ISSN:2321-1156
International Journal of Innovative Research in Technology & Science(IJIRTS)

THE P-PERSISTENT CSMA WITH THE FUNCTION OF MONITORING BASED ON TIME DIVISION MECHANISM

Yifan Zhao, Yunnan University, Kunming, Yunnan, China; Shengjie Zhou, Yunnan University, Kunming, Yunnan, China; Hongwei Ding, Corresponding Author, Yunnan University, Kunming, Yunnan, China; Qianlin Liu, Yunnan University, Kunming, Yunnan, China; Zhijun Yang, Yunnan University, Kunming, Yunnan, China; Chunfen Li, Yunnan University, Kunming, Yunnan, China.

Abstract

In the coming years, Internet of Things (IoT) is the rapid development of China-related industries as well as the application. IoT as the representative of the information network industry has become one of the seven emerging strategic industries, promoting industrial upgrading, towards the information society “launch machine”. This paper introduces P-persistent probability CSMA with the function of monitoring based on time division mechanism, its basic principle is that the channel is the continuous clock manner during channel is idle; the channel is the slot time manner during channel is busy. By the adding of function of monitoring, we make the transfer of information more securable, enhancing the performance of the system. By modeling analysis, the P-persistent probability can control the protocol throughput and the analytical results and simulation results show that the theoretical analysis and simulation experiments are consistent.

Introduction

The Internet of Things (IoT) have now become the darling of the times, this word so full of IoT to our attention, a lot of search results will appear in the site when entering any of IoT. There are a variety of things the site and a variety of Internet of Things conference. There are a variety of networking applications and all kinds of IoT of research and investment [1]. There are a lot of things applications too. In short, things are quietly walk into every aspect of our lives and production. Some applications of IoT is showed as Figure 1.

IoT’s value is to make objects have “wisdom” in order to achieve communication objects, things between things, characterized by perception of things, interconnected and intelligent stack [2]. Thus, IoT composed of three parts: the perception part, that two-dimensional code, RFID, sensor-based, to achieve recognition of the “substance”; transmission network through the existing Internet, radio and television networks, communication networks, etc. to achieve transmission of data; intelligent processing, namely the use of cloud computing, data mining, middleware and other technology to achieve automatic control and intelligent materials management [3].

Figure 1. Some applications of IoT.

IoT is a hierarchical network. Generally, there are three levels, from bottom to top in turn can be divided into perception layer, network layer and application layer. Between the layers, there is not only one-way to transfer information, there are also interactive or control. In the transfer of information, the main object of the information, including the object identification code, object static information, dynamic information objects [4]. The key of IoT technology among the three levels involve very much and it is a typical interdisciplinary technology.

The Internet of Things will be the next one to promote the rapid development of the world, "the main productive forces", the physical world and the virtual world of convergence brought about by the Internet of Things is a better vision, it is the depth development of the information in human society [5].

In this paper, we introduce P-persistent probability CSMA with the function of monitoring based on time division mechanism, its basic principle is that the channel is the continuous clock manner during channel is idle; the channel is the slot time manner during channel is busy [6]. Last, by the adding of function of monitoring, we can make the transfer of information more securable, enhancing the performance of the system.

In the paper, we use the averaging cycle period conduct analytical and simulation experiment with the control strategy mentioned above.

The model

In the proposed protocol, there will be three random events:

1. U events: Event that information packets are sent successfully.
2. C events: Event that information packets collide with each other (the collision appears).
3. I events: Event that there is no information packets in the channel arrive, the channel is idle.

The model of P-persistent CSMA with the function of monitoring based on time division mechanism is showed as Figure 2.

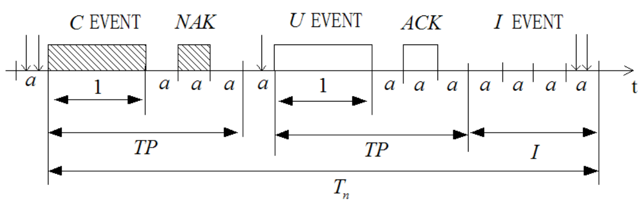

Figure 2. The model of P-persistent CSMA with the function of monitoring based on time division mechanism.

Upon sensing the channel is idle, at the beginning of the next slot, the nodes send the information packet with probability p, with probability (1-p) abandon send; when the packet idle period that is continuous clock arrives, sent at the same probability p, with probability (1-p) abandon sent [7].

