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A QoS-Aware Multipath Routing Protocol for Wi-Fi Based Long Distance Mesh Networks

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Abstract **- Routing plays a crucial role in provisioning Quality of Service (QoS) over WiFi-based Long Distance (WiLD) mesh networks. Traditional routing protocols normally maintain a single optimal path between each pair of source and destination nodes. In gateway-based mesh networks, the optimal paths between gateway and other nodes often overlap and hence degrades the overall network performance significantly. Multipath routing protocols are widely used in Wireless Mess Networks (WMN) for providing QoS to various network applications. Smooth routing of real time traffic with varying QoS requirements is a challenging task. In this paper, we propose a QoS-aware hybrid multipath routing protocol which can discover multiple maximally disjoint paths between a gateway and any other node. The gateway node selects n-best paths for the source node. Before starting a given real time flow, a path selection scheme chooses the appropriate path or set of paths amongst the available discovered paths. To evenly distribute the traffic among the paths chosen, an admission control mechanism has been proposed. In case of significant change in the quality of any discovered paths, a path maintenance process induces the source node to trigger a route update process. The proposed protocol enhances the performance of real time traffic significantly. The simulation results show that the proposed protocol achieves significant improvement in different QoS parameters. With the increase in number of disjoint paths from source to destination, a substantial improvement in throughput and delay is observed.**
Keywords**: QoS, Multipath Routing Protocol, Multipath Routing Protocol, Mesh Networks**

I. INTRODUCTION

WiFi-based mesh networks are becoming increasingly popular low cost technology for extending Internet to last mile connectivity. Long distance WiFi links are also being used in extending Internet connectivity from some central high bandwidth nodes to rural under-served areas. Real time services such as voice and video have become integral part of wireless mesh networks like in any other type of networks. Smooth running of such real time services demand some sort of QoS guarantees from the underlying networks.

The prospective real time applications over WiLD mesh network such as video-conferencing in rural Telemedicine, E-learning (mainly video traffic), Voice-over-IP (VoIP), etc., are required to run meeting the users expectations. The voice quality of most multimedia services deteriorate dramatically if the network delay increases beyond a certain level. On the other hand, a minimum throughput is also desirable in many bandwidth bound applications. Although there are many routing protocols specifically proposed for wireless networks, designing routing protocols for WiLD mesh network is still an active area of research. Routing protocols for WiLD mesh networks need to exploit the relatively static network topology with wireless links and deal with issues like interference and noise in a way that optimizes the overall network throughput and delay.

The classical routing protocols are not suitable in providing QoS over WiLD mesh networks. As a consequence, many new routing protocols have been designed to support QoS in WMNs. However, most of them do not address the overall QoS requirements of heterogeneous traffic types.

Various researchers claim that multipath routing technique is an effective strategy in achieving reliability over WMNs where the data transmission occurs through multiple paths from source to destination thus tolerating transient as well as permanent path failures. Reliable multipath routing protocols proposed in [1] and [2] support reliable data transfer between a pair of source and destination. Other existing multipath routing protocols ([3], [4], [5] and [6]) for WMN do not address the QoS requirements of traffic belonging to different priority classes. AOMDV [3] routing protocol discovers multiple loop-free disjoint paths and selects a single optimal path for transmission. A multigateway based multipath routing protocol proposed in [6]. Multipath routing protocols MP-DSR [7] and SMR [8] find disjoint for better performance. As most of the above protocols strive to provide QoS to a specific traffic class, they fail to provide QoS to heterogeneous real time traffic classes.

The multipath protocols discussed above fail to achieve bandwidth aggregation properties as they use only a single path to forward traffic. The path maintenance process of existing routing protocols only considers path failure condition, rather than considering path quality change. Most of the routing protocols do not have a novel path selection scheme to guarantee QoS for real time traffic. Attempting to provide QoS in single gateway based WiLD mesh network, this paper makes five key contributions.

First, we propose an integrated approach in determining delay and bandwidth metric on each hop to ensure delay and throughput requirements of real time traffic.

Second, we classify traffic flows from their characteristics and determine bounds in delay and bandwidth.

Third, we propose a novel multipath route discovery process by which multiple maximally disjoint paths , IEEE are discovered for a specific type of traffic. It also involves a route maintenance process having two major activities: path quality update and path failure update.

Fourth, a path selection scheme is proposed to find appropriate path for particular class of traffic.

Finally, a flow based admission control and load balancing scheme have been introduced in the routing protocol. The rest of the paper is organized into four sections. Section II takes a look on the related works and analyses the different existing routing protocols. Different aspects of the proposed protocols have been discussed in section III. Section IV describes the performance evaluation through simulation. Finally, section V gives the conclusion of the paper.

