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ANALYTICAL REVIEW ON RELIABLE MAC PROTOCOL

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Abstract:

In this paper we analyze the reliable MAC protocol called "RMAC" which is supporting reliable broadcast and multicast for wireless ad hoc networks. A wireless ad hoc network is formed by the group of wireless hosts, without the use of any infrastructure. To enable communication, host cooperates among themselves to forward packets on behalf of each other. By utilizing the busy tones to realize the multicast reliability, RMAC uses a variable length control frame to stipulate an order for the receivers to respond, thus solving the feedback collision problem, extends the usage of busy tone for preventing data frame collisions into the multicast scenario and introduces a new usage of busy tone for acknowledging data frames positively. The IEEE 802.11 multicast/broadcast protocol is based on the basic access procedure of Carrier Sense Multiple Access with Collision Avoidance. This protocol does not provide any media access control (MAC) layer recovery on multicast/broadcast frames. Due to increased probability of lost frames resulting from inference or collisions, reliability of multicast/broadcast services is reduced. Also MAC protocol provides both reliable and unreliable services for all three modes of communication: unicast, multicast, broadcast and making it capable of supporting various upper-layer protocols. This paper proposed that RMAC achieves high reliability with limited overhead and also involves lower cost as compare to other reliable MAC protocol.

I. INTRODUCTION

Media Access Control (MAC) remains a primary research problems in wireless networks, given the difficulties caused by transmission errors, collisions, and hidden nodes. These difficulties become even more severe when support is provided for multicast/broadcast communication in wireless networks. Such support is necessary for deliver up to standard quality of service in many applications of wireless communications, such as emergency transfer of data or video conferencing. Moreover, even in scenarios where applications themselves do not demand multicast/broadcast, several higher layer protocols rely heavily on reliable and efficient MAC layer Broadcast, for example DSR, AODV and ZRP routing protocols. It is important to note that multicast in the MAC layer refers specifically to the process of sending a data frame to some of the neighbor node and broadcast is refers to process of sending a data frame to all of the neighbor node. H e n c e w e c o n s i d e r b r o a d c a s t a s t h e s p e c i a l c a s e o f m u l t i c a s t .Of the many random access MAC protocols for wireless networks that have been proposed so far, most primarily target unicast communications and do not yield an efficient basis for simulating multicast. In the few that do deal directly with multicast, it is apparent that reliability is not a major concern. For instance, in the IEEE 802.11 specification, the multicast sender simply listens to the channel and then transmits its data frame when the channel becomes free for a period of time. There is no MAC-level recovery on multicast frame. As a result, the reliability of multicast is reduced due to the increased probability of lost frames resulting from interference or collisions. As another example, it is simply suggested that the sender transmits a Request To Send (RTS) frame immediately followed by the data frame(s). This RTS frame informs the neighbors which are idle to yield their transmissions to somewhat reduce the chance of message collisions. Again, the reliability of this scheme is low.

Recently a few multicast MAC protocols have been proposed to enhance the reliability and the efficiency of the 802.11 multicast protocols. We demonstrate this protocol and redressing their reliability and efficiency issue and further advancement in it are suggested.

First protocol, which is suggested can reduces the number of contention phases from n to 1, where n is the number of intended receivers in a multicast. Basically it provides a simple coordination mechanism for avoiding collisions in the transmissions of Clear To Send and Acknowledgement frames, and ensure that each time the data frame is transmitted ,it is received by as possible as many receiver. In this way average total time to complete multicast MAC request has been reduced.

Other one protocol suggests in this paper can uses location information to further improve previous suggested protocol. Let R denote the set of intended receiver of multicast MAC request. We show how the successful transmission of data frame to all node in R' using first protocol, where R' is subset of R, is enough to ensure the reception of data by all nodes in R without collision. Assuming transmission radius is constant; we provide a necessary and sufficient condition for R'. This significantly reduces the number of RTS, CTS, RAK and ACK frames in the first protocol.

Using the control and data frame formats in IEEE 802.11 specifications, this protocol are able to co-exist with the current unreliable IEEEE 802.11 multicast MAC protocol to provide reliable multicast MAC services when needed. Our demonstration can show that these protocols are more reliable and efficient than others.

II. EXISTING MULTICAST MAC PROTOCOLS

As we discuss in above section that there do exist some protocol of MAC multicast but they are not as much as reliable and efficient some of them are discussed in this section and problem associated with them are also described here.

