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Cloud Computing Solution for Sudan Comparison of Current Approaches

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Abstract: ***As part of a transformation of Sudan, e-government, and the transition from traditional techniques to cloud computing technology to meet the requirements phase. This paper reflects the efforts to move from traditional IT to cloud computing technology and data migration of traditional data center and operate in to the cloud computing environment. To provide e-government services and then move to smart government. Also, cloud computing technology based on cost reduction and optimal use of resources are fully fit technology with third world countries such as Sudan. The contribution of this paper is to provide a comprehensible overview of key-characteristics of current solutions and outline the problems they do and do not address. This paper should serve as an entry point for orientation of future research regarding new applications in cloud computing and advanced requirements for data management [2].***

Keywords: Cloud Computing, Data Management, Service

1. Introduction

The infrastructure for information technology in Sudan exist Islands isolated in the public and private sectors and here stemmed importance of this research for linking all the infrastructures in a single network in cloud computing serving users, and this linkage in turn reduces the cost and effort while providing existential permanent and high flexibility and scalability continuous and reliable and an increase in information security and quality of service, fast and direct access to the market and the stability of the services with pay per use and customer satisfaction.

Hence provide a single network to serve all sectors work to the principle of cloud computing based on the provision of infrastructure, software, hardware and platforms as service which reduces cost and provides balance in the data load distribution in the network. To do so would be to build integration of networking architecture for these isolated islands of infrastructures and develop a plan for data load distribution to provide the foregoing.

There is no unique and standard definition for Cloud Computing. However, it is generally accepted that Cloud Computing refers to a new IT paradigm for users [4]

Two of these definitions:

- Cloud computing is a style of computing paradigm in which typically real-time scalable resources such as files, data, software, hardware, and third party services can be accessible from a Web browser via the Internet to users [4].
- Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. [1]

Five essential **characteristics**, which differentiate cloud computing from grid computing and other distributed computing paradigms**:**

1) On-demand self-service: provision computing capabilities as needed automatically.
2) Broad network access: available over the network and accessed through standard mechanisms.
3) Resource pooling: computing resources are pooled with location independence.
4) Rapid elasticity: Capabilities can be rapidly and elastically provisioned.
5) Measured Service: automatically control and optimize resource.

2. 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's provider. [1]

- Completely automated
- Users abstracted from the implementation.
- Near real-time delivery (seconds or minutes).
- Services accessed through a self-serve web interface.

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. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter). Examples of resources include storage, processing, memory, network bandwidth, and virtual machines. [1]

- Resources are drawn from a common pool.
- Common resources build economies of scale.
- Common infrastructure runs at high efficiency.

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, laptops, and PDAs). [1]

- Open standards and APIs.
- Almost always IP, HTTP.
- Available from anywhere with an internet connection.

Rapid elasticity:
Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and rapidly released to quickly scale in. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time. [1]

- Resources dynamically-allocated between users.
- Additional resources dynamically-released when needed.
- Fully automated.

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. [1]

- Services are metered, like a utility.
- Users pay only for services used.
- Services can be cancelled at any time.

3. Cloud Computing Service Models

There are two main approaches to provide data management systems for the cloud. In the first approach,

a) Cloud Software as a Service (SaaS) [1]:
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 a thin client interface such as a web browser (e.g., web-based email). 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.

- Use provider's applications over a network.
- Consumer uses provider's applications running on provider's cloud infrastructure.
- SaaS is a model of software deployment where an application is hosted as a service provided to customers across the Internet. [3]
- SaaS alleviates the burden of software maintenance/support. [3]
- But users relinquish control over software versions and requirements. [3]

b)Cloud Platform as a Service (PaaS) [1]:
The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages 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 application hosting environment configurations.

- Deploy customer-created applications to a cloud.
- Consumer can create custom applications using programming tools supported by the provider and deploy them onto the provider's cloud infrastructure.

c) Cloud Infrastructure as a Service (IaaS) [1]:
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, deployed applications, and possibly limited control of select networking components (e.g., host firewalls).

- Rent processing, storage, network capacity, and other fundamental computing resources.
- Consumer can provision computing resources within provider's infrastructure upon which they can deploy and run arbitrary software, including OS and applications

To be considered "cloud" services are deployed on top of cloud infrastructure that has the key characteristics.

4. Cloud Computing Architecture

The Cloud Computing Architecture of a cloud solution is the structure of the system, which comprise on-premise and cloud resources, services, middleware, and software components, geo-location, the externally visible properties of these, and the relationships between them. The term also refers to documentation of a system's cloud computing architecture. Documenting facilitates communication between stakeholders, documents early decisions about high-level design, and allows reuse of design components and patterns between projects.

