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Optimized Multi Radio Extension to AD HOC On-Demand Distance Vector for Hybrid WMNS

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Abstract: Wireless Mesh Network (WMN) is one of the promising and emerging wireless technologies for a number of interesting commercial applications. WMN is a multi-hop wireless access network, in which node acts as both host as well as router. Due to high level interference, the key challenges that WMN technology faces are its scalability and limited capacity, which is distinctive for multi-hop wireless networks. To address this problem, multiple wireless network interfaces (radios) per node has been proposed which is relatively simple and low cost approach. Radios were operated on non-overlapping and different channels, which efficiently use radio spectrum and reduce contention and interference. In this paper, we proposed an optimized on-demand routing with multi radio extension. By assigning one interface dynamically, the proposed method will send the control packets or data packets. The interface allocation is based on traffic direction and mesh routers. The proposed work is compared with the existing AODV-MR and proven to be effective in terms of routing packet overhead, throughput, packet delivery ratio and end to end delay.

Key words: Wireless Mesh Network · Multi Radio · AODV · Mesh router · Mesh client

INTRODUCTION

Recently, Wireless mesh networks (WMN) has attained considerable attention due to their low cost, rapid deployment and self-configuring capabilities. WMNs comprised of combination of mobile mesh clients and static mesh routers. The backbone infrastructure is formed by mesh routers and affords connectivity among the mesh clients and wired networks. Typically Mesh clients are more resource constrained than mesh routers. The architecture of wireless mesh network is classified into three methods namely client wireless mesh network, infrastructural backbone and hybrid mesh network [1-3]. The work proposed in this paper focused on hybrid mesh network, in which for accessing external network or internet gateway routers are used. The mesh routers are divided into border mesh routers and backbone mesh routers. The backbone mesh routers represent the network backbone and maintain the connectivity between border mesh routers and mesh gateway. But there is no communication directly with mesh clients. Border mesh network forwards traffic between mesh clients and mesh routers. Numerous research works have been carried out to relate Ad hoc network routing protocol to wireless mesh networks [4- 6].

The hybrid mesh network is divided into two types of traffic namely from single source to multiple destination and from multiple source to single destination. The wireless mesh networks indirectly make use of traditional Ad hoc networks. Since routing control packets were broadcasted more than one interface, which makes routing protocol to have a high routing overhead. It causes needless processing for bandwidth utilization and routing packets, which degrade the overall performance of the network. A routing scheme called AODV-ST was proposed and they analyzed on traffic which flow to gateway from router. In this work proactive approach is employed to discover routes between gateway and routers [7, 8]. For dynamic wireless mess network, multichannel routing protocol was proposed for wireless mesh network. This work is classified interfaces into two factors, one is switchable interface and other is fixed interface. In case of high traffic load this work might not be effective because of high switching interface [9,10].

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Based on interference, new metric was proposed to find the routing path, which reduces the intraflow and interflow interferences and support multi-radio networks for AODV protocol [11]. In wireless mesh network to exploit and discover multiple links, another extensive and using queue length as a metric with ad hoc on demand distance vector routing protocol was proposed [12, 13]. To reserve a number of mesh router radio channels, channel reservation scheme is introduced to support gateway traffic and local traffic [14, 15]. The existing Ad hoc On-Demand Distance Vector with multi radio allocate interface randomly for sending data packets, which is useless since there is unpredictable environment changes in wireless channel. In this proposed work loosely coupled scheme was used, the channel status is passed by MAC layer to the network layer and the channel used is decided by network layer. In this paper routing overhead is eliminated, instead of using all interfaces, in this proposed work single interface is selected in a dynamic manner. Only for sending data packets other interfaces are used, which improves the network efficiency. The routing metric will not be affected in choosing channel to communicate. In this paper, overall performance is improved by deeply reducing the intra-flow and inter-flow interference. The proposed technique proves the effectiveness of AODV in hybrid mesh network

Proposed Methodology: The proposed modified Ad hoc on demand routing protocol takes traffic exchange between mesh clients themselves and between mesh client, mesh router and gateway. There is no additional overhead in the size of the packets, since the proposed mechanism will not amend any control packets of AODV. The statement made for the proposed system are, all mesh routes and gateway have same number of channel allocation and multi-radio interfaces, there is no common channel for sharing two interfaces, each radio has its own physical and MAC layer which is considered to be non-overlapping channels as shown in Figure 1. In the proposed method channel assignment is integrated with AODV routing. The information of each channel is gathered by MAC layer and in cross-layer approach it passes to the routing layer. An appropriate channel is chosen by routing layer to forward control or data packets to next hope. Source and destination address are used to differentiate the network traffic directions. The sending and receiving packets are classified into three ways likely from gateway to mesh client, from mesh client to mesh client and from mesh client to gateway.

