ACARS: Adaptive Context - Aware Rate Selection for DSRC in Vehicular Networks

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Abstract - **Throughput plays a vital role for data transfer in Vehicular Networks which is useful for both safety and non-safety applications. An algorithm that adapts to mobile environment by using Context information has been proposed in this paper. Since one of the problems of existing rate adaptation algorithm is underutilization of link capacity in Vehicular environments, we have demonstrated that in wireless and mobile environments, vehicles can adapt to high mobility link condition and still perform better due to regular vehicles that will be out of communication range due to range checking and then de-congest the network thereby making the system perform better since fewer vehicles will contend for network resources . In this paper, we have design, implement and analyze ACARS, a more robust algorithm with significant increase in throughput performance and energy efficiency in the mist of high mobility of vehicles.**

Keywords – DSRC, Data Transfer, Mobility, Vehicular Communication, IEEE802.11p, Rate Adaptation, MATLAB, Protocol, Algorithms, Context information

I. INTRODUCTION

Dedicated Short Range Communication (DSRC) is designed to offer complete solution for mobile data broadcast and also to active wireless access to vehicular environment (WAVE) protocol. It is a short to medium range communication service that supports applications like: electronic toll collection and public safety, which needs high data rate and low latency. DSRC has been regarded as one of the promising technologies to provide a robust communication medium in vehicular networks which is affordable enough to be built into every vehicle. It is designed to support both road safety and commercial applications [1].

Road safety applications will require reliable and timely wireless communications, while commercial applications will expect high data rate. An important technique for wireless communication is to provide reliable and high data rate with adaptive modulation and coding, which adapts to the communication channel quality and attempts to provide the best possible communication performances. However, due to the high speed of vehicles, the period during which two vehicles or a vehicle and access point (AP) are within communication range can be very short, which poses big challenges on rate adaptation for vehicular networks.

Safety of human lives is a priority in every nation. The United Kingdom is not an exception to this issue regarding road safety. The UK Department for Transport had 247,780 casualties in 2007 [1,15]. Due to many reasons such as reckless, vehicle mal-function, higher drunkenness and other acts of God contributes to accidents in various countries as a daily affair and these results to a greater percentage of death rate in each country. Vehicular communication is a promising technology to the problem of road safety. This may be vehicle to vehicle (V2V) or vehicle to infrastructure communications (V2I).

DSRC is the communication standard for V2V and V2I radio frequency communication links [1]. It supports the intelligent transportation systems (ITS) application, designed to offer complete solution for mobile data broadcast and also to active WAVE protocol [1]. DSRC supports both safety (control channel) and non-safety (service channel)to enable its effectiveness. Vehicles must be able to switch between control (CCH) and service (SCH) channels several times a second. Both of these share the limited resources of DSRC. Control channel interval (CCHI) has direct impact on reliability, the larger CCHI, the lower collision probability.

Since the Federal Communication Commission (FCC) has recently allocated the DSRC licensed spectrum to reduce latency and enhance bandwidth to support V2V and V2I communications [2-3], there is certainty that in the near future, vehicles supporting wireless applications and computer technologies will drastically increase with more solutions to road safety such collision avoidance and braking detection through DSRC technologies.

Rate adaptation is a link layer mechanism critical to the system performance in IEEE 802.11 wireless local area networks (WLANs) [15]. This is the process that enables the best rate for the current channel condition to be selected. It is also one of the fundamental resource management issues for 802.11 devices which deal with channel dynamics. The goal is to maximize the throughput via exploiting the multiple transmission rates available for 802.11 devices and adjusting their transmission rates dynamically to the time-varying and

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location dependent wireless channel conditions. A good rate adaptation scheme should be able to adapt the rate adjustment metrics.

IEEE 802.11 protocol specification allows multiple transmission rates at the physical (PHY) layer using different modulation and coding schemes. 802.11p offers eight different bit- rates ranging from 3 to 27 Mbps from which the transmitter can choose.802.11p is based on orthogonal frequency division multiplexing (OFDM) to compensate for both time and frequency-selective fading [2] and is very similar to 802.11a in that it uses 5.2 GHz while the latter uses 5.85-5.925 GHz. IEEE 802.11p has more emphasis on reduced channel spacing (10 MHz instead of 20 MHz in 802.11a). Analysis of IEEE 802.11p MAC sub–layer is an important and challenging problem.

