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Using Agent Solutions and Visualization Techniques to Manage Cloud-based Education System

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Abstract

Over the past few years, there are many requests from academic institutions, eLearning developers, education businesses owners, and global enterprises concerning cloud-based education systems. Nowadays, a range of software and applications have been created for managing teaching and learning resources via internet. Many of them have been even trying to integrate all the educational resources into a single cloud system. This paper proposes using agent technologies and visualization solutions to manage cloud-based education systems to match streamline of day to day business and operations. It focuses on adopting agents for University of Westminster's Cloud computing education system and mobile learning project. It shows how intelligent agents can be used as a good tool for cloud-based education service and associated applications provision and management within Software as Service (SaaS) level.

Keywords: Cloud Computing Theories; Cloud Computing for Education; Intelligent Collaborative Agent-based Solutions; Cloud-based Education System; Security issues in Cloud Computing, Cloud-based Service Engineering and Provisioning, SDN and Virtualization.

1. Introduction

In education sector, academic institutions, eLearning providers, education businesses owners, and global enterprises are considering to adopt a suitable cloud-based education system to provide services, save time and money. The demand for Cloud computing is driving organizations/vendors to develop cloud-based education systems and applications that allow educators and students to access their products and locked into their services. However, due to complexity, security and privacy issues and lack of standard solutions, many of them are struggling to find a cloud-based education system which is enable them to get tailored Cloud-based services in a safer and flexible way. Deep-rooted differences between Cloud vendors and educational service providers make it impossible to use a single solution and one cloud platform to manage resource and services. Moreover, the current solutions are often focused on provision technology rather than business operation and management.

As the cloud-based educational systems are embedded on vendors cloud infrastructure (IaaS) and use their platform (PaaS) and apps (SaaS) [9]. It is locked in inside of invisible vendors cloud system. Under the team and circumstance, client-side end-users/customers have very

little control ability and limited options for system management at all levels. Current systems also do not provide the flexibility to allow changes to be taken place and implemented as rapidly as one would desire. The researchers at University of Westminster are proposing in using intelligent agent technologies and visualization solutions to manage cloud-based resources, hardware, platforms, educational apps and services to match streamline of day to day business and operation.

2. Intelligent Agents for Cloud Computing

The modern concept of an agent itself has roots of the distributed artificial intelligence [2], it can be defined as an autonomous computer system [3] with certain intelligent skills and intelligent behaviours, capable of flexible interaction with other agents in order to perform autonomous actions and achieve its domain objectives in an dynamic, unpredictable, and complex open environment, typically a multi-agent domain [18].

Agents are based on the concept of Distributed Artificial Intelligence (DAI) work within Distributed Computing (DC) communities.[3] They are able to use flexible and manageable strategies for solving multiple and complex problems by fully using the advantages of multiple perspectives, distributed problem solving and task decomposition techniques, and the advantages of sophisticated patterns of interaction[4][5]. Beer and Huang [1] described an agent-based distributed medical care system which allowed patients' own needs to guide their individualized care management. The community care service agents are able to not only support traditional services but also provide a range of utility services such as individual care planning, health service advice etc. These applications successfully show that using intelligent agents can deal with complex problems in an open environment such as the Cloud. The agent paradigm is well suited to provide flexibility and reduce complexity for system organization and management.

3. Intelligent Agents for Cloud System Organization and Services Optimization

In mobile learning project at University of Westminster, Cloud computing education system is proposed and designed as follows in Fig1.

