IoT Adaptation Layer Network Protocol Based on 6loWPAN

Yijun Wang[a,*], Kai Gao, Yulin Gong

School of Electronic & Information Engineering, Changchun University of Science and Technology, Changchun 130022, China

[a]wyjs-107@163.com

Abstract. The three-layer network protocol architecture aimed to Internet of Things is proposed on the basis of 6loWPAN, and the M/I layer as the key of the protocol architecture implement the integration between WSN and Internet of Things. Firstly M/I layer implement periodic listen / dormant mechanism. After receiving an activation event signal, a node turn into listen and get ready for sending data frame. Simultaneously M/I layer carry out unslotted CSMA/CA protocol in condition; secondly M/I layer implemented EHC scheme which could compress IPv6 global address header, and a IPv6 address auto configuration method that use EUI-64 is put forward in M/I layer. The analysis on simulation result indicates that three-layer network architecture which is fit for large-scale Internet of Things application may save the network energy consumption and may improve the system throughput.

Keywords: 6LoWPAN; Network Protocol; WSNs; Internet of Things.

1. Introduction

The Internet of Things (IoT) supports two main ideas. Internet is the core and foundation of IoT, and everything could communicate with each other. Therefore, Internet and WSNs (Wireless Sensors Networks) become core technology in the IoT.

One of the problems that IoT need to solve is the integration between Internet and WSNs. For designing matched network architecture, it must choose a suitable network protocol [4]. IEEE 802.15.4 is the short-distance wireless network communication standard. IPv6 is the dominant technology in the next generation Internet network layer, and it has great advantages in address space, packet format, and security. 6LoWPAN (IPv6 over Low power Wireless Personal Area Networks) defines how to carry IPv6 packets over IEEE 802.15.4 low power networks. Due to 6LoWPAN, it is possible that integrate WSN protocol into IOT protocol. As shown in Figure 2, IOT protocol architecture based on 6LoWPAN include three layers. This paper is focused on that design of M/I layer which embed IPv6 into IEEE 802.15.4. M/I layer is shown in Fig. 1.

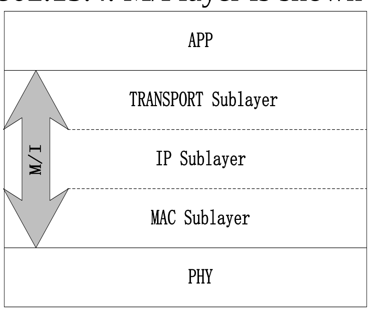

Fig. 1 IoT M/I layer protocol architecture

2. Analysis of 6LoWPAN

The data units on the Internet are transmitted by packets, so the IP packets become the data of MAC (Medium Access Control) frame when it is sent to MAC layer. But MAC protocol requires maximum length of data portion of the frame------- MTU (Maximum Transfer Unit). Moreover, starting from a maximum physical layer packet size of 127 octets and a maximum frame overhead of

25, the resultant maximum frame size at the MAC layer is 102 octets. If starting Link-layer security, it imposes further overhead. This is obviously far below the minimum IPv6 packet size of 1280 octets. Thus, IEEE 802.15.4 MAC frame cannot encapsulate whole IPv6 packet [5].

3. Design for M/I Layer

This paper define and design the M/I layer for satisfying the characteristics of the future IoT, the access requirements of WSN and Internet based on the 6LoWPAN[6]. M/I layer provides an easy, flexible, unlink and best-effort delivered datagram service up to the application layer; while it completes control to the network topology, network routing and network building with no need to consider how the physical layer to realize a bit transmission in details. This section will introduce M/I layer's MAC sublayer design philosophy, IP sublayer solutions, and routing policies in detailed.

3.1 MAC Sublayer

Link frame header fragmentation is used for the fragmentation and reassembly of link MAC packet. If the payload submitted by IP sublayer protocol is larger than that of MAC sublayer MTU, the source node will split the payload, and needs to use the fragment header to provide reassembly information. The first and the subsequent fragmentation header structures are shown as Fig.2 and Fig.3.

0 4	5 15	16 31
1 1 0 0 0	datagram_size	datagram_tag

Fig. 2 First Fragment

0 4	5 7 15	16 31
1 1 1 0 0	datagram_size	datagram_tag
datagram_offset		

Fig. 3 Subsequent Fragments

3.2 IP Sublayer

As mentioned previously, the IEEE 802.15.4 communications protocol stipulated 127 bytes for the maximum length of the link frame. While the basic header length of IPv6 is 40 bytes, which brings greater cost pressure to link frame MTU. The design principles of IPv6 header is to reduce the overhead to the lowest, therefore, a header compression strategy must be adopted to compress useless header information and to improve the link data frame transmission efficiency.

RFC4944[7] presents a header compression scheme of HC1, but it can only carry out header compression against local link addresses, which loses the compression function for global addresses. According to this purpose, the paper proposed a wider-applied header file compression scheme-EHC (Extensive Header Compression) based on HC1 scheme. Shown as figure 8, EHC structure is divided into compression area and non-compression area, and the field meaning of the compression area in detailed is shown as Fig.4:

0 4	5 6	7	8 9	10	11 12	13 14	15	16 31
0 1 1 0 1	TF	G/L	SA	M	DA	NH	X	Fields carried in-line follow...
Compressed fields								**Non-Compressed fields**

Fig. 4 EHC Header Compression Scheme

4. Stimulation Experiment

We set 20 sensor nodes and a beacon node in an area of 40m×40m to certify the effectiveness of the network protocol. By setting simulation parameters, the experiment carries a system simulation to IPv6 header compression scheme EHC of IP sublayer at first, and compares with the data payload that is not compressed in system throughput. Figure 5 shows the average system throughput under the two cases along with the increasing data payload. From the Figure 5, compared with the data payload that has not been compressed, the data payload that has been compressed by EHC has improved about 30% in throughput, which is the important advantage of this protocol.

