Congestion Control Technique for Wireless Mesh Networks

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***Abstract*— Wireless Mesh Networks are believed to be a highly promising technology and will play an increasingly important role in future generation wireless mobile networks. The growing popularity of wireless networks has led to cases of heavy utilization and congestion. Since TCP alone does not explicitly account for this congestion over such networks. So there are different techniques are used for controlling the congestion in Wireless Mesh Networks. Here in this paper we study about different Congestion control techniques for Wireless Mesh Networks.**

***Keywords*— Wireless Mesh Network, congestion, congestion control techniques**

I. INTRODUCTION

In now a day Wireless Mesh Networks are become more and more demanding networks due to the growth in the demand of the different wireless communication devices into the next generation. It's a communication networks that attracted Internet Service Providers because of its rapidly growing and developing of the wireless technologies. Wireless Mesh Networks are the Promising technology for providing high bandwidth network coverage.Due to the share bandwidth and shared wireless medium there is a major problem arise in fare rate allocation to all the nodes which are in the network. A network state where the arrival rate exceeds the service rate then congestion is occurred and it affect on the network bandwidth and the packet delay. So in wireless Mesh networking the congestion control is the one biggest challenge for the researchers. To overcome the congestion effect on a network there are different congestion control technique are established. In this Page Layout paper we study about some techniques which are used for the congestion controlling.

In this paper we study about congestion control techniques which are structured as follows:

- Neighborhood-aware and overhead free technique.
- Neighborhood-Centric technique
- Cluster based Congestion control technique
- XCP-Winf and RCP-Winf technique
- Variant of TCP
- Cross layer based technique
- Neural network based technique.

A. What is Congestion?

The occurrence of a high density of nodes within a single collision domain of an IEEE 802.11 wireless network can result in congestion, thereby causing a significant performance bottleneck. Effects of congestion include drastic drops in network throughput, unacceptable packet delays, and session disruptions.

On the Internet, a network link is said to be congested when the offered load on the link reaches a value close to the capacity of the link. In other words, congestion is the state in which a network link is close to being completely utilized by the transmission of bytes.

In a similar manner, wireless network congestion can be defined as the state in which the transmission channel is close to being completely utilized. The extent of utilization can be measured using a channel busy-time metric given as the fraction of a set period of time that a channel is busy.

B. Cause of Congestion

Congestion can occur due to several reasons. For example, if all of a sudden a stream of packets arrive on several input line and need to be out on the same output line, then a long queue will be build up for that output. If there is insufficient memory to hold these packets, then packets will be lost dropped).

Adding more memory also may not help in certain situations. If rout(er have an infinite amount of memory even then instead of congestion being reduced, it gets worse; because by the time packets gets at the head of the queue, to be dispatched out to the output line, they have already timed-out (repeatedly), and duplicates may also be present. All the packets will be forwarded to next router up to the destination,

all the way only increasing the load to the network more and more.

Finally when it arrives at the destination, the packet will be discarded, due to time out, so instead of been dropped at any intermediate router (in case memory is restricted) such a packet goes all the way up to the destination, increasing the network load throughout and then finally gets dropped there.

Slow processors also cause Congestion. If the router CPU is slow at performing the task required for them (Queuing buffers, updating tables, reporting any exceptions etc.), queue can build up even if there is excess of line capacity. Similarly, Low Bandwidth lines can also cause congestion. Upgrading lines but not changing slow processors, or vice-versa, often helps a little; these can just shift the bottleneck to some other point. The real problem is the mismatch between different parts of the system.

Congestion tends to feed upon itself to get even worse. Routers respond to overloading by dropping packets. When these packets contain TCP segments, the segments don't reach their destination, and they are therefore left unacknowledged, which eventually leads to timeout and retransmission.

So, the major cause of congestion is often the busty nature of traffic. If the hosts could be made to transmit at a uniform rate, then congestion problem will be less common and all other causes will not even led to congestion because other causes just act as an enzyme which boosts up the congestion when the traffic is bursty (i.e., other causes just add on to make the problem more serious, main cause is the bursty traffic). This means that when a device sends a packet and does not receive an acknowledgment from the receiver, in most the cases it can be assumed that the packets have been dropped by intermediate devices due to congestion. By detecting the rate at which segments are sent and not acknowledged, the source or an intermediate router can infer the level of congestion on the network.

II. DIFFERENT TECHNIQUES TO CONTROL THE CONGESTION (METHODOLOGIES).

A. Neighborhood-aware Technique[1]

In the IEEE 802.11 due to the MAC and TCP protocols the congestion control in wireless mesh networks are problematic in terms of the starvation of the flow control. In wireless networks bandwidth is shared among the different nodes and for this reason in Wireless Mesh Networks the Congestion is a neighborhood event and that should be handled using the mutual cooperation among the congested nodes.

