CROSS LAYER FRAMEWORK OVER WIRELESS NETWORK FOR SELF CONFIGURABLE ROUTING

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Abstract—There is tremendous growth in the use and applications requiring now a days in MANETs (Mobile Ad hoc NETworks) which will be very helpful in multimedia services. The framework has a service-aware multipath routing protocol having ability to self configure dynamically depending on the state of the network. Approach is named Self Configurable Routing for video streaming application. Maintaining and enhancing the video quality over IEEE 802.11e Wireless Mesh Networks is one of the challenging task. Quality of service provision over MANETs a matter that challenges attention due to variable link channel capacities affect the quality of video, interference from the neighboring nodes and several problems created by wireless links. It includes cross-layer techniques which improve the end-to-end performance of video-streaming services over IEEE 802.11e Ad Hoc networks. Estimate of path error probability is presented by a straight forward analytical model, which is used by source nodes to estimate the lifetime of the available paths to their destinations. This source nodes will be helped to take proper routing decisions. The performance of network in this approach improves with respect to parameters such as throughput, end to end delay, peak signal to noise ratio.

Keywords—Cross-Layer Design,Path Lifetime, IEEE 802.11e, Moving Picture Experts Group(MPEG)-4, Quality of Service (QoS).

I. INTRODUCTION

Mobile ad hoc network (MANET) is spontaneously formed from the mobile nodes in the network for communications set of wireless mobile devices that are able to communicate with each other following a similarity to peer-to-peer (P2P) without need of defined or specifically designed stationary network. Furthermore, because the transmission range of the wireless devices is limited, they can become intermediate nodes required to transfer data from one node through another network hence, each node can operate as source, destination or router in an ad hoc network. Mobile nodes are free to move arbitrarily, producing frequent changes in network topology.. Consequently, MANET must be able to dynamically adapt to maintain active connections despite these changes.Video signal is distributed using RTP/RTCP(Real Time Protocol/Real Time Control Protocol) over UDP as transport protocols. Moreover, variations in the radio channel and limitations of energy nodes can produce frequent changes in topology and connectivity Here MPEG-4 video coding is used which is formed by sets of frames, typically around 4-20 frames each, called GoP

(Group of Pictures). According to the MPEG-4 standards, video consists of three types of frames. These are I, P, B frames. I frames are Intra-coded frames with highest priority. Entire GoP would be lost if there is no I frame available at the time of decoding.P frames are Predictive-coded frames having the less priority than the I frame and B frames are Bi-directionally predictive coded frames having least priority. The most important information for decoding back the signal at receiver is carried by I frame. Since QoS provisioning is not dependent on a single network layer but a coordinated effortof all layers, and necessary to develop dynamic solutions based on a cross-layer approach. [1]

II. Related Work

A. *Video codification*

Layered coding allows enhanced layers of several qualities to be transmitted, given that a minimum bandwidth is guaranteed to transmit a base layer One of the most used data types in video-streaming is MPEG-4 hierarchical scalable multi-layer encoded video. Video is distributed using RTP/RTCP (Real Time Protocol/Real Time Control Protocol) over UDP as transport protocols.. We use a layered MPEG-4 coding of the video.

In a GoP there are three types of frames: I, P and B. In a GoP there is one I frame, several P frames and rather more B frames. I (Intra) frames encode spatial redundancy. They form the base layer and provide a basic video quality. The size of I, P and B frames are about 4000, 800 and 400 bytes, respectively. These video characteristics can be taken into account when planning a QoS aware scheme. For the decoding process at the receiving side they carry the most important video information. GoP could be decoded even if just I frames were present. Besides, I frames are absolutely necessary to decode the video sequence.P (Predicted) and B (Bi-directional) frames provide enhancement layers. P and B frames carry differential information from preceding, or preceding and following, I or P frames respectively. For example, different priorities could be assigned to the video frames according to their importance within the video flow. This way, I frames should have the highest priority whereas B fram MPEG-2 es should have the lowest one. [4]

B. *IEEE 802.11e*

The main difference in IEEE 802.11e with respect to the former IEEE 802.11 standard is that there are four different Access Categories (AC). The standard two access mechanisms: the Hybrid Coordination Function Controlled Channel Access (HCCA) and the Enhanced Distributed Channel Access (EDCA) and The proper access mechanism in MANETs is EDCA, since no centralized access point is needed. Each packet from the higher layer arrives at the MAC layer with a specific priority value and it is mapped into an AC.[2]

