MAC Layer Support for Real-Time Traffic in a SAHN

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Abstract

In multi-hop ad-hoc wireless networks with shared medium and a contention based media access control (MAC) protocol, guaranteed quality of service (QoS) support for real-time traffic (e.g. voice, video, interactive applications etc.) is very challenging. Commercially available contention based MAC protocols, e.g. IEEE 802.11e, do not provide any mechanism to prevent a network from getting overloaded. Hence they fail to provide desired QoS (e.g. throughput, end-to-end delay, delivery ratio) for realtime traffic when the network is loaded beyond certain limits. In our previous work we have explained in details why trivial solutions are inadequate to support deterministic QoS for real-time traffic in multi-hop ad-hoc networks. We have also presented an analytical model to offer a distributed admission control and bandwidth reservation scheme by extending the features of the basic channel access mechanism of IEEE 802.11e and coordinating with the network layer. In this paper we have extended our analytical model to make it more effective than the initial one by considering neighboring nodes in bandwidth calculation. We refer to the improved IEEE 802.11e as SAHN-MAC. The proposed admission control mechanism of SAHN-MAC prevents any new data stream from initiating if the new stream saturates or is about to saturate any part of the network. The bandwidth reservation scheme is necessary for the admission control scheme to work properly. The proposed mechanisms have also been verified and evaluated via various simulations.

1 Introduction

Due to the shared nature of wireless media and multiple hops it is a very challenging to provide desired QoS to various data streams in a multi-hop ad-hoc network like a SAHN [1]. This requires efficient and robust protocols to be deployed at each layer. Proper coordination among these protocols is also necessary to achieve overall network performance. Moreover without the support from the MAC layer, the QoS guarantee of higher layers is not possible.

Several channel access mechanisms built upon TDMA (Time Division Multiple Access) [2][3] have been proposed to provide QoS in ad-hoc networks. However, MAC protocols based on TDMA require proper synchronization which may be very difficult to achieve in ad-hoc networks with unreliable links. They may need central control station to allocate slots properly which is not a desired property of a SAHN. To reduce channel contention the number of slots may increase in networks with large number of nodes. This may result in increased end-to-end delay for sessions spreading over multiple hops since each intermediate node has to wait for particular slots to transmit data. Hence MAC protocols based on TDMA may not be suitable for a SAHN.

Alternatively contention based distributed MAC, e.g. IEEE 802.11e [4], can be used in a SAHN. However guaranteed QoS support becomes extremely challenging in contention based networks. Compared with the earlier variants of IEEE 802.11 (e.g. IEEE 802.11b), IEEE 802.11e reduces channel contention and allows better channel utilization. It provides differentiated access treatment for various classes of traffic so that real-time traffic, such as voice, video and interactive applications, can experience low jitter and latency. Real-time traffic may not be able to achieve required QoS if the network is loaded beyond certain limits. When a network exceeds its operating capacity we say that the network has become saturated. 802.11e does not provide any mechanism to prevent the network from getting saturated. MAC protocols based on CDMA (code division multiple access) over 802.11 (e.g. [5]) can improve network performance since multiple spreading codes increase channel capacity. However if the network becomes overloaded it may not be possible to provide guaranteed QoS to real-time traffic any more.

Sivavakeesar [6] has proposed a QoS aware MAC protocol based on IEEE 802.11 for multi-hop ad-hoc networks. 802.11 has been modified to accommodate MAC-level service differentiation for two types of traffic (i.e. real-time and best effort). The proposed MAC scheme switches between pure DCF (distributed coordination function) mode and combined [DCF + PCF (point coordination function)] mode depending on traffic types. Though it has been shown through simulation results that the proposed scheme improves network performance, it is not clear how the scheme will perform under saturation.

Xiao and Li [7] have presented two local data-control schemes and an admission-control scheme for ad hoc networks with IEEE 802.11e to prevent a network from getting saturated. The proposed distributed local data control scheme maps measured traffic-load condition into backoff parameters locally and dynamically. The proposed distributed admission control scheme enables each node to make decisions on the acceptances and rejections of flows. This later feature may prevent a network from getting saturated, hence can guarantee QoS to existing data streams. Since performance evaluation of this scheme was done using single hop ad-hoc networks, it is not clear whether it can guarantee QoS to real-time traffic over multiple hops.