Analysis of the model

Before analyze the system performance, first do the following assumptions:

1. The channel is ideal with no noise and interference;
2. The basic unit of the system control clock is a , the information packets arrived at time a will transmit at the starting time of the next slot [8];
3. The channel propagation delay is a , the packet length is unit length and is an integral multiple of a ;
4. The access method of channel is timeslot P-persistent CSMA protocol, and the arrival process of channel satisfy the Poisson process whose independent parameter is G [9];
5. The channel using the new protocol, the information packets need to be sent at the first slot in the transmission period can always detecting the state of the channel at last moment;
6. During the transmission of information packets, the phenomenon of packet collisions occur inevitably, and continues to be sent after a random time delay, it sends will not produce any adverse effects on the arrival process channel.

The arrival process of channel satisfies the Poisson process [10]:

$$P(n)=\frac{(aG)^n e^{-aG}}{n!} \tag{1}$$

In Equation (1), $P(n)$ is the event of n packets arriving during time of a.

First, solve the average length $E(U)$ of packet successfully sent in the event of U.

Packet successfully sent into the following two cases:

(1) If packets arrive during the last slot of idle period, namely packet arrives at the continuous clock control, and in the next slot time, no one but it adhere to send it, then it is sent successfully, the record for the event is U_1 .

The average length of U_1 is:

$$E(U_1)=E(N_U)\times 1=\frac{apGe^{-apG}}{1-e^{-apG}} \tag{2}$$

(2) If the packet arrives at the busy period, and the packet is the only packet adhere to sent at the current TP period, then the packet will be successfully transmitted within the next TP period, referred to as an event of U_2 .

At the transmission period, if there is no information packets to be sent, its possibility is:

$$q_0=\sum_{k=0}^{\infty}P(A_k)\times(1-p)^k=e^{-pG(1+3a)} \tag{3}$$

In the transmission period $(1+3a)$, if there is only one information packet to be sent, its possibility is:

$$q_1=\sum_{k=1}^{\infty}P(A_k)C_k^1 p(1-p)^{k-1}=pG(1+3a)e^{-pG(1+3a)} \tag{4}$$

In a cycle, the average length of information packets transmitted successfully at the U_2 is:

$$E(U_2)=\frac{q_1}{q_0}=pG(1+3a) \tag{5}$$

Then the average length $E(U)$ is:

$$E(U)=E(U_1)+E(U_2)=\frac{pGae^{-pGa}}{1-e^{-pGa}}+pG(1+3a) \tag{6}$$

Secondly, solve average length $E(B)$ during the busy period.

$$E(B)=E(N_B)(1+3a)=\frac{1}{q_0}(1+3a)=\frac{1+3a}{e^{-pG(1+3a)}} \tag{7}$$

Finally, solve average length $E(I)$ during the idle period.

Since the number of idle slots I within the geometric distribution with the mean: $E[N]=\frac{1}{1-e^{-Gpa}}$, an information packet arrive in a time slot with normalized probability: $p_{I1}=\frac{Gpae^{-Gpa}}{1-e^{-Gpa}}$, more than an information packet arrives in a time slot with the normalized probability: $p_{I2} = \frac{1 - Gpae^{-Gpa} - e^{-Gpa}}{1 - e^{-Gpa}}$.

Then we get:

$$E(I) = (\frac{1}{1-e^{-Gpa}} - 1)a + \frac{Gpa^2 e^{-Gpa}}{2(1-e^{-Gpa})} + \frac{(1 - Gpae^{-Gpa} - e^{-Gpa})a}{1-e^{-Gpa}} \quad (8)$$

The throughput of the new protocol is:

$$S = \frac{E(U)}{E(B)+E(I)} = \frac{\frac{pGae^{-pGa}}{1-e^{-pGa}} + pG(1+3a)}{\frac{1+3a}{e^{-pG(1+3a)}} + (\frac{1}{1-e^{-Gpa}} - 1)a + \frac{Gpa^2 e^{-Gpa}}{2(1-e^{-Gpa})} + \frac{(1-Gpae^{-Gpa} - e^{-Gpa})a}{1-e^{-Gpa}}} \quad (9)$$

Simulation

From the above analysis, the expression of the system throughput under the P-persistent CSMA with the function of monitoring based on time division mechanism is got. Based on the above analysis, with the use of simulation tool: MATLAB R2010a, the simulation results are shown as following. During the simulation, transmission delay time: $a = 0.01$.