Several rate adaptation algorithms [2][6][7][8][9] have been proposed in the literature. However most of them are based on either static scenario and using the MATLAB platform or with mobility by using C language with ns-2 and with indoor experiments. The majority of work published on rate adaptation has been on static scenario and experimental measurements of metrics. Vehicular network has distinguishing behavior either with indoor or outdoor or with static and mobility models. In this paper we have demonstrated the impact of context information on existing rate adaptation algorithm; ONOE, AARF, SampleRate and CARS with mobility model using MATLAB.

There are two basic problems faced by existing rate adaptation algorithms [2]. The first is that they depend on packets being continuously transmitted in order to calculate the packet loss estimate. And the second is the delay in estimation as a result of using estimation window.

The major contributions of this paper are:

- We show by means of mathematical analysis and simulation why some rate adaptation algorithms underutilize the link capacity in vehicular networks;
- We design, implement and analyze adaptive and context aware data transfer protocols that adapts to fast changing link conditions specific to vehicular networks;
- We design, implement and analyze adaptive and context aware data transfer protocols with power control and access point coordination.

The rest of the paper is organized as follows: section 2 is literature review, while section 3 deals with vehicular communication, section 4 is mathematical modeling, simulation setup is in section 5, while in section 6 we designed and implemented adaptive context aware rate selection algorithm was discussed, section 7 deals with result and analysis, discussion and future work is in section 8. Finally, section 9 concludes the paper.

II. LITERATURE REVIEW

Auto Rate Fallback (ARF) [10] was proposed as far back as 1996, as the simplest and first rate adaptation algorithm, other popular existing rate adaptation in wireless networks are ARF [11] , Adaptive Auto Rate Fallback (AARF) [11], ONOE [10], SampleRate [8], Context –Aware Rate Selection (CARS) [2] etc.

In ARF the decision whether to increase or decrease the transmission rate is based on the number of consecutive successfully or unsuccessfully transmission attempts respectively. This algorithm is widely adopted because it is simple. In this algorithm, the sender tries to send a packet at a higher rate after a fixed number of continuously successful transmissions at a given rate. The sender decreases the rate after one or two consecutive failures. If the probe packet is successful, the next packet will be sent at higher rate and if not, the sender will immediately lower the rate. The sender also lowers the rate after two consecutive failures.

The aim of ARF is to adapt to changing channel condition and take advantage of higher bit-rates. AARF algorithm is similar to ARF but distinguishes from it with the number of consecutive successful transmission attempts before trying the higher rate and increases exponentially every time the higher rate transmission fails. AARF performs better than ARF in case of single-user scenarios, but it has the same problems as ARF in a multi-user scenarios. It will instead wait exponentially longer before increasing the bit-rate if no other packet failures occur.

ONOE is a very slowly adapting algorithm whose implementation is available in the MADWifi driver code [10]. It tries to change the rate after one second interval. It is a credit based algorithm that maintains the credit score of the current rate for every destination and after the end of a second it calculates the credit and makes the rate change decision. It decreases the bit-rate when the packets need at least one retry on average and increases the bit-rate when less than 10\% of the packets require a retry. The problem with ONOE is that it is conservative because it does not increase the current transmission rate when it detects good channel quality, but waits until the credit value reaches the threshold.

In [8] SampleRate algorithm was proposed with the goal to maximize throughput in wireless networks. It is based on transmission statistics over cycles. In every tenth packet data, it picks a random rate that may do better than the current one to send the data packet. If it occurs that the selected rate provides smaller transmission time, it will switch to this rate. SampleRate eliminates those rates that cannot provide better performance than the current one by reducing the number of rate it must sample. It takes the highest rate when it starts and stops using a particular rate as it experiences four successive failures. It periodically sends a number of data packets as sample packets, at a certain rate other than the current rate to gather its statistics so that it can make a decision on appropriate rate selection.

Furthermore, in [2] another rate adaptation algorithm was proposed, CARS performed better in stressful scenarios since it adapts bit-rate faster as channel condition changes. It was also observed that CARS exploits available higher data rates than ONOE, SampleRate that comparison was made with, and that using optimum higher data rates allows CARS scheme to reduce network load. The limitation in this scheme is that it lacks the ability to tune the estimation window size dynamically, using the context information and is not robust to adapt to shadowing effect available in wireless and mobile environments.

