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A CENTRALIZED AND DISTRIBUTED BASED FORWARDING TECHNIQUE TO IMPROVE THROUGHPUT IN MULTI-HOP WIRELESS MESH NETWORKS

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ABSTRACT

Wireless Mesh Network (WMN) is a multiradio multihop network that is emerged as prime technology for the next generation wireless networks. Because of their vantages over other wireless networks, WMN gains rapid progress and renders numerous applications. This paper presents high throughput reliable multicast in multihop wireless mesh networks. The combined MAC layer retransmission, link quality awareness and wireless broadcast advantage are capture to design Expected Multicast Transmission Count (EMTX). EMTX based multicast routing will give high end to end packet delivery, less hop by hop transmissions per packet. The objective of EMTX metric is to minimize the transmission count and keep the throughput reliability of the system in specified level. We propose a polynomial-time greedy algorithm for the multicast problem and analyze its worst-case approximation ratio. Further, we extend the centralized algorithm to a distributed version as an EMTX based multicast routing protocol, and demonstrate their effectiveness in tackling the EMTX-based multicast problem with a combination of theoretical and numerical results. Simulation experiments show that, in comparison with two baseline approaches, EMTX-based multicast routing reduces the number of hop-by-hop transmissions per packet by up to 40% and yet improves the multicast throughput by up to 24%.

KEYWORDS: Wireless mesh networks, Expected Multicast Transmission Count, selfish node, multihopping.

INTRODUCTION

Wireless mesh network is a multiradio multihop network and one of the emerging technologies that are developed to provide solutions to the retreats caused by the wireless adhoc networks. WMN offer high bandwidth, low cost design, all time connectivity features to the wireless network. The main components of WMN include the mesh routers, mesh clients and the gateways where the mesh routers are stationary and form the wireless mesh backbone, which in turn provides the multihop connectivity for the mobile mesh clients to communicate with each other or to the Internet through the access points.

The mesh clients can be mobile or stationary and can form a particular wireless network like adhoc networks, LAN etc. The multihop connectivity of the mesh network provides reliable delivery of information to the proper destination through the intermediate nodes on the course of transmission, even if the specified hosts fails to forward the packets. This explains the major characteristics of wireless mesh networks. WMN are dynamically self-organized, self-healing and reliable networks that maintain continuous connectivity among the nodes. These distinguished characteristics of the wireless mesh networks make WMN highly reliable and fault tolerant networks. The main features of the wireless mesh networks can be listed below [1]:

- Flexible network architecture, ease of deployment and configuration, capability to provide fault tolerant services, low cost and scalability.
- Mobility features are dependent on the node (clients) type.
- Routers are having less mobility and clients are either stationary or mobile.
- Power consumption constraints: the mesh routers do not have any power constraints rather the clients are required to have power efficient protocols.

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- Compatible and interoperable with the other existing wireless networks.
- Mesh routers have multiple radios and non overlapping channels which can be assigned to these radios.
- Able to integrate the functionality of heterogeneous networks, including both wired and wireless networks which provide multiple access types.

Fig.1 explains the architecture and communication between the components of WMN. Numerous applications in WMN are deployed using multicasting which is feasible in the day to day life, like webcasting, distance learning, online games, and video conferencing. [12].

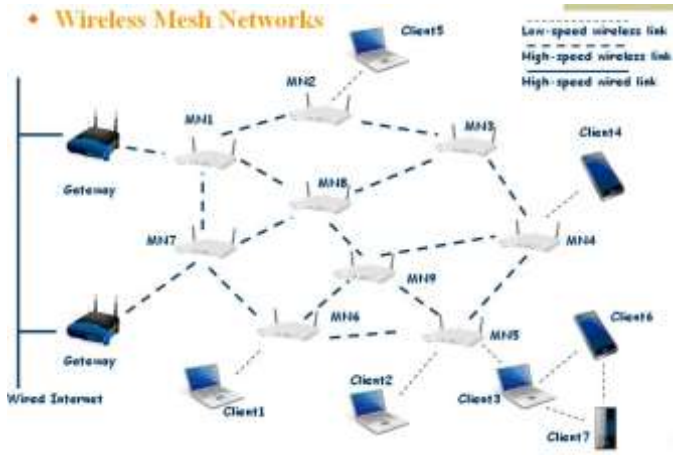

Fig. 1 Wireless Mesh Networks

Multicasting is a bandwidth conserving technology that helps to reduce the traffic by delivering the appropriate message or information to a group of receivers that can be anywhere or in any network. In the network environment, the host joins the multicast group by informing its local router that it wants to join the multicast group and the router in turn informs other multicast routers and thus a multicast tree is created using the multicast routing protocol. Multicasting reduces the cost of communication as compared to multiple uncasing [2]. It also reduces the bandwidth consumption and reduces communication delay.

