INCREASING QUALITY OF SERVICES IN WIRELESS MESH NETWORKS

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Abstract

Wireless networks evolve into next generation to provide faster and better services, a key technology Wireless mesh networks has emerged recently. A wireless mesh network comprised of radio nodes which a form of wireless ad hoc network. In wireless mesh network nodes are combination of mesh routers and mesh clients. Wireless mesh networking is a promising wireless technology for numerous applications and hence throughput drops significantly as number of nodes or hops increases. Hence we propose a novel method to increase throughput using max and min fair flow optimization followed by centralized and distributed algorithms. Simulation results shows that using this approach number of hop by hop per packet transmission is reduced and so the throughput is increased by 40 percent inducing increase in all quality of services.

Key words :- Wireless mesh networks, max min fair flow, greedy algorithm

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1.INTRODUCTION

In WMN each node operates as ahost and also as a router, forwarding packets on behalf of other nodes that are not in direct wireless transmission range of their destination. WMN is characterized by its dynamic features such as self organization, self configuration and self healing to enable faster deployment, easy maintenance, lower cost and trustable services for enhancing the network capacity, connectivity, resilience and robustness. WMN is becoming an important mode balancing to the infrastructure based wireless networks.

WMN is a promising wireless technology for numerous applications from small scale to very larger scale such as broadband home networking to enterprise networking, building automations. It is gaining extensive consideration as a possible way for cash strapped Internet service providers, carriers and others to roll out robust and reliable wireless broadband service access in a way that needs a very minimal up front investments. Deploying a WMN is very easier because all the desired components are readily available in the form of ad hoc routing protocols, IEEE802.11 MAC protocol, wired equivalent privacy security and so on. The main lead of WMN lies in its intrinsic fault tolerance against network failures, minimalism of setting up a network and broadband capability.

WMN is a wireless network having a partial or full mesh topology, characterized by wireless relay nodes providing a disseminated infrastructure for mobile clients over a partial mesh topology. Due to the presence of partial mesh topology a WMN utilizes multi hop analogous to an ad hoc network. Although WMN and ad hoc networks are mere and near similar, the protocols and architecture of ad hoc is poor compared to WMN. Additionally WMN are more resource rich having protocols and algorithms need to be premeditated that benefit from special topologies. The available MAC and routing protocols applies to WMN do not have enough scalability that is throughput drops significantly as the number of nodes or hops increases. Hence to increase throughput we formulate a innovative technique by applying max min fairness optimization continued by centralized algorithm and then distributed algorithm.

The rest of the paper is organized in the following manner, in section 2 we consider challenges faced in WMN. Section 3 deals all about max min fair flow optimization. Section 4 tells about centralized algorithms. Section 5 all deals about distributed algorithms. Section 6 we have simulations and results. Section 7 considers about conclusion and future enhancement.

2.CHALLENGES FACED IN WMN

WMN consists of two types of nodes mesh routers and mesh clients. The routing capability for gateway/ repeater functions as in a conventional wireless router, a wireless mesh router contains additional routing functions to support mesh routing

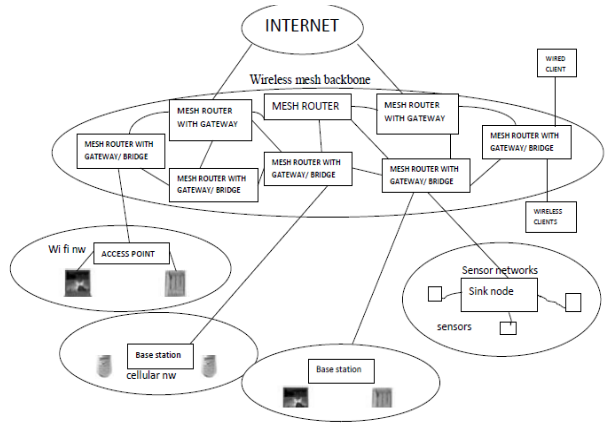

Fig 1.1 Architecture of wireless mesh networks.

. To further improve the flexibility of mesh networking, a mesh router is usually equipped with multiple wireless interfaces built on same or different wireless access technologies. Although mesh client act as a router gateways or bridges does not exist in these nodes. Mesh clients usually have only one wireless interface.

The architecture of WMN shown in fig 1.1 indicates both wired and wireless links. It provides backbone for conformist clients and enables amalgamation of WMN with existing wireless networks, through gateway functionalities in mesh routers. In this type of architecture client nodes represent the actual network to perform routing and configuration functionalities as well as providing end user applications to customers.