Carrier Sense Multiple Access with collision Avoidance,The idea of Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) proposed in [11] has been used in many wireless MAC protocols. It works as follows: A node wishing to transmit first listens to medium, if medium is idle, transmits the frame and if medium is busy, then continue to listen until the medium is idle; then backoff for x slot of time, where x is a random number within the contention window. If channel is still idle when the backoff timer expires, transmit the frame and if the channel becomes busy before the timer expires, stop the timer and listen to the channel again; when the channel is detected idle, restart the backoff timer and if the channel becomes busy before the timer expires, stop the timer and listen to the channel again; when the channel is detected idle, restart the backoff timer. After transmission, if the node does not receive an ACK, attempt to retransmit the frame and after receiving a data frame , the receiver returns an ACK.

The CSMA/CA protocol is known to suffer from hidden terminal problem. Assume stations p and q are within each other's transmission range, and so are station q and r; but p and r cannot hear from each other. Suppose node p wants to transmit a frame to node q while q's neighbor r is transmitting. Using the CSMA/Ca protocol, node p will find the medium idle and transmit the frame, causing collision at q.

Common method to solve the hidden terminal problem is to extend CSMA/CA protocol with a Request to Send/Clear to send handshake.

In IEEE 802.11, the RTS/CTS extension is not used for broadcast/multicast; and the receivers are not required to return an ACK. As a result, the quality of broadcast/multicast service is not as good as that of unicast.

BROADCAST SUPPORT MULTIPLE ACCESS (BSMA)

In the Broadcast Support Multiple Access (BSMA) protocol augments the broadcast MAC protocol in with NAK frame and following addition rules: After the sender transmits a data frame, it waits for WAIT_FOR_NAK time units for any possible transmission problem reported by the neighboring nodes. If a receiver does not receive the data frame after it transmitted the CTS frame for WAIT_FOR_DATA time units, it transmits a NAK frame and If the sender does not receive any NAK frame before its WAIT_FOR_NAK timer expires, the broadcast service is complete. Otherwise, the sender backs off and enters the contention phase again to retransmit the broadcast data.

The BSMA protocol in [20] is essentially the same as the protocol in [19], except that it includes the NAK frame. That means that the BSMA protocol has exactly the same CTS collision problem. The additional NAK frame in [20] does not help resolve the collision of the CTS frame. In fact, since the transmissions of NAK frame is not coordinated rather. The same collision problem exists when more than on end send the NAK frames.

BROADCAST MEDIUM WINDOW (BMW)

In [21], the Broadcast Medium Window (BMW) protocol is introduced to provide a reliable broadcast MAC. The fundamental idea of the BMW protocol is to treat each broadcast request as multiple unicast requests. Each unicast is processed using the reliable IEEE 802.11 DCF MAC protocol with some minor modifications. In BMW, each node maintains three lists NEIGHBOR list- contain the current neighbors, SEND BUFFER list- contains the ongoing broadcast messages, and RECEIVE BUFFER list- contains the sequence number of the data frames received by the node.

In BMW, when a node has a broadcast data to send, it first executes the contention phase. Afterwards, the sender places the message into its SEND BUFFER and sends out an RTS frame containing the sequence number of the upcoming data frame and the MAC address of the first node in its NEIGHBOR list. When a node receives a RTS intended for it, it checks its RECEIVE BUFFER list to see if has received all the data frames with sequence number smaller than or equal to upcoming one. If all the data frames have been received, the receiver sends CTS with appropriate information to suppress the senders data frame transmission. Otherwise, the receiver sends CTS with appropriate information to suppress the sender's data frame transmission. Otherwise, the receiver sends a CTS frame with all the missing data frame sequence numbers. The sender, upon receiving the CTS frame to transmit all the missing data frames and waits for an ACK. After receiving the data frames and sends an ACK. The sender moves onto serve the next node on the NEIGHBOR list if either the returned CTS frame indicates all the data frames have been received or an AACK has been received. If all nodes in the NEIGHBOR list have been served, the sender removes the message from its SEND BUFFER.

The protocol in [19, 20], whether with or without NAK [19, 20], are unreliable in that when a multicast is done, they do not know whether every intended receiver has received the data. These protocols do not improve much in reliability over the current IEEE 802.11 multicast services. Hence BMW is reliable because if necessary, the sender will retransmit the data frame until it has received an ACK from every intended receiver but it is inefficient due to Contention Phase and Timeout problem in it.

III. BATCH MODE MULTICAST MAC PROTOCOL

In BMW, the sender uses at least rounds of DCF-like unicasts for a multicast request intended for neighboring nodes. Each round requires one contention phase before an RTS frame can be sent. If we consolidate the contention phases into one, then the required time to serve a multicast can be greatly reduced. This is the primary idea of Batch Mode Multicast MAC Protocol (BMMM).

