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REVIEW ARTICLE

THE THREE-DIMENSIONAL PROBABILITY CSMA BASED ON DOUBLE CLOCKS MECHANISM

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ABSTRACT

IOT (Internet of Things, IoT) is predicted to continue another wave of science and technology and the global economy after the Internet information industry, by governments, businesses and academic attention, the United States, European Union, Japan, and even integrating them into national and regional information Strategy. As the Internet continues to rich business types, expand complex, from single to fusion, from a variety of access methods to the core network of the whole transition fusion. By applying the theory of double clocks control to the CSMA protocols, setting the probability of sending packet and the probability of sensing channel to improve system performance. Through modeling analysis, the proposed three-dimensional probability CSMA based on double clocks mechanism decrease the system idle time, making the channel resource highly use.

INTRODUCTION

IOT (Internet of Things, IoT) is predicted to continue another wave of science and technology and the global economy after the Internet information industry, by governments, businesses and academic attention, the United States, European Union, Japan, and even integrating them into national and regional information Strategy (Zhao Dongfeng, 1999).

Definition of things by ITU is: things was to achieve to object (Thing to Thing: T2T), person to object (Human to Thing: H2T) and person to person (Human to Human) interconnections. Interconnection refers here to persons and things, people use sensors and other equipment interconnected with the object, and the interconnection between people refers to people using sensing system instead of the current computer interconnects between people (Hongwei Ding *et al*., 2015). The core of Things is interconnected to achieve an object (including people) between, enabling information exchange and communication between the object and the object. After the object information is transmitted to the information processing center, services and applications can be achieved through a variety of information by the network (Shengjie Zhou *et al*., 2015). The primary role of Things is to reduce the distance between the physical world and information systems, it can be a radio frequency identification (RFID), sensors, global positioning systems, mobile phones and other devices, according to the agreed protocol, all the objects in the world are all connected the information network, making them active participants in the event handler, reflects the integration of physical space and information space (Zhao Dongfeng *et al*., 1997). These intelligent services and objects can interact through a network, access to any relevant information relating to these objects. As the Internet continues to rich business types, expand As the Internet continues to rich business types, expand the range of applications. Application requirements increasing, the network will pass the line from simple to complex, from single to fusion, from a variety of access methods to the core network of the whole transition fusion.

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Things following the PC, the Internet, wireless communications technology fourth IT revolution, have great scientific significance and application value. Things make that humans can rely on a more refined and dynamic management of production and life, to achieve "smart" state (Yi Shang *et al*., 2007), improve resource utilization and productivity levels, improve relations between man and nature. Things appear from the life, production, social, economic, political, military, technological and other aspects of the impact of human life and the world.

Wireless communication, wireless intelligent sensor networks, micro sensors, network communication, multimedia communication and wide band communication has been relatively mature, but not yet in-depth study of these technologies and the relationship between things, things to communications technology brings new problems. The key to ensure wireless sensor network communications media (MAC) protocol in wireless sensor network protocol just bottom part, for a fair and effective sharing of communication medium between the sensor nodes have a greater impact on the performance of the sensor network, is one network protocols. Performance of networks such as throughput, latency performance depends entirely on the dry MAC protocol used (Liu Binbin, 2006). Therefore, the design of a superior performance of MAC protocol algorithm has become a hot issue in research.

We proposed a three-dimensional probability CSMA based on double clocks mechanism, set the three probabilities to improves the controllability of the system, the channel utilization, system security, and reliability of packet transmission. Using the averaging cycle period conduct analytical and simulation experiment with the control strategy mentioned above. By modeling analysis, the analytical results and simulation results show that the theoretical analysis is consistent with the simulation experiments.

The Model

The model of three-dimensional probability CSMA protocol based on double clocks mechanism is showed as Fig. (**1**).