III. VEHICULAR COMNUNICATION

Vehicular communication can either be an Ad-Hoc network where all vehicles communicates with each other directly or infrastructure network where vehicles communicate via an AP as shown in figures 1 and 2 . The following conditions are applicable:

- Vehicles routinely broadcast their position, velocity and acceleration using built-in DSRC communication system;
- With the knowledge of nearby vehicles status, the on board DSRC alerts the driver of impending threats.

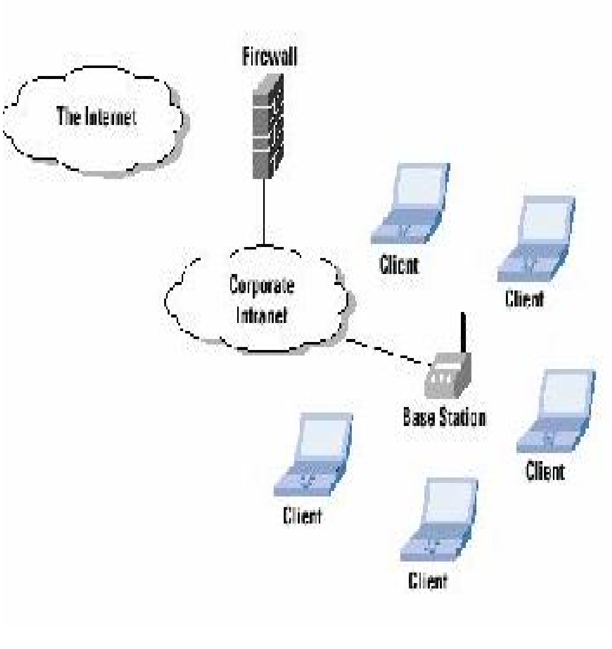

Figure 1. Typical IEEE802.11 Infrastructure network setup.

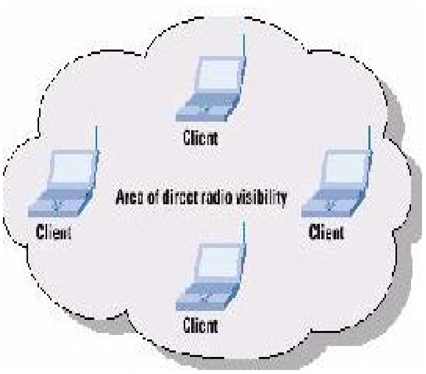

Figure 2. Typical IEEE802.11 Ad-Hoc network setup.

A. Data transfer

Vehicles transfer data to and receive from the road side unit (RSU) that acts as the server. All clients in a V2I serves as clients,by sending data to the RSU while they upload information from the RSU. Context information used by vehicular application is handled by the application layer and then the link layer takes responsibility of past frame transmission statistics. Rate changes is handled by the medium -access control (MAC) layer, where decisions and conditions on when rate changes should take place due to channel condition is all controlled by this layer.

IV. MATHEMATICAL MODELLING

In order to understand and model the behavior of this network, some mathematical analyses were carried out. Some of them include:

- Calculating the distance between the vehicle and AP as seen in equation (3);
- Empirical free space Path loss shown in equation (5);
- Shadowing effect expressed in equation (10) is added to received signal in equation (4).

If vehicles moves at a certain speed v at a time t, then the distance for both x and y axes can be represented below:

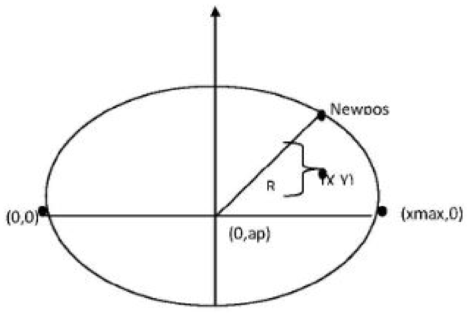

Figure 3. How Vehicle Position is generated.