To achieve this goal, the design issue is how to coordinate the transmissions of the control frames, including RTS, CTS and ACK, with no modification of the frame format in IEEE 802.11 specification. First, we want to ensure that there is no collision among control frame transmissions. Second, if one of the sender's neighbors has data to send, it should not pass its contention phase when the sender is exchanging control frames with its intended receivers. To avoid the collisions among CTS and ACK frames, the sender needs to provide a simple coordination among the intended receivers. To prevent a neighbor from passing its contention phase, the protocol needs to ensure the medium will not idle for long when a multicast request is processing. To meet the above requirements, we design the protocol such that the sender instructs its intended receivers (of a multicast) to transmit the control frame in order. The sender uses its RTS frames to sequentially instruct each intended receiver to transmit CTS. To coordinate ACK transmissions from receivers, a new control frame is required. We therefore propose a new control frame type called RAK (Request for ACK).It contains frame control, Duration, receiver address (RA) and frame check sequence (FCS). With the help of the RAK frame,the sender can coordinate the ACK transmissions in the similar manner it coordinates the CTS transmissions. That is, after the transmission of the data frame, the sender uses the RAK frames to sequentially instruct each in- tended receiver to transmit an ACK.

BMMM protocol has several advantages:

Our protocol greatly reduces the number of contention phases, which will be shown by our analysis and simulation. The time decreased by the reduction of contention phases is much larger than the time increased by the introduction of RAK frames because the trans- mission of each RAK frame takes one time slot while one contention phase generally takes much more than one time slot. Therefore, our protocol significantly decreases the required time to serve a multicast request.

Our multicast protocol does not modify any control frame format. This allows our multicast MAC protocol to co-exist with the other IEEE 802.11 protocols, including the unreliable IEEE 802.11 multicast MAC protocol. A multicast request can specify if it needs a reliable service or not from the upper layer to select the appropriate multicast MAC protocol to use.

In this protocol, the sender transmits RTS frames periodically before sending data and transmits RAK frames periodically after sending the data. This means that the medium will never be idle for more than 2.SIFS+, which is less than DIFS. Since any neighbor wishing to transmit data must listen to ensure the channel is free at least DIFS, having sender.

IV. LOCATION AWARE MULTICAST MAC PROTOCOL

As pointed out above that geographic location can be easily obtained from the Global Position System (GPS). Considering the transmission radius of the IEEE 802.11 (up to 500 feet for 802.11b), the GPS location information is accurate enough to be used for this purpose. In IEEE 802.11 specification, the frame body of the signal frame format is well enough to accommodate the GPS location information (<30 bits). If we including the location information in signal, neighbors will learn each other's location. Location information has been used in some routing protocols. In this section, we investigate the possibility of utilizing location information in medium access control.

The BMMM protocol reduces the number of contention phases by putting ||R|| pairs of RTS/CTS together. The nodes that successfully received the data frame are expected to each return an ACK after it receives a RAK. When the size of R is large, it may be desirable to reduce R's size by considering only a subset of it. That is, when running the BMMM protocol, we send RTS only to the addresses of nodes in a subset, R', of R, and expect only those nodes to return a CTS and, later after receiving the data frame and its RAK frame, return an ACK. Without an explicit ACK from each node in R\R', the sender of course has no way to know whether the nodes in R\R' have received the data frame. But is it possible that by receiving only the

ACKs from those nodes in R' is subset of R, hence sender is able to conclude that all nodes in R have received the multicast data frame without collision.

V. CONCLUSION

In this paper, we investigated the existing wireless multicast MAC protocols and showed that they are either unreliable or inefficient. We discussed two reliable multicast MAC protocols: The Batch Mode Multicast MAC protocol and the Location Aware Multicast MAC protocol that can co-exist with the current unreliable IEEE 802.11 multicast MAC protocol. Based on the IEEE 802.11 DCF unicast MAC protocol, BMMM coordinates the receiver's control frame transmissions by sender's RTS and RAK frames. It not only avoids the control frame collisions but also prevents any neighbor from passing its contention phase. This helps noticeably reduce the number of contention phases for a multicast request. As a result, it decreases the average total time required to complete a multicast request and reduce the chance of message timeout. LAMM uses two location based procedures to further improve upon BMMM.

We conclude with a pointer to future work. Throughout this paper, our focus has been on resolving the hidden terminal problem for multicast. Another problem that is challenging in wireless medium access control is exposed terminal problem. To the best of our knowledge, no multicast MAC protocol has overcome exposed terminal problem. This paper can help in solving these problems.

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