Vision in IT from Cloud Computing

Swapan Debbarma, Nikhil Debbarma, Kunal Chakma, and Braja Gopal Patra

***Abstract*—Our paper proposes a new concept for Automatic-economic IT and optimum usage of resource in IT, especially for educational institutes. Theoretical background and overview is presented on the basic underlying principles, auto-utility computing, Service Oriented Architecture (SOA) . Their relation to cloud computing is explored and focused as a case for scaling out vs. scaling up is made and scaling out of relational databases in traditional application is stressed a bottleneck. The rapid development in IT and availability of services at low cost has exponentially expanded the use of internet for multiple applications. By evaluating strategic issues and weighting in economic adoption pros and cons. Cloud computing is expected to be an economically visible alternative to conventional methodology for implementation of projects without compromising the quality of services. This paper specifically point out cost efficiency, vendor lock in effects leading to operational risks to be prevailing for the majority of larger business customers that could potentially mandate their IT and computing needs from the cloud. Leading Current cloud architectures are compared in software industry. By exploration, it is found that the process of cloud architecture deployment will be gradual. Ultimately, conclusion will lead to an outlook and recommendations for companies and cloud providers.**

***Index Terms*—Cloud architectures, cloud computing adoption, auto-computing, , and SOA.**

I. Introduction and Motivation

Cloud computing is a resource delivery and usage model, it means get resource (Hardware, software)via network. The network of providing resource is called 'Cloud'. The hardware resource in the 'Cloud' seems scalable infinitely and can be used whenever [1]. Cutting through the hype of cloud computing is not an easy task as a simple web search suffices to convince that there are nearly as many definitions on what constitutes 'cloud computing' as there are players in the market seeking to gain new territory in that promising new business field. Cloud computing is an emerging technology which play a vital role in effective implementation of a lower cost. Today's dynamic environment of changing needs require on demand location independent computing services which include software, platform and scalable infrastructure. The cloud computing can provide such an environment for optimum utilization of resources. They either provide cloud computing commercial Solutions in one form or another, or actively sponsor research centers, Pursuing development of marketable technology. Cloud computing aim at and what are typical services that are expected to be encompassed by the definition of cloud computing, as evidenced for instance by the work of the "new offerings that allow enterprises to benefit from the developments taking place in the area of Cloud Computing" yet they attempt to steer clear out of the hype and highlight that they have redefined cloud computing to include everything sharing among different platform. Cloud computing technology from industry optimism to critique on the viability and feasibility along with concerns on privacy, security and not least cost efficiency of the currently offered cloud computing models is available as and seems to be broadly discussed within the IT community. The main goal is to "clear the air on cloud computing" and provide an unbiased and independent, albeit critical outlook of the technology [2]. As the title of this thesis suggests its aim is to enable the reader to gain an overview of the vital aspects of cloud computing in a three-fold way: by a) providing common definitions of the important terms; b) by setting apart the advantages of the technology and the disadvantages and problems inherent to it; and c) by ultimately delivering concrete technical and business model details on popular cloud architectures, offered by the big players in the field. Special emphasis is put on the critical examination of each strategy as now more than ever in the face of the global economic crisis, companies face higher refinancing and investment and as any company thinking about Adopting or moving to cloud computing technology would do in practice, short-to-medium term disadvantages of the technology have to be pragmatically and carefully weighted out against any hyped long-term potential efficiency achievements, be it strategic, and technical.

II. Autonomic and Utility Computing

In order to understand the vision, goals and strategy behind cloud computing, two key concepts that form its foundations need to be explained first. What seem to be the promising advantages of autonomic computing – systems that manage themselves, coupled with the flexibility and freedom of utility computing mark the core values of the business proposition offered by what is referred to as 'cloud computing'.

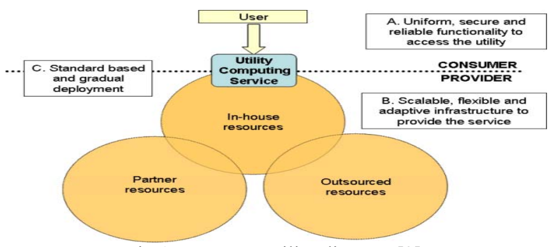

Fig.1. Resource utility diagram [3].

