Scientific Journal of Impact Factor (SJIF): 5.71
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 05, May -2018

IOT NETWORK ARCHITECTURE AND PACKETPROCESSING IN IOT DEVICES

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Abstract: *In the Internet of Things [IOT], data blocks are packetized from different variety of sensors by IOT devices, which are located different regions and data is transferred across different networks. By 2020 several hundredbillions of IOT devices are going to be connected, so packetized schemes should be optimized, and even though transmission capacity and processing power of network equipment is enhanced. This paper proposes packetized scheme for IoT devices, which uses ZigBee. ZigBee is an open global standard to address the unique need of low-power,low-cost wereless IoT network. In the proposed scheme data gathered from the sensors are aggregated and bundled into a packet. The performance of these schemes is discussed and their implementation in a prototype system is described to demonstrate their validity.*

Key terms*: IOT, ZigBee, Area Network, IoT device, Gateway, Packet processing.*

I. Introduction

Internet of Things [IOT] is one of the existing area of research. It is estimated that by the end of the 2020 several billions of IOT devices are going to be connected [1]. Internet of Things is the network of physical devices like electronic gadgets, vehicles, home appliances and the things which are embedded with sensors, actuators, electronics, software and the devices which enables the connectivity and helps to communicate among those devices. Each thing may be identified in a unique way in its embedded computing system. But it should has the ability to interoperate within the existing internet infrastructure. These IOT devices improves the accuracy, efficiency by reducing the human intervention. The IoT objects sensed and controlled remotely across existing network infrastructure, which intern creates an opportunity for the integration of physical world into computer based system. By this integration smart grids, smart homes, smart cities, intelligent transportation and virtual power plants can be achieved.

In the Internet of Things, Things are referred to a wide range of devices like automobiles which are built with sensors, heat monitoring implants, humidity monitoring in the agricultural fields, biochip transponders on farm animals, rodent monitoring devices in the store house, in field operation devices which help in search and rescue operations. Legal scholars suggested that “Things” as an inextricable mixture of hardware, software, data, and service. The vision of IoT is to make an information system infrastructure for implementing smart connected objects together.

Over the years many wireless and wired broadband communication technologies have been reserved and developed like 5G mobile systems in access networks and 10Gbits/s Ethernet-based passive optical network. Communication devices like Gateways and routers has been enhanced by increasing in CPU processing power, so that in addition to transmission capacity of broadband technologies, performance of these communication devices also increased.
One of the challenges in the large number of IoT devices is needed for reduction in number of packets for IoT communication at the network edges to mitigate packet processing load.
In this paper, we proposed about packet processing schemes which are based on data aggregation and addressing this issue at the network edges having many sensors.

The effectiveness of the proposed schemes is discussed for the case where ZigBee is used in IoT area networks. ZigBee is a low data rate, low power and close proximity wireless ad hoc networks. ZigBee is an IEEE 802.15.4 based specification for a suite of high-level communication protocols used to create personal area networks with small, low power digital radios such as medical device data collection , home automation and other low-power , low-bandwidth needs designed for small scale projects which need wireless connection. And this paper also includes prototype systems that can connect several sensors are introduced and the proposed schemes are validated using these prototype schemes.

II. Configuration of Network

The configuration of IoT network includes devices , which is shown in the below figure 1; see [2]and [3].

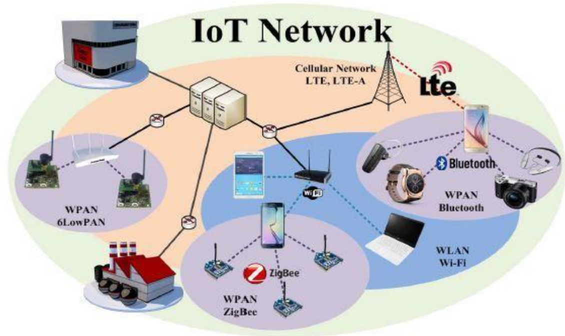

Figure 1. IoT Network

Simplified block diagram of basic building block of IoT is shown in the figure 2. In this IoT devices accommodate many sensors and those sensors are associated with the IoT area networks that assembles the packet containing signals from these sensors.

