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Self Configurable Multipath Routing using Cross Layer Framework over Wireless Network

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***Abstract*—Now a days there is tremendous growth in the use and applications requiring MANETs(Mobile Ad hoc NETworks) which will be very helpful in multimedia services. Enhancing and maintaining the video quality over IEEE 802.11e Wireless Mesh Networks is one of the challenging tasks. Quality of video is affected by varying channel link capacities, interference from the neighboring nodes and several problems created by wireless links, makes Quality of service provision over MANETs a matter that challenges attention. The framework includes a service-aware multipath routing protocol able to self configure dynamically depending on the state of the network. Our approach is named MMDSR (Multipath Multimedia Dynamic Source Routing). It includes cross-layer techniques which improve the end-to-end performance of video-streaming services over IEEE 802.11e Ad Hoc networks. A straightforward analytical model to estimate the path error probability is presented, which is used by source nodes to estimate the lifetime of the available paths to their destinations. This will help source nodes to take proper routing decisions. This approach improves the performance of network with respect to parameters such as throughput, average end-to-end delay, packet delivery ratio, average 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 a network of spontaneously formed for communications set of wireless mobile devices that are able to communicate with each other following a similarity to peer-to-peer (P2P) without the need for a fixed network infrastructure or administrative management centralized. 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. Therefore, in an ad hoc network each node can operate as source, destination or router. Mobile nodes are free to move arbitrarily, producing frequent changes in network topology. Moreover, variations in the radio channel and limitations of energy nodes can produce frequent changes in topology and connectivity. 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. Here MPEG-2 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-2 standards, video consists of three types of frames. These are I, P, B frames. I frames are Intra-coded frames with highest priority. The most important information for decoding back the signal at receiver is carried by I frame. 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.Since QoS provisioning is not dependent on a single network layer but a coordinated effort from all layers, it is necessary to develop dynamic solutions based on a cross-layer approach "cross-layer" taking into account the different specifications ad hoc networks. [1]

II. RELATED WORK

A. Video codification

Video is distributed using RTP/RTCP (Real Time Protocol/Real Time Control Protocol) over UDP as transport protocols. One of the most used data types in video-streaming is MPEG-2 hierarchical scalable multi-layer encoded video. Layered coding allows enhanced layers of several qualities to be transmitted, given that a minimum bandwidth is guaranteed to transmit a base layer. We use a layered MPEG-2 VBR coding of the video flow.

In a GoP there are three types of frames: I, P and B. Notice that in a GoP there are one I frame, several P frames and rather more B frames. The size of I, P and B frames are about 4000, 800 and 400 bytes, respectively. I (Intra) frames encode spatial redundancy. They form the base layer and provide a basic video quality. They carry the most important video information for the decoding process at the receiving side. 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. These video characteristics can be taken into account when planning a QoS aware scheme. 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 frames should have the lowest one.

B. IEEE 802.11e

The standard defines two different access mechanisms: the Enhanced Distributed Channel Access (EDCA) and the Hybrid Coordination Function Controlled Channel Access (HCCA). The proper access mechanism in MANETs is EDCA, since no centralized access point is needed. 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). Each packet from the higher layer arrives at the MAC layer with a specific priority value and it is mapped into an AC.[2]

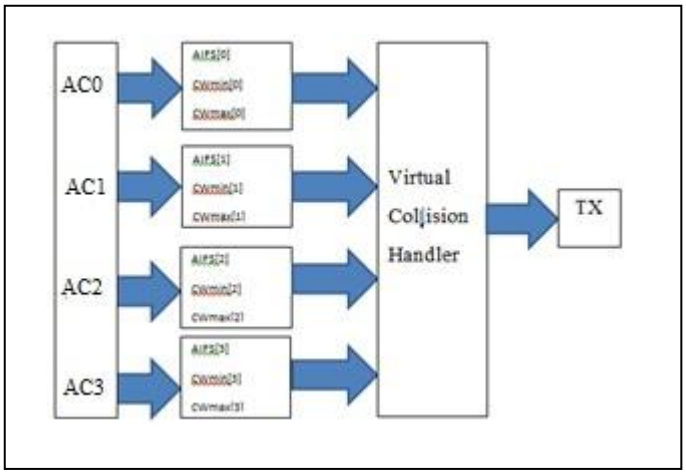

Figure 1. IEEE 802.11e framework

Each AC has different parameters in the backoff entity, named Arbitration Inter-Frame Spacing (AIFS[AC]), Minimum Contention Window (CW_{min}[AC]), Maximum Contention Window (CW_{max}[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. However, the probability of collisions may go up when operating with smaller CW_{min}.