Multicasting provides simple and robust communication in group communication scenario. Different algorithms are present today for multicasting in wireless mesh networks. Some algorithms use flooding of data, similar to broadcasting. But flooding may cause data overload in the network, because many nodes receive data that is not addressed to them. So better routing is needed to decrease the network load and ensure throughput reliability at the same time. In this paper we are considering multihop wireless mesh network (WMN).

Throughput reliability is a question in WMN, while the number of nodes and number of hopes increases. So we can utilize the wireless broadcast advantage in the design of routing algorithms which helps group communication. IEEE802.11 standard do not specifies a scheme for multicasting, which uses the basic RTS/CTS for multicasting[3]. Error recovery mechanism is not present in this basic multicasting. So, in case of multihop WMN the presence of selfish nodes and hidden nodes are often decreases the throughput of the system.

Many researchers put forwarded different algorithms to improve the reliability of MAC layer multicasting, but most of this studies are concentrated on singlehop multicasting [4,8,9]. Roy et al. [10] studied several routing metrics for throughput efficient multicast in WMN. They are all based on the conventional multicast mechanism defined in IEEE 802.11 standards, and do not take MAC-layer retransmission based reliability into account, In [5] Xin et al. proposed EMTX[EXPECTED MULTICAST TRNSMISSION COUNT] based algorithm for multicasting in multihop WMN, which is implemented over ADHOC routing protocol RMAC[6]. We used the same routing metric EMTX for algorithm development, but in a different way. We developed algorithm over multicast routing protocol Multicast ADHOC On-Demand Distance Vector With Backup Branches(MAODV-BB)[7].Retransmission based reliability of the system can be utilize to detect the selfish nodes[11].The rest of paper is organized as follows: Section II discusses about the Literature survey. Section III discusses about issues related works with multicasting transmission count. Section IV discusses about the EMTX based multicasting. Section V discuss about Simulation results and performance evaluation. And as we proceed further we conclude

with the related works, the factors that must be taken into consideration on designing the multicast protocols and the performance comparison of various protocols.

LITERATURE SURVEY

Wireless mesh networks (WMNs) consist of mesh routers and mesh clients, where mesh routers have minimal mobility and form the backbone of WMNs. Ref[1]is a detailed survey of the WMNs. A number of researchers study about the high- throughput multicast solutions for wireless mesh networks (WMN).In [2] Kuri et al. proposes a reliable multicast mech- anism for WLANs. It is a leader-based protocol to avoid the need of multiple positive ACK frames for multicast trans- missions. In [5]Xin et al. proposed EMTX based multicasting, which is developed over RMAC[6].In [7] Ujwala et al. proposed a multicast protocol for adhoc networks.We used the same MAODV-BB protocol as the base for EMTX proto- col development. MAODV-BB is an important multicasting protocol used in adhoc networks. A number of researchers evaluated its performance. Selfish node also can be detect by this algorithm. Selfish node is the node in a network which drops the packet selectively [11]

MAC layer multicasting with time-varying data rates has not been studied before. Most of MAC layer multicast protocols [13].[14] focus on the reliablility metric. In [15], Chaporkar *et al.* present an approach that tries to increase throughput by enhancing the resource utility in networks. This approach uses queue-lengths and estimates of the number of responding neighbors by measuring the busy tone power level, to determine whether to defer or continue with a multicast transmission. But accurately estimating the power level is difficult due to fading in the wireless links [16] and the latency introduced in this approach is unbounded. Time-varying channels and rate control has been studied by other researchers for unicast transmissions [17].[18]. To the best of our knowledge, our approach is the first MAC layer multicasting solution aimed at improving the throughput that accounts for realistic time-varying channels and uses multiple rates supported by the physical layer.