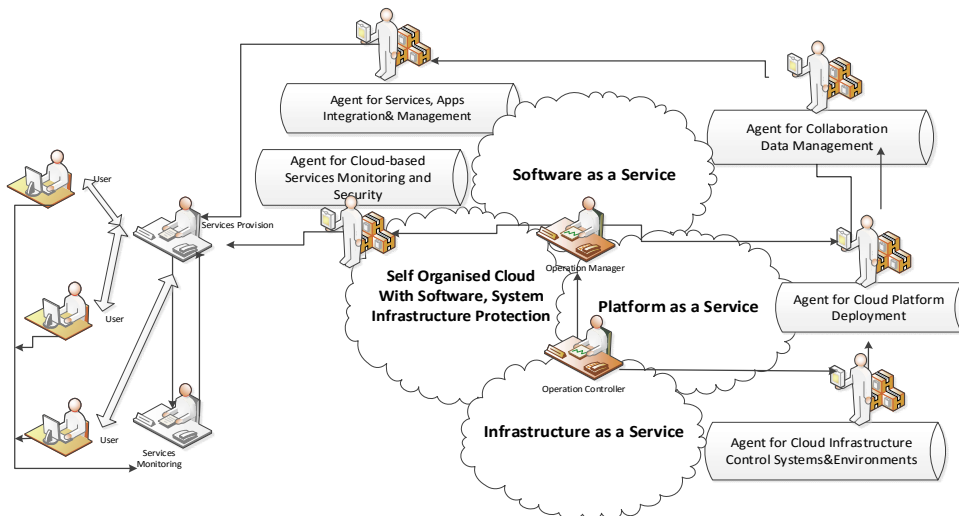


Fig. 1: Agents for Cloud organization and Service Management

As illustrated in Fig1 and Table 1, the Cloud and services are controlled and management by various intelligent agents. Based on individual agent's design objectives, functionalities and skills, there are divided into two groups: *Agents for Cloud Resource Organization* and *Agents for Service Management and Operation*.

Table 1: Proposed Agents in Mobile Learning Cloud System

Agents for Resource Organization	Agents for Service Management and Operation
<ul style="list-style-type: none"> • Agent for Collaboration Data Management • Agent for Cloud-based Services Provision Integration& Management • Agent for Cloud Platform Deployment • Agent for Cloud-based Services Monitoring and Security • Agent for Cloud Infrastructure Control Systems&Environments 	<ul style="list-style-type: none"> • Agent- Services Provision • Agent-Services Monitoring • Agent- Operation Manager • Agent-Operation controller

For Infrastructure as a Service (IaaS) level, *Agent for Cloud Infrastructure Control Systems&Environments* and *Agent-Operation Controller* help to find proper scalable infrastructure resources and maintain hardware systems operation.

With support from IaaS level agents, Platform as a Service (PaaS) level agents have opportunity to embed platforms through Multi-tenant architecture. The complex procedure is handled by *Agent for Cloud Platform Deployment* and *Agent-Operation Manager*.

In connection with the PaaS level agents, Software as a Service (SaaS) level agents are helping to provide services and applications to customers based on their needs, demand, licenses and subscription. In this paper, it is mainly focusing on using SaaS level agents to select services, adopt applications and manage operations.

4. SaaS Level Agents for Educational Resource Management

In SaaS level as highlighted in SDN architecture[11][12] and Open Flow-enabled SDN environments[13], there are so many applications available and too many services can choose from, agent-based management is to simplify this process and to provide useful apps packages to run quality services based on usability and experience. The vital data must be securely stored in reliable Cloud drives such as *Google Drive*, *One Drive* or *Dropbox* [17]. Therefore, there are two SaaS agents jointly to manage data storage and integrate services and related apps as shown in Fig 2.

