International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 08 | Aug-2016 www.irjet.net p-ISSN: 2395-0072

# QoS Based Congestion Control Algorithm for Video Traffic in Wireless Mesh Network

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**Abstract -** *Wireless Mesh Networks are popular as an attractive means to provide connectivity and broadband wireless internet access in a cost effective manner. It's a hybrid network which can be a combination of different networks like Adhoc networks, Wireless sensor networks etc. The latest pervasive mobile, wireless support and growth in smartphone features have increased user demand for rich media services on their devices. Unfortunately, main limitation associated with these networks are lack of guaranteeing high Quality of Service (QoS) levels to their clients. Since traffic is not evenly distributed across network, some nodes carry more traffic and become congested. Congestion results in packet loss. This will affect the quality of video deliveries around the network. Although different routing mechanism and routing metrics are available, proper metric has to be selected for routing, so as to avoid congestion or to rectify it. Each metric will be having advantages and disadvantages. The criteria used for selecting a metric is vital and depends on various factors. An algorithm is proposed which can be used for overcoming the congestion, thereby increasing the total network utilization.*

***Key Words***: WMN, QoS, Congestion, Mesh, Traffic, Quality, Routing, Metric

## 1.INTRODUCTION

Wireless Mesh Network (WMN) is a reliable network formed by interconnected routers arranged in mesh topology. It is a form of wireless ad hoc network. WMNs are becoming popular due to the cost effective and high bandwidth network connectivity for specific geographic area. When one node fails to operate in Wireless Mesh Network, rest of the nodes can still communicate with each other directly or through intermediate nodes. They can self form and self heal. WMNs provide wireless Internet service to a large coverage area with low infrastructure cost. They are suitable for both short term small range applications, long term service deployments and also in areas with weak cellular coverage such as rural zones. In case of a mobile network, network switching happens if one goes out of coverage area. Even after switching, functionalities will be limited. Main issues associated with wireless mesh networks are lack of guaranteeing high Quality of Service (QoS) to clients. In a wireless mesh network, the network connection is spread out among dozens or even hundreds of wireless mesh nodes that communicates each other to share the network connection across a wide area. Mesh nodes are similar to small radio transmitters that function in the same way as a wireless router. Nodes use the common WiFi standards like 802.11a, b and g to communicate wirelessly. Nodes are programmed with software that tells them how to interact within the larger network. The nodes automatically choose the quickest and safest path and this process is known as dynamic routing.

The present support and astounding growth in smartphone features have increased user demand for rich media services on their devices. But in reality, this traffic load adds up additional pressure on Wireless Mesh Networks, thereby affecting user QoS levels. WMNs are not actually designed to work in conjunction with any QoS Mechanism. Most of the times, traffic is not evenly distributed and it introduces congestion into the network. Congestion will cause nodes to drop packets which affect the transmission of contents. This Packet Loss affects quality of transmitted video which leads to drastic reduction in Quality of Service.

## 2.RELATED WORKS

The problem of load balancing in Wireless Mesh Networks are not handled properly. The conventional routing algorithms reroutes traffic without considering load at mesh node queues. Hence some mesh nodes might get overloaded quickly as it is carrying too much data. This heavy load causes congestion in network which results in significant reduction of overall network capacity and affects the transmitted video files quality.

## 2.1 Routing in Mesh Networks

The decision for choosing a route from multiple paths is decided by various routing metrics, which are used by routing protocols. It is very important to understand which routing protocol suits mesh networks , because it gives an idea on necessary properties of routing metrics to support effective routing in mesh networks. Depending on when the routes are calculated, Routing Protocols for mesh networks can be classified into two :

- Reactive Protocols
- Proactive Protocols

Reactive protocols are also known as On demand routing protocols. They create a route only when the source node actually needs to send packets to the destination. Usually, network wide flooding is needed for discovering routes . In case of ad hoc networks, high network connectivity is required for flooding-based route discovery due to frequent link breaks caused by the mobility of nodes. But, in mesh networks nodes are having static nature and links usually have much longer expected lifetimes. The frequency of link breaks is much lower than the frequency of flow arrivals in mesh networks, hence flooding-based route discovery very expensive in terms of control message overhead. Ad hoc On Demand Distance Vector (AODV) and Dynamic Source Routing (DSR) are examples for On demand routing protocols.

