



Combined Cross Layer Design for Video Streaming over Mobile Adhoc Networks

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Abstract– Mobile Adhoc networks are becoming more essential. Video Streaming is the main application in mobile Adhoc networks. Due to mobility of nodes Mobile Ad hoc networks (MANETs) does not support multimedia applications effectively. In this work, we propose a combined cross-Layer design using DSR (Dynamic source routing) protocol that aims to improve the performance of video transmission using signal to noise ratio (SNR) to make route reconstruction very easily. Utilization of SNR mechanism leads to improvement of video transmission over mobile Ad hoc network. The proposed cross-Layered approach tested by simulation (NS2 simulator) and simulation indicates increased throughput, packet delivery ratio, end to end delay and energy consumption.

Keywords –MANETs, Multimedia, DSR, video streaming, Cross-Layer, SNR.

I. INTRODUCTION

MANETs are a kind of wireless and Adhoc networks that usually has a routable networking environment on top of link layer and Ad hoc network. A mobile Ad hoc networks having mobile devices which is self-configured to form a network without having any infrastructure.

Each node in the MANETs acts as a router also being the sender or receiver of data packets. There are certain limitations when we consider MANETs for real time applications and especially for video streaming. First of all, routing became very complicated task in dynamic topologies. The routing protocols that have been developed for MANETs are directly affecting data transmission and the performance of the video. The performance varies depending on the network conditions like density of nodes in a specific area. Due to dynamism and heterogeneity of the network, quality of service demands in terms of delay, throughput and energy consumption. To cope with this cross-layer approaches have been proposed for specific mobile device characteristics [1-6].

Cross layer architecture means exchange of information between different layers will be done to improve the performance of a network. Cross-layer design mainly focus on Quality of service metrics delay, throughput and end to end delay. The cross-layer design provides individual solution for flow control [7]. In this paper design cross layer architecture which support combined solutions for rate adaption, link failure management, congestion control and energy optimization using SNR mechanism. In rate adaption module using Received Signal Strength (RSS) which is at physical layer is used to determine link quality [8, 9]. Queue length is used to estimate congestion control at network layer. For rate adaption available bit rate of the receiver should be known by using physical layer channel information [10-12]. Using energy efficient routing we can achieve energy efficiency at network layer [15]. To increase the performance of a video uses SNR mechanism which improves the throughput, delay, packet delivery ratio and energy consumption.

II. LITERATURE SURVEY

So many research works done in this area. Rate adaption is performed under two categories. Those are static-based and channel quality based approach. In static based approach using frame error or bit error we can achieve necessary information on wireless channel for rate adaption [10]. In channel quality based approach estimate the channel quality based on the measured SNR and adjust the data transmission mode by predefined threshold values. Channel quality based approach has three techniques. Those are sender based, received based and hybrid adaption techniques. Several rate adaption algorithms have been proposed over the past decades. Those algorithms focus on adjust their transmission rate with the help of channel feedback from mac layer. Most widely used rate adaption algorithm is (ARF) auto rate fall back [11, 12]. ARF algorithm is like a trial and error approach to select the bit rate which is optimal. If the channel is fluctuating rapidly this algorithm is not suitable for those types of channels.

Link failure management schemes based on physical layer parameters to identify the link quality. Signal strength is used to find the link quality at network layer [8, 9]. In proposed cross-layer uses link residual time (LRT) as a metric to identify link quality based on received power absorbed at the physical layer. Link residual time value is used in upper layers to take better routing decisions for sending packets.

Congestion aware routing has several metrics. Such as mac layer utilization, queue length, mobility parameters etc. to increase throughput of the network. Some protocols are discussed here. Hop by hop congestion aware routing protocol which employs a combine weight value as a routing metric based on the data rate, queuing delay, link quality and mac overhead. Dynamic congestion aware routing protocol (DCAR) which monitors the remaining buffer length of all nodes in router and exclude a certain congested node during the route discovery process [13 ,14].

Mobile Ad hoc network has limited resources so energy efficiency is more important to handle. Many algorithms have proposed for handling resources in efficient manner [15]. Energy efficient routing in MANETs divided into two categories. Transmission control approach and load distribution approach. In transmission control approach energy efficient routing is based on find the best route that minimizes the total transmission power [15]. In load balancing algorithms are there to improve the efficiency of the system by transferring packets from overloaded to other unloaded nodes.

III. PROPOSED CROSS LAYER DESIGN

We propose a cross-layer design whose aim is to provide a combined solutions for rate adaption, link failure management and congestion control, energy efficient routing for dealing quality of service metrics. Proposed system integrates rate adaption module with link failure management module named as DSR-RL. To maintain low error rate, the bit rate of the stream adapted to available bit rate. To achieve high performance under varying conditions, nodes need to adapt their transmission rate dynamically. In rate adaption module transmission data rate selection selects data rate in mac layer based on the channel information from physical layer. The receiver estimates the signal strength of transmission channel using channel mode simulation at the physical layer.

