

Cloud Computing in Agriculture

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Abstract

Cloud computing is a way to integrate the high end computing infrastructure at the backend so as to provide the computing services to a large community of users. Although, initially cloud computing was envisaged as a commercial process but in the modern context it is impacting immensely the scientific, technological, academic, social and many other domains. Agriculture is another field which is being benefited greatly with the applications of cloud computing. The collaboration of cloud computing with agriculture processes has provided the necessary impetus to agro production, marketing and sales around the globe. This paper present a brief introduction to cloud computing as well as highlights the primary applications of cloud computing being deployed across the globe in agriculture sector.

Keywords

Cloud computing, cloud service models, cloud deployment models, cloud computing in agriculture, farm management system.

Introduction

Cloud computing integrates enormous IT resources at the backend using internet to be made available to the user community through well defined interfaces. Cloud resources include processors, storage, networks, specialized hardware resources and various services etc. These resources are provided to the users per their requirement in cloud under pay for use model [1]. Cloud computing is based on the concept of resource virtualization. Through a virtualization layer above the cloud infrastructure, the virtual resources are allocated to the users.

Cloud is made available to the user community using three service models viz. software as a service (SaaS), platform as a service (PaaS) and infrastructure (IaaS). In SaaS users can access different the software, databases and software services existing on the cloud. Instead of installing a software at the local machine a user can use in from the cloud. Thereby the software purchase and installation cost is saved. Further user is not responsible to install the latest updated version of the required software. Cloud service provider keeps the updated versions of the software to be made available to the users. In PaaS user is provided with a readymade platform on cloud where the required software can be configured and installed. PaaS provides operating system, programming language and web server to design the software [1]. The cost and time in arranging the required

platform is saved in this model. In IaaS the infrastructure like virtual machines, storage, network, IP addresses and other specialized software or hardware resources through high speed networks are made available to the users [1]. In the model user can access the remote cloud resources (hardware/software) through high speed network.

Cloud can be deployed as public cloud, private cloud, community cloud and hybrid cloud. In public cloud, cloud infrastructure and services are accessible in the public domain. Cloud services are made available to the public on pay per usage basis. Any organization and person can access the resource and data from the cloud directly without the involvement of any third party [1]. Private cloud is maintained controlled by the individual organizations for its own use. It serves the needs of the individual organization. In the situations where security and privacy is the primary concern, an enterprise may decide to implement its own private cloud. But it is obvious that in a private cloud all the cloud management and upgradation functions are carried out by the owning enterprise. Sometime an enterprise wants to use some of the services from the public cloud whereas the critical and high security processes are kept in the private domain. In such case hybrid cloud is created. Thus hybrid cloud is the mix of public cloud and private cloud. If more than one enterprise collectively install and maintain their common cloud, such cloud is called community cloud. Primary objective of the community cloud is to mutual sharing of resources.

Now a day cloud computing has applications in almost all the domains whether scientific, engineering, commercial, social etc. Agriculture is another field which is being immensely benefitted with the applications of cloud computing. Farmers around the globe are using the IT resources for easy dissemination and management of their crop related data. Further different hardware/software resources for monitoring the temperature, humidity, soil moisture and luminosity measurement are also being deployed by the farming community [2]. Modernization of agriculture reduces climate dependency, improve the utilization of existing resources and imparting the knowledge about new techniques and resources at the earliest. Further it provides modern agriculture equipment and machinery, agriculture planting and breeding technology, weather observation and forecasting and production organization and management methods [3]. Moreover, cloud computing increased efficiency for agriculture and succeed the agricultural technology. It directly connected the farmers to the operation through the cloud and share their experience by communication and information sharing [4]. Rest of the paper is organized as. Next section highlights the applications of cloud computing in agriculture. Section III concludes the paper.

Cloud Computing in Agriculture

Attributed to the increasing world population, the demand for agro products is also increasing. The scientists and researchers around the world are suggesting the innovative methods to be applied in the agricultural processes to increase the production as well as optimum distribution of the agro products. Distribution of the agro products includes marketing and selling of the products. In the modern context cloud computing is another technology which has greatly impacted the agricultural activities around the world. This section presents a brief overview of the applications of cloud computing in agriculture.

