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Study on Exponential Back-off Mechanism for MAC Protocol

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***Abstract*—Mobile ad-hoc network have several advantages over the traditional wireless networks including ease of positioning, speed of formation and increased independence on a fixed infrastructure. It consist of mobile nodes that are move freely in an open environment. Communicating nodes in a Mobile Ad-hoc network uses to search to setup a communication. In the requirement of multihop traffic relay it's scalable to larger network. It is the main drawback in Mobile Ad-hoc network. The communicating nodes need help in order to reach the correspondent over one hop away from them. In order to decide the length of node suspension, a Back-off mechanism is established in the MAC (Medium Access Control) protocol. In this paper we have studied about the Exponential Binary Back-off Algorithm in MAC protocol. MAC protocol consists of two protocol that is MACA (Multiple Access Collision Avoidance) and MACAW (Medium Access Collision Avoidance For Wireless Network) protocol and how it is affected MAC layer protocol. Finally, We Simulate with the help of network simulator tool Omnet++ and then compare MACA & MACAW.**

***Keywords* - Ad-hoc network, Medium Access Control, Multiple Access Collision Avoidance, Wireless Network, back-off.**

I. INTRODUCTION

Mobile Ad-hoc network is a dynamic infrastuctureless approach. This is also known as MENETs. It is a collection of wireless node and dynamically exchange information without using any pre- existing fixed network infrastructure [1-5]. This type of networks is fully distributed at any place without the help of any pre-infrastructure. This property makes these networks highly flexible and robust. Such as in survivable, dynamic communication for emergency/rescue operation. In existing is mainly focuses on the external information such as network traffic load, transmission failure to other nodes in the network. Fig.1. Show the Mobile Ad-hoc Network.

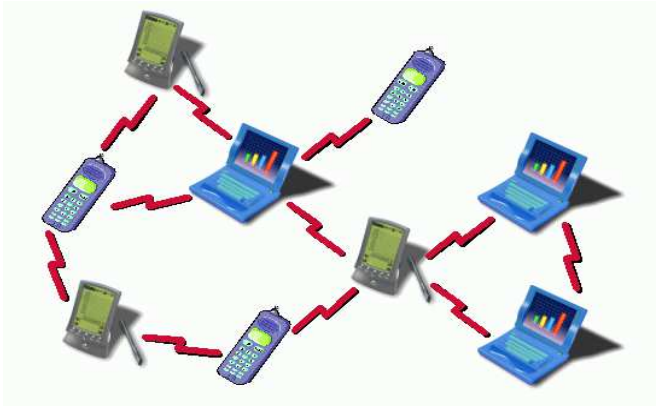

Fig.1 Mobile Ad-hoc Network

II. BINARY EXPONENTIAL BACK-OFF (BEB) APPROACH

In Binary Exponential Back-off algorithm we have seen that, it refers to an algorithm used to space out repeated retransmission of the same block of data. In this approach after c collision, a random number of slot times between 0 to 2c-1 is choosen. In the first collision, each sender will wait 0 or 1 slot times. After the third collision, the sender will wait anywhere from 0 to 1 slot times and so fourth. Retransmission mechanism increases the number of possibilities for delay increases exponentially. The "truncated" means that after a certain number of increases, exponential stops that is the transmission reaches the limit and does not increase further. For example, if the limit is set at i=5, then the maximum delay is 1023 slot times [4]. Because these delay occur possibilities collision at other station. For a given distribution of back-off times is the mean of the possibilities. After c collisions, the number of back-off slot is in [0, 1, 2, 3,.....,N] where $N=2^c-1$ and the expected back-off time is

$$\frac{1}{N+1}\sum_{i=0}^{N} i$$

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A. MACA (Multiple Access Collision Avoidance) Protocol

The Medium Access Control (MAC) sub- layer located in the lower Data Link layer in OSI reference model. The basic function of the medium access control is to arrange packet transmission fairly and efficiently among multiple stations that share the same channel. Wireless communications offers great mobility by allowing the users to get access to the networks anytime and anywhere. The often-fading and time-varying wireless links make the medium access control more complicated than in the wired networks. The related problems caused in the MAC protocol design is hidden/exposed terminals problems.

B. Problem Statement

1. Hidden terminal problems

Fig.2 show hidden terminal problem. Assume that node B is sending to the data node A. Node C also has data to send to node A. However, node C is out of B's range and transmission from node B cannot reach node C.

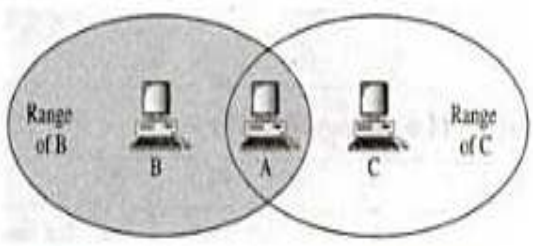

Fig.2 hidden terminal problem

Therefore node C thinks medium is free. Node C sends its data to node A, which result in a collision at node A because this node is receiving data from both node B and node C.

