The Architecture of Informatics Systems for Farm Management – a Cloud Computing and Big Data Approach

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Poster paper prepared for presentation at the EAAE 2014 Congress
'Agri-Food and Rural Innovations for Healthier Societies'

August 26 to 29, 2014
Ljubljana, Slovenia

Abstract

The present paper analyses the current trends in the IT&C field, according to which IT is delivered to the user as personalized, updated and secured service packages, at reasonable costs. This new technology class is symbolically named Cloud Computing. The agrifood sector is placed on top positions when the potential of applying the technology package defining cloud computing is concerned, in the operational, management and marketing area. All kinds of economic operators along the agrifood chain (farmers, wholesalers, processors, retailers) might thus become consumers of IT services in real time and at low costs. Such services are allowing the visualization of the whole production process in real time, while the managers are provided with essential information for decision making, such as the analysis of the demand-supply ratio, or quality control in the contracts with the business partners along the agrifood chain.

Keywords: cloud computing, big data, farm management

1. Introduction

Lately, the new IT&C based on Could Computing and Big Data has fundamentally changed the architectural approach of the informatics systems for farm management. Cloud Computing provides a scalable computational context, from the perspective of processing power and data storage, as well as from the perspective of delivering various software products as a service. This allows an increase of the management process efficiency at farm level, at significant lower costs as compared to the classical version (with use 'on location'). For example, FarmWizard is a software system available as a service, which manages the cattle herds, their genetic traceability, as well as the production costs in the farm. Another example is FarmLogs, a software platform available in cloud, for complex farm management.

'Cloud computing' and 'Big Data' (Sosinski, 2011) are the object of ample implementation strategy both in the United States and in Europe. The cloud computing world market in 2010, according to IDC, totalled USD 21.5 billion, and the same source estimates that in the year 2015 it will reach USD 72.9 billion, with a significant annual growth by 27.6% as compared to 6.7% which is the growth of the entire IT global market. In this context, on September 27, 2012, the European Commission presented its point of view on cloud computing in a document called *'Unleashing the Potential of Cloud Computing in Europe'* (European Commission, 2012). This document, with a deep strategic character, provides for measures targeting the creation of 2.5 million jobs and an annual contribution of EUR 160 billion to the EU GDP (about 1%) by the year 2020. 'Cloud computing' means promoting IT as service. This approach is cheaper, easier to implement, safer and more flexible than the local informatics solutions, as the European Commission considers. Many frequently utilized services (such as electronic mail – as Internet service) use cloud computing technologies, but the true economic benefits are obtained when these cloud solutions are adopted on a large scale both by companies and by the public sector. The strategy is conceived in such a way so as to speed up and increase cloud computing use in all the economy sectors, also due to the measures adopted in data protection by the European Commission in 2012, and it precedes a European strategy for information security. The design of these European cloud computing norms represents a prior condition for homogeneous digital space creation that will permit the creation of a genuine digital single market. All these measures represent together a global effort to create a dynamic and reliable online environment. Cloud computing is a tool by which IT is delivered in a simplified manner as a service with 24x7 availability, which should mask the complexity of intricate technologies behind these services. It is not necessary for the user to get involved in the technical issues of the provider of services. The term ‘cloud computing’ is essentially a black box that delivers IT services over the Internet (Kevorchian, 2013). An important aspect related to cloud computing is that the services can be consumed wherever and whenever it is necessary. It is also known that the IT delivered as a service implies a drastic diminution of costs. At the same time, the IT departments will experience a significant change of attributions in the sense that the work of specialists involved in the infrastructure maintenance and administration work will be significantly diminished, and their work will rather look like the work of solution architects rather than the IT Pro work. Another difficult problem is the management of licenses and versions for different software packages, which raises critical technical problems. With the approach to IT as a service, this problem will be transferred from the services consumer zone to the services supplier zone, which will deliver the most recent software and infrastructure variants to the beneficiary, facilitating the increase of efficiency in software use on the farm or holding.