1. Large scale information storage: Cloud computing provides high capacity data stores to store the large scale data and information. The databases pertaining to the farming community such as crop information, weather information, market information, farmers experiences of the agricultural processes, information about the pesticides and prescriptions etc. can be easily stored on cloud. The individual farmers can store the information and retrieve the information from cloud easily. Different researchers from agro related institutions can present the information about the newly developed agricultural techniques and tools to the farming community through cloud. Otherwise cloud is a suitable infrastructure to share the mutual information and experiences among the farmers across the globe. The market condition of different crops related data is helpful to taking decision in choosing the crops [5].
2. Low cost access to IT resources: Cloud computing provides low cost access to vast IT resources. It implements the pay on usage basis model. The farming community needs not to invest in owning the IT resources instead they can access the required resources can be rented from the cloud. It is the cheaper and reliable method to access the resources. Information communication technology is the modern cloud infrastructure to allocate the resources and services on demand means whenever and whatever a farmer required [5].
3. Cloud Agro System: Cloud agro system is the cloud based computerised system used to monitor the overall information related to agriculture. The farming community is scattered worldwide where the language and tradition (the ways of carrying out the agro activities) barriers exists. The modern IT tools provides the online language translation mechanisms. Thus the information stored on cloud may be presented to the farmer's native language in the cloud agro system. It helps the farmers to taking decision related to crops production according to the demand and supply of the crops in the market. The researchers can collect the experiences of wide range of farmers using sophisticated IT tools such as online from collection etc. and experiments the new tools and techniques in the agriculture based on the collected information [6].
4. Easy solution to farming queries: Every profession needs time to time expert opinions. Cloud computing has provided the ways for easy solutions to the problems the farmers may face at the different stages of their farming processes starting from tilling to marketing and selling of their products. In the situations when farmers do not have the answers to the queries at their own cloud computing is an easy alternative. They can get online expert advice from the stored databases on cloud. Thus, cloud computing is proved to be channel to solve the farmers difficulties immediately because it respond to the farmers very faster and accurately. Farmers can post regarding any disease and pesticide and may decide according to the expert replies [6].
5. Land record automation: With the availability of large scale storage infrastructure, the land records are being computerised in the entire world. Cloud computing storage facility store the record of land with the description related to that particular land like soil analysis result and production history etc. Different corporations store the accurate data pertaining to land records after the proper verifications of facts and figures [4].
6. Farm Management System (FMS): Farm management system provides the disease alert system and reaction of the disease on the crops. It also give the knowledge about the new software related machinery and techniques applied in agriculture.

Therefore, FMS organize online training program for the farmers to aware them about the diseases and pesticides and also tells about how to keep the maintenance of a farm. FMS has three components knowledge base preparation, training of the classifier and classifier update [2].

7. Data collection tools: In the modern time many effective and reliable data collections tools are available which can be easily integrated with cloud computing applications. For example wireless network, radio frequency identification sensors, WiMax, internet etc. Sensors has the applications in measuring quality of water and soil, forestry, predicting changing environmental conditions etc. The sensors can be soil gravity water detection sensor, a humidity sensor, a chemical sensor for measuring of the pH of liquids and a bending sensor for gauging pressure [4].
8. Weather Forecasting: Cloud computing provide the weather forecast for specific duration to the farmers so that they can take decision related to selection of the crops. Sometimes climate is not suitable for seasonal crop in that condition farmer can choose an alternative seasonal crop [6].

Conclusion

Cloud computing in agriculture sector plays a vital role to provide intensive farming. The implementation of latest technologies makes the management and monitoring of agricultural very simple and easy. Cloud computing facilitates the storage, management, access and dissemination of the agriculture information rapidly and in low cost. With applications of cloud computing, farmers are benefitted in the context of higher production, marketing selling and decision making processes. Various government schemes for agriculture can be presented to the farming community through cloud computing. The primary reason to adopting cloud computing is to help the farmers in taking decision related to crops and land.

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