Link Quality Based Routing for Vertical Handover in Multi Radio Heterogeneous Wireless Mesh Network

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ABSTRACT-Wireless Mesh Network (WMN) an emerging and promising technology in the next generation wireless network offering flexibility in design ,fast deployment , and low cost. WMN are taking advantage of existence of different wireless technologies and their simultaneous availability at a location. Multi mode nodes having multiple radio access interfaces are available to make use of advantages of heterogeneous technologies. Heterogeneous Wireless Networks (HWMN) are the emerging class of Wireless Mesh Network. The routing of the packets in WMN take place through a multi hop path involving Mesh Clients(MC) , Mesh Routers(MR), and Internet Gateways(IGW). The routing algorithms suitable for WMN donor perform well for HWMN. These algorithms do not make use of the advantage of heterogeneity in the network. The existing routing protocol need modifications to become suitable for HWMNs and makes use of resources available with heterogeneous networks. The present paper suggests a routing algorithm with is built over AODV algorithm for a HWMN involving Wi-Fi and UMTS network.

KEYWORDS *-Heterogeneous wireless Mesh Network(HWMN), Multimode nodes, Mesh clients(MC), Mesh routers(MR).*

INTRODUCTION

Mobile networks can be classified as infrastructure based and infrastructure less networks. In infrastructure based network two mobile nodes communicate with each other through a base station and switching system. The base station and switching system control the communication process. Absence of necessity of rigid infrastructure is the feature of infrastructure less networks, mobile nodes can form a network directly and can communicate with each other . Absence of rigid infrastructure make these network a flexible and quickly deployable with low cost [1].Such infrastructure less networks are also called as adhoc networks. Wireless mesh networks are a special class of adhoc networks, which consists of Mesh Clients(MC),Mesh Routers(MR) and Internet Gate Ways(IGW). In the conventional Wi-Fi networks every access point (AP) is connected to the wired network , where as in WMN only a small sub set of APs are connected to the internet through wired network, such APs are called Internet Gate Ways(IGWs) which form the top backbone layer of the wireless mesh network.

The APs that do not have wired connection are called as Mesh Routers (MR). They form the middle back bone layer of the mesh network. Mesh routers communicate with IGW and Mesh clients in wireless mode. The MR forward the traffic towards IGW in a multi hop path.

Mesh Client(MC)are the user mobile devices which form the lower level of the WMN. MCs can make peer to per communication and access internet by establishing a multi hop path involving, MCs MRs and IGW [2].

Mobile nodes have assigned different functions in a WMN. Based on function assumed by mobile nodes the WMN architecture is categorized into: Infrastructure WMNs, Client WMNS, and Heterogeneous WMNs.

Heterogeneous mesh network is a combined feature of infrastructure and client WMN. It supports diverse nodes and interoperability between nodes of heterogeneous technology. The mobile nodes in use are multimode type having interfaces to interact with diverse networks. Heterogeneous WMN offer more flexible design of wireless network taking the advantage of different radio access technologies.

Routing the packets in a WMN is achieved by forwarding the packets among mesh clients nodes and mesh routers following a multi hop path .In homogeneous WMN routing protocols consider that all the nodes in the network have equal capacity and uses common routing metric to find the path quality. In heterogeneous WMN involving multimode nodes and different radio access technologies, it become unrealistic in assuming that all nodes are of equal capacity [3]. The routing protocols must take heterogeneity into consideration. To select a route based on the quality of the links become important. Selecting a route which offer maximum quality which is dependent on various metrics necessitated designing of new route search protocols or the existing route discovery protocols are to be modified to make them suitable for heterogeneous wireless mesh networks.

This paper proposes a modified AODV route discovery protocol which is suitable for o heterogeneous wireless mesh network. The network metric Signal to Noise Ratio(SNR) and Available Bandwidth(AvBw) are used to access the quality of the links between source and destination nodes. The quality of the link is estimated by using a cost function. The links in the path are selected based on the cost offered by the links.

RELATED WORK:

Z. Li ,et al [1] Designed a proactive unified routing protocol(URP) for heterogeneous WMNs based on link state to overcome the redundancy in broadcasting route request packet. In the URP method nodes maintain a channel set based on link bandwidth and forward rout request packets on high bandwidth channel.

E. Dimogerontakis, et al [3] Developed gate way selection scheme for a client node. Gate ways are selected by client nodes based on load on the gateways. The load on gateway is accessed by passively measuring the delay time for the first byte HTTP request.

B. R. S. Belgrade et al .[4] Used artificial intelligent based path optimization scheme to wireless mesh network involving mobile client nodes of different types. The client nodes can access internet through a multi hop path involving wireless links and fixed wired link

Renda P. et al. [5] Sharing of resources is a major issue in wireless mesh networks. The overhead messages form a considerable portion of the total traffic which has an adverse effect on the performance. The authors proposed a combined Mesh chord protocol to reduce the overhead and improve the resource utilization

R. W. S. Allen et al [6] The authors suggested fixed cycle time scheme to optimize the transmission schedule for transition of data from mesh routers to wireless gate ways.

