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E-Agriculture Services Framework Design for Cloud

V. Keerthi
Research Scholar, Department of Computer Science
Dravidian University, Kuppam, India

Dr. T. Anuradha
Associate Professor, Department of Computer Science
Dravidian University, Kuppam, India

Abstract: ***For the assisting farmers in various areas of agriculture lot of information is to be delivered to them for high agricultural production at lowest prices, which is not possible through traditional computer services which is currently using by companies, but by using the latest trends in ICT like mobile computing, cloud computing will solve the problem of delivering technology at low prices. So if we apply these latest technologies to develop Agriculture Information system a dynamic, reliable, and customizable environment which guarantees the quality of service at low cost. Considering above facts in this paper we are proposing E-Agriculture Service Layered Framework in cloud which allows to design a web-based internet service mode like SaaS service to provide web service to farmers for sharing data between agricultural research stations, interaction with farmers for various queries related to cultivation, crop details, temperature details, and consultation with agriculture experts for up-to-date information regarding crop diseases, fertilizer usage, prices, etc.***

Keywords: Cloud computing, Web services, Agriculture service, Decision making system

I. INTRODUCTION

Computer 3D graphics, machine learning, mobile and cloud computing are the immerging 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 etc. As Agriculture plays major role directly or indirectly in improving economy of developing countries like India, China, Brazil, Japan etc., in the current era of liberalization, every sector is competitive including agriculture, so as to compete, agricultural sector should also use Information technology to achieve maximum benefits. Now-a-days decision making is important to improve productivity, so an expert system in the field of agriculture can be the best option to expand countries agriculture production.

Mostly the rural areas which depend on agriculture are information-poor and lack of facilities to apply recently invented technologies. It is of greater significance to apply Information technology to agricultural modernization and for rapid growth of income of the farmers, for achieving the agricultural economy leap-forward development. In the past, the Information technology is available only to some higher sections of society, but due to globalization, the IT is rapidly available in all the corners of the world at less cost. In Agriculture, Information communication and technology (ICT) plays a vital role in fetching latest bulletins regarding weather reports, prices, usage fertilizer, sowing of crops etc., to farmers at rural areas. Now-a-days government is pushing for better technology delivery schemes even to remote rural areas by offering telecom services including internet at cheaper prices which will help farmers to produce quality crops and to compete with markets at international level.

Agriculture sector will have characteristics like Spatiality, Complexity, Enormousness, Dynamics and number of factors that affect production and quality will be more as it is different for each crop. Because the environment of farmland is a very complicated ecology system and involves many different kinds of factors from environment to humane, from ecology to economic, from geography to society etc., the collecting of data usually incurs the substantial costs and technologies [1]. Recent trends show that IOT (Internet of Things) is playing major role in agriculture digitization in countries like Japan, Israel etc. The impact of IOT has given good results and it is extending to latest technologies like cloud and grid computing. The IOT is a network of Internet enabled objects, together with web services that interact with these objects. Underlying the Internet of Things are technologies such as RFID (radio frequency identification), sensors, and smart phones. The basic idea of the IOT is "the virtual physical thing in this world can also become a computer that is connected to the Internet, which can receive and send from its location" [2].

1.1 Cloud Computing in Agriculture

IT as a Service is a new IT invention due to Cloud Computing, the next generation of Internet which allow us to "buy" IT services from a web portal or rent the resources like CPU, memory, storage to build virtual data centres and, web application servers, databases, enterprise server bus, etc., as the platform(s) to support the applications that we rent from an Independent Software Vendor (ISV) or develop ourselves. Cloud computing which is part of Information technology which has evolved by making base of ICT, Internet, Web services and other existing technologies. As IOT is also part of ICT we can use this along with new Computing paradigm to the agriculture sector to improve quality and to achieve better crop results by using information precisely. In Cloud Computing, with web-based internet service mode like SaaS service, we can build an unimpeded high speed information system among the government, service supplier

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and farmers to speed up the pace of agriculture informatization for data sharing, remote data storage, interaction with farmers, and consultation with agriculture experts for up-to-date information regarding crop diseases, fertilizer usage, prices, etc.