Secondly, the experiment testifies the reliability of the M/I protocol from the perspective of energy consumption. From Fig. 6, the energy consumption increases linearly as the increase of data payload bytes, but it is always maintained at the level of 0.1mJ. Even though transmission payload achieves maximum bytes for 127, the energy consumption still remains within the 1mJ; while the typical communication protocol needs to consume several millijoules in variety when it transmits one byte. Therefore, the improved light network protocol reduces the energy consumption, which lays the foundation for Large-scale popularization of the Internet of Things.

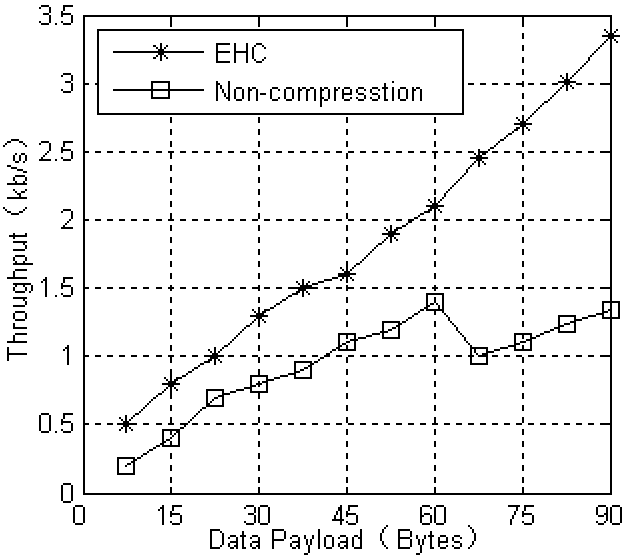

Fig. 5 EHC Scheme

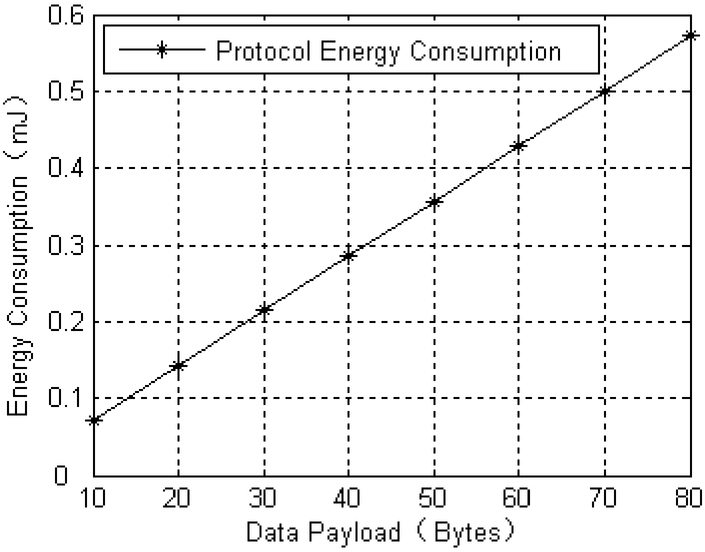

Fig. 6 Network Protocol Energy Analyses

5. Conclusion

On the basis of analyzing the problems for 6LoWPAN that develop future IOT, the paper proposes the three-layer network protocol architecture which is the same with IOT: Application layer, M / I layer and Physical layer. By researching on M/I layer, the paper proposes MAC sublayer protocol solution and link frame header fragmentation method, IP sublayer header compression scheme. Simulation results show the network protocol fits for large-scale popularization of the Internet of Things. However, there are many uncertainties for large-scale popularization of the Internet of Things, and many technical aspects that need to be broken through [8]. Therefore, we plan to perform further experiments in WSN time synchronization and Ubiquitous Network Protocol.

References

[1] X. Wang, Z.H. Qian, Z.C. Hu: Research on RFID anti-collision algorithms based on binary tree, Journal on Communications, Vol. 31 (2010), No.6, p.49-57.

[2] Y.J. Wang, Z.H. Qian, D.Y. Sun, C. Zhou: A Cellular Automata Model for Wireless Sensor Networks[C]. ICONS 2012: The Seventh International Conference on Systems, Saint Gilles, Reunion Island, Feb 29-Mar 5, 2012, p.169-174.

[3] J. Yang, M. Xu, W. Zhao and B.G. Xu: "A Multipath Routing Protocol Based on Clustering and Ant Colony Optimization for Wireless Sensor Networks", Sensor, Vol. 10 (2010), No.5, p. 4521-4540.

[4] Q. Liu, X.H. Huang, S.P. Leng: Deployment strategy of wireless sensor networks for Internet of Things[J], China Communications, Vol.8 (2011), No.8, p.111-120.

[5] Viani F, Rocca P, Oliveri G, et al: Localization, tracking, and imaging of targets in wireless sensor networks: an invited review. Radio Science, Vol.46 (2011) No.5.

[6] Emeka E E, Abraham O F: A survey of system architecture requirements for health care-based wireless sensor networks. Sensors, Vol.11 (2011), No.5, p.4875-4898.

[7] G Montenegro, N Kushalnagar, J. Hui: Transmission of IPv6 Packets over IEEE802.15.4 Networks. IETF RFC 4944, Sept. 2007.

[8] Z.H. Qian, Y.J. Wang: Internet of Things-oriented Wireless Sensor Networks Review, Journal of Electronics & Information Technology, Vol. 35 (2013), No.1, p.215-227.