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Effective Video Streaming over MANET: A Cross Layered Approach

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Abstract: ***Mobile Ad Hoc Networks (MANETs) became popular communication networks with their utility in civilian and military applications. With advancements in electronics and communications besides increased availability of bandwidth MANET is found to be an attractive alternative for video streaming. Video streaming needs more resources like energy and processing power. In other words, MANET needs to optimize the resources for video streaming applications. In order to meet delay constraints with respect to video streaming which is of delay sensitive kind it is essential to have measures to cope with the expectations and quality streaming. Moreover the dynamic nature of MANET with mobility to devices can throw challenges. In this paper we proposed an approach known as cross-layered approach for improving video streaming quality in MANET. The proposed approach monitors different aspects such as congestion, delay constraint, and transmission rate. We proposed an algorithm to achieve quality video streaming and tested MANET with NS2 simulations. The results revealed that the quality of the streaming is improved significantly.***

Keywords: MANET, cross-layer design, congestion control, link failure, video streaming

1. Introduction

Mobile Ad Hoc Network (MANET) is widely used in the real world when situation demands. They are popularly known as on-demand networks that are automatically configured without having any fixed arrangements. The network needs no infrastructure with prior installations. The MANET devices are self-configured and thus network among the devices is formed automatically. The topology is also not fixed as the nodes move from one place to another place. When such network is used for any application, the nodes in the network are resource constrained. Due to the increase in its resources and innovations in technologies, of late, they are being used for video streaming as well. Video streaming applications are becoming popular in the real world. People across the globe and people of all walks of life started using smart phones and other hand – held devices. In this context, the MANET devices can also be used to have video streaming. However, there are many issues related video streaming with MANETs. The main issue is that the devices in MANET are resource constrained. The resource constrained nature makes it difficult to use for video streaming. In this context, it has become an important research to adapt to video streaming by improving layers in the OCI model. There are different layers including physical and MAC layers in the reference model. These layers can be improved in order to enhance quality in video streaming. Many researchers contributed towards this end. In this paper, we focused on implementing a cross-layered approach that can help in quality improvement with respect to video streaming in MANET. Our approach is based on the architecture we defined in this paper. The video streaming using cross-layered approach was supported by our algorithm in this paper. The simulations made in NS2 revealed that the algorithm is effective.

Our contributions in this paper include the design of cross-layered approach and its implementation in MANET for improving quality of video streaming. We also build an algorithm for achieving this. The remainder of the paper is structured as follows. Section II provides review of literature. Section III presents the proposed system in detail. Section IV presents experimental results while section V concludes the paper.

2. Related Works

Video streaming in MANET has been new area of research. Due to innovations in technologies and bandwidth allocation, the MANET devices are able to participate in video streaming. This section provides review of literature in this area. In [1] the authors explored different techniques like channel-quality based approaches and statistics-based approaches that come under rate adaptation strategy. Success or failure of data transmissions is the criterion used in [2] for estimating quality. In [15] an approach known as sleep/power-down is followed for energy efficiency. Load distribution approach is focused in [14]. In [12] energy efficient MANET protocols were explored for overcoming resource constrained nature of MANET devices. Transmission control approach is followed in [13] for efficient data transmission. In [11] load balancing and congestion aware scheduling algorithm was proposed for MANET. The algorithm decreased data transmission through congested nodes by balancing node to other nodes. Congestion aware routing protocol for MANET was proposed in [10] based on metrics such as data rates, buffer delay, control congestion and MAC overhead.

Congestion aware routing and rate adaptation [9] was proposed with measures like queue length, average MAC layer utilization and congestion for improving performance of MANET. The research pertaining to congestion in MANET has been around. However, it needed new techniques based on different kinds of metrics such as

channel interference, contention and MAC layer utilization. Congestion adaptive routing protocol [8] makes use of called bypass, and additional paths for improving performance. A cross layer design was proposed in [7]. It uses a metric known as link residual time (LRT) that is calculated using received power that is observed in the physical layer. Managing link failure in physical layer is explored to predict the quality of links. Signal strength is used as metric in order to predict link quality in the network layer. The link layer and transport layer can help improve the quality and thus the Link Adaptive Transport Protocol Transport Protocol as explored in [6]. It provides a systematic approach in controlling transport layer load in multimedia applications. It is achieved by considering degree of contention found in the network.

The channel quality-based approaches can find the conditions of channel directly and can switch to a robust transmission mode. An example for this is Receiver Based Auto Rate [5] as explored in [5] for rate adaptation for better video streaming quality. Auto Rate Fallback (ARF) explored in [4] was subjected to frequent problems with collisions. In order to overcome this problem collision-aware rate adaptation scheme was proposed. This scheme makes use of the frames like RTS/CTS besides channel assessment provision. Channel based – schemes were explored in [3]. They are classified into different techniques known as hybrid adaptation receiver based, sender based approaches.

