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Software defined networking for internet of things

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Abstract
Internet is growing rapidly in the last decades and continues to develop in terms of dimension and complexity. Recent advances in computer networking have introduced a new technology paradigm for future communication, the Software Defined Networks (SDN). The flexibility and general programmability offered by the SDN technology has supposed a disruption in the evolution of the network. SDN can be applied to the Internet of Things (IoT) and thus resolve some of the main challenges it exposes. In this article we will introduce SDN and IOT technologies. We will then outline the challenges ahead of the IOT, and introduce SDN as a solution to these problems.

Keywords: internet of things, software defined networking

Introduction

Internet is growing rapidly in the last decades and continues to develop in terms of dimension and complexity. Recent advances in computer networking have introduced a new technology paradigm for future communication, the Software Defined Networks (SDN). A central software program, called SDN controller, manages the overall network behavior. Into SDN the control and data planes are decoupled, network intelligence is logically centralized. The controller can add, update, and delete flow entries, both reactively in response to packets and proactively with predefined rules (FLAUZAC and GONZALEZ, 2015).

Software-Defined Networking emerged as a strategy to increase the functionality of the network, reducing costs, reducing hardware complexity and enabling innovative research. SDN architecture models have three layers (https://www.opennetworking.org/ - Sezer et al , 2013): an infrastructure layer consists of network devices (e.g., switches, routers, virtual switches, wireless access point), a control layer consists of SDN controller(s) (e.g., Floodlight, Beacon, POX, NOX, MUL, Open daylight, etc.) and an application layer that includes the applications for configuring the SDN (e.g., Access control, traffic/security monitoring, energy-efficient networking, management of the network).

Nowadays, most people, if not all, complete their needs, work, or even transactions through the Internet. To achieve this, they need to interact with many devices or objects. Moreover, objects might need to communicate with each other. Such communication between humans and objects (things) requires connecting the objects around us with the Internet. The internet of thing (IoT) paradigm, as mentioned in (Gubbi et al, 2013) reflects the current and future situation of the world. Indeed, IoT researchers argue that by 2020, IoT will grow significantly to cover all the objects in our environment creating what they call the internet of everything (IoE) (Jararweh et al, 2015).

The Internet of Things (IoT) is a recent communication paradigm that envisions a near future, in which the objects of everyday life will be equipped with microcontrollers, transceivers for digital communication, and suitable protocol stacks that will make them able to communicate with one another and with the users, becoming an integral part of the Internet (Atzori et al, 2010). The IoT concept, hence, aims at making the Internet even more immersive and pervasive. Furthermore, by enabling easy access and interaction with a wide variety of devices such as, for instance, home appliances, surveillance cameras, monitoring sensors, actuators, displays, vehicles, and so on, the IoT will foster the development of a number of applications that make use of the potentially enormous amount and variety of data generated by such objects to provide new services to citizens, companies, and public administrations. This paradigm indeed finds application in many different domains, such as home automation, industrial automation, medical aids, mobile healthcare, elderly assistance, intelligent energy management and smart grids, automotive, traffic management, and many others (Bellavista et al, 2013).

Challenges in IOT

The rapid growth of the IoT produces a lot of data and information collected by the huge number of objects connected to it. Storing, managing, controlling and securing such big data are considered critical issues if we want to connect everything to the Internet in a useful and practical manner. Moreover, in real time transaction or any simple work there is a need to connect these objects with each other's to accomplish the desired work. Any delay in response time through the communication will negatively effect on the overall performance and accuracy the system. So finding ways to accelerate the communication process is also considered a hindering point to the IoT acceptance and growth. The software defined systems is considered a vital solution for these challenges.

The growing interest in the Internet of Things (IoT) has resulted in a number of wide-area deployments of IoT sub networks, where multiple heterogeneous wireless communication solutions coexist: from multiple access technologies such as cellular, WiFi, ZigBee, and Bluetooth, to multi-hop ad-hoc and MANET routing protocols, they all must be effectively integrated to create a seamless communication platform. Managing these open, geographically distributed, and heterogeneous networking infrastructures, especially in dynamic environments, is a key technical challenge (Zhijing et al, 2014). On the other hand there are more objects connected to the internet than humans in the world, and these generate an enormous amount of traffic (i.e., voice, video, data, etc.). All of these factors increase

considerably the cost pressure on network operators, due to the emerging mobile devices and applications. One of the greatest challenges concerns the security of the Internet of Things (IoT), since it will include every object or device able to connect to wireless or wired networks (FLAUZAC and GONZALEZ, 2016).
One of the challenges to be addressed in the development of IoT in general is the great variety of participating devices. Already a multitude of different devices with different capabilities exist. This diversity manifests itself in terms of different capabilities (processor, memory and storage), different communication standards supported (Bizanis and Kuipers, 2016).
The network security threats increase with internet evolution. A special concern will be dedicated to the security of the Internet of Things, since it will include every object or device with networking capabilities. Objects can include simple home sensors, medical devices, cars, airplanes and even nuclear reactors and other things, which can pose risks to human life (FLAUZAC and GONZALEZ, 2015).