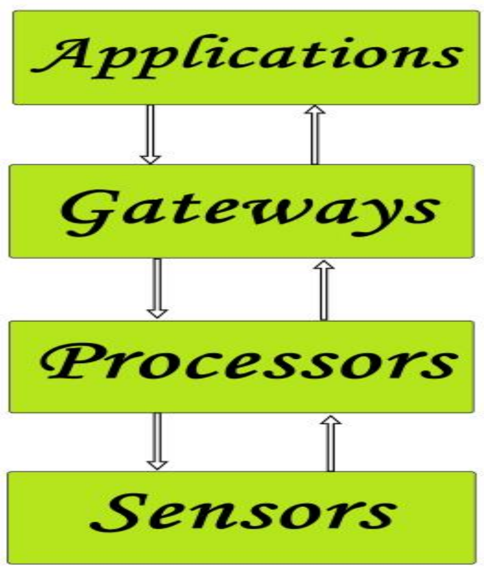

Figure 2. Basic building block of the IoT.

The data chunks collected by these sensors are processed by the processor and transferred to gateways over the IoT area networks, which are configured using several transmission technologies of which majority are wireless network technologies. Some of the technologies which rule in IoT network are wireless Personal Area network [WPAN]. This WPAN includes network like ZigBee, Bluetooth, and Ipv6 over low power wireless personal Area Network etc.

On a slightly larger wireless network area scale, WLAN (Wireless Local Area Network) which includes Wi-Fi is to be used. On a larger scale, the mobile communication technologies like 2G, 3G,4G, LTE remains. Smartphones and mobile communication system will be used and they will connect to the base stations and base stations will provide connectivity to the Wide Area Network (WAN) which is the Internet.

Considering this, we can think of many other options – Smartphones are equipped with Bluetooth and Wi-Fi, therefore we can think of an IoT network. The most common topology control is the WPAN which is Bluetooth or NFC (Near Field Communication). The WPAN are connected to a smartphone and the smartphone can bring the signal up through 3G, 4G, and LTE through the base station and the base station will connect that to the WAN.

ZigBee: Supported by the ZigBee Alliance

- Provides IEEE 802.15.4 higher layer protocols required for low powered radio system.
- IEEE 802.15.4 defines the physical and MAC layers.

- ZigBee provides the application and network layer protocols.
- ZigBee works well in isolated network environments.

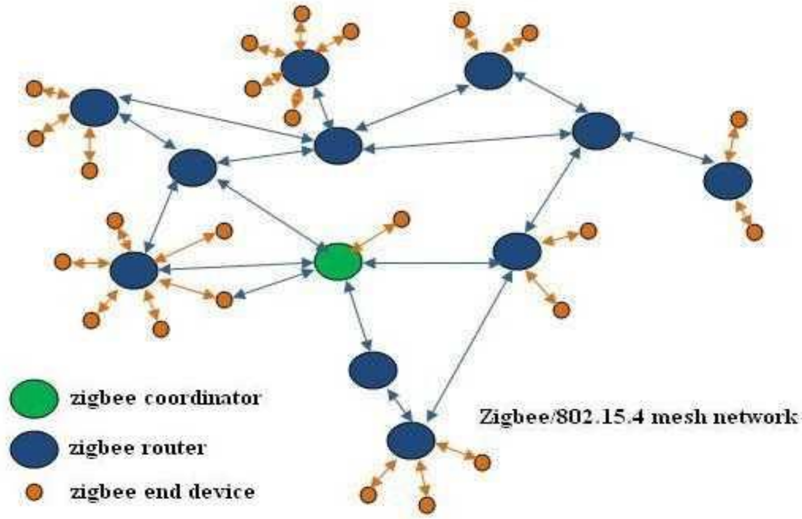

Figure 3. ZigBee Network

ZigBee network is made up of Coordinator (C) which is required to establish a network connection. 'C' establishes PAN, router (R) which provide the network connection to the end devices and End Device (E) which are the IoT devices connected to the network.

III. Schemes Proposed For Packet Processing

Usually date blocks from a sensor are very small, when the block of data is packed into the service data unit of a packet, the size of the packet is small. As a consequence of this protocol overhead has a major impact on the communication capacity [4].

To reduce this problem, two packet processing schemes are proposed based on the aggregation of data blocks, this reduces the number of packets which is required for communication products.

Problems like we are unable to use widely adopted technologies for web like Hyper Text Transfer Protocol [HTTP]. As this protocol creates large message which consumes a large amount of power, so there is a strong need for new technologies that enable communications for such resource constrained equipment. The Constraint Application Protocol [CoAP] is one such light weight communication technology.

One of the major aspect of CoAP is reducing the message size by that consumption of power can be reduced during the communication. Smaller the message size shorter the communication duration, so that it is possible to extend the battery life of the resource constrained devices like sensors, smart meters and actuators.

