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GBC-TD: Gateway Based Congestion and Traffic Distribution Model for Load Sharing in WMN

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Abstract: *Effective communication can be categorized by its approaches used to handles the uncertainties and especially in wireless medium. Wireless mesh network is one of the ad-hoc networks having huge applicability with variety of protocols supporting different routing situations. Load balancing over the gateway is one of the key issues related to optimal routing in WMN. In case of multiple networks inter communication; WMN suffers from the gateway selection problem and its load distribution commonly taken as NP-Hard complexity. Mainly these gateway nodes are having the maximum traffic flows due to their central locations and bridge functionality, also the traffic distribution is uneven at those gateways. This paper proposes a novel GBC-TD (Gateway Based Congestion and Traffic Distribution) model from overcoming the above issues of gateway selection problem by using a load balancer through relaying information, TTL values and flag bits status. The approach is capable of distributing the load over the network. At the primary level of work the approach is proving its efficiency and will shows its strong presence in near future.*

Index Terms: *WMN (Wireless Mesh Network), Routing, Load Balancing Gateway Selection, Congestion, Traffic Divergence, GBC-TD (Gateway Based Congestion and Traffic Distribution);*

I. INTRODUCTION

Wireless medium is gaining popularity these days due to their wide applicability in several areas such as: healthcare, transportation, military, telecommunication etc. Wireless mesh network is a ad-hoc network consists of mesh routers and clients. Here each node will acts as a router as well as client. The transmission is of supportive communication in which the nodes transfer the packets with the help of some other node in the range of source to destination. Since the deployment effort required with WMN is very less thus taken as most effective means for establishing the communication is disaster affected areas. Thus in such cases where the number of routers or intermediately nodes are less the traffic flow form them is very high causes congestion at their gateways. Hence a new mechanism has to be designed for resolving those load balancing issues of underutilized and over-utilized mesh nodes. Distribution of traffic from those nodes can be made after analysis of traffic patterns which might be affected by different parameters such as: mesh router location, channel assignment, scheduling and transmissions etc. In most of the cases of static networks the topology is fixed so as the gateway selection and connections diverts the network performance factors. Largely there are some problems which continuously affects such situations and includes the problems of congestion, load balancing, gateway selection, and flow and topology control.

Consider wireless mesh network having routers and a base station, which is directly connected to external network by some gateway node. Now the in above situation the node transmitting the maximum number of packets between two different networks is taken as a gateway node. Here the base station is located at some central position after gateway selection is performed from the existing mesh nodes with larger relaying data. These selected gateways are collaborated by a common communication channel between them.

In this the managing node is termed as a base station and is located at the centre of the wireless mesh network. This station chooses a certain number of wireless mesh routers as sink or gateways, and creates connections among them. The purpose of this work is to effortlessly and promptly discover the candidate gateways that maximize the system throughput with solvable optimization issues. It also includes number of evaluating parameters and involves intense computation load values. The performance of the proposed scheme is evaluated by numerical analysis, and demonstrated through computer simulations. In future the results show that our proposed scheme can determine the appropriate candidate gateway with high accuracy when there is a certain variance in the amount of traffic generated by users at each wireless mesh router.

II. BACKGROUND

Ad-hoc network provides wide area of applicability and range of communication options for several technologies to ease the networking usages. These technologies still suffers from many issues and challenges to make this communication more effective, performance oriented and secure. Among them routing is considered to be a major task required for such improvements. Routing involves source to destination communication via

optimal path and medium with support of dynamically changing topologies. Optimal solution requires effective utilizations of bandwidth, battery power, processing and networking devices. In case of wireless medium the protocols are used to achieve these goals with here lightweight versions embedded to movable devices. Routing also involves the proper distribution of traffic between over utilized and underutilized devices and termed as load balancing. It works towards the minimization of congestion and optimize the resource utilizations. Performing this process of balancing the load suffers from several issues due to its frequently changing nature. It is applicable to the same domain and also works in inter-domain areas.

Wireless mesh network is a type of ad-hoc network with high capacity internal structure known as backbone used to support the communication of inter-domain routing as given by figure 1. This structure provides the internet connectivity between the two different types of networks. Thus the traffic flows between those different types of network have a node gateway to support this communications which maximizes the traffic distributions. Inter-domain networks communicates via gateway node which is responsible for routing process and traffic distribution and diverting. Thus among the several functions of gateway load distribution and traffic divergence is considered to be a major part. Also the nodes working centrally in the network are likely to get congested more than some edge based nodes because the probability of traffic flows from these nodes more. Gateway nodes are these centrally managed nodes and transfers traffic heavily because of their communication between the two different networks and hence the probability of them to gets stucked in traffic is more than any other cases. Thus here load balancing schemes needs to perform well. But due to the lightweight functionalities of existing protocols for routing these phenomenon's is not taken care of effectively.

