CLOUD COMPUTING IN PRACTICE

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1. ABSTRACT

In the past years, Cloud Computing has become the hot topic of literature of technical and information technology. The Cloud Computing has gained impetus in the applications as well. It can be observed that enterprises in increasing number started moving their application systems into the "Cloud". In this paper, we discuss the Cloud Computing as an approach for Business Information Systems and the typical services delivered by the various deployment modes. We present an overview of the methods for migration of traditional business information systems and their data into Cloud Computing environment. Moreover, we explore the novel selection criteria for ERP systems (Enterprise Resourcing Systems) introduction that emerged in relationship with the Cloud Computing phenomena. One of our aims is to provide a survey about the subjects that can be encountered within the first phases during the preparation to plan a migration into a Cloud Computing environment.

2. THE CONCEPT OF CLOUD COMPUTING AND THE TRENDS OF ITS APPLICATIONS

Cloud Computing is proliferated as a steadily available, flexible deployable service that can be easily aligned to requirements. One of the basic technologies that enabled the Cloud Computing, the sophisticated virtualization of hardware, operating systems and networking.

> *The concept of virtualization: A mapping of architectural building blocks of Information Technology by software tools that is not based on real physical artefacts. However, the mapping produces the same functionality as the physical, hardware building blocks may deliver. What does this conceptualization mean? A virtual server is operated on one or more physical server, within a software environment that created by a hardware* ***emulation.*** *The operating system of the virtual server makes use of services of the emulated hardware environment; nevertheless the so called* ***guest operating system*** *uses the same interface as it would have been real, physical hardware. Similar statement is valid for the network virtualization especially for the Virtual Private Network solutions.* ([1])

The virtualized networks within a Cloud Computing environment have specific feature that have some similarity to VPNs (*Virtual Private Network*) in morphological sense but they are not the same, neither technologically nor architecturally. The Cloud Computing through exploiting the available technology delivers services for data migration within their own infrastructure of service providers and moving the processes among the local and remote data centers that are deployed all over the world. (To leverage the smooth and seamless changeover from a service provider to other one, proper technologies are anticipated to emerge in the future). The services provided by the Cloud are scalable to avoid the bottle neck of data processing. The next enabler of Cloud Computing is the Internet that provides the opportunity that data and services can be accessed independently from the geographic location.

The concept of Cloud Computing is relatively new for that reason there is not a stable and widely accepted definition. There are circumscriptions of notion to help the perception:

> *The Cloud Computing is a model that provides the opportunity that distributed resources – i.e. networks, servers, storage, applications, services – can be accessed comfortable any time and from any place and they are easily configurable on demand through a network whereby ensures that the resources will be available quickly and require minimal operating efforts or support from the service provider* ([2], pp. 14.).

Another attempt to define Cloud Computing:

> *The Cloud Computing is a set of services, applications and resources that are offered for the customer through the Internet. The services can be flexibly scaled or customized to requirements without long time capital investment, furthermore without necessary skill, knowledge and know-how dedicated to operate IT (Information Technology). The customer freely decides depending on the degree of the vertical integration as whether a complete software application system or only IT infrastructure services are needed* [3].

Figure 1. depicts the creation of Cloud Computing through the evolution of various patterns of data processing.

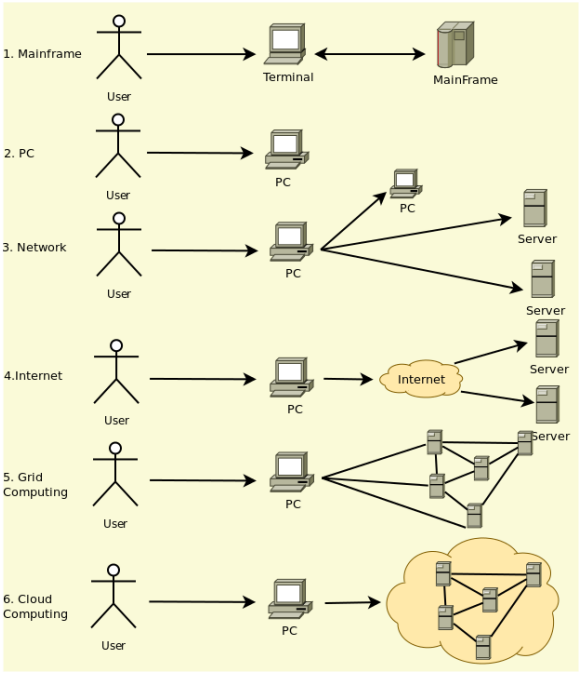

Figure 1.
Development of data processing approaches (based on [6])

The Cloud Computing offers various forms of services for customers; the following arts are used most frequently:

