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SURVEY ON VARIOUS LOAD BALANCING TECHNIQUES IN WIRELESS MESH NETWORKS

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ABSTRACT

Wireless Mesh Network (WMN) is a narrative networking standard for next generation wireless network. The center technology involves a network of wireless routers forwarding each other's packets in a multihop fashion. Wireless Internet Service Providers are now opting WMN to provide internet connectivity, as it allows a fast, easy and economical network operation. A result of gateway node will become congested due to the high traffic load towards it. Load Balancing (LB) can be used to expand the lifetime of a Mesh Network. In a WMN, where multiple paths to the destination node are very common, LB is the best approach to increase network throughput and to reduce congestion. A LB scheme is important to balance the traffic in the network across the various gateway nodes and avoids the overloading of any gateway node. In this paper we survey various load balancing techniques to avoid congestion in the network.

KEYWORDS: Wireless Mesh Networks, Load Balancing, Multihop, Routing Metric, Gateway.

I. INTRODUCTION

WMN has emerged as a key technology for next generation wireless networking because of its advantages over other wireless technologies. Wireless Mesh Network is used to provide low cost broadband internet access to a large community of users.WMN is a combination of two point-to-point or point-to-multipoint networks. Mesh Networks are semi-mobile. The nodes may change but the overall coverage is somewhat constant. Mesh nodes normally are connected to every other node within range creating a mesh of coverage paths.WMN include broadband wireless access, building automation, transportation system, industrial applications, hospitality etc.

A. Overview of Load Balancing in WMN

LB of a computer network is a method to distribute workload across multiple computers or a cluster of computers, processing devices, different network links, storage units, or other available resources, to achieve optimality in respect to resource utilization, throughput maximization and minimization of response time.
Load balancing in WMN include two levels as follows

i. Gateway-based load balancing
ii. Mesh-router-based load balancing

Gateway Level Load Balancing Techniques for WMN

The GWLB can be further improved, specifically with an enhanced capability of measuring domain capacity and overload situations, the protocol can yield better results. Other possible extensions include applying GWLB to multi-radio Mesh Networks, and employing more advanced routing metrics such as ETX and ETT.

Router Level Load Balancing Techniques for WMN

WMN routing is the process of finding a path from a source node to destination node. Mesh network requires each node to share route information with others. A resourceful routing algorithm should consider the factors like maximizing probability of path delivery, minimizing delay, fault tolerance and load balancing.WMN is a technology developed to provide high bandwidth broadband service to a large community of users. As a result a great portion of users intends to communicate with the outside networks via the internet gateways, so due to

high traffic there will be potential bottleneck in the gateway. The number of gateway nodes does not improve the throughput of Wireless mesh network unless load balancing scheme is employed. If the routing algorithm does not take account of traffic load, some gateway may be overloaded while others may not. So load balancing is essential to use the underutilized paths in the network.

II. PROPOSED LOAD BALANCING TECHNIQUES

Congestion in a network causes different problems like high end to end delay, throughput degradation, packet drop, etc. Different routing techniques have been used.

WCETT-LB

Weighted Cumulative Expected Transmission Time with LB is a routing metric which is an enrichment of WCETT routing metric. WCETT-LB enforces LB at mesh routers and maintains global load aware routing. LB component consist of two parts: congestion level and traffic concentration level at each node in a particular path. Standard queue length at each node is considered for valuating congestion level. The standard queue length is compared with a threshold value and if the queue length is greater than the threshold value, then the path is said to be overloaded. The valid time required for transmission can be calculated by dividing the queue length with the transmission rate at a node (b_i). The routing metric for LB can be formulated as follows:

$$WCTT\text{-}LB(_p)=WCETT(_p) +L(_p) \text{ - - - - - - - - - (1)}$$

Where,

$$L(_p)= \quad / \quad +\min(ETT)N_i \text{ - - - - - - - - - - (2)}$$

Load balancing component consist of two parts at each node in a particular path:

Congestion Level

In the congestion aware routing segment a congestion threshold α is introduced to determine whether a particular node in the network is congested or not. A node *i* will calculate its possess congestion level and if it is better than the threshold value then the node will update this information by recomputing WCETT-LB, and this congested node will multicast this updated routing metric to all the nodes.

Load Balancing Level

In the load balancing phase each node compares the recent WCETT-LB with the best WCETT-LB after it receives updated WCETT-LB and if it is greater than the threshold value, then the mesh router will exchange from the recent path to the best there by avoiding congestion .This routing metric addresses both load balancing and interference and it efficiently reduces ping-pong effect but introduces computational overhead.

Hop-Count Based Congestion-Aware routing

Hop-count based routing protocol is calculated which permits each mesh router to quickly discover multiple paths based on hop count metric to the Internet Gateways. A bandwidth estimation technique has been proposed to apply at each mesh router to permit it to foresee congestion risk over its connected links and to select high available bandwidth link for forwarding packets. Multipath routing protocol two phases are employed-Route discovery phase and path selection phase. Here route discovery phase, whenever a mesh router needs a route to an internet gateway, it initiates a router discovery process by sending a route request (RREQ) to all its neighbors.