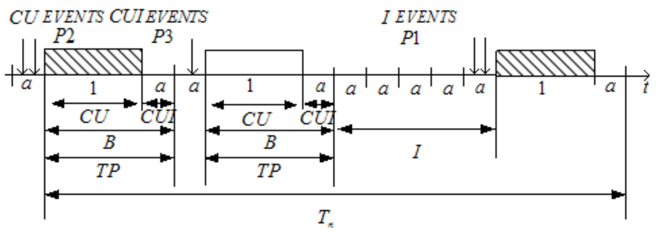

Fig. 1. The model of three-dimensional probability CSMA based on double clocks mechanism

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

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

Set the probability P_1 of sending packet at the I events, the probability P_2 of sensing channel during “1” of the TP time and the probability P_3 of sensing channel during “a” of the TP time.

Analysis of the system throughput

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

a. The channel is ideal with no noise and interference;
b. 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 (Ma Zuchang *et al*., 2004);
c. The channel propagation delay is a, the packet length is unit length and is an integral multiple of a;
d. The arrival process of channel satisfy the Poisson process whose independent parameter is G (Huang Jiancheng *et al*., 1983);
e. 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 (Zhao Dongfeng, 1999);
f. 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 (Zhao Dongfeng, 1997).

The arrival process of channel satisfies the Poisson process:

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

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:

$$E(U_1)=E(N_{U_1})\times 1=\frac{ap_1Ge^{-ap_1G}}{1-e^{-ap_1G}} \tag{2}$$

(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:

