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HIGH THROUGHPUT RELIABLE MULTICASTING IN MULTI-HOP WIRELESS MESH NETWORKS

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***Abstract*— Wireless adhoc Networks (WANs) have evolved as one of the most advanced field in wireless communications. They consist of a number of static wireless routers which form an access network for end users to IP-based services. A new MAC protocol called RMAC that supports reliable multicast for wireless ad hoc networks has been introduced in this paper. RMAC employs the busy tone mechanism to realize multicast reliability and has the three characteristics: (1) it uses a variable-length control frame to specify an order for the receivers to respond, thereby solving the problem of feedback collision (2) By extending the traditional usage of busy tone, to prevent data frame collisions in the multicast scenario; also introducing a new use of busy tone mechanism for acknowledging data frames. Additionally, the RMAC can be generalized into a comprehensive MAC protocol providing both reliable and unreliable services for all the three modes of communication: unicast, multicast, and broadcast. The evaluations of this paper shows that RMAC achieves a high degree of reliability with very limited overhead. Also, by comparing RMAC with other reliable multicast MAC protocols shows that RMAC not only provides higher reliability but also results in decrease of cost. This paper focuses on using ARQ technique to implement the MAC layer reliable multicast for wireless adhoc networks where the number of one-hop multicast receivers is not very large. Examples of such adhoc networks include battlefield ad hoc networks, emergency rescue networks, sparse sensor networks, etc.**

Keywords—component adhoc network,multicasting, mesh networks, MAC

I. INTRODUCTION (*HEADING 1*)

Till date, most of the MAC protocols for wireless networks do not provide a reliable multicast service. For example, IEEE 802.11, the widely-used wireless MAC protocol today, only supports reliability for unicast with the RTS/CTS/DATA/ACK scheme; and for multicast or broadcast, it simply transmits the data frames. However, in recent years, the provision of multicast reliability at the MAC layer has received increasing attention due to the following two observations. First, mechanisms solely at the network layer cannot provide highly reliable multicasting for wireless adhoc networks in an efficient manner. So far, many network layer multicast protocols have been proposed, They can be classified into tree-based protocols mesh-based protocols. Unfortunately, both types of protocols encounter problems in achieving multicast reliability. In tree-based protocols, where a tree is used to do multicast, severe packet loss occurs due to the scarce connectivity of the tree. As manifested if one node in the tree does not receive a multicast packet, then all its downstream children cannot receive the packet. On the other hand, mesh-based protocols overcome the problem of the tree by forwarding multicast packets with a mesh, such that a node can receive the packets from several upstream nodes. Mesh-based protocols, however, mesh protocols are inefficient in that they introduce redundant packet transmissions and nodes should be able to distinguish previously-received packets in some way. As a result, reliable multicast support is needed from the MAC layer to improve the upper layer performance.

Second, in the perspective of functionality provisioning in the protocol stack, the MAC layer is a proper place to provide the reliability for wireless ad hoc networks. Unlike the wired networks where, with almost error-free links, reliability can only be implemented at the end-to-end level (e.g., TCP), wireless networks are characterized by error-prone links, so it is worthwhile to perform local recovery at each hop. As shown in adding local recovery at the MAC layer can greatly improve the end-to-end performance for unicast in wireless networks. For multicast, we believe that the same effect will be produced if MAC layer reliability is provided. For the implementation of multicast reliability, two basic technologies exist: Forward Error Correction

(FEC) and Automatic Repeat request (ARQ). In FEC, redundant data are transmitted for error recovery and no feedback is needed from the receivers. The advantage of FEC is that it scales to a large number of receivers and its disadvantages are that it involves encoding/decoding overhead and the sender cannot know whether full reliability has been achieved. On the other hand, in ARQ, retransmission is used for error recovery and feedback is needed from the receivers. The advantage of ARQ is that it can achieve full reliability and its disadvantage is that it cannot scale to a large number of receivers due to the feedback implosion problem. In this paper, we focus on using ARQ to implement the MAC layer reliable multicast for wireless adhoc networks where the number of one-hop multicast receivers is not very large. Examples of such adhoc networks include battlefield ad hoc networks, emergency rescue networks, sparse sensor networks, etc. In applying ARQ to multicast for wireless ad hoc networks, two problems have to be solved: (1) how to reserve the wireless channel for multiple receivers so as to increase the successful transmissions and (2) how to collect the feedback from multiple receivers. Several existing ARQ-based multicast MAC protocols (to be described in Section 2) try to solve these two problems by extending the IEEE 802.11 RTS/CTS/DATA/ACK scheme to the multicast scenario. Observing that these IEEE 802.11 based protocols are not efficient, in this paper we present the RMAC protocol which solves these two problems by the introduction of the busy tone mechanism. Besides supporting multicast reliability, RMAC is also generalized into a comprehensive MAC protocol that provides both reliable and unreliable services to the upper layer, with each service covering three modes of communications: unicast, multicast, and broadcast. Our evaluation shows that RMAC achieves a high degree of reliability with very limited overhead.

