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IMPLEMENTATION OF CHANNEL-AWARE DYNAMIC RATE ADAPTATION ALGORITHM IN MOBILE AD-HOC NETWORK

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Abstract—Asexcludes the difficulties of base station arrangement by allowing transmission among its nodes “on the fly”, Mobile ad-hoc network (MANET) is becoming unavoidable in a modern communication system. However, it does not efficiently support real-timemediatransmission since it has huge resource requirements andhard timing constraints for data delivery.In this work, we propose a framework to provide systematic assimilation between the Physical (PHY) and MAC layers. A Channel aware dynamic data rate adaptation (CaDRA) algorithm is proposed at the MAC layer to regulate the transmission data rate according to the present channel condition. This will result in a substantial performance improvement of real-time applications in terms of QoS constraints including packet latency, packet delivery ratio, and networkthroughput.The performance of CaDRA is evaluated and compared with different data rate schemes including 6 Mbps, 24 Mbps, 54Mbps and Path-centric on-demand Rate Adaptation (PRAM) protocol.Simulation results using NS-2 demonstrates that CaDRA outperforms fixed-rate scenarios as well as the PRAM in terms of performance metrics such as average throughput, average end-to-end delay, and packet delivery ratio for different node density owing to the adaptive behavior of CaDRA under variouschannel conditions.

Keywords —data rate; MANET; channel quality; challenges;

I. INTRODUCTION

Increasing interest in mobile computing devices and penetrating advanced technologies in computer networking has spawned demands for infrastructureless and fast deployable mobile networks. Such networks are called as MANET. It is a peer-to-peer, self-configuring network of sovereign mobile nodes. The peers of this network can be traced ubiquitously within the coverage area irrespective of their fluctuating topographic position and would be able to move to a required location randomly.MANETs are deployed for varioussafety- and mission-critical applications. Anapplication is considered as safety-critical whose malfunction leadsto endanger forhuman life or severedamage to the environment (e.g. military strategicprocesses, search and disaster relief management, etc.).Malfunction of mission-critical applications can causea smalldisturbance in the system that is not catastrophic (e.g., virtual classrooms, teleconferencing, multi-user games, etc.)[1].

Demand for Quality of service (QoS) guarantees in real-time applications is pushing the investigators in the arena of ad hoc networks to bring revolutions. QoS is defined as a set of services guaranteed by the network to its users. The absence of the central administrator, frequent link breakage and limited bandwidth make communication in MANET particularly challenging. In view of these issues, it is very difficult to satisfy a specified level of QoS in MANET. Rate adaptation in MANET is a procedure to regulate the data bit-rate dynamically according to channel conditions. Indeed, implementing multi-rate data adaptability is more difficult because of the following reasons:

(i) The maximum data rate is realizedby means ofeffective modulation techniques and therefore, involves high signal-to-interference-noise ratio (SINR). This consecutivelynecessitates a larger hop count or shorter communication range for a particular source-destination pair. Owing to this distance- data rate or number of hop-data rate trade-off, higher rates are not always desirable;

(ii) In a dynamic network, the mobility of the terminal is one of the major causes of path breaks and can lead to packet loss and higher control overhead for route maintenance subsequently.

(iii) The node interference on the selected route also distresses the performance benefit than normally anticipated.

Recently, several studies dealing with optimal data rate adaptation for IEEE 802.11 in the occurrence of concurrent transmissions. IEEE 802.11 standard and its extensions (IEEE 802.11a/b/g) offer the competence to transmitinformation at variousdata rates. For instance, IEEE 802.11a/g provides 6, 9, 12, 18, 24, 36, 48 and 54 Mbps. However, it is found that the network efficiency does not increase proportionatelyas the data rate rises even in single-hop communication. This is owing to the fact that the PHY and MAC layers overheadsare fixed irrespective of the transmission rate[2]. Furthermore, this overhead becomes a great issue as the sending rate increases since the communication time of the useful data decrease proportionally.

In this work, a Channel aware Dynamic Rate Adaptation (CaDRA) algorithm is proposed at the MAC layer to improve the adaptability of data rate dynamically. The MAC layer guarantees that network resources are effectivelyassigned to increaseoverallnetwork performance while satisfying user QoSconstraints. The MAC can facilitateinactive periods by scheduling shutdown intervals in line withload requests, buffer states,and different channelconditions. The MAC layer regulates medium access to ensure network performance and individual QoS requirements. In distributed access methods, MAC should be enhanced to decrease the amount of packet loss due to concurrent transmission of other nodes; whereas centralized access methods implement efficient scheduling algorithms in order to increasethe energy efficiency of the network[9].