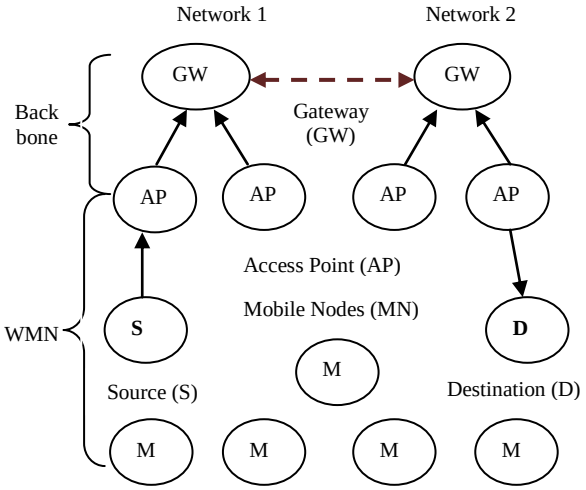

FIGURE 1: GATEWAY BASED TRAFFIC SCENARIO OF INTER-DOMAIN ROUTING

Load balancing protocols is categorized according to their traffic distribution scenarios like channel load, nodal load and neighbour load. On the basis of which some schemes and protocols are suggested to overcome those falls in the category of delay based, traffic based and hybrid based schemes. Examples of those approaches are: Load-Aware On-Demand Routing (LAOR), Associatively Based Routing (ABR), Load Balanced Ad Hoc Routing (LBAR), Traffic-Size Aware (TSA) scheme, Content Sensitive Load Aware Routing (CSLAR) and Load Aware Routing in Ad Hoc (LARA).

III. LITERATURE SURVEY

During the last few years various approaches had been suggested to overcome the gateway congestion problems. Most of them succeeded to resolves but in certain dynamic scenarios the load balancing scheme fails. Some of the well recognized approaches are taken here as a literature on which survey is been conducted to identify the remaining issues and their behaviours.

In the paper [8], an approach is suggested to remove the issues of congestion and lossy nature. The approach is capable of resolving both the issues and gives a improved congestion control mechanism. For doing this the authors takes a decision making problem for gateway selection known as multi-armed bandit problem. After to which the author had proposed three myopic policies to achieve a near-optimal solution for the mapped problem since no optimal solution is known to this problem. The evaluation reveals that the proposed mechanism can achieve up to 52% increased network throughput and 34% decreased average energy consumption per transmitted bit in comparison to the other end-to-end congestion control variants.

In the paper [9] a Rate-based congestion control for wireless mesh networks is proposed using an adaptive pacing scheme to overcome the drawbacks of TCP with Internet connectivity in wireless mesh networks areas.

The suggested pacing method is implemented at the wireless TCP sender as well as at the mesh gateway, and reacts according to the direction of TCP flows running across the wireless network and the Internet. TCP packets are transmitted rate-based within the TCP congestion window according to the current out-of-interference delay and the coefficient of variation of recently measured round-trip times. At the evaluation basis the approach is proving its efficiency for Linux based systems.

With all the existing mechanism the goal is to improve TCP performance by several mediums. Among several wireless mediums it is identified that the use of signal strength based cross layer approach resolves the congestion issues most of the times. Thus this paper [10] gives a signal strength based measurements to improve such packet losses and no need to retransmit packets. Node based and link based signal strength can be measured. If a link fails due to mobility, then signal strength measurement provides temporary higher transmission power to keep link alive. When a route is likely to fail due to weak signal strength of a node, it will find alternate path and consequently avoids congestion. Some of the output parameters prove the results of the above approach on AODV and DSR protocols.

In the paper [11], the load is reduced by identification of the candidate gateways that maximize the system throughput without solving a complex optimization problem. It will include a large number of optimization parameters and involves intense processing load. The performance evaluation of the suggested scheme is achieved by numerical analysis computer model. The results show that proposed scheme can determine the appropriate candidate gateway with high accuracy.

Normally in WMN, a traffic aggregation occurs in the paths leading to a gateway and due to the limited wireless link capacity, these nodes are expected to be potential problems. This paper [12] proposes a distributed load balancing algorithm to achieve load balancing on gateway nodes which leads to proficient traffic allocation as well as highest use of network ability. This algorithm uses Learning Automata in order to select the appropriate gateway node to send traffic. Evaluation results reveal that the projected scheme mostly avoids jamming and can successfully make the traffic stable.