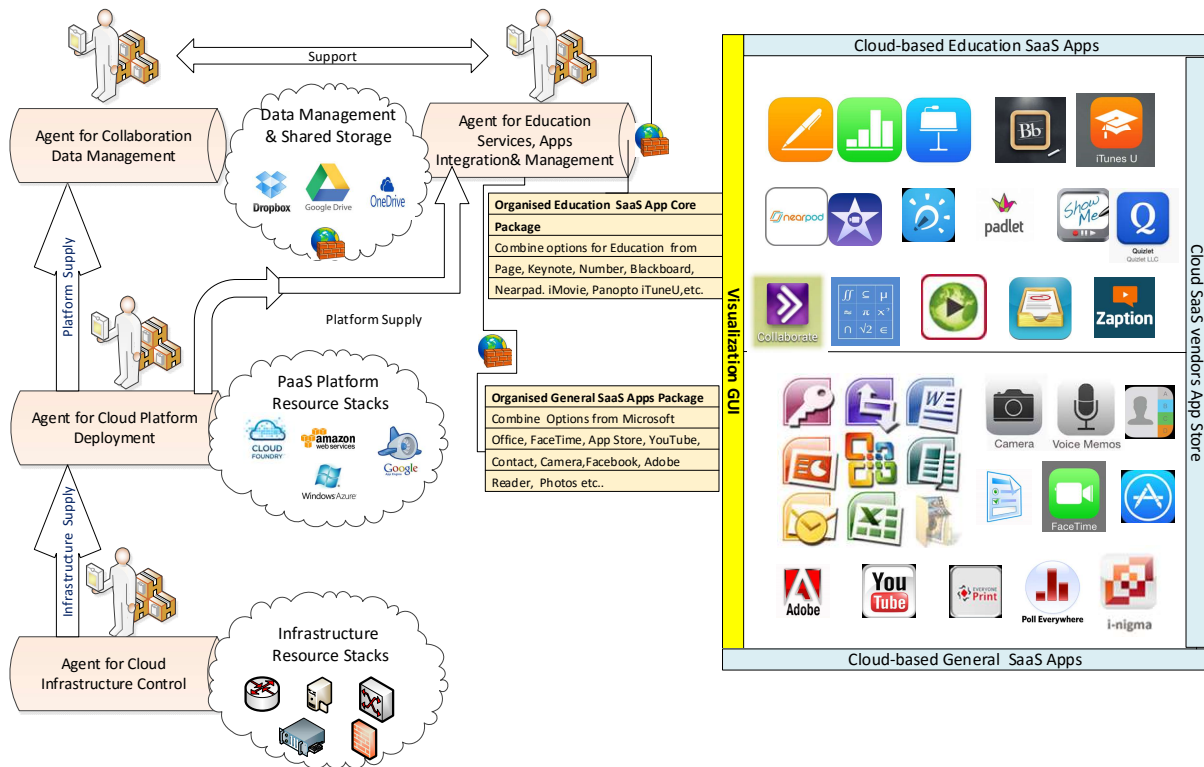


Fig. 2: SaaS Level Agents for Educational Resource Management (Data Storage, Apps and Services)

Agent for Collaboration & Data Management is responsible to manage database and maintain data center. It involves database monitoring, setting and maintenance to ensure data can be accessed, stored, integrated and retrieved, backed up consistently to multiple online drives such as on *Dropbox*, *Google Drive* and *Microsoft's One Drive* etc [17].

Agent for Education Services and Apps Management plays vital role to collect educational resource and find suitable related applications for education service management. In cooperation with *Agent for Collaboration & Data Management*, together to organize SaaS packages to education providers and learners.

In the University of Westminster's mobile learning project, the educational SaaS packages are provided to users by combining its popularity, cost and frequency rate of usage. Through SDN and Virtualization interface, agent is able to select a package which integrates tailored General Apps and Education Apps for customers and users.

By using Kolb's teaching and learning model [8], the development stages for learners are divided into *Acquisition*, *Specialization* and *Integration*. Each of progressing stages of learning requests special tools and experience. In this learn style, it is vital to *observe and think*, *try to do* and *reflect the experiences* gained. To help staff and students to work within a user friendly cloud-based education system, based on demand of basic services and apps and specialized services and apps, the key services and apps for this educational project are offered and included into the packages. It consists of Generic Services (e.g. email, presentation, social media, video/audio conferencing etc) and Education Services (eLearning, learner portfolios, course content management, assessment etc.). So the specialised apps are offered according to services, such as *keynote*, *Nearpod*, *Showme*, *Panopto* [17] for

presentation and demonstration; *blackboard*, *iTunes U*, *Coursera* [17] for global teaching resources gathering. It is clearly a better and efficient option to education business and organizations as there is no longer need to purchase individual product and service. Obviously, the service and cost of the package is more attractive to business owners than individual consumers. The App and Service requests from academic institutions, eLearning developers, education businesses owners can also be customised, shared, managed and centrally updated accordingly.