Proactive routing protocols are also known as table-driven routing protocols. In proactive routing protocols, each node will be accessing set of tables, which contains routing information to every other node in the network. All the nodes update these tables to have a consistent and up-to-date view of the network. If the network topology changes, nodes forwards update messages throughout the network to maintain consistency in the network. An example for this protocol is Optimized Link State Routing (OLSR). Maintaining up-to-date information incurs additional overhead costs . As a result, throughput of the network may be a reduced, but it provides the actual information to the availability of the network.

There are other set of protocols known as Hybrid Routing Protocols. It is a combination of proactive and reactive protocols taking the best features from both set of protocols. Example for Hybrid Routing Protocol is Hybrid Wireless Mesh Protocol (HWMP).

## 2.2 Routing Metrics

All the routing protocols are driven by routing metrics for identifying the best route between a source and a destination. For supporting communication among mesh nodes, it requires the use of routing protocols that must be combined with a routing metric to determine which route among all possible routes between a pair of nodes will be used. Routing metrics used should be isotonic, topology dependent and must capture the characteristics of mesh networks. Some of the traditional routing metrics used are discussed below.

Hop count is the most commonly used routing metric . Using this metric, the routing protocol identifies the shortest route in number of hops between source and destination nodes. A hop count of n means that n gateways separate the source node from the destination node. The main disadvantage of hop count metric is that it does not consider interference or packet loss ratio. ETX is another important metric and it stands for Expected Transmission Count. ETX metric selects route between two nodes based on paths quality. The link quality is estimated based on the number of probe packets received by each node. The quality of a route in a multi-hop scenario will be the total of ETX values of the links belonging to the path. Main issue with ETX is that it does not consider differences in transmission rates and link load. An ETX of one represents a perfect transmission medium, where an ETX of infinity indicates a completely non-functional link.

Expected Transmission Time (ETT) is an improvement over ETX by considering differences in link transmission rates and packet size. The quality of the link is evaluated by sending two back-to-back probes, one small probe followed by a large one. The node that receives the probes measures the inter-arrival time between them and reports it back to the sender. After reception of some specific number of probes, the sender computes the capacity of the link by dividing the size of the larger probe by the smallest measured delay. The route with the lowest sum of ETT values of the links will be selected for routing. The drawback of ETT is that it does not consider link load and hence it might route traffic along congested nodes. The Weighted Cumulative ETT (WCETT) is proposed as an enhancement over the ETT by taking into consideration interference and the multi-radio nature of the nodes. WCETT tries to reduce the number of nodes that transmit on the same channel along a path. WCETT gives lower weights to the path with more diversified channel assignment on the links, ie. they have lower intra-flow interference. The main drawback of WCETT is non isotonicity property which makes it unusable for proactive routing.

## 3. PROPOSED SYSTEM

In the proposed algorithm for overcoming congestion at mesh node queues, load at each nodes are considered. It is a queue based load balancing mechanism. For each source and destination, we are actually broadcasting the traffic across nodes. List of all next hop nodes are collected and if neighbour is not destination ,we check whether its in range . Routing requests will be accepted if its in range and routing table will be updated with the RREQ message. For each link QoS value is calculated which will be considered as the QoS factor and it will be added to QoSF list. If the range is outside, the packet will be discarded. The process is continued till it reaches the destination. Select the path with best or highest QoS value. Then a check is made to monitor whether the load is above Maximum load allowed in path. If its greater, it indicates congestion and the loaded path will be changed to underloaded path, else the path will be selected for flow.

### 3.1 Proposed Algorithm

1. For each source-destination , do
2. Establish local broadcast route discovery process
3. Select the list of next hop node from Source S
4. For each neighbour node of the current node do
5. if (Neighbour Node != destination) then check
6. if (tx range of received RREQ packet is < transmission range)
   accept RREQ
7. Update route table with the RREQ message and insert the QoS factor(QoSF) to QoSF list, which is used to record the QoS value of each link along the path
   else
   discard RREQ
8. Repeat the steps 6 and 7 until it reaches destination node D
9. Select the path with best QoS Path
10. If (load of the path is >= MAXPATHLOAD)
11. Change the loaded path to underloaded path
    else
12. Select the path with current flow

Different performance parameters like throughput, delay, packet loss, packet delivery ratio can be compared for ensuring the effectiveness of algorithm. Video files can be send through the nodes along with the usual CBR traffic. Transmission of multiple files will cause congestion in network. The proposed algorithm can be used for overcoming the congestion in network.