A New scheme called Neighborhood-aware and overhead-free Congestion Control Scheme (NICC) that used to solves the starvation problem without impacting the scare bandwidth of WMNs [1]. To avoid starvation of flow the NICC can control the congestion through mutual cooperation among nodes which are located in a congested neighborhood. The NICC can detect the congestion by supervising the evolvement of the queue length at transitional nodes. The NICC can allows source nodes to adjust flow rate using an AIMD-based algorithm that processes at the different congestion levels. In NICC frames they use the last bits-combination (11) which is not used in the traditional IEEE 802.11 frame header. The Bit-combination (11) is used as a data frame they define 8 new control frames and up to 16 new data frames.

Using these bit-combination they new frame types: (1) congestion notification Acknowledgement (CN_ACK) it includes the new control frame; (2) Congested Link Data (CL_DATA) it include the half of the new data frames; and (3) Congestion Signalling Data(CS_DATA) it include the other half of the new data frames[1]. Using the simulation results they shows that the NICC can perform better in the way of fairness in term of overall throughout

B. Neighborhood-centric Technique[2]

In multihop wireless networks the TCP does not well defined to solve the problems like starvation and congestion. For these reason in this paper for achieving fair and efficient congestion control they design AIMD-based rate control protocol called Wireless Control Protocol, which recognizes that wireless congestion is a neighborhood phenomenon, not a node-local one, and appropriately reacts to such congestion [2]. They also design a WCPCap (Wireless Control Protocol with Capacity estimation) to estimating the available capacity within the each neighborhood and depend on them they distributes the load among relevant flows. The WCPCap uses the achievable rate computation technique to estimate the achievable capacity (bandwidth) and give the feedback to the source.

Through the simulation results observed that (1) WCP allocates a rate that depends inversely on the number of congested neighborhood traversed by the flow and the intensity of congestion in those regions [2]. (2) WCPCap allocates to each flow a rate within 15% of the rate allocated to it by the max-min fair rate allocation [2]. WCPCap shows low delay and fast convergence.

C. Cluster Based Technique[4]

In most of the time Congestion is the the main problem in the WMNs. Changing in the Routing techniques may prompt to control the congestion in this type of network. In these paper they give the solution with the application of the clustering based technique for solving the congestion and routing problems in WMNs.In this paper the discuss about the various clustering algorithms which are used for providing the efficient route in the wireless networks. The algorithms are categorized as Weighted Clustering Techniques like LID, Distributed Clustering algorithm, weighted clustering algorithm, Enhanced Weighted Clustering algorithms, etc., and Emergent Clustering Algorithms, Hierchical clustering Techniques like, HSR(Hierarchical State Routing), LEACH (Low Energy Adaptive Clustering Hierarchy), And summarized that many of these clustered solutions are attempts to improve routing technique [4] also used in solving

the congestion problems in WMNs without any modification to their original forms.

D. XCP-Winf and RCP-Winf Technique[6]

Congestion is the severe problem in the Wireless networks for this reason in this paper they proposed a congestion control technique for the WMNs. There are some most known and widely used protocols XCP (Explicit Control Protocol) and RCP (Rate Control Protocol) for providing the minimizing the control effects. These two networks are mostly proposed for a wired type networks and likes environments.

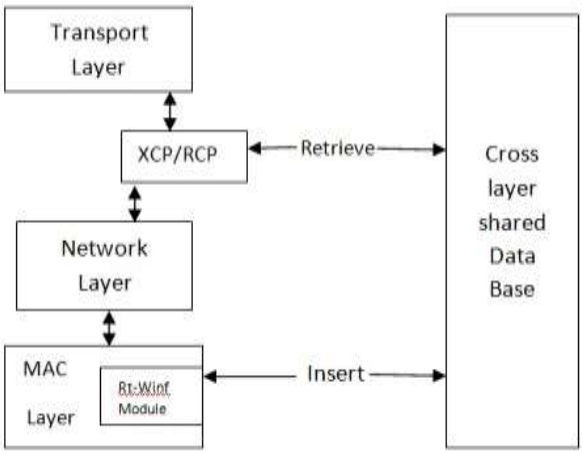

Fig1: XCP-Winf/RCP-Winf System [6]

In this technique a new flow control protocols for the mesh networks, which are based on the XCP and RCP, and which are introduced as XCP-Winf and RCP-Winf. These two congestion control mechanism are supported on a new method rt-Winf which can measures the capacity and available bandwidth in the Wireless Mesh Networks. The rt-Winf mechanism can rely on the RTS(Request to send) and CTS (Clear To Send) handshake on the packets. They proposed a integration of rt-Winf in the XCP and RCP through a cross layer approach and then define two different approach called XCP-Winf and RCP-Winf. These two protocols are used the capacity and the bandwidth of rt-Winf in congestion control technique to evaluate the congestion status as the wireless mesh networks links,and after evaluation it take proper action to avoid the congestion as well as reduce the congestion .

E. TCP Varients [7]

In this paper they proposed a congestion control mechanism of the various version of the TCP in Wireless Networks and techniques for improvement of throughput and the window size variations. They describe various congestion control techniques like cross layer, per-flow for controlling the window.