- IaaS *(Infrastructure as a Service),* Cloud infrastructure services typically offer virtualization platforms. The customers buy the resources, instead of having to set up servers, software, and data center space themselves, and pay-as-you-go, i.e. the payment happens on the base as resources consumed. The tenants deploy their own software on the virtual machines and control and manage it. The virtual machines can be rented for as long as necessary they can be as short as an hour. The amount of virtual machines can be scaled dynamically to fulfill the customers' needs. Billing is based on resources, the duration, and additional services used, e.g. additional storage space. The service provider of Cloud computing generally has data centers in multiple locations to offer quick access all over the world through Internet. Typically, Web interfaces allow controlling, monitoring and managing of the Cloud services.
- SaaS *(Software as a Service),* generally provide specific operational application systems on a Cloud infrastructure. One of the most proliferated solutions is the *web-based e-mail*. Most *Software as a Service* in the form of Cloud Computing services is web-based applications, which can be accessed from a thin client interface, such as a web browser. A significant difference is that the customers of those services do not manage or control the underlying infrastructure and application system. The user can configure the services only in a limited way that touches only some very restricted user specific features. Provision for Internet-based storage is also often considered to be part of SaaS offerings. Modules or entire ERP *(Enterprise Resource Planning)* systems can be accessed by a scalable way. In this service construction, the task of service providers is the operation and the maintenance of software.
- PaaS *(Platform as a Service)* provides a managed software infrastructure, where clients can build and deploy certain applications and services using the tools, environments, and programming languages supported by the actual service provider. PaaS includes the exploitation of the underlying infrastructure, such as servers, network, storage, or operating systems which the tenants cannot handle or manage, as it is abstracted away through virtualization and infrastructure management technology below the platform existing hardware and software services. Platform services are mostly targeted at specific domains – such as the *development of web applications* –, and are dependent on the integrated software development environment involving the programming languages.
- DBaaS *(Database as a Service),* services to run database basically can be put into two categories. The customer may buy or rent a virtual machine and the database can run within the virtual instance.
  - The tenants can place their own virtual machine image with a database installed on it into the Cloud.
  - The user may employ a ready-made virtual machine images that already include an installation of a database.

Although there are obvious advantages of Cloud Computing, but there are several open issues for customers. Critical points for the acceptance of Cloud Computing are security, safety and the protection of users' data, moreover the location of actual storage for data after migration and transfer. Data transfer can happen for several reasons as load balancing, in sake of efficiency, disaster recovery and business continuity. Large enterprises cannot support the public Cloud concept until the location of data storage can be geographically precisely identified. "Legal environments and jurisdiction that is different and incompatible to the domestic one provide no guarantee that third parties may access the data. It may occur that the insurance policy may exclude that the actual and physical storage of data may manifest in specific geographic region." [7].

> *The security requirements make the proliferation of Cloud Computing difficult. The major concern related to Cloud Computing is security. The enterprises may have to transfer their data and applications into Cloud though the physical locations are either not known or there is no trust in the certain geographic region as there is no proper and direct experiences about the security.* [8].

The reference [9] summarizes the issues as it follows: *"There is no information in the location of data; we do not know where the servers on which the applications for data processing are executed are hosted; we have no knowledge who is the tenant in the very same virtual environment where our applications run."*

The enterprises may finally conclude that they tend to operate their critical applications in Cloud or exploiting the advantages of Cloud services through some renting construction. One of the tangible benefits is that the capital and operational expenditure (CAPEX, OPEX) related to the building-up and maintaining an IT infrastructure can be significantly reduced. This value can be measured properly if either the demand for the products of the enterprise is fluctuated enormously, or the enterprise is in an expansion phase, or creation of a data center is not justified by the economy of scale.

The customer may exploit the advantages provided by the Cloud Computing in two ways; either the existing applications will be deployed into the Cloud environment or the customer selects business information services from the offerings of Cloud, e.g. ERP, that fits the best to its own requirements to run the business In the next section we will discuss both solutions.

3. MOVING BUSINESS INFORMATION SYSTEMS INTO CLOUD

Several surveys demonstrate that the application of Cloud Computing is proliferating. *"On the German market, the total revenue from the business of Cloud Computing can reach five billion €."* [4].

IDC *(International Development Company)* as a market research and consulting company anticipates that the Cloud Computing will play a significant role in the Hungarian economy as well. A research report about the impact on the Hungarian economy by Cloud Computing claims that the revenue from Cloud Computing can reach 87,3 billion HUF for the businesses. According to IDC, the Cloud Computing as business will create at least two thousands new job in Hungary. [5].

Migrating the Business Information Systems generally, the ERP systems especially into Cloud emerge as a business issue at several enterprises. In the preparation of a decision, the factors that should be considered are the scalability, elasticity, decreasing the operational costs and avoiding a massive infrastructure investment. However, it may occur that the new business information system cannot be aligned to the changing business environment, e.g. because of an acquisition; so that the information systems should be enhanced. To mitigate this risk, it is necessary to take into account the long term business strategy of the enterprise what business processes are expected to be modified in time.