II. Related Work

A communication pattern where a source host can send a message to a number of target hosts is known as Multicast (point-to-multipoint) as shown in Figure 1.1. Though this can be sent by different unicast (point-to- point) messages, multicasting capability is much desired for a lot of reasons. Decrease in the network load is the basic advantage of multicasting. Viewing from the point of developers, multicast is very interesting, as all the complications are removed from the end-host and moved to the network. Multicast has an efficient delivery system of information, as it sends only once the message over each link in the network. Only when the destination link is split, copies of the message are created. Since the routers create an optimal distribution path, it is more complex [1]. To get the packets to the destination, a spanning tree is constructed. In many applications e.g. stock ticker application, it is required to send packets to hundreds of stations. A group of links are shared on their paths, by the packets to their destinations.

IP networks originally introduced Multicast. Many applications, for example, Internet gaming, IP teleconferencing, and Internet television need data to be sent from one or several senders to several receivers. Multicast applications involve multipoint communication/multicast whereby data is delivered from one or several sender nodes to several designated nodes. The 2 types of addresses on the Internet are unicast and multicast. Normally on the internet a host/node has only one unicast address and it can be a member in multiple multicast groups.

A. *Multicast Support for Applications*

The majority of applications in today’s Internet rely on point-to- point transmission. Local area network applications traditionally used point- to-multipoint transmission. For the past some years many new applications in the Internet are using the multicast transmission. In multicast IP, bandwidth is conserved as the networks do packet duplication only if necessary. Multicast IP also offers an alternate to unicast transmissions for many applications such as live stock quotes, network ticker tapes, shared whiteboard applications, and multiparty video-conferencing. Very importantly IP Multicast is not limited only to the Internet, as it can have a big role in large distributed commercial networks.

B. *Reducing Network Load*

For example, consider a transmission of packets to hundred stations in a stock ticker application for an organization’s network. In unicast transmission for the group of stations, it will require for the packets to traverse the same links, for the periodic transmission of hundred packets. Multicast transmission is a better transmission for this type of applications, as it sends only a single packet transmission at the source and it is only duplicated at forks in the multicast delivery tree. Broadcast transmission is not ideal for this type of application as the CPU performance is affected at each end station which sees the packet and also bandwidth is wasted.

C. *Resource Discovery*

Many applications transmit packets to group members of the same network by multicast group addresses instead of broadcasts. A multicast transmission need not be limited to a single LAN as the Time-To-Live (TTL) field of the IP header can limit the multicast transmission’s range/scope.

D. *Support for Data casting Applications*

In a series of “audio cast” experiments in 1992, The Internet Engineering Task Force (IETF) has sent live audio and video through multicast from IETF site to around the world destinations. In Data casting, the audio and video signals are compressed at the source station and sent as a set of UDP packets to a group address. An organization’s requirement for parallel networks for voice, video and data is eliminated by Multicasting.

E. *Unicast And Broadcast*

Commonly data is sent from one host to another by unicast. Generally a 2-direction path is setup on a single connection/path between the sender and receiver. When the ‘Server’ (host) sends data to ‘computer 1’ and ‘computer 2’ (2 hosts), 2 connections are setup. All Data has to be sent twice from the Server. The best way to send data is unicast, when different data is sent to computer 1 and computer 2. It is not a viable solution as Server load is directly related to the number of client computers. Also, when a single transfer of data would have been enough, in many cases the data travels numerous times over the same network connection.

III. Proposed System

A new MAC protocol called RMAC that supports reliable multicast for wireless Adhoc networks. By utilizing the busy tone mechanism to realize multicast reliability, RMAC has the following three novelties:

1. It uses a variable length control frame to stipulate an order for the receivers to respond, such that the problem of feedback collision is solved.

2. It extends the traditional usage of busy tone for preventing data frame collisions in to the multicast scenario.

3. It introduces a new usage of busy tone for acknowledging data frames.

To date, most MAC protocols for wireless networks do not provide a reliable multicast service. For example, IEEE 802.11 the widely-used wireless MAC protocol today, only supports reliability for unicast with the RTS/CTS/DATA/ACK scheme; and for multicast or broadcast, it simply transmits the data frames once without any recovery mechanism.

For the implementation of multicast reliability, two basic technologies exist:

- Forward error correction (FEC)
- Automatic repeat request (ARQ)

The multicast routing protocol proposed in this paper can be implemented over any of these single-hop MAC layer multicast protocols. In this paper we use RMAC in our simulations as the reliable MAC layer multicast protocols.