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There primary target is by developing 'autonomic elements' to combat the ever growing complexity of integrating and interconnecting the myriad diverse software systems that still continue to emerge exponentially throughout all areas of IT. A parallel could be drawn from these four characteristics to the desired characteristics one would want (or expect) systems deployed 'in the cloud' to posses

- **Self-management** – automatic configuration of components according to high-level policies. This would assure seamless adjustment of the rest of the system.
- **Self-optimization** – components strive proactively to optimize their own performance. That would accounts for a continuously improving efficiency of the whole system in general.
- **Self-healing** – the system in general diagnoses and removes software (IBM cited even hardware) issues. Thereby the system should ideally self-repair and self-maintain to the extent possible.
- **Self-protection** – the system defends itself from malicious attacks and cascading failures. Software organizations 'early warning' mechanism to prevent systemic failures. According to software industry even though their own claims for such a high degree of automation might seem like science fiction, increasingly autonomic systems in their vision would not spawn out of nowhere, but rather gradually as engineers add more and more sophisticated autonomic managers to existing humanly managed elements. However, software industry states in addition two necessary attributes to autonomic computing, that taken in the context of cloud computing seem to be problematic and relevant right now, long before the significant engineering challenges towards developing all the fancy autonomic systems are overcome. These purely organizational challenges are:
- **Privacy policies and laws** – autonomic systems must appropriately segregate and protect private data (not even remotely mentioned how)
- **Open standards** – the system must rely on such, also including its communication protocols; it cannot and shall not exist in a proprietary world. Additional arguments are provided further on in this thesis that emerging cloud computing providers almost naturally expect to perform a 'vendor lock' into their proprietary world on their clients, which reflects both the customer as well as the cloud computing industry negatively.

III. CLOUD COMPUTING

Cloud computing is a model generally defined as the clusters of scalable and virtualized resources like distributed computers, storage, and system software etc which makes use of internet to provide on demand services to the user. The opinions differ, but a pattern is found such that the wording in almost all explanations hovers around the keywords scalability, on-demand, pay-as-you-go, self-configuration, self maintenance and Software as a Service. A technical stance and considers a 'cloud' to be a pool of virtualized resources that hosts a variety of workloads, allows for a quick scale-out and deployment, provision of virtual machines to physical machines, supports redundancy and self-recovery and could also be monitored and rebalanced in real time. "A Cloud is a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements established through negotiation between the service provider and consumers". It emphasize that a 'cloud' is thereby not only a combination of clusters and grids, but is also extended by the implied usage of virtualization technologies such as Virtual Machines (VMs) to meet a specifically negotiated service quality level[4].

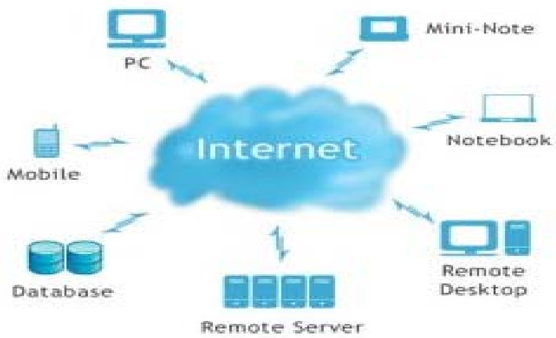

Fig. 2. A typical cloud computing architecture.

This definition implies and captures two potentially problematic issues of

1) The business issue of negotiating *the proper* SLA from the customer's perspective and
2) Having the technical capacity to correctly account for and guarantee the service outlined in that SLA at all resource monitoring, failure redundancy, rebalancing of workloads, etc. from the provider's perspective "Cloud Computing refers to both the applications delivered as services over the Internet and the hardware and systems software in the datacenters that provide those services (Software as a Service - SaaS).
3) When a Cloud is made available in a pay-as- you-go manner to the public, we call it a Public Cloud; the service being sold is utility Computing.". The could also be seen as recursive in case of mash-up provider that is a cloud user of another platform at the same time: Cloud Provider SaaS Provider / → Cloud User → SaaS User

