CloudIoT: Towards Seamless and Secure Integration of Cloud Computing With Internet of Things

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ABSTRACT

The Internet of Things (IoT) is seen as a novel paradigm enabling ubiquitous and pervasive communication of objects with each other and with the physical/virtual world via internet. With the exponential rise of sensor and RFID-based communication, much data is getting generated; which becomes arduous to manage given the constrained power and computation of low-powered devices. To resolve this issue, the integration of Cloud and IoT, also known as CloudIoT, is seen as a panacea to create more heterogeneous smart services and handle increasing data demands. In this article, the authors examine and survey literature with a focus on the integration components of CloudIoT and present diverse applications including driving factors for CloudIoT integration. The article also identifies security vulnerabilities implied by the integration of Cloud and IoT and outlines some suggested measures to mitigate the challenge. Finally, the article presents some open issues and challenges providing potential directions for future research in this area.

KEYWORDS
CloudIoT, IoT, RFID, Sensor

INTRODUCTION

Technological innovation in wireless communication allows real-time scanning, management, and transmission of sensitive data (Zorzi et al., 2010). Since 2011, the population of internet-enabled devices has already surpassed the number of human beings on earth. Cisco Systems predict that by the year 2020, the global internet will be an amalgam of over 50 billion connected devices which include sensor nodes, output actuators, mobile and GPS connected smart devices and technologies (Nordrum, 2016). The Internet of Things (IoT) is seen as a technological evolution having distinct applications in human life rendering future connectivity and accessibility. The IoT involves interconnection of small devices embedded with sensing software and hardware that permits these objects to acquire
and transmit data to the cloud or internet using a wireless medium (Chen et al., 2014). These sensors use diverse enabling technologies and protocols for data transmission such as Bluetooth, Near Field Communication (NFC), Zigbee and Radio Frequency Identification (RFID). For long distance data transmission; they can also use mobile data communication services such as GSM, GPRS-Edge, 3G and 4G over LTE (Devipriya, 2017). IoT working is based on autonomous Machine-to-Machine (M2M) communication without any human interaction. The application areas of IoT such as smart home systems, remote environment monitoring, automated industrial systems, and remote healthcare generate and deliver data which needs to be processed in real time (Soliman et al., 2013). This in turn necessitates support for high network volume traffic being generated by heterogeneous systems. As these heterogeneous devices keep on increasing, IoT performance tends to decrease given the constrained power and bandwidth limitation (Botta et al., 2014). In such a scenario, there is a demand of data mapping from physical IoT world to virtual world of Cloud computing. The Cloud computing platform offers a suitable, on-demand, extensible and seamless access to pool of networked computing resources (Cook et al., 2018). These remote resources dispense enormous processing power for computations and scalable storage that augment the low power and storage drawbacks of IoT devices, hence offering complimentary and coherent platform for ubiquitous computations by end users (Aazam et al., 2016).

The integration of Cloud and IoT known as CloudIoT or Cloud of Things (CoTs) was recently conceived by MIT’s Auto-ID labs to signify interconnection between heterogeneous physical objects and virtual cloud (Distefano et al., 2012). The IoT’s are represented by small physical objects that are highly distributed in nature and suffer limited processing power and storage. These constraints generate issues affecting performance, reliability, security, trust and privacy in IoT devices (Parwekar, 2011). Cloud computing technology on the other hand provides robust, scalable and immense capacity solution to IoT issues. With Cloud of Things, the two independent technologies are expected to work together for energy efficiency, planned resource management, and creating new and extended range of services (Aazam et al., 2016). Delay sensitive applications as well as mission critical services can benefit from this new technological prototype. The integration of Cloud and IoT is highly pervasive given the fact that large volumes of data are being generated which entails requirement for virtual storage resources. This data after pre-processing should create not only information, but also knowledge and wisdom that will help in developing smarter application for the users (Khodkari et al., 2016).

The CoT framework is highly scalable and distributed in nature owing to the fact that computational resources are offered as service. CoT allows easier deployment of applications harnessing benefits of cloud service models such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). There is also a provision for ensuring that Quality of Service (QoS) is maintained dynamically (Velte et al., 2010). For example; when application requests increase from a user, the cloud must scale up to suffice the growing load. On the contrary, when the load decreases, the cloud must automatically scale down to accommodate the change. The CoT finds diverse application areas because of its economical, flexible, extensible, management-less and subscription-based model. The cloud service providers offer services through internet on a subscription or pay-per-use basis. Some precise advantages of CoT implementation include massive data storage and processing power, distributed nature of service for supporting location independence of users, platform independence and cross application support, multi-versioning application support, power and resource efficient and support for Quality of Service (QoS). Given the advantages of CoT framework, the process of integration of Cloud and IoT is not that simple (Aazam et al., 2016). In addition to data and resources, issues with respect to business point of view need to be taken care of. The framework offers bigger business platform and opportunities, which in turn invites attack from malicious users. In case of hybrid clouds, major concern and emphasis should be laid on security and privacy which also includes identity preservation (Velte et al., 2010). Other concerns in CoT framework include secure transmission of sensitive data and secure data storage (Cook et al., 2018). This necessitates use of cryptographic techniques and encryption during data processing and storage. Additionally, deployed
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