IJASR International Journal of Academic Scientific Research
ISSN: 2272-6446 Volume 2, Issue 2 (May-June 2014), PP 19-26
www.ijasrjournal.org

Study of Routing Protocols in Wireless Mesh Networks

Binish Raza[1],Faiza Qaiser[2],Muhammad Ahsan Raza[3]

[1]*Department of Electrical Engineering Pakistan Institute of Engineering and Technology Multan, Pakistan*
[2]*Department of Computer Science &Engineering University of Engineering & Technology, Lahore, Pakistan*
[3]*Institute of Computing Bahauddin Zakariya University,Multan, Pakistan*

ABSTRACT
Today the growing interest in Internet, Wireless Mesh Network (WMN) plays important roles towards the next-generation wireless networking called 4G. It is a key technology to support wireless multi-hop networks. Wireless Mesh Network is a combination of mobile ad hoc and conventional networks. In contrast to conventional networks, Wireless Mesh Network has no fixed configuration. Wireless Mesh Networks is configured using mesh routers and mesh clients.WMN significantly improved of performance of Wireless Ad hoc and traditional networks. Due to dynamic routing nature of WMNs, the optimization of routing protocol is most critical task. In this study we discuss various existing routing protocols and issues related to routing in WMN.

Keywords*- 4G, Routing Protocols, Routing Issues, Wireless Mesh Network, WMN*

INTRODUCTION

At present, the growing interest for mobile devices is a call for advanced researches in the emergence of wireless networks. Wireless Mesh Network (WMN) is one of new emerging key technology in wireless network that provide adaptive, flexible and cost effective structural network [5]. The WMN has built on client routers and server routers. These routers works as a host and router both, by transferring packets from one node to destination node that is out of range of sender node. Due to flexible and adaptive infrastructure the routers act a multi-hope access point to the internet for mesh clients' nodes. These mesh client nodes also connect with the other nodes to make whole network adaptive. Through WMN various devices such as mobiles, laptops and PDAs can access the network at anytime and anywhere by their network interface card (NIC). The users that have no NIC can access the network using Ethernet. The adaptive and flexible nature of WMN makes its integration in any network such as cellular, wireless, WiMax and WiFi networks easy [6]. WMN is self-organizing, self balancing and self maintained network, by the nodes automatically built mesh connection among themselves. Due to large number of nodes involvement in communication routing is the most important issue in this network.

Routing is a mechanism through which the packet can transfer from source to ultimate destination. Due to self configured and self awareness features of WMNs, it is expected that in WMN the nodes can decide best path automatically. Efficient communication in WMN depends on these routing decisions [7]. For efficient routing different routing protocols are used for network route. These routing protocols are more problematic issue for researchers. The packet switched network nature of WMN make role of routing protocol more essential. For ad-hoc network recently many routing protocols are used. For WMNs these protocols can be used with making some modifications. In next section II we describe the architecture of WMN. In section III we explore the routing properties for efficient routing protocols. In section IV we describe the related work that has been done on relating routing protocols. In last section we conclude our result.

WIRELESS MESH NETWORK (WMN)

WMN is a dynamic self-organized, self-configured and self-maintained, multi hoped packet switched network [4]. It consists of number of nodes that are connected through wireless media and arranged in a mesh topology. These nodes can automatically link and leave the network at anytime.WMN provides services at anywhere and anytime even if no fixed infrastructure exists at that place. A WMN has combined features of both wireless ad-hoc networks and traditional fixed networks[15]. The nodes in WMN configured as ad-hoc network and make mesh connectivity among themselves. The nodes in WMN can be act as a both router and a host, but generally it is categories as a two types of nodes: Mesh clients (MCs) and Mesh routers (MRs) [3].MRs are fixed and build the backbone infrastructure of the network where MCs are usually mobile and roam among these MRs. These MRs are gateway to internet where MCs can connect to the MRs and other MCs also. The fixed backbone infrastructure of network provides multi-hopping access services to the internet for MCs. The route for packet communication is selected by using certain routing protocols.

ARCHITECTURE MODEL

The WMN consist of Mesh Routers (MRs) nodes and Mesh Clients (MCs) nodes. In WMN the MRs required more power and capacity to perform routing due to its more responsibilities. To perform additional functionality, they have multiple network interface cards (NICs) that connect with multiple wireless interfaces. The functions performed by traditional wireless routers can perform by these MRs with much low power consumption by using multi-hop environment. MRs can be implemented on basis of embedded systems and general-purpose computer systems.