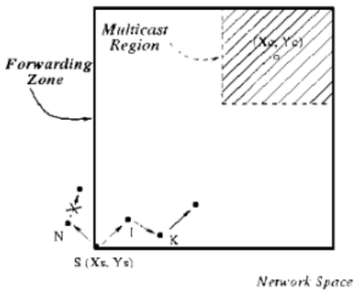

Fig.1.The first location algorithm

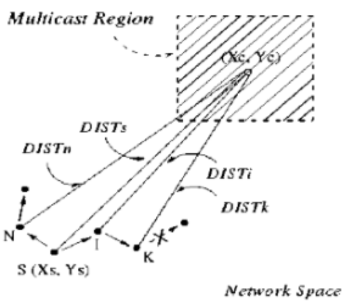

Fig.2.The second location algorithm

IV. Module Description

There are many characteristics/challenges to be considered when multicast routing protocols are developed. They include network topology dynamics, energy constraints, network scalability limitation, and wireless and wired links differing characteristics like limited bandwidth and poor security. A good multicast routing protocol includes characteristic shown below:

Robustness: Some data packets are dropped In Mobile Ad-Hoc Networks (MANETs) due to different reasons leading to low packet delivery ratio. Hence, a multicast routing protocol must be robust to withstand node mobility ensuring high packet delivery ratio.

Efficiency: Multicast efficiency is the ratio of the total number of received packets from receivers to the total number of transmitted data and network control packets.

Control overhead: Bandwidth limitation is important in MANETs. So a multicast protocol design should lower total number of control packets transmitted to maintain a multicast group.

The prototype has several modules which are discussed one by one.

A. Normal Route Discovery in WMN

The route node uses the reactive protocol to find its neighbor. We use the AODV protocol i.e., it is one of the reactive protocol. In the wireless sensor network the route node first sends the root request to all the nodes in the network. In reactive protocol we just find the shortest route as we travel in the network. So which ever node accepts the request sent by the source sends the response to it and the source travels through those nodes.

B. Routes Discovery using EMTX algorithm

Reputation based models consider interactions from past history and based on this enable nodes to identify cooperative (trusted) or uncooperative (untrusted) nodes. Nodes build up subjective reputation from direct interaction experiences. These histories are visible to new interacting nodes through second hand reputation information. Expected transmission count (ETX), computes the expected numbers of retransmissions required for a packet to move to and from a destination. The link quality is calculated based on the number of successful packets received by the node and its neighbor within a window period.

C. Proposed RMAC Functionality in WMN

The RMAC protocol is a comprehensive MAC protocol that provides both reliable and unreliable transmission services to the upper layer. Both of them cover three modes of communications: unicast, multicast, and broadcast. Hereafter, the two services are called Reliable Send and Unreliable Send services respectively. The provision of both services is due to the consideration that an MAC layer protocol should be able to support various upper layer demands. In RMAC, the data frames in Reliable Send and Unreliable Send are distinguished

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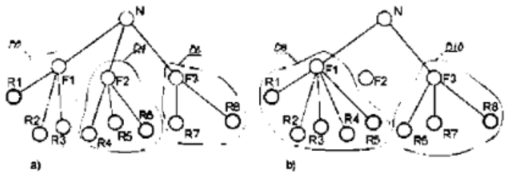

Fig.3.EMTX multi routes

into "reliable data frames" and "unreliable data frames" by labeling the data frames with different frame types.

In RMAC, the back off procedure is used by both Reliable Send and Unreliable Send services. It is invoked under any of the following three conditions: 1) a node has a packet to transmit, but either data or RBT channel is busy; 2) a node tries to retransmit upon a failed transmission; 3) a node completes a successful transmission or drops a frame.

D. ARQ and FEC association in WMN

This module to formulate the ARQ and FEC to perform some operation on the existing and proposed system to model the behavior analysis of the proposed MAC protocol performance on the different variation this protocol module deliver the high reliability and concise on the network parameters.

E. Compare Existing System to Proposed System Using Xgraph

In this module to compare the both system to perform the existing and proposed using xgraph approach to formulate the better performance of the whole system. Xgraph is an X-Windows application.

F. Qos of the proposed system

Qos of the proposed system that will provide the best quality of service along on the network dynamics and path recovery of the network status will be analyzed.

V. Conclusion

In this paper, we presented a new MAC protocol for wireless ad hoc networks called RMAC that implements the reliable multicast service at the MAC layer using the busy tone mechanism. In addition, we generalize RMAC into a comprehensive protocol that supports multicast in both reliable and unreliable. Evaluation is done on RMAC and comparison is also made with BMMM, an example of other ARQ-based reliable multicast MAC protocols. The evaluation and comparison showed that RMAC achieves high reliability with very limited overhead. Multicast routing can effectively reduce transmission overhead and yet enhance multicast throughput. Open research problems include studying the performance of the proposed protocol in more realistic simulation environments as well as real-life wireless networks.

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