$$q_0=e^{-G(p_2+ap_3)} \tag{3}$$

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

$$q_1=G(p_2+ap_3)e^{-G(p_2+ap_3)} \tag{4}$$

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

$$E(U_2)=\frac{q_1}{q_0}=G(p_2+ap_3) \tag{5}$$

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

$$E(U)=E(U_1)+E(U_2)=\frac{p_1Gae^{-p_1Ga}}{1-e^{-p_1Ga}}+G(p_2+ap_3) \tag{6}$$

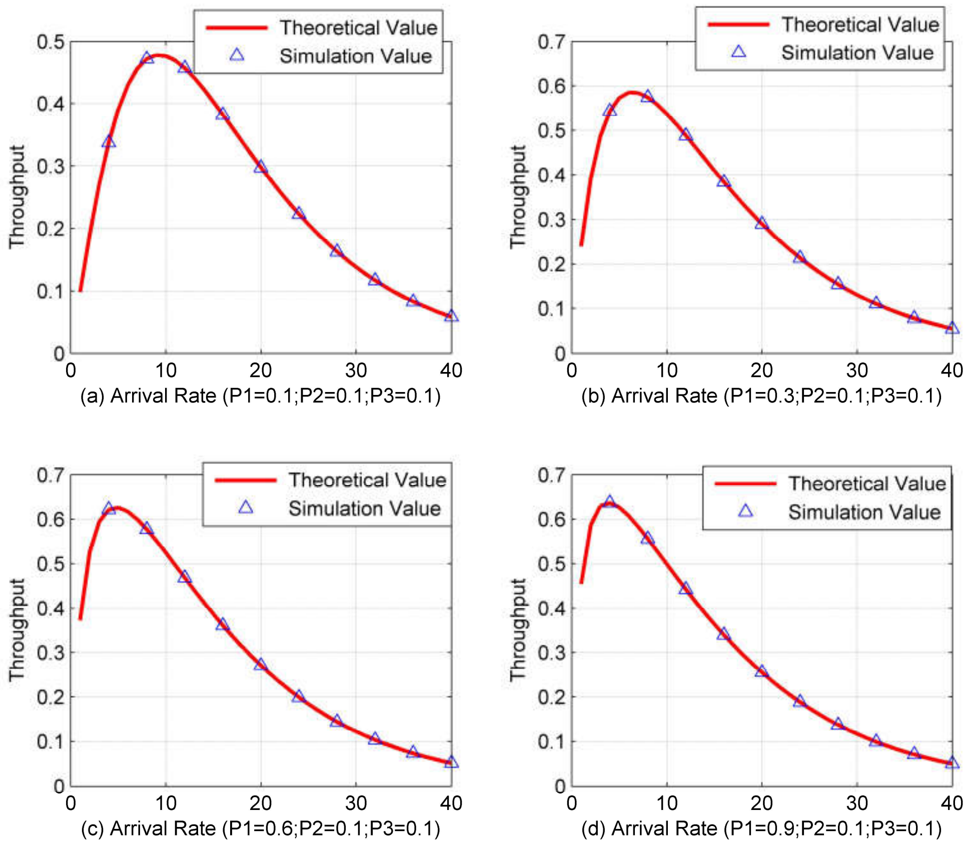

Fig. 2. The throughput of the new protocol with different P1

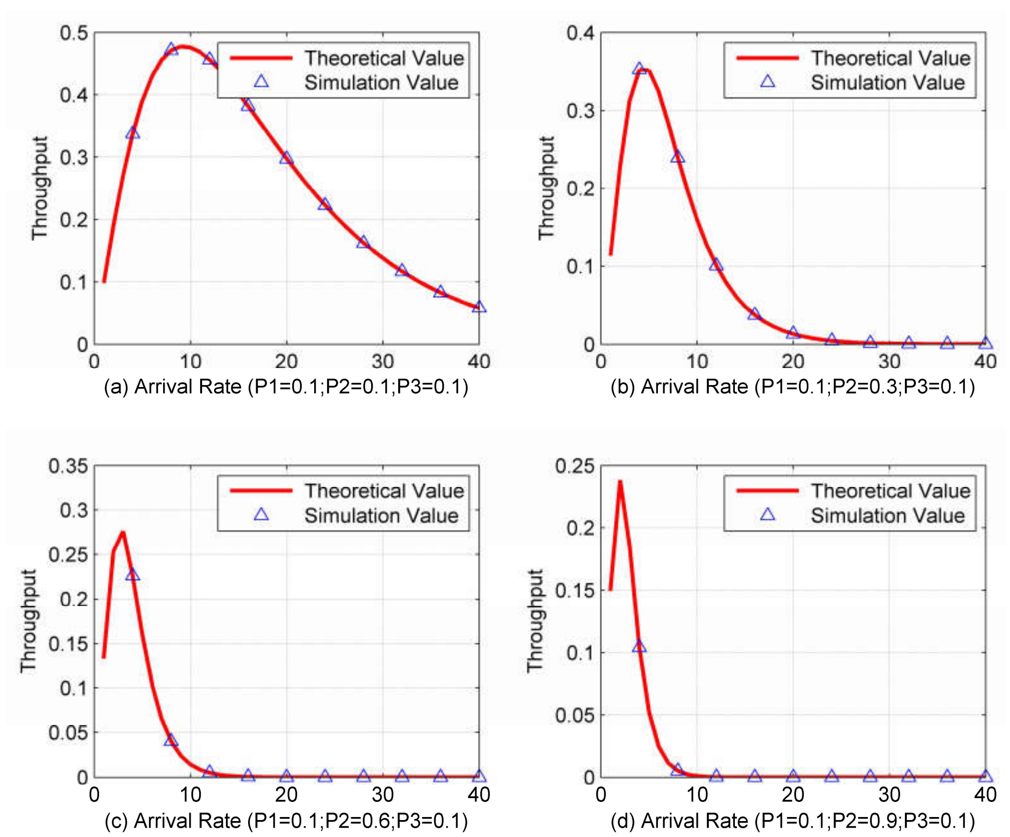

Fig. 3. The throughput of the new protocol with different P2

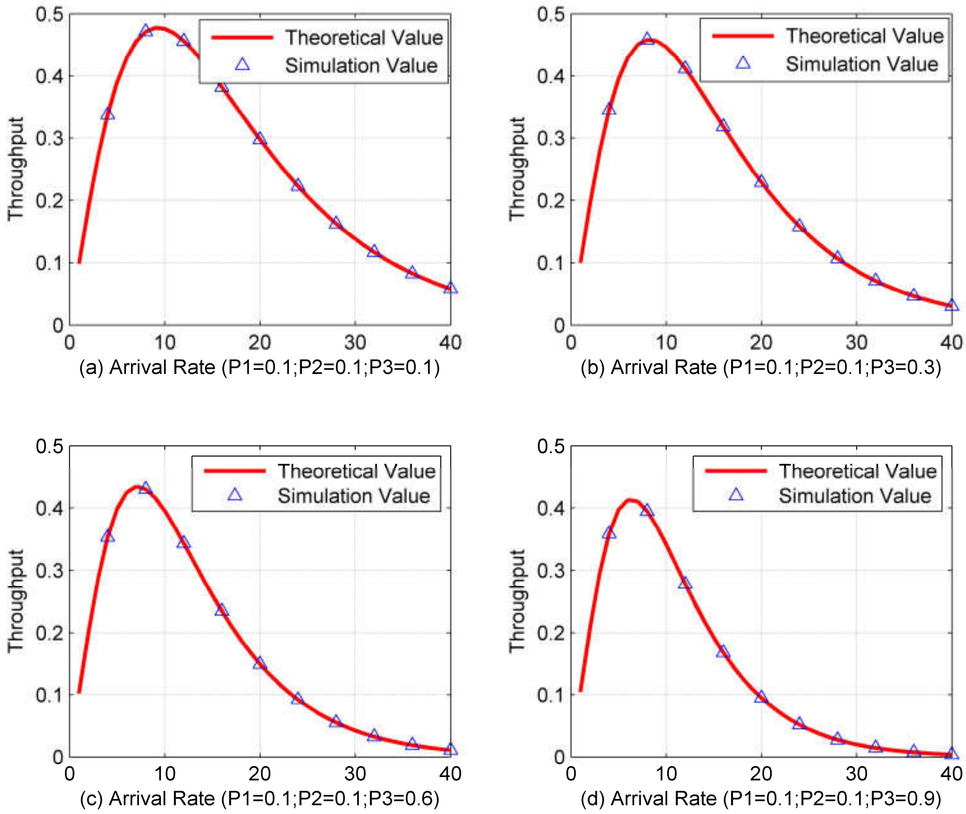

Fig. 4. The throughput of the new protocol with different P3

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

$$E(B)=E(N_B)(1+a)=\frac{1}{q_0}(1+a)=\frac{1+a}{e^{-G(p_2+ap_3)}} \tag{7}$$

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

Since the number of idle slots I within the geometric distribution with the mean: $E(N)=\frac{1}{1-e^{-Gp_1a}}$, an information packet arrive in a time slot with normalized probability: $p_{I1}=\frac{Gp_1ae^{-Gp_1a}}{1-e^{-Gp_1a}}$, more than an information packet arrives in a time slot with the normalized probability: $p_{I2}=\frac{1-Gp_1ae^{-Gp_1a}-e^{-Gp_1a}}{1-e^{-Gp_1a}}$.

Then we get:

$$E(I)=(\frac{1}{1-e^{-Gp_1a}}-1)a+\frac{Gp_1a^2e^{-Gp_1a}}{2(1-e^{-Gp_1a})}+\frac{(1-Gp_1ae^{-Gp_1a}-e^{-Gp_1a})a}{1-e^{-Gp_1a}} \tag{8}$$

Besides, we know that the average length $E(I^{'})$ during the idle period under the traditional three-dimensional probability is:

$$E(I^{'})=\frac{a}{1-e^{-Gp_1a}} \tag{9}$$

The throughput of the new protocol is:

$$\begin{aligned} S&=\frac{E(U)}{E(B)+E(I)}\\ &=[\frac{p_1Gae^{-p_1Ga}}{1-e^{-p_1Ga}}+G(p_2+ap_3)]\\ &/[\frac{1+a}{e^{-G(p_2+ap_3)}}+(\frac{1}{1-e^{-Gp_1a}}-1)a+\frac{Gp_1a^2e^{-Gp_1a}}{2(1-e^{-G_ip_1a})}\\ &+\frac{(1-Gp_1ae^{-Gp_1a}-e^{-Gp_1a})a}{1-e^{-Gp_1a}}] \end{aligned} \tag{10}$$

Simulation

From the above analysis, the expression of the system throughput under the double clocks three-dimensional probability CSMA with the functions of monitoring 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: $a=0.1$.