- **The front end** - is the part seen by the client, i.e. The computer user. This includes the client's network (or computer) and the applications used to access the cloud via user interface such as a web browser. [4]
- **The back end** - is the 'cloud' itself, comprising various computers, servers and data storage devices. [4]
- **Users/brokers:** they submit their service requests from anywhere in the world to the cloud. [4]
- **Sla resource allocator:** it is a kind of interface between users and cloud service provider which enable the sla-oriented resource management. [4]
- **Service request examiner and admission control**: it interprets the submitted request for qos requirements before determining whether to accept or reject the request. Based on resource availability in the cloud and other parameters decide. [4]
- **Pricing**: it is in charge of billing based on the resource utilization and some factors. Some factors: (request time, type and …) [4]
- **Accounting**: maintains the actual usage of resources by request so that the final cost can be charged to the users. [4]
- **Vm monitor**: keeps tracks on the availability of vms and their resources. [4]
- **Dispatcher**: the dispatcher mechanism starts the execution of admitted requests on allocated vms.

- **Service request monitor**: the request monitor mechanism keeps track on execution of request in order to be in tune with sla. [4]

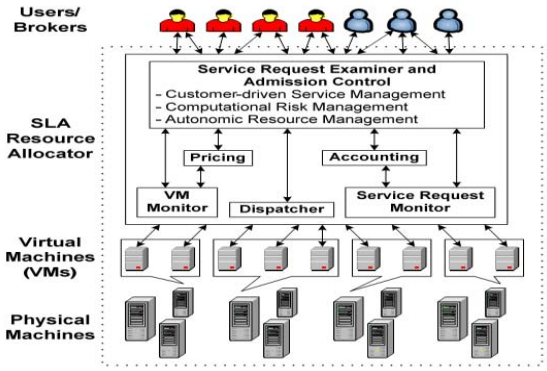

Figure 1: Cloud computing architecture [4]

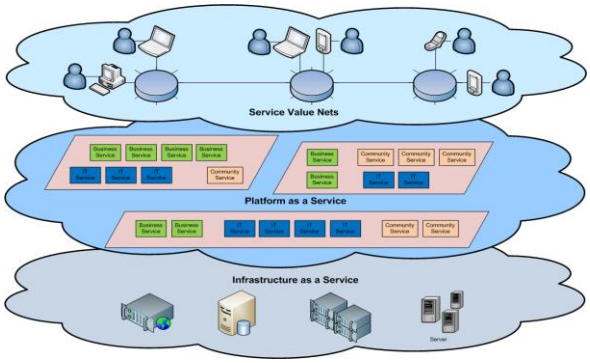

Figure 2: Cloud architecture [3]

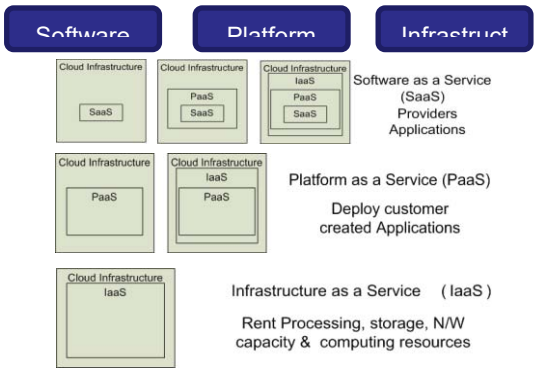

Figure 3: Cloud Computing Service Model Architectures [3]

5. Benefits of Cloud Computing

Cloud computing offers your business many benefits. It allows you to set up what is essentially a virtual office to give you the flexibility of connecting to your business anywhere, any time. With the growing number of web-enabled devices used in today's business environment (e.g. smartphones, tablets), access to your data is even easier. There are many benefits to moving your business to the cloud:

Reduce capital and operations costs:
Moving to cloud computing may reduce the cost of managing and maintaining your IT systems. Rather than purchasing expensive systems and equipment for your business, you can reduce your costs by using the resources of your cloud computing service provider. You may be able to reduce your operating costs because: [5]

- The cost of system upgrades, new hardware and software may be included in your contract
- You no longer need to pay wages for expert staff
- Your energy consumption costs may be reduced
- There are fewer time delays.
- No longer required to make large up-front capital investment on datacenters.
- Eliminate the need to plan ahead for cost provisioning.
- Allow companies to start small and increase their resources investment as needed (pay-as-you-go).
- Simplify applications deployment & management:
- Common programming model across mobile, browser, client, server, cloud.
- Access to strong ecosystem of widely deployed applications.
- Integration with existing it assets (software + services).