II. RELATED WORK

Many protocols have been developed for supporting multipath routing in WiLD network to improve QoS support. The QoS satisfaction using routing solutions in such network has been studied by many researchers. Some of the related works on routing protocols for WMN based on multipath discovery and providing QoS are presented as follows. The goal of a QoS routing protocol is to find a loop-free path satisfying a given set of constraints on parameters like bandwidth, delay, etc. The existing classical routing protocols are not suitable to providing QoS in WMNs

III. PROPOSED METHODOLOGY

The proposed routing protocol targets QoS provisioning in exploiting the relatively static nature of wireless nodes in WMN. The protocol uses a flow-path mapping technique which maps a flow to paths that meets the QoS requirements of the corresponding traffic. It establishes multiple paths for a single flow in order to meet the bandwidth requirement which could be provisioned as an aggregate of the available bandwidth of the selected paths. In its venture to provide QoS to real time traffic, it increases the throughput of the network with multipath consideration. Before moving to the detail proposed protocol, we discuss the traffic classes, routing metric, and routing tables used in this scheme.

Five different tables are used to maintain the routing path and flow related information at various nodes which help in implementing the routing mechanism. Routing Table is used for routing best-effort traffic and updating route information during maintenance phase. The source node maintains n best paths stored in Path Table to each destination corresponding to different real time traffic class using. A Flow table is maintained at each node in a path for forwarding the active flows through it. Source List is used in route maintenance. Neighbour Table is used to store information about all the neighbour nodes of a node. Below we provide the working of the routing protocol.

A. Principle

Algorithm Algorithm to process MPREQ Input:
Pkt MPREQ ← MPREQ packet from source node P N List ← Neighbor list at node Q
R Table ← Routing table at node Q ctimer ← Request cache timer

1. Dest ← DESTINATION REQ(Pkt MPREQ)
2. Src ← SOURCE(Pkt MPREQ)
3. Path ← PATH(Pkt MPREQ)
4. path delay ← PATH DELAY(Pkt MPREQ)
5. path BW ← PATH BW(Pkt MPREQ)
6. if Src = Node Q then
7. DISCARD PKT(Pkt MPREQ)
8. else if Dest = Node Q then
9. if ctimer = 0 then
10. start ctimer
11. end if
12. if path delay ≤ Δd ∧ path BW > Δb then
13. cache Pkt MPREQ
14. end if
15. else if Node Q not in Path then
16. for all Node u in N List do
17. Add hop delay(Q,u) to path delay
18. path BW ← min{path BW, avail BW(Q,u)}
19. if path delay ≤ Δd ∧ path BW > 0 then
20. Add Node Q in the Path
21. SEND PKT(Pkt MPREQ, u)
22. else
23. DISCARD PKT(Pkt MPREQ)
24. end if
25. end for
26. else
27. DISCARD PKT(Pkt MPREQ)
28. end if

B. Simulation Methodology

Wireless half-duplex links with 11 Mbps bandwidth are used for establishing communication between adjacent nodes. VoIP flow with packet size of 160 bytes generated at an interval of 20 ms is used for the simulation of traffic Class 1. To simulate Class 2 traffic, we have used video streaming traffic with 1250 byte packet size and at an interval of 33 ms. CBR traffic has been used to simulate Best-effort (Class 3) traffic.

IV. RESULTS

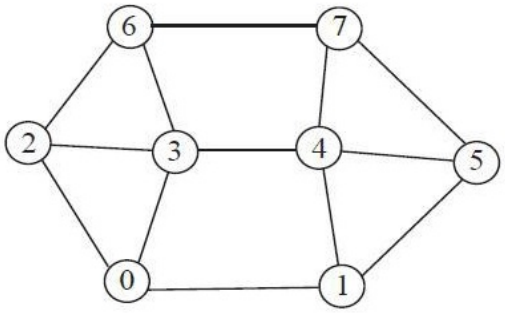

Fig. 1 Considered Simulation Topology

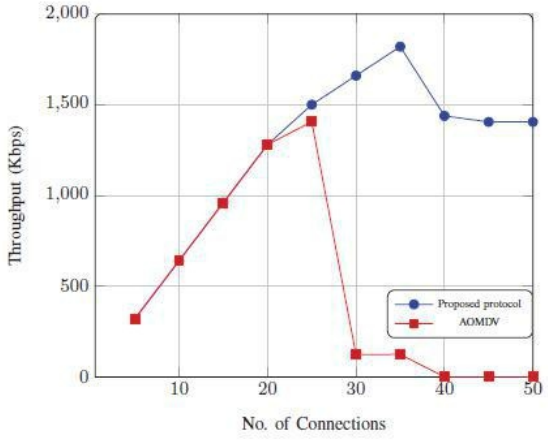

Fig. 2 Throughput achieved by VoIP traffic using the proposed and AOMDV routing protocol

V. CONCLUSION

In this paper, we have proposed a novel multipath routing protocol taking the QoS requirements of different real time applications into account. Classifying real time traffic into three specific categories and finding multiple quality path to the destination, the protocol allows the priority classes to route traffic with guaranteed QoS using the path selection procedure. Also the protocol uses a feedback based load balancing and path reservation scheme. Designing a multi-gateway based routing protocol to provide QoS with proper load balance

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