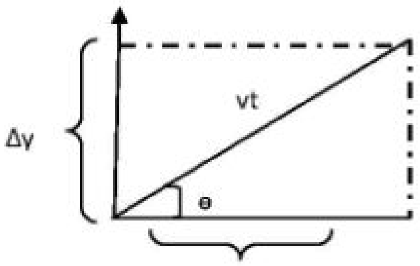

Figure 4. How to Calculate Vehicle Position from co-ordinates.

$$\Delta x = vt\cos\theta \quad (1)$$
$$\Delta y = vt\sin\theta \quad (2)$$

Therefore, distance between vehicle to vehicle or vehicle to AP can be determined by using equation (3). Furthermore, vehicles in communication range and those out of range can also be determined with the following equations.

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + \cdots + (x_n - y_n)^2} \quad (3)$$

$$I(v_i) \triangleq \begin{cases} 1 & \text{if } v(i) \text{ is within communication range} \\ 0 & \text{otherwise} \end{cases} \quad (4)$$

$$\text{Ntotal in commn range} = \sum_{i=1}^{N_{total}} I(v_i) \quad (5)$$

$$\text{Ntotal not in CommRange} = \text{Ntotal} - \text{Ntotal in CommRange} \quad (6)$$

$$\text{Ntotal not in CommRange} = \text{Ntotal} - \sum_{i=1}^{N_{total}} I(v_i) \quad (7)$$

If C is a class of vehicles in communication range, then from equation(7) that $v_1 \ldots v_n$ will be an element of C.

$$(v_1, v_2, \ldots v_n) \in C$$

Equations (7-11) are used as a counter to determine the number of vehicles in communication range and those outside the communication range.

A. Geometry of the Simulation Model

From the following figures 4,5 and 6 ,the distance between vehicles and AP is calculated which is shown in equation(6), with respect to figure 2. The distance L affects the received signal power level within the affected wireless network. While the distances d and e affect the interference power level received at the affected wireless network (AWN).

