and data insecurity. Because the hackers find many paths to get connected to cloud applications. The common operating system also make the connections easy. Computer as a Service (CaaS) deploy hardware and software required to offer Voice over IP(VoIP), data and video Calling, messaging, chat etc services. CaaS services are in huge demand among business organizations and people for their personnel use. CaaS provide enhanced technology, networking, dense circuitry, and software applications and continuous maintenance of infrastructure to customers thus minimizing capital investment. CaaS need to ensure high quality, secure and adaptive communication to all its users.

CaaS service offerings are flexible, scalable and do not need service management and capital expenses. Cloud outsources the computer infrastructure to the customer. IaaS is mainly platform virtualization environment. Cloud Company provides data center space, server, software, network equipment to the user and billing is done on utility basis. Amazon Elastic Cloud Compute (Amazon EC2) provide virtual computing environment. The customers use the variety of operating systems using web connection. Amazon EC2 works in unison with Amazon Simple Storage Service (A S3), Amazon Simple DB, Amazon simple queue service (ASQs) etc. MaaS is cloud service rendering for security, primarily on business platforms. MaaS monitor the operational status at any time. The IT industry's manage their data over cloud based companies on service level agreement. [10] Says the IT managers accessing the data storage facility monitor and trace the data streaming to the cloud and relieved of challenges of security risks. Data storage applications concerned about the security, trust and privacy issues.

Platform as a Service (PaaS) is an outgrowth of SaaS. PaaS provide web based applications irrespective of operating system used. PaaS enables any user with internet connection to build powerful applications and deploy it for global use. The resources needed to run applications on user premises are provided by PaaS over the internet. PaaS offers are application design, development testing, deployment and hosting and leverage this on pay-per-use billing models. SaaS is a software distribution model. Applications are provided by service vendor to the user on internet. Ease of configuration, multitenant efficiency and scalability are key features of SaaS.

Large traffic of internet is fueled by multimedia data. The processing of multimedia data is done using large and complex algorithms. Multimedia information representation use different standards. Hence processing of data requires faster processors and large bandwidth. Application Specific Integrated Circuit (ASIC) designs give better solution where high speed hardware is desired. ASICs are designed to perform specific functions with high performance levels. But the main limitation of ASICs is higher Research and Development (R&D) cost to design and implement. Use of new equipments in IT industries involved long process of purchase, license install and integrate. Later at regular intervals to the management, maintenance and security process made it more complex. Introducing of new models of middle ware components in IT industry, organizations were burdened with more complexity of equipment installation. The installation is added with more complexity when purchasing and managing of components is from cross vendors. Thus Platform as a Service gained more popularity. In mid 2000s service in the form of PaaS was born. The PaaS service was delivered through Application Programming Interfaces. The services were mainly restricted to storage, server and network services. When PaaS was evolved to be used in production workloads, PaaS grew to provide middle ware solutions.

PaaS gained popularity due to production of workload requirements along with Service Level Agreements. Key features of PaaS are: standardized deployment, automated service, rules reduction, scalability and reduction etc. Disaster recovery chatbots, Blockchain services are few examples of modern app developed were PaaS is heading towards. Video is a more impressive way of data communication in telecom industry. Animations, graphics, entertainment, satellite communication, video information over mobile phones are various fields that use video processing. Each of these areas requires algorithms and hardware with different levels of complexity. Even video require more memory as compared to other forms of data. C/C++, python, MATLAB are software tools needed for video processing. Embedded processors, DSP kits, FPGAs are different hardware's used for improving speed. Even the peripheral devices required for video display are costlier. In current state of art, multimedia processing use cloud computing resources. cloud computing provides Video compression, encoding, transcoding, video streaming, video delivery service, video adaptation are different video processing algorithms used in video communication. These algorithms are required to be optimized for better service by the cloud. So continuous innovations in terms hardware usage and optimized algorithms are taking place for improving the service delivery. Cloud computing reduce the cost of video services by load sharing. Due to flexibility, cloud computing is gaining more popularity. Video delivery service gives solution to cloud computing during over burden of load. It is one of the cloud services, where without intervention of network provider the workload is rendered and managed by two cloud networks.

Table -1 Cloud Service providers

Host	Year	Services	Users	Data rate	Global occupancy
EC2	2003	Computation, storage	IT companies and developers	5Gbps	34
Orange Scape	2003	PaaS	Companies of Asia Pacific	500Gbps	5
Azure	2008	IT infrastructure	Small and medium enterprises	1Gbps	11
Google	2008	Infrastructure, data analytics	industries	2Gbps	4
Ctrls	2008	SaaS	Storage, backup, security	3Gbps	5
Bluemix	2014	PaaS, IaaS	Organizations, small industries	2Gbps	6
Cisco	2017	IaaS, NaaS,VXI	Network operators, telecom ind.	10Gbps	4

Table 1 shows cloud service providers and services they provide. Cloud systems provide enhanced capabilities and features, ranging from dynamically scalable applications and data, over controlled distribution to integration of all types of resources. In order to exploit these features during development of enhanced applications and services, the according interfaces and features need to be provided in an easy way for common users, but should also allow for

extended control for more advanced users. In order to facilitate such enhanced control features, the cloud system needs to provide new means to manage resources and infrastructure, potentially taking quality of service, the green agenda and other customer specifications into consideration.

Enterprises ensure the data security in accordance with legal issues, standards and audit practices, regardless of the location of the system at which the data resides. The dynamic fluid nature of cloud computing make rethinking on users side. So cloud computing vendor has to find solution for data security. Implementation of IT based applications always aims for improved performance in terms of speed and power.

SOCs are designed to perform specific functions with high performance levels. SOCs find wide application in signal processing applications and real time multimedia communication applications, where dense calculations and complex operations are done. But main limitation of SOCs is its higher Research and Development (R&D) cost to design, implement and market. Most of multimedia applications are drifting towards cloud computing. But limitations of SOC design stops it from migrating into cloud computing. Multimedia applications demand faster and real time service. Xilinx provides the advanced floor planning, hierarchical design, and timing tools to allow users to maximize performance for the most demanding designs. FPGA has flexibility, i.e the ability to rapidly implement or reprogram the logic in an FPGA for a specific feature or capability that a specific customer requires.

Reconfigurable hardware operates on bit stream data which promise data security. The hardware implementation of any application improves the speed. High-end FPGAs are growing in density while handling higher-speed applications and more complex designs.

V.CONCLUSION

Flexibility, scalability, and reduced cost investment features of cloud computing attracted large pool of IT industries to deploy cloud computing. Trust, Security and Privacy are on-going research issues in any development. The dynamic and fluid nature of cloud computing pose data security threats. Hence the cloud vendors need to adopt methods and algorithms to ensure data security. As reconfigurable hardware (FPGAs) operate on bit stream, they promise high data security in comparison with computers. FPGA implementation has many advantages in comparison with SOC design. FPGAs also add to flexibility and scalability property of cloud environment. High end FPGAs used in application development also speed up the application with its advanced features. Even the application is more robust from attackers. It is aimed to provide improved performance of cloud architecture using reconfigurable hardware by implementing video transcoder application.

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