3. Proposed Cross-Layered Approach

This section presents the proposed cross-layered design. It provides cross-layered approach or a combined solution for different aspects that arise in video streaming in MANET. Those aspects include quality of service, energy efficiency, delay constraint, packet loss, and congestion control and rate adaptation. There are many modules involved in the proposed solution. They include rate adaptation, congestion control, energy efficiency and link failure management. The overview of the architecture of cross-layer design is in Figure 1.

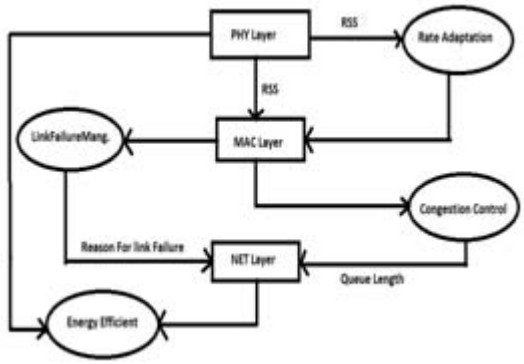

Figure 1: Overview of the cross-layered approach

The link failure and rate adaptation modules are integrated based on the parameter known as received signal strength. In case of adaptation module, the transmission rate selection process chooses rate of data transfer in MAC layer which in turn is based on the channel estimation process in the physical layer. In order to achieve high performance nodes need to adapt to different transmission rate. The link quality is determined by studying received signal strength obtained from physical layer. While selecting the routes, the links with least signal strength are discarded. This has also led to reduction in routing overhead.

Rata Adaptation

Low error rates are the indication of the quality of video streaming. Therefore the aim of this module is to ensure low error rate. The bit rate of the video being streamed is adjusted to the available bit rate. This is possible when physical layer information is provided to MAC layer. We made use of channel state of the sender node in order to determine the bit rate to be adapted. The channel model simulation takes place at the physical layer. The channel estimation parameter used is in the form of power indication.

Link Failure Management

Nodes in the MANET have different capabilities. They have different power levels and transmit data accordingly. When a node with high power sends data to low power node, there is link asymmetry arising. When low power nodes transmits data that cannot be sensed by the high-power node. Thus there is a chance of arising hidden terminal issues. When link failure is occurred it is possible to use received signal strength in order to find whether link failure occurred due to congestion or for any other reason like broken link. The reason behind the link failure is transmitted to the routing layer of the network. Therefore a routine maintenance is required in order to identify and handle link failures.

Congestion-Aware Routing

Routing protocols when carefully designed they can reduce congestion. While transmitting packets the proposed system takes care of congestion in routes and performs routing in order to reduce congestion and increase throughput. Besides it also makes the process in an energy efficient fashion. It considered both shortest path and minimal energy consumption routes in order to promote energy-efficient and congestion-aware routing.

4. Simulation Results

The simulation results show the performance of the proposed system in terms of different parameters. Performance is compared with existing system in terms of PDR, throughput, energy efficiency and PSNR.

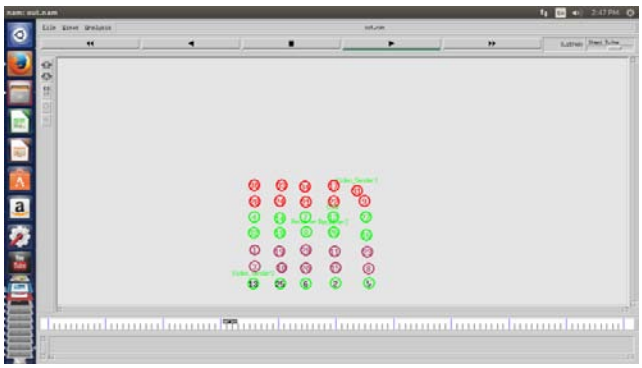

Figure 2: MANET simulation

As can be seen in Figure 2, it is evident that there are many nodes in MANET. There are nodes designated as video sender and receiver. There are 34 nodes in the MANET.

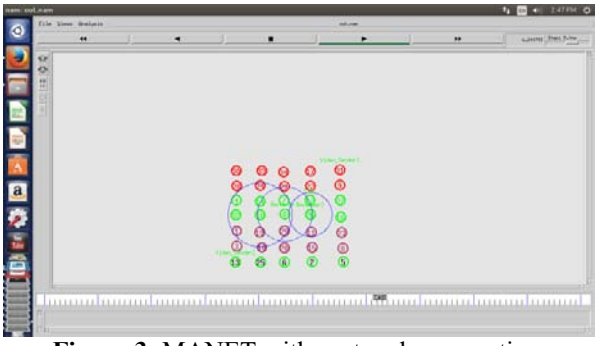

Figure 3: MANET with protocol propagation

As shown in Figure 3, it is evident that there are sender nodes and receiver nodes in the network. The protocol propagation is also shown in the network.