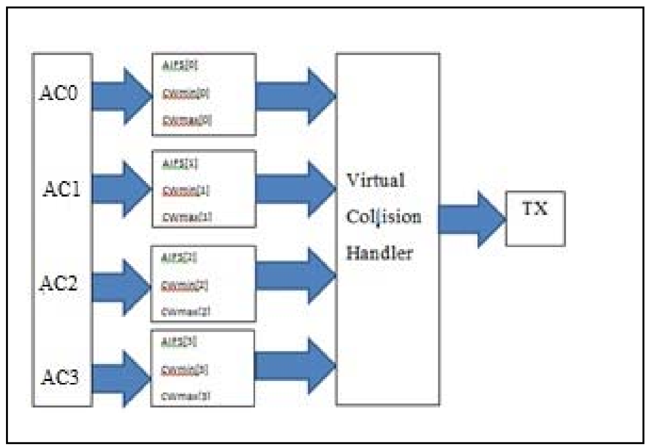

Figure 1. IEEE 802.11e framework

Each AC has different parameters in the backoff entity, named Arbitration Inter-Frame Spacing (AIFS[AC]), Basically, the smaller AIFS, CW_{min} and CW_{max}, the shorter the channel access delay, and hence the more capacity share for a given traffic. Minimum Contention Window (CW_{min}[AC]), Maximum Contention Window (CW_{max}[AC]). However, the probability of collisions may increase when operating with smaller contension window.

There is another parameter, the Transmission Opportunity (TXOP[AC]) defined as an interval of time when a station has the right to initiate transmissions. Finally, each AC has a different

Retry Limit [AC] value, so that packets are discarded in case the number of retransmissions exceeds that value. These parameters can be used to differentiate the channel access among different priority traffics. We have defined the mapping of the different packets into each one of the four Access Categories of the IEEE 802.11e MAC as follows:

1. AC0: high priority packets (signaling + I frames)
2. AC1: medium priority packets (P frames)
3. AC2: normal priority packets (B frames)
4. AC3: low priority packets (best effort)

C. *Self configurable multipath routing*

It has been designed to support multiple video sources. All the decisions (e.g. path selection) and operations (e.g. tuning of configuration parameters) are managed from the source and they depend on the state of the network, so that the framework operation is adaptive to the environment. It is assumed that the well-known potential benefits of multipath routing in MANETs, i.e. multiple paths can offer load balancing, better fault-tolerance, and higher aggregate bandwidth, provided that there is a proper algorithm to manage the system seeking an optimal performance.

It is Started from standard DSR as the routing engine to find available paths, since it is suitable to be easily extended for multipath operation. The customer requirements are established by means of a Service Level Agreement (SLA). Such SLA specifies network QoS parameters and their values to provide the committed image quality.

$$Customer\_req = \{BWmin , Lmax , Dmax , Jmax\} \ldots (1)$$

The QoS parameters considered are: minimum expected bandwidth (BWmin), maximum percentage of data losses (Lmax), maximum delay (Dmax) and maximum delay jitter (Jmax).

III. Proposed Methodology

Prior to the start of a video transmission, packets are intended to be sent from different paths. These Paths will provide different priority for sending the packets. The paths are Best Path, Medium Path and Worst Path provided for high priority packets, Medium priority packets and Low priority packets. High priority packets will contain I frame passing through the

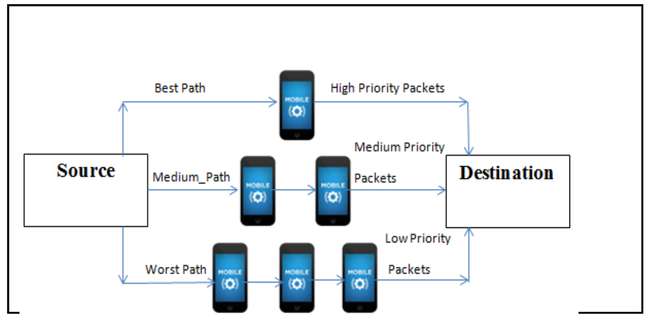

Figure 2. Multipath scheme for packet sending using three paths

lowest number of hops, Medium priority packets will contain

p frames through second lowest number of hops, Low priority

packets will contain B frames which will pass through worst path which contains large number of hops than Best path and Medium path. Best path is given to the I frame because only byusing I frame original signal can be regenerated.[4]

A. *Multipath scheme*

It is proved that it is not worthwhile to arrange more than three paths simultaneously in a multipath scheme, due to excessive overhead increase and small improvement. Similar works arrived to same conclusion. The most important frames of the coded video flows (I frames) are sent through the best available path. P frames are sent through the second best path and B frames through the third. If only two paths were available, I frames would be sent through the best one, and P and B frames through the other one. In case of a unique available path, every frame would be sent together. Let us remark that this distribution of frames over a 3-path scheme contributes to improve the performance of the perceived video quality as simulation results will show.