Like [7] SAHN-MAC also addresses the shortcomings of the legacy 802.11e. SAHN-MAC provides a solution by coupling an efficient and robust admission control and bandwidth[1] reservation scheme with IEEE 802.11e and by coordinating with the network layer. However the working mechanism of admission control scheme is different from [7]. Moreover the performance of SAHN-MAC has been evaluated using both single and multi hop ad-hoc networks. The admission control unit of SAHN-MAC prevents any new session from initiating if the new session saturates or is about to saturate any part of the network. This feature is not available in [6]. The bandwidth reservation scheme is responsible for proper functioning of the admission control unit. SAHN-MAC does not use existing bandwidth reservation schemes designed for wired or single hop wireless networks since they may not work properly in a multi-hop ad-hoc network with shared media. These schemes assume that the required bandwidth for a specific data stream should remain almost the same at all the associated nodes responsible for sending and receiving data. However, due to the RTS/CTS mechanism, multiple hops and the shared medium, the bandwidths consumed by these nodes differ. Additionally, existing bandwidth reservation schemes do not consider that the data stream may waste bandwidth in nodes neighboring its communication path. Our previous work [8] on SAHN-MAC have discussed these issues in details with simulation results. The aforementioned unique features of SAHN-MAC provide a robust and efficient MAC layer support for real-time traffic in a SAHN.

This is how the rest of the paper has been organized. We have defined some commonly used terms and described our simulation setup tool in Section 2 and Section 3 respectively. We have outlined the working mechanisms of SAHN-MAC in Section 4. We have built analytical models to find different parameters of SAHN-MAC in Sections 5, 6, 7 and 8. Then we have validated the effectiveness of our proposed scheme in Section 9 with simulation. Finally we have concluded our paper with future research directions.

2 Definitions

- **Session (s):** It is a data stream flowing in one direction and passing through intermediate nodes.
- **Throughput:** It is the amount of data that can be carried from one node to another in a given time period. It is usually expressed in bits per second (bps) and associated with the application layer.
- **Active participant (a):** Nodes responsible for sending and receiving data for a particular session s will be referred to as the active participants of s.
- **Passive participant (p):** Passive participants refer to those neighbors of the active participants of a session s who do not actively take part in sending/receiving data for s.
- **Link:** A directional communication channel between two neighboring nodes.
- **Bandwidth utilization (U):** Defined as $\mathrm{U} = \frac{\text{Bandwidth Consumed}}{\text{Total Bandwidth}} \times 100\%$.

3 Simulation setup

Throughout this paper, if not mentioned explicitly, we have considered the following setup for our analyses and simulations. We have used GloMoSim (version 2.02) for simulating various layers and wireless media. Nodes are separated by at most 240 meters, use same transmission power with an transmission range of maximum 240 meters, share the same frequency channel and use IEEE 802.11e in the link layer. The physical layer modulates/demodulates signals using OFDM (Orthogonal Frequency Division Multiplexing) with a transmission rate of 54 Mbps and uses a single network card with a single omnidirectional antenna. Each session consists of CBR (Constant Bit Rate) traffic using UDP and routed using DSR (Dynamic Source Routing [9]).

4 Overview of SAHN-MAC

SAHN-MAC is an extension of IEEE 802.11e. Its basic channel access mechanism is as same a 802.11e. In this paper we will describe only the new features added to 802.11e.

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[1] Bandwidth refers to the data-carrying capacity of a transmission medium expressed in bits per second (bps). Any network transaction adds headers to each packet at each layer. Moreover, the channel access mechanism of 802.11 needs additional time slots for accommodating RTS, CTS and ACK packets with each data packet. Thus the bandwidth required at the physical layer for a given session is always greater than that of the application layer. Throughout this paper the bandwidth required to achieve a certain throughput will include the overheads of all layers.

The admission control scheme of SAHN-MAC prevents the active/passive participants of a session from getting saturated. The bandwidth reservation scheme ensures that the admission control scheme can work properly. Here are the working mechanisms of SAHN-MAC:

