Routing For Power Controlled and Mobility Constraint Ad Hoc Networks

R. Rajyashree, N.M. Balamurugan

Abstract--- Time varying nature of wireless channels due to the dynamic establishment of node communication imposes significant challenge in data apportion especially if the sender follows static transmission strategy with respect to transmission rate and transmission power. An approach of Power Control and Rate Adaptation (PCRA) scheme that makes adjustment of the parameters at the physical and application layer respectively proposed in this study to attain the required video quality while achieving fairness among communicating nodes. Mobility issue of the wireless network need attention in improvising video delivery. In this paper an algorithm has been adapted in which data from the network layer is used for retaining the path without link deterioration. Performance evaluation have been carried out and found to have enhanced data relegation.

Keywords--- wireless network, power control and rate adaptation, link deterioration, fairness.

I. INTRODUCTION

Ad-hoc wireless network, a category of wireless network, which is utilizing the multi hop relay and capable of operating without any infrastructure. In the absence of base station routing becomes complex. Under this situation, an intelligent mechanism is required to transmit and receive the data and also route the packets. Admission control for ad hoc networks has many challenging problems to solve due to the probabilistic nature of wireless medium. To achieve a high rendition under different channel conditions, nodes need to adapt their transmission rate dynamically.It is observed that the data transmission in an ad hoc network are simultaneous involving multiple source destination pairs. There by the occurrence of interference is high. When the data transmission recurring in different pathways often resulting in lower transmission rates comparatively. To overcome the loss of rate the sender can adapt dynamic rate adaptation in accordance with the recipient.

Several researchers reported the adaptation of rate and implemented in the modules. An online algorithm was implemented by Chao Chen et.al [10] to mitigate the playback interruptions during streaming. When the receiver receives the data from source, it measures the arrival rate and transmits the information to the source.

The rate control of real time video transmission over wireless channels remains a challenging task. It is statutory for both the wireless channel and the video encoder to protect the video data from losing. Wireless medium is highly fitful in nature. Some of the factors viz fading, attenuation, interference from other radiation sources, mobility of nodes, moving objects are affecting the performance. Hence, to perform better under wavering conditions, nodes need to adapt their transmission rate dynamically.

To support the admission control channel estimation is deployed that describes the propagation of signal from the purveyor to the collector under the above mentioned factors. A comprehensive literature survey on the rate selective caching for streaming over information centric networks is presented in [4], observes the challenge in providing scalable streaming over adaptive requests for different bit rates. Some of the rate control algorithms include AAF, AARF, RBAR, CARA, RRAA, Soft Phy.

In video transmission over a duplex wireless channel the possibility of packet loss is observed. The automatic repeat request (ARQ) retransmission helps in mitigating the loss of data. Data loss leads to alternation of channel throughput, thereby making the rate adaptation effortful. Automatic Repeat request (ARQ) retransmission has been widely used as an efficient mechanism to recuperate the burst packet errors in the incidence of the duplex channel. It is the concern of the rate control algorithms to acknowledge the retransmission predicament. RCA's are investigated in the following conditions (i) Variations of the Received Signal Strength Indicator (RSSI) values and (ii) Application level throughput for different traffic.

The first commercial rate control algorithm implemented in plain 802.11 network as per the receiver's requirements is found to be Auto Rate Fall back (ARF). The improvised version of ARF is adoptive ARF, used for efficient rate control at the acceptor's end. In the present study, this basic concept has been taken and different module has been adopted for transmission and power control and rate adaptation [16].

In wireless communication systems, the need to allocate resources simultaneously and reliably to multiple users is crucial. Achieving a high rate communication link among the claiming multiple users is difficult. The resource allocation that involves the distribution of resources among the users are facilitated by a variety of procedures.

In FDM (frequency division multiplexing) to conduct individual signal, the entire bandwidth available to the broadcasting medium is divided into a series of non-overlapping bands of frequency. At the source a carrier is generated by the oscillator to carry the information. The combination of the high frequency carrier signal with the low frequency baseband signal in the modulator is referred as modulation. Demodulation is performed at the receiver's end to isolate the baseband signal from the carrier.

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In TDM (time division multiplexing) the independent signals are transmitted and received over a common path by means of synchronized switches at the end of the communication line. The time domain is split into recurrent time slots of fixed length, one for each sub-channel. An error correction channel is also found before synchronization [10]. An advanced version of TDM is statistical time-division multiplexing in which both the address of the terminal and the data are transmitted together for better routing. Using STDM allows bandwidth to be split over one line.

