Cloud Computing and Agricultural Development of China:

Theory and Practice

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Abstract

Cloud computing technology has brought great opportunities to the development of China's agriculture；however it is also facing unprecedented challenges. According to the advantages of cloud computing, based on the status quo of China's agricultural development, the paper first discussed the impacts of cloud computing for China's agricultural development; and analyzed the field and the prospects of its possible applications in agriculture; then presented the application and promotion of cloud computing technology is a long-term system works, not only need to build the data center, integrate resources, enhance service capabilities, and also need to make information security .
Keywords: *Cloud Computing; China's Agriculture; Agricultural Informationization; Agricultural Modernization*

1. Introduction

With the continuous development of computer technology and network technology, various areas of the world have been undergoing enormous changes. The application of information technology will not only change the way of information interaction to shorten the distance of the world, but also conducive to social and economic development, improvement of production efficiency. Especially with the emergence and application of cloud computing technology, the resurgence of the climax of the national information construction, being seen as the third IT wave following the computer technology and Internet technology.

Currently, the countries in the world for the study of cloud computing technology is not very mature, Research in developed countries started earlier, and has made outstanding achievements in the basic framework, technical support, platform building. Major world-class IT companies, such as Microsoft, HP, Google, IBM, Oracle, and so on, have deeply realized the huge market potential and business opportunities in the field of "cloud computing", and all have been engaging in these studies (Zhang, 2010). Now, cloud computing has been used and promoted in the field of medicine and medical, manufacturing, financial services, energy, communication and other key areas, which will play an important role for improving the efficient use of resources, information sharing and integration. In China, Cloud computing applications in agriculture are in the phase of theoretical research, and lack mature cases. Therefore, this technology is great significant to improve management level in the weak field of agriculture information construction, the combination of agricultural informationization and modernization.

2. Cloud Computing Technology Overview

Cloud computing is a distributed computing technology, through a computer network the huge computing handler will be split and analyzed by a number of separate servers, then ultra millions or even hundreds of millions of information services will be available within seconds, so the users not only can get super computing capabilities but also can reduce resource inputs and waste. This is a paid service usage model, with ready access to demand unlimited expansion metering pay features, including IaaS (Infrastructure-as-a-Service), PaaS (Platform-as-a-Service), SaaS (Software-as-a-Service) and three levels of service(Chen & Deng,2009). Thus, cloud computing means computing power can be used as a commodity or service to be circulated and consumed through the Internet. Cloud computing technology application system framework is shown in Fig.1.
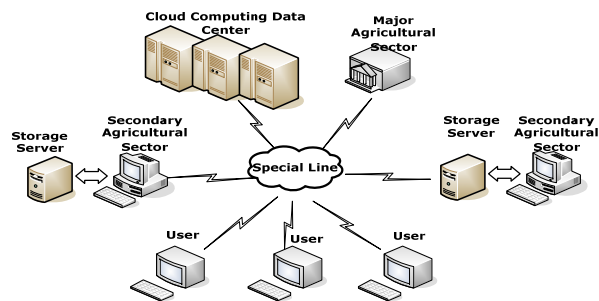
Fig. 1 Cloud computing technology application system framework

Cloud computing technology is an emerging hot technology appeared in recent years; it is very similar with utility computing and grid computing, and is considered as combined product with the computer technology such as grid computing, utility computing, distributed computing, network storage, load balancing, and network technology (Zhang & Gu, 2010) The evolution of this technology mainly experienced power plant mode phase of the pursuit of economies scale, utility computing phase, grid computing based on distributed processing and distributed cloud computing four stages(Chen,2009).

With Amazon launched Elastic Compute Cloud service, Google CEO Eric Schmidt first proposed the concept of "cloud computing", more and more IT companies such as IBM, Yahoo, HP, Dell have recognized the huge market potential for the technology advantages, and have started to research and promote in a number of areas. This technology also attracted the attention of the Governments of the United States, Britain, Japan and other developed countries, and all have begun to deploy a national cloud computing infrastructure, provide technical support for the development of information technology in areas such as government, economy, people's livelihood.