MULTICAST TRANSMISSION COUNT

The properties of the EMTX metric for multicast routing in multi-hop wireless mesh networks is similar to the EMTX proposed in[5]. EMTX based multicasting takes, retransmission based reliability, wireless broadcast advantage of the wireless nodes, channel quality awareness in to account. With the help of branch backup protocol we can sent group hello message for the development of multicast tree[7]. We set the number of retransmissions to seven which counts the number of trans- missions including retransmissions required to send a packet successfully. Algorithm selects the minimum transmission path as the efficient path. The computation of EMTX for a single-hop multicast transmission takes as input the link quality from the sender to each of its next hop receivers. We define the link quality of the (directed) wireless link i; j from node i to node j as the probability that a multicast transmission from node i is successfully received and acknowledged by node j. Note that the link qualities of hi; ji and hj; ii are not necessarily the same because the delivery probabilities for data and ACK frames can be different in the directions i; j and j; i. In our multicast framework, MAC-layer retransmission is used for reliability.

This means that a sender will retransmit a multicast packet to its next-hop destinations, which is not acknowledged the hello packet successfully. The EMTX of single-hop transmission of a multicast packet is defined as the expected number of multicast transmissions needed for all next-hop recipients to receive and acknowledge the packet successfully including retransmissions. The single- hop neighborhood of node n is defined as the set of nodes within the transmission range of node n. For an another node j to be within the transmission range of node n, we require that the link quality of the wireless link (n; j), denoted by p(i;j), is non-zero. In computing EMTX, we assume that the MAC layer of the sender continues to retransmit the multicast packet until it is successfully received and acknowledged by each of its next-hop receivers. We also assume that the link quality from the sender to each of its next-hop receivers is spatially and temporally independent. In this manner, the sequence of transmission/retransmissions of the multicast packet forms independent Bernoulli trials with an identical success probability. The formulation of routing metrics that incorporate the effect of reliable MAC layer broadcasts must not only account for the variable number of transmissions to different neighbors, but should also factor in the wireless broadcast advantage (WBA), whereby a single transmission can potentially cover multiple neighboring nodes The EMTX metric accurately captures the transmission over- head resulting from the use of a retransmission-based reliable MAC layer for link-layer multicast transmissions. EMT is not only able to account for the different loss rates on different.

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EMTX BASED MULTICASTING AND SELFISH NODE IDENTIFICATION

EMTX based multicasting is a transmission count based multicasting. Number of retransmissions purely related to the link quality. More number of retransmissions indicates less probability of successful transmissions i.e, poor link quality. If the number of transmissions in a multicast session increases, bandwidth consumption also increases. So the throughput decreases. Figure 2 shows multicast transmission by different algorithms.

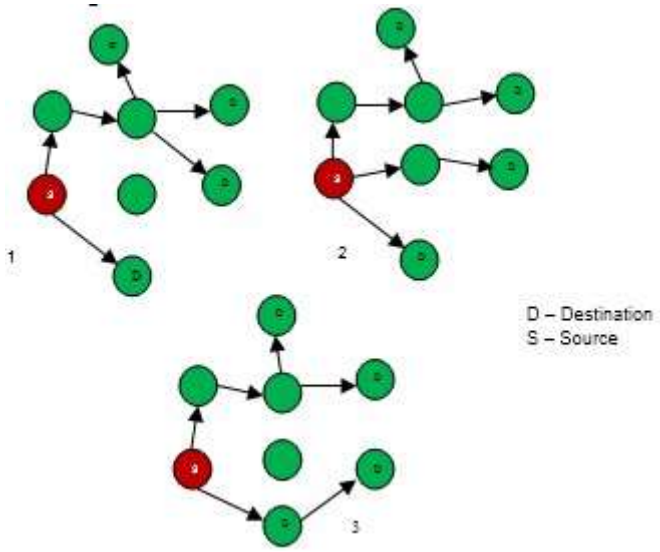

Fig. 2. Multicast by (1)EMTX based, (2) shortest path tree based,(3) Steiner tree based