Mesh clients (MCs) can also act as a router in WMN but they cannot act as gateway or bridge for the network. They have only one network interface card (NIC), because they interact with only one wireless interface. As compared to MRs, MCs have simpler structure and they have a variety of devices such as PDAs, laptops, desktop PC etc.The architecture model of WMN can be classified into three types [1, 2].

BACKBONE/INFRASTRUCTURE WMNS

In this type of WMNs the routers build a backbone/ infrastructure for mesh clients through which clients can access or connect with internet. The connection between the backbone, mesh clients and internet can be of wired or wireless. Mostly backbone/infrastructure uses IEEE 802.11 among radio technologies. The mesh routers (MRs) nodes can perform the function of gateway or bridge among WMN and other existing wireless networks. Traditionally the clients are connected with routers through Ethernet. But if the routers have different radio technology, the clients cannot directly communicate with routers. In this situation the clients connect with the base station that has same Ethernet connection to the router. WMNs mostly use this category of networks for communication [1, 2, 3].

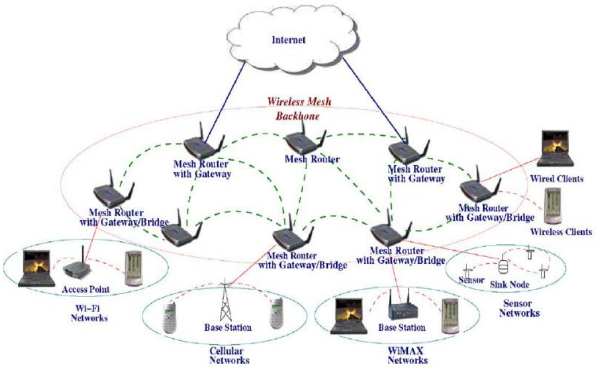

Figure 1: Backbone/Infrastructure WMN

CLIENT WMNs

It provides peer-to-peer (P2P) connection between mesh clients. In this type of network the mesh clients are self organized and self configured. The actual routing and configuration is performed by these clients and also provide end user applications. Therefore mesh routers are not required in this client network. The packets are transfer to the recipient through multi nodes. In client WMN the end nodes be requisite to do further operations such as configuration and routing [1, 2, 3].

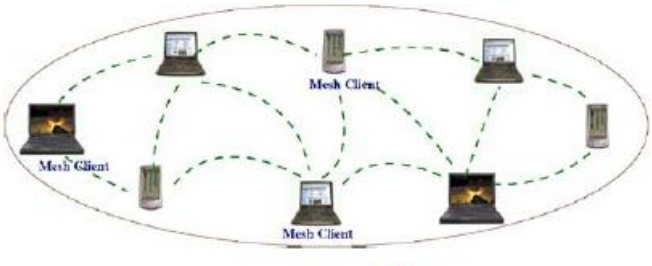

Figure 2: Client WMN

Hybrid WMNs

This network used the combine features of backbone/infrastructure and client WMNs. Backbone/infrastructure WMN provide connectivity to the internet or other networks whereas the client WMN provide additional routing processing during communication [1, 2, 3].

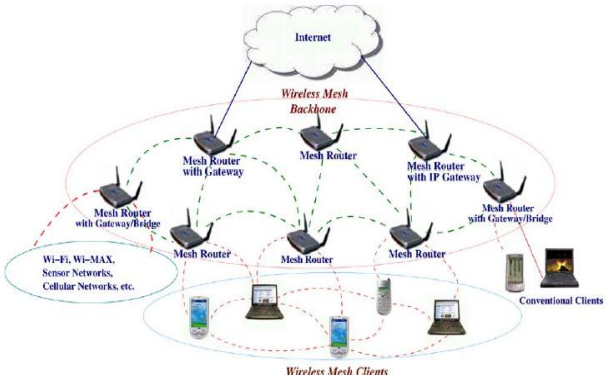

Figure 3: Hybrid WMN

ROUTING IN WMNs

Routing is a key part of a wireless network as overall communication of the network nodes depend on it. Here we are dealing with WMNs which are a form of packet switching so routing can be define as a process of sending data packets from sending nodes to receiving node. To deal with the limitations of WMNs there are some essential properties that an ideal routing protocol must integrate in its model. [11, 14] These properties are described as:

- BANDWIDTH AGGREGATION:
  To cope with the bandwidth limited environment, the protocol should have efficient mesh topology that uses multi-hop bandwidth.

