Cloud of Things for Supply Chain Management in Precision Agriculture

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ABSTRACT
Modern technology is rapidly altering and enhancing all aspects of our lives. The cloud computing is a game changing phase of IT that provides several benefits. There are some significant issues to be solved in effective deployment of the cloud computing for agriculture sector. Introducing integration of the cloud computing and Internet of things into agricultural development will most likely take care of the issues related to these social purposes. Agriculture is the embodiment of large amount of ancient knowledge. The accumulation and sharing knowledge has resulted in better productivity and efficiency. Agriculture has traditionally been maintained by families and communities, where passing and sharing knowledge is regarded is very important. Based on major characteristics of cloud computing and key features of the internet of things innovations can help development in rural areas. Supply chains are increasingly virtualized with the objective of building a synchronizing supply with demand, competitive infrastructure, creating net value and measuring performance. This work focuses on how Cloud Computing and IoT together enhances virtualization of supply chains in agribusiness portion coming up with knowledge based software as a service. The proposed framework provides less or no expenditure, on-demand, efficient agricultural knowledge management. It gives a centralized knowledge bank which plays an important role in agriculture sector, also for agribusiness associated with supply chains.

General Terms
Information Storage and Retrieval, Distributed Systems, Cloud Computing.

Keywords
Software as a Service, Internet of Things, Virtulization, Supply Chain Management.

1. INTRODUCTION
Agriculture sector is the broadest economic division and assumes a critical part in the general economic development of India. Today, India positions second worldwide in Agricultural production. 13.7% of the GDP (Gross Domestic Product) in 2013 is based upon Agriculture and allied sectors like forestry and fisheries for 13.7% of the GDP (Gross Domestic Product) in 2013. India is the world's biggest vote based system with 1.2 billion populations. Notwithstanding with its present position, the sector needs to look forward with a target of advancing new things and to stay leading the pack. While reducing food supply chain losses, the focus has been given on improving production. This advantages issue of food wastage combating hunger and improving food security. It is hard to realize that the amount of food is lost and wasted in India today because of absence of proper infrastructure. However, a 2011 report by a UN body, gives data about wastage in products of the soil as high as 45% of the produce (post-harvest to distribution) in India.An application of Information Communication Technology (ICT) will cater all such data needs of an Indian farmer at an extremely reasonable and affordable expense. That most recent and most promising region of ICT is Cloud Computing. It empowers the clients to make utilization of various services and tools with pay-per use basis without the need to know the physical location. Taking about the potential benefit of cloud computing we can list out its part in agricultural advancement in India. Utilizing the applications of cloud the farmers have nothing to stress over hardware and software investment and also the specialized learning needed to learn them. The agriculturists will send the appeal for the particular cloud administration utilizing a user friendly device, and the cloud administration supplier will examine and handle the request, lastly the results will be passed once more to the customer. They can get most progressive cultivating and proliferation procedures, pest control information, and can likewise track and check the entire procedure from generation, distribution to utilization. They can likewise power the systematic methods in information collection, supply chain logistics, market forecasting and business decision-making.

In such virtual supply chains, arranging, organization and coordination are focused around virtual representations of physical products and resources, enabled by new information and communication technologies. The actors in charge of arranging, organization and coordination are not necessarily the ones handling and observing these physical objects. They can be at total different locations [1].

The most recent and most promising area of ICT is Cloud Computing. It empowers the clientsto make utilization of decentralization or decoupling of physical streams from centralized planning, orchestration, and coordination taking place in other locations and by other partners. The Internet of Things (IoT) standard has points of interest of the ubiquitous interconnection of billions of embedded devices that can be uniquely identified, localized, and communicated. IoT architectures are either Internet driven or object driven. Scalability and cost efficiency of IoT services can be accomplished by the integration of cloud-computing into the IoT architecture, i.e., cloud-centric IoT [2]. Applications that can be enhanced by the coordination of Iot into cloud computing are many, for example, healthcare [3], smart homes [4], smart cities [5]. Built-in sensors in mobile devices can leverage the performance of IoT applications in terms of energy and communication overhead savings [6]. In this manner, the Supply Chain administration can be efficiently addressed by taking advantage of cloud and IoT integration.

2. RELATED WORK
All Supply chain management (SCM) is the strategic, systematic coordination of the traditional business functions and the tactics across business functions. The purposes of the supply chain are to improve the long term performance of different companies [7]. The requirements of the SCM are

sensing objects, the proposed deployment, development, and management of the IoT applications over the cloud, namely, cloud-centric IoT framework. In a cloud-centric IoT framework, sensors provide their sensed data to a storage cloud as a service, which then undergoes data analytic and data mining tools for information retrieval and knowledge discovery [2]. Built-in sensors in mobile devices can leverage the performance of IoT applications in terms of energy and communication overhead savings. Therefore, it has a benefit of strong candidate for front-end access to the cloud-centric IoT, where mobile devices provide their sensed data based on the pay-as-you-go fashion [8].