2. Exposed terminal problems

The Fig.3 show node A is transmitting to node B. Node C has some data to send to node D, which can be sent without interfering with the transmission from A; it hears what A is sending and thus refrains from sending.

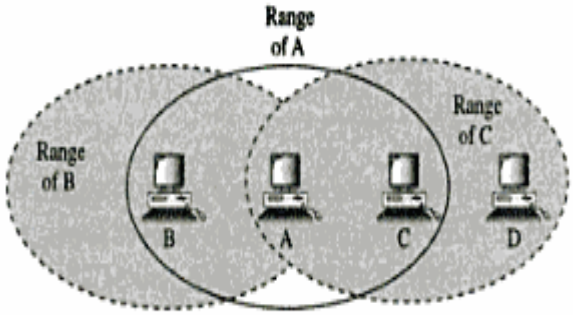

Fig.3. Exposed terminal problem

C. Proposed Solution

1. MACA avoids the Hidden terminal problems

The solution to the hidden station problem is the use of the handshake frames (RTS/CTS). The Fig.4 shows that the RTS message from node B reaches node A, but not node C. However, because both node B and node C are within the range of node A, the CTS message, Which contains the duration of data transmission from node B to node A reaches node C. Node C knows that some hidden node is using the channel and refrains from transmitting untill that duration is over [6-7].

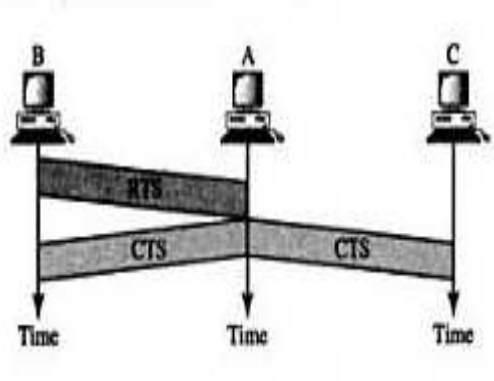

Fig.4 prevent hidden terminal problem

2. MACA also avoids Exposed terminal problems

Node C hears the RTS from node A, but does not hear the CTS from node B. Node C, after hearing the RTS from node A, can wait for a time so that the CTS from B reaches A; it then sends an RTS to node D to show that it needs to communicate with node D. Both node B and node A may hear this RTS, but node A is in the sending state, not the receiving state. Node B, however, responds with CTS. If node A has started sending its data, node C cannot hear the CTS from node D because of the collision; it cannot send its data to node D. It remains hide until a finishes sending its data as Fig. 5, shows Avoid exposed terminal problems [2].

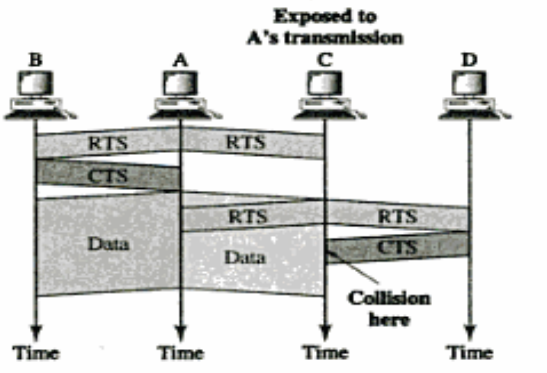

Fig.5. Avoid exposed terminal problems

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III. MACAW (Medium Access Collision Avoidance for Wireless Network) Protocol

MACAW protocol avoids the problem of MACA protocol. The sender senses the carrier to see and transmits a RTS (Request To Send) frame if no nearby station transmits a RTS. Then the receiver replies with a CTS (Clear to Send) frame. Neighbors see the CTS frame then keep quit until the CTS is back to the sender. The receiver sends an acknowledgement when receiving the frame.

A. Algorithm design & Flow chart of back-off mechanism

1. Back-off algorithm

Back off (BO) = [Rand () MOD Contention Window]* aSlotTime (1) ..... (i)

Back-off time (BO) new = (Back Off) old - a SlotTime (2) ..... (ii)

In above algorithm the node will be choosen a random time [2-3]. And equation (i) calculates the back- off time then put the old back-off in equation (ii), gets the new back-off time. Using CSMA medium is sensed at every time slot. If medium is found to be idle then back-off time is decremented by one time slot. The disadvantage of this algorithm is the problem of fairness. Due to this reason this algorithm is modified.