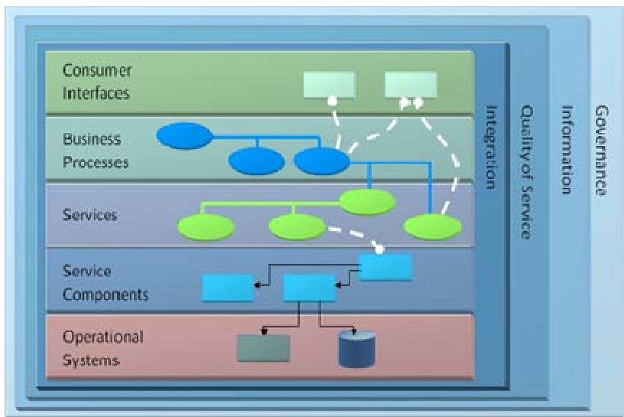

Fig. 3. Cloud computing infrastructure architecture.

It is specifically of the usage of the terminology Infrastructure/Hardware as a Service and Platform as a Service, which is commonly found in cloud computing explanations by industry experts and academics – rather Utility Computing (used here again interchangeably with Cloud Computing) is classified in three models – Computation, Storage and Networking [5].

The following building blocks of cloud computing [6]:

- Storage-as-a-Service
- Database-as-a-Service
- Information-as-a-Service
- Process-as-a-Service
- Application-as-a-Service
- Software-as-a-Service
- On-demand self-Service
- Infrastructure-as-a-Service
- Platform-as-a-Service
- Integration-as-a-Service
- Security-as-a-Service
- Management/Governance-as-a-Service
- Testing-as-a-Service
- Measured-as-a-Service

IV. Service Oriented Architecture

Service-oriented Architecture refers to a modular design principle in software architecture. Service orientation aims at separating individual functions into distinct units or "services", that could be accessed, e.g. via a network, by developers to integrate them in a reusable manner in their applications. A Paramount is the loose coupling of those services to programming languages and specific underlying platforms, i.e. the services communicate with the applications (or other services) that invokes them via their predefined interfaces. Ideally, those should be standard, available, documented and easily implementable. It suggests the following guiding principles towards designing a service – it should be granular, componentized, encapsulated, eve raging existing modules, having life cycle management and complying to common industry and IT standards. Ultimately, SOA based applications should leverage a multitude of already developed services – purposefully designed, stateless pieces of business logic that compute specific tasks and deliver clear and usable results in return. XML/SOAP protocols are examples of commonly used for building SOA applications and utilizing web services (services accessible via HTTP protocols). From the business perspective SOA should allow for reuse of existing investments through leverage of already bought technology, evidenced e.g. as plenty of companies are creating services extracted from existing applications to be mandated for further standardized usage company wide in the enterprise SOA. Moreover, by deploying a flexible SOA in the enterprise, existing systems could be changed more flexibly to accommodate for changing business and user needs. SOA, as an architecture design principle is a necessary ingredient towards enabling any of the cloud computing models and paradigms mentioned in this thesis for two key reasons:

- ***Firstly***, the term Service-oriented Infrastructure (SOI), as defined by software organizations to be the "virtualized IT infrastructure in an industrialized way" manages a multitude of services as well as SOA applications. Intel reaches to draw a parallel with autonomic computing and further enhance the understanding of the" SOI layer" with a couple of very high-level tasks such as management of virtualization, load balancing and capacity planning, monitoring and problem diagnosis, security enforcement and utilization metering (incl. SLA compliance)[7]. If and when, theoretically, systems (including those of normal, non-IT enterprises) are made to be capable of such seamless encapsulation, abstraction and management of whole computing resources, moving, providing or acquiring them from the Cloud would be the next logical thing to do. However, for the time being this as well as most of software industry vision of autonomic computing remains largely wishful thinking, yet still points towards the general trend in automating enterprise IT resources.
- ***Secondly***, any software or software platform that is to be 'offered as a service' or "provided in a payas- you-go manner" should be designed along SOA principles. Customers, or software application developers would thereby theoretically design their systems to be modular or use other's modules and ideally pay only for the components they need (if they are drawing on external pieces of code). Although apparently not a new concept at all, I would argue that the trend towards cloud computing and the resulting need for more interoperable systems (as they are hosted/executed in the cloud) would naturally strengthen the case for SOA based software [8].