- The node initiating a session s sends a session initialization request (SIREQ) packet with the required throughput and the total duration of s.
- An active participant a, receiving SIREQ, estimates $\mathrm{U_a^s}$, i.e. bandwidth utilization for s at a. a also calculates $\mathrm{U_p^s}$, i.e. bandwidth utilization of each of its neighboring passive participants p related to s.
- SAHN-MAC requires each node in a network to maintain up-to-date information about the bandwidth utilization of itself and its one hop neighbors. Let us denote $\mathrm{U_a^{Total}}$ and $\mathrm{U_p^{Total}}$ as the total bandwidth utilizations of a and p respectively. a can predict future $\mathrm{U_a^{Total}}$ by adding $\mathrm{U_a^s}$ to its current bandwidth utilization. Similarly a can estimate future $\mathrm{U_p}$ of each its neighboring passive participants. If the calculated future $\mathrm{U_a^{Total}}$ and $\mathrm{U_p^{Total}}$ do not exceed a certain threshold[2], a can reserve the additional bandwidth temporarily for a certain period and forwards the SIREQ to the network layer for routing. Otherwise a drops SIREQ.
- In SAHN-MAC nodes operate in promiscuous mode. Any passive participant p receiving SIREQ for s estimates $\mathrm{U_p^s}$ and reserves the additional bandwidth temporarily for a certain period.
- If a SIREQ reaches its final destination, a reply (SIREP) packet is sent back. Any active and passive participants receiving SIREP update the timeout period of the reserved bandwidth with the total duration of s.

In the following sections we will show how $\mathrm{U_a^s}$ and $\mathrm{U_p^s}$ can be estimated. In this paper we will consider networks with a single frequency channel and omnidirectional antennas. We will also provide experimental results to verify the correctness and effectiveness of our protocol.

5 Estimating $\mathrm{U_a^s}$

We use a session s that consists of a single data packet for our analytical model. We also assume that nodes are aligned in a straight line and the transmission of any node can reach up to one neighbor in each direction.

First of all consider the base case for s. A network setup with only 2 nodes and a session s is considered as the base case for s. Here the network shown in Figure 1(a) is the base case for s. Assume that for the base case a single network transaction takes place between $\mathrm{T_1 - T_2}$. Based on the basic principle, described at the beginning of this section, we can say $\mathrm{U_A^s = U_B^s}$. If $\mathrm{U^{s(b)}}$ denotes the base case bandwidth utilization for s we can write

$$U^s_{A/B} = U^{s(b)} \tag{1}$$

Now assume that s is executed in a network with 3 nodes (Figure 1(b)). Within $\mathrm{T_1 - T_2}$ s will consume almost the same amount of bandwidth at all three nodes, i.e. $\mathrm{U_A^s = U_B^s = U_C^s = U^s(b)}$. Since all links are sharing the same frequency channel, A will hear the transmissions from B while another transaction occurs between B and C from time $\mathrm{T_3}$ to $\mathrm{T_4}$. Hence from $\mathrm{T_3}$ to $\mathrm{T_4}$ all three nodes will spend the same amount of bandwidth as they have spent within $\mathrm{T_1 - T_2}$. If we add all the bandwidth utilization of each node from $\mathrm{T_1}$ to $\mathrm{T_4}$ we can come up with the following expressions:

$$U^s_{A/B/C} = 2 \times U^{s(b)} \tag{2}$$

If the number of active participants of s are increased to 4 (Figure 1(c)), there will be 3 transactions occurring between $\mathrm{T_1}$ to $\mathrm{T_6}$. Both A and D can hear at most 2 transactions whereas both B and C can hear 3 of them. Hence the bandwidth utilization of each active participants can be expressed as follows:

$$U^s_{A/D} = 2 \times U^{s(b)},\ U^s_{B/C} = 3 \times U^{s(b)} \tag{3}$$

Increasing the number of active participants of s to 5 results in 4 transactions (Figure 1(d)) to take place between $\mathrm{T_1}$ to $\mathrm{T_8}$. Node in the middle, i.e. C, is able to listen to all 4 transactions. This number decreases as we move towards the ends. The bandwidth utilizations of each node during $\mathrm{T_1 - T_8}$ become

$$U^s_{A/E} = 2 \times U^{s(b)},\ U^s_{B/D} = 3 \times U^{s(b)},\ U^s_C = 4 \times U^{s(b)} \tag{4}$$

Eq. 4 is also valid if the number of active participants of s is increased to 6 (Figure 1(e)).