In the paper [13], author proposes an approach of gateway based load distribution by identifying the similarity in traffic patterns inherent in the meshed environment. While all the traffic is anticipated to traverse through the gateway, an enforced rate control scheme there, anticipating that the sources will react to limit their traffic to their gateway-limited capacity. The approach here uses a fair-share computational model to determine the appropriate rate for the various sources. The evaluation of performance is shown in the paper using simulation over various mesh topologies.

In the paper [14], an adaptive online load balancing protocol is proposed for multi gateway based wireless mesh network having the functionality of traffic distribution according to the assessed networked conditions. The improvements is identified over the assessed TCP based throughput and flow. The scheme is named as gateway load balancing (GWLB) and is a responsive mechanism shows the selection of best gateway according to the current network traffic conditions. It is also capable of analysing the traffic flows such as inter domain or intra domain. The approach proves its effectiveness by strong results improvements in gateway selection accuracy and traffic distribution performance.

Some of the work had also restricted them towards the application areas such as disaster based environments. In the paper [15] on of such approach is proposed for voice traffic measurement achieved in disaster areas. Based on these measurements, a statistical analysis is performed of channel holding and inter-arrival times. We show that the traffic in disaster area scenarios has characteristics different from public mobile telephony systems. Thus, simulating disaster area networks, different traffic characteristics should be assumed. With the results presented in this paper, it is possible to reach a realistic traffic for disaster area scenarios.

IV. PROBLEM STATEMENT

Gateway is centrally located node used to maintain the communications and routing decisions between the two different types of network. It has the highest probability of traffic crossing out from this node to some other network. Thus the congestion of traffic and packets losses is high at the gateways. There must be some entry on the basis of which the gateways are selected for further transmitting the packets. It might be number of packets relayed and from this it is decided that which gateway is best for carrying the communication having less traffic and load. This is taken as gateway identifying criteria as should occurs at media access control layer. If some mechanism is not planned than the packets drops and loads are excessively increased which later on causes the delays and drops. By this routing performance is degraded. Some of the further clarification of the problem on which this work focuses is given as:

Problem 1: In case of multiple gateways the existing system is not having any synchronous operation between them. In some cases temporary routing problems can be taken as route breakage because of this miscommunication between the multiple gateways.

Problem 2: Independent load balancing is not provided with congestion control at distributed gateways. It causes the traffic divergence at intermediate gateways always and from which the network performance get dropped.

Problem 3: Congestion and flow control scheme along with gateway selection is not available.

These are the problems which remain unaddressed by the existing schemes and this work focuses its concerns towards solving the above issues for wireless mesh network.

V. PROPOSED GBC-TD APPROACH

The GBC-TD is suggested to overcome the existing issues related to gateway selection problem and load balancing. Gateway is a centrally located nodes works to holds the inter domain communication between the two different type of network. Here the network might contain the multiple gateway thus selection of best gateway among them is performed by identifying their load individually. For this some of the basic assumptions are made like each node overhears the transmission of its neighbour nodes to identify the total number of packet relayed. Node keeps the track of its neighbour working which also includes the relayed information along with flag bit status and TTL values form which the delays in the delivery is measured which gives the congestion analysis. The suggested model performs the functionality of effective gateway selection by its three components:

(i) **Node:** It must have the protocols which permits overhearing of the neighbour node. The frame format must be of light weight so as to make the approach less complex in terms of computational operations than any existing mechanism.

(ii) **Information Fetcher:** This module gets the information collected from various nodes in a network and let the information to be processed and transferred to the load balancer module. It contains the values of TTL, flag status and relayed information.

(iii) **Load Balancer:** After the basic information from the network is collected the load balancer starts working as a traffic distribution and identifies the best gateway for further hosting the communications.

Description: Initially nodes broadcast the RREQ hello message to its entire neighbour in a specific range. The node receiving this message will enters the required information to the packet which includes Node ID; the total number of packets relayed or transmitted information, the flag bit values for accurate complete quantity and the time to live values for measuring the delays in the transmissions. The node which is unable to receive this hello RREQ packet means that the link to that node is not active or node leaves the network. Thus it is mandatory for each node to reply this hello message.

After collecting all the artefacts about the transmissions the load balancer decides the load on its underutilized and over utilized conditions. This decision making is for effective load free gateway selection from multiple gateways. Because the node having maximum packets relayed is a gateway. The packet traversing from source to destination with a flag bit and each node in a way will insert its load values and sets its flag bits. At the end destination replies will the total computed load of this path from gateway 1. At the same time the path load values from the gateway 2 is identified and similar process is executed for all the gateways. The gateway having least total should be taken as less congested and the net traffic is diverted from this gateway node by the load balancer. Thus over-utilized traffic is diverted to underutilized gateway.