### 3.2 Peak Signal to Noise Ratio

The quality of reception of signal is measured in terms of PSNR. The PSNR value for a video is computed by comparing individual frames of transmitted and received video. The signal in this case is the original data and video, the noise is the error introduced by compression. Although a higher PSNR generally indicates that the reconstruction is of higher quality, in some cases it may not. Since many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel scale. Quality will be increasing with increase in PSNR value.

## 4. SIMULATION AND RESULTS

To evaluate the performance of the proposed protocol, a simulation of Wireless Mesh Network with 50 nodes is created using Network Simulator 2 (NS2)and video traffic is passed along with normal CBR traffic through the network. The simulation consisted of 20 independent runs with 95% of confidence. Graphs are plotted using Xgraph Tool for Throughput, Delay, Packet Loss, PDR and Overhead with congestion and by overcoming congestion.

### 4.1 Simulation

A Wireless Mesh Network is created with 50 nodes using NS2. Existing protocols were modified to incorporate properties of WMN. Video files in different formats and quality are identified which has to be downloaded and to be converted to equivalent text format as NS 2 supports only inputs in the form of text. So text files with bit patterns representing videos are converted. This video traffic is then made recognizable to the network. It has to be fragmented and merged during transmission and its quality and purpose should not get affected. For this simulation a video is selected and 2 flows of video will be passed through the selected nodes.
Video files has to be fragmented while sending and at the receiving end it has to be merged so as to be in the same format as it is while sending. Three pair of nodes are selected for sending CBR traffic and One pair of node is selected for sending video traffic. At first, congestion is introduced into the network and various QoS parameters are measured. Then again traffic is sent using the QoS based congestion control algorithm for video traffic in WMN, to ensure that the network is not getting affected by the congestion. In case of congestion, it re routes along the next immediate path available. So Congestion, Packet Loss and other network overheads are reduced, which in turn leads to increasing Packet Delivery Ratio and Throughput.

**Table -1:** Simulation Parameters

| | |
|---|---|
| Working Platform | NS2 |
| Routing Protocol | AODV |
| Number of Nodes | 50 |
| Video File Format | qcif |
| Resolution | 176 X 144 |
| Number of Video Files | 1 |
| Topology | Mesh |

### 4.2 Results

The following screenshots are obtained during the simulation. The network contains 50 nodes. Multiple source and destination nodes are there. Yellow coloured nodes exchanges video traffic. Red , Green and Blue indicates source and destination pairs with CBR Traffic.

