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Priority Based Congestion Control Routing in Wireless Mesh Network

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---ABSTRACT---
Wireless mesh network (WMN) is a wireless networking model which currently attracts research and industry. In WMN every node passes information to the nearest node and there may be number of hops from one node to the other. In WMN the information is forward using the best possible route to any destination. The best path can be determined using the routing protocol. The congestion problem arises when every time routing protocol determines the same best path due to which traffic load occurs on that path while other path seldom used. Due to the abrupt use of single path the packets may drop causes the greater effect on the network's performance. In this paper a technique is used to overcome such congestion problem that faced by the network. In the technique priority based selection mechanism for the paths is adopted which can ensure the performance of the network.

Key Words: Scheduling, Wireless-Adhoc Networks, Routing protocol.

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I. INTRODUCTION

As the name indicates wireless mesh networks is a mesh networks that can be implemented over wireless LAN. The infrastructure of wireless mesh network is that it forms a mesh in such a way that each node is connected to every closest node [1-8]. It is the sub type of ad-hoc network in which every node is willing to forward data to every other node but in wireless mesh networks every node act as routers and sends data to nearby computers. But the main thing in WMNs is that, it increases its reliability and the data transmission power is stronger if the distance between two nodes is small and vice versa. Now-a-days wireless mesh networks is widely used and hence fourth there are many application area in which it provides benefits like it is easily expandable, maintainable, flexible and so on [9]. There are many infrastructures available for wireless mesh networks which can be centralized or decentralized through server. Although wireless mesh network have some key advantage such as high speed, low interference, large service coverage, low up-front cost, fast deployment, easy maintenance, and robustness [10]. But besides these advantages there must be some disadvantages as well.

Routing protocol that determine the best path route to any destination out of the various paths available [11]. There are two types of nodes in wireless mesh networks mesh routers and mesh clients. Mesh routers can use intermediate mesh nodes to transmit data, voice, instructions etc [12]. So the question arises here that the communication is done through which path. Mesh router actually finds shortest path to reach destination on the basis of some selection mechanism, for selection of path the mechanism uses any of path's characteristics depends on the selection mechanism developer. Through routing protocol, wireless mesh routers either throws the traffic on internet gateways or either internet gateways to the access points (APs). These APs contain several connections. Several nodes are connected with each AP. So, nodes are communicated via these nodes. But the problem is that all the time the routing protocol chooses the same path for communication due to which the load is increase on the same path while other tracks seldom use. The traffic congestion on the same path can affect the performance of networks in such a way that due to traffic congestion the packets may lose cause in a severe loss of data [13, 14, 15, 16, and 17].

In this paper an elegant technique is proposed that is helpful for distributing the traffic on multiple paths and ensures the network performance. The paper is organized as in section 2 the review of existing approaches for congestion control in WMN are given, Section 3 expresses the proposed work with theoretical example scenarios and finally in section 4 the concluded remarks are given.

II. EXISTING WORK FOR COUNTERING CONGESTION PROBLEM IN WMN

Several contributors paid attention towards congestion control problems in WMN and provide solutions. In [18] Simple Opportunistic Adaptive Routing protocol (SOAR) is proposed to explicitly support multiple simultaneous flows in wireless mesh networks. The protocol makes use of priority based adaptive path selection mechanism and also capable of retransmission of lost packets. In [19] a novel network graph preprocessing method is proposed to achieve better QoS routing in wireless mesh networks. In [20]a novel optimization framework is proposed for opportunistic routing based on network utility maximization (NUM) which enables certain thing in wireless mesh networks as optimal flow control, multipath routing, scheduling, and rate adaptation schemes. In [21] deadlock free routing policy is proposed which is based on channel overlapping and the technique is also capable of fault-tolerance. Unlike the existing approaches in the next section of the paper the simple congestion free routing mechanism for wireless mesh networks is presented.

III. PROPOSED TECHNIQUE

Suppose a wireless mesh network (see figure 1) a node wants to communicate with another node then in wireless environment communication between these nodes occur via APs.

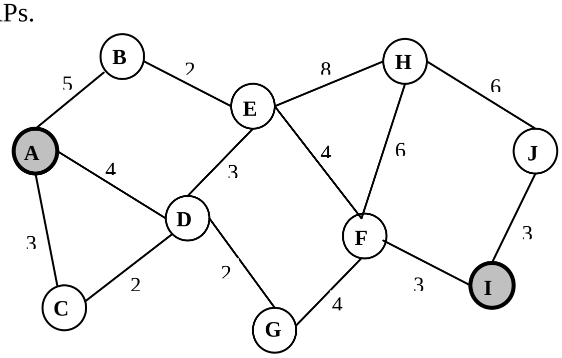

Figure 1. Wireless mesh scenario

In the proposed algorithm assigns the priority to each route on the basis of number of intermediate nodes and the length between the source to destination then the traffic is distribute on possible multiple paths on the basis of priorities to each route. The diagrammatic work flow of algorithm is given in figure 2.