B. *Self Configurable Routing implementation*

Enabling multipath routing in DSR: Modified the DSR route cache to be able to store all the discovered paths between two nodes, and to maintain them during the duration of the current period of the algorithm.

i. *Probe Messages generation and sending*

PM are generated at the beginning of each iteration. The function GenerateProbeMessage() is the one which creates as many PM as paths are currently available in the route cache. All the parameters are initialized and the respective route is inserted into each one of the packets. An identifier is inserted in the packet, in order to know the iteration number that packet belongs to.

ii. *Probe Messages Reply generation and sending*

PMR are generated once all the information of the Probe Messages has been interpreted. GeneratePMR() is the function which creates these packets. Information collected is stored into this reply packet to be processed at the video source. A PMR is sent through each one of the discovered paths. All PM and PMR copy packets are sent with the corresponding iteration identifier included and waiting small random delays of time of some milliseconds.

iii. *PMR stored values process and computation of new path qualifications*

Once a PMR packet has arrived at the video source node, the information regarding the QoS parameters of the path is extracted, processed and compared to certain thresholds. Then, qualifications are assigned to each one of the paths.

iv. *Hello Messages generation and sending*

HM messages are generated with a certain period using the sendHelloMessage() function. They are sent to the neighbouring nodes of a node involved in each one of the discovered paths between source and destination.

v. *Hello Messages Reply generation and sending*

Once a HM has been received, the received power signal strength and the SNR sampled values of the reception of the packet are stored in special header fields of the HMR packet. Also, the route of the original HM packet is reversed and stored as the route for the new HMR. Source and destination nodes' addresses are interchanged, as the packet has to be sent backwards. Finally the packet is sent. Notice that in case of non-symmetric channels, a new process to find a reverse route to the source should be carried out.

vi. *Hello Messages Reply reception*

Stored information related to the SNR and the received power signal strength, are processed using the assigned thresholds and equations.

vii. *Packet identification*

Here used an identifier to differentiate each one of the packets that arrive to a node.The identifier depends on the origin and content: standard DSR signalling messages, PM/PMR, HM/HMR, RTP/RTCP, etc.

IV. SIMULATION PARAMETERS

Simulation tool which is used to study behavior of networks in communication is Network simulator (NS2). As there is tremendous growth in deployment of the real time applications like video conferencing, Video streaming hence evaluation of video in communication network needs to be done. Thus requirment of QoS for these applications is also growing. Hence before the application, these systems must be studied in terms of quality and behavior. NS 2is used for the simulation of video signal. For the simulation of video over wireless networks NS2 generates traffic patterns using packets that can be used for study and simulation.[6]

Many video streams standard can be used for the simulation of communication networks. NS 2 is used to support MPEG-4standard. MPEG-4 standard is used worldwide for video streaming over internet also.It provides better quality of video signals for customers to buffer the video.

V. Simulation Results

Mobility of the nodes is the main reason for quality of video. If nodes are less in number in between the source and destination then packets will be dropped if there is not sufficient number of nodes to route packets upto the destination. Evaluationof video quality can be done under two conditions,

1. For Stationary nodes
2. For Mobile nodes

using NS 2 creation of Mobile nodes in the wireless network is obtained. Fig. 3 shows Wireless network with 20 mobile

nodes. When nodes are stationary performance gets better for the routing protocol, on the other side if nodes are moving in nature then performance degrades depending on the movement of the nodes in network. In Fig. 4 There are shown 20 mobile or moving nodes which are sending video encoded data packets to the destination through intermediate nodes.Time interval for nodes to move can be varied according to the requirments, hence upto decided time limit, nodes are stationary and after that they start moving. So under these two scenarios the variation of the video quality of the signal received can be studied.

