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AN INTEGRATED CROSS LAYER DESIGN TO ENHANCE THE QUALITY OF SERVICE OF VIDEO STREAMING IN MOBILE ADHOC NETWORKS

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Abstract

This paper aims to propose a novel technique for improving the Quality of Service (QoS) of multimedia applications in Mobile Adhoc Networks (MANET) by using Modified Dynamic Mapping algorithm, Multipath Transport (MPT), and Multi Description Coding (MDC). The study strives to attain the intended improvement by applying MDC in the application layer, Lightweight User Datagram Protocol (UDPLite) in the transport layer, MPT at the network layer, and Modified Dynamic Mapping in the Media Access Control (MAC) layer. In contrast to the conventional methods, it is realized that this method attains an increase of 30.84% in Peak Signal to Noise Ratio (PSNR) and 18.57% decrease in delay.

Keywords:

Wireless Networks, Multiple Description Coding Multipath Transport, PSNR, Delay

1. INTRODUCTION

Multimedia transmission at MANETs is random and explosive, and, hence, the quality of the video delivered to the end-user can be deteriorated. To overcome this flaw, MDC with MPT and Modified Dynamic Mapping has proven to be an effective system to transmit video over MANETs using a variety of solutions [1].

In the application layer, MDC uses the viable option for source coding. The video file in MDC is split into sub-streams with the same significance and each one is called a description. This allows for a secure level of fundamental quality for the reconstruction of each unaccompanied description, while the other descriptions can enhance quality. Consequently, if one description is lost, the others are not affected, thereby curtailing the retransmission of the description [2].

The packets are then transferred to the transport layer from the Application Layer. UDPLite is used in the Transport Layer for adding sensitive information to the frames and for reducing the chance of those frames from being dropped and sent out to the Network Layer. The Network Layer proposes and implements the Split Multipath Multimedia Dynamic Source Routing (SMMDSR) protocol, a new multi-path routing protocol. The SMMDSR sets multiple maximum disjointed paths to avoid congestion in links and to expedite use of network resources [3].

The Route Request (RREQ) packets are sent to find the routes in the SMMDSR protocol. The target node returns to the source Node with a Route Reply (RREP). After waiting, additional RREQs are received at the destination node. The destination selects the path that is disjointed at most from the primary reacted path between the received RREQs and delivers a second RREP in order to establish the next path. Once the sender node receives the four RREPs, four routes are created and four descriptions are separately transmitted from Network Layer to MAC layer, via all four routes. The Modified Dynamic Mapping algorithm in the MAC layer allows the multimedia streaming to be of low delay and good quality [4] [5].

In [2] - [16], the approaches discussed require a prior understanding of the networks. So, a cross-layer approach by applying MDC in the application layer; UDPLite in the transport layer; SMMDSR in the network layer; and Modified Dynamic Mapping in the MAC layer is proposed to overcome the limitations encountered by the previous projects. MDC is suggested for the application layer and the video from the application layer is sent to the UDPLite Layer in the proposed MDC, UDPLite, and SMMDSR dynamic cross-layer mapping approach.

The UDPLite protocol [6] [7] maintains the quality of frames received from the application layer by supplying the damaged frames instead of discarding them in the network layer. SMMDSR is used in network layer. SMMDSR is the extension of the multi-path DSR. A set of alternative split roads with maximum split paths are constructed in SMMDSR. SMMDSR uses Route Request (RREQ) and Routing Reply (RREP) to choose different paths suitable for video description transmission, and no additional path control packets are used.

The SMMDSR extracts, uses, and sends packets to MAC Layer information embedded in typical routing messages. In the MAC-level, modified dynamic mapping algorithm is more effective than the dynamic mapping, thus improving quality of video in end user experience, which leads to less inter-packet delay and a high PSNR ratio.

The remainder of this paper is organized as follows: In section 2 and 3, the proposed system and the proposed multipath routing are discussed. Section 4 depicts the system simulation model and illustrates the significance of the proposed work, while conclusions drawn are given in section 5.

2. CROSS LAYER ARCHITECTURE OF THE PROPOSED SYSTEM

It is a difficult task to provide quality of service (QoS) in Adhoc Networks for multimedia applications. The QoS delivered by the MANET depends on all layers of coordination. It is therefore very advisable, in the various technical requirements of the TCP/IP protocol stack, of developing dynamic solutions based on cross layer approaches which can take QoS provisioning into account. This paper aims to increase the quality of the video streaming service by proposing a new cross-layer approach for Mobile Adhoc Networks.