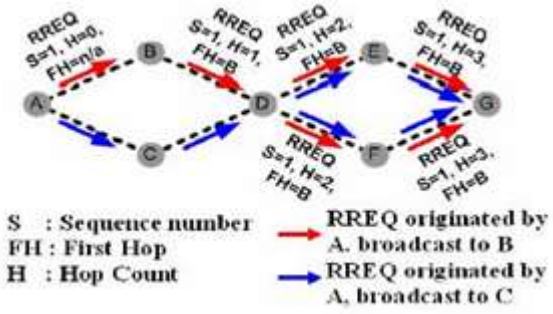

Fig 1: Broadcasting RREQs

Path selection phase a source should decide which one is the best path among the multiple path established in the route discover phase.

The path selection can be prioritized in following order:

a) If there exist manifold paths to a source's primary gateway then, take the path with lowest hop count and if there is still a tie, we can select a path randomly.
b) If there is no path to source's primary gateway but a numerous paths to secondary gateways then, take the path with lowest hop count and if there is still a bind select a path randomly.

Load Balancing through multiple gateways

LB through multiple gateway technique balances the load among different internet gateways (IGWs) in a wireless mesh network. Depending upon the average queue length at the IGW, the gateway which services the active source can be switched.

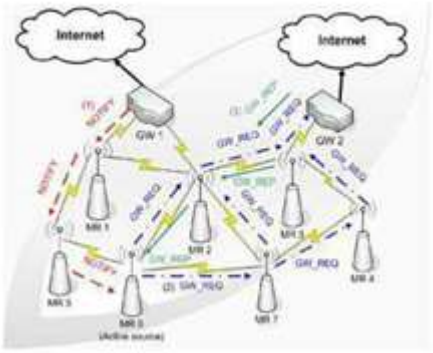

Fig 2: Load balancing in WMN through gateway switching

The load balancing scheme includes two modules:

Gateway Discovery Modules

GDM determines a crucial gateway for a mesh router and a load balancing module that rebalances the load among the gateways. During the gateways discovery phase all nodes discover their main gateways. The gateways inform their presence by sending intermittent beacons. On receipt of a beacon signal the node will register itself to the gateway.

Load Balancing Modules

Following the initial gateway discovery procedure, in the second phase, each IGW continuously monitors its queue length during a time window. When the average queue length exceeds a positive threshold value, the gateways sends a congestion notification message to the active sources.

Distributed Load Balancing Protocol

Distributed LB protocol the gateway coordinates to redirect flows from congested gateways to other underutilized gateways. Along with load balancing this scheme also considers interference which makes it suitable for implementation in practical scenarios, achieving good results and improving on shortest path routing. At this time a mesh network is divided into domains. A domain d_i can be defined as set of sinks served by gateway, where sink is a router that receives internet traffic. For each domain a specific capacity is assigned and is compared against the load in the domain.

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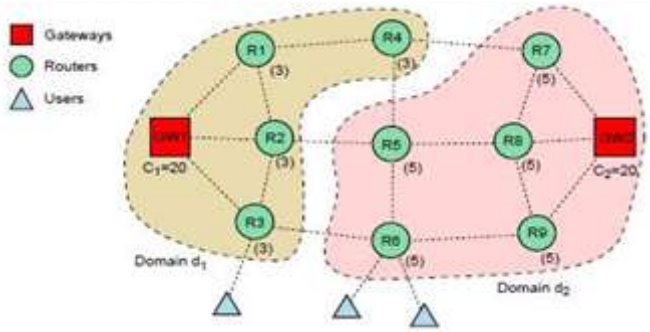

Fig 3: Mesh network divided into domains for load balancing

Gateway –Aware Routing

Gateway- aware routing solution that smartly selects gateways for each mesh router based on multihop route in the mesh as well as the potentiality of the gateway. A several routing metric is designed that picks high throughput routes in the presence of multiple gateways. The metric designed is able to identify congested portion of each path, and choose a proper gateway.

The gateway capacity metric can be defined as the time needed to transmit a packet of size S on the uplink and is uttered by

$$gwETT=ETX_{gw}\ S/B_{gw} \quad \text{- - - - - - - - - - - - - (3)}$$

where $ETX_{gw\,is}$ the probable transmission count for the uplink and B_{gw} is the capacity of the gateway.

For forwarding packets a GARM is defined which follows is:

$$GARM = \beta.M_i + (1-\beta)\ .(mETT+gwETT) \text{ - - - (4)}$$

This Gateway-aware Routing Metric includes two parts.

The first part of the metric is dependable for bottleneck capacity and the second part accounts the delay of the path. To control the balance between these two factors is used. The gateway with least GARM value can be selected as the default gateway for balancing the load. This paper overcomes the disadvantage of correct bandwidth estimation recommended in and also improves network throughput.

III. CONCLUSION

In this paper, different load balancing techniques for gateway level and router level are discussed with respect to their level of working. LB is a significant issue that needs to be addressed in wireless mesh networks. The nodes in a WMN communicates in multihop manner, this causes congestion in the network due to high traffic towards the gateway. LB is necessary to utilize the entire available paths to the destination and prevent overloading the gateway nodes. In this paper we surveyed different LB techniques with different routing metrics that can be employed to deal with load overhead in the network to a great extent

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