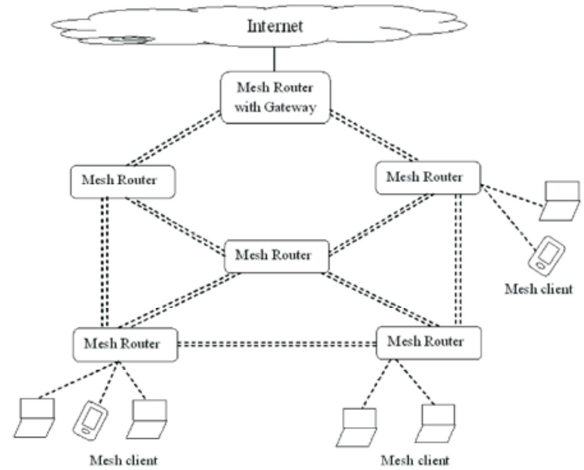

Fig. 1: Multi Radio WMN

In this proposed work route reply will be identical as that of route discovery, which means through an appropriate interface the destination node will unicast as mentioned in the process of route discovery. In route connectivity, for sending hello messages periodically both gateway and backbone mesh router will use same route discovery, whereas border mesh router will use channel same as that of mesh client. If gateway is a route source, then through best interface it will send precursor mesh routers, else it will use mesh client of same channel in case of source is mesh client. After establishing the route, data packets will be dynamically transmitted via interface from hop to hop, which makes high possibility of using channel diversity.

The efficiency and effectiveness of the proposed mechanism have been checked by packet delivery fraction, end to end delay, throughput and packet overhead. All these factors depend fully on latency, hop by hop and average number of packet losses or path losses based on hops and distance. The metrics Latency and delay depends on route discovery delay. The route discovery delay was also computed in the proposed system.

Performance Evaluation: The simulation of the proposed system is carried out with different Scenarios. The result obtained is compared with existing AODV-MR. The parameters packet delivery ratio, throughput, routing overhead and end to end delay were analyzed in the proposed system. In varying transmission rate circumstances, transmission rates are varied to learn the impact of traffic load. As shown in Figure 2, there is a direct relationship with transmission rate and end to end delay. MAC layer back off time and link layer contention will increase with the increasing traffic load, which increase the queue interface waiting time of packets. It prevents arrival of new packets and causes a queue overflow problem, which result in loss of new packets and arrival of retransmission mechanism and cause a high delay. The work proposed in this paper will drastically reduce the end to end delay when compared with the existing AODV-MR. In the proposed system, instead of using all interface to send packets, only single interface were used based on level of channel utilization. It will reduce the packets waiting time in queue interface and packet loss is eliminated due to overflow problem. In this proposed work, there is a prominent improvement in packet delivery fraction (PDF) as shown in Figure 3. From the Figure 4, it is clear that there is a direct relationship between overhead and packet rates. Compared with AODV-MR the work proposed in this paper has a reduced overhead. Due to packet loss, throughput also affected as shown in Figure 5. Compared with existing AODV-MR, our proposed system has a noticeable improvement and proven to be effective. In varying mesh clients scenario, network size is varied by varying mobile mesh clients. The number of connections between destinations and sources is fixed to 20 and rate of transmission is 20 packets per second. If the number of mobile mesh clients increases, end to end delay will also increases, since the hops between mesh clients themselves and gateway to mesh client will be high as shown in Figure 6. The existing AODV with multi radio uses all interfaces to send control packets of multiple copies in mesh routers. Queue waiting time is increased in each interface, which also increases the end to end delay. The work proposed in this paper will select channel that helps to choose a path with less probability of packet collision and waiting time. Control packets were sent using single interface and for sending data packets other interfaces can be utilized. Compared with existing AODV-MR, this proposed work will attain less delay because of the decreased queue interface. As shown in Figure 7, if there is an increase in mesh clients, packet delivery fraction (PDF) will be decreased. This is because of high collision at link layer which increases the no. of loss packets. In proposed methodology, packet delivery fraction (PDF) is 67.11% which is higher than that of existing AODV-MR. When compared with existing AODV-MR, the proposed work will reduce the routing overheads as shown in Figure 8. Since there is a direct relationship between mesh clients and routing overhead, due to the collision and number of mesh client at link layer