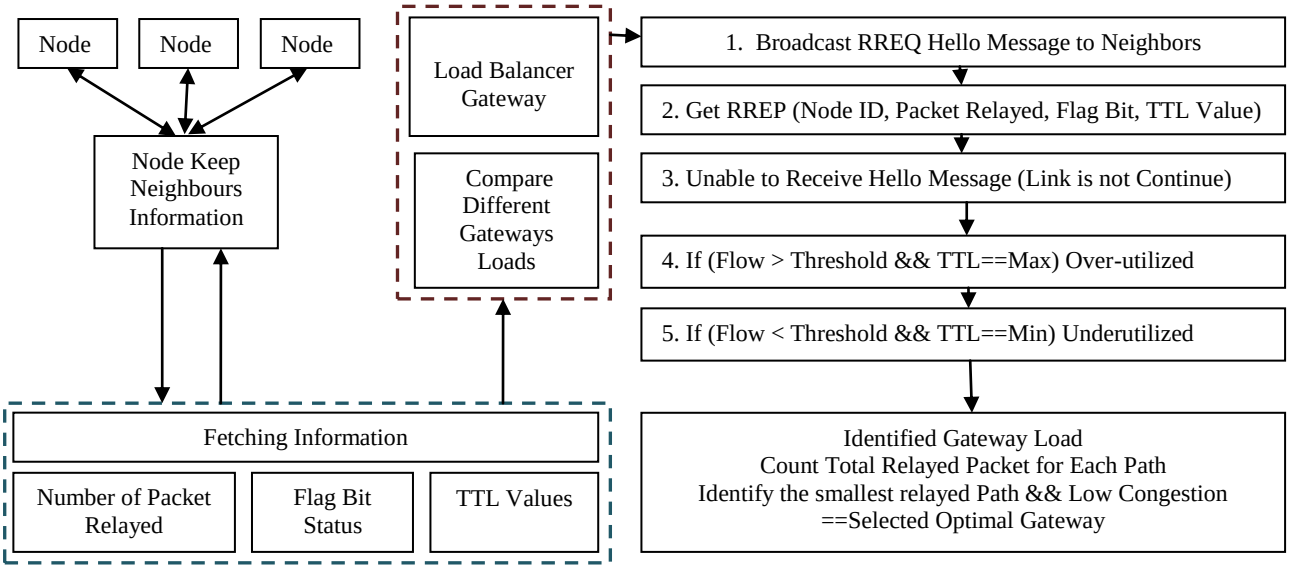

FIGURE 2: GBC-TD: GATEWAY BASED CONGESTION AND TRAFFIC DISTRIBUTION MODEL

At the primary level of work the approach seems to provide effective result in near future. The approach suggested by the paper is congestion free and after analysis of traffic is capable to distribute it evenly and also in real time. The simulation environment of the suggested mechanism will proves its efficiency over the other existing approaches.

Expected Outcomes

The given scheme can be able to:

(i) Route the upload & download traffic at Intermediate Gateway.
(ii) Network state monitoring can be performed based on congestion at gateway or sink node.
(iii) Underutilized node problem can be solved.
(iv) Low complexity route balancing can be achieved.
(v) Flow can be locked down or diverted at specified time for a particular duration.
(vi) Flow classification can be done in a controlled manner.

VI. PERFORMANCE EVALUATION

In future the results will show the effectiveness of proposed scheme. For network simulation, there are several performance metrics which is used to evaluate the performance. In future simulation purpose this work will use performance metrics for showing the expected results.

- *Packet Delivery Ratio*
  Packet delivery ratio is the ratio of number of packets received at the destination to the number of packets sent from the source. The performance is better when packet delivery ratio is high.
- *Average end-to-end delay*
  This is the average time delay for data packets from the source node to the destination node. To find out the end-to-end delay the difference of packet sent and received time was stored and then dividing the total time difference over the total number of packet received gave the average end-to-end delay for the received packets. The performance is better when packet end to end delay is low.
- *Loss Packet Ratio (LPR)*
  Loss Packet Ratio is the ratio of the number of packets that never reached the destination to the number of packets originated by the source.
- *Normalized Overhead Load:*-The amount of control traffic generated (in bits) per data traffic delivered (in bits).
- *Average Discovery Period:*-Average duration of a discovery period in seconds.

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VII. CONCLUSION

In this paper a novel Gateway Based Congestion and traffic distribution (GBC-TD) model is proposed to improve the existing problem of gateway selection based on their load values. The approach also resolves the issues of load sharing with congestion and flow control based on certain threshold limits. For getting the exact analysis of traffic flows the number of relayed packets information and flag bit status is important. The approach is capable of providing the adaptable nature for gateway selection problems. At the initial level of work the approach is capable of providing effective traffic distribution, optimal route identification and congestion control.

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