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 does not explicitly account for this congestion over such networks. So In this research work we will explore some systematic mechanism for controlling the congestion for wireless mesh networks. First we examined wireless control protocol which is based on AIMD (Additive Increase Multiplicative Decrease) and design a protocol which efficiently manage congestion by asking data availability of neighborhood nodes and based on data packets contains node ,capacity is divided among those nodes to competing flows by maintaining queue size, we named it WCPACap(Wireless Control Protocol by Asking Capacity). By using analysis and simulation we found that our design generates fair and efficient results compared to WCP.
Keywords – Wireless mesh network, congestion control, Wireless Control Protocol (WCP), Wireless Control Protocol by Asking Capacity (WCPACap)

I. INTRODUCTION

Wireless mesh networks are self-organized and self-configured .The nodes in the network are automatically establishing an ad-hoc network and then maintaining the all mesh connectivity. Two types of nodes there are in the WMNs: (i) mesh routers and (ii) mesh clients. There is an additional routing functionality of mesh routers for supporting the mesh networking. The same coverage can be achieved by the mesh router with much lower transmission power through multi-hop communications, for better flexibility of mesh networking, mesh router is usually equipped with multiple wireless interfaces built on either the same or the different wireless access technologies. There is minimal mobility and form the mesh backbone for the mesh clients of the mesh router. The mesh clients can also work as a router for mesh networking, the hardware platform and software for them can be much simpler than those for mesh routers. For example, communication protocols for mesh clients can be light-weight, gateway or bridge functions do not endure in mesh clients, and a single wireless interface is required in a mesh client.

Therefore, instead of being another type of ad-hoc networking, WMNs changes the capabilities of ad-hoc networks. This aspect brings much dominance to WMNs, such as minimum cost, simple network maintenance, robustness, reliable for service coverage, and many more. Thus, in addition to being universally accepted in the usual application sectors of ad hoc networks, WMNs are undergoing fast commercialization

A. OVERVIEW OF CONGESTION

Congestion can result when the high density occurrence of nodes within a single collision domain of an IEEE 802.11 wireless network, so it causing a consequential performance degradation. Effects of congestion include network throughput, unacceptable packet delays.When the offered load on the link reaches a value near to the capacity of the link then the link is said to be congested. Congestion is the state in which a network link is completely utilized by the transmission of the bytes.

B. CAUSE OF CONGESTION

Congestion can arise due to several reasons. If a number of packets arrive on some input lines and need to be out on the same output line then a large queue will be build. If there is not sufficient memory for these arrival packets, then packets will be dropped. If router have an unlimited size of memory even then congestion being reduced; reason is, by the time the packets are at the head of the queue, they have already timed-out, and their duplicates may also be present. All the packets will be transmitted to next router up to the destination or last node. At last because of the time out, when the packets arrive at the destination, the packet will be discarded.

Congestion can also cause by the Slow Processor. If the performance of the router-CPU is slow the task required for them, queue can build up even if there is excess of line capacity. Congestion can also be cause by the low-bandwidth.

Busty traffic is the major cause of congestion to occur. At a uniform rate the packets are transmit, then congestion problem will be less. This means the reason for that is when a device sends a packet and does not receive an acknowledgment from the receiver; assumptions are made in most the cases 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 deduce the level of congestion on the network.

C. EFFECT OF CONGESTION

Congestion affects two imperative parameters of the network performance, like throughput and delay. The throughput can be defined as “the percentage utilization of the network capacity”. In figure 1, we can see that the throughput is affected as the offered load is increases. At starting, throughput increases linearly with the offered load, because utilization of the network increases. Even so, as the given load increases beyond determined limit, say 60% of the capacity of the network, the throughput gets drops. If the given load increases further, a point is reached when not a single packet is delivered to any destination, this situation is known as deadlock situation. In Fig. 1, we can see, there are three curves, in the ideal curve, the situation when all the packets introduced are delivered to their destination up to the maximum capacity of the network. Another curve we can see that the situation when there is no congestion control. The third curve is the case when some congestion control technique is used. This prevents the throughput collapse, but provides lesser throughput than the ideal condition due to overhead of the congestion control technique.

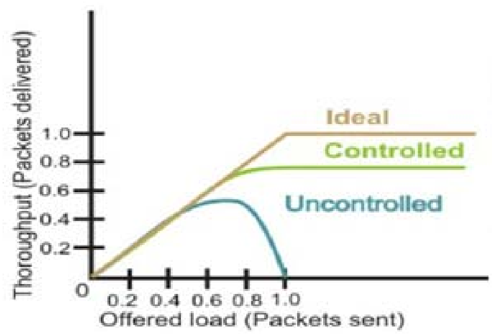

Fig.1 Effect of Congestion on Throughput

The delay also increases with offered load, as shown in Fig. 2. And no matter what technique is used for congestion control, the delay grows without bound as the load approaches the capacity of the system. It may be noted that initially there is longer delay when congestion control policy is applied. However, the network without any congestion control will saturate at a lower offered load.

