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A Multi-Layer Routing Protocol for Mobility Management in Wireless Mesh Networks

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Abstract

In the recent trends, Wireless Mesh networks are proven to be one of the emerging fields in the wireless networks. WMNs comprises of Gateways (GWs), Mesh Clients (MCs) and Mesh Routers (MRs). However, it is challenging job to provide seamless connectivity when MC moves around the network. The recent advances in the field of wireless technology created a chance to overwhelmed the disadvantages of wired and wireless networks. The mobility management in the WMNs motivated the researchers to concentrate. In this paper, we are proposing a model called as multi-layer routing protocol for WMNs. This protocol works with the data link layer and network layer for data frame transmission. The proposed algorithm is implemented with intra domain for experimental evaluation. The experimental results show the effectiveness of the routing protocol.

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Keywords: Mobility Management; Multi Layer Routing Protocol; Packet Latency; Packet Loss Ratio; Wireless Mesh Networks.

1. Introduction

In the recent trends, the wireless networks are gaining popularity over the communications specifically, multi hop networks, such as opportunistic networks (mobile ad hoc networks)[1–3]. WSNs (wireless sensor networks) placed their type of mark by introducing the cognitive radio networks[4–6]. The vehicular sensor networks and vehicular ad hoc networks are proceeding in the research based on the internet of things. The wireless mesh networks received high attention based on the reliability and the extensibility. The WMNs provide low cost, high data rate and reliability over the communication in different type of applications[7,8]. The WMNs are extensively used in military fields, disaster relief and smart grid technologies.

The WMNs uses the IEEE802.11 standard for the connection establishment in wireless broadband services. Figure 1 shows the typical WMNs having the mesh gateways, mesh routers and mesh clients.

Mesh clients are very rich in mobility when compared to the mesh routers. Thus, the static network is composed of mesh routers[9,10]. In conventional mesh networks, the mesh clients itself act as mesh routers, bridges and gateways. The architecture of conventional WMNs is almost similar to the wireless ad-hoc networks. The clients with in the mesh network are in mobile nature which can send and receive the information from the mesh routers. The mesh routers

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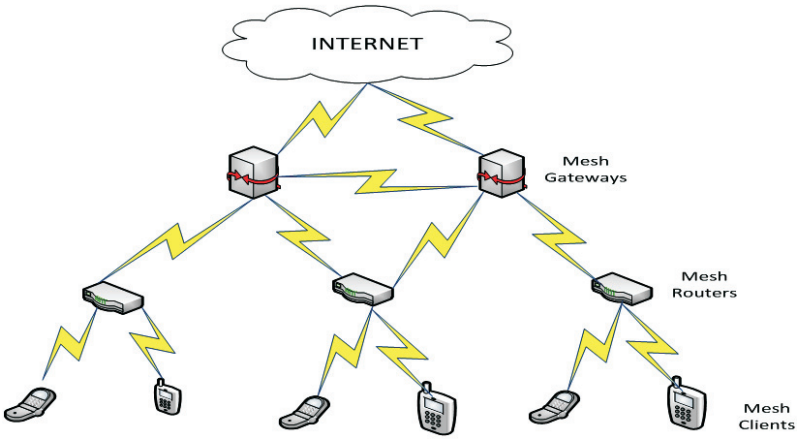

Fig. 1. Wireless Mesh Network.

send the collected information to the mesh gateways which is already connected to the internet. The mesh routers form self-reliable and self-manageable links at the time of communication.

In the recent trends, many routing protocols are proposed for MANETs and WSNs. But, WMNs are different from the remaining networks. The routing protocols available in the WMNs are weighted cumulative ETT (WCETT)[11], Expected Transmission Time (ETT)[12], Expected Transmission Count (ETC)[13], AVAIL[14], and Inference Neighbouring Count (INX)[15]. The above stated protocols achieved results in their state of art. But, the dynamic traffic in the WMNs is not fully absorbed by the above categories. In this paper, we are concentrating on the mobility management scheme for intra domain in the WMNs. The intra domain refers to the mobility of the clients with in the same routers

2. Literature Survey

In WMN, the mobility management contains both handover and location management in the communication. The mobile nodes in the WMNs store their information at the routers, based on that information; the nodes present location can be identified. This information updating process at the router is a continuous process. The handover management is accountable for forming the new link whenever the node is moving to the control of another router. The router in the handover process is belongs to the different domains (inter domain) or same domain (intra domain). In the present system we are dealing with intra domain mobility management.

2.1 Intra domain

There are number of mechanisms proposed for intra domain mobile management in conventional wireless networks. But, the exiting mechanisms are not comfortable for WMNs. In this literature some intra domain mobility management schemes are studied.

