

# Cloud Computing for Agriculture- An Incipient Technology

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## Abstract—

*Resource sharing is a model that greatly simplifies huge infrastructure requirements. Cloud computing is an internet based computing paradigm where resources such as processing, memory and storage are not physically present at the user's location. A service provider owns and manages these resources, and users access them via the Internet. Cloud computing is a technique to use of computing resources that are delivered like a service over a network. Cloud contains large amount of information, provides various services to the users with the ability to scale up or down service requirements. Cloud is made of many servers which increases capacity of servers without new infrastructure. In this paper we are analyzing benefits of cloud computing and finding applicability towards agriculture.*

**Keywords**—Cloud; cloud computing; resource sharing; internet

## Introduction

Cloud computing is a computing paradigm which relies on resource sharing. Here the word "Cloud" is symbol for internet. Cloud computing is the delivery of computing resources or services over the internet. The services allow individuals or business groups to use resources (software and hardware) which are managed third party at different locations [1].

Cloud computing encompasses activities such as the use of social networking sites and other forms of interpersonal computing; most of the time cloud computing is concerned with accessing

online software applications, data storage and processing power. It is a way to increase the capacity and/or add capabilities dynamically without having new infrastructure, training new personnel, or licensing new software. It extends Information Technology's existing capabilities [2].

Developers with innovative ideas for Internet services no longer need large capital outlays in hardware to deploy their services; this paradigm shift is transforming the IT industry. The operation of large scale, commodity computer datacenters was the key enabler of cloud computing, as these datacenters take advantage of economies of scale, allowing for decreases in the cost of electricity, bandwidth, operations, and hardware [3].

## I. CHARACTERISTICS OF CLOUD COMPUTING

Cloud computing may exhibit following characteristics [4]:

- 1. On demand self-service-** A consumer may have provision for computing capabilities.
- 2. Broad network access-** Capabilities are available over the network and access through standard mechanism.
- 3. Resource pooling-** Provider's computing resources are pooled to serve consumers.
- 4. Rapid elasticity-** Capabilities can be rapidly and elastically provisioned to quickly scale out and rapidly released to quickly scale in.
- 5. Measured service-** Cloud systems automatically control and optimize resource use by leveraging a metering capability.



Fig. 1. Cloud computing

## II. TYPES OF CLOUDS

Based on purpose and characteristics cloud computing uses several delivery models [6]:

### 1. Public Cloud

Cloud computing services from vendors that can be accessed across the internet or a private network using one or more data centers, shared among multiple customers with varying degrees of data privacy control. Public clouds are run by third parties, and applications from different customers are likely to be mixed together on the cloud's servers, storage systems, and networks. Public clouds are most often hosted away from customer premises, and they provide a way to reduce customer risk and cost by providing a flexible, even temporary extension to enterprise infrastructure.

### 2. Private Cloud

Private clouds are built for the exclusive use of one client, providing the utmost control over data, security, and quality of service. The company owns the infrastructure and has control over how applications are deployed on it. Private clouds may be deployed in an enterprise datacenter, and they may also be deployed at a co-location facility. Private clouds can be built and managed by a company's own IT organization or by a cloud provider. In this "hosted private" model, a company such as Sun can install, configure, and

operate the infrastructure to support a private cloud within a company's enterprise datacenter. This model gives companies a high level of control over the use of cloud resources while bringing in the expertise needed to establish and operate the environment.