- RELIABILITY:
  From source to destination WMNs deal with several paths, an ideal protocol should have ability to learn the different routing paths that respond to connection or wireless mesh router node failure.

- WIRELESS-AWARE DECISION-TAKING:
  The routing layer on protocol stack should have ability to analyze the any irregular events on wireless MAC and physical layer and take the decision according to this.
  Low path stretch: From source to destination the use of best route is necessity. The shortest route is not best route as in wired but here due to instability of wireless link the best route depends on the scenario. So ultimately a path should be provided that consider the wireless limitations but not very different as of smaller one such as low path stretch.

- LOW CONTROL MESSAGE OVERHEAD:
  A good routing protocol should have ability to decrease the whole operating cost that are introduced to the system and upset the bandwidth.

- DISTRIBUTED OPERATION:
  A protocol should have an ability to distribute the control information of routing throughout the network.

- LOAD BALANCING:
  A function of the routing protocol is to switch the all or a part of traffic to the alternative routes when a path is very congested so that the resources of network utilize efficiently.

- SCALABILITY:
  A wireless mesh network must be scalable and performance of a routing should not affect by the increase in number of nodes or number of interfaces per nodes.

- QoS SUPPORT:
  Quality of service (QoS) is a significant constraint of WMNs because these networks supports real time multimedia applications on restricted channel capacity and have large number of users also effect of interference.

RELATED WORK

To explore the wireless Mesh network and its routing protocols, Irini Reljin, Reljin, Nenad Kojić, Branimir [8] proposes a hybrid routing protocol that is based on artificial intelligence: Neural Networks, for Mesh routing. It is depends on link state routing .It is a hybrid ad-hoc routing protocol. It has avoided the flooding and builds new routing metrics in the view of bandwidth, delay and number of hops. The protocol is based on neural network. The technology uses two Hopfield neural networks. The first Hopfield is used to distribute the changes in the network frequently as possible through mobile agent. The other Hopfield is used for route selection decision on the bases of previous information, through routing protocol. Due to intelligent artificial logic the proposed protocol take full advantage of the network resources and also shows efficient routing performance. On the bases of providing continuous up-to date routing information the protocol provide best routing path on demand. The protocol only sends the changing parameters of the routing table not the whole routing table. The routing decision is based on previous calculated information. This protocol has used effective data exchange and multi criteria for route selection in order for best utilization of network resources. The proposed protocol focused on all network constraints and metrics for improved performance. This uses digital computer for simulation and can be used in any real time network and dynamically created network topology.

Jangeun Jun [9] proposes a innovative protocol for routing in WMN called mesh routing protocol (MRP).This protocol can be categories as three versions: MRP based on on-demand routing , MRP beacon mode, and Hybrid MRP. The proposed protocol only configures the routing trees between mesh clients and mesh gateways. It removes the overhead related with making of routes between clients. In this protocol the nodes can only known one gateway to access the internet and the node can also accessible only through that gateway. Every mesh client select only one gateway to connect with internet, if this gateway becomes stop working then they select another gateway for internet. In this design a super gateway is connected to many gateways through wired or wireless links. All traffic of gateways is passing through this super gateway to internet. In this protocol a routing table is established and routing is possible only by maintaining the routing table. MRP uses UDP packets for messages communication instead of TCP to avoid overhead and delay. All version of MRP have using routing table calls to interface with the Kernel and ICMP for message failure notification.

The first version of MRP is based on entirely on-demand protocol called on-Demand (MRP-OD) protocol. In this category the node who wants to enter in WMN broadcast a route discovery message (RDIS) locally to the network. All nodes that received this route discovery message will respond with message (RADV) that contains information about routes and routing metrics related to node. The node who wants to join the network received this reply message only from neighboring gateway. When the new node linked with network it complete its half-connected state and can access the internet but for reverse path towards the node it has passing through registration phase. After receiving this RACK the new linked node is fully connected. This protocol make routing graphs in a tree organization that make this protocol loop free routing protocol.