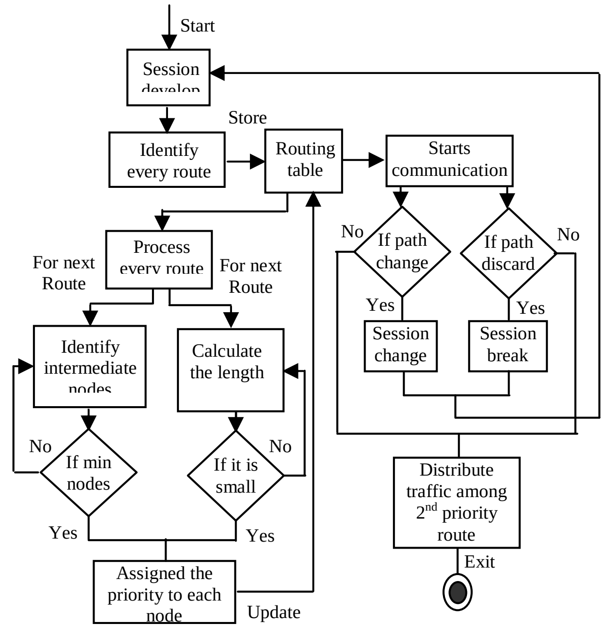

Figure 2. Flow Chart of proposed algorithm

Now in general there may be the several paths from source (first AP) to destination (second AP). Here routing protocol take the intelligent decision that which path is chosen for communication. As soon as communication starts in wireless mesh networks than a session is develop while routing protocol detects every possible path to reach the target AP after detecting the path it can stores the information into the routing table. Then assign priorities to each path on the basis of length and the number of intermediate APs from source to destination. If there are large numbers of intermediate APs from source to destination then the priority of that route should be low and vice versa. On the other hand if there are smaller length then assigned the priority to that route as high and so on. The formulation is given as:

$$X_i = \sum_{i=0}^{n} L_i + T ....(1)$$

Where: X = priority of each route

n = total number of intermediate APs

L = lengths from one AP to other

i = 0, 1, 2, 3…

T = process time for intermediate APs

On the basis of these two scenarios (lengths and number of intermediate A]Ps) set the priorities to each route

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accordingly. After this update the routing table and use this information when required. Here is an interesting thing that in wireless environment if a node changes its position then every time its multiple routes change and hence the value (Li ant T) change in the routing table as shown in Table 1. So in this scenario again session should develop and again assigned the priorities to each route.

Now communication starts using the highest priority route and distributes the traffic among second highest priority route after some specified interval of time. But if path change then session will change or if path discard then session will break. Hence to precede further communication will occur by developing the session again. The packets are transmitting in to frames. Each frame contains number of bits so that each frame is distinguishable from other. In this paper variable frames size are used. In variable size framing, it needs a way to define the end of the frame and the beginning of the next. It has header and trailer that contain the sender and receiver address and other relevant information. But if an error occur in the frame or frame is not sent to the receiver than it allows the receiver to inform the sender of any frames lost or damage in transmission and coordinates the retransmission of those frames by the sender. This process is called "automatic repeat request" (ARQ). Lost frames are more difficult to handle than corrupted ones. Beside the header and trailers it contains redundancy bits to detect and correct corrupted frames. Mostly the corrupted frames are silently discarded. When the receiver receives a data frame that is out of order, this means that frames were either lost or duplicated.

The proper steps of communication are as follows:

1. Develop the session.
2. Identify every possible route from source to destination
3. Store it in to the routing table
4. Process every route
   (i). Identify total number of intermediate APs from source to destination.
   (ii). Calculate the length of each route from source to Destination
5. Assigned the priority to each route on the basis of (i) and (ii).
6. Update the routing table in such a way that the route with the highest priority should be at the top
7. Starts communication through highest priority route
8. Distribute the traffic among 2^{nd} highest priority route after some specified interval of time.

Example Scenario

Consider an example of mesh in which each access point is connected to form a mesh (see figure 1). These access points contain the network addresses of each node that are connected to it. In the figure 1 the length from every node to next node are also mentioned. Let's any node X that are connected to access point A wants to communicate with another node Y that are connected to access point I then in general we say that A sends data to I. Now there are many possible ways of communication from A to I. First of all a session is develop among every access point and then communication starts but the question arises here is that from which path A sends data to I. For this routing table determines every possible path from source (A) to destination (I) as shown in Table 1.