By the introduction of the three-dimensional probability CSMA, we are able to control the system throughput by change the probability of sending packet or the probability of sensing channel. Also we can change all of them at the same time too. So the new protocol can perform better than other protocols on the controllability. In Fig. (**2**) and Fig. (**4**), the simulation values of system throughput under the new protocol are consistent with the theoretical ones, verified the correctness of mathematical derivation done before.

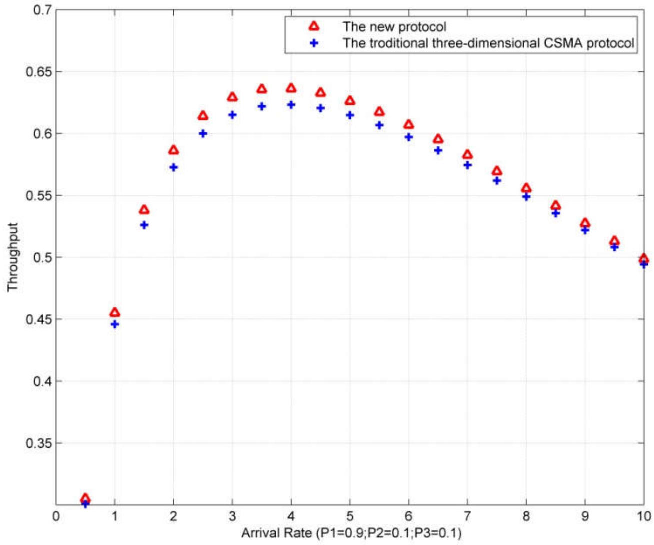

Fig. 5. The throughput of the new protocol and the traditional one

By the Fig. (**5**), we know the system throughput under the new protocol is higher than the traditional three-dimensional probability CSMA protocol.

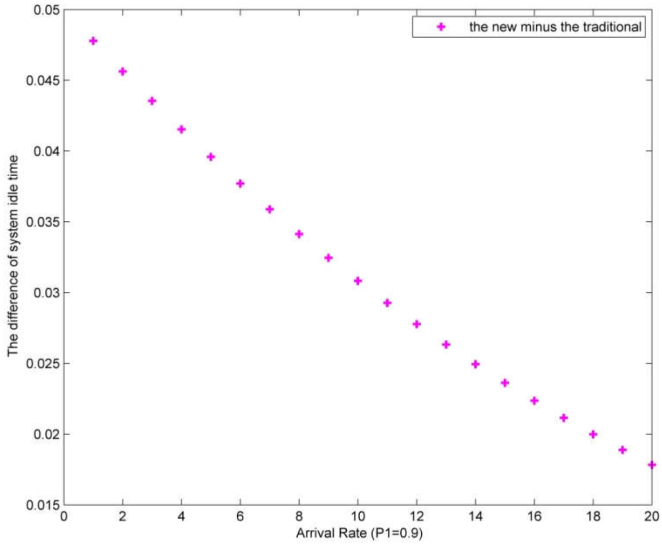

Fig. 6. The difference of system idle time between the new protocol and the traditional one

The introduction of double clocks is to lower the system idle time. In the Fig. (**6**), we know the system idle time under the new protocol is lower than the traditional three-dimensional probability CSMA protocol. And the channel resource is use more highly than the usually ones. Therefore the mechanism works effectively

Conclusions

IOT (Internet of Things, IoT) is predicted to continue another wave of science and technology and the global economy after the Internet information industry, by governments, businesses and academic attention, the United States, European Union, Japan, and even integrating them into national and regional information Strategy.

As the Internet continues to rich business types, expand complex, from single to fusion, from a variety of access methods to the core network of the whole transition fusion. By applying the theory of double clocks control to the CSMA protocols, setting the probability of sending packet and the probability of sensing channel to improve system performance. Through modeling analysis, the proposed three-dimensional probability CSMA based on double clocks mechanism decrease the system idle time, making the channel resource highly use. At last the analytical results and simulation results also show that the theoretical analyses are consistent with simulation experiments.

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