Scalability:
Your business can scale up or scale down your operation and storage needs quickly to suit your situation, allowing flexibility as your needs change. Rather than purchasing and installing expensive upgrades yourself, your cloud computer service provider can handle this for you. Using the cloud frees up your time so you can get on with running your business. [5]

Business continuity:
Protecting your data and systems is an important part of business continuity planning. Whether you experience a natural disaster, power failure or other crisis, having your data stored in the cloud ensures it is backed up and protected in a secure and safe location. Being able to access your data again quickly allows you to conduct business as usual, minimizing any downtime and loss of productivity. [5]

Collaboration efficiency:
Collaboration in a cloud environment gives your business the ability to communicate and share more easily outside of the traditional methods. If you are working on a project across different locations, you could use cloud computing to give employees, contractors and third parties access to the same files. You could also choose a cloud computing model that makes it easy for you to share your records with your advisers (e.g. a quick and secure way to share accounting records with your accountant or financial adviser). [5]

Flexibility of work practices:
Cloud computing allows employees to be more flexible in their work practices. For example, you have the ability to access data from home, on holiday, or via the commute to and from work (providing you have an internet connection). If you need access to your data while you are off-site, you can connect to your virtual office, quickly and easily. [5]

Access to automatic updates:
Access to automatic updates for your IT requirements may be included in your service fee. Depending on your cloud computing service provider, your system will regularly be updated with the latest technology. This could include up-to-

date versions of software, as well as upgrades to servers and computer processing power. [5]

6. Opportunities and Challenges

The use of the cloud provides a number of opportunities: [3]

a. It enables services to be used without any understanding of their infrastructure.
b. Cloud computing works using economies of scale:
   - It potentially lowers the outlay expense for start-up companies, as they would no longer need to buy their own software or servers.
   - Cost would be by on-demand pricing.
   - Vendors and Service providers claim costs by establishing an ongoing revenue stream.
c. Data and services are stored remotely but accessible from "anywhere".
   - In parallel there has been backlash against cloud computing: [3]
d. Use of cloud computing means dependence on others and that could possibly limit flexibility and innovation:
   - The others are likely become the bigger Internet companies like Google and IBM, who may monopolise the market.
   - Some argue that this use of supercomputers is a return to the time of mainframe computing that the PC was a reaction against. [3]
e. Security could prove to be a big issue:
   - It is still unclear how safe out-sourced data is and when using these services ownership of data is not always clear.
f. There are also issues relating to policy and access: [3]
   - If your data is stored abroad whose policy do you adhere to?
   - What happens if the remote server goes down?
   - How will you then access files?
   - There have been cases of users being locked out of accounts and losing access to data.

7. The Reflections of Cloud Computing on e-Government

The use of cloud computing technology in the countries of the Third World, such as Sudan have positive influence and that because the lack of resources and lack of funding as it reduces the financial expense on government and peoples, and provides

Sustainability and stability of e-Government services. High Reliability, availability and flexibility of e-Government services. Also

- Scalability.
- Data load balancing.
- Ease to access to information's.
- Ease to use.
- Help state officials in decision-making.
- Quality of Service.
- Reduce or stop corruption.
- cost and time efficiencies.
- Customer satisfaction.
- Elasticity

Using cloud computing technology Especially in Sudan is very useful because is the very large country and have very huge infrastructure cove all area of Sudan. Also internet service.

More than 50% of Sudanese peoples used internet service through smart phones, laptop, pc and official work networks. Sudan have more than 4 data center tier 3 and one data center tier 4. And now Sudan going to build cloud data center for e-government and move to smart government by year 2020.

8. Replication Techniques

Replication is used by data management systems in the cloud to achieve high availability. Replication means storing replicas of data on more than one storage node and probably more than one data center. The replica placement strategy affects the efficiency of the system [2]. In the following we describe the replication strategies used by cloud systems:

Rack Aware Strategy [2]:
Also known as the Old Network Topology Strategy. It places replicas in more than one data center on different racks within each data center.

Data Center Aware Strategy [2]:
Also known as the New Network Topology Strategy. In this strategy, clients specify in their applications how replicas are placed across different data centers.