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.

$$\text{Customer\_ req} = \{BW_{min}, L_{max}, D_{max}, J_{max}\} \quad \ldots (1)$$

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

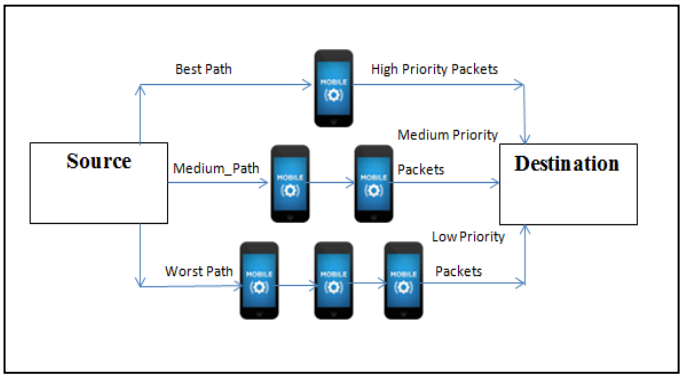

Figure 2. Multipath scheme for packet sending using three paths

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.

IV. SIMULATION PARAMETERS

Simulation tool which is used to study behavior of networks in communication is Network simulator (NS2.27). 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 requirement of QoS for these applications is also growing. Hence before the application, these systems must be studied in terms of quality and behavior.NS2.27is used for the simulation of video signal. For the simulation of video over wireless networks NS2.27generates traffic patterns using packets that can be used for study and simulation.

Many video streams standard can be used for the simulation of communication networks. NS 2.27 is used to support MPEG-2standard.

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 2.27 creation of Stationary nodes and Mobile nodes is obtained. Fig. 3 shows Wireless Grid network with 20 stationary 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.

Fig. 4 There areshown 20 mobile or moving nodesfrom fig. 3 which are stationary in it.Time interval for nodes to move canbe 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.

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 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.

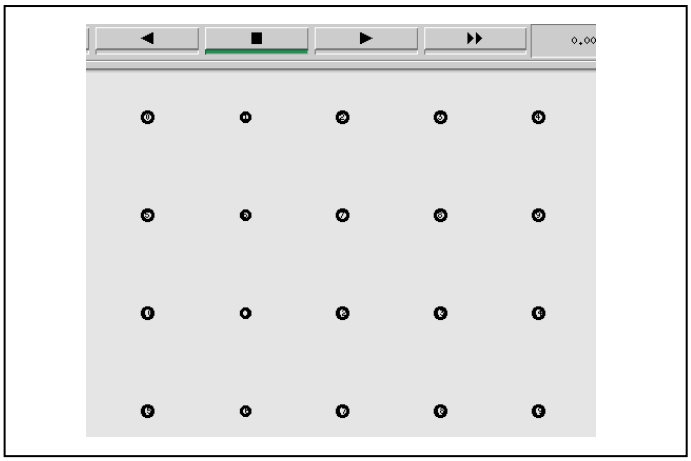

Figure 3. Wireless Grid Network with Stationary Nodes

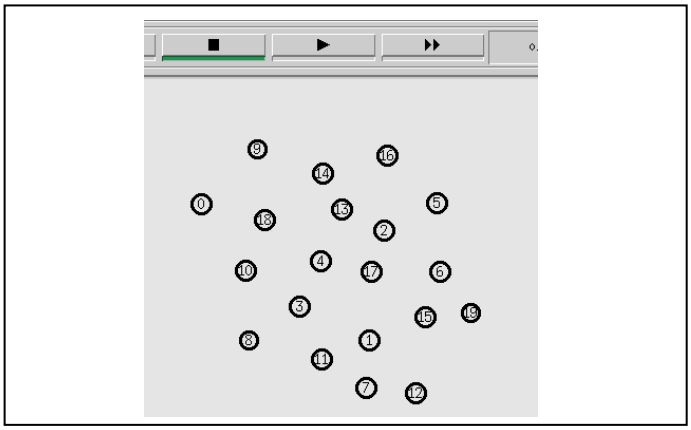

Figure 4.Wireless Grid Network with Mobile Nodes

IV. CONCLUSION

This paper reviews the protocol which is very much useful in video streaming through mobile ad-hoc network. 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.

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