In many countries budget allotted to agriculture sector is less so by using this latest technology the grass-roots departments in under developed regions don't need to build computer rooms or buy lots of software and hardware because all they demand can be obtained from the cloud service supplier through the network, which reduce their difficulty in building service portals and maintenance in great degree and overcome shortages for talents and finance [3]. So by considering above facts we have proposed framework based on Cloud model for agriculture field which uses both IOT and Cloud computing technology for data acquisition, processing, storing at large quantities in cloud data centers. So in this paper we are proposing E-Agricultural Services Framework which enables in designing a web based model for providing services to farmers, Agriculture experts, and Government officials working in Agriculture departments. Main purpose of designing our model is make users in rich or poor countries to use at very cheaper cost.

II. LITERATURE SURVEY

With the development of ICT (Information and Communication Technologies), it has played an important role in agriculture sector by providing services through computer based agriculture systems at higher costs [4]. But these agriculture systems are not able to fulfill the needs of today's generation due to lack of important requirements like processing speed, lesser data storage space, reliability, availability, scalability etc. and even the resources used in computer based agriculture systems are not utilized efficiently [5]. To solve the problem of existing agriculture systems, there is a need to develop a cloud based service that can easily manage different types of agriculture related data based on different domains (crop, weather, soil, pest, fertilizer, productivity, irrigation, cattle and equipment for which we have proposed the agricultural framework for cloud.

Information Technologies (ITs) have the potential to affect virtually all sectors of the economy by imbuing greater information and development content in products and processes. Information Technologies (ITs) have vital role in agricultural development such as improvement in efficiency and productivity in agriculture, provide inputs to agriculture, deal with agricultural output etc.

The IOT (Internet of Things) is a network of Internet enabled objects, together with web services that interact with these objects. Underlying the Internet of Things are technologies such as RFID (radio frequency identification), sensors, and smart phones. The basic idea of the IOT is that virtually every physical thing in this world can also become a computer that is connected to the Internet. To be more accurate, things do not tum into computers, but they can feature tiny computers. When they do so, they are often called smart things, because they can act smarter than things that have not been tagged. Agriculture greenhouse production environment measurement and control system is an example of IOT technology application in agriculture. The critical temperature, humidity and soil signals are collected real-time in the agriculture production process, which is transmitted by wireless networks through M2M (machine to machine) support platform. It is to gain real-time data of agriculture production environment using SMS (Short Messaging Service), web, WAP (wireless application protocol) pattern, so that the terminal can master the information to guide the production [2].

Since IOT depends on internet and internet is the base for cloud, we can use cloud computing services for agriculture which benefit the farmers to obtain information regarding weather, crops cultivation, soil, agricultural techniques, fertilizers utility etc. Yan-e Dan [1], discussed about characteristics agriculture data and how Agriculture information management system is useful in agriculture field. He has considered IOT to AMIS for information collection, processing and given an idea about Intelligent Agriculture Management information system which facilitates to make decisions regarding crop growth, Fertilization of soil, pricing etc. in more precise manner. In their work by Yifan Bo, Haiyan Wang [3] have analyzed and given idea of how the latest technologies IOT and cloud computing can be used in agriculture and forestry for precise agriculture management. In his paper he pointed problems in cloud computing regarding security, IPV6, data center maintenance etc. In the article by Yin Qirui [6] has proposed an agricultural knowledge service model based on Agriculture expert service with a purpose of providing accurate and efficient agricultural knowledge service to users with browser interface. In the above works, the authors have given usage of IOT with agriculture, but at the same time they have not addressed the problem of delivering the service to the rural area farmers at an affordable cost.

In the paper[7], authors have proposed QoS-aware Cloud Based Information System (Agri-Info) by applying ETL process for Agriculture Service has been presented which contains the various types of agriculture related data based on different domains through different user preconfigured devices but does not address the problem of security with agricultural data after extraction from resources.

III. E-AGRICULTURE SERVICES FRAMEWORK

Cloud computing and with combination of (Internet of things) IOT offers resources and services at cheaper cost which is essential for farmers working at cultivation lands, so we have proposed this framework of E-Agriculture Services which offers expertise service to farmers regarding cultivation of crops, pricing, and fertilizers to be used etc. Scientists working at Agriculture research stations can add their discoveries, suggestions regarding modern techniques for cultivation ,usage of fertilizers, can obtain cultivation history of the region etc.,. E-Agriculture Services can benefit Government officials/private organizations by obtaining/inserting information regarding pricing of crops, farming of lands at various places, benefits to be given to farmers for various crops like supplying seeds, fertilizers etc.