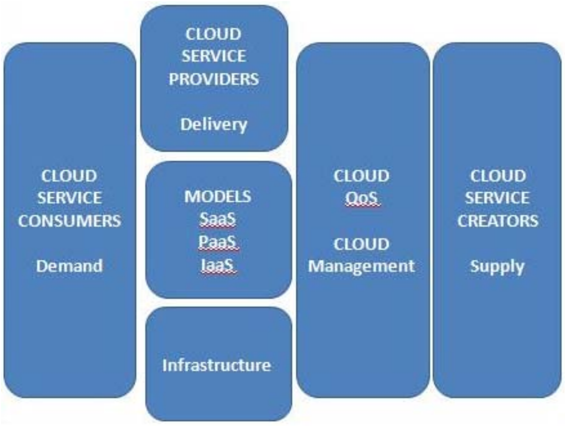

Fig. 4. Service oriented architecture [9].

V. Business Access From Anywhere [10]

Cloud computing is a network based service. This makes accessibility to the cloud services location independent. The only prerequisite is the use of standard internet-enabled devices like low cost desktop computers, mobile handsets etc at client side with high speed network. Business access is a fast reaction to change and the ability to rapidly implement changes. Business agility needs to be holistic in scope. Business agility consists of three interoperable components: Human, Business Process, and Technical agility. Humans are assumed to be agile in management and operations for the enterprise to be agile. Human agility is the main enabler of business agility. Business process agility has gone long road till it reached Business Process Management System (BPMS). Technical agility, that addresses IT infrastructure and information systems architecture, can make use of SOA.

Aligning BPMS and SOA can enhance business agility.

VI. Business Process Management

Potential Business Advantages VS Setbacks in Reality: Cloud computing, is a pragmatically and independent point of view. Advantages and pros spread faster as the technology gains traction – prominent examples are outlined in the introductory section. The goal is however to critically set apart the following, more unpopular key aspects[11]: • Marketing claims for future potentials vs. current technical capabilities • Business models for which cloud computing makes sense vs. those for which it does not – arguably, the majority of IT spending • Different types of vendor lock-in effects – explained and weighted • Security issues to which more concern should be paid Business Process Management (BPM) is the key to business agility. Business process is a Series of interrelated activities that cross functional enterprise boundaries with individual inputs and outputs. Business processes are either operational or supporting. Operational Business processes are associated with the way enterprise develop strategies, invent, market and sell products or services. Support processes include the provision of Human Resource Management (HRM) activities, information systems infrastructure, and finance and asset Management. The Cloud computing implies, the effectiveness of resource usage and scalability of grid computing. Grid computing architectures are not easy to set up as they imply complexities of all sorts – middleware and network configurations among others. However, as grids are 'taken to the next level', here are some of the often quotes pros from the business perspective of companies to move to cloud computing.

• **Countering of standardized resources usage** – based on actual consumption – utility computing and pay-as-you-go models are introduced to charge the customer for hardware usage, be it server- RAM-hours, gigabyte-storage-hours, CPU-hours, etc. Thus, in addition to the currently spread standardized-server-configuration-hours (for renting a dedicated server from a datacenter) and network bandwidth usage (GB of data transferred), more flexibility is introduced as resources are relinquished after no longer being needed [12].

• **Elasticity**– scalability and load-balancing of the server resources are built-in. There by short-term automatic provision, enabling invocation of additional resources is paramount. The benefits of this could be enormous to companies that experience frequent and significant Changes in computing or storage needs. *Service unavailability* and therefore lost-customer costs are avoided as all potential computing needs/server requests are possible to be met. A classic example may include social networks that receive a sudden surge in popularity ("victim of own success"), a web shop during peak pre-holiday times, but also a news or company website (e.g. an airline) that, due to critical events receives an overwhelming amount of traffic that requires more than the planned/available computing resources, in order for all of the requests to be served

• **No capital expenditure** – on hardware (as well as software) that performs the computing needs. These are the fixed costs associated with one time purchases of IT infrastructure that are amortized over time. They are converted to operating expenses for renting the resources of the cloud provider.