Different versions of TCP which are used during congestion are:

1) TCP Tahoe: It is used for Avoidance Congestion and slow start.

When congestion occur in network, TCP Tahoe use the triple timeout to detect congestion or the packet loses from the current network. In TCP Tahoe it decrease the congestion window size to one after detecting the congestion and then increases the congestion window size from one to threshold value which is act as limit point for exponential increase and is set to the half of the congestion window size before experiencing.

2) TCP Reno: It is used for fast recovery and fast retransmits.

When the TCP enters into fast recovery it records the highest outstanding unacknowledged packet sequence number. When sequence number is acknowledge, TCP returns to the congestion avoidance state.

3) TCP Vegas: For congestion control TCP Vegas is the new approach in wireless networks.

TCP Vegas uses additive increases in the congestion window when the congestion is occur in the network. TCP Vegas is able to catching the most of the bandwidth.

F. Cross layer based technique [11]

In this technique the authors Pradeep reddy and P.Venkata Krishna proposed a new congestion control technique for wireless mesh network called Cross Layer Congestion Control (CLCC). In this technique they estimate the congestion for the different traffic models like single source to single destination and multiple sources to the multiple destinations.

They proposed a cross layer architecture involving the MAC layer and the Transport layer. The level of the congestion is estimated in the MAC layer and then communicated to the transport layer for utilizing the proposed cross layer architecture, where they control the traffic type-non real time and real time traffic. When the congestion is absent or minor then chosen the real time traffic and when the congestion is utilized and high then non real time traffic is selected. The process is repeated but every time it reduces the congestion window by 25%. The reduction in congestion window is occurs only in case of the high congestion level in the chosen path and the process requires repetitions. This cross layer technique is used for optimizing of the congestion control mechanism.

From the simulation result observe to have better control over the bandwidth management issue in the network and enhances the network performance in terms of ratio of delay, dropped packets, receive packets and size of the sending window. This model attracts many applications like campus networking, high speed internet applications, transport systems and public safety.

G. Neural Network based technique [8]

The authors Tom Jacob Thomas and M.Balasubramani proposed a Neural Network based congestion control

technique for reliable data transfer over wireless mesh network. This technique incorporated into TCP to create a new variant named Intelligent TCP or iTCP.

The end-to-end congestion control mechanism with neural network completely eliminates the conventional nations of slow start, congestion avoidance etc. They maximize the utilization of bandwidth by selecting those path that maximum utilized bandwidth. In the Mesh nodes the low power nodes will be used only if there are no other alternative paths are available.

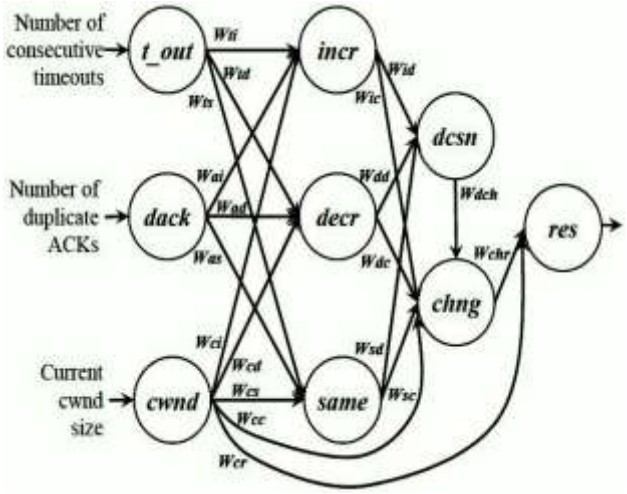

Fig2. Multi-layer feed-forward NN for iTCP[8]

In neural network design uses a multi-layer, feed forward and zero bias neural networks with reinforcement learning for intelligent end-to-end congestion control in wireless mesh networks.

Figure2 shows the design of the multi-layer, feed-forward NN for iTCP. The NN has one input layer, two hidden layers, and one output layer. The input layer consists of three neurons (t_out, dack, and cwnd) to separately process three different inputs. With adjustment of weights, Choice of activation functions and rebroadcasting protocol methods they increase total network throughput and decrease energy consumption of nodes.

III. CONCLUSIONS

In wireless mesh networking there is a major problem of congestion due to shared bandwidth and the remote nodes. For minimizing the effect of congestion in wireless mesh networks there are different techniques are used for the different type of the mechanism to control the effect of the congestion. Using Neighborhood-aware and Neighborhood-centric techniques they control the congestion which are due to the congested nodes. In XCP-Winf and RCP-Winf technique they measure the WMN status through passive monitoring tool rt-Winf, and measure the wireless capacity and bandwidth of links and from this capacity and bandwidth they control the packet delivery through nodes. Neural network based technique use the new variant if TCP called iTCP and increase network throughput and decrese average energy consumption of nodes in WMN.Using the cross-layer technique they define new bandwidth utilization algorithm called CLCC. In Cluster based congestion control technique they used many of the clustered solutions to solving congestion problem in WMNs without modifications to their original forms.

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