Load Balancing in Mobile Ad-hoc Network

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Abstract— Mobile Ad-hoc network (MANET) is a collection of mobile nodes that are dynamically and arbitrarily located in such a manner that interconnections between the nodes are capable of changing on continuous basis. As the load on MANET networks increases the importance of bandwidth efficiency also increases. Coordinated channel access protocols are well suited under the uniform load distribution but these protocols are not well suited under the non-uniform load distribution due to lack of on demand dynamic channel allocation mechanisms. To overcome this problem we present a lightweight dynamic channel allocation mechanisms and cooperative load balancing mechanism that are applicable to cluster based MANETs. Apply these two algorithms for managing nonuniform load distribution in MANETs into energy efficient real time coordinated MAC protocol named as MH-TRACE. These mechanisms improve performance in terms of throughput, energy consumption.

Keywords— bandwidth efficiency, dynamic channel allocation, load balancing, MH-TRACE, mobile ad-hoc network.

I. INTRODUCTION

Mobile Ad Hoc Network (MANET) is the category of wireless network which uses multi hop radio relaying & is capable of operating without any fixed infrastructure. Due to mobility of node its topology changes dynamically [1].

Some of the applications of MANETs are military or police exercises, disaster relief operations, mine site operations, search and rescue operations and urgent business meetings[1]. Group communications has been essential for many applications in MANETs and applications supported by these networks have become increasingly resource intensive. This in turn, has increased the importance of bandwidth efficiency in MANETs. It is important for the medium access control (MAC) protocol of a MANET not only to adapt to the dynamic environment but also to efficiently manage bandwidth utilization. Medium Access Control (MAC) protocols are employed to control access to the channel in order to regulate transmissions to avoid or minimize collisions. The MAC protocol is the key element in determining many features of a wireless network, such as throughput, Quality of Service (QoS), energy dissipation, fairness, stability, and robustness. In other words, the performance of a particular network highly depends on the choice of the MAC protocol.

Network load of MANET is not uniformly distributed due to node mobility and dynamic nature of sources in MANET. Proposing two algorithms that is cope with non uniform distributions in MANETs 1) A light weight distributed dynamic channel allocation algorithm that based on spectrum sensing. 2) A cooperative load balancing algorithm in which nodes select their channel access providers based on the availability of the resources. These two algorithms are used for managing nonuniform load distribution in MANETs into an energy efficient real-time coordinated MAC protocol, named MH-TRACE [2].

II. LITERATURE SURVEY

Cidon and M. Sidi,[3]present new distributed dynamic channel assignment algorithms for a multihop packet radio network are introduced. The algorithms ensure conflict-free transmissions by the nodes of the network. The basic idea of the algorithms is to split the shared channel into a control segment and a transmission segment. The control segment is used to avoid conflicts among nodes and to increase the utilization of the transmission segment. It is shown how these algorithms can be used in order to determine time-division multiple access (TDMA) cycles with spatial reuse of the channel. This algorithm does not optimally guarantees for a network with a fixed a-priori control channel assignment.

L. Gao and X. Wang [4] model the channel allocation problem in multi-hop ad hoc wireless networks as a static cooperative game, in which some players collaborate to achieve a high data rate. However, this approach is not scalable. In multi-hop wireless networks, CSMA techniques enable the same radio resources to be used in distinct locations, leading to increased bandwidth efficiencies at the cost of possible collisions due to the hidden terminal problem. Different channel reservation techniques are used to tackle the hidden terminal problem. Use of RTS/CTS packet exchange mechanism before the transmission of the data packet. 802.11 distributed coordination function (DCF) [5] uses a similar mechanism. Although this handshake reduces the hidden node problem, it is inefficient under heavy network loads due to the exposed terminal problem. Several modifications to the RTS/CTS mechanisms have been proposed to increase the bandwidth efficiency including use of multiple channels.
However, these approaches attempt to solve the problem of channel assignment when there is a single intended destination of each transmission, and they do not cover group communication. In many cases, using link layer multicasting/broadcasting increases the efficient use of network resources. Indeed, many MANET applications such as military field communications and inter vehicle communication systems make use of broadcast services. In this paper, we particularly focus on link layer broadcasting and consider MANET scenarios where the destination of the generated packet is not a specific node in the local neighborhood but all the nodes in the immediate neighborhood of the transmitter. The IEEE 802.11 standard defines and allows link layer broadcasting services for both infrastructure and ad hoc modes. In ad hoc broadcast communication mode, the IEEE 802.11 MAC DCF specification disables the RTS/CTS mechanism as well as acknowledgments (ACKs). There is no MAC-level recovery or re-transmission for broadcast frames.

Y.-C. Tseng, C.-M. Chao, S.-L. Wu, and J.-P. Sheu [6] proposed a location aware dynamic channel allocation scheme for the MANETs. In this paper, a new location aware channel assignment protocol called GRID-B is proposed. The protocol assigns channels to mobile hosts based on the location information of mobile hosts that might be available from the positioning device (such as GPS) attached to each host. No location-aware channel assignment protocol has been proposed before for MANETs. Several channel borrowing strategies are proposed to dynamically assign channels to mobile hosts so as to exploit channel reuse and resolve the unbalance of traffic loads among different areas (such as hot and cold spots).