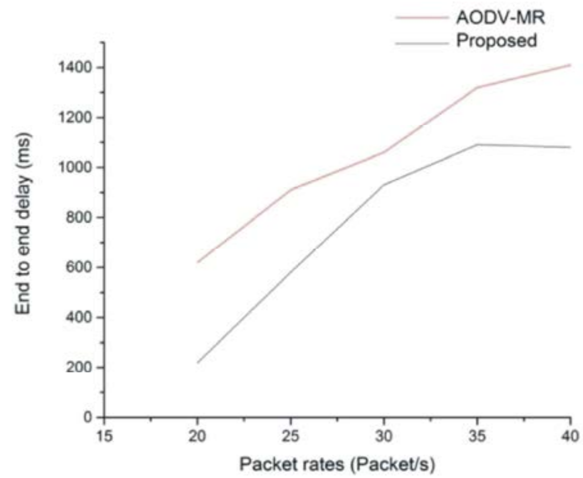

Fig. 2: Packet rates vs end to end delay

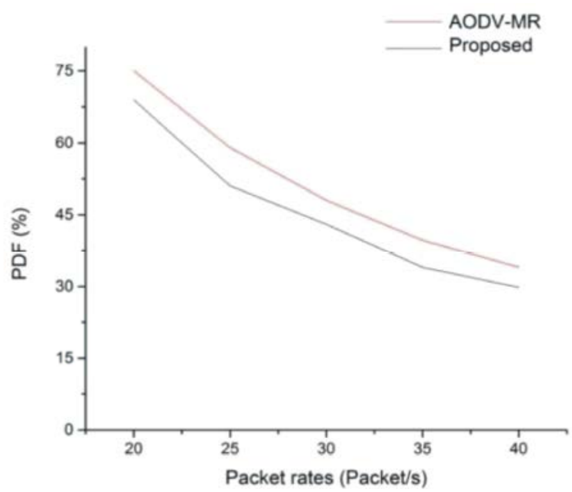

Fig. 3: Packet rates vs PDF

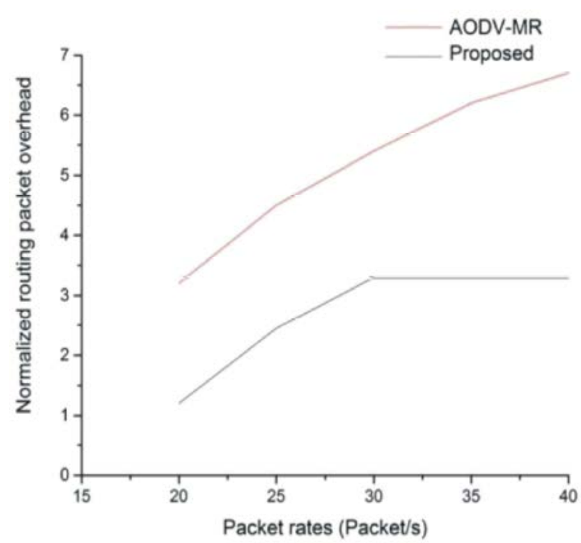

Fig. 4: Normalized routing overhead vs packet rates

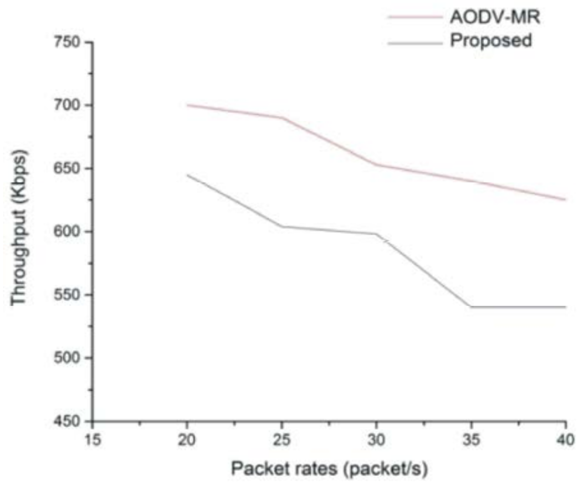

Fig. 5: Throughput vs packet rates (packet/s)