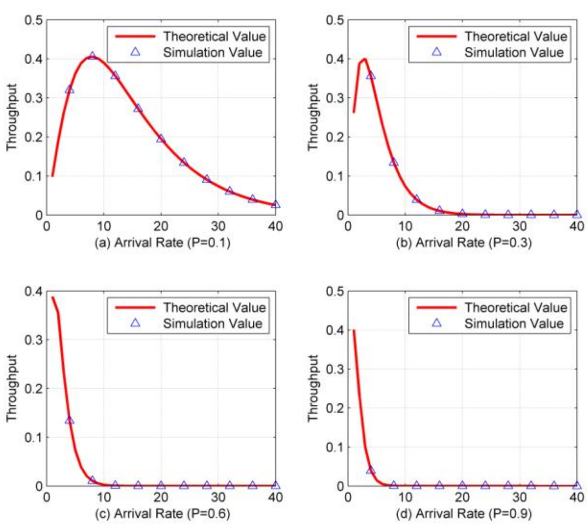

Figure 3. The throughput of the new protocol with different P.

We know from Figure 3, the system throughput is changed by selecting the different values of probability P.

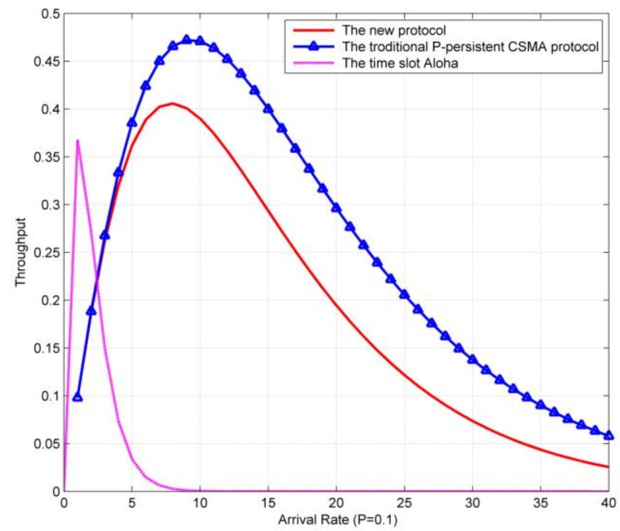

Figure 4. The throughput of the new protocol, the traditional P-persistent CSMA and the time slot Aloha.

From the Figure 4, the system throughput of the new protocol is lower than the traditional P-persistent protocol, higher than the time slot Aloha protocol. The system throughput of the new is lower than the traditional one because the ACK information takes up some information resource when transmitted. And with the ACK, we can make the information transmitted safer. Thus, we get more reliability than losing the little throughput.

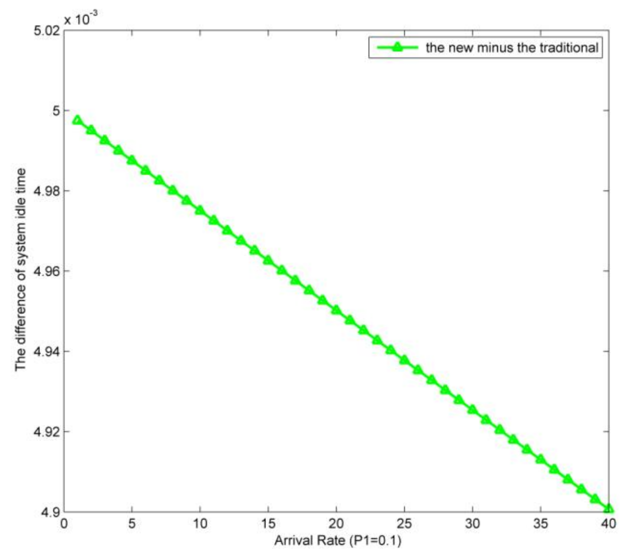

Figure 5. The difference of system idle time between the new protocol and the traditional one.

In the Figure 5, we can see that the system idle time under the new protocol is less than the one under the traditional protocol. Therefore the system channel resource is used more efficiently.