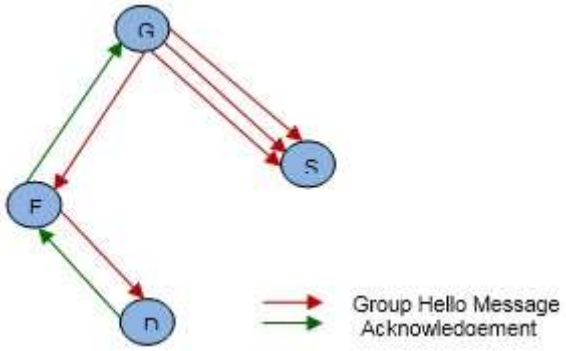

Fig. 3 Group hello message transmission

DISTRIBUTED ALGORITHMS

After forming shortest path we have to assign proper channel assignment for the transmission. Also if we want to add any new nodes we can add in this module. Also if there are any node failures or repair due to node mobility we can make repair or changes in this module. The main purpose of distributed algorithm is whenever a new node enters into the mesh network a path or channel must be assigned so that it can communicate easily with the other nodes. Moreover increase of new nodes reduces the capacity. The mesh network is a very large network, but we have centralized algorithms to find a shortest path and network flows are maintained by max min fairness. Now designing of distributed algorithm is to assign channel for the nodes. The output of centralized algorithm is input to distributed algorithm.

Algorithm Channel Assignment(node i)
Set of nodes V, channel c_j and current channel c_i

Begin
For all m = 1,2… M
$f(m) \leftarrow \sum_{J \in Si} f(m, c_j)$
if $f(c_i) > f(m)$ *for any m= 1,2…M then*
$c_i \leftarrow m_{min}$

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end for
end

Each node selects a minimum channel hence inference is minimized and throughput gets increased.

SIMULATION RESULTS AND PERFORMANCE EVALUATION

We run simulations with NS-2 to analyze the performance of EMTX based multicasting in wireless mesh networks. NS- 2 helps to transmit UDP packets over wireless environment by using TCP application. Also supports routing and multicasting over wired and wireless networks. With the help of branch backup protocol we can sent group hello message for the development of multicast tree we set the number of retrains- missions to seven which counts the number of transmissions including retransmissions required to send a packet success fully. Algorithm selects the minimum transmission path as the efficient path.

Table 1 Simulation Parameters

Parameter	Value
Number of nodes	30
Scene range	1500 BY 1500
Data pay load	512 Bytes/packet
Simulation time	80 sec
Propagation model	Two ray ground

Simulation environment

In the following simulation, 30 nodes and two access points distributed randomly in a square area about 1500 x 1500 meters. Radio propagation range for each node is 250 meters and channel capacity is 2 Mbps. Simulation is executed for 80 seconds of simulation time. A traffic generator is developed to simulate MCBR sources. The size of the UDP packet is 512 bytes. Each source node sends out 80 packets per second. In our experiments, two-ray ground propagation model is used which provides bidirectional transmission and the MAC layer protocol is IEEE 802.11.

While considering link quality and transmission count, we can see that EMTX based multicasting is efficient. However, in WMN environment some participants can exhibit selfish behaviors, by dropping the packets selectively, in order to prioritize their own traffic and increase their network utilization EMTX based multicasting can be used to detect the selfish nodes figure shows the group hello message transmission while multicast tree formation group leader, forwarder node, selfish node, destination node all are mesh clients.

From the above figure it is clear that selfish node drops the packets and more number of transmissions become needed this causes less link quality assignment to the selfish node Our algorithm selects minimum transmissions path with better link quality so selfish node do not come in the efficient path provided by the EMTX based algorithm.

Simulation results and evaluation

We observe from the simulation result that EMTX based multicasting can perform efficient multicasting in wireless mesh network. Group members can share more efficient routing data by Backup branching technique this algorithm minimizes the number of hops. Fig.5 shows average throughput.

We started multicast transmission from 25th second of simulation time. When the load of network is 70 packets per second, average throughput obtained is about 320Kb/s. Fig. 6 shows the packet delivery ratio (PDR), Which is also maintained at a high level. The existence of backup branches reduce the repetition of tree reconstruction and ensures high packet delivery ratio. Fig. 7 shows the average energy, which is decreasing, but it reaches to only 83 Joules after whole simulation.