The characteristics of WMN are given as follows

- **Multihop Wireless Network**

  WMN is to extend the coverage range of current wireless network without sacrificing channel capacity. Hence we propose distributed algorithms in section 5 to increase the channel capacity.

- **Support for self forming self healing and self organization**

  It is flexible network architecture, easy deployment and configuration, fault tolerance and mesh connectivity with the help of multi hopping. For this reason we propose in section 3 max min flow fair optimization to increase throughput in multihop connectivity.

- **Compatibility and interoperability with existing wireless networks.**

  WMN must be compatable with IEEE, MAC layers, Wimax, zigbee etc. Hence there must be shortest path possibility for faster transmission than other existing networks. So we propose in section 4 centralized algorithms to identify shortest path for faster transmission.

3. MAX MIN FAIR FLOW OPTIMIZATION

WMN are relatively cheap and easy to deploy, achieving efficient and fair resources. Without network optimization, which ideally should be simple, fast and distributed WMN behave poorly delivering significantly lower throughput. For WMN, network optimization tasks range from transmission scheduling, through channel assignment, transmission power adjustment and rate adaption to routing. Transmission scheduling on radio links realized by MAC layer, Channel assignment is done by distributed algorithms, transmission power adjustment and rate adaption is done through centralized algorithms.

The throughput is a bandwidth vector assigned to traffic demands in their downstream direction, assuming that a routing path for each demand is fixed and given. The max min fairness approach tackles fairness by not only maximizing the flows equally assigned to the routes, but also increasing the flows for which this is possible in subsequent iterative steps. A max min fairness solution means that no route can gain higher flow without having to decrease the flow on a route where the current flow is lower.

The Wireless mesh network is a directed graph $= (V, E)$. V is a set of nodes, $v \in V$, $V = g \cup r$ where g set of gateways and r mesh routers. The set E represents links modeled as directed arcs e, $e \in E$ is denoted by a(e) and b(e) that is when $e = vw$, $v, w \in V$ then $a(e) = v$ and $b(e) = w$. A link $e = vw$ is provided only when nodes v and w can communicate.

3.1 ALGORITHM FOR MAX MIN FAIR FLOW OPTIMZATION

Let $\wp = \{p_1, p_2 \ldots\ldots p_n\}$be given set of paths between nodes. Each path pn is treated as a subset of links , $p_n \subseteq E, n = 1,2 \ldots N$. For each link $e \in E$, the set of all indices in path P that contains links will be denoted by Ÿ = {n : n ∈ p_n ,1 < n < N}. Each time the flows in path is recorded in vector ɠ, stored in an non decreasing order. Hence importance is given to the last value in flows and increase the optimization in that specific node.

Input : mesh network

Output: max min fairness solution increasing flow

Step 1

Set n = 1

Solve the program

$$\text{Maximize } na_n - \sum_{x=1}^{n} = 1$$

Flows $f_o, f_1 \ldots f_n$ are arranged in non decreasing order.

$$ɠ_n^0 \le ib_j - \sum_{j=1}^{n} gij, \text{ I} = 1,2\ldots \text{ n-1}.$$

$b_i - f_i \le$ gij, j= 1,2…N and i = 1,2…n-1.

gij ≥ 0, j = 1,2… N and I = 1,2…n.

resulting an optimal objection at flow ɠ.

Step 2

If n < N put n = n+1 and goto step 1.

Otherwise stop.

The flows at each node get optimized and flows increases at each node and hop constantly indicating an increase in throughput.

4. CENTRALIZED ALGORITHMS

In multi hop networks such as WMN routing is one of the most important issues that has momentous brunt on network performance. There are lot of nodes in the WMN and so to increase throughput we must also find the shortest path for traversal from source node to destination node. There are several shortest path algorithms such as BFS, DFS, Dijkstra, Bellman Ford etc. All these algorithm solve shortest path in speculated polynomial time in fixed infrastructure WMN support both wired and wireless links. Therefore we introduce greedy algorithm in centralized algorithm to solve the shortest path in both wired and wireless network. The flows got optimized using max min fairness and now using Greedy algorithm technique we find the most suitable shortest path and traverse in that path.

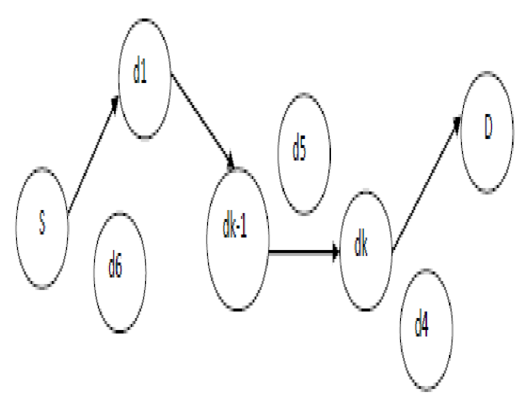

Fig1.2 Example for shortest path routing

Figure 1.2 is an example of shortest path traversal. As per figure 1.2 S is a source node and D is destination. The shortest path traversals happens based on the weight. The flows which we arranged in max min fairness optimization will be given as input to this greedy algorithm. The algorithm starts with an initial tree the destination is not included in the tree, it finds shortest paths through multi hopping techniques with various nodes and reaches destination D.