Z.-Y. L. Rua Yang et al [7] Proposed a reverse AODV routing protocol for wireless mesh networks, which is a modified AODV method. The performance of R-AODV is better than AODV in terms of throughput.

G. M. Shengyang et al [8] Power is the main constraint in wireless mesh network. The mobile nodes should consume less energy. The authors proposed a E-mesh where nodes adopt energy aware cross layer solutions for high level applications. These solutions reduce the power consumption of nodes in the mesh net work.

N. T. H. Vo Thanh et al [9] Proposed an routing algorithm for MANET which is an extension of AODV method. The routing scheme is called Mobile Agent AODV. The proposed routing scheme observed to have improvement over AODV scheme in terms of reduction on congestion.

K. Vaishnavi et al [10] Designed bee-hive routing algorithm for the WMN architecture sectioned in to regions, each region has a coordinator. The coordinators have Wi-Fi and wi-max and client nodes have only Wi-Fi interface

Q. Li,et al [11] Link quality aware geographical routing in hybrid cognitive radio mesh network was proposed. The data packets are forwarded to a neighbor node which is geographically closer to the destination node. The link quality of the one hop neighbor is obtained by Ack messages and chooses the next neighbor which has high link quality. The link quality is assessed by the metric as distance between nodes and destination, residual energy and load on the neighbor.

C. Houaidia et al [12] Presented link quality based routing metric for routing in wireless mesh networks. The method adopts load sensitive, distribution of the traffic to nodes depending on the present node and their availability.

A. B. Paul,et al [13] Developed a reactive path selection in heterogeneous wireless networks. Source node gets the willingness of neighbor nodes to forward the packets prier to deciding the path to destination. The path metric are accessed from each link and over all path quality is computed to arrive at the best path.

THE PROPOSED SYSTEM:

The proposed system architecture is shown in the figure1, it is a heterogeneous wireless mesh network consisting of UMTS and Wi-Fi wireless networks. Multimode mesh client nodes have dual radio interfaces to communicate with Wi-Fi and UMTS network form the primary layer of the wireless mesh network. The Mesh Routes (MR) are also of multimode having dual interfaces of Wi-Fi and UMTS.. The Radio Network Controller (RNC) of the UMTS are also considered to have radio access interfaces of both UMTS and Wi-Fi. The mesh client nodes can access the internet and communicate with each other by forming multi hop path involving Wi-Fi links and UMTS radio links. The mesh clients can communicate directly with another mesh client using either of the wireless links when they are closer to each other. The mesh clients can also forward the data and control packets of other nodes when they are less loaded. The mesh routers do the function of forwarding the data and control packets to wireless gateways which are connected to internet by wired links. They do so by forming multi hop wireless links through other mesh routers, RNCs of UMTS and through other mesh client nodes. The RNCs which are connected to next levels of wireless network by fixed infrastructure can also forward the packets through mesh routers if they are busy with existing load.

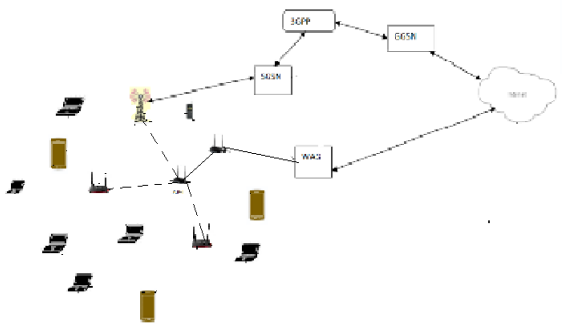

Fig 1: Proposed system architecture

Our aim is to develop a route search algorithm which finds a path to the destination node. The route selected should be robust which provide high quality link measured interns of Signal to Noise Ration (SNR) and Available Bandwidth(Av Bw).The routing scheme is built over AODV method of routing.

METHODOLOGY:

Each mobile node maintains two tables which give information required for routing. One is the neighborhood table, another one is routing table.

The nodes periodically broadcast Hello messages. The nearby nodes on hearing to Hello messages register the node in its neighborhood table and make radio measurements of bit error rate and hence calculate SNR .Nodes also measure Available bandwidth(BW) by computing time delay in the reception of hello packets and compute a cost function "C" which is given by

C = α (1- 1/(1+SNR)) + (1-α)(1- 1/(1+BW)) [14] and register the cost in the neighborhood table . The hello messages are not forwarded, hence one hop distance neighbor nodes are listed in the table. On the repeated arrival of hello massages nodes compute cost function and update in the neighborhood table. The contents in the neighborhood table are shows in the table1

Table 1. Content of neighborhood table

Sourced ID	Link type	Link Cost

The mobile nodes also maintain a routing table which has recent routing information to various destinations. The contents in the routing table are shown in the table2

Table 2. Content of routing table

Destination ID	Destination Sequence number	Next hop node id	Link type	Hop count	Active time

The routing information in the routing table are maintained for a active time out period. If the route is not used within the active time, route information for that destination will be deleted from the table. If route is used then route active time period is reset to active time out period.