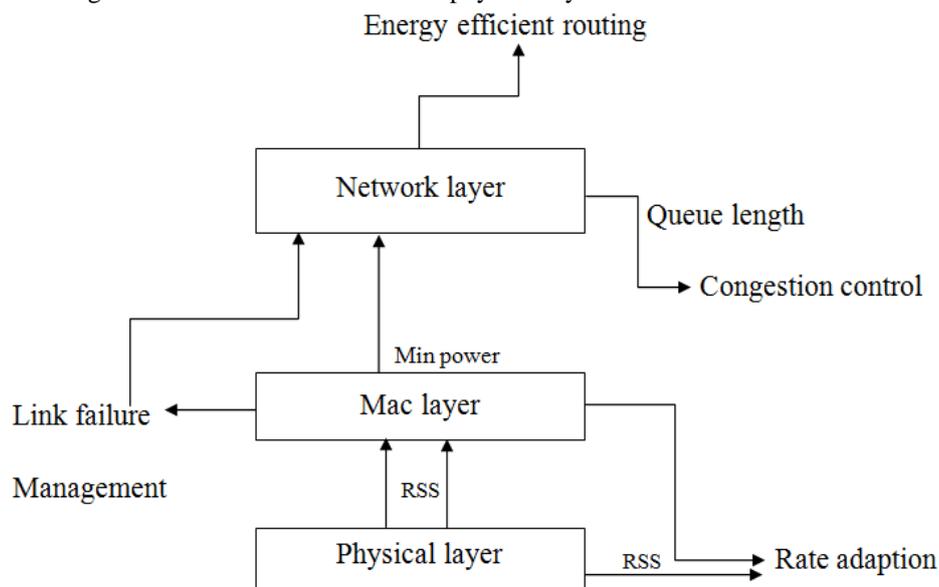


Fig.1 Cross-layer architecture

Proposed system integrates rate adaption module with link failure management module named as DSR-RL. To maintain low error rate, the bit rate of the stream adapted to available bit rate. To achieve high performance under varying conditions, nodes need to adapt their transmission rate dynamically. In rate adaption module transmission data rate selection selects data rate in mac layer based on the channel information from physical layer. The receiver estimates the signal strength of transmission channel using channel mode simulation at the physical layer. For estimating channel information our scheme uses power indication P_r , which is calculated as

$$P_r = \frac{P_t * G_t * G_r * H_t * H_r * \lambda^2}{(4 * \pi * d)^2 * L}$$

Where P_t and P_r are signal power at receiver and transmitter. G_t and G_r are gain for a signal to a node from the transmitter and receiver, H_t and H_r are height of the transmitter and receiver, d is the distance between the transmitter and receiver. Then received signal strength(RSS) is mapped to a transmission data rate based on threshold based techniques at the mac layer. In mobile Ad hoc networks due to different power capabilities of a node link failure occurs. Link asymmetry arises when a node with high power transmits to a lower power node. Due to node mobility also link failure occurs. The link failure management module sent the reason for unsuccessful communication to the network layer. MAC layer informs the routing layer not only that there was a problem but also includes if the neighbouring node is still reachable.

Integrate the congestion aware routing and energy efficient routing named as DSR-CE. Congestion aware and energy efficient routing uses two metrics queue length for congestion and remaining energy of node. Use queue for identifying congested nodes. Checks current queue length is less than maximum queue length when a packet needs to wait in a queue for a longer time, there is a possibility for delay. So the average queue size should be maintained based on the traffic load. The calculation of average queue size is updated every T seconds based on the following equation.

$$\text{len} = \beta * \text{qlen} + (1 - \beta) * \text{qlen}_{\text{sample}}$$

β is the exponential co-efficient filter, q length sample is set to 0.3 in our simulations. Q length is average queue length. Communication is the main source of energy for a mobile node. Nodes consume energy while transmitting data. Hence calculating energy metric as power consumed with the following equation. By using this we can identify a node which is not having any congestion and consuming less energy for transmitting data from source to destination.

$$E_n = P_{tx} - P_r + P_{th} + P_m + P_{\text{over}}$$

Where E_n denotes total energy consumed by node. P_{tx} is power consumed in transmission mode, P_r is power consumed in reception mode, P_{th} is receiving power threshold, P_m is power consumed in idle mode. P_{over} is power consumed in overhearing mode. When an intermediate node receives a router discovery packet a node checks the source node energy and source node ID advertise the destination node ID. It saves all information into a router cache. Calculates the queue cost from equation and checks whether it is minimum or maximum. Queue cost is less than threshold value it will forward the packet. Otherwise drop the packet until the destination reached.