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E-Agriculture Services for Farmers Architecture at SaaS layer supports various services to farmers to interact with cloud by using cheaper ways or IOT such as Sensors, Mobile devices, Scanners etc., to query for information and access it in no time at free of cost and by paying meager amount for pay services. E-Agriculture Services can use existing cloud infrastructures like networks, servers etc., other than the resources discussed below.

The proposed *E-Agriculture Services for Farmers Architecture* shown in figure-4.1 is a layered architecture contains various service layers like

1. Data Acquisition Service Layer (DASL)
2. Teiler-RSA Library Security Service (TRLSS)
3. Agriculture-Services Provider Module (ASPM)
4. Agriculture-Data Storage Service layer (ADSSL)
5. Agriculture Solution Reporting Service Module (ASRSM)

All the above layers can be implemented in SaaS or PaaS services and data storage is maintained at IaaS which allows data storage securely.

3.1 Data Acquisition Service Layer (DASL)

DAL layer provides an interface to farmers, agriculture experts or government officials using Internet or IOT to add or query data by using their applications service interfaces either through browsers, Tablet PC's, sensor(RFID) device or mobile devices. DAL is deployed as SaaS in Cloud which provides various interface services to be used by different types of consumers with different devices. DAL services layer mainly used for agriculture data acquisition and supply solutions to users. Vast data or historical data used for various purposes is stored in Agri-DB.

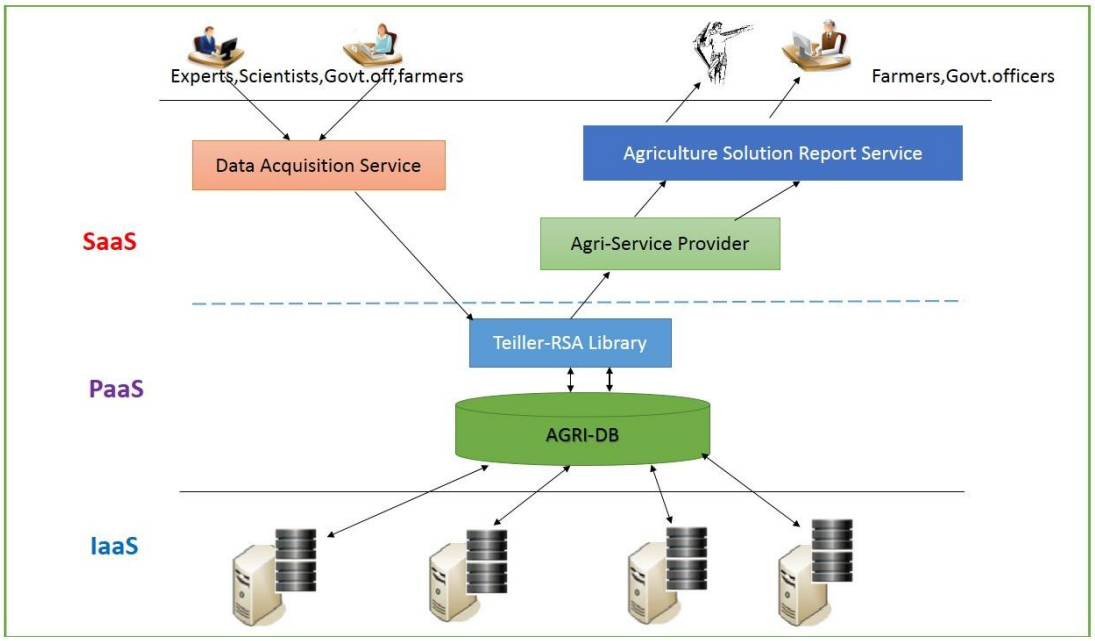

Figure 1: E-Agriculture Services Framework for Farmers

3.2 Teiler-RSA Library Security Service (TRLSS)

The above service can be implemented as Platform as service in PaaS layer in E-Agricultural Services in Cloud application which is used to encrypt or can be used to authenticate Agriculture experts, Government officials etc., to use Cloud services. This service uses the proposed Teiler-RSA algorithm for securing data in Agriculture data in databases stored in data servers in cloud. In this service Teiler-RSA algorithm is used to encrypt data to store it in secure manner in databases. As the database is in public cloud there is a possibility of unauthorized user can modify data which will give wrong decisions to farmers, experts and officials which is huge loss, to avoid such as dangerous security breach we are using the secure Teiler-RSA cryptosystem for securing agriculture data in database.