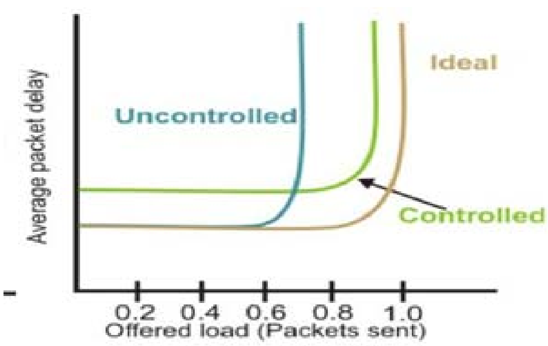

Fig. 2 Effect of congestion on delay

This paper is organized as follows. In section II we described related work for different

Congestion Control Techniques. Our proposed Protocol to control congestion is discussed in section III. Simulation results is discussed in section IV and finally section V, conclusion and future work is discussed.

II. RELATED WORK

In this section we discuss some existing technique to detect the blackhole attack Ali El Masri, Ahmed Sardouk, Lyes Khoukhi, Abdelhakim Hafid and Dominique Gaiti [1] proposed neighbourhood aware and overhead free congestion control technique for wireless mesh networks. In these paper they Proposed a New scheme called Neighborhood-aware and overhead-free Congestion Control Scheme (NICC) that 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 allow source nodes to adjust flow rate using an AIMD-based algorithm that processes at the different congestion levels. In NICC frames they uses 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 Signaling 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.

Sumit Rangwala, Apoorva Jindal, Ki-Young Jang, Konstantinos Psounis, Ramesh Govindam [2] for achieving fair and effective congestion control they design “AIMD-based rate control protocol called Wireless Control Protocol”, which identify that wireless congestion is a neighborhood incident, not a node, and suitably 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 determine the achievable capacity (bandwidth) and it give the feedback to the source.

Congestion detection in WCP is deliberately simple. A router detects congestion on its outgoing link using a simple thresholding scheme. It maintains an exponentially weighted moving average (EWMA) of the queue size, $q^{avg}_{i->j,}$ for every outgoing link i->j as

$$q^{avg}_{i->j} = (1 - Wq) * q^{avg}_{i->j} + Wq * q^{inst}_{i->j}$$

Where $q^{inst}_{i->j}$ is the instantaneous queue size and Wq is the EWMA weight. A link is congested when its average queue size is greater than a congestion threshold K

Luis_Barreto and Susana_Sargento [6] proposed 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 the bandwidth in the Wireless Mesh Networks. The rt-Winf mechanism can depend 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 assess the congestion status as the wireless mesh networks links, and after evaluation it take appropriate action to avoid the congestion as well as reduce the congestion.

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III. SIMULATION RESULTS

In this section we discuss simulation environment and describe the simulation results.

We are using Network simulator NS-2 to build our simulation environment. Following are metrics which we use to evaluate our method.

Parameter	Value
channel type	Channel/WirelessChannel
radio-propagation model	Propagation/TwoRayGround
network interface type	Phy/WirelessPhy
interface queue type	Queue/DropTail/PriQueue
antenna model	Antenna/OmniAntenna
Congestion Threshold (K)	4
EWMA Weight(Wq)	0.5
Packet size	2000 bytes
Utilization factor (U)	0.85
Epoch (k)	10
Scaling factor (ρ)	0.3
Router Buffer Size	50 packets

Table: Simulation Parameters

A. Performance Metric:

Some parameters evaluated and analyzed based on simulation are:

- packet delivery ratio
- Dropping Packet Ratio
- Delay

We have implemented WCP and WCPACap using NS-2 Simulator version 2.29. We apply these in two different topologies like Stack Topology and Chain Cross Topology with four different types of traffic. We check these protocols by four parameters such as packet delivery ratio, dropping packet ratio and Delay. The results obtained are shown in the form of graphs.

B. Different Types of Traffic

Traffic1: In Traffic1 there is only one source node and one destination node communicated with each other.
Traffic2: In Traffic2 there are two source nodes and two destination nodes starting communication.
Traffic3: In Traffic3 there are three source nodes and three destination nodes starting communication.
Traffic4: In Traffic4 there are four source nodes and four destination nodes starting communication.

C. Stack Topology

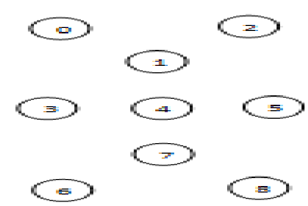


Fig 3: Node arrangement in Stack Topology

D. Chain-Cross Topology

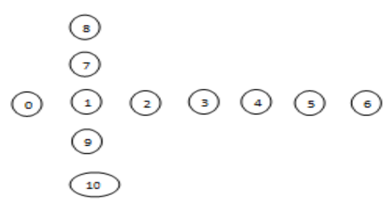
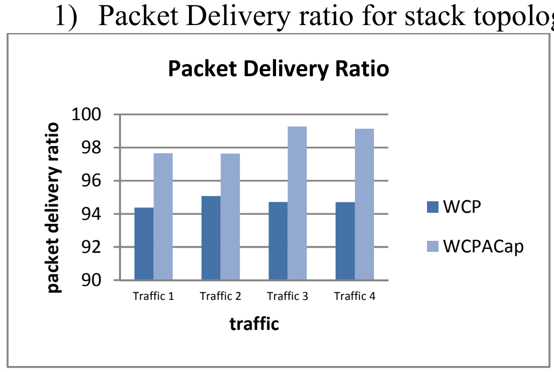