The simulation utilizes the SNR mechanism for further performance metrics. A number of simulations have been conducted in order to investigate the effect of SNR threshold on the perceived video quality by the end user. For this purpose we calculate the (PSNR) peak signal to noise ratio by directly comparing the video file sent by the sender with the same file at the end user on a frame-by-frame basis. Equation gives the definition of PSNR between the luminance component Y of source image and destination image D.

$$\text{PSNR} = 20 \log_{10} \frac{V_{\text{peak}}}{\frac{1}{\sqrt{N_{\text{col}} N_{\text{row}}}} \sum_{i=0}^{N_{\text{col}}} \sum_{j=0}^{N_{\text{row}}} [Ys(n,i,j) - YD(n,i,j)]^2}$$

where

$$V_{\text{peak}} = 2^k - 1, \quad k = \text{number of bits per pixel (luminance component)}$$

The selection of SNR threshold affects the efficiency of the routing path reconstruction. Choosing a low threshold may result to very late reconstruction while choosing a high threshold may result to very frequent route discovery process that will add routing overhead to the network. For the evaluation of the performance of the proposed cross-layer design, we examine the PSNR of the received video with respect to the original video the average throughput, the packet delivery ratio and average end to end delay. Calculate the PSNR value of each and every node. Then identify at which SNR threshold the PSNR value is high. We choose the SNR threshold to be 33.0 dB for the rest of the simulation. Using of signal to noise ratio mechanism identify the congested nodes so that we can drop that nodes and send the packets. So that the throughput, packet delivery ratio is more and energy consumption, end-to-end delay is less.

IV. SIMULATION RESULTS

Simulations were carried out by taking into account realistic conditions and using ns-2.34 network simulator. The simulation area is 500*500 meters in a 5*5 grid. 35 mobile nodes are representing with the data rate of 5mbps. Each node transmits in a constant bit rate mode. Summarizes the simulator parameters that are used.

Simulation parameters

Routing protocol	DSR
Propagation Model	Two ray Ground
Antenna Model	Omni Antenna
Interface queue type	Drop tail
Mac type	802.11
Data rate	5mbps
Number of nodes	35
Channel type	Wireless channel

The performance metrics are described in detail.

- Throughput
We compute the network throughput as the total number of bytes per second.
- End to end delay
The time a packets take to be transmitted across a network from the source to destination.
- Energy consumption
We compute the energy per byte as the ratio between the total energy consumed and the total throughput.
- Packet delivery ratio
Ratio of actual packets delivered to total packets sent.

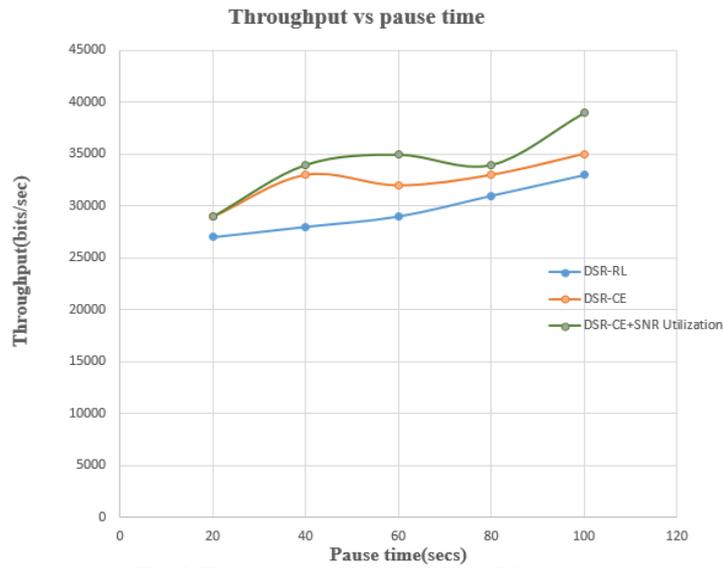


Fig.2 Throughput for network of 35 nodes

Fig. 2 compares the throughput between DSR-RL, DSR-CE and DSR-CE+SNR utilization. When a network size is 35 utilization of snr leads to higher throughput compare to other two protocols. Using of signal to noise ratio mechanism identify the congested nodes so that we can drop that nodes and send the packets. So that the throughput of the network is more.