Carrier frequency offsets (CFO), one if the many non-ideals of receiver design. The lack of synchronization of the carrier signal contained in received signal results in CFO. The major factors attributing to CFO are (i) frequency mismatch in the sender as well the collector oscillator (ii) Doppler effect as the result of movement in the conveyor and receptor. A detailed analysis is disclosed in [18].

In summary the trading of data over wireless network can be enriched by adapting the rate at the upper layer and the power at the PHY layer to ensure fairness among the node. The mobility of the nodes makes the problem challenging. This paper deals with this problem.

II. RELATED WORK

Wireless ad hoc network also referred as *on the fly* are a group of self-configuring, dynamic structure where the nodes are free to move. They are infrastructure less and the topology is constantly changing. This impacts the connectivity where the topology might have been altered due to node failures. In [19] an approach that incorporates the pattern of node failure into a model and the connectivity is studied. Results observed shows the increase in lifetime of the network with the maximum utilization.

The movement of the nodes also results in collision that degrades the link resulting in packet loss. It may also prevent other transmitting nodes from sending packets leads to exposed terminal problem. [20] discusses the methodologies to mitigate the exposed as well hidden terminal problem. Block acknowledgement (BACK) properties of 802.11 are exploited to upgrade CSMA/CA to CSMA/OCA (opportunistic collision avoidance).

Achieving Quality of Service (QoS) in wireless transference is highly demanding in recent years, and colossal compendium exists in this area. An elaborate inspection on the QoS perspective of streaming is presented in [5] and [10]. The problem of admission control and resource allocation subjected to various arête circumstances are addressed in [2] and [8]. In [6] methodology to procure equitable beaconing rate for congestion control in vehicular networks is discussed. A reinforcement learning in which the problem is formulated as a Markov Decision Problem (MDP) and dynamic programming techniques are applied as discoursed in [7].

One of the major limitations observed is energy harvest in ad hoc networks and that various energy prediction models have been developed that ply the renewable sources from ambience namely solar, airflow, vibration and radio frequency sources as schemed in [3]. Information centric networking is an approach to evolve the internet infrastructure to that kind of network foundation where the prime focal is information. The reservations against content dispersion is considered in [9]. The volatile nature of wireless medium imposes a significant challenge in data delivery and one of the main issue being fading.

Fading refers to the attenuation of the signal and may be induced due to multipath propagation. A joint antenna and path selection for multipath propagation for multi-input and multi-output system is investigated in [11]. Information theory, a study of quantification, storage and communication of information uses a relay channel for transmission. DF (decode forward) technique that decodes the source message in one block and transmits the re-encoded message in the following block is discussed in [12].

A packet based energy efficient technique was devised for selective fading , that occurs when the signal arrives at two different paths and one of the paths is changing. An interference algorithm (IA) is also included in multi-input multi-output (MIMO) system with OFDM (orthogonal frequency division multiplexing) as briefed in [13].

These deviating conditions influence the throughput of the network. The throughput can be improvised by combining the data rate and power control based on the BER (bit error rates). An analog network coding (ANC) is illustrated in [14]. The technique also provides resilience to attacks and eavesdropping and improves scalability of the network.

The quality of wireless connections is measured by SINR (signal to noise ratio). Path loss occurs in a network when the energy of the signal typically fades with the distance. The SINR can be modelled by the use of stochastic geometry models due to the various complexities and the randomness of the wireless network. A widespread survey exists in this sphere.

In [1] Ayaz Ahmed et.al probed the SINR properties for efficient and scalable video streaming over ad hoc networks by developing a cross framework model. The objective is to control the power at PHY layer and rate at the application layer while achieving fairness and satisfaction among the communicating nodes.

Similar work was carried in [15] where a model was built based on the PSNR (peak signal to noise ratio), ratio between the maximum possible power of the signal to that of the maximal power of corroding noise. Predictive coding schemes and closed loop approach are used to solve the problem.

III. PROPOSED WORK

It is based on cross-layer framework that refers to the manipulation of data from the lower three level layer in a distributed joint power control and rate adaptation frame work [1] [16]. It is very much essential in conditions wherein wireless network of multiple transmitter-target pairs that use the same bandwidth by interfering with each other [2]. Whether network based on ad hoc or a device-to device, efficient use of power to the node with different time slot is very much essential[8][10].

