International Journal of Information Management 36 (2016) 645–652

Contents lists available at ScienceDirect

International Journal of Information Management

journal homepage: www.elsevier.com/locate/ijinfomgt

Outlook on moving of computing services towards the data sources

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ARTICLE INFO

Article history:
Received 18 March 2016
Received in revised form 29 March 2016
Accepted 29 March 2016
Available online 27 April 2016

Keywords:
Big Data
Internet of things
Nano data centres
Cloud computing

ABSTRACT

The internet of things (IoT) is potentially interconnecting unprecedented amounts of raw data, opening countless possibilities by two main logical layers: become data into information, then turn information into knowledge. The former is about filtering the significance in the appropriate format, while the latter provides emerging categories of the whole domain. This path of the data is a bottom-up flow. On the other hand, the path of the process is a top-down flow, starting at the strategic level of business and scientific institutions. Today, the path of the process treasures a sizeable amount of well-known methods, architectures and technologies: the so called Big Data. On the top, Big Data analytics aims variable association (e-commerce), data mining (predictive behaviour) or clustering (marketing segmentation). Digging the Big Data architecture there are a myriad of enabling technologies for data taking, storage and management. However the strategic aim is to enhance knowledge with the appropriate information, which does need of data, but not vice versa. In the way, the magnitude of upcoming data from the IoT will disrupt the data centres. To cope with the extreme scale is a matter of moving the computing services towards the data sources. This paper explores the possibilities of providing many of the IoT services which are currently hosted in monolithic cloud centres, moving these computing services into nano data centres (NaDa). Particularly, data-information processes, which usually are performing at sub-problem domains. NaDa distributes computing power over the already present machines of the IP provides, like gateways or wireless routers to overcome latency, storage cost and alleviate transmissions. Large scale questionnaires have been taken for 300 IT professionals to validate the points of view for IoT adoption. Considering IoT is by definition connected to the Internet, NaDa may be used to implement the logical low layer architecture of the services. Obviously, such distributed NaDa send results on a logical high layer in charge of the information-knowledge turn. This layer requires the whole picture of the domain to enable those processes of Big Data analytics on the top.

1. Introduction

IoT as a technology relies on machine to machine communication through the internet. Embed systems of various kinds of devices gather data from the environment for more interpretation and information extraction. Since, the involved environment with technology becoming bigger, IoT theoretical limit is as big as the internet itself. The IoT are pervasive to our day-to-day lives, people can get to the internet and get connected to each other through small sensors on different smart and portable devices. RFID, NFC, Wi-Fi, Bluetooth are various types of local area connection that IoT can be used (Atzori, Iera, & Morabito, 2010; Gubbi et al., 2013). In this way, IoT can break down boundaries in all areas to enable "anytime, anywhere, anyone, and anything" access (Welbourne et al., 2009). In the top-down path information is coming to the strategic level, enabling new ways of market penetration, collecting a wide range of information from the underlying data infrastructure. Similarly, challenges are encountered such as designing the appropriate architecture and data centre to prepare networking and security (Domingo, 2012).

Cloud computing has a complementary role for IoT and currently they are inextricably linked (Gubbi et al., 2013). Cloud computing can provide the virtualization facilities to help device applications for integrating their utility computing, monitoring devices, storage devices, analytics tools and visualization platforms. In this

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http://dx.doi.org/10.1016/j.ijinfomgt.2016.03.014
0268-4012/

case, what enables applications and users to access applications on demand anytime, anyplace and anywhere is the utility-based model of cloud computing. While blending this characteristic of Cloud with IoT, data could be gathered as much as intended.

In this paper, apart from the fact of providing an overview about cloud computing and internet of things, we discuss issues and challenges when, cloud and IoT collaborate with each other for a better proficiency. We focus in the possibilities of moving computing service towards the data sources and new high level applications of Big Data in the information-knowledge logical layer. The idea of this multiple layered clouds is not new. NaDa approach was proposed several years ago (Valancius, Laoutaris, Massoulié, Diot, & Rodriguez, 2009) to improve video streaming services taking advantage of the in-transit machines of the IP providers. The same concept has been applied to other applications, for example in P2P clouds based in nano centres (Babaoglu, Marzolla, & Tamburini, 2012). More recently, multiple layered clouds can solve several IoT applications with nano and micro data centres in front of the conventional cloud infrastructure (Petri et al., 2014). The contribution of the present work is to describe de possibilities of a generic logical architecture for Big Data applications, composed of a data-information layer in the IoT and NaDa infrastructure and an information-knowledge layer in the Cloud. For example, a market segmentation system selects target information from NaDa in-transit data. Then, it sends the result of this filter processing to a cloud computing storage. On the top, a cloud application is obtaining clustering of market segmentation from the whole domain statistics. The two main logical layers are break down as follows. Section 2 by suggesting an IoT architecture in four physical layers, we aim to give a new approach to fill research gaps. In Section 3 we describe current integration of IoT and cloud, as well as key research problems in data size and security constrains, disaster recovery and categories of cloud services to IoT. Section 4 is focusing the NaDa alternative to some of the problems found in Section 3, particularly what is related to data management. It details the main idea of moving computing services towards the IoT data sources. Section 5 summarizes a questioner to professionals. We conclude in Section 6.