Routing mechanisms

In[16], cross layer mobile management scheme was proposed by Navda *et al.* each mesh router contains the routing table to record the information about the mobile clients in the network. Before handover process, every client searches for better router by sending probe request message. The mesh client selects the best router based on the link quality according to its signal strength.

In[17] MAC layer triggered mobility management adopts mobility management scheme. This scheme works with the principle of assigning the IP address to the hash function for finding the mobility of the client.

Tunnel based mechanisms

In[18], authors concentrated on ANT mechanism for intra domain. This structure follows the location update process while performing the handover operation. To reduce the delay between the routers, the mechanism introduces the tunnels between the neighbouring routers.

In[19], M^3 (Mesh Mobility Model) proposed by Huang *et al.* The gate ways, access routers and superior routers are introduced in the handover process. The location information at the access routers are updated periodically based on the data base presented at the gateway.

3. Multi-Layer Routing Mechanism

Multi-Layer Routing Mechanism (MLR) is a hybrid mechanism in which it enables faster handover process in WMNs. In this paper, we are considering infrastructure network. In this network, mesh clients can connect or disconnect with the network at any time and also the client can move over the network. Based on the movement of client, the access router adopts the changes.

The proposed mechanism is a multi-layer routing mechanism in which it involves data link layer and network layer. The access router communicates with the clients with packet message and the client's response to the access router packet message with their MAC address, which contains the information of routing in the data link layer. To decrease the size of the routing table at the data link layer, mesh clients can use the data link layer routing and the packet forwarding is done at the data link layer of the mesh routers. The entries in the routing table is minimized due to the communication is carried on between the access routers. The number mesh routers is less than or equal to 100.

For instance, in algorithm 1, the mesh router has to send the frame to the destination MAC address which is give as 00 15 58 83 DF 16 and the mesh router searches in the routing table for neighbouring node MAC address of the destination. It is identified as the 00 15 58 83 DF 21, then the mesh router sends the frame to the identified neighbouring router.

When the clients join in the network, it checks for the better link establishment with the router, the link quality is based on the number of parameters like noise, signal, delay etc. After selecting the router, the clients sends the request message to the router, then the router registers the IP address of the client and send the router IP address as an acknowledgement to the client. Each router maintains the table having the MAC and IP address of all the clients register under it.

In algorithm 2, whenever the data frame is received from the data link layer, the client checks for the destination IP address in the routing table of the router, if the destination IP address is found at the routing table, then the IP address is bind with the MAC address and creates the data gram by adding the data frame with MAC address in it. If the routing table contains the specified path for the destination then clients follows the destination path according to the routing table. The Fig. 2 explains about how the packets can be transferred to the destination using the multi-layer routing protocol.

1. Begin
2. Initialize all the mesh clients and access routers
3. Initialize the destination to receive the frame
4. Find the MAC address of the destination node
    a. if (A = current access router MAC address) then
        i. decapsulate the data frame
        ii. Transmit the data gram to network layer
        iii. Apply the network layer routing from algorithm 2
5. Else if the routing table contains the specified route for the destination A then
        i. Transmit the frame according to the routing table
    b. Else
    c. Error in data link layer routing
    d. End if
6. End

Algorithm 1. Routing Algorithm for Data Link Layer

1. Begin
2. Identify the destination IP address B
3. If B matches the clients IP address in the routing table of the router then
    a. Binds IP address B with MAC address
    b. Encapsulate the data frame with MAC header for the datagram
    c. Send the datagram to the destination
4. Else if the route is found for the destination B in the routing table then
        i. Based on the routing table, transmit the datagram
    b. Else
    c. Error in Network layer routing
    d. End if
5. End

Algorithm 2. Routing Algorithm for Network Layer

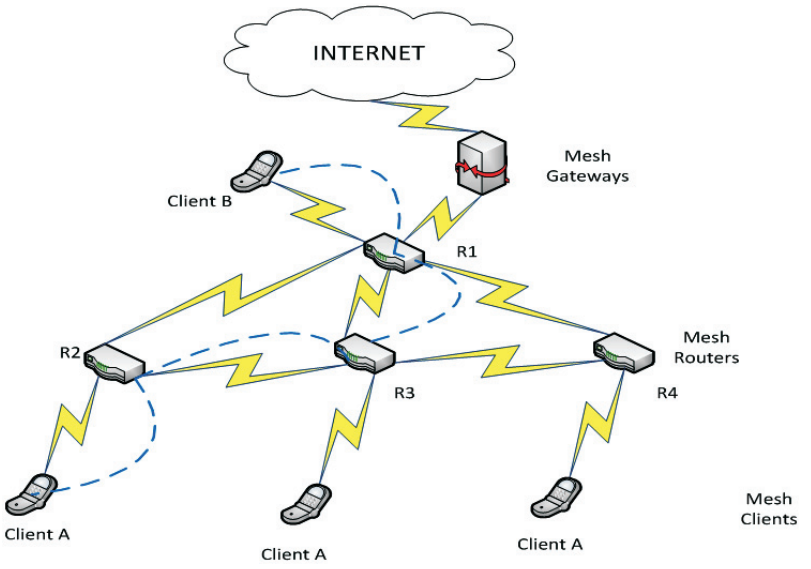

Fig. 2. Intra Domain Communication.