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The time diversity of the wireless channels along with hard delay constraints associated with quality of the video which needs a certain fairness criterion among the nodes [6]. Due to the disparate channel conditions the multiple nodes that d experience the packet loss while demanding unvarying quality of video. An efficient sharing of the wireless radio resources are deployed, among the multiple streaming users for they are very constrained. This issue of mobility in Power Control Rate Adaptation Scheme (PCRA) can be resolved by enhancing to LPCRA (Link breakage probability in PCRA) by increasing the connectivity with increased power that sustains the data remittance by the avoidance of rediscovery of new path. The following diagram showed the proposed architecture is given in Fig3.1.

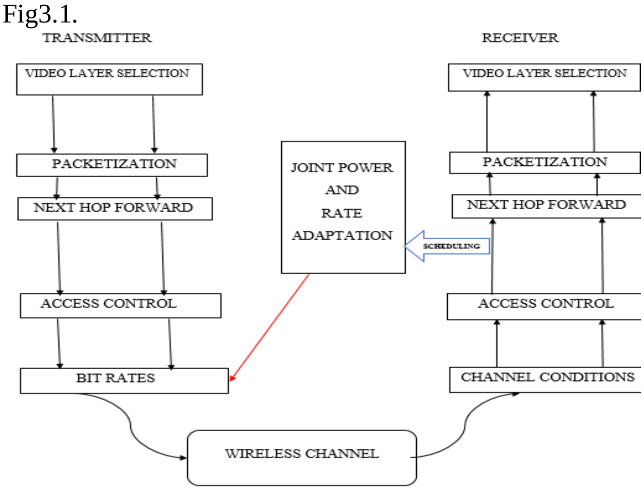

Fig 3.1: Power control and Rate Adoption

A. Link Prediction Algorithm

The link prediction algorithm used in the study has been given in the following.

a. For each neighbours
b. Calculate the distance d
c. Update the record of (power of node, time)
d. If d>=200
e. Prediction ( )
f. {
g. Estimate and update the d prior to the link break
h. If (current time >== t $_s$)
i. {
j. Sent warning message to upstream node
k. }
l. On consent of repair message
m. {
n. Set the route
o. Local route repair ().
p. }
q. Local route repair ()
r. {
s. Find the route to the next node s;
t. If (found a path in h hops within time)
u. {
v. Adopt the new route for routing.
w. Adapt rate ().
x. }
y. Adapt rate()
z. {
aa. Set w(t)=0.5
bb. Calculate fairness and average fairness using (4) and (5)
cc. Compare (4) and (5) if (4)<(5) then
dd. W(t+1)=w(t)+0.25
ee. Else
ff. W(t+1)=w(t)-0.25
gg. }
hh. Else
ii. Find a route to terminal T.
jj. If (path is found)
kk. Route the packet through the new path.
ll. Send message to the source to find shortest path.
mm. Adapt Rate()
nn. }

It has been developed to predict the link failure based on the calculation of distance between the nodes. The power and time of the transmitting nodes are recorded in steps ‘b’ and ‘c’ respectively. In step’ d ‘the optimal distance between the nodes are measured which can be greater than or equal to 200 meters then we predict the node to be soon failure. The time at which link breakage is set to occur is recorded in step ‘h’ and a warning message regarding the failure is indicated to the sender in step’ j.’

On the receipt of repair message the sender sets a route and initiates a local route repair by following successive steps. Step‘s’ finds the path to the next node within the time specified and also with the minimum number of hops as mentioned in step ‘t’. Thus in step ‘y’ the path is used for transmission and the sender is updated with the shortest path.

B. Modified Link Prediction Algorithm

a. For each neighbours
b. Calculate the distance d
c. Update the record of (power of node, time)
d. If d>=200
e. Prediction ( )
f. {
g. Estimate and update the d prior to the link break
h. If (current time >== t $_s$)
i. {
j. Sent warning message to upstream node
k. }
l. On consent of repair message
m. {
n. Set the route
o. Local route repair ().
p. }
q. Local route repair ()
r. {
s. Set flag=1;
t. Set power =1;
u. Find the route to the next node s;
v. If (found a path in h hops within time)

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w. {
x. Adopt the new route for routing.
y. Adapt rate ().
z. }
aa. Adapt rate()
bb. {
cc. Set w(t)=0.5
dd. Calculate fairness and average fairness using (4) and (5)
ee. Compare (4) and (5) if (4)<(5) then
ff. W(t+1)=w(t)+0.25
gg. Else
hh. W(t+1)=w(t)-0.25
ii. }}

In this the link breakage is identified and the sender is informed by setting a flag. The power value is set to '1' in order to maintain the existing path and measurement of link breakage probability by every router in the path with respect to its next hop has been introduced.