Cloud computing industry in China is still in the import phase; China Mobile, China Telecom, China Unicom, Huawei, Lenovo and other famous enterprises jointly established the "China Cloud Computing Technology Industry Alliance", and began to explore the road of cloud computing technology. In the same time, all over the country have launched the cloud computing development plan, such as the Beijing "Xiangyun plan, the Shanghai "sea of clouds Plan", the Chongqing "cloud plans", Guangzhou days cloud plan", shows China attaches great importance to the development of cloud computing technology; it also shows the determination to strengthen industry applications and promote economic development.

3. the relationship between Cloud computing and agricultural development

Although China has achieved fruitful results in crop cultivation, animal and plant breeding, agricultural production is still decentralized operation, low level information technology, coupled with farmers limitations constraints, the speed of agricultural modernization resulting is slow. Therefore, it is often the obvious contradiction between supply and demand in agricultural products; it not only hurt the enthusiasm of farmers engaged in agricultural production, reducing farmers' income, but also hindered the rapid socio-economic development. The applications of cloud computing technology in agriculture can solve the bottleneck problem of agricultural modernization and agricultural information, and can also break agricultural producers' limitations in knowledge or technology, reduce duplication, improve utilization of existing resources to make up for dispersed, small-scale, regional differences agricultural production and the strong dependence on the natural climate vulnerability of agricultural production..

3.1Agriculture modernization needs cloud computing

Modernization of agriculture include three aspects: ① Widely use modern agriculture production equipment, agricultural machinery. ② Extensively use modern agricultural planting and breeding technology, Dohi technology, weather observation and forecasting; ③ Use modern forms of production organization and management methods, etc.

Europe, the United States or other developed countries have been the basic realization of agricultural modernization as early as the middle of the last century, but the level of agricultural development in China is still relatively backward, and still in the stage to forward the agricultural modernization. Seen from the development of agriculture, the agricultural mechanization goal has been basically achieved, but there are still many outstanding issues in technology and management, such as fewer agricultural technology service organizations and personnel, less necessary technical guidance, especially in the breeding, pollution-free crop cultivation and livestock breeding, soil testing, fertilizer, irrigation and soil improvement, meteorological observations and weather forecast were not enough technical support, most of farmers are in a state of blind conformity.

Organizational form of production in agriculture is relatively simple, backward, and a low degree of specialization of agricultural production areas, it is difficult to achieve Integrating Agriculture. In addition,

due to the limitations of the farmers at market forecasting, business decision-making, information gathering and logistics management capacity is more lacking; it often leads to a mismatch between the supply and demand, not only damages the farmers' own interests, have also hindered the healthy development of the market supply and demand .

Therefore, to resolve these outstanding issues can not be separated from the IT technology application in the field of agriculture, especially cloud computing technologies play in the integration of resources, information sharing, online services differentiated advantages, will provide strong support for the realization of agricultural modernization.

3.2 Cloud computing role in promoting agricultural development

Cloud computing applications in agriculture makes agricultural producers do not need too much hardware and software investment, do not need to master advanced knowledge of computer and network technology; they can enjoy a more professional and more comprehensive services. The client just need to send the request to the cloud, then resources dispatch center will analysis and handle dynamically, and finally the corresponding processing results will be passed back to the client. For this calculation, the user does not need to know the calculation principle and process, simply according to the amount to pay. Agricultural producers can get planting and breeding techniques, pest control knowledge, and can also track and monitor the whole process of animals and plants from production, circulation to consumption, to achieve the scientific method in market forecasting, business decision-making, information collection and logistics.

Cloud computing application and implementation will play the following role:

(1) Agricultural Informatization

Agricultural information construction in China is relatively weak, compared with developed countries is still lagging behind. Some local government investment in the information construction is very inadequate, and producers can't pay enough attention to the information, so low degree of information sharing hampered the process of the construction of agricultural information seriously (Qian, 2012). At present, import cloud computing technologies into agricultural industry, establish information network services platform, the level of Agricultural informatization will be a qualitative upgrading.