Developing countries like China is exploiting the latest technologies like cloud computing. Authors have proposes a cloud deployment model, Agri-assistant to assist farmers in efficient decision making which in turn will improve not only the farm productivity but will also help the agriculture[9]. Cloud computing technology has brought great opportunities to the development of IRAN's agriculture. Presented the application of cloud computing technology is a long-term system works with data canter, integrate resources [10].

3. PROPOSED ARCHITECTURE

The Inside proposed framework for SCM, the control and Coordination of components supply chain business processes are orders, products, and demand and supply information. This Cloud based IoT Framework removes fundamental constraints concerning place, time and human observations.

Cloud centric IoT Architecture is following layers in the proposed framework,

3.1 Object Management

Objects have a central role in SCM, objects is a digital representation of information that communicated and processed via the internet. In SCM objects are information transferred between different partners from primary production to the market. These objects submit sensing task request to the cloud platform and receives sensing data of corresponding task.

3.2 Cloud Computing Platform

Maintains a user database where objects, sensing tasks and associated events are stored. This middleware enables a seamless exchange of object information between different supply chain participants. Cloud centric IoT framework processes functionalities for service management and service composition. The data exchange and information integration are done with this platform.

3.3 Knowledge Base

This layer is considered as a data publisher layer. The knowledge base [11], is the part of cloud computing platform. This contains information integration, which collected from crop advisor which are the domain experts. It includes information of facts based upon conditions. Facts are responsible for setting the rules for selection of crop variety.

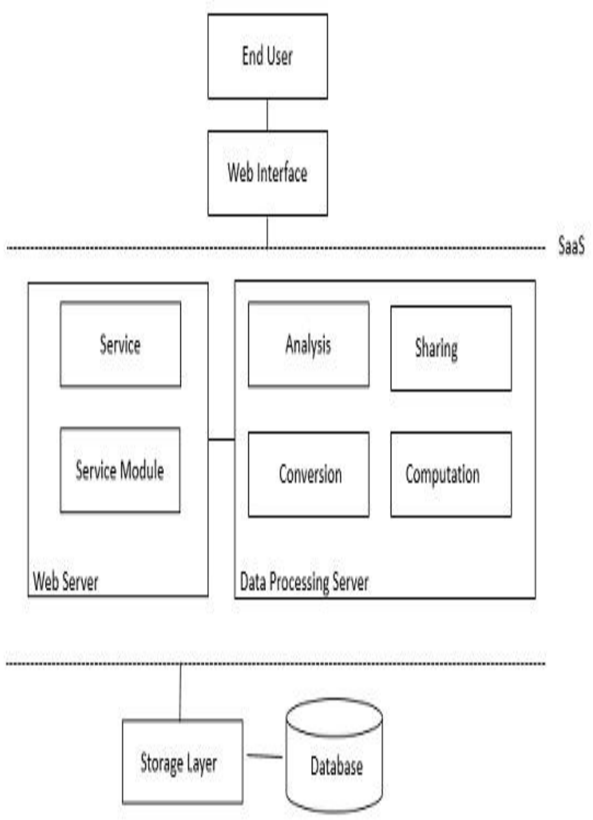


Fig 1: System Architecture

3.4 Information as a Service

Farmers rely on weather forecasts to decide what work to do today and tomorrow. Hence IoT framework provides SaaS to monitor the weather conditions without typing any location. Proper advice for correct crop to plant is very much needed. Farmers use their own traditional way of cultivation and harvesting and may result well, but the new farmers with young group who require more knowledge to do farming.

3.5 End Users

The farmers will send the request to the specific cloud service using a user friendly device such as smart phone users, and the cloud service provider will analyze and handle the request dynamically. A user who to publish his sensed object data on object management layer.

4. RELEVANT MATHEMATICS

Let S= {P, R, TR, Oi, DB, RC}

Where,

P is set of number of participants.
R is set of roles of the participant.
TR Set of activities performed by the participant
Oi Object information of participant.
DB A set of object information is stored.
Rc Set of knowledge discovery rules.

Let demand of services during the interval, t be the time

$$(t) = Oi \leq Ti \leq T$$

Value of set D, V(D) denotes total number object information, as

$$V(D) = \sum_{\vec{i}Tw} Vt$$

Throughput gives the performance of the system S, it measures the data transfer rate per number of requests.

