Cluster–Based Routing Scheme for Wireless Mesh Networks

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***Abstract*— Wireless Mesh Networks (WMNs) is a part of Ad-hoc network. WMNs is very emerging and fast growing technology in wireless field. WMN has many research fields and one of them is routing field. Many routing protocol has been proposed and works by researchers for WMNs but still it's requires many works in this field. Exiting routing protocol has path discovery with help of broadcast method. Due to this reason node requires many power and message collision and congestion occurs in network. Toward this direction, we proposed a cluster-based routing protocol in which all nodes in mesh network grouped into different clusters, each cluster or group has cluster head (CH). In our proposal, we use path discovery with the help of unicast method. Unicast method helps communication in a way that networks have very less congestion and data loss too.**

***Keywords*— Wireless mesh network, routing, cluster head, cluster, Mesh Portal point.**

I. INTRODUCTION

Wireless Mesh Networks (WMNs) is a part of wireless networks. Wireless mesh network is fast growing technology in ad-hoc networks. Wireless mesh network is featured with self organized, self configured and self healing characteristics. WMNs had established with low cast, high scalability, and reliable communication without data loss [5]. WMNs can enhance network capacity after network establishment; easily make connectivity between nodes. In Wireless mesh network as show in Figure1, all Mesh points (MP) are connected wirelessly with fixed mesh point portal (MPP). International organizations are actively providing the specification for mesh network such as IEEE802.11, IEEE802.15, IEEE802.16 and etc [9]. In this article we will concentrate on IEEE802.11s network. WMNs are providing reliable and fast communication within network due to mesh connectivity. In mesh connectivity each nodes are interconnected. If any path failure occurs, it will find an alternative path. WMNs can easily maintain network capacity with help of adding or deleting nodes from network [7].

Many researchers have proposed many routing techniques for WMNs. Most of them focus on routing field such as high mobility scenario; unpredictable networks change [6]. Many on demand routing protocols such as DSR and AODV were proposed from these points of view. These are traditional routing protocols. After these traditional protocols, researchers propose opportunistic routing protocols such as ExOR [10], ROMER [11] and etc; which are also of broadcast nature. They lack of node selection during the forwarding, avoid duplicate transmission and etc.

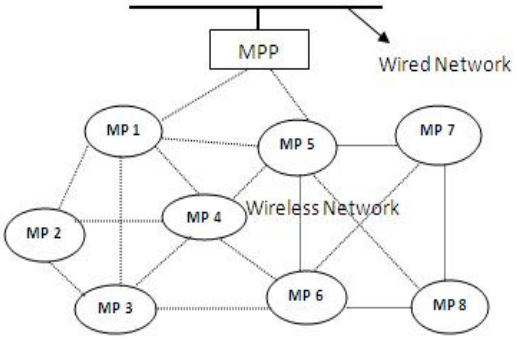

Figure 1. Simple wireless mesh networks

In this paper, we design an alternative approach, Cluster-Based routing protocol for wireless mesh network. We have given some extra power and responsibility to mesh portal point (MPP) and cluster head of each group. This paper has been structured as follows: section I provides the introduction, section II describes the overview of routing protocols of wireless mesh networks, section III specifies the proposed cluster based routing protocol, section IV concludes our proposal.

II. OVERVIEW OF 802.11S ROUTING PROTOCOLS

Many routing protocols were proposed for IEEE802.11s and still very emerging research area for WMNs even though many routing protocols were proposed for IEEE802.11s. Hybrid wireless mesh protocol (HWMP) is the default routing protocol for WMNs [3]. HWMP is the combination of reactive routing and proactive routing. On-demand routing protocol is acquired for mesh points that works for mobility while proactive routing protocol is used for fixed nodes. Airtime metric is a compulsory routing metric used to measure the quality of links.

Radio-metric ad hoc on-demand distance vector routing (RM-AODV) is commonly used for IEEE802.11s ad hoc networks [6]. The proactive routing is tree based routing; in which WMNs define root node before its works. In WMNs, on-demand routing and proactive routing are working simultaneously.

In the on-demand routing, source node will first broadcast path request (PREQ) message in network. When the intermediate node received PREQ message, it replies a path to the destination node if it is available [12]. Otherwise, it will just forwards the PREQ message to next nodes and finally to destination. After destination node received PREQ message, destination node generates path reply message (PREP) for source node and send it back to same path in reverse order. After receiving PREP, source node starts communication with destination [2].

In the proactive tree-based routing, two functions are working; which are PREQ and root announcement (RANN). Root node periodically broadcasts PREQ message to network. When a MP received PREQ message from root node, it creates the path through PREP to root. In RANN mechanism, the root node periodically broadcasts RANN message into network. When a MP received RANN it creates a route to the root, and sends a unicast PREQ to the root. When the root received PREQ from the MP, it replies with PREP to MP [8].