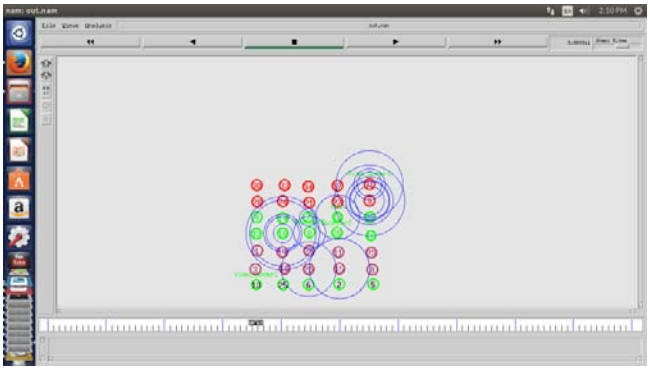

Figure 4: Simulation showing the results of cross layer approach

As shown in Figure 4, it is evident that there are sender nodes and receiver nodes in the network. The protocol propagation is also shown in the network. There is evidence of data transmission which internally uses the cross layer approach.

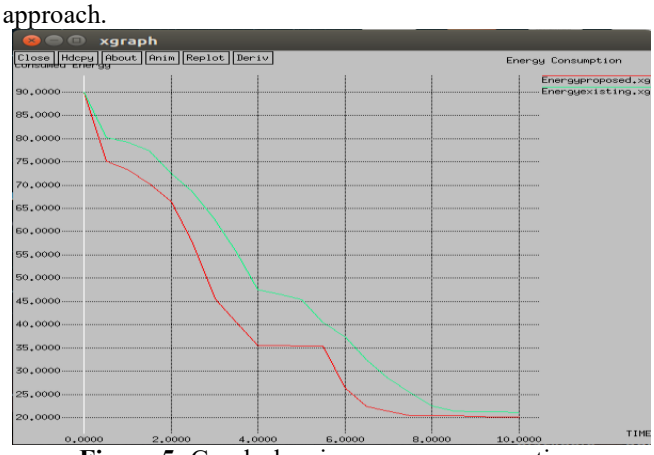

Figure 5: Graph showing energy consumption

As can be seen in Figure 5 the graph shows the comparison between existing and proposed system. There is performance improvement in the proposed system in terms of energy efficiency.

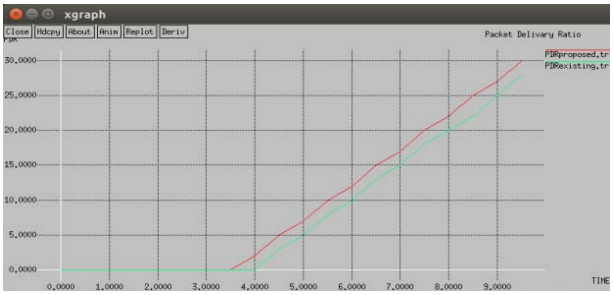

Figure 6: Graph showing PDR performance

As can be seen in Figure 6 the graph shows the comparison between existing and proposed system. There is performance improvement in the proposed system in terms of PDR performance.

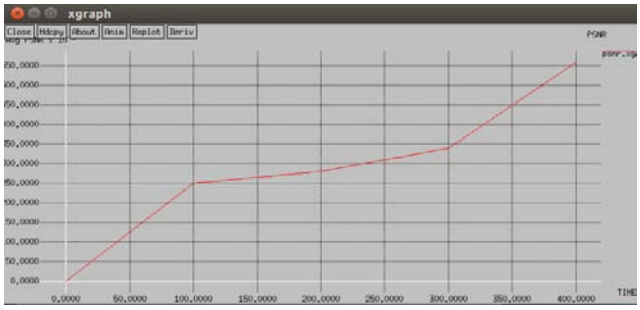

Figure 7: Graph showing PSNR

As can be seen in Figure 7 the graph shows the PSNR of the proposed system. As the time increases the PSNR gets increased.

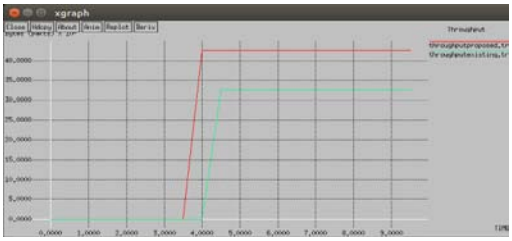

Figure 7: Graph showing throughput performance

As can be seen in Figure 7 the graph shows the comparison between existing and proposed system. There is performance improvement in the proposed system in terms of throughput performance.

5. Conclusions and Recommendations

In this paper, we studied cross-layer approach for improving video-streaming in MANET. We understood that it is an ongoing and important research as MANET devices have acquired capabilities to support video streaming due to innovations in technologies. It is also found in the literature that cross layered approach is suitable for improving quality of video streaming. The issues that arise due to mobility of the devices are to be handled besides congestion control and delay constraints. In this paper we focused on designing and implement a cross layered approach that could improve the quality of video streaming. The proposed approach was tested with NS2 simulations and results revealed that the video streaming quality is improved with the cross-layered

approach. This research can be extended further by exploring other layers in the OSI model.

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