Now we will deduce a generalized form of the equations 1-4. From these equations we can infer that $\mathrm{U_a^s}$ of an active participant a depends on the number of transactions that a can hear transferring the same data packet for s. For example node C in Figure 1(d) can sense that the same data packet is being carried in 4 different transactions. Since the bandwidth utilization for each transaction is $\mathrm{U^s(b)}$, $\mathrm{U_C^s}$ of all 4 transactions should be $4 \times \mathrm{U^s(b)}$. This matches with equation 4. It should be noted that each transaction involves a specific link that joins the transmitting and the receiving active participants. For example node C in Figure 1(d) can sense that the same data packet is being carried by 4 links (i.e. links AB, BC, CD and DE) in 4 different transactions. Hence for a given session s the number of transactions can

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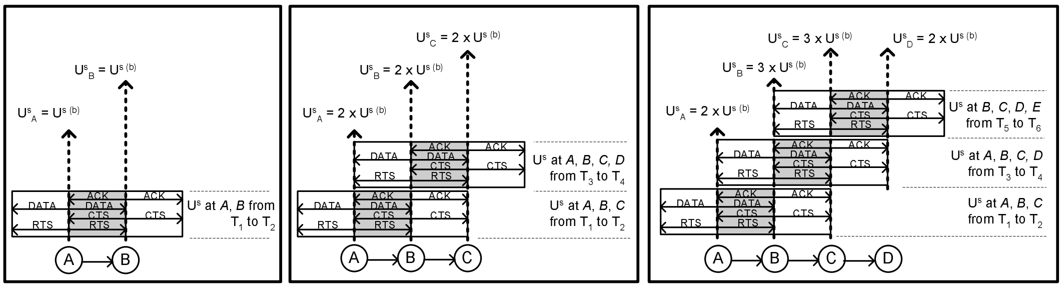
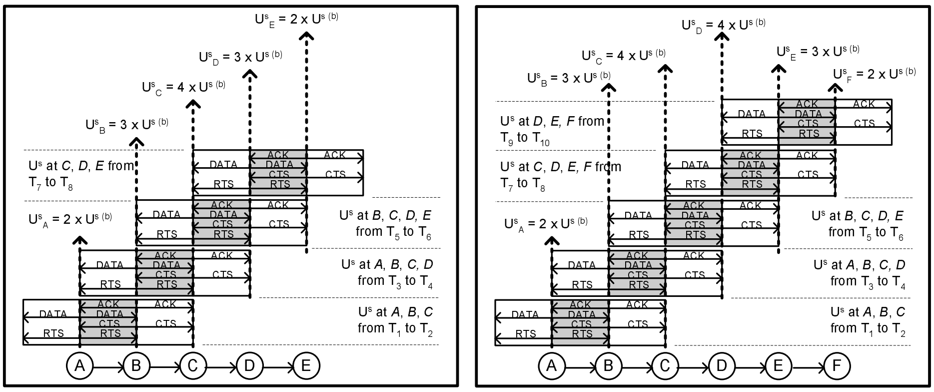
[2] This threshold should be less than the saturation limit, e.g. 90%.



(a) U^s in a 2 node network

(b) U^s in a 3 node network

(c) U^s in a 4 node network



(d) U^s in a 5 node network

(e) U^s in a 6 node network

Figure 1. An analytical model showing U^{s} of each node in different networks. A network setup with only 2 nodes and a session s is considered as the base case for s. It is denoted by $s(b)$. Therefore $\mathrm{U}^{\mathrm{s(b)}}$ denotes the base case bandwidth utilization for s.

be replaced by the number of links that an active participant a can hear carrying the same data packet for s. Therefore the generalized form of equations 1-4 can be written as

$$U_a^s = x \times U^{s(b)} \quad \text{where } x = 1,2,3... \qquad (5)$$

Here x denotes the number of links that a can hear carrying the same data packet for s.

When an active participant receives a SIREQ for a session s, it can predict the additional bandwidth utilization for s using equation 5. However, this equation does not consider the U^{s} of neighboring passive participants. The next section deals with this issue.

6 Estimating $\mathrm{U}^{\mathrm{s}}_{\mathrm{p}}$

Let us consider the same session s from previous section to be used in network shown in Figure 2. This network consists of both active (i.e. nodes A-D) and passive (i.e. nodes E-K) participants of s. The passive participants are placed in such a way that each of them could be within the transmission range of at most 2 active participants.