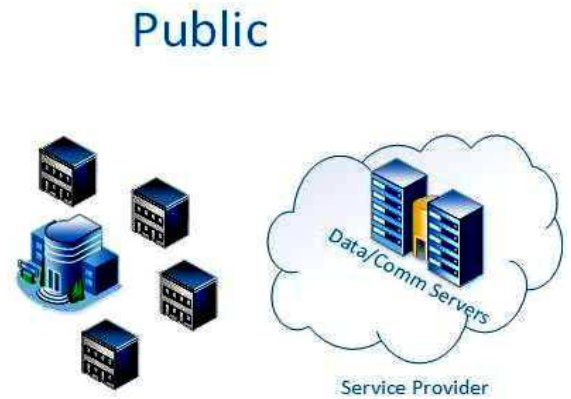


Fig. 2. Public Cloud

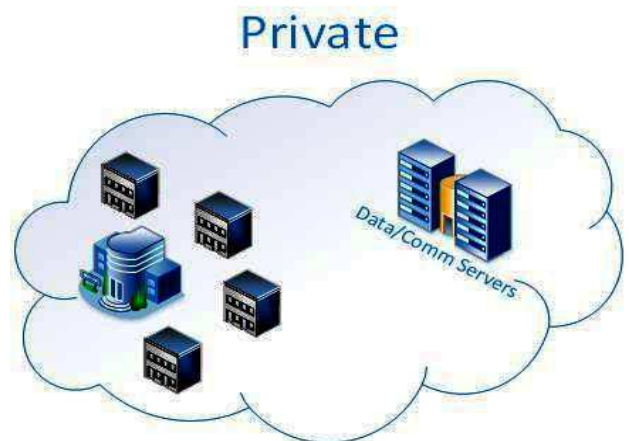


Fig. 3. Private Cloud

### 3. Hybrid Cloud

Hybrid clouds combine both public and private cloud models. They can help to provide on-demand, externally provisioned scale. The ability to augment a private cloud with the resources of a

public cloud can be used to maintain service levels in the face of rapid workload fluctuations. This is most often seen with the use of storage clouds to support Web 2.0 applications. A hybrid cloud also can be used to handle planned workload spikes. Sometimes called “surge computing,” a public cloud can be used to perform periodic tasks that can be deployed easily on a public cloud. Hybrid clouds introduce the complexity of determining how to distribute applications across both a public and private cloud. Among the issues that need to be considered is the relationship between data and processing resources. If the data is small, or the application is stateless, a hybrid cloud can be much more successful than if large amounts of data must be transferred into a public cloud for a small amount of processing.

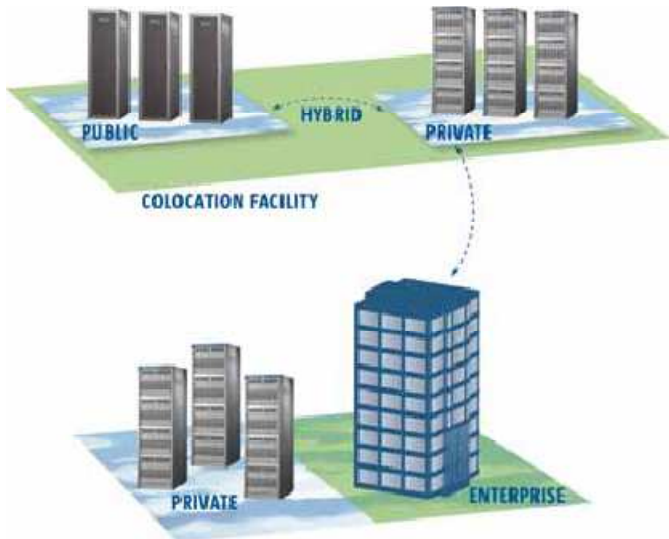


Fig. 4. Hybrid Cloud

### III. SERVICE MODELS OF CLOUD COMPUTING

The cloud computing services are divided into three categories: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS) [7].

**Software as a Service:** Software-as-a-Service (SaaS) is a model of software deployment whereby one or more applications and the computational resources to run them are provided for use on demand as a turnkey service. Its main

purpose is to reduce the total cost of hardware and software development, maintenance, and operations. Security provisions are carried out mainly by the cloud provider. The cloud subscriber does not manage or control the underlying cloud infrastructure or individual applications, except for preference selections and limited administrative application settings.

Some defining characteristics of SaaS include [8]:

- Web access to commercial software.
- Software is managed from a central location.
- Software delivered in a “one to many” model.
- Users does not required to handle software upgrades and patches.
- Application Programming Interfaces (APIs) allow for integration between different pieces of software

**Platform as a Service:** Platform-as-a-Service (PaaS) is a model of software deployment whereby the computing platform is provided as an on-demand service upon which applications can be developed and deployed. Its main purpose is to reduce the cost and complexity of buying, housing, and managing the underlying hardware and software components of the platform, including any needed program and database development tools. The development environment is typically special purpose, determined by the cloud provider and tailored to the design and architecture of its platform. The cloud subscriber has control over applications and application environment settings of the platform. Security provisions are split between the cloud provider and the cloud subscriber.