5. PROPOSED ALGORITHM

The algorithm starts with a set of participant entering their object information, cloud computing platform updates the database of participant within step 3 to 6 which defines the role of the participant. Step 7-11 updates the activities according to the role. Knowledge discovery rules are applied in step 9. Finally the results are processed back to the participant by providing knowledge to the end user.

Input: Participant P, Object Information Oi

Output: Crop Information

1. Begin
2. for all Oi_P
3. P ← P(S)
4. i←V (D) // total number of requests
5. end for
6. role (R) // Role of the participant is found
7. for R € P
8. TR Oi(R ← P)
9. serv(TR,Oi,RC)
10. res(P)
11. update(Oi)
12. end for
13. return(R,serv)
14. end for
15. repeat
16. End

5.1 Rules

Crop advisor defines the rules based upon the crop variety selected based upon the location. Based upon these rules the decision is given to the farmer. The rules depend on the climate condition, soil type, previous market prices, and season.

5.2 Parameters Selection

This condition varies in the case of irrigation, rained, limited irrigation. Type of soil varies as sandy, black, red, etc. Crop selection depends on the above conditions and the type of soil. Following facts shows various facts about rule selection.

Vn is the rule applied on the object information.
F1: Vn is selected crop.

F2: Vn is grown in particular climate conditions.

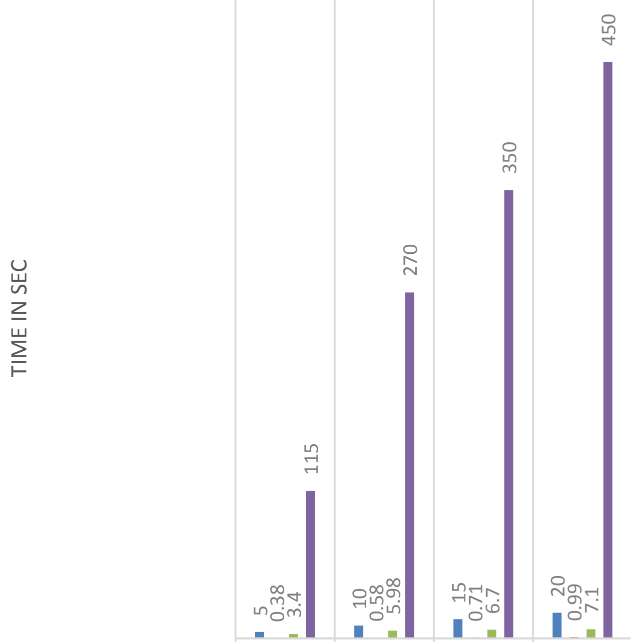
F3: Vn requires a particular type of soil for better result.

F4: Vn has got particular amount of price.

F5: Vn has previous production.

6. RESULT ANALYSIS

In the SCM model, performance analysis is done with the varying condition of the load. Load of parallel request is given to the system, rather than sending multiple request from a single system. To provide more precise result experiments is done in the different network region.



	1	2	3	4
users	5	10	15	20
Throuhput (Hits/sec)	0.38	0.58	0.71	0.99
Response Time (sec)	3.4	5.98	6.7	7.1
Bandwidth (Kb/s)	115	270	350	450

Fig 2: Graph for Performance Analysis

From above comparisons as the number of user's increases. Above graph shows the impact of increasing users on the average quality service to end users is measured. The experimental results show that the average response time is increasing model gives better performance depending upon what kind of service is requested. Throughput is the important measure to evaluate performance of the cloud based service. Response time metric measures how fast the service is provided.

Experimental results show that, the need of large scale computing framework is satisfied. As compared with existing system the SCM framework is scalable and also gives decision and planning support. Introduction of knowledge base helps in to manner like suggestions regarding modern techniques of cultivation, usage of fertilizers, weather updates, market information etc. The SCM framework gives intelligent and large scale computing service by introducing integration of cloud and Internet of things. The sharing of knowledge has resulted in an improved overall efficiency and productivity. Agriculture is embodiment large amount of ancient knowledge. The SCM framework is scalable and efficient in on demand agricultural knowledge management and decision support.

7. CONCLUSION

It is significant that latest technologies rapidly altering and enhancing. The proposed framework gives efficient supply chain management, which applied for precision agriculture. The cloud based IoT architecture, SCM model provides less or no expenditure, on demand agricultural knowledge management. The large scale storage and computing power efficiently organizes the scattered agricultural information and turns it into a centralized knowledge bank. The results of experiments performed confirm the reliability and stability of the system. Farmers have nothing to worry about software and hardware cost, they get updated as soon as new crop request is entered and can track and check the whole process of production, distribution to consumption.

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