POWER SAVING IN IOT GATEWAY

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Abstract - Internet of Things (IoT) is a system of interconnected devices, vehicles, objects, wearables which can exchange the data over a wireless network. Smart city, smart energy, smart home are the few examples of IoT applications. IoT network is a high degree heterogeneous network in terms of connectivity, communication capacity between devices, interoperability, protocols or security. IoT devices are expected to grow millions in near future, to support such devices and to handle the large volume of data, IoT networks are becomes more complex. To overcome system complexity, increase reliability and enhance security IoT networks use the concept IoT gateway. This gateway can communicate with end devices as well as the core network. Gateway remains active all the time to transmit data and control the entire network traffic. This causes the increase in power consumption. This paper cover various power saving techniques in IoT gateway.

Keywords - Internet of Things (IoT), Gateway, Architecture, Power saving

I. INTRODUCTION

IoT connects large number of physical objects or devices to the internet. These devices are capable of sensing different types of data. Consumer, commercial, industrial and infrastructure spaces [1] are the main applications of IoT. Smart home, remote monitoring, wearable technology are the few examples of consumer applications. Fig.1 shows differentIoT applications. IoT can play the significant role and enhances the excellence in human lives [2]. Billions of connected devices with sensors that sense the physical world and collect the data. It senses the environmental changes, real-time traffic conditions, the health status of a patient, home automation, defense, public safety etc. The number of IoT devices are expected to increases by 75 billion in 2025 [3]. These connected devices can communicate with each other. Examples of typically used communication protocols for IoT devices are WiFi, Bluetooth, Z-wave, and LTE-Advanced.

Fulfilling IoT applications is not an easy task. There are many challenges to be addressed in IoT systems. Major challenges include security, heterogeneity of devices, data collection and analysis, and management. Due to the increase in heterogeneous devices, it is extremely difficult to manage the large amount of collected data. The IoT network experiences a huge burden because of this big data [4]. Collecting the useful data from this data stream is the new challenge in IoT systems [5]. IoT gateway is the promising solution to reduce system complexity and increases the storage space. The data generated by the various sensing devices, other smart objects, and social media can be first analyzed by the gateway. The IoT gateway allows communication of the devices and core network [6].

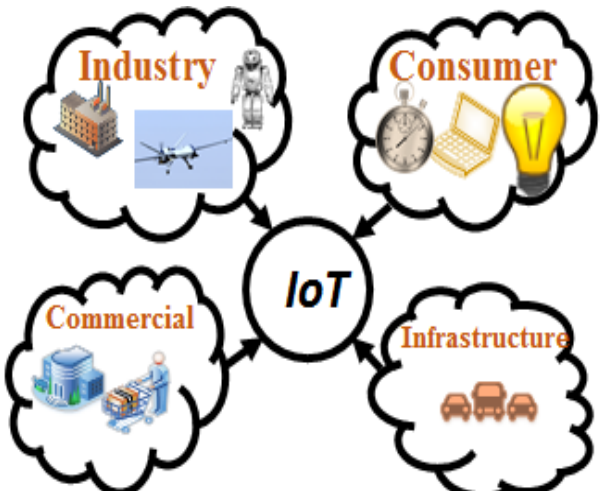


Fig. 1: IoT Applications

An IoT gateway can carry out numerous demanding functions. It is able to extract intelligent data from the data stream. It reduces the communication cost. Security is the major problem for IoT networks. Gateway can handle security issues. IoT gateway offer real-time data transmission. Healthcare or personal security devices need real-time data. . The end devices need not have the processing power, storage ability or memory. The gateway does all these functions. The heterogeneous device produce big data is a problem in network efficiency. IoT gateway is also a demanding component in the IoT networks. There are many papers addressing different aspects of IoT technology. However, very less work is related to IoT gateway. In this paper we survey about the IoT gateway power saving issues and their solutions. IoT gateway architecture and related works are briefly explained in Section II. In Section III, we present a survey about IoT gateway power consumption issues and solutions. We conclude our paper in Section IV.