Algorithm 1 Dynamic Transmission Range Algorithm

```
a is a constant
N = $T_s$
T
$M_R$ is maximum transmission range
Ts
T is fraction of time stopped
K = estimate$_K$ (N) (19)
Input: $T_s$
T
Output: $T_R$
if $T_s$
T == 0 then
$T_R = M_R$
else
Calculate
TR = min($M_R$ *(1 - k), $\sqrt{\left(\frac{M_R * \ln(M_R)}{k + a * M_R}\right)}$
end if
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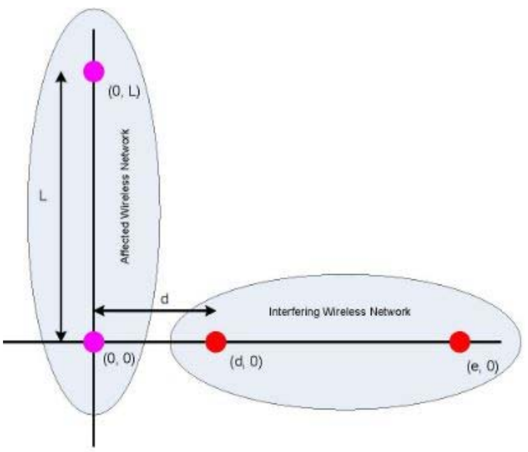

Figure 5. Geometry of the Network [16].

B. Free Space Path Loss

Free space Path loss model is a power off those relatives to distance. Due to high mobility of vehicles as speed changes, the distance between the transmitter and receiver changes. This makes empirical free space path loss necessary in order to model the effect of distance on packet delivery probability. This space loss accounts for the loss due to spreading of Radio Frequency (RF) energy as transmission of signals propagates through free space. From the equation of path loss, it is seen that the power density is reduced by $\frac{1}{R^2}$ as distance is increased.

$$L_{\text{emp-freespace}}\,[\text{dB}] = 10\log10(16\pi^2 d\alpha^2/\,\lambda^\alpha) \tag{8}$$
$$\text{Ptx} = 10*\log10\,(\text{Phy.power}*103) \tag{9}$$
$$\text{Prx} = \text{Ptx} - \text{Lemp-freespace} \tag{10}$$
$$\text{Prx} = \text{Ptx Lemp-freespace} + \text{Xsigma} \tag{11}$$
$$\text{Prx} = \text{Ptx} - \text{Lemp-freespace} + \text{Ysigma} \tag{12}$$
$$\text{Snr (dB)} = \text{Prx-Pnoise} \tag{13}$$
$$\text{Prx}=\text{Ptx}\,(\lambda 0/\,4\pi R)2 \tag{14}$$

where λ is wavelength in meters,d is distance in meters Lemp-freespace is empirical path loss, Prx is received power, Ptx is transmit power in milliwatts Pnoise is noise power in dBm,Phy.power is normalized transmit power in milliwatts and α is alpha, Xsigma is shadowing and Ysigma is fast fading added to the received signal.,Ptx (λ0/ 4πR2) is the power density.

In free space,the power of electromagnetic radiation varies inversely with the square of distance, making distance an ideal indicator of signal level as well as loss rate. Due to imperfect propagation environment, in practice it is not exactly the inverse square. Distance between sender and receiver gives a high correlation between signal level and error rate as this affects the number of transmitted packets that will be received [16].

C. *Power Control on Context Information*

The level of received power affects the quality or level of signal for transmitted packets, it is similar to the effect that distance has on the signal, as vehicles move aware or close to the AP. The path loss of a wireless link can be represented by the difference between the transmit power Ptx and receive power Prx.

$$\text{Path Loss} = \text{Ptx} - \text{Prx} \tag{15}$$

$$\text{PTx opt} = \text{Path Loss} + \text{Pthresh} \tag{16}$$

In practice, since the lower limit of the transmit power is 0 dBm, PTx opt is the minimum of 1 mW as shown in equation (16)[18].

D. *Shadowing Effect in Mobile Environment*

In wireless communication design, it is very vital to predict what type of fading that may occur and providing remedies to it if it possible, and where remedies may not be possible it is important to predict the likelihood of the outage. In order to get a more realistic received power, it is important to model or add to the system, the effect of shadowing which occur as a result of the presence of obstacles and tall buildings that may interfere with the reception of the signal from the transmitter to the receiver. It is very obvious, that tall buildings and trees are the basic interferers of signals in vehicular communication. Therefore it is necessary to consider them when estimating received power. Furthermore, shadowing effects are usually incorporated into path loss estimates by the addition of a zero-mean Gaussian random variable, with standard deviation δ which values can be chosen between 6 dB and 12 dB.

The shadowing effect is described from equation (1) as log-normalised distribution.

$$\text{P(x)} = \frac{1}{\delta\sqrt{2\pi}} * \exp\frac{-(x-m)^2}{2\delta^2} \tag{17}$$

where m is the mean value of the signal strength and x is the threshold. We have simulated with a value of 8 dB (6.309573445) converting it to decimal from equation (16) which is added to Prx in equation (11) to implement shadowing.