To operate a Business Information System in the Cloud, there is a need for a plan. The plan should include a number of stages to take care several viewpoints. The reference [10] discusses five points to make decision as it follows:

- The degree of utilization of Cloud

It seems sensible that instead of a Big-Bang approach, i.e. moving all the applications into Cloud, the non-critical applications should be deployed in the Cloud in the first stage, and then later on the modules of the ERP system could be transferred that support the main activities and processes of the business. (N.B.: In the Big-Bang approach, all or most of the developed modules are coupled together to forms a complete software system or major part of the system and then used for integration testing. The Big Bang method is very effective for saving time in the integration testing process).

- Maintaining the independence from software vendors in the case of ERP

The existing ERP system for architectural reason is not appropriate to operate in the Cloud so that the demand for rent of an EPR system within the Cloud environment appears. It should be taken into account that a new ERP system within a Cloud environment is inflexible; it cannot be customized to satisfy individual requirements as the ERP system is used in a multi-tenant environment. The modification of the system can be achieved cost-effectively only in a single-tenant environment where the customer has a dedicated database and application system adjusted its own requirements.

- The priority ranking of data migration

Although the data within the Cloud are protected by high-level and reliable security mechanisms, it could be considered as whether all the data asset of the enterprise will have to be migrated into Cloud? If the data are used and modified most frequently (i.e. critical data) and are moved and permanently stored into Cloud then the backup and recovery could be more efficient within the Cloud environment. (There are software solutions to block data leakage either in the case of storage of data at the local hardware or in the Cloud. [11]).

- Criteria for services and security

It should be clarified in advance whether how the data can be accessed, what is the method for the routing of data traffic, the reliability of the security system, the references of potential service provider. It is advisable that the service provider should possess a certificate in ISO 27001 and the daily operation should follow strictly the prescription of the security management principles and objectives.

- Disaster Recovery

A Disaster Recovery Plan should be prepared for the most unlikely risks too, as e.g. flood, fire, terrorism, cyber-attack etc. The loss of data, damage to the infrastructure, temporal breakdown in data processing belongs to the responsibility of service provider; for this reason appropriate solution should be developed for handling the situations and the liabilities of the service provider should be contractually formulated. The Cloud service provider should be audited regularly for compliance to regulation that can arch over a wide spectrum from finance through ICT *(Information and Communication Technology)* to physical and logical security mechanism. The agreement should contain obligations on the aforementioned areas as well.

4. SELECTION CRITERIA FOR BUSINESS INFORMATION SYSTEMS IN CLOUD

It can be anticipated that the demand against SaaS solutions increases. According to Gartner, the revenue out of software in Cloud from 12,1 billion $ in 2011 can grow to 21,3 billion $ in 2015, worldwide [12]. The growth in revenue can be explained by the impact of the cost-reduction on the small and medium-sized enterprises as a number of SMEs *(Small and Medium Enterprises)* may appear as a buyer of services on the market of Business Information and ERP Systems in Cloud.

The question arises what kind of criteria should be taken into account in the selection process of Business Information Systems in the Cloud. Which are the new criteria appearing because of Cloud Computing? What are the decisive features of software in the Cloud that support their proliferation? The question can be answered by the conclusions from literature overview and investigation of case studies in practice. There are four main features as responses:

- Modular software architecture: *"A component-based architecture for ERP system separate and isolate the tiers and layers of architecture that can be flexible modified later on. The component-based architecture provides the opportunity for incremental implementation in stages."* [13]. The component-based architecture as structuring principle supports the selection of functions required for the data processing activities that are actually needed, e.g. some accounting processes or controlling functions.
- Scalability: the number of clients that should use the application unconditionally can be identified explicitly then consequently the required capacity of servers can be assessed. [14].
- Mobility: The accessibility of applications is a *must* from the heterogeneous mobile devices (e.g. iPad, iPhone, MID, smart phones etc).
- Cost reduction: The Cloud Computing decreases the capital and operational expenditure (CAPEX, OPEX) in opposition to the traditional ERP system. [15].

5. SUMMARY

The Cloud Computing can be regarded as a high-level implementation of the *dynamic infrastructure* that can unify the available computing capacities through the virtualization that creates an “IT factory” that delivers its services on demand to the potential customers. There are definitive advantages of the Cloud Computing Technology but there exist uncertainties. The security issue is a critical focus point whether to adopt the Cloud Computing Technology by an enterprise so that it is worth considering the security service level that a given service provider can deliver. Up till now there are not widely accepted, unified standards for security in Cloud Computing environment, but the rapid development promises that the emerging standards and best-practices can deal with the security problems at an acceptable level. There some commercial Cloud service providers that is an example to other players. We have discussed only a minor part of the topic of Cloud Computing that relates to the selection and operation of applications in Cloud. The spread of Cloud Computing can be observed in all sectors of economy that can be perceived as reaction and response to the crisis of finance and economy in the form of evolution of IT. It may be considered as the next stage in the development of computing technology that becomes part of our everyday life.

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