(2)Efficient use of agricultural resources

Decentralized management of agricultural production leads to low utilization of agricultural resources. However, cloud computing can integrate isolated production facilities, technical equipment, information services and other resources effectively; this form of paid services like as easy to buy hydropower (Cui, 2011).

(3) Promote the circulation of agricultural products

Currently, agricultural producers' facing a prominent difficulty is the problem of sales of agricultural products. In China, farmers and consumers at both ends of the supply chain are difficult to derive much benefit because of small proportion direct sales, long distribution chain and complex link. Cloud computing will establish a bridge of communication between farmers and consumers; it is not only beneficial to the farmers to produce marketable products, as well as conducive to the realization of the value-added of the agricultural products.

4. Cloud computing applications in agriculture

4.1 High integration and sharing of agriculture information

During the transformation from China's traditional agriculture to modern and digital agriculture, increasing but disorderly information brings tremendous problems. Cloud computing offers a new management mechanism, which can integrate information resources in different regions and departments, build information sharing space and share infrastructure(Cao,2012) . In the 'Agriculture Information Resources Cloud (AIRC)', the agricultural sector and farmers can be real-time access to a full range of agricultural information that satisfies users extremely, and greatly reduces operating costs while substantially increase the efficiency of information haring. Meanwhile, the cloud computing technology has a powerful wireless access function. Users are able to get agricultural information through a variety of terminal not just the computer, which promotes the information sharing significantly.

4.2 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.

Cloud computing technology also can be applied to the study of agricultural science. Particularly for some time consuming and high-cost experiments, or some experiments which are difficult to implement because of conditions limitations, the simulation can be great help to obtain the experimental results.

4.3 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.

4.4 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 AIRC 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. The agricultural products supply chain based on cloud computing technology is shown in Fig.2 (Qiu, 2010).
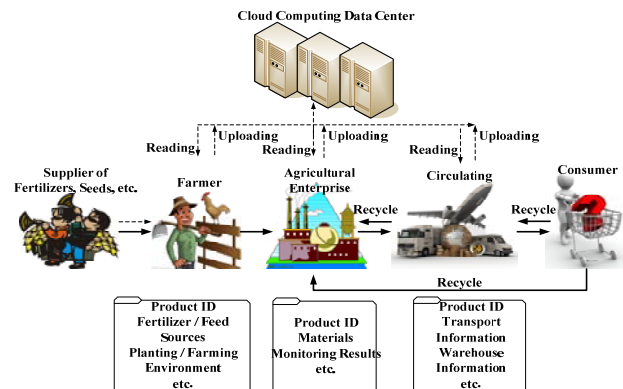

Fig.2. Agricultural Products Supply Chain Based on Cloud Computing Technology

4.5 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.

5. Implementation of cloud computing technology in agriculture

Promotion and application of cloud computing technology is an inevitable choice to achieve the modernization and informatization of agriculture, is also an inevitable trend in the Internet technology popularization. But cloud computing application is still in its infancy stage and lacks references of success cases, therefore needs long-term exploration and step-by-step implementation. Meanwhile, it is more needed to raise awareness of the abundant

agricultural producers and all-level government departments to improve their own qualities and enhance management capabilities for safeguarding the smooth implementation of cloud computing technology.