Adjacent nodes

Table 1. Identification of every route from source to destination

	Path	Length Li	Process time of intermediate nodes (T)
1	A- B- E- F- I	14	3T
2	A- D- E- F- I	14	3T
3	A- D- G- F- I	13	3T
4	A- D- E- H- F- I	24	4T
5	A- D- E- H- J- I	24	4T
6	A- C- D- E- F- I	15	4T
7	A- C- D- G- F- I	14	4T
8	A- B- E- D- G- F- I	19	5T
9	A- B- E- F- H- J- I	26	5T
10	A- D- G- F- H- J- I	25	5T
11	A- C- D- E- H- F- I	25	5T
12	A- C- D- E- H- J- I	25	5T
13	A- D- G- F- E- H- J- I	31	6T
14	A- C- D- E- F- H- J- I	27	6T
15	A- C- D- G- F- H- J- I	26	6T
16	A- B- E- D- G- F- H- J- I	31	7T
17	A- C- D- G- F- E- H- J- I	32	7T

During processing for every route and assigned the priority on the basis of total number of intermediate APs and the length from source to destination, using the eq (1):

$X_1 = (5 + 2 + 4 + 3) + 3T$
$= 14 + 3T$------------------------------------- (i)

$X_2 = (4 + 3 + 4 + 3) +3T$
$= 14 + 3T$------------------------------------- (ii)

$X_3 = (4 + 2 + 4 + 3) + 3T$
$= 13 + 3T$------------------------------------- (iii)

$X_4 = (5 + 2 + 8 + 6 + 3) + 4T$
$= 24 + 4T$------------------------------------- (iv)

And so on…

When the priority is assigned then routing table is updated in such a way that priority with the highest route should be at the top as shown in table 2. So when communication occurs then it is done using that path which is at the top most in the routing table. But after some specified interval of time the traffic is distributed among second highest priority route so that the problem of packet losing is minimize and the performance of network is improved.

Table 2 . Updated table with possible route to destination

Nodes	Adjacent Nodes	Length	
A	B	5	
	D	4	
	C	3	
	B–E	5+2=7	
	D–C	4+2=6	
	D–E	4+3=7	
	D–G	4+2=6	
	C–D	3+2=5	
A	B–E–D	7+3=10	
	B–E–F	7+4=11	
	B–E–H	7+8=15	
	D–C	6 Discarded	→ Discard
	D–E–B	7+2=9	
	D–E–F	7+4=11	
	D–E–H	7+8=15	
	D–G–F	6+4=10	
	C–D–E	5+3=8	
	C–D–G	5+2=7	
A	B–E–D–C	10+2=12	
	B–E–D–G	10+2=12	
	B–E–F–G	11+4=15	
	B–E–F–H	11+6=17	
	B–E–F–I	11+3=14 1st	→ 1st route
	B–E–H–F	15+6=21	
	B–E–H–J	15+6=21	
	D–E–B	9 Discarded	
	D–E–F–G	11+4=15	
	D–E–F–H	11+6=17	
	D–E–F–I	11+3=14 2nd	→ 2nd route
⋮	⋮	⋮	
A	C-D-G-F-H-F, B	27 Discarded	→ Discard

In figure (3), part (a) its route contains three intermediate APs from A to I so for all intermediate APs at this route contains the process time of 3T. In Table 1 here is an interesting thing that entries (1) and (2) have the same length and the same process time. In this case choose any path that is feasible. If any two routes have the same length but different process time then assigned the highest priority with less intermediate nodes and so on.

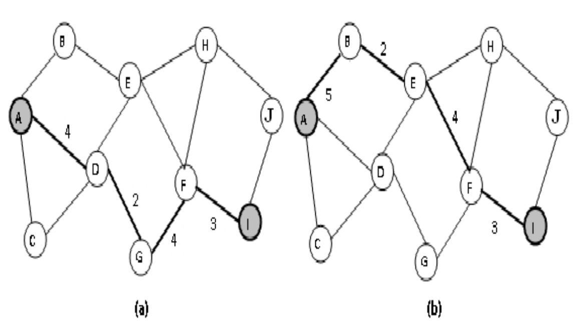

Figure 3. (a) Showing highest priority route part. (b) Showing second highest priority route

Now, when ever communication occurs then the packets are transmitted from A to I using the path X3 (iii) that have highest priority. On the other hand after some interval the packets are distributed among second highest priority route as shown in fig 3 part (b). The entries (1) or (2) in table 2 have same process time (same length and process time of intermediate APs). Now the question arises that which path should we assign the second priority route. In this type of situation the traffic is distributed on either of the two paths either 1st or 2nd route as shown in table 2. This will improve the performance of network in such a way that the packet losing is minimized.

IV. CONCLUSION

The proposed technique improves the performance of networks in such a way that overhead of packet loss is minimized because the packets are transmitted from one access point to other. On the other hand if can distribute the traffic on different routes according to the priorities of each route while this algorithm is helpful for determining the shortest path and store it in to the memory so for next time it at the top. So when communication occurs then it is done using that path which is at the top most in the routing table. But after some specified interval of time the traffic are distributed among second highest priority route so that the problem of packet losing is minimize and the performance of network is improved. But what happens if a node is moving (say he is at journey). Still this node is also a part of the wireless network. At this situation distance from that node to each access point is changed continuously. Also at each time multiple possible routes are changed. Now for every time the session break and again priorities assigned to each route.

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