Table 1. Simulation Setup.

Parameter	Value
Packet Size	240 bytes
Packet Interval	10 sec
Range	250 m
Simulation Time	500 sec
Interference range	500 m
Data Rate	1–6 Mbps
Data Traffic	CBR
End to End Delay	<100 ms

4. Experimental Evaluation

The proposed model is implemented by using the well-known simulator called as NS2 simulator[22] and compared with the existing protocols TORA and IZRP. In Table 1, the simulation parameters are listed.

The data rates for the protocols are taken as 1–6 mbps. The data traffic is CBR flow with fixed packet size of 240 bytes. The interference range is 500 m and the transmission range of each zone is taken as 250 m and other parameters are not mentioned in the Table 1.

Intra domain communication:

The proposed model is evaluated using the 10 fixed mesh routers which are placed randomly over the specified regions and are interconnected to one another. 20 mobile nodes are deployed into the network and established the flow of packets between two nodes.

Packet latency:

The packet latency is referred as the how much time taken form packet creation to packet delivery. In the experiment, the packets are transferred form mesh client to the router for every 10 seconds with in the area of 250 meters. The

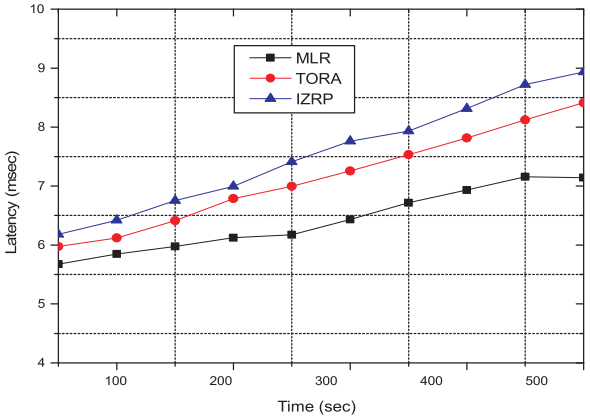

Fig. 3. Average Packet Latency for the Proposed Model.

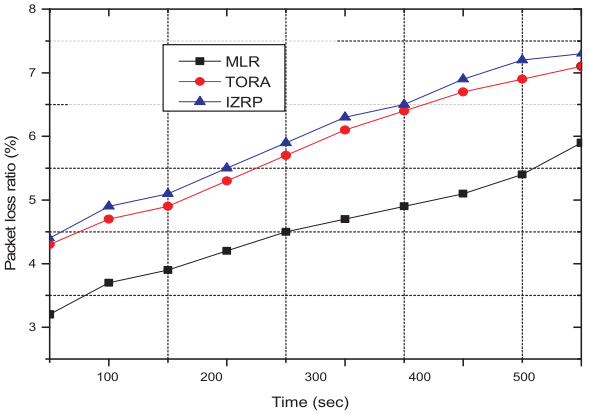

Fig. 4. Average Packet Loss Ratio for the Proposed Model.

Fig. 3 shows how the latency is reduced from the proposed multilayer routing mechanism and the existing Temporarily Ordered Routing Algorithm (TORA)[20] and Intra Zone Routing Protocols (IZRP)[21].

Packet loss ratio:

It is defined as the number of packets had reached the destination to the total number of packets sent by the client node. The packet loss ratio must be minima for the effective approach. The Fig. 4 shows the average packet loss ratio of the proposed MLR and the existing TORA and IZRP algorithms.

5. Conclusions

This proposed multilayer routing protocol had dealt with the two layer routing i.e., data link layer routing and network layer routing. The paper carried the research in the field of mobility management and the proposed protocol uses the data link layer MAC address and the network layer IP address for routing in the Wireless Mesh Networks. The intra domain mobility is observed here by implementing the proposed protocol. The simulation of the proposed protocol is carried out using the NS2 simulator. The performance of the proposed protocol is compared with the conventional protocols. The packet latency and the packet loss ratio are the parameters used for the evaluation of the protocols.

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