K. Chowdhury, P. Chanda, D. Agrawal, and Q.-A. Zeng [7] proposed a distributed channel allocation scheme to exploit multi-channel capacity in sensor networks while taking into interference avoidance. If allocated channels do not repeat within 2-hops of a node, both primary (sender and receiver using same channel) and secondary (communication between sender and receiver interfering with another pair-wise data transfer) interference can be avoided. In this channel assignment algorithm has to ensure minimum energy consumption for its operation and use the fewer number of channels separating them as much as possible in the frequency band, thus achieving high frequency reuse. DCA achieves a significant reduction in latency, reduced message complexity and considerable energy savings in the coloring process when compared with the existing schemes. But it does not suited to larger k-hop clusters.

III. METHODOLOGY

Multi-Hop Time Reservation Using Adaptive Control for energy efficiency (MH-TRACE) is a distributed MAC protocol for energy efficient real-time packet broadcasting in a multi-hop radio network. In MHTRACE, the network is dynamically partitioned into clusters without using any global information except global clock synchronization. In MH-TRACE, the network is partitioned into overlapping clusters through a distributed algorithm, which needs very little control overhead. In MH-TRACE, certain nodes assume the roles of channel coordinators called as cluster heads (CHs). All CHs send out periodic Beacon packets to announce their presence to the nodes in their neighbourhood. When a node does not receive a Beacon packet from any CH for a predefined amount of time, it assumes the role of a CH. This scheme ensures the existence of at least one CH around every node in the network.

MH-TRACE Frame Format

Fig. 1 shows a snapshot of MH-TRACE clustering and medium access for a portion of an actual distribution of mobile nodes.
In MH-TRACE, the network is organized into overlapping clusters through a distributed algorithm. Time is organized around super frames with duration $T$, matched to the periodic rate of voice packets, where each super frame consists of $N_f$ frames. The frame format is presented in Fig. 3. Each frame consists of two subframes: a control subframe and a data subframe. The control subframe consists of a beacon slot, a clusterhead announcement (CA) slot, a contention slot, a header slot, and an information summarization (IS) slot. At the beginning of each occupied frame, the clusterhead transmits a beacon message. This is used to announce the existence and continuation of the cluster to the cluster members and the other nodes in the transmit range of the clusterhead. By listening to the beacon and CA packets, all the nodes in the carrier sense range of this clusterhead update their interference level table. Each clusterhead chooses the least noisy frame to operate within and dynamically changes its frame according to the interference level of the dynamic network.

A. Collaborative Load Balancing for MANET

DCA-TRACE, which tackles non-uniform load distribution by allowing the CHs to access more than one frame in the superframe. The same problem can also be tackled from the member nodes’ perspective. The majority of the nodes in a TRACE network are in the neighborhood of more than one CH. The nodes that are in the vicinity of more than one CH can ask for channel access from any of these CHs. Using a cooperative approach and a clever CH selection algorithm on the nodes, the load can be migrated from heavily loaded CHs to the CHs with more available resources. In the TRACE protocols, nodes contend for channel access from one of the CHs that have available data slots around themselves. After successful contention, they do not monitor the available data slots of the CHs around them. Due to the dynamic nature of the network load, a cluster with lots of available data slots may become heavily loaded during a data stream. In order to tackle this issue, nodes should consider the load of the CH not only when they are first contending for channel access but also after securing a reserved data slot during the entire duration of their data stream. Consider Fig. 3.

Nodes A-G are source nodes and need to contend for data slots from one of the CHs. Each CH has 6 available data slots. In MH-TRACE, if their contentsions go through in alphabetical order, node G would mark CH1 as full and would ask for channel access from CH2. However, if node G secures a data slot from CH1 before any of the nodes A-F, one of the source nodes would not be able to access to the channel. In DCA-TRACE, once CH1 allocates all of its available slots, it triggers the algorithm to select an additional frame.

However, accessing one additional frame might not always be possible, if the interference levels on all the other frames are too high. Moreover, accessing additional frames increases the interference in the Beacon and Header slots of these frames and may trigger CH resignations and reselections in the rest of the network that temporarily disturbs ongoing data streams on the resigned CHs. Finally, accessing additional frames increases interference on the IS and data slots of the new frame and decreases the potential extent these packets can reach.

Figure 3. Demonstration of a Scenario for the collaborative load balancing algorithm [2].

IV. CONCLUSION & FUTURE WORK

The proposed light weight dynamic channel allocation algorithm and a cooperative load balancing algorithm to MH-TRACE protocol is used to solve the problem of non uniform load distribution in mobile ad hoc networks. For the maximizing the improvements in system, two algorithms Dynamic Channel Allocation for TRACE and Collaborative Load Balancing for MANET used simultaneously. DCA-TRACE, CMH-TRACE,CDCA-TRACE give the improved performance in the MANET as it reduced the number of blocked nodes, increases the rate of transmission, increases the throughput, less energy consumption and decreasing the delay and it also not increase much overhead of within a system.

Due to dynamic channel allocation mechanism DCA-TRACE is not affected from the non uniformities in the load distribution as much as MH-TRACE. Hence rate of increase of average no of transmitted packets per packet generation interval for DCA-TRACE compared to MH-TRACE,CDCA-TRACE not only increase the no of source nodes that can get the channel access compared to uncoordinated protocol,IEEE 802.11, but also reduces no of collision average energy consumption.

This paper focuses on bandwidth efficiency and leaves the adaptation of the system for delay sensitive communication as future work. In this channel handover is not implemented.
REFERENCES