The remainder of this paper is structured as follows: Section II provides substantial relevant approaches aiming to support rate adaptation over MANET. The fundamental concept of CSMA/CA protocol is given in Section III.Optimal transmission rate calculation between a node pair is discussed in Section IV. The implementation detail of CaDRA is explained in Section V.As a final point, we conclude this paper in Section VI.

II. RELATED WORKS

Most of the studies focusedon optimizing the transmission rate according to the channel conditionsonly. Some approaches utilize the received signal strength (RSS) to select the data rate. But, these approaches are restricted by many factors such as contention-related issues, asymmetric communication link, fluctuation in the medium access time, etc.Qiao et al. propose a MAC protocol data unit (MPDU) based Link Adaptation Scheme (MBLAS) that implements a mathematicalmodel to estimate the data rate with respect to the data length, signal-to-noise ratio and the PHY mode [3]. The MBLAS considers the backoff and retransmission procedure to deliver the ideal data rate theoretically. Nevertheless, the proposed method is suboptimal in multiple user real-time environments.

Pavon and Choi develop an RSS-based Link Adaptation strategy [4]. The optimal data rate is preferredaccording toreceived signal strength (RSS), which is relatedto dynamicthresholds. The application of dynamically defined thresholds caneliminate both the channel asymmetry and erroneous RSS calculation. On the other hand, this approach leads to frame losses due to collisions.

Another renowned algorithm for data rate adaptation is the Auto Rate Fallback (ARF) [5]. Apart from hop-interference, a certain amount of data loss isexpected due to low signal-to-loss ratio, so that a more stable bandwidth has to be nominated. On the other hand, if a certain number of successive positive transmissions are found, the maximum sending rate is preferredin order to increase the throughput. ARF is neither depends onchannel asymmetry nor erroneousness calculation of RSS problems. One of the shortcomings of this technique is that it sporadicallyattemptsthemaximumtransmission rate to assesswhether it is feasible or not; this characteristic is not suitablefor static network environment where the selected transmission rate remains constant for a certain amount of time.

The Adaptive Auto Rate Fall back (AARF) targets mitigating channel related issues using a binary exponential backoff to a number of consecutive positive transmissions required to attempt the maximum sending rate [6]. Thus, AARF is more reliable than ARF and realizes improved performance in static network circumstances. However, both schemes assume that data losses are always owing to medium errors so that their efficiency can quickly reduce in high traffic scenarios, where a considerable quantity of packet drops are triggered by collisions. Few other adaptation techniques attempt to integrate the best characteristics of the RSS-based and loss based methods [7].

Saehoon Kang et al. discuss complex trade-offs in a mobile environment and propose a new multi-rate adaptation protocol in the context of IEEE802.11 MAC and AODV without suffering a high control overhead [8]. The authors develop a new protocol. The core concept of the proposed protocol is a top-down approach. It determines more appropriate sending rate for a node pair and then, dynamically adjuststhe data ratebased on the lifetime of the route. The simulation results demonstrate that PRAM outdoes fixed-rate scenarios and the multi-hop version of ARF with respect to packet loss rate and end-to-end communication latency in the entire range of node density due to the flexibility of PRAM under various channel states.In conclusion, no prior work has delivered an ideal rate adaptation in terms of contention-related disputes and channel conditions, comprehensive of both channel access times and frame collision possibility. In this work, a channel aware data rate adaptation technique is proposed to provide dynamic adaptation against different channel conditions[9].

III. A VIEW OF CSMA/CA PROTOCOL

In MANET, contention-free MAC schemes (e.g., IEEE 802.11) have been extensively used with Distributed Coordination Function (DCF), where the nearby hops are competing for the shared wireless medium. The DCF exploits Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) protocol to synchronize the channel access and to combat the drawbacks associated with exposed-terminal and hidden-terminal problems (Andre 2008)

The DCF allows nodes to send data frames only if the channel is idle for a definite time period which is named as the Distributed Inter-Frame Space (DIFS). The nodes are restricted to communicate until the carrier becomes idle. When the medium is currently busy or turns into busy for the period of the DIFS due to another transmission, the sending node automatically delays its transmission, and then it comes into the exponential backoff with the initial size of the backoff window. Hence, every node has a buffer space where it queues the incoming packets until the medium becomes free to access.