5.1 Build cloud computing data center

In order to operate and implement of the agricultural cloud computing technology better, first we must determine what constitutes the cloud computing data center and how to achieve the functions. The underlying of cloud computing data center is constituted by a large number of servers connected through the network and various types of controllers. Load balancing and computing virtualization are used for balancing the computing power of underlying server, and then dynamically deploy computing resources to agriculture-related personnel. Storage virtualization and cloud distributed file system are used to provide cross-server file storage service, automatically migrating information from the full server to get high utilization of storage resources (Cao, 2012). Application layer provides applied service for the agriculture-related personnel, users can select their desired landings when accessing to the cloud computing data center, but the underlying computing and storage details can not been seen. Cloud computing data center system is shown in Fig.3 (Cao, 2012).
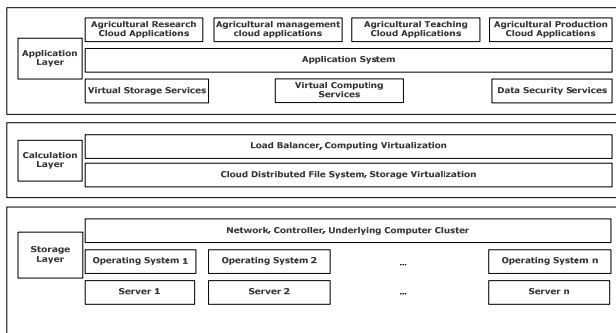

Fig. 3 Cloud Computing Data Center System.

5.2 Integrate agricultural resources

Repetition phenomenon is very serious in China's agricultural information construction and all-level agricultural sectors use their self-built information management system independently. Non-uniform informatization standards cause less networking to merge process relevant business between departments, plus low information shared degree, forming "islands of information". Therefore, in order to achieve cloud computing, first, we must establish the agricultural informatization standards complying with the law of agricultural production, and measure and reflect the characteristics and differences of the various components in agricultural management information system comprehensively, for facilitating establishment of national information platform (M.2010). Second, assess the utilization and applicability of the regional facilities and equipment resources, guide agricultural producers to rationally use local resources, and provide basis for implementation of cloud computing technology. Third, integrate technical resources of all enterprises, institutions and research institutes, strengthen the establishment of cooperation mechanisms in technology research and development, marketing, consulting, etc, and improve utilization and market-oriented operation of agricultural technology.

5.3 Improve the information service capacity of the agricultural sector

The agricultural sector will be the main force to promote the use of cloud computing technology in the agriculture field, and is also a direct participant in public cloud building. Service capacity and quality level of the agricultural sector will be directly related to the application results of this technology. Therefore, on the one hand, the knowledge level and technical ability of the agricultural sector personnel should be improved, being familiar with computer technology and network technology, to provide technical support for building and applying cloud computing platform. On the other hand, we should increase the service awareness, starting from the needs of agricultural producers, and eliminate bureaucracy and unrealistic blind construction. For the relevant government departments, they should be out of the misunderstanding that cloud computing is to build a data center, buy equipments and hardware. They not only should include the cloud infrastructure into the overall national plan for unified construction, but also should actively organize various types of research and development efforts to execute the research and development, pilot demonstration and promotion applications of the cloud application software, according to the regionalism, dispersion and farmers' ability to accept in agricultural production (Peng, 2011).

5.4 Pay attention to the agricultural information security

Cloud computing data center has strong openness and complicated business types, plus uncertain access source, will inevitably facing lots of threats and risks, therefore it is particularly important to better the data center information security. First, improve the security of data storage. Cloud computing data is divided into sub-modules

and stores in different servers dispersing even cross-sector and cross-region, which is subject to many threats, so it is particularly important to backup the various blocks and update data to prevent the malicious tampering and attack. Second, implement the identification and classification of user rights to ensure the reliability, preventing the data destruction causing by illegal operation and intrusion. Third, strengthen network monitoring and maintenance efforts, and monitor network attacks situation and type in three-dimensional way in case of possible troubles (Wu, 2011).

6. Conclusions

Cloud computing technology attracts more and more attentions of countries and enterprises with its powerful advantages and market potential, the feasibility and applicability of whose application are also exploring in various industries. This technology will bring greater opportunities to the agricultural development in China, and also be the inevitable choice to achieve modernization and informatization in agriculture. However, all-level governments should be fully aware that its implementation will be a long exploring process, especially in the weak infrastructure and information construction agriculture area, where the application difficulties are hard to imagine. Therefore, government departments and institutions should pay full attention to the implementation of this technology, raise awareness, and especially provide strong support in platform construction, resource integration and service capabilities. We believe that with the supporting of modern information technology and network technology, China's agriculture is bound to usher in a rapid and healthy development period.

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