Characteristics of PaaS include [8]:

- Services to develop, test, deploy, host and maintain applications in the same integrated development environment. All the varying services needed to fulfill the application development process.
- Web based user interface creation tools help to create, modify, test and deploy different UI scenarios.

- Multi-tenant architecture where multiple concurrent users utilize the same development application.
- Built in scalability of deployed software including load balancing and failover.
- Integration with web services and databases via common standards.
- Support for development team collaboration – some PaaS solutions include project planning and communication tools.
- Tools to handle billing and subscription management.

**Infrastructure as a Service:** Infrastructure-as-a-Service (IaaS) is a model of software deployment whereby the basic computing infrastructure of servers, software, and network equipment is provided as an on-demand service upon which a platform to develop and execute applications can be established. Its main purpose is to avoid purchasing, housing, and managing the basic hardware and software infrastructure components, and instead obtain those resources as virtualized objects controllable via a service interface. The cloud subscriber generally has broad freedom to choose the operating system and development environment to be hosted. Security provisions beyond the basic infrastructure are carried out mainly by the cloud subscriber.

Characteristics of IaaS include [8]:

- Resources are distributed as a service
- Allows for dynamic scaling
- Has a variable cost, utility pricing model
- Generally includes multiple users on a single piece of hardware

#### IV. ASSOCIATED CHALLENGES

Major challenges that prevent cloud computing adopted by organizations are [2]:

1. Security: Security plays important role for hindering of cloud computing. Security issue involves data loss, phishing, botnet.

2. Cost: Migrating to cloud greatly reduce the cost of infrastructure, but increase cost of data communication.
3. Charging Model: The elastic resource pool has made the cost analysis a lot more complicated than regular data centers, which often calculates their cost based on consumptions of static computing. An instantiated virtual machine has become the unit of cost analysis rather than the underlying physical server.
4. Service Layer Agreement: Cloud consumers do not have control over the underlying computing resources; they do need to ensure the quality, availability, reliability, and performance of these resources when consumers have migrated their core business functions onto their entrusted cloud.
5. Cloud Interoperability Issue: proprietary cloud APIs makes it very difficult to integrate cloud services with an organization's own existing legacy systems. The primary goal of interoperability is to realize the seamless fluid data across clouds and between cloud and local applications.

#### V. BENEFITS OF CLOUD COMPUTING

Cloud computing can profoundly change the way organizations access and use ICT products and services. Instead of owning and managing ICT products and services, or using a “traditional” outsourcing approach built around dedicated hardware, software, and support services, organizations employing cloud computing services can meet their ICT requirements using a flexible, on-demand, and rapidly scalable model requiring neither ownership on their part, nor provision of dedicated resources by the cloud services provider. Both parties stand to benefit from the considerable economies of scale and scope that are possible under such an arrangement. Cloud computing technology is being used or considered by many organizations [9].

## VI. ADVANTAGES & DISADVANTAGES OF CLOUD COMPUTING

Advantages of cloud computing is given below [10]:

- 1) Lower-Cost Computers for Users
- 2) Improved Performance
- 3) Lower IT Infrastructure Costs
- 4) Fewer Maintenance Issues
- 5) Lower Software Costs
- 6) Instant Software Updates
- 7) Increased Computing Power
- 8) Unlimited Storage Capacity
- 9) Increased Data Safety
- 10) Improved Compatibility between Operating Systems
- 11) Improved Document Format Compatibility
- 12) Easier Group Collaboration
- 13) Universal Access to Documents
- 14) Latest Version Availability
- 15) Removes the Tether to Specific Devices

Disadvantages of cloud computing is given below:

- 1) Requires a Constant Internet Connection
- 2) Doesn't Work Well with Low-Speed Connections
- 3) Can Be Slow
- 4) Features Might Be Limited
- 5) Stored Data Might Not Be Secure
- 6) If the Cloud Loses Your Data, You're screwed.