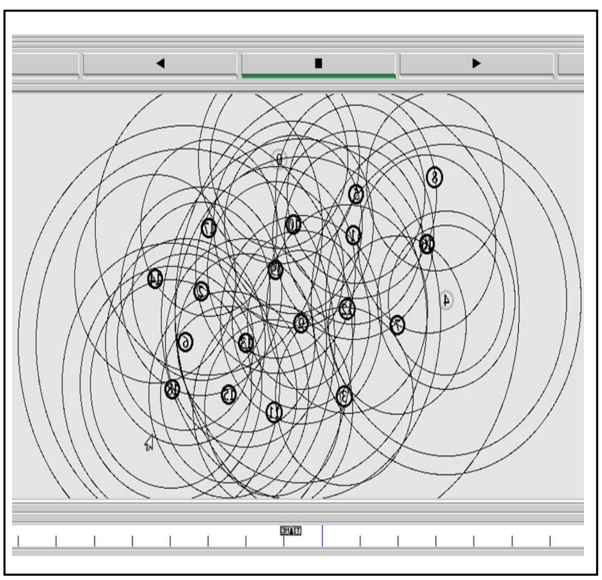

Figure 3. Wireless Network Nodes in NS2

When nodes are stationary performance is better at its level but when performance is tested by taking the moving nodes performance of routing protocol is comparatively reduced. Because nodes moves in between source and destination and when packet path is shifted from one node to other there are some drop of packets at this instant and results in reduced performance. This indicates that when larger number of nodes are taken there can be flexible switching of nodes and hence increasing the performance. Network nodes continuously search for the neighbouring nodes for the purpose of creating minimum hop path and hence for the packets sending purpose. They continuously store the information such as position addresss of the nodes which comes near by to it and as per

their positions and ability to send the packets with minimum losses it selects the nodes in between the path of source and destination. Each node requires some energy to perform actions given to it i.e. sending the packets, receiving the packets etc. considering this in our contents it is clearly visible that when more umber of nodes are taken there is more

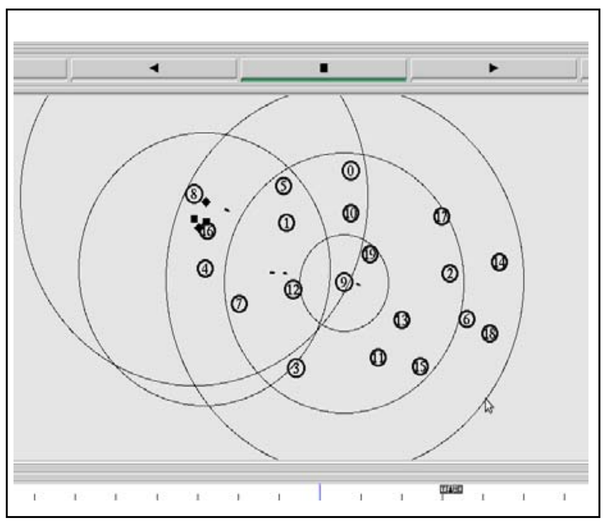

Figure 4. Wireless Network Nodes Video Data Packets Transmission

required energy to perform given required actions. In DSR there is increased number of losses in the frame types I,P,B but in the self configurable routing technique as there are comparatively very less number of losses in the frame types such as I,P,B frames hence reconstruction of the original video signal is easier and also better in the quality of service. The PSNR (Peak Signal to Noise Ratio) is a measure of the distortion between two images. It is used to compare the received video stream and the original video stream. To measure the PSNR there are many utilities, but most of them are focused on evaluating the performance of video codecs with compression enabled, where there are no frame losses.

This way, these tools compare the original video with the compressed video frame-by-frame, as they are sure that all the frames will be present in the compressed video But this is not the case, where some frames may get lost due to congestion in the network,.

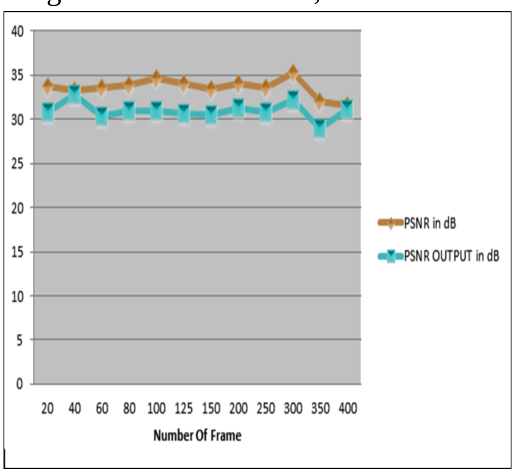

Figure 5. PSNR output in dB for Video Transmission Quality

Therefore, no frame by frame. Comparison is possible if we do not process correctly the original video stream prior to be compared to the received video stream.