Video streams are fed to the application layer in this cross-layer architecture. This video source file has been encoded and compressed in several descriptions using the MPEG-4 standard and fed to the transport layer from the application layer. UDPLite contains sensitivity information on the frames on the transport layer, reducing the likelihood of dropping the frames and sending the frames to the network layer [8].

Multiple paths in the network layer are preferable to provide stable and reliable communication, thus overcoming bandwidth and time differential restrictions of the topology can be overcome. In this research work on the routing resilience and less end-to-end delay, the SMMDSR protocol and modified dynamic mapping in the MAC layer have been proposed. The need for multimedia applications has been satisfied due to the availability of more paths in the network layer and the modified dynamic mapping algorithm in the Mac layer [9].

The packets from different paths are collected and transmitted on the reception side in the Network Layer. Packets with corrupted header are discarded, and the remaining packets are merged into the Application Layer which merges all the descriptions received and sends to the media player. A raw video sequence of 15 MB size YUV CIF (176×144) is the input source for the frame. In a frame-based approach, the source file is broken down into 4 descriptions [10].

The split video sequences are encoded with MPEG-4, and the parser program will parse each compressed video sub-stream. A trace file is created that contains frame-id, frame type, frame size and sending time. According to the trace file records the network simulator generates packets. The generated packets are transmitted to the lower UDPLite layer according to the time specified by the user. The user of the UDPLite agent specifies the output file name of the sender trace file. The time signs for each packet transmitted are also recorded by the agent along with the packet ID and the packet size [11].

The packets sent to the network layer will be routed over multiple disjointed paths using the SMMDSR protocol. This protocol identifies five paths from which four paths will be used to send the packets and a path will be held by path. The four descriptions are sent via 4 separate routes. This means that the MAC Layer can be reached by more packets sent from the network layer. The 802.11e standard defines four Access Categories (ACs) AC_{VO} (for voice traffic), AC_{VI} (for video traffic), AC_{BE} (for best effort traffic), and AC_{BK} (for background traffic) that have different transmission priorities [12] [13].

The 802.11e provides traffic differentiation by assigning video traffic to one category of access to improve the quality of services for video streaming in wireless networks. However, the channel access mechanism and the transmission scheme does not consider the importance of video data. Therefore, by considering the video meaning information generated from the application layer, the characteristics of video data content are to be exploited by the transmission layer mechanism. The video data therefore has priority because the video data is assigned to different categories of access. The video frames are mapped in line with the significance of video-coding in Access category (AC) queues like AC [0], AC [1], AC [2] and AC [3] and then the Physical Layer are assigned additional traffic [14] [15].

On the recipient side the video data is received from Physical Layer and transmitted via the MAC Layers and Network Layers to UDPLite Sink. The sink agent records the timestamp, packet identification and size of each packet that is sent to the user's file. The file is evaluated and checked by the sender with the trace file after the simulation. The number of packets sent and received is known from the evaluation trace file. In addition, corrupted video is formed on the recipient side as distorted video file [16].

The actual video is reconstructed using merger after the decoding of each received video file. The merger program generates the video sequence reconstructed from the unclear decoded video sections that are fed by the decoder to the merger program. The amount of video frames should be equal to the total amount of video frames in the restructuring video sequence in the original video. If the fusion program is not equal, it will be deleted by replicating the latest decoded sub-stream frame in the lost frames, until a correct decoded frame has been identified.

3. MULTI PATH ROUTING

Dynamic Routing source (DSR) is a MANETs routing protocol. It is like AODV because it forms an on-demand route when a computer transmits one. Instead of using a routing table for each intermediate device, however, it uses source routing. The protocol is based on source routing, which retains (continually updated) all the routing information on mobile nodes. The DSR protocol consists of deux systems which work together to enable source routes for ad hoc network routes to be discovered and maintained.