Table 1. Power saving techniques in IoT gateway

Ref	Techniques	Results
17	Mixed Integer Linear Programming (MILP) model supported by cloud computing.	Save power up to 36%.
18	An energy efficient hardware platform for building fog layer facilities.	Proposed architecture has better energy efficiency than MSP430 and ARM Cortex M3
19	More than one gateway system for WSN management in Building Management System (BEMS).	Both power consumption and data delay of the network can be decreased.
20	Proactive scheduling for IoT gateway	Effectively save the energy.
21	5G-enabled IoT gateway.	Support massive number of IoT devices, Improve uplink resource utilization, and Energy efficiency.

II. IOT GATEWAY ARCHITECTURE

To connect the various IoT devices in communication networks [7] is the primary function of IoT gateway. Gateway can collect and process the data from sensor devices and transmit it to the core network. IoT gateway offer local processing. It improves the security. IoT gateway updates the data in real time. Morabitoet al. [8] developed a lightweight edge gateway (LEGIoT).

This gateway is suitable for IoT edge computing applications. It uses the lightweight virtualization technologies. In [9], authors are studied about the reliable and self-configurable IoT gateway. The authors also test the gateway using the IoTivity framework. The proposed gateway can register each end devices within 2.4 seconds. Real time monitoring and controlling the devices is a big challenge in IoT network. Gloria et al. [10] proposed a gateway to overcome the real time problems. This gateway can monitor the swimming pool. They uses the Raspberry Pi, for bidirectional communications.

Huang et al. [11] developed an intelligent IoT gateway architecture. Due to the large number of heterogeneous devices as well as variety of applications, it is very difficult to design an IoT gateway. Other significant issues of designing an IoT architecture include protocols or standards, and lack of standardization.Ray et al. [12] formulated domain specific and service oriented IoT gateway architectures. In [13], performed the comparative study about the different IoT architectures. Authors also focus on the IoT gateway architectures. They showed comparative study based on CISCO IoT architecture, IBM architecture, and INTEL architecture. Three layer IoT architecture is not enough for practical applications. Zhonget al. [14] introduced a five layer architecture for better quality of applications.

III. POWER SAVING TECHNIQUES USED IN IoT GATEWAY

IoT devices can collect the data all the time. IoT gateway remain active all the time to manage these data. It increases the power consumption of gateway and reduce the system efficiency. Researches are curiously finding the solution for IoT devices power consumption issues. Naveen et al. [15] developed quick sleeping technique in DRX mechanism to improve the efficiency of IoT devices. Fowler et al. [16] utilized extended DRX mechanism to reduce the power consumption of edge devices. It is also important to save the battery life of gateway. Mixed Integer Linear Programming (MILP) model can design an energy efficient IoT networks [17]. The IoT network contains four layers. The gateway is located in the networking layer. The proposed system can save power up to 36%. Internet of Mobile Things (IoMT) is the new paradigm of IoT, due to its mobility, it requires more accurate solution in all the aspects. Tcarenko et al.[18] implemented a hardware platform with Fog layer facilities. Building Energy Management System (BEMS) is one of the promising application of IoT. It can handle other applications also. Authors in [19] proposed a multiple gateway system to handle large data transmissions in the network. This multiple gateway can reduce the network power consumption and data delay. In [20], formulated proactive scheduling scheme for the IoT gateway. The proposed algorithm is tested by real time devices. This scheduling scheme effectively save the energy in IoT network. Moreover research work mainly focuses on the IoT with LTE/LTE-A network services. Saxenaet al. [21] developed a fifth generationgateway with efficient compression schemes. This gateway improves the resource utilization. Table I shows the different power saving techniques of IoT gateway and their results.

CONCLUSION

In this paper we have presented on IoT gateway power saving techniques. First, we have presented the idea of IoT and IoT gateway architecture. Second, we discussed various power saving techniques of IoT gateway.

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