2. SaaS Architecture

The cloud computing concept is based on a new architectural paradigm named SOA *(Service Oriented Architecture)*, which enables information delivery as a service (Furht and Escalante, 2011); this service is broadly divided into three categories:

- **Software as a Service (SaaS)**: it is a model for the delivery of software products that are installed in cloud and consumed on *thin client* platforms by means of a browser web (figure 1). SaaS became a usual delivery model for the business software applications mainly in fields like: customer relation management (CRM), enterprise resources planning (ERP) (Lehmann, Reiche and Schiefer, 2012), human resource management (HRM), content management (CM), etc. SaaS was incorporated in the IT strategies on many companies acting on a global basis. One of the most important operational targets is the diminution of support and maintenance costs by hardware externalization and software utilization as a service.

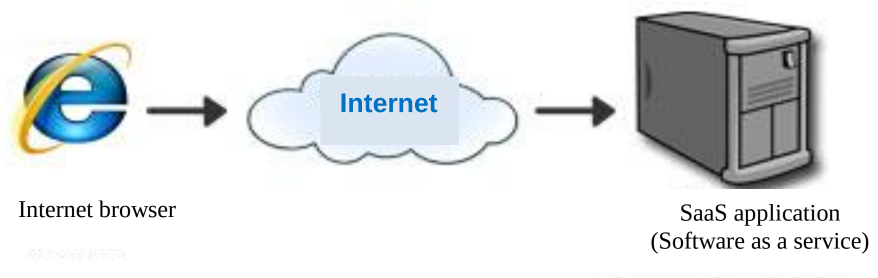


Figure 1. Software as service (source: www.san.ro)

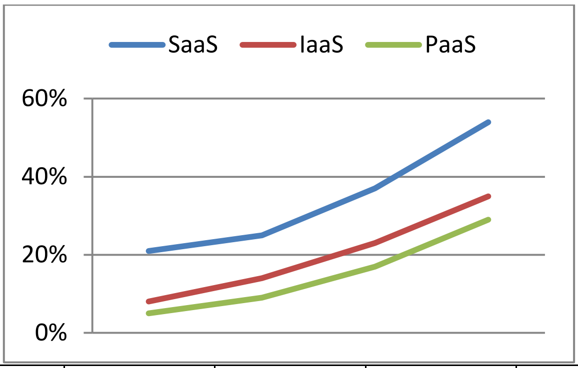
- **Platform as a Service (PaaS)**: it is a delivery model, as a service, of a virtualized development platform and of a set of attached solutions. More concretely, this means that the platform provider puts at the disposal of the consumer of services a working tool, the operating system inclusively, together with a set of APIs, programming languages and other tools that facilitate the development of applications, without software acquisition costs (basic or applications) or hardware and software management costs, together with their hosting related capacities. In the provider’s offer, PaaS includes the necessary facilities for the development of software products throughout its life cycle. An important advantage is that PaaS makes it possible for the companies to use the software development resources on a joint basis. The customer neither administers nor controls the basic infrastructure, network infrastructure inclusively, servers, operating or data storage systems, but it has full control of the installed applications and eventually of certain information on the hosting applications configuration. PaaS permits the diminution of infrastructure and licenses costs, as well as the more efficient use of IT resources of the company for development projects instead of repetitive activities for system administration and maintenance, or infrastructure problems solving up.

- **Infrastructure as a Service (IaaS)**: it is based on the *virtualization* concept and gives the customer a consolidated version of the computational infrastructure. When the customers procure IaaS, they receive a virtualized standard environment (figure 2). This does not mean that these will buy their own servers or data centres and related stuff. The customers who procure IaaS services can create and maintain a system of virtual machines on the provider’s infrastructure. The customers will administer themselves the virtual infrastructure through dedicated interfaces. The invoicing of services is based on the utilized physical resources: computational power (‘processor time’), memory, network band, storage capacity, etc. The providers of IaaS services offer a higher availability of data and a better protection in case of disasters, at lower costs, for increased redundancy and reliability. The costs associated to a data center are eliminated: cooling equipment, physical access protection systems, utilities, fire prevention measures. The user will have to manage the data and applications himself, and this implies investments in the technical support. The user will have to ensure the development, implementation and maintenance of own applications, as well as the data management and security from platform level upwards. Although there is no need to manage the Cloud infrastructure, the customer can be confronted with limited options for the network or data storage components.