IV. MODULE DESCRIPTIONS

A. Simulation and Data Transmission

Simulation and data transmission module to assume the source and destination pair and measures the arrival rate of transmission. It is essential because the data transmission in an ad hoc network are simultaneous involving multiple source destination pairs (Fig 4.1). However, there are the situation wherein the occurrence of interference will be high, that results relatively lower data transmission rate, due to recurrence of same path. To overcome this rate loss the sender can adapt dynamic rate adaptation in accordance with the recipient. To mitigate the playback interruptions during streaming, Chao Chen et.al [10] proposed an on line algorithm.

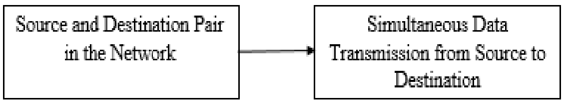

Fig 4.1: Data transmission

$$\text{Arrival Rate} = \frac{\text{Total number of packets received}}{\text{Current Time-Starting Time}} \qquad \text{Eq (1)}$$

$$\text{Bytes per second conversion} = \frac{\text{Count * Packet size}}{\text{Time Difference}} \qquad \text{Eq (2)}$$

B. Fairness Measurement

The transmitter nodes are implemented with the controller that performs power and rate adaptation jointly. The fairness is calculated at each node in a distributed manner, and every node performs the power control and rate adaptation based on its estimated fairness. In order to calculate the satisfaction and the fairness parameters the following equations (3,4,5) (Fig 4.2) is used.

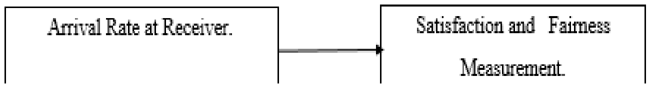

Fig. 4.2: Fairness measurement.

$$\text{Average Arrival Rate} = \frac{\sum \text{Arrival Rates}}{\text{Count}} \qquad \text{Eq (3)}$$

$$\text{Satisfaction} = \frac{\text{Average Arrival Rate}}{\text{Maximum Arrival Rate}} \qquad \text{Eq (4)}$$

$$\text{Fairness} = \frac{\text{Satisfaction}}{\text{Average Satisfaction}} \qquad \text{Eq (5)}$$

C. Power Control For Video Quality

The video quality improvement is based on the given rate criterion, the intent and the transitory fairness of the correlated recipient. To achieve the utmost acceptable transmit power level of desired video rate, power allocation at the physical layer have been proposed. Equation (6) has been used to calculate average fairness with the following condition. If the computed average fairness is more than the fairness of individual node (5) Fig(4.3), then a decrease in the transmission rate is followed or otherwise transmission rate is increased.

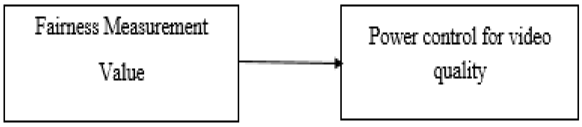

Fig. 4.3: Power and rate adjustment.

$$\text{Average Fairness} = \frac{\text{Individual Fairness}}{\text{Total number of nodes}} \qquad \text{Eq(6)}$$

D. Connection Based Power Control

If an alternate route is followed, power adjustment can be utilized to improve the connectivity. Therefore, in the present algorithm, hop count between the intermediate nodes are measure. Then the measured link breakage probability in every router in the path with respect to its next hop is made for power adjustment. Hence we can able to achieve an increase in transmission power at higher link breakage probability Fig(4.4) so as to to communicate for a long distance router with reduced data loss. The modified link prediction algorithm has been given in Algorithm 2.

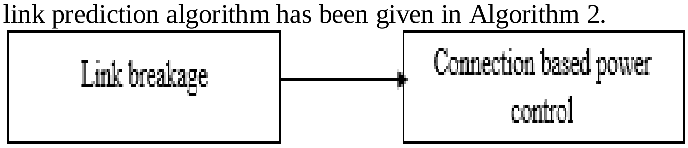

Fig. 4.4: Connectivity ensuring power control.

V. EXPERIMENTAL RESULTS

Performance between power control and rate adaptation as well link breakage probability has been evaluated using the algorithm 1 and 2 and compared the results.