If the source node S wants to send a packet to the destination node D but has no route to D, S node starts a route discovery. Source node S floods the RREQ packet network. Each node adds its own address to the paquet header when RREQ is forwarded. Destination node D sends a Route Reply (RREP) on receipt of the first RREQ. On a reversed route, RREP is forwarded including the reverse route S-D through which the RREQ was received at Node D, and is attached to receive RREQ.RREP.

The path maintenance procedure ensures validation of the routes saved in the path cache. All nodes that want to communicate in the ad hoc network willingly participate fully in the network protocols. Every network node should also be willing to send packets to other network nodes. When the topology of the network has changed so that its route to D can no further be used as a link no longer functions along the route. If Route Maintenance indicates that an initial route has been broken, S may try to use any route D knows about, or Route Discovery may call up again to find a new route for subsequent packets for D. Route Maintenance is only used if S actually sends packets to D for this route.

Five paths are chosen and 5 paths are therefore always available, one of which is stored on a stand-alone route. These five routes are chosen for four routes, and, if one route does not exist for the stand-by-path to send, the video data can be used so that the video is sent. The four paths are selected. The following describes how all five paths are selected in the Split Multipath Dynamic Source Routing Protocol.

The source transmits RREQ packets to discover the routes in the Split Multipath Multimedia Dynamic Source Routing protocol. A route reply (RREP) is returned to the source node by the destination node. The destination node receives more RREQs after a certain time period. The destination selects the most disjoint path from the received RREQs to the first reacted path and sends another RREP to take the second path, thereby creating five routes. Of the five routes, four routes are chosen and video descriptions are transferred to low-delay and superior video streaming via these four routes.

We modified the route cache with the new RouteID attribute and introduced a charging table in this proposed work. Load Table has two RouteID and Packet counts attributes. In ROUTE CAHCE the source node maintains five paths and the Target Node receives RREQ packets and sends RREP packets for the first five requests received. The target node receives up to five paths. At the moment, only the first received RREQ packet will answer and the rest will be rejected.

This process is initiated when there is no path to a given target node and the total no. for a target node is less than 5 paths at any time while transmitting. In Route Discovery, the source knot prepares and distributes the RREQ packet to neighbors in the above two situations. After entering the Route Request Table, the neighbors will do the same. These multiple copies of RREQ packets move the network through all possible paths to the target node.

Finally, for the first five RREQ packets, the objective node replies and thus the source node receives 5 different routes at the most to the target node. It may be possible to reach less than 5 RREQ packets because of mobility of network topology nodes. The multipath functionality is incorporated by enabling the target node to answer more than one RREQ and at most 5 RREQs. The original maintenance mechanisms of routes have not changed.

If 5 routes are not there and only 4 routes are available, four routes will be described. If only three pathway descriptions are available, the three routes will be dispatched and the video quality will be reduced from 52dB to 49dB in PSNR and the PSNR will be reduced to 47dB only if two paths are available. If five paths cannot reach the target, the intermediate node sends the unavailable error message to the source.

For ongoing transmission, packet will be forwarded on round robin manner amongst the 5 paths (or available multiple paths less than 5). When originating a new packet, a node must perform the following steps:

Step 1: Search the Route Cache for a route to the address given in the destination address field in the packet's header.

Step 2: If no such route is found in the Route Cache, then perform Route Discovery for the destination address.

Step 3: If total routes available in Route Cache for given destination address are more than 5, select the 5 shortest routes.

Step 4: Identify path to transmit packet on, considering load balance.

Step 5: Transmit the packet to the first-hop node address given in the identified source route.

The activity in road maintenance will also be affected since mobility now allows for more than one route breaks. Compared to DSR and MP-DSR this generates great results.

4. SIMULATION RESULTS AND DISCUSSION

In general, the result is based on the MDC simulation setup along with UDPLite and a dynamic mapping scheme modified and multi-pathing system. The MDC along with an UDPLite and SMMDSR mapping system and an adhoc network modified dynamic mapping system is simulated with an NS2 simulator and the video received is assessed at the recipient. The proposed MDC is compared to UDPLite and SMMDSR in the simulation and to the modified dynamic mapping method. Five routes are considered in SMMDSR with MDC and the four descriptions are sent in four different routes. The "Foreman" video sequence has 400 images in QCIF format.