2. The modified logarithmic back-off algorithm

Step 0: set back-off to the initial value
Step 1: while back-off! = 0
For each time slot
If channel is idle Then
Back-off = back-off - 1
If channel is idle for more than IFS Then
Send
Else
Back-off = log (back-off) * back-off
Goto step 1
Stop

In the modified logarithmic back-off algorithm avoid the random back-off time and use the logarithmic back-off value. This algorithm gives the optimal solution.

3. Flow Chart of Back-off mechanism

The CSMA does not give the solution for a collision. Due to this reason CSMA/CD adds a function to handle a collision. To reduce the collision the second time node waits. Fig.6, show the process of back-off

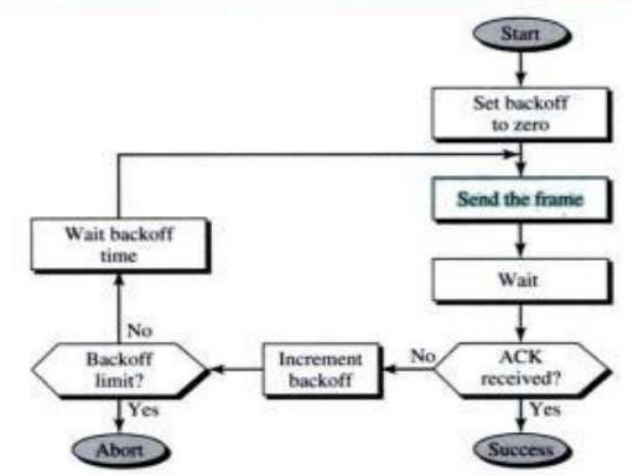

Fig.6 Flow Chart of Back-off mechanism Algorithm.

IV. SIMULATION RESULT

The simulation shows about collision between nodes and how, minimizes collision between nodes.

1. for collision between nodes

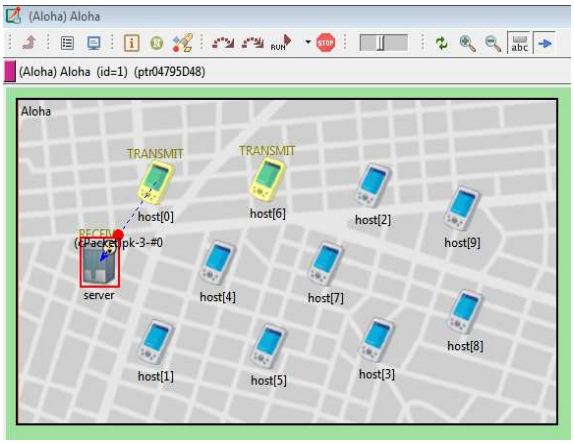

Fig.7. collision between nodes

Fig.7, show that one host send message to another nodes. In first step host senses the channel, if channel is idle then host sends the message. After receiving message server indicate the signal. Due to transmission delay, collision has occurred and gives large numbers of collision frames. In this simulation minimize the collision but not gives optimal solution, so we use MACAW protocol.

2. For minimize collision between nodes

Fig.8, show minimizes collision between nodes. In first step host senses the channel, if channel is idle then host sends the message. After receiving message server gives the ACK to host, after this host sure about no any collision occurs during

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transmission. So repeat this process and minimize of collision. There for MACAW protocol provides optimal solution in compare to MACA.

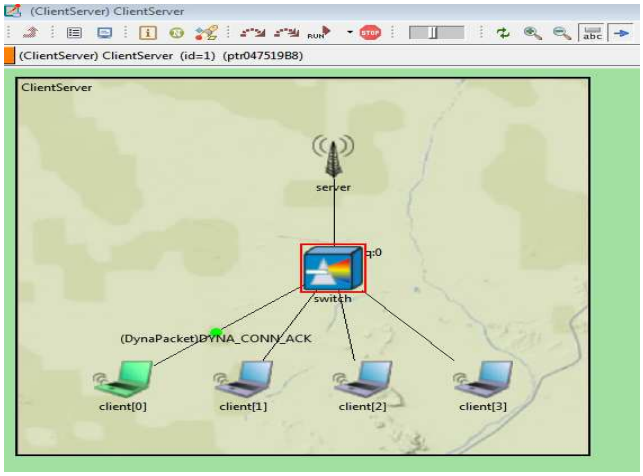

Fig.8. minimize collision between nodes

V. CONCLUSION

In this paper, we study the application and discuss about algorithm of Exponential Back-off Mechanism for MAC Protocol. Here concluded that the performance of MACAW protocol in terms of end-to-end delay and throughput is better than MACA Protocol. We can use this mechanism have wide application in different area such that personal area network, emergency operations, military environments and so on. There are few challenging issues and limitation such as packet loss due to transmission error, short battery lifetime, limited communication bandwidth, limited capacity, lack of mobility awareness by system etc. We intend to explore further in this direction in our future work.

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