• **Uncomplicated deployment** – as well as availability of autonomic management features that lead to easier and less costly maintenance, i.e. less personnel costs of the cloud provider for managing a given pool of server resources (e.g. administrators per 1000 servers), thus the ability to offer the resources at lower prices. All of the above listed lead to *faster time-to-market* as well as *lower specific project costs* related to the implementation of a given software solution in a cloud rather than a traditional internal IT department or datacenter. However, as argued further on in this chapter, those benefits are easily pinpointed if one were to "create the next Face book" or "the next YouTube", but largely questionable if one were to move their on premises or own datacenter existing computing resources to the cloud.

VII. Technical Migration to New Technology

In a dynamic environment, the government policies of various ministries change from time to time requiring appropriate changes in e-government applications. Sometimes it may require migration to new technology in the distributed setup, migration is a challenging task which requires implementation at site, often at multiple locations. comparatively, migration to new technology is relatively easier and faster in case of clod based architecture because changes at one location alone ensure migration to new application by its users. Technical agility refers to the ability to quickly change the type and flow of information within an organization within enterprise. Technical agility parameters are IT infrastructure, and information system architecture. IT advance has not yet satisfied business requirements due to improper information systems architectures. SOA addresses technical agility requirements by presenting compos ability, modularity, and loose coupling concepts as services that wrap underlying IT infrastructure, databases, and legacy systems and present them via standard interface. There is a need to stabilize IT infrastructure rather than developing new ones and SOA enables this stabilization. Enterprises should balance IT to become better positioned and more agile .Services is the building Blocks of an agile enterprise Service as 'A Component capable of performing a task'. Service is 'A vehicle by which a consumer's need or want is satisfied according to a negotiated contract (implied or explicit) which includes Service Agreement, Function Offered and so on.

VIII. Privacy and Security Issues

Shared infrastructure scares many enterprise customers. Placing enterprise data in a public cloud is a serious concern and companies wary about their sensitive data logically question the ability of public cloud computing providers to provide the same level of security as their own datacenters[13]. Depending on the type of cloud computing used and the level of abstraction (OS-level vs. platform vs. application level) different security issues arise in public clouds. The cloud provider is responsible for the physical security of the machines, for ensuring that virtual machine instances are running isolated from one another (i.e. crashes and software exploits of one system do not affect the others) as well as for setting up firewalls to protect the Virtual Machines from the network. However, higher level cloud services such as Google App Engine and platforms like Azure are also responsible for their application-level security and clients have less control controlling it. In addition, downtimes, outright data losses in storage services and risks of cloud provider malfeasance are further threats to be weighted when a company considers public cloud services usage. Data Security – Confidentiality and Availability**:** Virtual Machines have shown vulnerabilities to certain kinds of memory attacks. Even though physical access to the PC running the Virtual Machines is a prerequisite, I argue that private clouds are generally more secure, as availability of the physical machines and full administrative rights are at the company's disposal. Arguably, it is much more likely that in case a bug is found (or proactively with malicious attacks) problems arise that allow Virtual Machines users to access other users' Virtual Machines instances or storage data. Naturally, such problems exist in large datacenters too, yet the implications of ultra large scale failures given hundreds of thousands of potential cloud users sharing the same infrastructure could be devastating [14]. Debugging such distributed such developed; widely distributed systems may later be very difficult, as some errors could not be reproduced in smaller, test configurations. Companies should spend additionally to ensure that their data and applications are as secure as possible in the cloud. Encrypted all data sent to the cloud may be an option to ensure security, yet this may have implications on costs for developing/configuring applications appropriately.

IX. Conclusion

Cloud computing is undoubtedly still work in progress – both from a technical and business perspective. Although projects attempt to bring about a platform that is provider-independent, the lack of open standards and the abundance of proprietary APIs that each provider actively tries to bestow upon its users is still a major setback to wider scale adoption in my opinion. Clearly put, my conclusion is that non-IT industry businesses' IT departments are not yet justified to be moved to cloud architectures, and if so only for very specific business tasks and with great caution. Yet, execution of batch jobs/parallel processing tasks and smaller online businesses running only pure web applications seem to be a nice fit, regardless of being locked in with a specific cloud provider.

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