Table.1. Simulation Parameters for MDC with Multipath routing and Modified Dynamic mapping

Parameter	Value
Area	500×500m
Number of Mobile Nodes	20 nodes
Mobility Model	Random waypoint model
Speed	(0<5) m/s
Routing Protocol	SMMDSR
No of routes	N = 1 - 4
MAC protocol	802.11e
Video	Foreman YUV QCIF

Compared with the routing Aware MDC and other related works, multiple description coding with SMMDSR concept works well. The video sequence of this method is separated into two descriptions using MPEG-4 encoder and is dispatched through two routes wherein the odd images are as a one-picture description and the even frames are as another description. In the network, 20 nodes are placed in a 500×500m^2 region. The random model is used. The MAC layer uses IEEE 802.11b parameters.

The possibility of losing packets transmitted is calculated using the adhoc routing messages for the split multipath routing. In order to reduce the propagation error caused by packet loss, the estimated frame loss probability outcomes are transmitted into the application layer and the reference framework is selected dynamically. MSVC decoder is used in the decoder. The decoder receives the descriptions and decodes the correct descriptions by using refined macro block substitution methods and dissimulates the lost macro blocks.

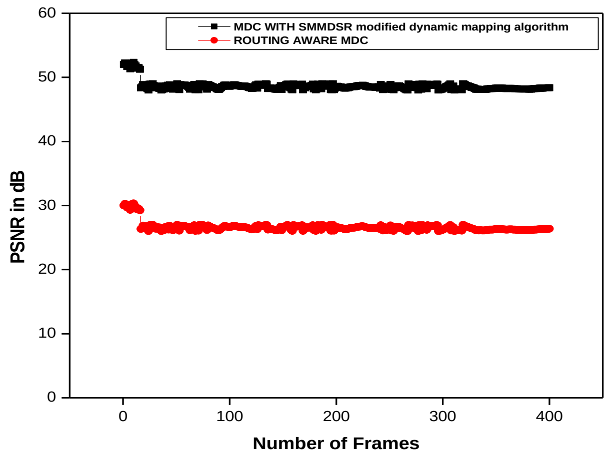

Fig.1. PSNR produced by MDC using UDPLITE and SMMDSR

The RAMDC procedure limitation is that it takes more time to estimate the probability of the frame loss and to select frames based on threshold-based algorithms in order to mitigate error propagation. In addition, if both paths fail, the losses are higher. The Fig.1 shows that PSNR is higher than the RAMDC method in the proposed method. In comparison with Routing Aware MDC, the multiple design coding of the SMMDSR concept works well. In Fig.1, it is observed that the PSNR is higher than the RAMDC method in the proposed method.

The delay generated by MDC with UDPLITE and SMMDSR with changed dynamic mapping algorithms with other similar approaches to the former video is shown in Fig.2.

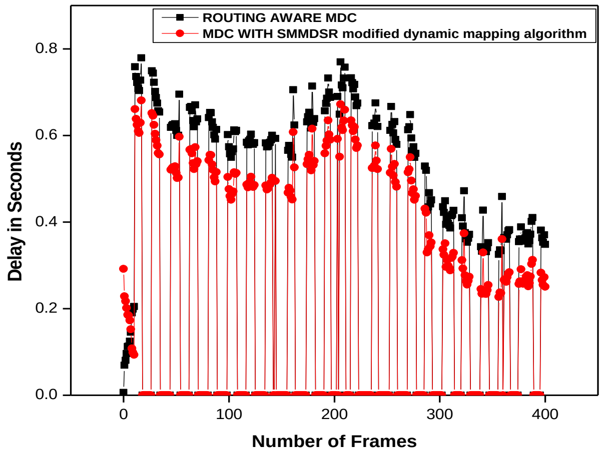

Fig.2. Delay produced by MDC-UDPLITE and SMMDSR

5. CONCLUSION

In this paper, a novel technique is proposed to improve the QoS of multimedia applications in MANET using Modified Dynamic Mapping algorithm, MPT and MDC. The study strives to attain the intended improvement by applying MDC in the application layer, UDPLite in the transport layer, MPT at the network layer, and Modified Dynamic Mapping in the MAC layer. The MDC together with UDPLite, SMMDSR, and Modified Dynamic Mapping improves well the transmission of video over MANETs. The simulation results prove that the proposed perspective has achieved an increase in PSNR by 30.84% and a reduction in delay by 18.57% when compared to conventional methods.

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