Since s consists of a single data packet and there are 4 active participants, there will be 3 transactions involving 3 links (i.e. links AB, BC and CD) for carrying the data packet. From the initial discussions of previous section we can say that the first transaction, occurring between $\mathrm{T}_1 - \mathrm{T}_2$ and carrying the data packet through the link AB, consumes almost the same amount of bandwidth at nodes A, B, C, E ,F , G and H. That is during $\mathrm{T}_1 - \mathrm{T}_2$, $\mathrm{U}^{\mathrm{s}}_{\mathrm{A}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{B}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{C}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{E}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{F}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{G}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{H}}$ = $\mathrm{U}^{\mathrm{s}}(\mathrm{b})$. Similarly for second transaction, taking place between $\mathrm{T}_3 - \mathrm{T}_4$, we can write $\mathrm{U}^{\mathrm{s}}_{\mathrm{A}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{B}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{C}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{D}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{G}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{H}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{I}}$ = $\mathrm{U}^{\mathrm{s}}(\mathrm{b})$. Finally for the last transaction, happening between $\mathrm{T}_5 - \mathrm{T}_6$, we can say $\mathrm{U}^{\mathrm{s}}_{\mathrm{B}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{C}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{D}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{D}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{H}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{I}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{J}}$ = $\mathrm{U}^{\mathrm{s}}_{\mathrm{K}}$ = $\mathrm{U}^{\mathrm{s}}(\mathrm{b})$. Summing up the bandwidth utilization of each passive participant from $\mathrm{T}_1 - \mathrm{T}_6$ we get

$$U^s_{E/K/F/J} = U^{s(b)}, \ U^s_{G/I} = 2 \times U^{s(b)}, \ U^s_H = 3 \times U^{s(b)} \qquad (6)$$

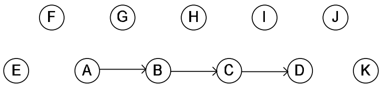


Figure 2. A communication path consisting of nodes from A to D with neighbors from E to K.

It is evident from equations 6 that the relationship between $\mathrm{U^s_p}$ and $\mathrm{U^s(b)}$ depends on the number of links that p can hear carrying the same data packet for s. Therefore $\mathrm{U^s_p}$ can be calculated using an equation similar to 5, i.e.

$$U^s_{a/p} = x \times U^{s(b)} \text{ where } x = 1,2,3... \tag{7}$$

Here x denotes the number of links, joining active participants, that a or p can hear carrying the same data packet for s.

It should be noted that SAHN-MAC requires each active participant of a session s to estimate both $\mathrm{U^s_a}$ and $\mathrm{U^s_p}$. On the other hand, passive participants need only to calculate $\mathrm{U^s_p}$.

7 Determining the value of x

A node broadcasts the following information up to 2 hop neighbors: (1) its geographical location, (2) list of its neighbors and their geographical locations, and (3) transmission ranges assigned to each neighbor.

Each node records such information from all the neighbors residing within 2 hop radius. This information are needed for determining the value of x. A node does not need to broadcast this information very often if the network is quasi-static (i.e. nodes are not mobile) in nature like a SAHN. Now we will show how a node, i.e. active or passive participants of a session s, can use the aforementioned information to find the value of x.

7.1 Determine x of $\mathrm{U^s_a}$ by a

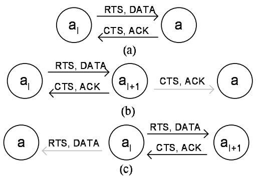


Figure 3. Possible positions of an active participant a from where it may hear the transactions related to s.

An active participant a receiving a SIREQ for a session s calculates $\mathrm{U^{s(b)}}$. Then it goes through the following steps to determine the value of x to estimate $\mathrm{U^s_a}$:

(1) Initializes x to 0.

(2) Makes a list of all active participants of s within 2 hop radius of a. The nodes in this list should be ordered based on the hopping sequence of the data packets of s. Assume the list consists of $a_1, a_2...a_n$ including a.

(3) For each $a_l \in \{a_1, a_2...a_n\}$, a increments x by 1 if any of the following cases is true:

- a_l is an immediate upstream neighbor
- $a_l = a$, e.g. Figure 3(a)
- a_l is a two hop neighbor as shown in Figure 3(b) and the transmission range corresponding to the link $a_{l+1}a_l$ match with that of $a_{l+1}a$
- a_l is an immediate downstream neighbor as shown in Figure 3(c) and the transmission range associated to the link a_la_{l+1} match with that of the link a_la

7.2 Determine x of $\mathrm{U^s_p}$ by a

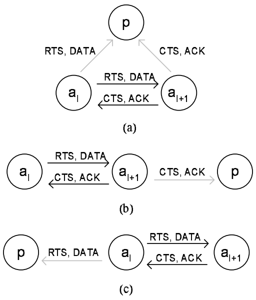


Figure 4. Possible positions of a passive participant p from where it may hear the transactions related to s.