Algorithm : MMF Greedy

Input: G = (V,E), path p, Source S, Destination D, flow f

$T \leftarrow \{S\}$

for all $i \in V$ do

    $route_i \leftarrow \Phi$

end for

for all $i,j \in E$ do

    $weight_{i,j} \leftarrow f_{i,j}$

end for

while $D \neq \Phi$

    for all $v \in D$ do

        find route(T,v) and weight(T,v)

    end for

find $v^* = min_v$ weight(T,v)

$T \leftarrow T$ + route(T,v*)

for all $(i,j) \in$ route(T,v*) do

    $route_i \leftarrow route_i + \{j\}$

    for all $n \in N_i - route_i$ do

        $weight_{i,n} \leftarrow f_{i,routei+(n)} - f_{i,routei}$

    end for

end for

$D \leftarrow D - \{v^*\}$

end while

5. DISTRIBUTED ALGORITHMS

The main purpose of distributed algorithm is whenever a new node enters into the mesh network a path or channel must be assigned so that it can communicate easily with the other nodes. Moreover increase of new nodes reduces the capacity. The mesh network is a very large network, but we have centralized algorithms to find a shortest path and network flows are maintained by max min fairness. Now designing of distributed algorithm is to assign channel for the nodes. The output of centralized algorithm is input to distributed algorithm.

Algorithm Channel Assignment(node i)\

Set of nodes V, channel c_j and current channel c_i

Begin

For all m = 1,2… M

$f(m) \leftarrow \sum_{J \in Si} f(m, c_j)$

if $f(c_i) > f(m)$ for any m= 1,2…M then

$c_i \leftarrow m_{min}$

end for

end

Each node selects a minimum channel hence inference is minimized and throughput gets increased.

5.1 NEW NODE INSERTION

Wireless mesh networks compromises of many nodes both wired and wireless. Hence there will be a inclusion of new nodes all times throught the travel of the network. We use centralized algorithm to generate shortest path between source and destination. Though we form shortest path between source and destination there arises a probability of new nodes in the formation of the path since wireless mesh networks travels hop by hop. Therefore to overcome such difficulties we use distributed algorithm for insertion of a new node in wireless mesh networks.

Algorithm new node insertion

Set of nodes V, path p, source S, Destination D

If S exists then

New node $n \in p$

Check MMF Greedy(n)

If n is TRUE

$route_i \leftarrow n$

end if

end if

5.2 REPAIR EXISTING NODE

When Wireless mesh networks travel in shortest path using centralized algorithms there me some node failure or path disclosures occurrences since nodes have mobility feature they can move from their position, inducing a path breakage or failure from source to destination. To avoid such confusions when there is node repair in our network we use distributed algorithms to find next nearest node.

Algorithm node repair

Set of nodes v, path p, source S, destination D

For all $i \in V$ do

If $Route_i \leftarrow$ Data not found

Find route(v_{+i}) and weight(v_{+i}) in path p

Find v^* = min weight(v_{+i})

End if

End for

6.SIMULATIONS AND RESULTS

The results are simulated using NS2 simulator with 50 nodes. Each nodes are uniformly distributed in a prescribed area of 2500m * 2500m. Each time packets are send from source to destination. The size of a multicast packet is 512 bytes. Each time the throughput gets increased.

6.1 THROUGHPUT COMPARISON

Throughput is defined as amount of data moved successfully from source to destination in a given period of time. We compare the throughput results with the EMTX multicast problem. We obtain that each time the throughput gets increased by 40 percent when compared with EMTX.

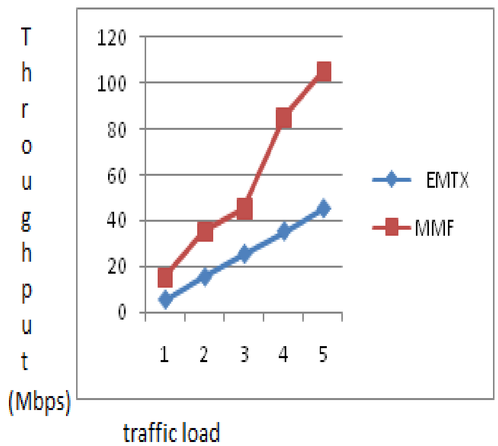

Fig 1.3 Comparison of throughput of EMTX and MMF

6.2 ERROR RATE COMPARISON

Error rate describes the degree of errors encountered during data transmission from source to destination. We compare the error rate with EMTX multicast problem. Each time the error rate gets highly reduced. Lesser the error rate is the efficiency of the data transferred.