When a source mobile Client node is engaged in data transmission with a destination node ,the source node keep track of the transmission quality by measuring SNR and Bandwidth of the current traffic and compute a cost function C= α (1- 1/(1+SNR)) + (1- α)(1- 1/(1+BW)) [14]. If the cost of the current traffic is less than the threshold value the source node will search for a new route to handover. The source node broadcast a Route Request Packet "RREQ" on its interfaces. This RREQ packet has the contents as shown in the table3

Table 3. Content of RREQ packets

Source -ID	Source-sequence number	Destination - ID	Destination-sequence number	Broadcast sequence number	Hop count

The intermediate node receiving the RREQ has routing information to the destination, unicaste RREQ to the next hop neighbor on a link which has high cost. The link cost information is obtained from the neighborhood table in the node. It there is no route information the intermediate node broadcast the RREQ on its interfaces and set a reverse path for the source node. The RREQ on reaching the destination, destination send Route Replay Packet (RREP) to the source node with its current sequence number. The RREP passes through the nodes which are in the path of RREP traversal but in reverse direction. The contents in the RREP are shown in table4. The intermediate node on receiving the RREP, forward the RREP to the neighbor node in the reverse path on a link which has high cost. The link cost information is obtained from the neighborhood table in the node

Table 4. Content of RREP packets

Source ID	Source sequence number	Destination ID	Destination sequence number	Broadcast sequence number	Hop count	Life time

The intermediate nodes also set the forward path for the destination, increment the hop count and update the routing information in the routing table. Ultimately RREP reach the source node. The source node accepts the first RREP and initiate handover process to the new route to transmit data packets through new route.

RESULT ANALYSIS

For the analysis of the performance of the proposed routing method five mesh routers are considered. These mesh routers are consist of four Wi-Fi routers and one RNC. The performance is analyzed by observing the through put for varying number of mobile client nodes when moving at a speed of 2m/sec. A graph is plotted for through put as number of nodes increases. Proposed Link Quality Based AODV outperforms pure AODV. The reason for decrease of throughput as nodes increases is due to increased overhead packets as number of nodes increases.

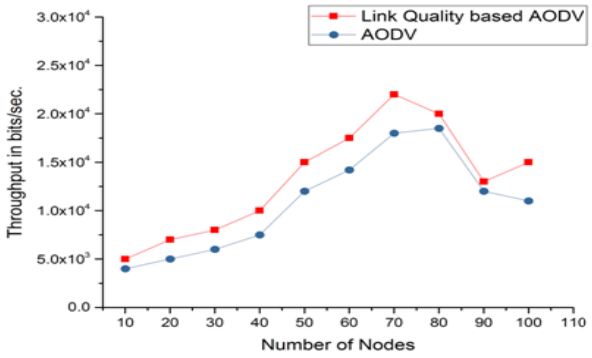

Fig 1: Throughput v/s number of nodes.

Figure 2 shows the comparison of the through put achieved by AODV and Link Quality Based

AODV, when nodes are moving at different speeds and number of nodes in the location is fixed to 50 nodes. It is

observed that as speed increases through put decreases. Increased speed of nodes causes the need for frequent handovers and hence through put falls. Link Quality Base AODV achieves higher through put compared to Pure AODV

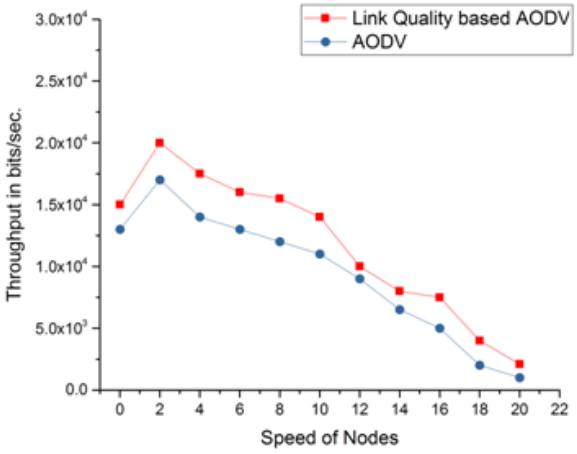

Fig 2:Throughput v/s speed of nodes.

CONCLUSION

Wireless mesh network are the emerging network types to provide wireless access to remote areas and easy establishment with less infrastructure is found to be advantageous. Heterogeneous wireless mesh network with multi mode nodes provide better network connectivity. The routing algorithm as AODV is modified to suitable for heterogeneous wireless networks. The selection of the path based on the link quality provides higher through put in performance for situations of increased number of nodes in a location and nodes moving at higher speeds

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