Conclusions

In following years, the Internet of Things is the rapid development of China-related industries as well as the application. IoT as the representative of the information network industry has become one of the seven emerging strategic industries, promoting industrial upgrading, towards the information society "launch machine". We introduces P-persistent probability CSMA with the function of monitoring based on time division mechanism, its basic principle is that the channel is the continuous clock manner during channel is idle; the channel is the slot time manner during channel is busy. By the adding of function of monitoring, we make the transfer of information more securable, enhancing the performance of the system. By modeling analysis, the P-persistent probability can control the protocol throughput and the analytical results and simulation results show that the theoretical analysis and simulation experiments are consistent.

Acknowledgments

This work was supported by the National Natural Science Foundation of China (61461053, 61461054, 61072079); Natural Science Foundation of Yunnan Province (2010CD023); The Financial Support of Yunnan University (No.XT412004).

References

[1] Zhao Dongfeng. Study on A New Method for Continuous-time Systems of Random Access Channel [J]. Journal of Electronics, 1999, 21(1): 37-41.

[2] Hongwei Ding, Yingying Guo, Yifan Zhao, Shengjie Zhou, and Qianlin Liu. Research on the Multi-Channel Probability Detection CSMA Protocol with Sensor Monitoring Function. Sensor Lett. 13, 143-146 (2015).

[3] Shengjie Zhou et al., Research on the Discrete time Three-Dimensional Probability Csma Protocol In ad-hoc Network. International Journal of Recent Scientific Research Vol. 6, Issue, 5, pp.4257-4262, June, 2015.

[4] Zhao Dongfeng, Li Bihai, Zheng Sumin. Study on a New Method for the Slotted Access Channel [J]. Journal of Electronics, 1997, 19(6):814-819.

[5] Yi Shang, Hongchi Shi. Flexible Energy Efficient Density Control on Wireless Sensor Networks[J]. International Journal of Distributed Sensor Networks, 2007, 3(1): 101-120.

[6] Liu Binbin. The Analysis of Multi-channel Random Multiple Access Wireless Communication Network Protocol based on Probability Detection [D]. Kunming: Yunnan University, 2006:55-59.

[7] Ma Zuchang. Sun Yining and Mei Tao, "Survey on Wireless Sensor Network"[J], Journal of China Institute of Communications,Vol.25, pp.114-124, No.4,2004.

[8] Huang Jiancheng. Xie Hai and Xu Bingzheng, "Random Prediction Tree Protocol Decomposing Collision Packets"[J], Journal of China Institute of Communications,Vol.3, pp.21,1983.

[9] Zhao Dongfeng, "Study on the Average Cycle Method for Slotted Multiple-Access Communications"[J], Journal of China Institute of Communications,Vol.20, pp.80-85, No.8,1999.

[10] Zhao Dongfeng, "Study on A New Method for the Slotted Access Channel"[J], Journal of Electronics,Vol.19, pp.814-819, No.6,1997.

SHENGJIE ZHOU received the Bachelor of Engineering degree from Yunnan University, Kunming, China, in 2011. Currently, from 2013 to 2015, he is a graduate student at Yunnan University, Kunming, Yunnan, China. His major field of research is random multiple access and its application in WSN. He has authored a paper: Research on the Discrete time Three-Dimensional Probability Csma Protocol In ad-hoc Network. International Journal of Recent Scientific Research Vol. 6, Issue, 5, pp.4257-4262, June, 2015. He has co-authored some papers: Research on the Multi-Channel Probability Detection CSMA Protocol with Sensor Monitoring Function. Sensor Lett. 13, 143-146 (2015). He may be reached at 814627093@qq.com

HONGWEI DING (CORRESPONDING AUTHOR) received the Bachelor of Engineering degree from Yunnan University, Kunming, China, in 2011. chaired or participated in the more than 20 projects. Among them, presided over 10 research projects, including the National Fund, the provincial fund, Department of Education funds, school funds and other six large projects in Yunnan, as well as four horizontal projects; members to participate in 10 major subjects of research. Among the 20 topics, there are national issues six

provincial fund, a Department of Education Fund, a fund of Yunnan University and horizontal project. Obtaining a Yunnan Natural Science Award, December 2013; published more than 100 papers, including the first author or corresponding author SCI, EI retrieval; access to software copyright registration of more than 20 items. Currently, his research interests include random multiple access system, polling multiple access systems and wireless sensor networks. He may be reached at dhw1964@163.com