2. Internet of things

Internet of things (IoT) contains a wide range of smart objects, connected through the internet via sensors, exchanging data and information update. According to Vermesan et al. (2011), internet of things is the biggest community right after the internet itself. "Things" in internet of things could refer to any devices which have the ability to switch to the internet with unique IP addresses. IoT enlarge internet connectivity beyond customary devices like computers, laptop and smartphones to a diverse range of devices and things of daily life and industry. Such devices have integrated embedded systems to control operations. Besides, it is relevant that embedded systems can communicate and interact with the exterior environment, via the Internet. This definition includes everything from heaters, cell phones, doors, people and animals, security systems, thermostats, cars, electronic appliances, lights in household and commercial environments, alarm clocks, speaker systems, vending machines and any items which can be identified with unique IP addresses. In summary, they are called IoT or internet of everything (Gubbi et al., 2013).

IoT can be regarded the extended version of the virtual Internet into the physical arena. This can be illustrated by the spatially distributed devices, enabling local sensing and remote actuation (Atzori et al., 2010; Atzori, Iera, Morabito, & Nitti, 2012; Miorandi, Sicari, De Pellegrini, & Chlamtac, 2012). Most important IoT facilities are physical establishments, sensors, software and radio frequency identification (RFID). These facilities help things or physical objects in IoT to collect, send and receive data back and forth in machine to machine, machine to man and both converse communications.

Majority of IoT objects use RFID technology. RFID is widely used for tracking objects, people, and animals (Miorandi et al., 2012). RFID system architecture is signed by a split of simple RFID tags and considerable infrastructure of networked RFID readers. This approach optimally supports tracking physical objects within obvious boundary such as warehouses or data centres, but limits the sensing power and disposal flexibility that acquire new infrastructure or architecture in IoT. A more suitable model for the internet of things can be illustrated by considering the technological requirements; demands on the services; and finally decentralized systems of smart objects, autonomous physical/digital objects supplement with sensing, processing, and network abilities. In contrast to RFID tags, smart objects carry a patch of logical facilities that let them feel their local situation and cooperate with human users. They sense, log, and process what's occurring around their environment, act based on their smart, intercommunicate with each other, and exchange information with end users or people. By perceiving RFID properties, architecture can be developed in such a way that data warehouses are closer to these sensors (Kortuem et al., 2010).

Another characteristic should be considered for constructing a new architecture in IoT is, how objects communicate with each other. Machine to machine communication is how objects make interactions. This kind of communication paradigm provides ubiquitous connectivity between devices, plus an ability to communicate autonomously without human intervention. In IoT machine-to-machine communications enable remote sensors to gather data in the first layer of IoT architecture and sends it wirelessly to a network in the next layer, where it lead to hubs and next routed through the Internet, maybe to a server such as an application or personal computer for more analyse. At that point, the data is analysed and acted upon, according to the software in place and this is how IoT infrastructure work (Rui & Danpeng, 2015).

2.1. Architecture for the internet of things

The IoT architecture contains different layers. However, there are several ways of modelling the IoT layer infrastructure. To ensure the architecture can be adopted easily, four key layers are proposed as follows: sensor layer, network layer, platform layer and application layer. As Fig. 1 shows, first layer belongs to physical objects like sensors. This sensor layer consists of a Wireless Sensor Network (WSN), RFID reader, and M2M terminals to collect various data from environments. Gathered data from things or objects in first layer going to the second layer where gateways and hubs lead data to the internet and clouds for more processes and storage in central servers.

Platform layer or the Internet of Services (IoS) involves the analysis of Big Data uses open platforms and interface architectures to support user's requests in the last layer. What is important for users in the last layer is, real-time statistics and historical analysis reports from the gathered data from sensors, till they could react to anomalies, occurrences or other events appropriately and quickly as soon as they occur, so we need such a platform to satisfy these needs for maximizing IoT potential and that is the topic for our paper (Ning et al., 2015).

Last layer is where end users exist. In this layer there are screen displays with friendly and graphical user interfaces, the virtual infrastructure for utility computing, integrating applications, monitoring devices, analytics tools which allow users access real-time analysis reports. Furthermore, we have visualization platforms and client delivery in this layer. The utility-based model, cross-platform and mobile management facilitate that cloud computing offers in