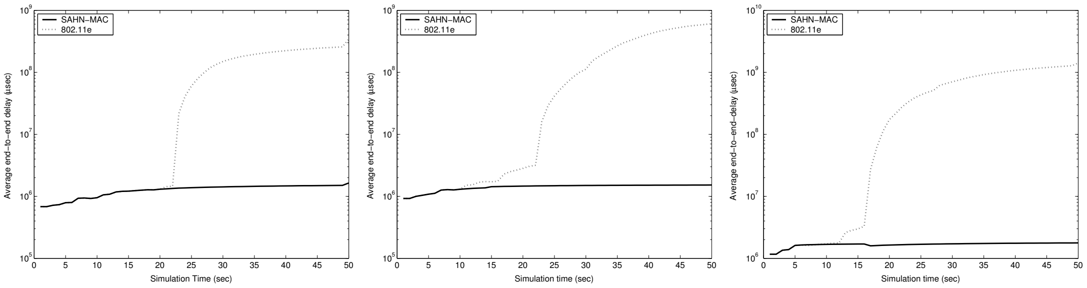
Lets assume that p is a neighboring passive participant of a. a has to determine the value of x related to $\mathrm{U^s_p}$ as well. To do so it performs the following tasks:

(1) Initializes x to 0.

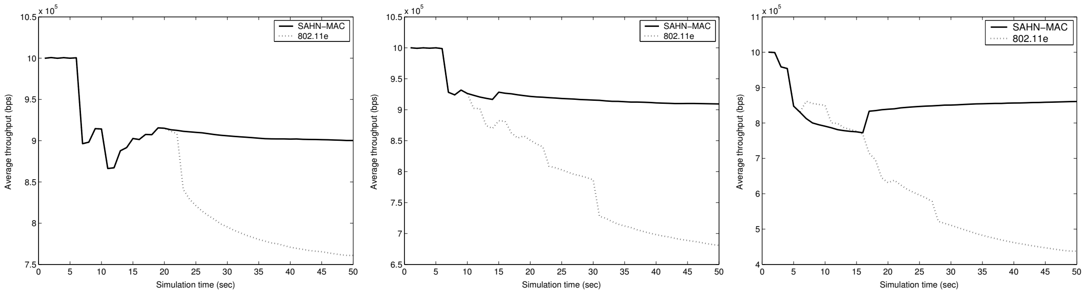
(2) Makes a list of all active participants of s within 2 hop radius of p. The nodes in this list should be ordered based on the hopping sequence of the data packets of s. Assume the list consists of $a_1, a_2...a_n$ including a.

(3) For each $a_l \in \{a_1, a_2...a_n\}$, a increments x by 1 if any of the following cases is true:

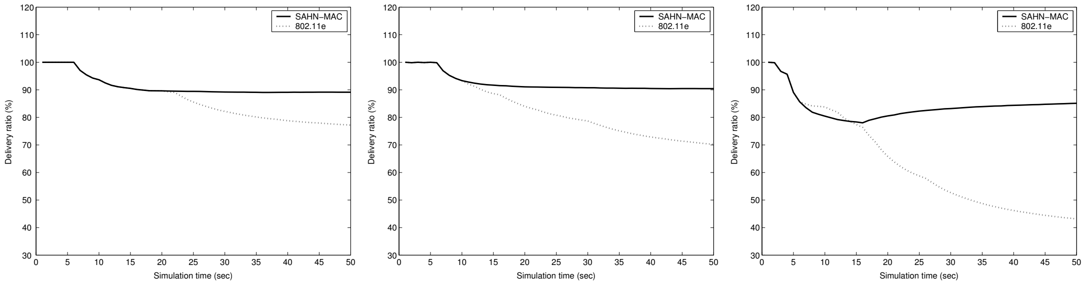
- $a_l = a$, p is located in a position similar to Figure 4(a) and the transmission range corresponding to the link a_la_{l+1} (or $a_{l+1}a_l$) match with that of a_la_p (or a_la_p)
- a_l is a two hop neighbor of p as shown in Figure 4(b) and the transmission range corresponding to the link $a_{l+1}a_l$ match with that of $a_{l+1}p$
- a_l is a two hop neighbor of p as shown in Figure 4(c) and the transmission range corresponding to the link a_la_{l+1} match with that of a_lp



(a) Path length of each session is 4 (b) Path length of each session is 5 (c) Path length of each session is 6



(d) Path length of each session is 4 (e) Path length of each session is 5 (f) Path length of each session is 6



(g) Path length of each session is 4 (h) Path length of each session is 5 (i) Path length of each session is 6

Figure 5. Performance results using SAHN-MAC and 802.11e. (a), (b) and (c) show average end-to-end delay. (d), (e) and (f) represent average throughput. (g), (h) and (i) refer to number of bytes received successfully. For each performance category path length of each session was kept fixed. However the path length was varied from 4 to 6 among the three cases of each category.