If the medium is free, then the sender first transmits a control frame, namely Request-to-Send (RTS) to the destination. After successful reception of RTS frame, the destination node postpones its transmission for a small duration which is called as Short Inter-Frame Space (SIFS), and then sends a Clear-to-Send (CTS) frame to the sender of RTS, confirming that the RTS frame has been correctly received [2].

After receiving RTS, the receiver estimates the data rate to be used by the sender and piggybacks that information to the sender with the CTS frame. The sender’s MAC layer can access this information and use it to regulate its data rate for successive transmission. The sender’s PHY layer receives the CTS and as a side effect, MAC can estimate the quality of the link from the receiver to the sender. The intermediate nodes will update this information in their Network Allocation Vector (NAV) and preserve that information as long as the current transmission gets successfully completed. According to the current utilization and quality of the channel, a node can define its data rate for every packet. If a node has a higher quality channel, then it will send at a high data rate and vice versa.

IV. OPTIMAL DATA RATE

Channel-aware Dynamic Rate Adaptation algorithm is a path-centric adaptation technique. On receiving a route request from the sender, every receiver node estimates the available bandwidth based on the current channel utilization. After computing the available bandwidth, the receiver sends this information to the sender. On receiving this information, the sender can make a decision on how many data packets should be admitted at that time and regulates its data rate accordingly. On the other hand, the relay nodes which receive the packet will update and preserve bandwidth information in their NAV[10].

If the sending rate is maximum, then there could be anissue of connectivity. Conversely, ifthe sending rate very less, then the network isnot able to realize its determined capacity certified by the radio hardware. Hence, the CaDRA estimates the optimal data rate at the destination node. The mechanism ofCaDRA is (i) to define the maximum sending rate according to available bandwidth and (ii) to adapt it according to the channel condition. If a transmitter does not have any statistics about the receiver, then it will use the moderate data rate (24Mbps). Nonetheless, if the transmitting node has interacted with the receiver in the recent past, it can select the same data rate as an initial try. During communication with the receiver, the transmitting node will adjust the rate as below; (i) If the channel condition is estimated as good, the transmitter may be comfortable by rising the current data rate because the route is consistent enough to provide a maximum sending rate and transmit data at a rate of $R_{curr}+\delta$. (ii) If the channel state is estimated as bad, the source node decreases the current data rate and send data at a rate of $R_{curr}-\delta$.

4.1 Estimation of channel quality

This protocol assesses the channel condition based on packet success rate, tested at two levels (i) At the destination and (ii) At each relay node along the route. The sending node has no possibilities to determine the reason forfailed transmission. The links qualities of destination and relay nodes are independent of each other. Only if the requirements at both the levels are satisfied, the medium is confirmed to be in good state. At the destination node, by sharing the two short control frames among source-destination pair, all nearby hops identify the transmission and backoff during the transmission time advertised along with the RTS and CTS frames. In the channel quality prediction, the CTS and ACK frames are tested at the destination node. According to the results of these frames, the channel is categorized into three states namely GOOD1 (G1), BAD1 (B1) and AWAITING1 (A1). Consequently, a flag (FL) is used to point out the equivalent channel condition. The flag can indicate three values: G1, B1 or A1.[10]

- Check for the CTS frames, which report to the source that the frames are confirmed to be sent.
- Also check for the ACK frames, which is an acknowledgment of successful data transmission.

When the CTS and ACK packets are delivered successfully within their time-out duration, then the condition of the medium is designated as GOOD. If the node fails to receive an ACK frame within its time-out duration, then condition of medium is designated as AWAITING state. If both the frames are not successfully received, then the medium is considered as in BAD state and ultimately the successive transmissions are dropped out.

At each Intermediate node, the packet success rate (PS) is compared with a predefined threshold value (P_{th}) (in this simulation $P_{th} = 0.7$) in order to estimate the quality of the channel. The packet success rate is the ratio of the number of positive transmissions to the most recent transmissions. If the value of Ps is higher than the predefined value, the link is in good condition with its state designated as GOOD2 (G2) else the link is considered bad and designated as BAD2 (B2). As the channel status is validating at each and every node, the variations in channel quality are updated with the exact channel status.