3.3 Agriculture-Services Provider Module (ASPM)

ASPM is a Data processing layer contains set of libraries (classes) which will accept data from data provider service layer below it and performs computations on large data sets and reports to users of E-Agricultural Services through ASRM. This service contains libraries for Data Processing, Expert services which allows Decision making and Data Reporting. ASPL contains services for Data analyzing and formats data accordingly in a simple manner to be viewed by the users in secure manner.

3.4Agriculture Solution Reporting Service Module (ASRSM)

ASRSM module is designed in keeping in view of displaying information in understandable format to users of E-Agricultural Services application after querying for some solution regarding crop to be sown, fertilizer to be used, price

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index of agriculture commodities in market. This service can be used in SaaS layer, and it can be implemented in such a way, to that the report can be in different languages to different users using different devices.

3.5 Agriculture-Data Storage Service layer (ADSSL)

This layer supports storage of agriculture information in AGDB which will be used by higher layers for providing efficient service to clients. The agriculture data like soil name, soil type, region, crop data like crop name season, fertilizer data like component, soil type, pesticide data like disease, crop, season, pesticide name are stored in Agri-Database(AGDB) in IaaS layer. The data in AGDB is in encrypted format for security purpose as it is in public cloud.

E-Agricultural Services Framework shown in figure-2 is implemented as E-Agriculture Services Web Application which will be used as a SaaS service in cloud. When application deployed on cloud it will work in layered architecture where layer below will provide services to high level layers. Farmers, Agriculture experts, Government officials etc., will interact with Application by using various devices like Web browsers, Sensors, Mobile devices, PDA etc., will use appropriate application interfaces available in this application. Each layer in E-Agricultural Services framework is designed as software modules to develop the system. E-Agriculture Services Application will be deployed in any of web server which will provide services online to various users.

All the layers in the proposed framework is mapped as services in web application into software model shown in figure according to users with clear functionality. Agri-Data Acquisition layer is designed as a set of interfaces for farmers, Agriculture experts, and government officials to give input to application which will pass data to underlying layers for further analyzing for updating Agricultural Database (AGDB). In this layer the interfaces used by farmers will provide solutions to queries given by them by computing decisions from the data in AGDB. The solutions are reported through Agri-Solution Reporting Service module (ASRSM) interfaces which will be easily understandable to farmers, experts, officials etc. Decisions regarding soils, crops, irrigation, fertilizers, and pesticides are computed by Agri-Expert service from the data available from the database, so AGDB should contain valid data for giving correct solutions to farmers/experts/officials.