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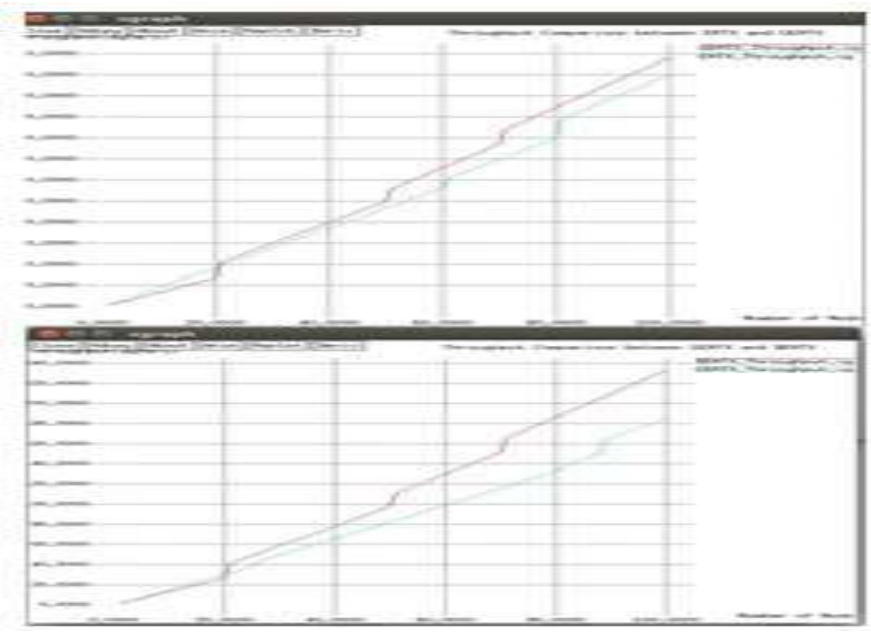

Fig. 5. Average throughput comparison

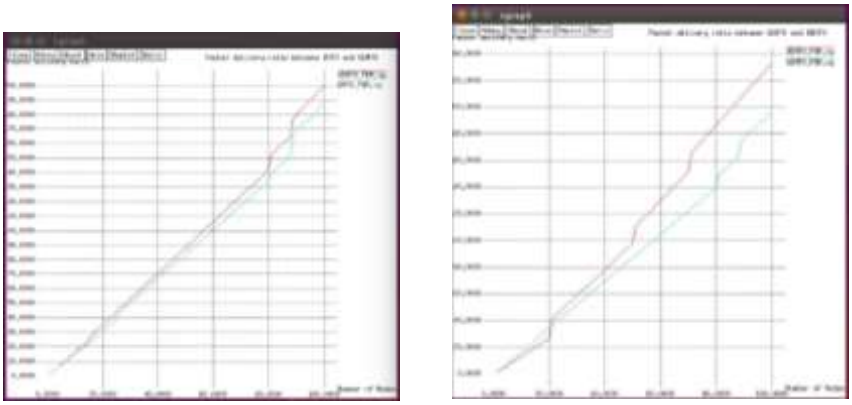

Fig. 6 Packet delivery ratio

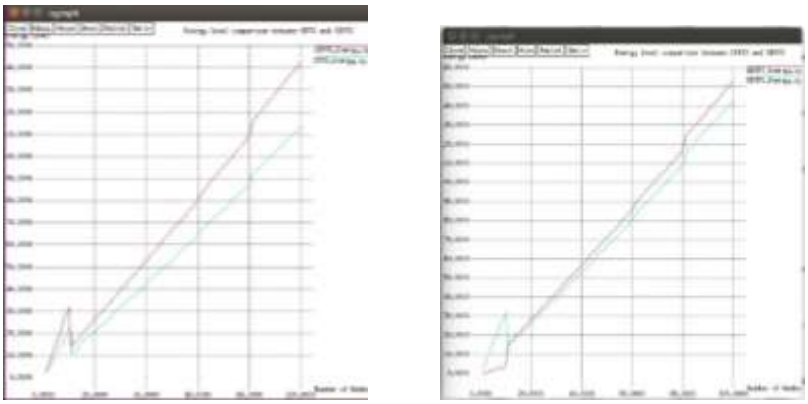

Fig. 7 Average energy comparison

CONCLUSION

This work is on developing high-throughput algorithms for Reliable Multicast in Multihop Wireless mesh network. We have proposed EMTX as a robust metric that capture the combined effects of MAC-layer retransmission based reliability, wireless broadcast advantage,and link quality awareness. we have proved an

efficient Greedy based EMTX and we present Greedy algorithm and optimal algorithm to achieve quality of parameters and designed for the multicast problem. we have also implemented distributed algorithm as a multicast routing protocol and EMTX based multicast routing can effectively reduce transmission overhead and yet enhance multicast throughput. The evaluation of the proposed scheme is done by comparing the performance of EMTX two scenarios namely Greedy based EMTX and Distributed based EMTX. From the simulation results we observe that Greedy based EMTX give better performance than general EMTX .Similarly we observe efficient output to DEMTX

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