Suppose a route has several links with both good and bad states, then in such cases the route is acceptable only if it comprises maximum number of links with state good or else the route is unacceptable (i.e.) not appropriate for communication and will be preserved in the AWAITING (A2) state for a certain time period (t_{th}) (in this simulation t_{th} = 150 ms). For example, if there are totally 7 links in a route with 4 of the links in state G2, then the path is acceptable as the maximum links have G2 state. Suppose only 3 of the links are in G2 state, then the route is unacceptable. After the channel status increases and if the maximum number of links in the route have state G2, then the route is acceptable. Also once the t_{th} value is surpassed, then also the route is unacceptable and is not appropriate for communication.[11]

4.2 Estimation of optimal data rate

The objective of the proposed dynamic rate adaptation module (DRAM) in this work is to choose the most suitablesending rate according to the present channel conditions. On receiving a route request from the sender, every receiver node estimates the available bandwidth based on the current channel condition. Available bandwidth is the highest throughput which can be exploited for the data transmission amonga node pair. The effective utilized bandwidth ($B_{utilized}$)is the number of packets in bits, transmitted during channel occupation time at MAC layer.[12]

$$B_{utilized}(bps) = \frac{\sum_0^{Nt}(\sigma)}{\sum_0^{Nr}(T_{co})} \qquad (1)$$

In the above equation, σ is the packet length in bits; N_r and N_t are the number of the received and transmitted packets respectively; T_{co} represents channel occupation time. It is the period measured from the instant when a frame starts competing for carrier access to the instant at which the whole data is acknowledged. T_{co} is calculated in the MAC layer as follows

$$T_{co} = T_{busy} + T_{cw} + T_{const} \qquad (2)$$

T_{busy} is the reserved channel time taken for RTS-CTS handshake, and it can be derived from the network allocation vector. NAV-RTS and NAV-CTS represent the idle period for the node which listens to the RTS/CTS exchange. T_{cw} is the duration of the contention window (CW) for a transmission opportunity and T_{const} is a constant time which comprises of several components as shown in the Equation (3). Whenever a node observes the access collision, it increases the CW size until its pre-defined value is reached; clearly, the size of CW can interpret the collision condition more precisely.

$$T_{const} = T_{DIFS} + T_{PHY\_Header} + T_{MAC\_Header} + 3T_{SIFS} + T_{ACK} + T_{Back\_off} \qquad (3)$$

where T_{DIFS} is the duration of distributed inter-frame space; $T_{PHY_Header}$is the transmission period of the physical layer header; $T_{MAC_Header}$is the transmission period of the MAC header; T_{SIFS} is duration for short inter-frame space; and $T_{Backoff}$is the duration for executing backoff procedure to query the channel again. If B_{max} is the maximum data rate supported by the network[13], then

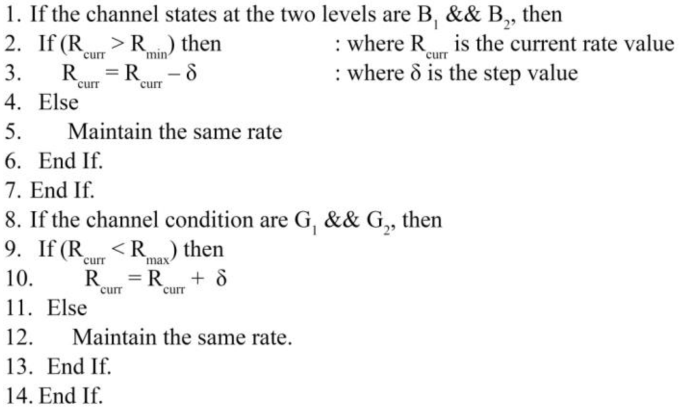
$$B_{avail} = B_{max} - B_{utilized} \qquad (4)$$

After calculating the available bandwidth, the receiver sends this information to the sender. On receiving available bandwidth information, the sender can make a decision on how many data packets should be admitted at that time and regulates its data rate accordingly. On the other hand, the intermediate nodes which receive the packet will update and preserve bandwidth information in their NAV.

4.3 Channel-aware Dynamic Rate Adaptation Algorithm

In the Channel aware Dynamic Rate Adaptation (CaDRA) Algorithm, the basic data rate is varied between two values namely, R_{min} and R_{max}, where R_{min} is the lower limit of data rate to which it can be reduced and R_{max} is the upper limit of data rate to which it can be increased (i.e. $R_{max} = B_{avail}$). Suppose the channel states at the two levels specified in the preceding section are B_1 and B_2, then the current rate (R_{curr}) is reduced by a step value (δ). Suppose the channel states at the two levels are G_1 and G_2, then the current rate (R_{curr}) is improved by a step value (δ). This rate calculation is done at the destination and puts such an intended sending rate in the CTS frame so as to the sender can take on this rate in the successive transmission [14]. Additionally, the calculation errors and the channel state variations can be reimbursed by appending a bit in the ACK from the receiver to designate the optimalsending rate for the subsequentDATA frame.