E. *IEEE 802.11p and DSRC*

DSRC is the communication standard for V2V and V2I radio frequency communication links. Both support the intelligent Transportation Systems (ITS) applications. It is designed to offer complete solution for mobile data broadcast and also to active WAVE protocol. DSRC is a short to medium range communication service that supports applications like: electronic toll collection and public safety, which needs high data rate and low latency.

F. *IEEE 802.11p Physical (PHY) layer*

The PHY is responsible for transmitting raw bits in wireless channels and this is achieved via channel assignment. IEEE 802.11p is an extension of 802.11 Wireless LAN medium access (MAC) and physical (PHY) layer in order to add WAVE Three different PHY Layer mode has been defined by 802.11-2007 standard. They are the 20 MHZ, 10 MHZ and 5 MHZ. These modes can be achieved by using a reduced clock/sampling rates. It can be used by Advanced Driver Assistance (ADAS) and Intelligent Transport System (ITS). 802.11p is OFDM –based to compensate for both time and frequency-selective fading and is very similar to 802.11a in that it uses 5.2 GHz while the later uses 5.85 - 5.925 GHz. IEEE 802.11p has more emphasis on reduced channel spacing (10 MHz instead of 20 MHz in 802.11a).

IEEE 802.11p allows the use of frequencies at 5.8 GHz using only the OFDM bit-rates [8,17] which are a variation of the IEEE 802.1a standard. It has 10 MHz frequency and uses a half clock mode out of which 20 MHz is used by IEEE 802.11p so as to accommodate tolerance for multi-path propagation effects caused by both constructive and destructive interference and phase shifting of the signal and is optionally implemented. The IEEE802.11p PHY employs 64-sub-carrier OFDM, out of which, only 52 is used for actual transmission consisting of 48 data sub-carriers and 4 pilot sub-carriers [3][15].

G. Medium -Access Control (MAC)Layer Modelling

The function of MAC layer is to coordinate the use of the communication medium.MAC layer protocol decides which node will access the shared medium at any given time. There are two methods used in IEEE 802.11 to determine if the medium is idle or not. The physical carrier sense multiple access with collision avoidance (CSMA/CA) does not rely on the ability of stations to detect a collision by hearing their own transmission; an Acknowledgement (ACK) is transmitted by the station- to -signal the success of the transmitted packets and then transmission of ACK is immediately done following the received packets after a short interframe space (SIFS).

The packet is re-scheduled if either the transmission of a different packet or if the transmitting station does not receive the ACK within a specified ACK-Timeout is detected [5]. When a node wants to transmit a packet, it will wait until the medium is idle for at least a distributed inter-frame gap (DIFS) and then it will pick a random time within its back-off window and waits until this time expires. In case the medium has been idle during the entire back-off period, it will send packets and resets the back-off window to the minimum value. Otherwise, it doubles the back-off window and waits until the medium is idle for at least a distributed inter-frame gap (DIFS) period of times, and then begins the back-off period again.

H. Enhanced Distributed Coordination Function (EDCF)

This mechanism clearly differentiates between 802.11 and 802.1e wireless standards. It is able to provide a differentiated channel access to frames with different priorities. This exhibits an optional feature called the contention-free burst (CFB) that enables multiple MAC frame transmissions during a single transmission opportunity (TXOP).With this new scheme, multiple queues can work independently with a single MAC which is not available in distributed coordination function (DCF) mechanism.

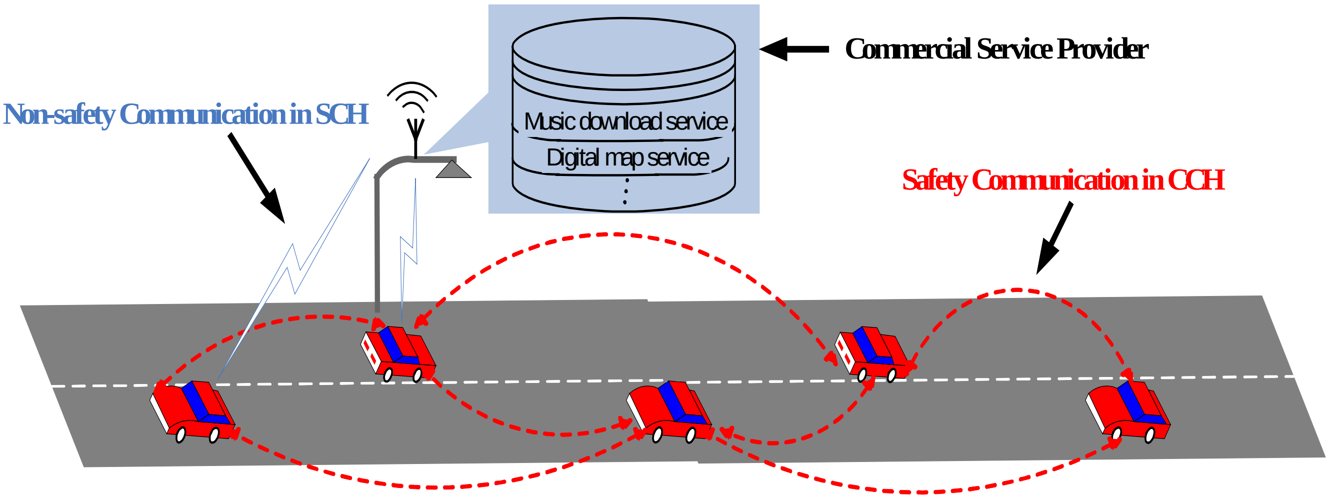

Figure 6. Co-existence of safety & non-Safety Application.

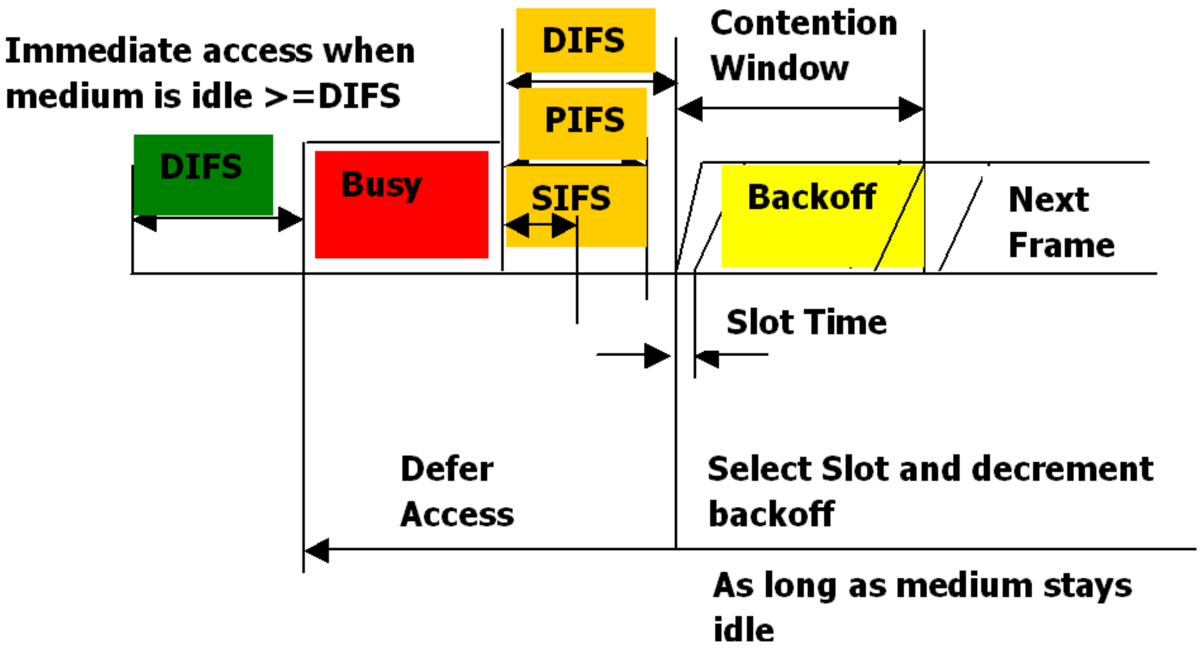

Figure 7. EDCA Prioritized Channel Access.