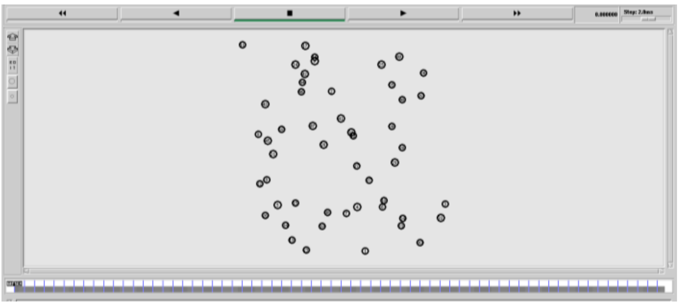


**Fig -1**: Network Topology

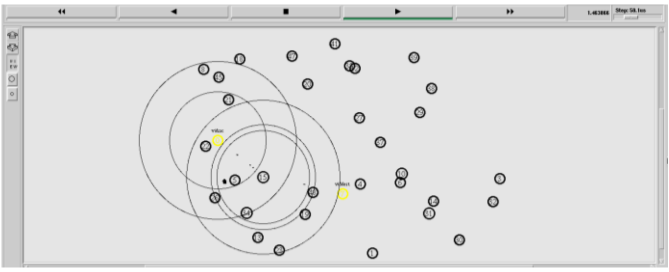


**Fig -2**: Video Transfer Between Node 0 and Node 7

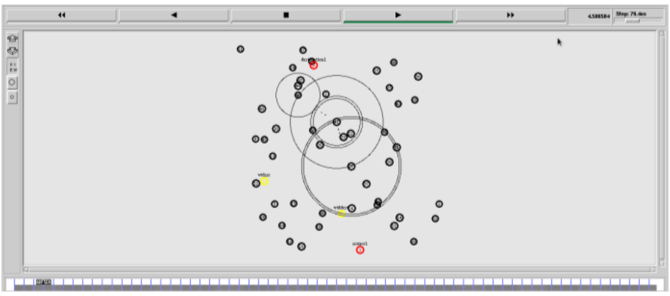


**Fig -3**: CBR Traffic between Node 1 and Node 9

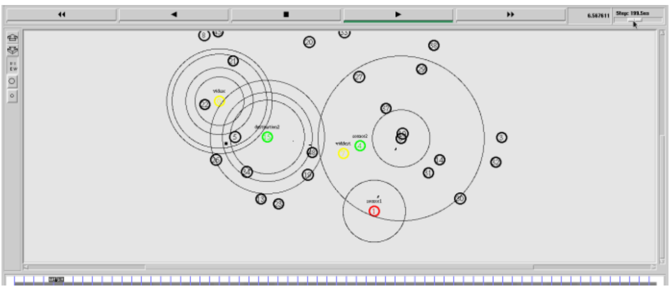


**Fig -4**: CBR Traffic between Node 4 and Node 15

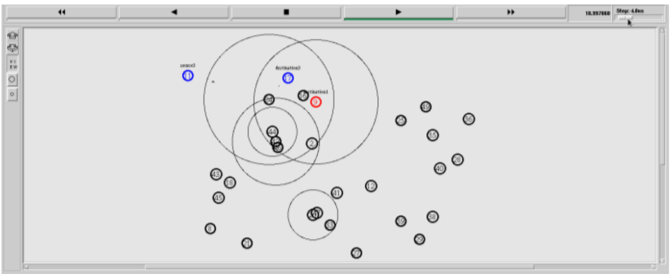


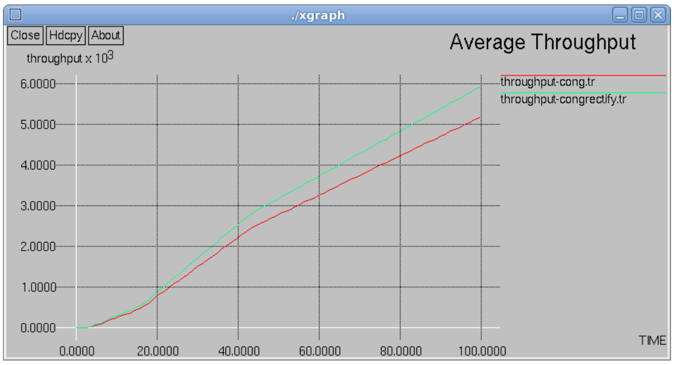
**Fig -5**: CBR Traffic between Node 11 and Node 17

### 4.3 Analysis

Following factors are considered for comparison with existing system. They are :

- Throughput
- Delay
- Packet Loss
- Packet delivery ratio
- Overhead
- PSNR Value

A detailed comparitive study has been made and the observations are plotted in graph. On analysis, performance of the proposed system is higher than the existing system.




Sa **Chart -1:** Graph for average throughput

X-Axis: Transmission Time

Y-Axis: Throughput

Throughput = File Size / Transmission Time (bps)

Implementation of the algorithm results in better throughput. The red line in the graph indicates the performance of existing system using AODV protocol. The green line indicates the throughput of the proposed system.

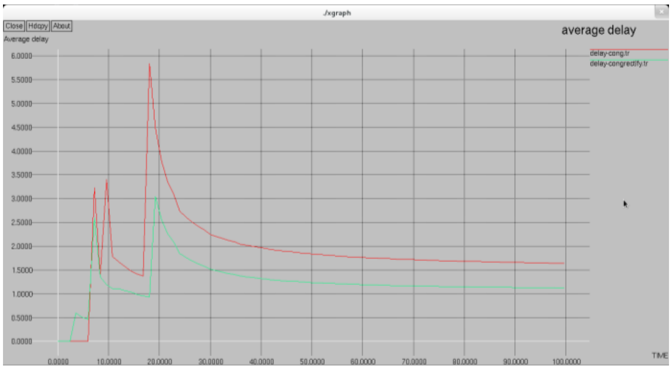



**Chart -2:** Graph for average delay

End to End Delay = ∑ ( arrive time – send time ) / ∑ Number of connections

X Axis denotes the time taken for the transmission to complete and Y axis indicates the average delay for the packets to arrive at the destination. Delay of the proposed system is very less than that of the existing system. Lower value indicates better performance of the system.