Algorithm 1: CaDRA



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If the channel states at the two levels are $B_1$ && $B_2$, then
    If ($R_{curr} > R_{min}$) then          : where $R_{curr}$ is the current rate value
        $R_{curr} = R_{curr} - \delta$            : where $\delta$ is the step value
    Else
        Maintain the same rate
    End If.
End If.
If the channel condition are $G_1$ && $G_2$, then
    If ($R_{curr} < R_{max}$) then
        $R_{curr} = R_{curr} + \delta$
    Else
        Maintain the same rate.
    End If.
End If.
```

V. PERFORMANCE EVALUATION

Simulation is an application intended to reflect a real-time scenario. The NS-2 simulator is extensively used to assess network protocols. It has several benefits over other approaches such as physical experiments and analytical modeling. The key benefit of NS-2 is that they can delivera practical response to the users when scheming real-time applications. Therefore, the user can estimate the accuracy and competency of a system before it is actually fabricated. NS-2 allows network architects to investigate a problem at many different levels of abstraction. By dealingwith a communication system at a high level of abstraction, the researchers can understand the operations and synergy of all protocols and therefore better prepared to reduce the intricacy. By means of simulators, it is possible to relateother designs and develop the ideal network[15].

The performance of CaDRA is assessedby means of NS-2. The data traffic simulated is Constant Bit Rate (CBR) traffic. 20 CBR sessions are simulated at the rate of 20 packets/second. Two-ray ground reflection approximation model is used in this simulation with the lower and upper bound of node speed of 1 m/s and 5 m/s with zero pause time. With this mobility model, a node moves in the direction of an arbitrarily designated receiver. After the node arrives at the receiver, it moves to another arbitrarily designated receiver. Simulation time is 300 seconds for each trial. Multiple runs of each experiment are carried out, and the average results for all runs are obtained. The parameters and their corresponding values that are considered to carry on the simulation are given in Table 1.

Table 1 NS-2 parameter setting to simulate CaDRA

Number of nodes	20 to 140
Grid Topology	1500 m X 500 m
Rate of control signal	1 Mbps
Data transmission rate	20 packets/s
Length of the packet	512 bytes
Transmission Power	100 mW
Carrier frequency	2 GHz
Traffic	CBR
MAC protocol	IEEE 802.11
Transport protocol	TCP

5.1 Performance Metrics

The effectiveness of the proposed approach is evaluated using comparison experiments in terms of the following well-known performance metrics.

Mean end-to-end delay: Delay specifies the average amount of time taken to transmit an information packet from an emitter node to an intended destination. It is measured as the duration between the generation of the information packet and the reception of an ACK for the corresponding packet. The mean delay along the path is equal to the sum of queueing delay, contention delay, and transmission delay.

Average Throughput: Average throughput is the number of information bits passing through the network in a particular time period.

Packet delivery ratio (PDR): This metric shows the level of packets at the receiver node. PDR is the fraction of the number of delivered packets to the receiver node over the amount of generated packets at the emitter node. The lesser delay, higher PDR and higher throughput indicate the superior performance of the protocol.