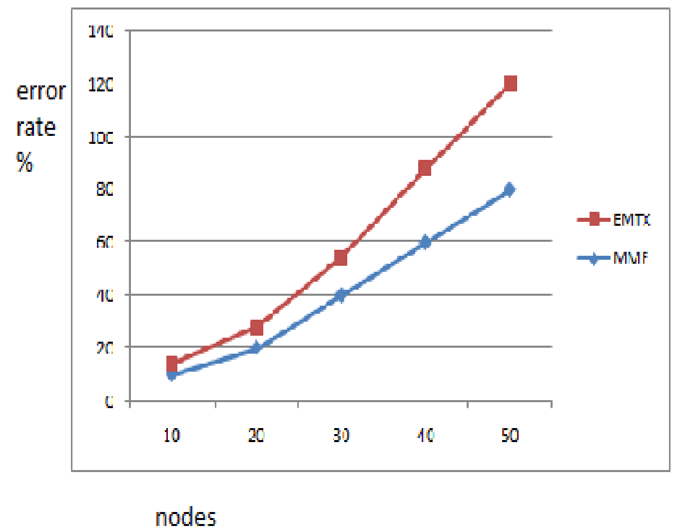

Fig 1.4 Comparison of error rate with EMTX and MMF

6.3 PACKET DELIVERY RATIO

Packet delivery ratio is the number of successful packets delivered to the destination when compared with number of packets sent by sender. When compared with EMTS every time MMF shows higher packet del;ivery ratio.

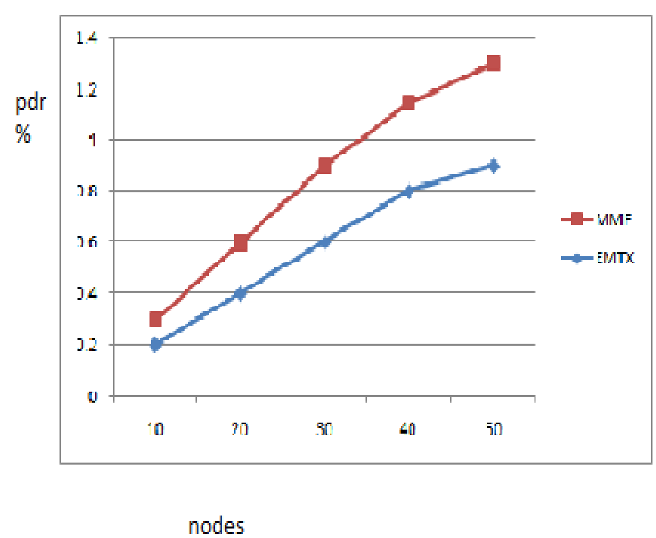

Fig 1.5 Comparison of PDR of MMF and EMTX

6.4 ENERGY LEVEL

Energy level determines the lifetime of a node in the network. Each time of comparison between EMTX and MMF, the nodes in MMF shows higher energy level.

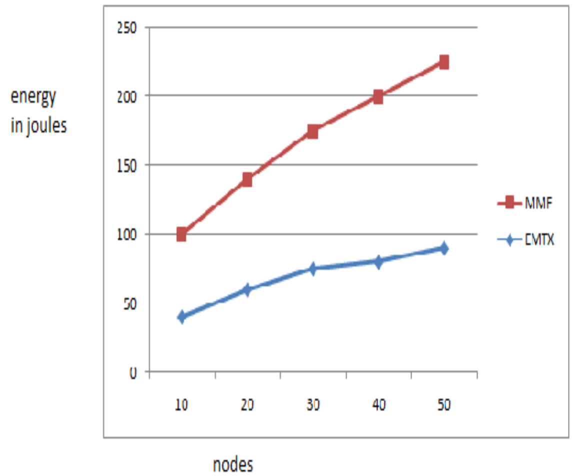

Fig 1.6 Comparison of Energy level in MMF with EMTX

7.CONCLUSION AND FUTURE ENHANCEMENT'

We develop high throughput in mutltihop mesh networks. We use all techniques such as max min fairness, centralized algorithms and distributed algorithms and increase throughput. We can also increase the node values and implement the same scheme to increase the throughput. Also we try to increase many quality of services such as error control, jitter erc

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