## VII. AGRICULTURE: SYSTEM AND VALUE OF INFLOWING THE PITCH

Computer vision, machine learning, mobile and cloud computing are the emerging techniques and are used in almost all fields of research as well as in our day-to-day activities such as medical imaging and agriculture. India being an agriculture based developing country has more than 70% of its population depending on agriculture and farming [11, 12]. The growth in the agriculture production directly increases the Indian Economy and vice-versa is also

true. Various studies has been carried out for how cloud computing helps agro system in different countries like Japan, China. Moreover, now that environmental issues are recognized as global issues, and the future food supply has emerged as a global problem. Hence we need to improve our agro system by support of cloud computing. With the exception of "cultivated land data management," are not specific to agriculture but also have potential applications in various other fields (such as medicine/nursing and maintenance work), where technologies such as GPS activity sensing, Web-based mapping applications, and data mining are already being used. We are therefore working not only on vertical integration of these concepts, but also on horizontal expansion into other fields. IT resources are said to have spread throughout the world. This can certainly be said of offices and facilities such as factories and research centers. However, for this sort of on-site work, new IT applications are likely to be incorporated into terminal equipment other than personal computers and mobile phones.

There are some Cloud computing applications in agriculture which are as follows:

**1.High integration and sharing of agriculture information:** During the transformation from India's traditional agriculture to modern and digital agriculture, increasing but disorderly information brings tremendous problems. Cloud computing can offer a new management mechanism, which can integrate information resources in different regions and departments, build information sharing space and share infrastructure.

**2. Real-time monitoring and guidance in agricultural production:** Application of cloud computing technology in agricultural production can be reflected in two aspects: production process monitoring and controlling, experiment simulation and support. Currently, cloud computing technology already achieves real-time visual monitoring of crop growth(Zhang, 2011),

not only able to quickly get the surface information, such as leaf area, leaf perimeter, stem diameter, stem height, etc, but also be able to detect the water and fertilizer content in the soil. Meanwhile, the crops information received from the cloud platform intelligent processing can automatically trigger corresponding improvement measures. For example: open the spray device when water content reaches the minimum threshold, alert to farmers when crops are ripe, identify weeds from crops and spray weed herbicide precisely.

**3. Providing agricultural science and technology service:** As an important supporting technology of digital agriculture, cloud computing technology offers advanced information technology services, and realizes digitizing and visualizing expression, controlling, design and management of all the agriculture involving objects and the whole process. Agricultural extension, education and scientific research achieve trinity in the cloud computing environment. In addition, the cloud computing technology can be used to build precision agriculture technology and equipment systems, which make use of advanced agricultural production information and professional geographic information software to gain organic links among agricultural production and operating procedures. The system is able to optimize the investment in agricultural materials and improve material utilization, to achieve the purpose of reducing costs and increasing efficiency, and at the same time, it is able to effectively reduce the environmental pollution and realize sustainable agriculture development.

**4. Construction and improvement of the agricultural products supply chain:** Agricultural products have strong seasonal and regional features as necessities of life, which is prone to hoarding phenomenon. The convenience, breadth and popularity of the cloud based system for agriculture help farmers or agricultural

enterprises understand the market information, the cloud platform facilitates the information exchange and communication between farmers and agricultural enterprises, it has very important significance for constructing and improving agricultural products supply chain, ameliorating agricultural products sales, and increasing farmers' profits.

**5. Tracking and monitoring of the agricultural products quality:** In the cloud computing platform, the animal husbandry can take advantage of advanced computer imaging technology to evaluate the animal meat, select and cultivate superior varieties, establish the magneto-therapy database and animal nutrition demand model, optimize feed formulation, to meet a number of animals nutritional needs indicators and exert the maximum production potential of livestock and poultry. In addition, tracking and monitoring of agricultural products quality and safety can be fully realized in the cloud computing platform. The cloud computing technology has been integrated into the scientific research, raw materials access, production and processing, storage and transportation, marketing, quality traceability and information services, inspection and quarantine, supervision and administration, etc.

## VIII. CONCLUSION

Cloud computing offers benefit for organizations and individuals. Cloud computing can significantly reduce the cost and complexity of owning and operating computers and networks. If an organization uses a cloud provider, it does not need to spend money on information technology infrastructure, or buy hardware or software licenses. Cloud services can often be customized and flexible to use, and providers can offer advanced services that an individual company might not have the money or expertise to develop.

In Section VIII we have discussed various benefits towards AGRO system if we adopt IT

support (Cloud based Agro System) for agriculture.

There are numerous direct benefits as well as indirect benefits too such as medicine/nursing and maintenance work, where technologies such as GPS activity sensing, Web-based mapping applications, and data mining are already being used. We are therefore working not only on vertical integration of these concepts, but also on horizontal expansion into other fields. IT resources are said to have spread throughout the world. This can certainly be said of offices and facilities such as factories and research centers.

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