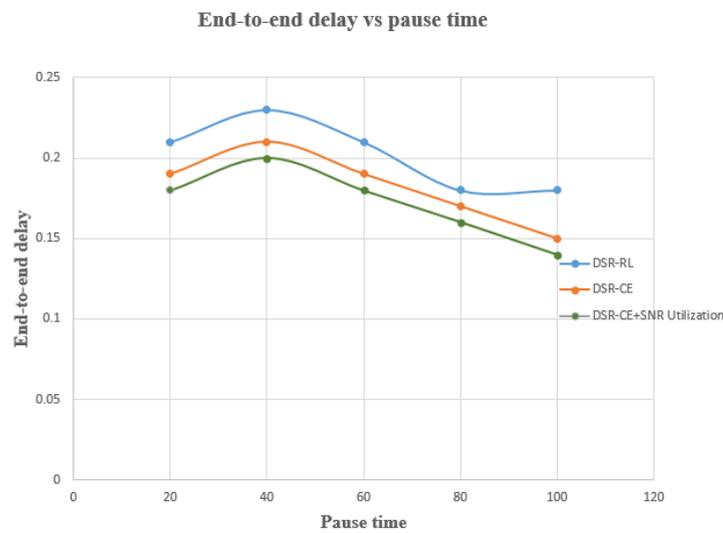


Fig. 3 End to end delay for network of 35 nodes

Fig. 3 depicts the average end-to-end delay during the three evaluation scenarios. Use of SNR mechanism leads to important improvement of end-to-end delay.

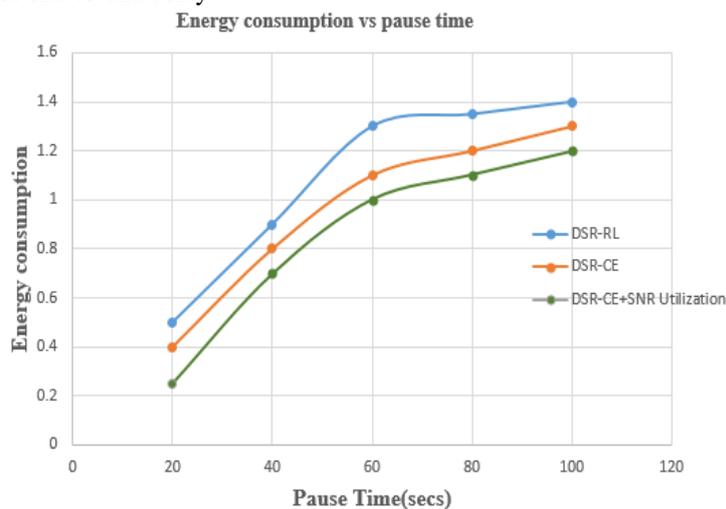


Fig. 4 Energy consumption for network of 35 nodes

Fig. 4 depicts the energy consumption during the three evaluation scenarios. Use of SNR leads to important improvement of energy consumption. Using of SNR threshold the congested nodes are dropped so energy consumption is less compare to other scenarios.

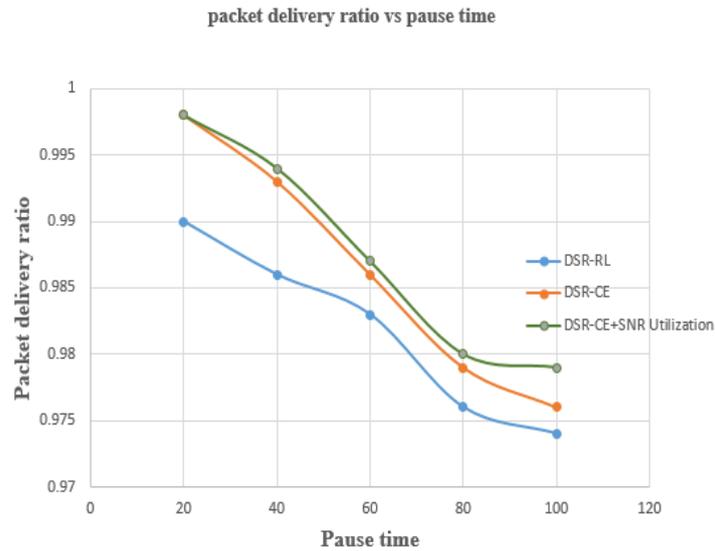


Fig. 5 Packet delivery ratio for network of 35 nodes

Fig. 5 compares the packet delivery ratio between the three scenarios. The utilization of SNR leads to improve the packet delivery ratio.

V. CONCLUSION AND FUTURE WORK

Proposed combined cross layer design aimed that to improve the performance of video transmission with the use of SNR threshold value. We have design a cross-layer provide a combined solution for link failure management, rate adaption, congestion control and energy efficient routing by using DSR protocol. Simulation results showed that the proposed combined cross layer design led to important improvements in the throughput, delivery ratio, end to end delay and energy consumption. We also showed how a cross layer design involving the mac layer, network and physical layers can improve the performance by sharing the information between non-adjacent layers. Our future work includes the use of SNR in the performance of other routing protocols in MANETs.

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