Rack Unaware Strategy [2]:
Also known as the Simple Strategy. It places replicas within one data center using a method that does not configure replica placement on certain racks.

Replication improves system robustness against node failures. When a node fails, the system can transparently read data from other replicas. Another gain of replication is increasing read performance using a load balancer that directs requests to a data center close to the user. Replication has a disadvantage when it comes to updating data. The system has to update all replicas. This leads to very important design considerations that impact availability and consistency of data. The first one is to decide whether to make replicas available during updates or wait until data is consistent across all of them. Most systems in the cloud choose availability over consistency. The second design consideration is to decide when to perform replica conflicts resolution, i.e., during writes or reads. If conflict resolution is done during write operations, writes could be rejected if the system can't reach all replicas or a specified number of them within a specific time. Example of that is the WRITE ALL operation in Cassandra, where the write fails if the system could not reach all replicas of data. However, some systems in the cloud choose to be always writeable and push conflict resolution to read operations. An example of that is Dynamo which is used by many Amazon services like the shopping cart service where customer updates should not be rejected [2].

9. Summary and Conclusion

The cloud with its elasticity and pay-as-you-go model is an attractive choice for outsourcing data management applications. Cloud service providers, such as Amazon and Microsoft, provide relational DBMSs instances on virtual machines. However, the cloud technical environment, workloads, and elasticity requirements lead to the development of new breed of platform systems. These systems range from highly scalable and available distributed resources with simple interfaces for data access to fully equipped of platforms [2].

Cloud computing is the best solution to Third World countries for its reduced cost and optimal use of resources, with economic development, in addition to improving performance.

a) Eliminate the need to plan ahead for cost provisioning.
b) Lower computer costs [3]:
   - You do not need a high-powered and high-priced computer to run cloud computing web-based applications.
   - Since applications run in the cloud, not on the desktop PC, your desktop PC does not need the processing power or hard disk space demanded by traditional desktop software.
   - When you are using web-based applications, your PC can be less expensive, with a smaller hard disk, less memory, more efficient processor...
   - In fact, your PC in this scenario does not even need a CD or DVD drive, as no software programs have to be loaded and no document files need to be saved.
c) Improved performance [3]:
   - With few large programs hogging your computer's memory, you will see better performance from your PC.
   - Computers in a cloud computing system boot and run faster because they have fewer programs and processes loaded into memory…
d) Reduced software costs [3]:
   - Instead of purchasing expensive software applications, you can get most of what you need for free.

   most cloud computing applications today, such as the Google Docs suite.
   - Better than paying for similar commercial software.

   which alone may be justification for switching to cloud applications.
e) Instant software updates [3]:
   - Another advantage to cloud computing is that you are no longer faced with choosing between obsolete software and high upgrade costs.
   - When the application is web-based, updates happen automatically.

     available the next time you log into the cloud.
   - When you access a web-based application, you get the latest version.

     without needing to pay for or download an upgrade.
f) Improved document format compatibility [3]:
   - You do not have to worry about the documents you create on your machine being compatible with other users' applications or OS.
   - There are potentially no format incompatibilities when everyone is sharing documents and applications in the cloud.
g) Unlimited storage capacity [3]:
   - Cloud computing offers virtually limitless storage.
   - Your computer's current 1 Tbyte hard drive is small compared to the hundreds of Pbytes available in the cloud.
h) Increased data reliability [3]:
   - Unlike desktop computing, in which if a hard disk crashes and destroy all your valuable data, a computer crashing in the cloud should not affect the storage of your data.

     if your personal computer crashes, all your data is still out there in the cloud, still accessible.
   - In a world where few individual desktop PC users back up their data on a regular basis, cloud computing is a data-safe computing platform.
i) Universal document access [3]:
   - That is not a problem with cloud computing, because you do not take your documents with you.
   - Instead, they stay in the cloud, and you can access them whenever you have a computer and an Internet connection.
   - Documents are instantly available from wherever you are.
j) Latest version availability [3]:
   - When you edit a document at home, that edited version is what you see when you access the document at work.
   - The cloud always hosts the latest version of your documents.

     as long as you are connected, you are not in danger of having an outdated version.
k) Easier group collaboration [3]:
   - Sharing documents leads directly to better collaboration.
   - Many users do this as it is an important advantages of cloud computing.

     Multiple users can collaborate easily on documents and projects.
l) Device independence [3]:
   - You are no longer tethered to a single computer or network.
   - Changes to computers, applications and documents follow you through the cloud.
   - Move to a portable device, and your applications and documents are still available.

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