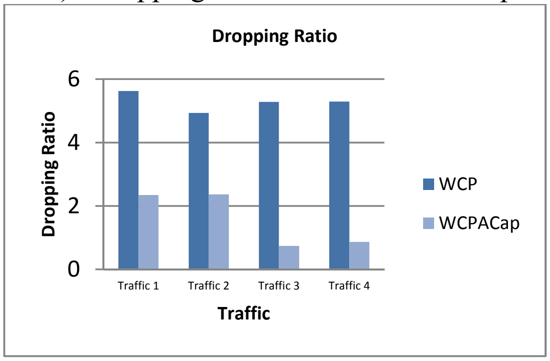
Fig 4: Node arrangement in Chain-cross Topology

1) Packet Delivery ratio for stack topology



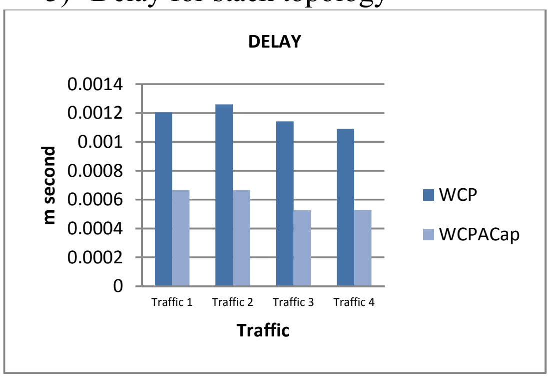
Graph 1: Packet delivery ratio

2) Dropping Packet Ratio for stack topology



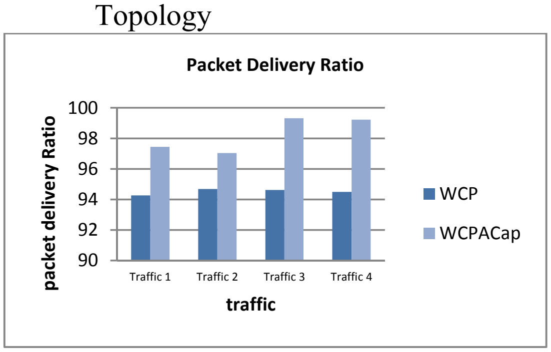
Graph 2: Dropping ratio

3) Delay for stack topology



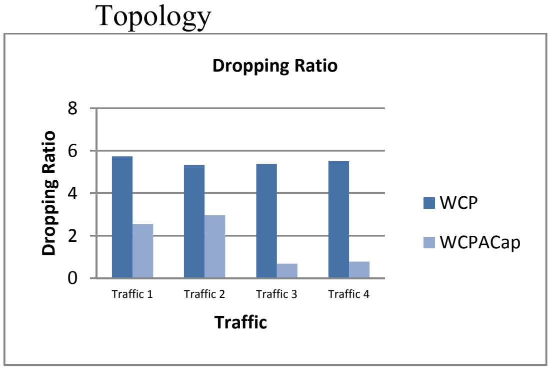
Graph 3: Delay

4) Packet Delivery Ratio for Chain cross Topology



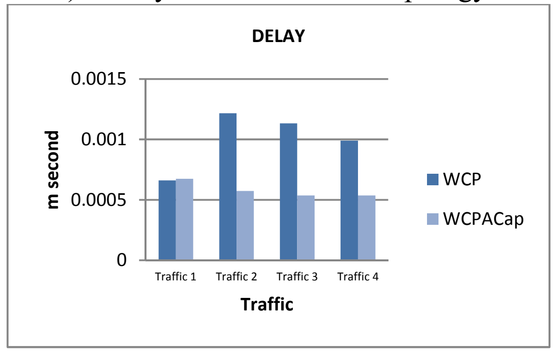
Graph 4: Packet delivery ratio

5) Dropping Packet Ratio for Chain-cross Topology



Graph 5: Dropping Ratio

6) Delay for Chain-cross Topology



Graph 6: delay

IV. CONCLUSION AND FUTURE WORKS

In Wireless Networking Congestion is severe problem for researchers and it is harder than in wired networks. For this reason in this thesis there are some significant steps to understanding congestion control for mesh networks.Wireless Mesh Network Suffer from the Congestion Issue and for controlling congestion generally WCP protocol was implemented but here we have implemented WCPACap protocol to control the congestion. This protocol works on allocation of capacity to nodes which are containing data by asking to the neighbor node .After analyzing the performance from simulated data and graphs obtained, results shows that the implementation of WCPACap controls congestion better than WCP on different parameters for different traffics.We have implemented WCPACap and fair results are achieved but in future dropping ratio may be reduced by thoroughly defining the intuiting concept of congestion intensity. Further researcher can explore the impact of short lived flows and mobility of node based performance of WCPACa.

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