5. Agents for Service Monitoring and Security

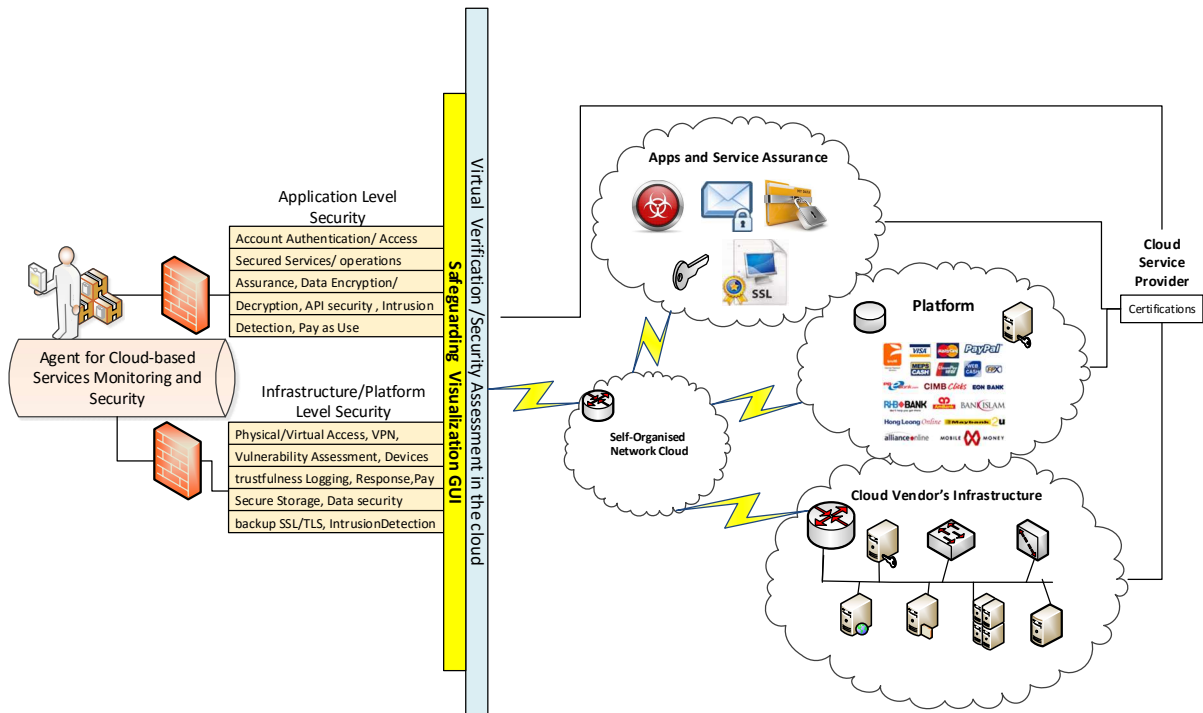


Fig. 3: Managing Agent for Cloud-based Services Monitoring, Security and Protection

To facilitate agent operations and education service provision within Cloud-based Education System, the security must be emphasized and privacy need to be ensured [7] [14][15].

Agent for Cloud-based Services Monitoring and Security is responsible to manage both physical resources (e.g. devices, servers, storage, networks) and virtual resources (e.g. data, services). This agent is act as a security gate guard for protection of self-organised network/cloud which is illustrated in Fig 3. It handles and solves security issues through visualization interface. Especially for Application and SaaS level issues are: user account authentication, secured services access, operations assurance, data encryption/decryption, API security, intrusion detection, pay as use payment etc. It also helps to maintain digital information using code signing certificate technique and keep them updated from trustful vendors and service providers.

6. Conclusions

It is forecasted that the Public cloud service revenue is going to top \$200 billion in 2016. It will grow by 16.5 per cent than year 2015's total of \$175 billion in sales, according to market analyst Gartner [6]. It is expected that is business growth ad market trend will be continuing through next decade.

With the significant increasing in popularity of Cloud Computing and high demand for affordable education from worldwide audience and institutions[16], the Cloud-base education and service provision is also booming because more and more enterprise and business owners are accepting the idea of adopting the Cloud to run their key services, and importantly to build data center. Moving their infrastructure, platform, IT services to the public cloud is popularity than ever. However, the cloud-based education systems are facing many ongoing challenges on resource management, service provision, system protection and security.

Getting agents and agent technology on board is not only a good solution but also cost effective and efficient. As Cloud business vendors and Education Service providers have to offer more and more reliable Cloud-based platforms and services to customers and learners, agent's usage and extension abilities, agent's productivity and its opportunities will appear more significantly along with the Cloud technologies further development.

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