The second version of MRP is MRP beacon mode (MRP-B). In this version each node is in full-connected state and send beacon message to advertise the available routes. Every beacon can occur at different time instances

and can work as a free route announcement. These beacons contain routing information. The node who wants to link with the network listen these free routing announcements. After route selection and registration the node become the part of network. For packet failure notification, this protocol uses beacons and monitor the parent forwarded beacons. If the predefined beacons are lost during the process the process will again initiated and node entered in disconnected mode. The third version is a blending of both versions: MRP-OD and MRP-B. This protocol is called hybrid protocol (MRP-H).In this protocol, the new entering node broadcast the route discovery messages (RDISs) and waits for route advertisement (RADVs) reply. The received RADVs contain responses of both route discovery message (RDISs) and beacons.The error in communication can be identified by monitoring forward packets and missing beacons. This protocol identifies the connection failure faster than other two versions. But none of these three versions uses flooding to maintain or establishing the routing.

Jayesh Seshadri [10] proposes a new Simple Opportunistic Adaptive Routing protocol (SOAR) that supports multiple instantaneous traffic in network by efficiently selecting nodes that forward traffic , dynamic data rate control and priority based timers. It is a link state routing protocol. SOAR protocol uses four mechanisms for getting high performance and throughput. These four mechanisms are: efficient path selection for message forwarding, message forwarding on priority based time, locally recovery of losses and adaptive control of channel data rates. The grouping of these all four mechanisms makes SOAR more efficient and it can provide bulk of traffic flow.In this protocol every node calculates the quality of the link. On the bases of this information the sender decides the route for data sending and also recognizes the expected forwarding nodes that can be used for sending data. As all opportunistic routing protocols, SOAR broadcast the information packet at predetermined physical data rate. Due to adaptive forward node selection, instantaneous flow of traffic is achieved. Control data rate of channel make fairness for all sender who are involved in communication and also increases the throughput. Paramjeet Kaur Bedi [11] study the different issues and metrics of routing protocols for WMN that serve as a guideline for deciding that which routing protocol and metric will serve best in which situation. Before describing the routing protocols some features of a best routing protocol are highlighted such as tolerance of error and faults, balancing of network load, QoS support, scalability and reduction of routing overhead. In category of taxonomy, routing protocols categorized in routing protocol that is based on network topology and other is routing protocol that is based on position. Furthermore topology based routing protocols renowned in *active, proactive and hybrid* routing protocols. In WMNs most commonly used proactive routing protocols are highly *dynamic destination sequenced distance vector routing protocol (DSDV)* which is a table driven protocol and is required the consistent modernizing of table so it may consume the resources unnecessarily, and second proactive routing protocols is *optimized link state routing protocol (OLSR)* which centered on the multipoint relays and use the shortest path algorithm. And most commonly used reactive routing protocols are dynamic source routing (DSR) which see the routes when required, and second is *ad-hoc on demand distance vector* routing protocol (AODV) which is designed for ad-hoc mobile networks and it accomplished unicast and multicast routing equally, and also makes the routes when required by source node. Multipath routing in a network use not just the best path but a number of paths to reach the destination so different multipath routing protocols are briefly discussed for WMNs. Then routing metrics explore for evaluating a routing protocol for mesh network and comparatively analyze the result is tabular form for the all multipath routing protocols.

Mousa Dashtianf [12] proposed a QoS routing protocol based on field routing for WMNs. The proposed protocol WMQR is based on the problem that the more traffic load is passing through or from the gateway towards the internet. A routing algorithm is used that is based on field. In this algorithm a broad or wide network field is to be build that monitored the packets which is passing from or to all the nodes to their identified source or target, and this algorithm is intended to offer the greatest exploitation of resources output and networking by reducing the interflow and intra-flow intervention and hence reduce the delaying chance of QoS sensitive flows. For selecting a route optimally a new routing metric is introduced that is based on total network performance and flow condition.

Before explaining offered algorithm properties of recent algorithms which are linked to proposed algorithm are revised. In context of proposed algorithm frame work, aspects and metrics of algorithm, method to calculate the unfilled bandwidth on a given node are presented. To prove that WMQR algorithm is effective for reducing the overall bandwidth consumption two scenarios are simulated in NS2 for proposed algorithm and one other algorithm .The result shows that by using route that are decided by filed based protocol, perform much better least two times by reducing the delay that is occur due to routes finding towards the gateway.