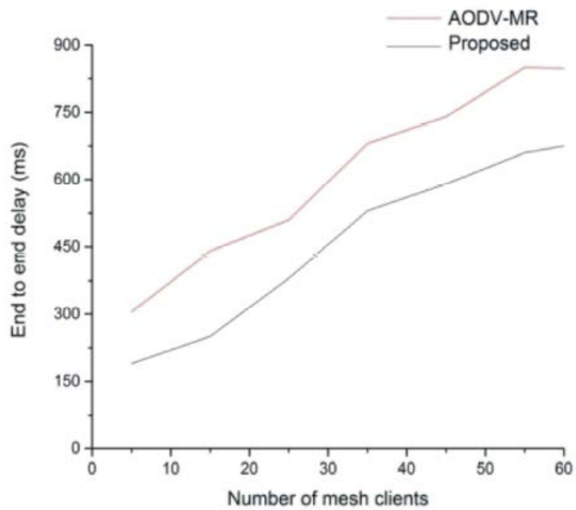

Fig. 6: No. of mesh clients vs end to end delay

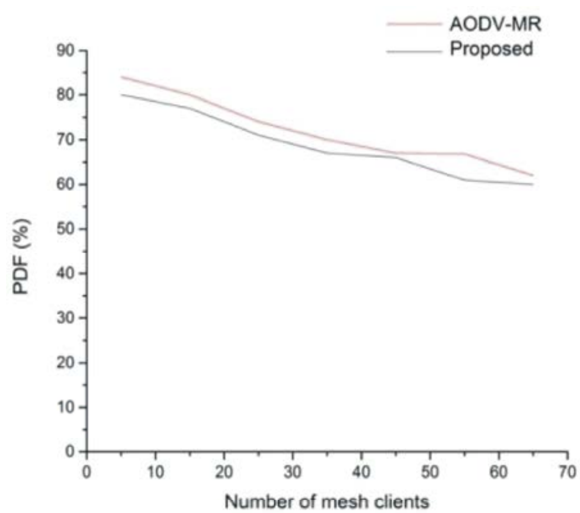

Fig. 7: No. of mesh clients vs packet delivery fraction

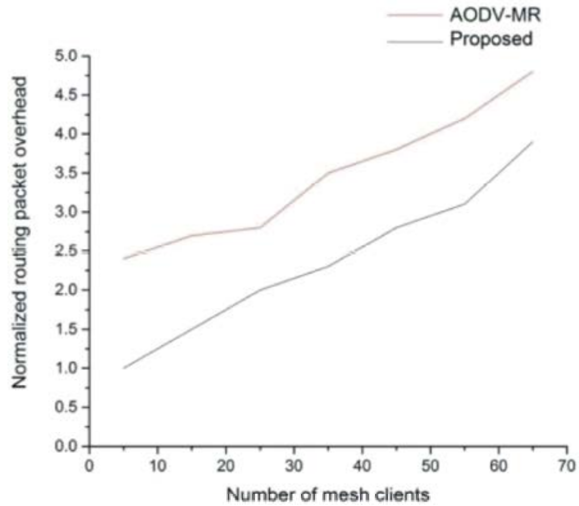

Fig. 8: No. of mesh nodes vs normalized routing overhead

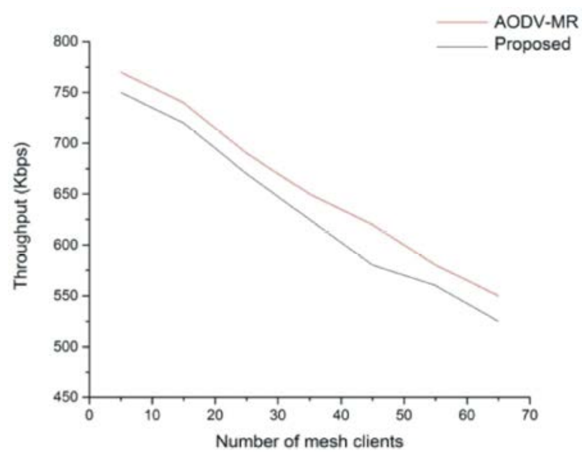

Fig. 9. Throughput vs No. of mesh clients

there will be a link break. This link break consequently increases the route request packets and error packets. In the proposed work, single interface is used based on the best channel, which reduces the overhead compared with the existing method. As shown in Figure 9, due to high packet loss and high bandwidth consumption there is an inverse relationship between throughput and number of nodes.

CONCLUSION

Wireless mesh networks has a huge prospective for several applications because of its features like self-configuration, robustness, low cost of equipment and deployment. In this paper, proposed mechanism reduces the overheads than that of existing AODV and at queue interfaces it facilitates to select path with minimum probability of buffer overflow. Among the multiple interfaces, the proposed work helps to improve the load balance between destination and source and along the path it also helps the backbone and gateway mesh routers to select the best interface to send broadcasting packets. It provides a simple mechanism for interface assigning during traffic exchange between mesh and gateway client. The simulation result obtained proves the effectiveness of the proposed modified AODV in hybrid mesh networks.

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