HWMP routing protocol has many problems such as, on-demand routing and proactive routing both have limited scalability, and proactive routing is centralized and constrained by the root node even when any short path is available between source and destination. In reactive routing, it still initiates with path discovery [13]. So its need much power to path discovery process. It has also broadcasting storm problem and wastes power resources on other MPs. HWMP cannot defend route optimization between two MPs. In HWMP, broadcasting method for path creation will be used quite often. This shows the waste of power and congestion problem in network.

Opportunistic routing is different from the traditional routing. It has differed path selection process after packet transmission. It has feats the broadcast nature of wireless medium. Researchers proposed many opportunistic routing protocols such as ExOR [10], ROMER [11], etc. ExOR routing broadcasts a batch of packets by senders. Every packet contains a list of nodes that can potentially forward it. In ROMER [11] routing, it tries to forward the packet simultaneously along multiple paths. Both traditional and opportunistic routing protocol use broadcast message method for path creation.

In this paper we design a new cluster based routing scheme [15] for initial path discovery that utilize multicast instead of broadcast

III. A NOVEL CLUSTER–BASED ROUTING SCHEME

We design a cluster based routing scheme for WMNs as we have mentioned, most of the algorithm use initially broadcast route request to entire node in networks. It is possible that if network partitioned into the cluster, we can reduce the initial broadcast to all nodes. As each cluster has one cluster head that have all information of its neighbour and so path request only multicast to different cluster heads only. In this scheme we distribute the whole mesh network into groups (figure 2). Mesh point portal (MPP) assigned one node as a cluster head (CH) of each cluster group and stored the cluster head information in its own table such as CH id, CH neighbours etc.

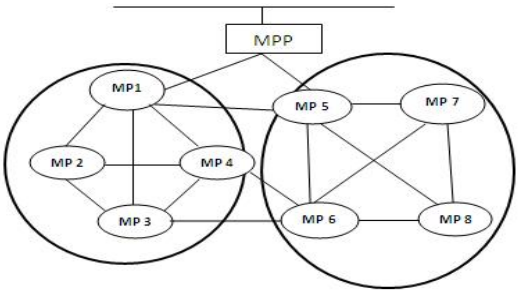

Figure 2. Wireless mesh networks devided into cluster groups.

Each cluster head has some extra authority compare to others cluster member. Each cluster head has two tables, one table stores the information of neighbours cluster heads and second table stores the information about cluster group member which is assigned by the MPP. Every cluster member stores the information of his CH. When a normal cluster member wants to communicate with any destination node, it sends path request (PREQ) message to his cluster head (figure 3).

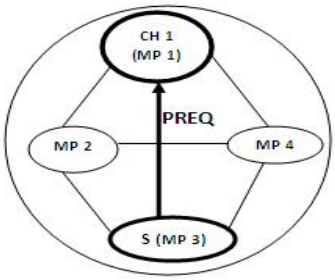

Figure 3. Source sends PREQ message to CH1(unicast).

Then cluster head check own group member list. If the destination exists in the same group, it sends path reply with path information quickly and source node starts transmission according to that path. If destination node belongs to other cluster, cluster head sends PREQ message to mesh portal (figure 4) and the mesh portal multicast PREQ message to all cluster heads (figure 5).

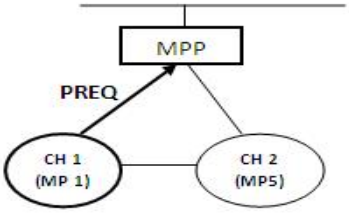

Figure 4. PREQ message between CH and MPP.

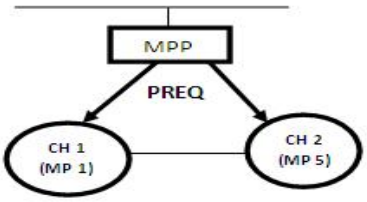

Figure 5. MPP Multicast PREQ forward message to networks CH (Multicast).

Cluster heads check own group table and if any CH finds destination node in area then its send PREQ message to destination node (figure6). Destination node sends own status to his cluster head (figure 7). After received status message of destination node, destination cluster head sends path reply message to mesh portal (figure 8), and send them to source node with destination path information.

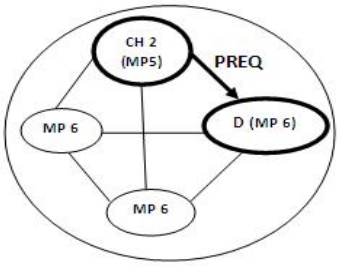

Figure 6. CH2 checks status of destination node (Unicast).