A. Packet Aggregations for IoT

Sensors and smart meters are typical IoT devices that have limited battery capacity and processing capabilities. When we use these devices for IoT communication, we need to minimize packet size and number of transactions. Therefore, lightweight communication protocols such as 6LoWPAN-HC [3] and CoAP [2] are used. These protocols generate short packets compared to those of HTTP, which adopts a generally very long text message for its payload. On the other hand, the CoAP uses binary encoding for its payload for conveying control messages for devices with poor resources. This dramatically reduces packet size. The CoAP has a fixed 4-byte header. Other fields are nonmandatory options so that the minimum packet size is only 4 bytes; this results in very small header overhead. The CoAP architecture consists of clients, servers, and proxies. A client sends requests for data retrieval, renewal, and removal. A server responds to a message from a client, and a proxy relays the CoAP messages. With 6LoWPAN-HC, the IP header is compressed in accordance with IEEE 802.15.4 [4]. This enables a lightweight protocol that adapts to the IEEE802.15.4 frame with 127 bytes. In order to reduce the number of transactions, aggregation techniques have been investigated [5], [6]. They combine individual packets and send a single packet rather than individual packets as they are. Merging multiple packets increases the effectiveness of packet processing, reduces power consumption, and reduces bandwidth usage.

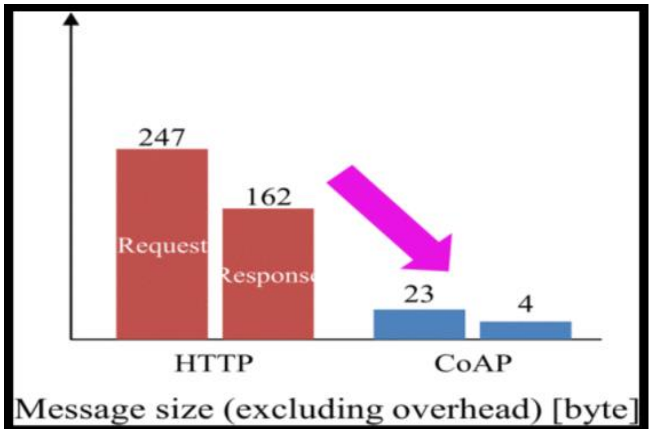

Figure 4 Comparison of message size between HTTP and COAP.

A. Existing Aggregation Techniques for IoT

In this subsection, we give a brief overview of current aggregation techniques in local area sensor networks. There have been several studies on aggregation in such networks. We studied a case in which multiple sensor devices form a multi-hop tree structure network toward a single destination sink node. When an intermediate sensor node receives successive packets from its leaf sensor nodes, it aggregates the multiple packets to a single packet and transmits it to its parent node. The parent node repeats the same process (Figure 5).

When the intermediate sensor node receives data from multiple leaf sensor devices, it performs certain operations and transmits the result to the parent node. Example operations are summation or taking the average of multiple data. These operations create new data, and the node transfers the data to its next hop parent node. By repeating these operations from the beginning of the leaf to the root sink node, we can dramatically reduce the amount of data, reduce power consumption for communication, and efficiently use the restricted bandwidth.

