

# MAC Protocols in Adhoc Networks

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## Abstract

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**With the increasing rate of wireless networks, the research work is increased in this field. Adhoc network is infrastructure less type of network in which nodes are communicating with each other. Collision occurs when two transmitters transmit at the same time. CSMA, CSMA/CA and Aloha are random access MAC protocols. The purpose of this paper is to give a general idea of MAC protocols. CSMA and CSMA/CA protocols are more efficient than Aloha protocol due to carrier sense mechanism before transmission.**

**Keywords:** Adhoc network, Aloha protocol, CSMA protocol, Hidden terminal problem.

## 1. Introduction

Adhoc network is a wireless network in which nodes are sharing information over a wireless channel. The nodes in adhoc networks act as routers that transmit data to desired destinations. Adhoc network is infrastructure less kind of network. Due to movement of nodes, the topology is changed frequently in adhoc networks. Mobility of nodes in adhoc networks decreases the fair management of bandwidth and collision occurs when two nodes simultaneously transmit the data. For controlling access to the physical medium, new protocols are needed. The design of Medium Access Protocol (MAC) becomes more challenging due to the special properties of adhoc networks. MAC defines random access protocols in which nodes can access the channel randomly. Random access protocols defined that how to detect collision and how to recover from collisions[1]. Random access protocols are: Carrier Sense Multiple Access (CSMA), Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA) and ALOHA. Adhoc networks are used in disaster recovery, battlefield communications and rescue operations when the wired network is not available[2].

CSMA protocol senses the medium before transmitting. If the channel is idle then packet is transmitted. When channel is busy it will wait for a random time. CSMA/CA is the extension of CSMA protocol. CSMA/CA uses Request to Send and Clear

to Send (RTS/CTS) when collision occurs and improves the performance[3]. In aloha protocol, if a node wants to send a packet it will send immediately. No carrier sense mechanism is used in aloha protocol.

## 2. Design Issues in MAC protocol

When designing a MAC protocol following are the main issues that are to be considered.

- 2.1 Bandwidth efficiency: The MAC protocol must be designed in such a way that the scarce bandwidth is utilized in an efficient manner. The MAC protocol must try to maximize this bandwidth efficiency[4].
- 2.2 Quality of service support: The nodes are moving in adhoc network that's why providing QOS in these networks is very difficult.
- 2.3 Hidden node problem: Hidden nodes in a wireless network refer to nodes that are out of range of other nodes or a collection of nodes[5]. In fig. 1 node A is transmitting to B but at the same time node C wants to transmit to B. Because node C is out of range of A so it cannot detect the transmission and collision occurs at node B.

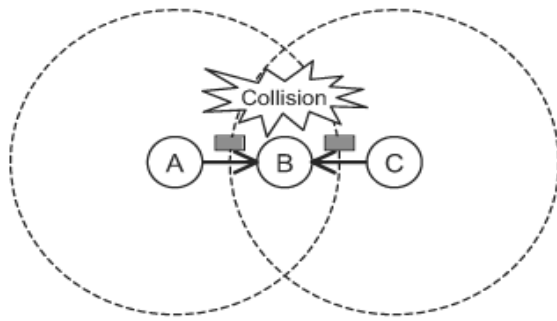


Figure 1. Hidden node problem [6].

2.4 Exposed node problem: The exposed node problem refers to the problem in which a node is blocked due to transmission by a nearby transmitting node. In fig. 2, S1 is transmitting to R1 but S2 wants to transmit to R2. So already transmission is going between S1 and R1 that's why transmission between S2 and R2 is blocked.



Figure 2. Exposed node problem.

2.5 Mobility of nodes: Nodes in an adhoc network are mobile. If the node mobility is very high, the bandwidth reservation made or the control information exchanged may end up being of no use.

### 3. Random Access Protocols

In random access protocols, any node can access the channel randomly. Random access protocols are: Aloha, CSMA, CSMA/CA. Random access protocols decreases the collisions. These protocols are defined as follows.

3.1 Aloha protocol: Aloha protocol refers to a simple communication scheme in which each station in a network sends data whenever there is a frame to send. If the frame successfully reaches to the destination, the next frame is sent. If the frame fails to be received at the destination, it is sent again. The Aloha protocol was originally developed at the

University of Hawaii for use with satellite communication systems[7]. To reduce the number of collisions and increase the number of users that can use the given network a scheme called slotted aloha was developed. In slotted aloha, time is divided into discrete intervals and these intervals are slots. A frame is sent by the stations at the beginning of the slot and only one frame is sent in each slot. If any station is not capable to place the frame on the channel at the beginning of slot then it will wait for next time slot. There is possibility of collision if two nodes transmit at the beginning of same slot[8].

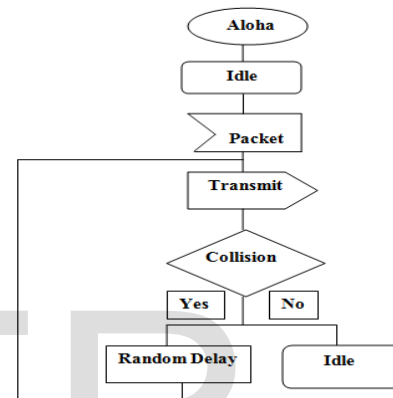


Figure 3 Aloha Protocol.