5.2 Simulation Results

The performance of CaDRA is evaluated and compared with four different fixed data rate schemes including 6 Mbps, 24 Mbps, 54Mbps and PRAM protocol[8]. The fixed-rate scenarios represent the network condition, where all control and data packets are sent at the fixed transmission rate. For simplicity, only three (i.e., 6Mbps, 24Mbps, and 54Mbps) out of the eight cases are considered. PRAM determines more appropriate sending rate between source and destination nodes and dynamically exploits it according to the route lifetime[16]. Simulation results on the different sending rates are also discussed to realize the adaptive behaviour of CaDRA protocol. The channel aware adaptive behavior of the proposed algorithm is demonstrated using the above three performance metrics.

5.2.1 Effect of Node Density on PDR

Figure 1 compares PDR of the fixed rate cases, PRAM, and CaDRA against the number of nodes. In a sparse network scenario (e.g., network with 20 hops), the 54 Mbps case would suffer the most due to the connectivity issue as shown in the figure. But, it will become beneficial as the number of nodes increases. Its performance riseshastily as the number of nodes upsurges. One might anticipate similar resultsin other high sending rate scenarios.

In the fixed 6Mbps scenario, the PDR is the maximumfor a network with 20 nodes and drops as the number of nodes increases. What matters at 6Mbps is not the end-to-end connectivity, but the load intensity since control overhead increases with the number of nodes. A similar style is witnessed for 24 Mbps schemes. PRAM performs superiorto the 24 Mbps scenario but the resultant enhancement is trivial. The proposed CaDRA realizes the better PDRas depicted in Figure 1. The cause behind the greater performance of CaDRA is that it regulates available data rates according to the channel condition in order to increase the network performance.

It is evident from the numerical results that the PDR of CaDRA is 84.43% which is 31.64% higher than 6Mbps scheme, 20.47% higher than 24Mbps scheme, 51.27% higher than 54Mbps scheme and 3.55% higher than PRAM. Hence, the CaDRA outperforms all other studied schemes with respect to PDR.

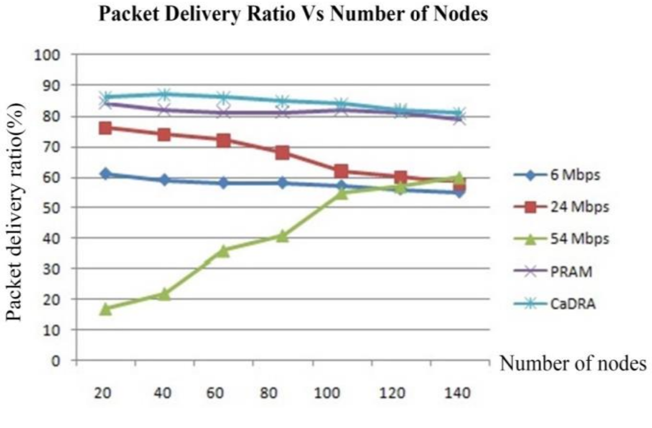


Figure 1. Comparison of CaDRA and other protocols in terms of PDR

5.2.2 Effect of Node Density on Transmission Delay

Figure 2 illustrates the mean transmission delay againstthe number of nodes. The 6Mbps scenario has the maximum communication delay since it has slow transmission speed. CaDRA achieves on par with high sending rate scenarios as given in the graph. But, the lower mean transmission delay for high rate cases does not denote their true performance since their delivery ratio is low, and the estimation of the mean delay does not consider the lost packets. Conversely, CaDRA’s low transmission delay illustrates its unique performance since it has a maximum delivery ratio as depicted in Figure 2. The end-to-end delay of PRAM is lesser than the 6Mbps scenario but then again, it is still higher than CaDRA protocol.

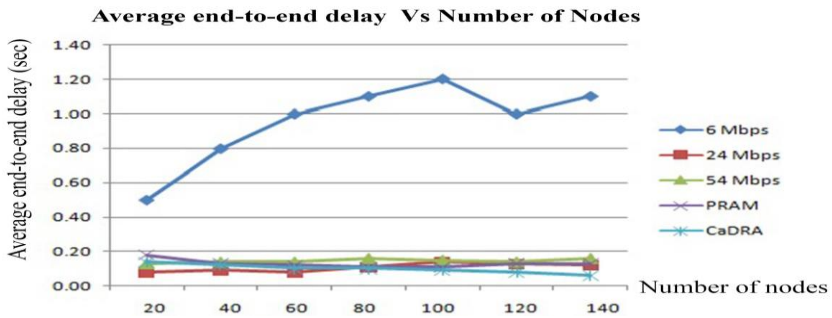


Figure 2. Comparison of CaDRA and other protocols in terms of mean end-to-end delay