Solving IoT challenges with SDN

The large number of objects in the IoT network make the traditional IP standards are unable to fit the large number of things connected to the Internet. In addition, these objects may have different characteristics and features, so there is a need to merge another routing protocol to accommodate this growing. Using the IPv6 may considered a good choose to deal with such number of objects, but it does not address the heterogeneity of the underlining objects. In a recent (Martinez and Skarmeta, 2014) the SDN was used to allow different objects from different networks to communicate with each other by using IPv6 and at the same time simplify the management and control operations of various objects types by adding an additional IoT controller over the SDN controller. Significant benefits of integrating SDN and IoT include (Keshav et al, 2015):
a) SDN has a potential to intelligently route traffic and use underutilized network resources. This will significantly enhance network's ability and therefore it will be much easier for networks to prepare for the data onslaught of IoT. This will eliminate bottlenecks to efficiently process the data generated by IoT without placing a large strain on the network, especially on Wi-Fi network. b) SDN integration with IoT will simplify the information acquisition, information analysis, decision making, and action implementation process. c) The deployment of SDN in IoT will provide visibility of the network resources and management of access based on user, group, device and application that eventually enables the ability to exchange data capacity between users and even devices. d) Researchers are designing intelligent algorithms in SDN to build effective traffic pattern analyzer, which simplifies the tools of data collection from IoT devices. This facilitates the design of novel debugging tools. IoT networks will benefit with the integration of Software Defined Wireless Networking (SDWN) technology to strengthen networks controlling ability. e) With SDWN, IoT networks can become more agile and scalable based on demand.

Recent research

The benefits of employing SDN techniques in IoT environments is becoming recognized in multiple domains beyond the smart transportation setting discussed earlier by both researchers and industry practitioners. For example, (Sydney, 2013) developed a robust control and communication platform using SDNs in a smart grid setting. Similar efforts have been explored in the smart home domain where IoT devices are extremely heterogeneous, ranging from traditional smartphones and tablets, to home equipment and appliances with enhanced capabilities. Recent efforts include a home network slicing mechanism (Yiakoumis et al , 2011) to enable multiple service providers to share a common infrastructure, and supporting verifying policies and business models for cost sharing in the smart home environment. At a lower device level, (Luo et al, 2012) employs SDN techniques to support policies to manage Wireless Sensor Networks.
In (Zhijing et al, 2014) researchers presented an original SDN controller design in IoT Multi networks whose central, novel feature is the layered architecture that enable flexible, effective, and efficient management on task, flow, network, and resources. They gave a novel vision on tasks and resources in IoT environments, and illustrated how we bridge the gap between abstract high level tasks and specific

low level network/device resources. A variant of Network Calculus model is developed to accurately estimate the end-to-end flow performance in IoT Multi networks, which is further serving as fundamentals of a novel multi constraints flow scheduling algorithm under heterogeneous traffic pattern and network links.
In (Jararweh et al, 2015) a software defined based framework for Internet of Things (SDIoT) is proposed. The proposed model was built to provide a proof of concept, and we explained how the systems can be built to accommodate large data which produced from the widespread of the IoT. We plan to develop an experimental framework for SDIoT to test different forms and types of the IoT topologies.
There exist some papers (Zhijing et al, 2014 - Martinez and Skarmeta, 2016) of software-defined approach for the IoT environment. These papers had the focus of determining the integration of SDN and IoT, it's do not propose a security mechanism.
In (FLAUZAC and GONZALEZ, 2015), researchers provided an overview of a new SDN-based network architectures with distributed controllers and this solution can be used in the context of Ad-Hoc networks and IoT.
In (Bizanis and Kuipers, 2016) the researchers examined the fusion between SDN, network virtualization and IoT. More specifically, this survey is, to the best of our knowledge, the first one to discuss the application of both SDN, network virtualization, and their combination, as key facilitators for the deployment of IoT. It presents an overview of the proposed protocols, architectural models, algorithms and applications for the application of those technologies to IoT.
Review article (FLAUZAC and GONZALEZ, 2015), presents the current key research efforts on Software Defined Wireless Network. They emphasize that integration of SDN in IoT network can potentially bring exciting opportunities. We also highlighted that the traditional network tools to collect, store, process, and forward massive data, are inefficient to meet critical future IoT network needs whereas SDN can significantly simplifies the network control and management needs.

Conclusion

as discussed throughout this document, the flexibility offered by SDN can be effectively used to allow objects connected to heterogeneous networks to communicate each other. This is independent of the capabilities of such objects, so it fits perfectly into IoT scenarios. Limited computation or communication ability is an important factor that determines the shape of IoT networks and the protocols they use. It has meant the design of specific protocols for specific purposes which are generally incompatible each other and does not permit the objects to easily interact. This problem can be resolved by using the mechanisms offered by SDN by just building a network service on its top that gives support to IoT objects. Nevertheless, this exposes other challenges that must be resolved before continuing with the design of the discussed approach. However, the new challenges and research objectives are much simpler than the premises of the general problem, so resolving them would be a good start towards the design of the integrated architecture.

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