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SPECIAL ISSUE: AUTONOMOUS DECENTRALISED SYSTEMS IN WEB COMPUTING

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Autonomous decentralised systems in web computing environment

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1 Introduction

Service-oriented computing (SOC) considers a software system consisting of a collection of loosely coupled services that communicate with each other through standard interfaces and via standard message-exchanging protocols. Cloud computing extends the scope of SOC to include the development platform and the execution infrastructure, and thus, cloud computing is typically characterised by the features such as software as a service (SaaS), platform as a service (PaaS), infrastructure as a service (IaaS), and hardware as a service (HaaS) (Chen and Tsai, 2010). However, any other virtualised services, say, X as a service, can be submitted to the cloud infrastructure as long as the standards are followed (Schaffer, 2009). SOC and cloud computing are becoming pervasive. They are the foundation of today's web-based applications (Chen and Tsai, 2010; Erl, 2005). All major computing companies support software development in SOC and cloud computing, including Amazon web services (EC2 Cloud), Google (Google Code and App Engine), IBM (Eclipse and IBM Cloud), Microsoft (Visual Studio and Azure), and saleforce.com multi-tenancy cloud. The current SOC and cloud computing environments make it possible to move completely away from the desk-top-based computing to the full web-based development and application: developers use a platform on web through a web browser, develop software and store data on the web, configure the hardware/infrastructure, including processing power, memory capacity, communication bandwidth, and execute application in the web. Finally, the developers can deploy the application or a part of the application the physical devices to interact with the physical environment.

SOC and cloud computing have been focused on e-commerce and enterprise computing systems so far. Applying them in physical devices and embedded systems is one of the most recent challenges and research approaches. Majitek (2010) applied the concept of device as a service to implement the machine-to-machine communication in SOC standards and in a web-based IP network. Chen et al. (2010) developed a robot as a service (RaaS) unit that allows a physical robot to collaborate with the cyber services and to offer physical services. Huang et al. (2010) presented a framework for efficient service composition in cyber-physical systems, which allow developers to utilise the service physical devices in the cyber environment. Tsai et al. (2007) studied the service-oriented system engineering issues of integrating embedded devices into SOC environment.

On the other hand, autonomous decentralised systems (ADS) technologies, initially proposed and implemented by Mori (2001), have been a driven force in designing mission-critical distributed applications, where safety, reliability, real-time attributes of physical devices are concerned. Mori's (2010) and Takahashi et al.'s (2010) recent work is extending the ADS technologies and their assurance to SOC and cloud computing environments. This special issue devotes to two major aspects: applying ADS technologies for improving the safety and reliability of web applications, and extending ADS technologies to operate in the web computing environment.

The rest of the notes will discuss the six papers selected for this special issue and their roles in extending ADS technologies to SOC and cloud computing environments. The papers are selected from The *Eighth International Workshop on Assurance in Distributed Systems and Networks*. The authors of the selected papers have made significant extension to the original papers.

2 Coverage of the special issue

We focus on three aspects of ADS technologies and their roles in supporting the integration of ADS with SOC and cloud computing environment. They are cyber security and reliability, communication infrastructure, and failure detection and monitoring using ADS technologies.

2.1 Cyber security and reliability

Two papers that address cyber security and reliability are selected. The public key infrastructure (PKI) is a critical infrastructure to ensure the security of today's web-based applications. In the paper 'A mission-critical certification authority architecture for high reliability and response time', Coronado-García and Pérez-Leguízamo proposed a PKI model using autonomous and decentralised principles for ensuring the high performance, online expandability, online maintenance, and fault tolerance. The model consists of a root certification authority responsible for issuing authorities' certificates and verifying the uniqueness of the public keys issued on its own or by any of the others authorities belonging to this PKI, a number of certification authorities that issue end user's certificates, and a number of registration authorities (RAs) that store the user certificates. The autonomous and the decentralised features of the model can ease the bottleneck of issuing the certificates.

The second paper deals with the cyber attacks. There are many kinds of cyber attacks that threat the safety and reliability of web applications. Sybil attack is one of the serious threats in cyber physical system, such as the vehicular ad hoc networks (VANETs), as the drivers may receive false information, which could lead to the failure of the mission and even jeopardise the drivers and passengers. In the paper 'Sybil attack detection based on signature vectors in VANETs', Chen, Han, and Wang presented a novel solution to detect Sybil at-tacks. The idea is to let each node gathers the digital signatures in an autonomous and decentralised way; then the proposed algorithm can detect the Sybil attack by analysing and comparing vehicle nodes' signature vectors independently. The challenge is that the algorithm must deal with the absence of the infrastructure and the in-complete information collected among the moving nodes. Simulation is developed to prove the concept and the results show that the method outperforms the existing detection schemes in terms of robustness, detection rate, and lower system requirements.

2.2 Communication infrastructure

Cloud computing model is a scalable model, with constantly increasing demanding on the performance and communication capacity. Unfortunately, the increasing resources often lead to increasing complexity and computational cost. In addressing these problems, Sun discovered an 'A constant-time method for TCP/IP socket I/O multiplexing', which can complete TCP/IP multiplexing functionality iPBX for any number of N sockets in a small constant time. Although the method is applied to multiplexing, the concept can be applied in generic event polling systems for other kinds of networks and applications.

Mobile ad hoc networks and their applications is another domain of the anywhere connected world. Not only performance, but also power efficiency is a key consideration in designing and implementing such environment. In the paper 'Improvement of TCP/UDP performance using adaptive transmission power control for hierarchical MANET routing', Kohno et al. developed a new transmission power-controlled hierarchical routing scheme for improving communication and power efficiency for the purpose of reducing signal collisions. In this scheme, each node changes the transmission power according to the number of neighbouring nodes in the autonomous clustering.

2.3 Detection and monitoring

As the SOC and cloud computing technology matures, software development starts to focus on the composition of using existing services. As many of the services are discovered on web and are developed by third parties, quality of service (QoS) is the critical factor. Monitoring is a key component for the service quality management of a web service. In the paper, 'A design of policy-based composite web services QoS monitoring system', Yeom et al. presented a service quality monitoring system with the help of the service broker. OWL-S is used to specify the composite service process and the service policy. If there is any discrepancy between the service policy and the monitored data, the service provider and the user are notified so that they take necessary actions. As a case study, a travel reservation system was developed and experimental data were collected on the average response time. The timeout policy was applied and evaluated in the experiment.

As web-based computing environment can deliver computing, platform, and infrastructure on demand, with heterogeneous requirements and expectations, quality of user experiences (QoE), such as the continuity of the service, instead of QoS, is considered a more appropriate measurement for judging the quality of such services. Lu and Mori developed, in the paper 'Autonomous demand-oriented streaming system architecture and fault-tolerant technology for service continuity', an autonomous demand-oriented streaming system sustained by mobile agents for information service provision and utilisation. In this architecture, autonomous fault detection and recovery technologies are proposed to assure service continuity.

3 Conclusions

In the opening notes of the special issue, we presented, from the special issue's editors point view, the current development of ADS technologies and their assurance, and particularly, the trend of applying and extending ADS technologies to SOC and web-based computing environments. Six papers in three categories are selected and included in this special issue.

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