Furthermore, in this scheme, a station cannot transmit a frame that goes beyond a time interval called EDCF transmission opportunity (TXOP) limit. EDCF is not a separate coordination function but part of a single coordination function known as hybrid coordination function (HCF) that combines both attributes of DCF and point coordination function (PCF). Improvement on DCF mechanism led to EDCA which ensures traffic prioritizations (such as voice, video, best effort, background).

V. SIMULATION SETUP

Simulation was carried out using MATLAB by implementing a V2I network so that analysis of AP coordination for data transfer protocol and Context information can be evaluated. In mathematical modeling and calculations used in this paper were all implemented and used in our simulations. To ensure accuracy of result, simulation was done to 4 iterations and for a highly dense network of 150 vehicles.

A. Vehicle-to Infrastructure (V2I)

In this scenario, all vehicles act as clients while the RSU is acts as the receiver. Vehicles generates their positions randomly ,while distance between vehicles and AP was calculated from equation (18). Our scenario consist of a road length of 100 m with a communication range of 300 m. Other parameters for this scenario are shown in table 1.

All vehicles starts at the same time at the beginning of the road, and establishes connection once in range with the server(AP) which is located at the middle of the road, known as RSU . Vehicles selects speed uniformly over this range and to ensure that all vehicles were within 0 and x_max (length of high way), a modular function was adopted in this implementation in our mob_model function.

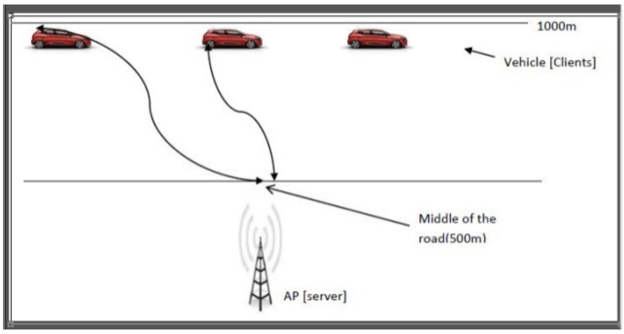

Figure 8. Vehicle- to infrastructure communication.

ConstSpeedMobility model is used so that vehicles can move along a line with constant speed to a randomly chosen target, and when the target is reached it selects randomly a new one. It is used so as to model the randomize position and also helps calculate a new target position the vehicles will move to, get distance and when next the vehicles can change speed.

This algorithm is robust to wireless and mobile environment as it is able to over the challenges of short duration, fast change in link condition and underutilization of link capacity which affects other schemes from selecting the optimum data range.

By using the optimum higher data rate, ACARS is able to reduce network load and congestion as some vehicles depart from communication range, thereby improving the throughput of the network.

We used same Speed_avg as in [2][17] which is 55Km/h,and simulated for different number of vehicles. We also calculated the distance between vehicles and AP by using the distance equation between two points, so that number of vehicles in communication range can be counted using equation (5) and those out of communication range in equation (6). Parameters used in this simulation are listed in Table 1.

$$[\ Speedavg*0.75,\ Speedavg\ *1.25]Km/h \quad (18)$$

TABLE 1. CONFIGURATION PARAMETERS

Parameters (Units)	Values
Length of Road (m)	1000
Number of vehilces	150
Position of AP (m)	500
PHY and MAC Protocol	802.11p
Frequency (GHz)	5.89
Normalized Transmit Power (mW)	40
Noise Power (dBm)	-90 [4]
α	2.0
α (dB)	8 (6.309573445) in decimal
Communication Range	2.0
	300m

TABLE 2. MAC PARAMETERS

Parameters (Units)	Values
DIFS (µs)	50
SIFS ((µs)	30
HPHY (bits)	192
HMAC (bits)	200
Data rate (Mbps)	3, 4.5, 6,9,12,24,27
Maximum Retransmission	3

VI. ADAPTIVE CONTEXT AWARE RATE SELECTION ALGORITHM

This section describes the design, analysis and implementation of ACARS that adapts to high mobility of vehicular environments using data transfer protocol and AP coordination to achieve a high throughput performance even in the presence of shadowing effect. This algorithm makes use of an empirical model in addition to path loss and shadowing to learn the effect of context information on packet delivery probability by using the function mob_model (t,v,old_pos,ap,commRange,n,x_max)) in algorithm 2 and equation (11)

A. Overview of Algorithm

The basic concept of this algorithm is summarized in figure 5 and simulation model in algorithm 2.

Algorithm 2 The Adaptive Context Aware Rate Selection Algorithm