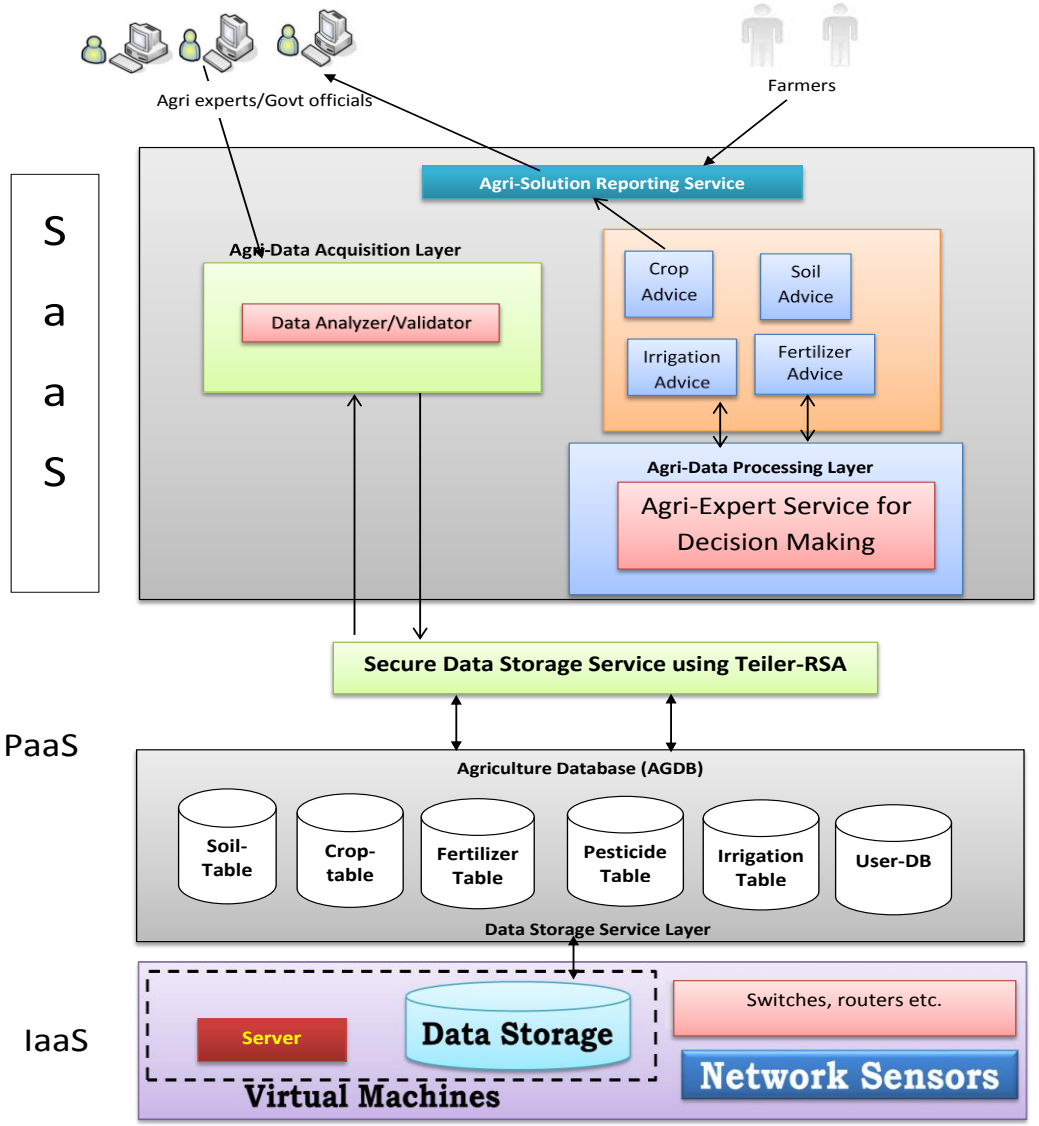

Figure 2: E-Agricultural Services Application Architecture

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In this framework we proposing service in web application which provides authentication for farmers, Agriculture experts at research stations, and Agriculture department government officials. Authentication is done by Secure Authentication Service using a novel Cryptosystem. Authentication for farmers is optional as they ask advices regarding crops, fertilizers, irrigation, pesticides etc., without provision for updating database (AGDB).

Agri-data storage layer is used to provide storage facilities at IaaS layer E-Agricultural Services *Application* , which contains Soil table, Crop table, Fertilizer table, Irrigation table, User table for storing valid users. Data in these tables are stored in encrypted format by using secure data storage service using a novel cryptosystem and the same service will return plain decrypted text to Agri-Data acquisition layer for processing and returning results to users.

IV. TECHNICAL ASPECTS OF E-AGRI APPLICATION SERVICES

E-Agricultural Services *Application* web application is developed using Java technologies like Java Server Pages (JSP), Java Bean, and Java Data Base connectivity and code Java Utility classes. The E-AGRI-APP web application is deployed in Apache Tomcat server and the database support is provided by MySQL Community server back end technology as shown in the figure 3.