Muhammad Shoaib Siddiqui [13] offers a hybrid protocol that secure multi-path communication which increases the consistency in the mesh network. It offers protected routing and effective methods of detecting other paths when a route is misplaced in WMNs. A brief overview of other protocols that are used to provide secure multi-path routing. Then architectural overview of offered hybrid multipath routing scheme is presented in which motivation for the superlative result is to utilize the different routing protocol for different portion of the hybrid network, and also suppose that the records of the nodes is verified by a trusted third party and provides the key in the setting out phase. Security mechanisms of multipath routing are discussed that reduced the difficulty and overhead of security control by using the Diffie-Hellman algorithm for the authentications of the shared secret key between the router and client nodes. Simulation and analytical evaluation is presented by comparing routing overhead, energy expended at every node and output of data for offered routing protocol with the others secured routing protocols.

CONCLUSION

With the growing interest and development in wireless technology, the user expects better and more services that can be access at anywhere and anytime. Wireless mesh network has provided these services by combining wireless technology with multi hop communication. The backbone of Wireless Mesh Network has facilitated the user to access the Internet at anytime and anywhere. It has provided low cost, reliable and high quality multi-hop communication.WMN has provided better performance and services as compared to traditional wired network.

Routing in wireless networks is challenging for researchers. It is a difficult process due to interference of multiple hop communication. To transfer the packet from one node to other, routing protocols have played important role in network performance. For effective performance a routing protocol has to be selected on the bases of network constraints.

In this paper we have described the characteristics and architecture of wireless mesh network and also review the exiting routing protocols used in WMNs. The performance of these routing protocols could be increased by using multi-paths or multi-channel routing algorithms.

REFERENCES

[1] Safak Durukan Odabasi, A.Halim Zaim,A Survey on Wireless Mesh Networks, Routing Metrics and Protocols, IJEMME,Vol.2 pp.(92-104)

[2] AKYILDIZ I.F., WANG X., Wireless Mesh Networks, WILEY , United Kingdom, 2009, 978-0-470-032565.

[3] Akyildiz, Ian F,Xudong Wang, and Weilin Wang, Wireless Mesh Networks: A Survey, Computer Networks, 2005, 47.4.

[4] K.P. Vijayakumar, P. Ganeshkumar and M. Anandaraj,Review on Routing Algorithms in Wireless Mesh Networks, IJCST, May 2012, Volume 3, Issue 5.

[5] Liang Zhao, Ahmed Y. Al-Dubai,Routing Metrics for Wireless Mesh Networks: a survey, Springer Berlin Heidelberg. 127: 311-316.

[6] Paramjeet Kaur Bedi, Yadu Nagar, Amit, Rajni Yadav, Study Of Routing Protocols: Single And Multipath For WMN", (TIJCSA),March 2012, Volume 1, No. 1, ISSN No. 2278-1080.

[7] Jeevan A.C, Avinash B, Srikanth V, A Review of Routing Protocols in Wireless Mesh Networks (WMN), IJCA, 2010, vol. 1, no. 11

.

[8] Kojić, Nenad; Reljin, Irini; Reljin, Branimir, A Neural Networks-Based Hybrid Routing Protocol for Wireless Mesh Networks, *Sensors* 12, 2012, no. 6: 7548-7575.

[9] Jun, Jangeun, and Mihail L. Sichitiu, MRP: Wireless mesh networks routing protocol, Computer Communications 31, no. 7.

[10] R. Eric, SOAR: Simple Opportunistic Adaptive Routing Protocol for Wireless Mesh Networks, IEEE, vol. 8,2008, pp. 1622-1635.

[11] ParamjeetKaurBedi, Yadu Nagar, Amit and Rajni Yadav, Study of Routing Protocols: Single and Multipath for WMN, (TIJCSA), Volume 1, No 1, ISSN No 2278-1080,2012.

[12] MousaDashti and Siavash Khorsandi ,WMQR: A Field Based QoS Routing Protocol in Wireless Mesh Networks, NSW, 2010,1 - 6.

[13] Muhammad Shoaib Siddiqui, Syed Obaid Amin, Jin Ho Kim and ChoongSeon Hong ,MHRP: A Secure Multi-path Hybrid Routing Protocol for Wireless Mesh Network, IEEE, Orlando, FL, USA, 2007, 1 – 7.

[14] Edmundo Chissungo, Hanh Le, Edwin Blake,Routing Protocols and Metrics used on Wireless Mesh Networks, University of Cape Town 2013.

[15]J.-D. Abdulai,M.Ould-Khaoua, L. Mackenzie, Adjusted probabilistic route discovery in mobile ad hoc networks, Computers and Electrical Engineering 35 (1), ,2009, 168–182.