3.2 CSMA Protocol: Carrier Sense Multiple Access (CSMA) is random access protocol used in wireless networks. CSMA protocol was established to overcome the problem found in ALOHA that is to minimize the chance of collision so as to improve the performance. The key feature of CSMA is to sense before transmit. If channel is idle then transmits a frame but when channel is busy then wait for a random backoff time. Variations of CSMA protocols are used when hidden node problem occurs called CSMA/CA (Carrier Sense Multiple Access/ Collision Avoidance) Protocol is used[3].

CSMA/CA Protocol: CSMA/CA is used in wireless networks to avoid collisions. The IEEE 802.11 standard determines DCF (Distributed Coordination Function) which is used for infrastructure less network. DCF is based on CSMA/CA protocol. It is variation of CSMA protocol[9]. CSMA/CA uses RTS/CTS frames to avoid collisions. For reserving a channel, first one node sends RTS frame to another node. The other node replies by a CTS frame.

RTS/CTS frames include the information about duration of channel reservation. All hosts that could collide with either the sender or the receiver are informed of the reservation that has been sent in both RTS and CTS frames. They can compute the total duration of the transmission and defer the transmission[10].

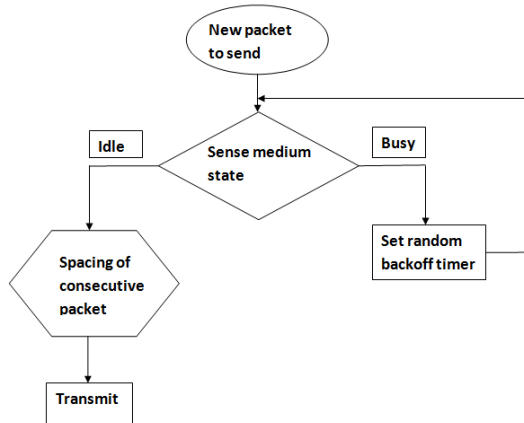


Figure 4. CSMA/CA protocol

#### 4 Related Work

In [11], the performance of the MAC protocols Aloha and CSMA is computed in terms of probability of outage. The expressions for the probability of outage for unslotted Aloha and CSMA and the probability of backoff for CSMA are derived. The result shows that for higher densities CSMA is more effective. When the transmitter senses the channel CSMA performs worse than Aloha. Performance of CSMA is significantly improved if the receiver informs to the transmitter over a control channel.

A comparative analysis of MAC protocols is proposed in[2]. In this paper medium access protocol used are CSMA and MACA. These protocols are compared based on throughput, end to end delay and packet delivery ratio using ns2 simulator. Result states that using RTS – CTS in MACA needs more energy and more time to transmit data than CSMA. As number of packets sending increases there is memory overflow at nodes and packet delivery ratio is less in MACA then CSMA.

Beam forming antennas have the ability to increase the spatial reuse, enhance the transmission reliability, raise the transmission range and save the power consumption. Adhoc network suffer from the hidden node problem which leads to degradation of network

throughput. [12] provide the general overview of Medium Access Control (MAC) protocols which address this problem.

#### 5 Protocols Comparison

Random access protocols increases the collisions. CSMA protocol is more efficient than Aloha. Because in aloha protocol the chances of collisions are more and it reduces the performance. But in case of hidden node problem CSMA/CA protocol works more efficiently. So the performance comparison between random access protocols is as follows:

- CSMA and CSMA/CA protocols investigates that the channel is free before the transmission and aloha protocol doesn't try to find whether the channel is free or not before transmitting.
- Slotted Aloha performs better due to discrete intervals called slots and data is transmitted within these time slots but in case of hidden node problem, CSMA/CA increase performance due to RTS/CTS mechanism.

- CSMA protocol senses the channel before transmission and collision is reduced but in aloha protocol, all frames are transmitted when there is a frame to send. So, there are more chances of collisions in Aloha protocol.

CSMA is better than aloha protocol. CSMA/CA performs better due to RTS/CTS frames. So following are the advantages and disadvantages of CSMA and CSMA/CA protocols.

5.1 Advantages: CSMA protocol uses all available bandwidth when it is possible.

- It increases the efficiency of network.
- In CSMA protocol, two or more stations wait for the same amount of time and will retransmit at the same time.
- It is effective and avoids the data collisions.
- CSMA/CA uses RTS/CTS frames and reduces collisions.

5.2 Disadvantages: As the network becomes large the performance decreases in CSMA protocol.

- In this protocol, the priorities cannot be assigned to few nodes and the performance decreases as the devices are added[13].
- CSMA/CA is used only for wireless networks.

#### 6 Conclusion

Adhoc network is wireless network in which nodes are transmitting signal. Collision occurs when data is transmitted simultaneously. MAC uses random access protocols to control the flow of data over wireless channel. Random access protocols are used to avoid collisions. Research work in this field is carried out in the direction of avoiding collisions and increasing transmission by comparing MAC protocols. As compared to Aloha, the more efficient protocol is CSMA because it senses the medium before transmission. CSMA protocol uses all available bandwidth and works efficiently for small networks. For better performance, CSMA/CA protocol is used and it uses RTS/CTS mechanism to avoid collision. CSMA/CA protocol is used for wireless networks.

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