The average packet delay of CaDRA is 0.10 sec which is 89.70% better than the delay experienced by a packet in 6Mbps scheme, 8% better than the delay experienced by a packet in 24Mbps scheme, 32.35% better than the delay experienced by 54Mbps scheme and 24.18% better than the delay experienced by PRAM.

5.2.3 Effect of Node Density on Average Throughput

Figure 3 demonstrates the average throughput versus node density for the schemes 6 Mbps, 24 Mbps, 54Mbps, PRAM, and CaDRA. In all the cases, the average throughput decreases with an increase in the number of nodes. The proposed CaDRA outdoes the other schemes because, when a loss occurs, CaDRA retransmits the lostpacket at the lowest data rate, increasing the probability of successful retransmission.A successful transmission based on the lowest data rate strongly hints that the frame drop is due to channel impairment. Accordingly, CaDRA reduces its data rate and usually has to retransmit the lost frame again in case of channel impairment. The average throughput of CaDRA is 33.53 Mbps which is 85.94% higher than 6Mbps scheme, 56.69% higher than 24Mbps scheme, 16.57% higher than 54Mbps scheme and 3.71 % greater than PRAM.

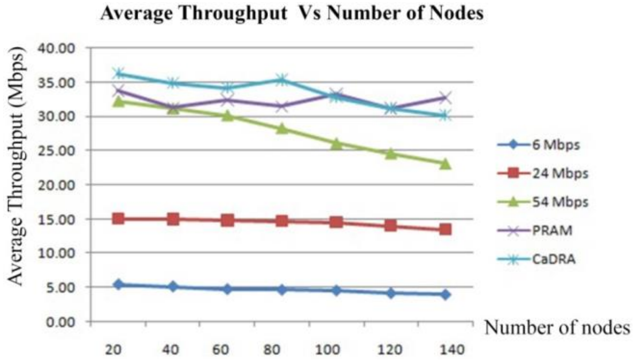
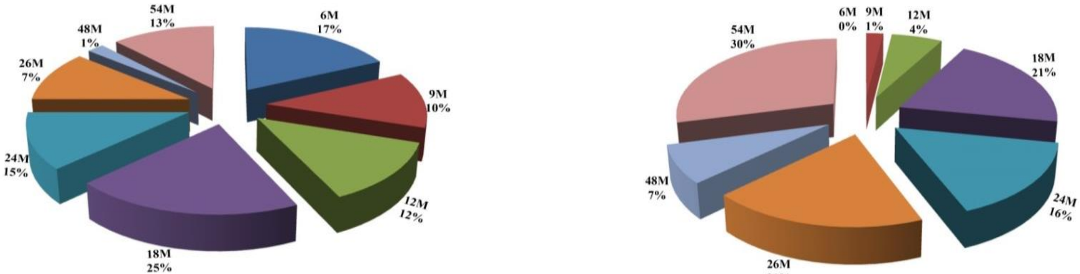


Figure 3. Comparison of CaDRA and other protocols in terms of Average Throughput

To illustrate in what way CaDRA increases the network performance, information about the data rate of various data transmission is collected. Figure 4exhibits the combination of sending rates exploited in the network scenario with 20 and 140 nodes, correspondingly. In the sparse network, low rate transmission dominates the network as shown in Figure 4(a). In the 20-node network, the combination is 18%, 12%, 13%, 20%, 12%, 11%, 2% and 12% for 6, 9, 12, 18, 24, 36, 48 and 54 Mbps respectively. Almost 75% of data transmission uses 6 to 24 Mbps. Conversely, in the 140-node network, the combination becomes 0%, 2%, 6%, 20%, 16%, 19%, 8%, and 29%, for 6 to 54Mbps and more than 90% of data transmission uses high data rates (18 to 54 Mbps) as shown in Figure 4(b). Hence, the CaDRA selects higher data rates when the network is dense and lower data rates when the network is sparse.



(a) Data rates used by source node (20-node network)

(b) Data rates used by source node (140-node network)

Figure 4.Statistics of the sending rate used by source nodes in CaDRA.

VI. CONCLUSION

In this work, we develop a framework to provide systematic assimilation between the physical and the MAC layers. A Channel aware dynamic data rate adaptation (CaDRA) algorithm is proposed at MAC layer to regulate the sending data rate based on the present channel condition. The proposed CaDRA exploits a good combination of sending rates according to their number of active nodes and hence, uses nominalnetwork resources to considerably enhance data delivering competency without increasing the transmission latency. This will result in a substantial performance improvement of real-time applications in terms of QoS constraints including PDR, average throughput and communicationlatency. The performance of CaDRA is evaluated and compared with different fixed data rate schemes including 6 Mbps, 24 Mbps, 54Mbps and PRAM protocol. Simulation results using NS-2 demonstrates that CaDRA outperforms fixed-rate scenarios as well as the PRAM in terms of PDR and end-to-end latency in different network scenarios with various node density owing to the adaptive behavior of CaDRA under variouschannel quality.

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