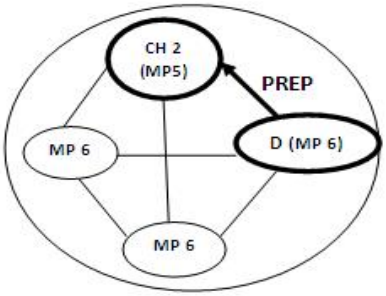

Figure 7. Status message from destination node to destination CH (unicast).

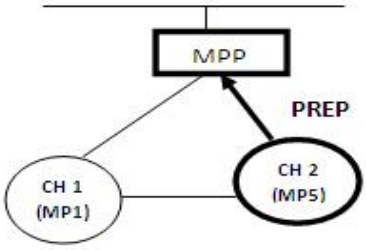

Figure 8. PREP message destination CH2 to MPP.

MPP forward PREP which was received from destination CH2 to source CH1 as shown in figure 9. CH1 forwards

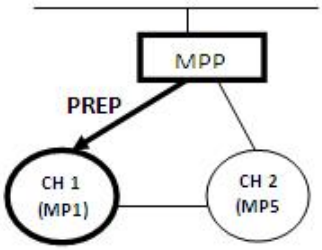

Figure 9. MPP sends detination CH2 information to source CH1.

A bidirectional path established between the CH1 & CH2 nodes shown in (figure 10) and it forwards the destination information to source node (figure 11). So the final path between the source and destination nodes is as showing (figure 12).

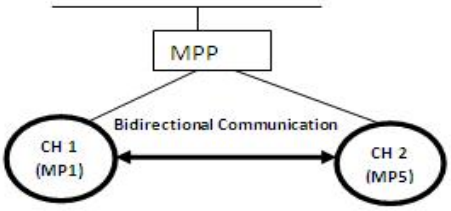

Figure 10. Bidirectional path between source CH1 and destination CH2.

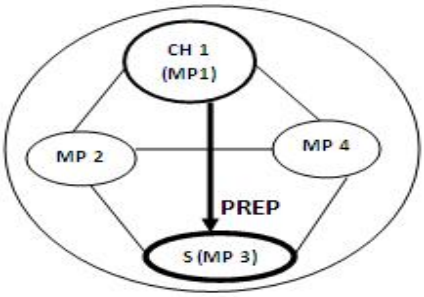

Figure 11. PREP message CH1 to source node.

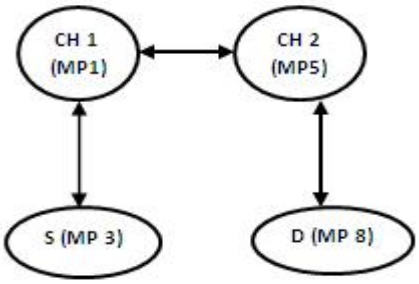

Figure 12. Final path between source to destination.

In this scheme, MPP multicast during path discovery for only once and remaining all transmission use unicast messaging. Hence it reduces power consumption & improves the network performanceMesh portal and cluster head periodically updates own table that helps to detect any change

occurs in network. Ffurther, In case of link-failure, transmission redirected to mesh portal by CH of the clusters that eliminate error message (RERR) broadcasting, but when cluster head fail, then broadcasting is required.

IV. DISCUSSION AND FUTURE WORK

Our proposed protocol has used less energy and path setup time because in our scheme we used 1 multicast and 3 unicast message for path discovery process. Due to this reason it will create fast path between source node and destination. Wireless mesh network has hybrid wireless mesh protocol (HWMP) default routing protocol. HWMP has used both reactive and proactive routing protocol. In path discovery process it broadcast the PREQ message in network. Message broadcast is needed more power and energy and sometimes congestion also occurs in the network.

This paper has defined cluster-based routing scheme, in this scheme, the network has partitioned into number of clusters. If the destination within the cluster, cluster head sends path information to source, thus, it is just unicast. But in case of above mentioned wireless routing protocol (session II), flooding over the whole network is take place in spite of destination just nearer to the source which seems much costly approach. If the destination node does not member of same cluster as source, route request send to the MPP and it send route request to all cluster head through multicast. So again it does not require broadcasting of route request for path. Larger the cluster size, less will number of multicast and more unicast, but cause overload on cluster head. Decision of size of cluster and number of cluster depend on the topology and application of networks.

We will evaluate proposed scheme thorough simulation analysis and make correction in scheme according problem if we will face.

V. CONCLUSION

The paper has presented routing scheme for WMN, aimed to reduce the usage of broadcast message for path discovery and the failure of path message (Path Error) over the network to increase the efficiency of network. Nodes were divided into clusters, and each cluster has cluster head. Hence, request for path is sent to cluster heads using multicast message only, by MPP. This eliminates the necessity of broadcast that reduces power consumption & improves network performance. Further, any link failure will be handled by MPP as well and no broadcasting of error message is required except cluster head failure.

VI. ACKNOWLEDGEMENT

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