Cloud computing users: farmers, agricultural policy designers, experts, researchers, market analysts, agricultural data scientists, etc.	**SaaS**: Browsers, agricultural databases, CRM, ERP, MIS
	PaaS: SalesForce, Amazon, Windows Azure
	IaaS: PC, laptops, smart phones, tablets

Figure 2. Cloud computing structure

Although cloud computing is an efficient IT service delivery model with a significant penetration potential (figure 3) on the market of IT&C services, there are a series of problems in relation to legislation compatibility in data processing across countries. This situation mainly affects the provider of services, and the customers coming from different countries may encounter problems in data relocation. For this reason, the providers of cloud services such as Microsoft created data centres all over the world. For instance, for Europe, there are data centres in Dublin and Amsterdam. Another great challenge is related to the security of data and services. This can be taken into consideration when selecting the provider of services that delivers IT security as a service - SECaaS.



	2009	2010	2011	2012
SaaS	21%	25%	37%	54%
IaaS	8%	14%	23%	35%
PaaS	5%	9%	17%	29%

Figure 3. Penetration rate (source: Forester)

3. Architecture of a FMIS system from Cloud Computing perspective

According to an analysis from September 2012 of CloudTweakers site, although *cloud computing* has a significant adoption rate, agriculture is not among the first ten domains that would gain from the implementation of solutions distributed as IT services. The first 10 sectors in the above-mentioned site are: education, marketing, online entertainment, health, IT, finance and banks, communications, hotel industry, start-ups, IT security. Few countries, such as China, Japan, USA, Singapore, Malaysia, India, began to implement solutions based on cloud computing in the agricultural sector, yet in an early stage, according to a BSA survey. In this context, Fujitsu launched *Cloud Services for Agricultural Industry* in April 2010, delivering cloud services to support agriculture through applications in farm management, production management and customer relation management. SaaS is the form of applications distribution. A farmer can access the applications placed in cloud from any computational equipment provided with a browser, in order to integrate the IT services dedicated to farm accountancy, payment of taxes and fees, and of different categories of payments based on daily registrations. The farm management solutions must also cover the agricultural products safety solutions.

3.1. Online system services

The IT systems placed in cloud represent a family of online services available 24x7 for all users regardless of their geographical positioning. The system can orchestrate dedicated services (Sosinski, 2011), such as:

- **Analysis of demand-supply ratio**: an updated picture of the demand of agrifood products throughout the world can be obtained. The component helps farmers to obtain an optimized crop structure, according to certain market tendencies. In addition, it provides information for a comparative analysis of price formation in different geographical areas.
- **Knowledge exchange**: the system supplies online communication facilities with experts (consultants) who provide support to online training programs based on the communication services from cloud. This will be useful in the case when the farmers need information that is not available locally.

- **Research development**: researchers from agriculture (both from Romania and abroad) will be able to obtain data directly from the database systems from cloud, be they structured or unstructured (BIG DATA) (Eaton et. al., 2012), together with important analytic reports, in order to develop research at national or international level. The research results will develop the knowledge systems stored in the cloud.

3.2. Online database system

The structured and unstructured database systems, placed in the cloud, can be used for obtaining information on:

- **crops**: data on all the crops, with their history, at local and zonal level. It will help farmers from different parts of the country to make decisions on the best way to use their output.
- **weather**: historical weather data and weather forecasts for a given period information is stored for all areas of the country. This will allow an evaluation of weather risks and of the appropriate methods to cover this risk.
- **soil**: the system provides detailed data on the of soil types in different areas of the country.
- **harvest monitoring**: it is achieved by taking over data in real time from plant level to evaluate its development stage and comparing these data with data from other geographical areas.
- **farmers involved in local agriculture**: this component will help decision makers to design zonal agricultural policies, and in addition, it can be used for the substantiation of support policies that should encourage and promote the agriculture of a certain region.
- **consultancy**: solutions are provided to the problems that farmers are facing in their current activity.

4. Conclusions

The presented *cloud computing* systems were designed to support agricultural management, production management (e.g. protected environment control, soil analyses, fertilizer application planning, livestock production management) and the sale of agricultural products (sales management and the management of deliveries to customers), together with a series of advisory services. By using mobile equipment (smart phones, tablets, laptops, etc.) for the collection, storage and analysis of data in cloud, the farmers can consult the historical data on the production programs and make forecasts on expected yields and incomes. This will mainly result in a better connected world, which should provide an economic environment less exposed to local or global disequilibria.

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