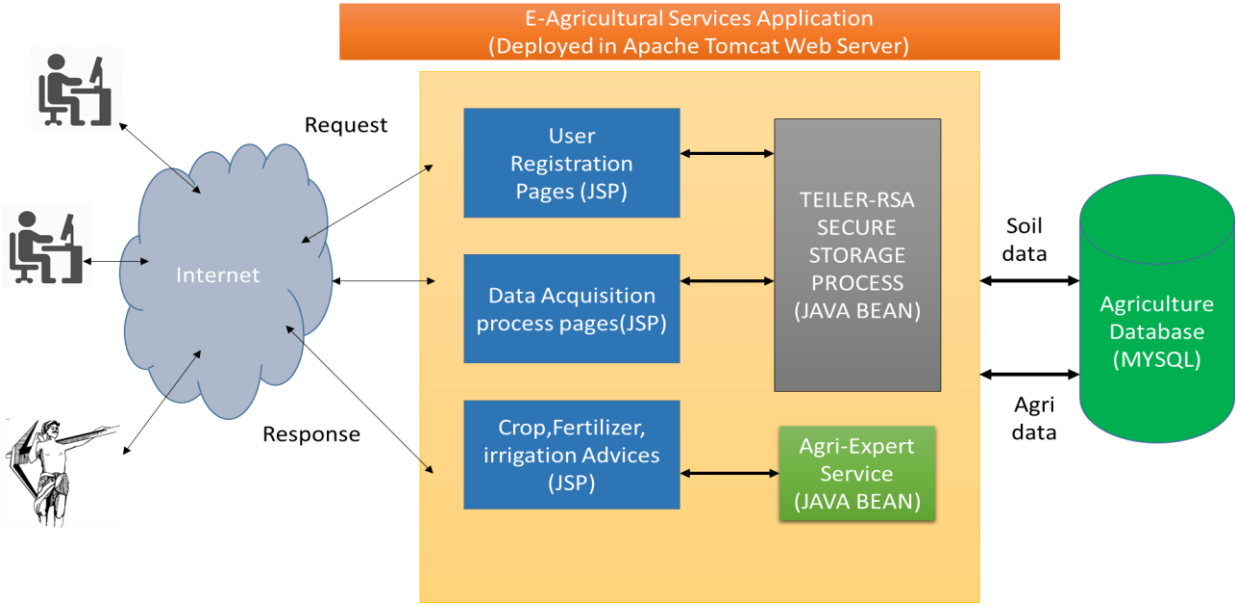

Figure 3: E-AGRI-APP Web Application deployment Architecture

The client side of our proposed E-Agricultural Services *Application* is designed in HTML 5.0 with Cascading Style sheets. Cascading Style Sheets (CSS) is a style sheet language used for describing the presentation semantics (the look and formatting) of a document written in a markup language. Its most common application is to style web pages written in HTML and XHTML, but the language can also be applied to any kind of XML document, including plain XML, SVG and XUL.CSS is designed primarily to enable the separation of document content (written in HTML or a similar markup language) from document presentation, including elements such as the layout, colors, and fonts. HTML5 is a cooperation between the World Wide Web Consortium (W3C) and the Web Hypertext Application Technology Working Group (WHATWG).WHATWG was working with web forms and applications, and W3C was working with XHTML 2.0[8].

4.1 Implementation of E-Agricultural Services *Application*

The Web application designed based on the proposed framework is intended for agriculture field which will perform following activities depending upon the user like

- Farmers in getting decisions regarding soils, Crops, fertilizers, irrigation facilities to be used.
- Agriculture Experts to get decisions regarding crops, can post data regarding latest scientific developments regarding crops that would benefit farmers etc.,
- Government Officials can exchange information to lower departments and also can post data regarding prices which will benefit farmers.
- Application admin can authenticate Agri-expert, government officials, farmers to login for posting data and in maintenance of database.
- Cloud Admin can authenticate Application admin after registering for purchase of E-Agricultural Services application as SaaS service by generating keys for data encryption and decryption for secure data storage.

V. CONCLUSION

The various technologies related to development of cloud computing applications are concisely given along with impact Information Technology and cloud computing on Agriculture field. The E-Agricultural Services *Application* framework and its architecture with technical aspects has been proposed for agriculture sector. The application provides

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services information between Farmer, Agriculture Expert, Application admin and cloud admin respectively. E-Agricultural Services *Application* can be deployed in Public Cloud infrastructure by purchasing cloud space from third party vendor on internet with a domain and with security to agricultural data.

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