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Evaluation is based on the simulation settings in the model by following consideration namely, 3,4,5 source destination pairs independently using the parameters : delay, overhead, packet delivery ratio.

The evaluated Metrics Delay, PDR and Overhead are shown in the following.

Delay

It is the time taken for the packet to reach from source sensor to destination.

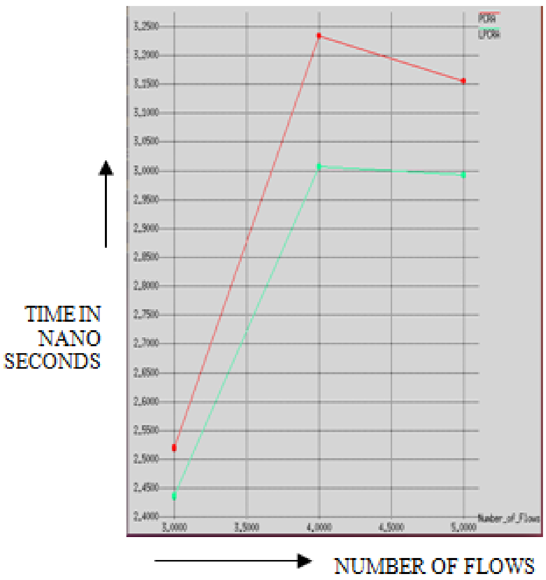

Fig. 5.1: Delay of PCRA vs LPCRA

Overhead

It is the number of control packets involved in the data transmission from source to destination.

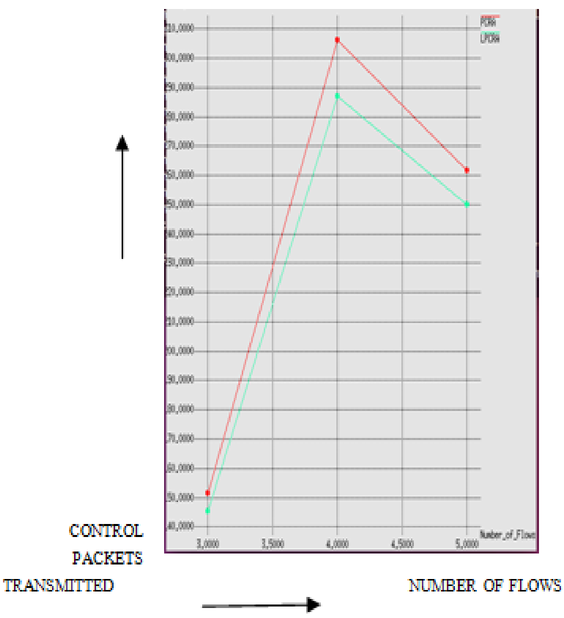

Fig. 5.2: Overhead of PCRA vs LPCRA

VI. CONCLUSION

In this paper we made an empirical study of the problem of link breakage that challenges data consignment in wireless networks with time differing interference. A cross layer framework that allocates power at the PHY layer and calculates the next hop of the router at the network layer is developed. The framework manoeuvres the mobility of the nodes under varying channel conditions and covenants the fairness and satisfaction of the network. The proposed LPCRA framework avoids the rediscovery of a new path and the time taken for the re-establishment of a new path is considerably reduced. Simulation results show that the proposed system outperforms the existing framework.

Packet delivery ratio

Packet delivery ratio is defined as the ratio of total number of packets delivered to the destination and number of packet sent by the source.

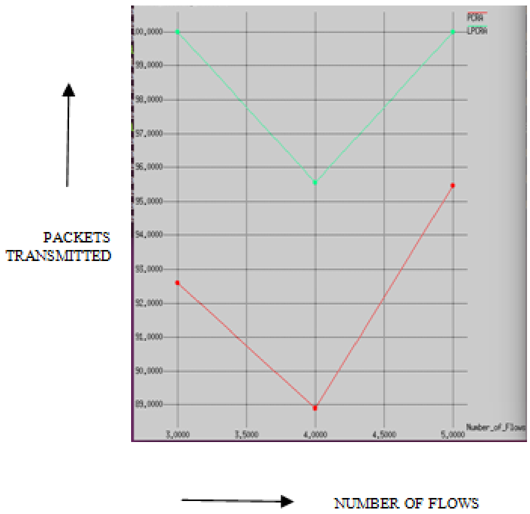

Fig. 5.3: Packet delivery ratio of PCRA vs LPCRA

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