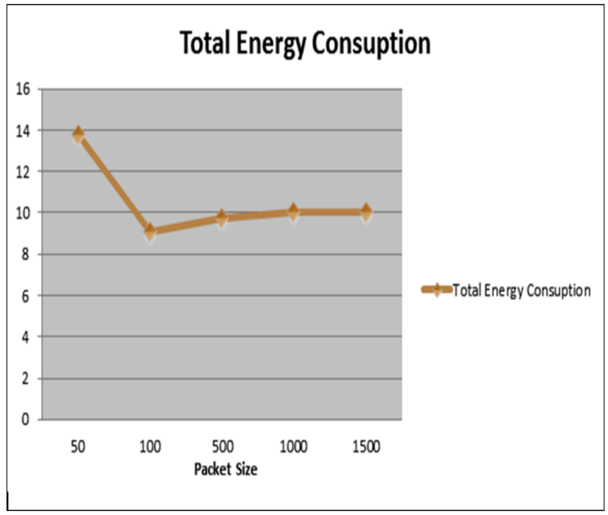

Figure 6. Total Energy Consumption

IV. CONCLUSION

High percentage of losses suffered by each of the flows when using DSR protocol. This high loss due to the fact that all frame of each of the flows transmitted through the same path

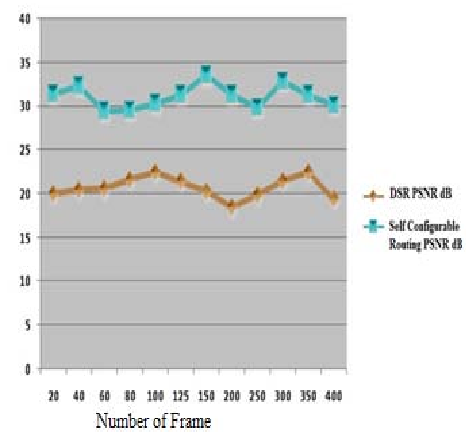

Figure 7. Comparison between DSR and Self Configurable Routing

between source and destination, and via the same lines at each intermediate network interfaces.A reduced loss is observed received by each of the five destination nodes using this self configurable multipath routing protocol. Sending the most important packages by the best available paths increase performance. Increased number of mobile nodes in between source and destination will help to increase system performance as it provides number of available paths for sending packets towards the destination.

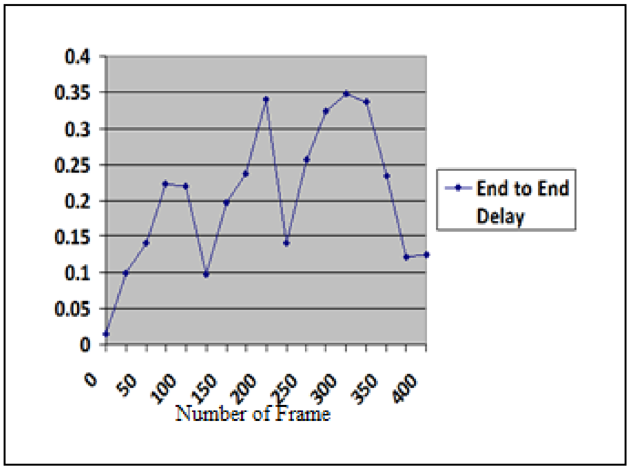

Figure 6. End to end delay

End to end delay for the processed video is shown in Figure.6 it is taking time in milliseconds to send and receive the packets. Throughput goes on increasing upto specific size of the packet

Table 1. Throughput for different packet size

Packet Size in Bytes	Throughput
50	97.58
100	162.90
500	350.80
1000	411.29
1500	411.29

frames. For smaller size of the the packets throughput is lower and as we move towards increasing size of the packets it is visible that throughput is increasing.

Table 2. PSNR for video of 400 packets for 8 node and 20 node network

Frame Number	PSNR for 8 Nodes	PSNR for 20 Nodes
1	26.43	32.34
50	24.54	31.29
100	23.68	30.767
150	25.67	29.89
200	22.56	31.97
250	21.46	32.45
300	23.87	31.34
350	23.45	30.43
400	23.56	32.34

PSNR shown for 8 nodes is lower in comparison than that of 20 nodes. As it is seen that for lower number of nodes in the network available paths for transmission of the frames are lower in number hence drop is more in comparison with 20 nodes network. So there is increased PSNR value for network that is having 20 nodes. Average PSNR can be calculated for network of 8 nodes and 20 nodes , respectively it is 23.91 and 31.42. Visible results are there with 20 nodes that it having larger value for the PSNR of video data being processed.

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