7.3 Determine x of $\mathrm{U}^{\mathrm{s}}_{\mathrm{p}}$ by p

A passive participant p receiving SIREQ packets associated with a session s calculates $\mathrm{U}^{\mathrm{s(b)}}$. Then it performs the following tasks to determine the value of x to estimate $\mathrm{U}^{\mathrm{s}}_{\mathrm{p}}$:

(1) Initializes x to 0.

(2) Makes a list of all active participants of s within its 2 hop radius. The nodes in this list should be ordered based on the hopping sequence of the data packets of s. Assume the list consists of $a_1, a_2...a_n$.

(3) For each $a_l \in \{a_1, a_2...a_n\}$, p increments x by 1 if any of the following cases is true:

- p is located in a position similar to Figure 4(a) and the transmission range corresponding to the link $a_l a_{l+1}$ (or $a_{l+1} a_l$) match with that of $a_l a_p$ (or $a_{l+1} a_p$)

- Same as 7.2

- Same as 7.2

It should be noted that though p may receive multiple $\mathrm{RTS}_{\mathrm{SIREQ}}/\mathrm{CTS}_{\mathrm{SIREQ}}$ from multiple active participants of s, it estimates $\mathrm{U}^{\mathrm{s}}_{\mathrm{p}}$ once.

8 Updating total U of neighbors

Whenever an active participant a receives a SIREQ for a session s, it has to know the current $\mathrm{U}_{\mathrm{p}}^{\mathrm{Total}}$ of each neighboring passive participant p. The estimated $\mathrm{U}_{\mathrm{p}}^{\mathrm{s}}$ is added to the current $\mathrm{U}_{\mathrm{p}}^{\mathrm{Total}}$ of p and checked to see whether the estimated future $\mathrm{U}_{\mathrm{p}}^{\mathrm{Total}}$ exceeds a certain limit. Disseminating $\mathrm{U}^{\mathrm{Total}}$ of each node to its neighbors can be achieved via periodical broadcasts of a special control packet. Alternatively a node can piggyback this information on other control packets periodically sent to its neighbors. This later process may reduce network overhead for SAHN-MAC.

9 Performance of SHAN-MAC

This section compares performance of SAHN-MAC and 802.11e with respect to end-to-end delay, throughput and delivery ratio. Delivery ratio of a session s can be defined as the percentage of data received successfully at the final destination of s. We have placed 30 nodes on a 1500×1500 square meters flat terrain. Each node had at most 6 neighbors. Each simulation run consisted of at most 12 1 Mbps sessions where each session was added every 2 seconds and executed for 50 seconds. For simplicity it was assumed that all established sessions were of the same access category and executed till the end of the simulation run. The path lengths (in terms of total number of active participants) of all sessions in each run were kept fixed. However among various runs they were varied from 2 to 6. The average values of all performance metrics were recorded at 1 second interval. With current configurations both SAHN-MAC and 802.11e performed similarly up to path length 3. Therefore we have omitted these results in Figure 5.

The graphs in Figure 5 can be explained as follows. Additions of new sessions increased network load. Since 802.11e does not have any admission control mechanism, it could not stop the network from overloading. On the other hand, SAHN-MAC did not allow any session to initiate if the new session was vulnerable to network performance. Thus SAHN-MAC maintains fairly stable network performance compared to 802.11e.

10 Conclusion

We have extended our initial MAC layer admission control and bandwidth reservation scheme [8] to support QoS to real-time traffic by involving neighboring nodes in bandwidth calculation. Simulation results show that SAHN-MAC can prevent network from getting saturated, hence can ensure desired QoS to existing data streams. At present we are extending our protocol for multiple frequency channels and directional antennas [10]. In future we would also like to build a scheduling scheme at the MAC layer to handle different classes of traffic efficiently.

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