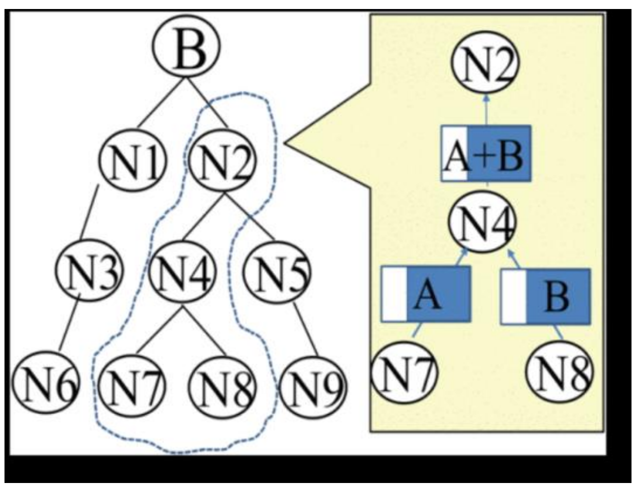

Figure 5 Packet aggregation in local area sensor network

B. Issues of Aggregation in Wide Area Network

Issues of power consumption and processing load are not limited to resource-constrained devices. These issues also apply to entities constituting a wide area network where various local networks for different types of devices are inter-connected. The above-mentioned aggregation technique is, however, only applicable for a specific sensor network. A fixed type of data, such as temperature or power usage, is assumed so that it can add or take the average for those data. If we allow various types of data, devices, and interconnects of a large number of such devices, the above technique incurs difficulties. A wide area network, such as the Internet, has such characteristics and also must handle various communication patterns and routing paths. For example, the above technique only takes into account one-way aggregation. If we want to aggregate packets at some part of a wide area network but do not want to for some other parts, we cannot differentiate both cases if we use the above technique. Another problem is that for a local sensor network, we can assume a unique single destination. Sensors usually send data to a single sink in a local network. We then can assume that the final destination can perform some complicated processes on the aggregated data. This means we only need a simple operation for intermediate nodes. On the other hand, a wide area network has nodes with different capabilities. We cannot assume a single destination node for the Internet. Therefore, if we perform a specific operation in a node, it affects the overall network and negatively affects a large amount of data flowing through the Internet. Furthermore, in a local network, irreversible operation is an option. For example, if we only need the average value of an area, we can aggregate sensor data by taking their average. For a wide area network, we usually do not assume that a network changes the data content. Therefore, we cannot adopt such irreversible operation for a wide area network.

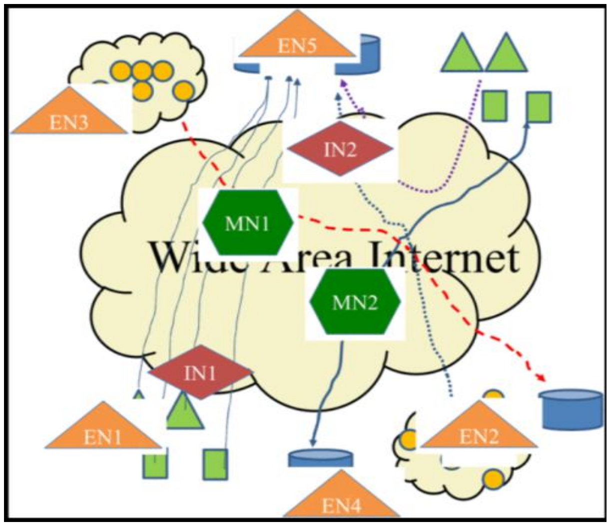

Figure 6. Wide area network supporting IOT.

Conclusion

This paper discussed packet processing in IoT devices at the edges of IoT networks. Schemes were proposed to mitigate the number of transmission packets in IoT devices.

We proposed a packet aggregation scheme and described the requirements and an implementation for applying it to a wide area network. With our proposed aggregation scheme, we can reduce the burden on the core network in the wide area Internet due to the huge amount of short packets.

From the architectural viewpoint, our scheme creates overlay networks. We anticipate the emergence of a huge number of IoT devices connecting to the Internet. By constructing overlay networks, we not only can reduce the packet processing load in a router but also create a logical network over the Internet. We can define this logical network based on the types of information created by devices. Different types of information have different requirements for network performance, such as delay and loss. If we can aggregate appropriately, we can create multiple logical networks with different characteristics. If we further extend the logical network to implement the meaning of sensor information, we can achieve networking based on the meaning or value of information [8].

We implemented our proposed scheme by extending CoAP as a type of transport layer. Future work includes considering the appropriate layers for our scheme from the viewpoint of logical networking by using aggregation.

References

[1] Ministry of Internal Affairs and Communication, Panan, “White paper 2016: Information and Communication”, 2016
[2] T. Yokotani, “Tutorial: M2M/IoT Technical Overview and its Standardization”, APNOMS 2016, 2016
[3] T. Fujita, Y. Goto, A. Koike, “M2M Architecture trend and technical issues” The Journal of Institute of Electronics, Information and Communication Engineer, Vol.96, No.3, pp.305- 312, 2013
[4] T. Yokotani, Y. Sasaki, “Transfer Protocols of Tiny Data Blocks in IoT and their Performance Evaluation”, IEEE WF-IoT 2016 Paper No. 1570294002, 2016
[5] D. Malak, H. Dhillon, J. Andrews, “Optimizing Data Aggregation for Uplink Machine-to-Machine Communication Networks”, IEEE Transactions on Communications, Vol. 64, No. 3, pp.1274 - 1290, 2016
[6] T. Shiobara, P. Palensky, H. Nishi, “Effective metering data aggregation for smart grid communication infrastructure”, IECON 2015, pp. 002136 – 002141, 2015
[7] A. Sawabe, K. Tsukamoto, Y. Oie, “QoS-aware packet chunking method for multimedia communications”, IEICE Technical report, NS2013-124, pp.49-54, 2013
[8] ZigBee Alliance, “ZigBee Specification”, 2008