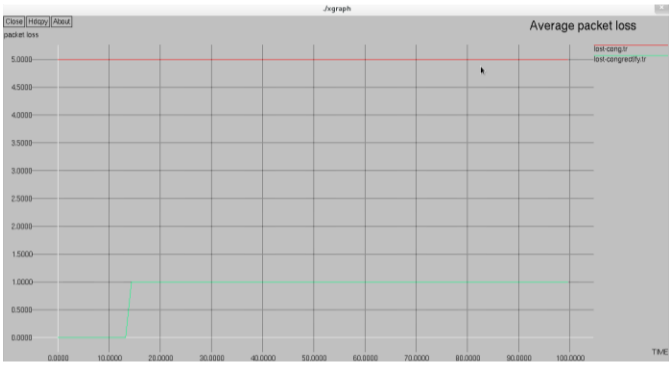



**Chart -3:** Graph for average delay

Packet Loss = GeneratedPackets - ReceivedPackets

On the application of algorithm, packet loss is reduced from 5 packets per second to 1 packet per second. As majority of the packets are reaching the destination, QoS will be more.

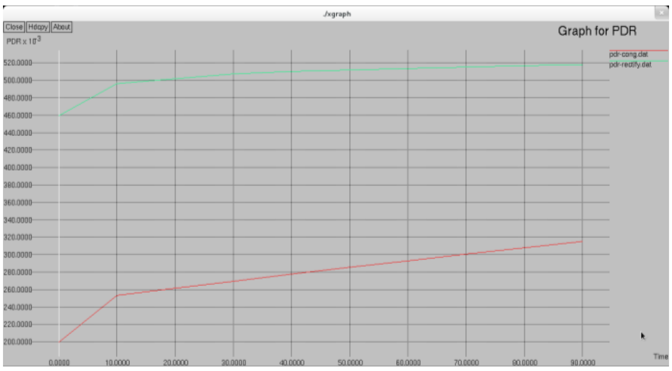



**Chart -4:** Graph for Packet Delivery Ratio

PacketDeliveryRatio = (Total Packets Sent/Total Packets Recieved) *100

Implementation of the algorithm increases the Packet Delivery Ratio. The red line in the graph indicates existing system and the green line represents the proposed system.

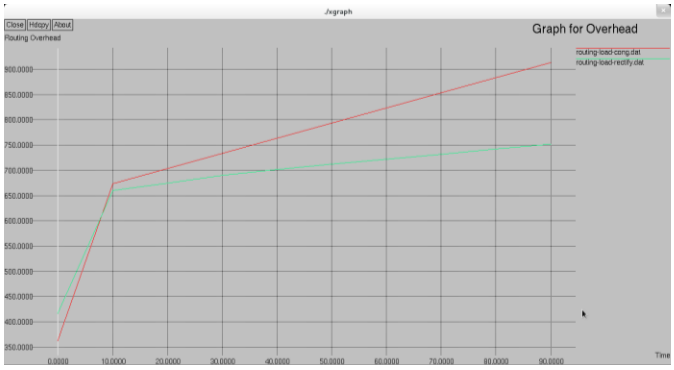



**Chart -5:** Graph for Overhead

X Axis indicates time taken for the transmission and Y axis indicates the routing overhead. From graphs itself its clear that the network overhead for the existing system is much higher than the proposed system.

PSNR values were also compared as part of the analysis and the obtained values are given below.

PSNR value with Congestion = 26.599162

PSNR value with Algorithm = 29.385197

## 5. CONCLUSIONS

Distribution of unbalanced traffic in a mesh network leads to poor utilization of network resources by overloading some of the mesh nodes in the network thereby creating congestion in network and this in turn leads to reduction of user perceived video quality. This is an important issue in wireless mesh network. In case of congestion, the proposed algorithm re routes the traffic along the next immediate path available. The performance evaluation of QoS Based Congestion Control algorithm for video traffic in WMN was carried out using a hybrid emulated-simulated test-bed in terms of QoS parameters such as packet loss, delay,pdr, overhead, throughput and PSNR. Video sequences encoded at various quality levels and video sequences with different characteristics are considered for evaluation. it is observed that the algorithm is having greater impact on the network and there is significant changes in throughput, packet delivery ratio and overhead.

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