```
Input: ctx, α,len
Output: rate
Requires : Position of Vehicles
Requires : Speed of Vehicles
Check : if Vehicle(s) is in Communication Range
Initialize : the Positions of the Vehicles
Determine : new Positions of the Vehicles from equation(1; 2)
Determine : the distance of the Vehicles from equation(3)
Determine : the Vehicle(s) in Communication Range from equation (5)
Requires : mobmodel(t; v; oldpos; ap;CommRange; n; xmax) for Context information
MaxThr ⩽ 0
BestRate⩽ MINRATE
for all rate do
    PER = min(1; exp(polyval (Phy:power); SNRtemp)
    avgretries = $\frac{Rate}{avegretries\ (1-PER^{N})}\rho$
    if Thr > MaxThr then
        BestRate ⩽ bitrate
        MaxThr⩽Thr
    end if
end for
Return BestRate
```

Context information such as speed, distance, number of vehicles in communication etc is used by ACARS to estimate packet delivery probability. The vehicles also known as mobile nodes (MN) uses information from application layer available from each MN, then the MAC layer handles the rate selection algorithm .SNR was calculated for different bit-rates which helps in the Calculation of true value of packet error rate (PER),instead of estimation as used by [2] by using an interpolation of bit error rate (BER) table generated during simulations as expressed in Algorithm 1 in line 12 and finally, the algorithm determines the bit-rate that gives the maximum throughput.

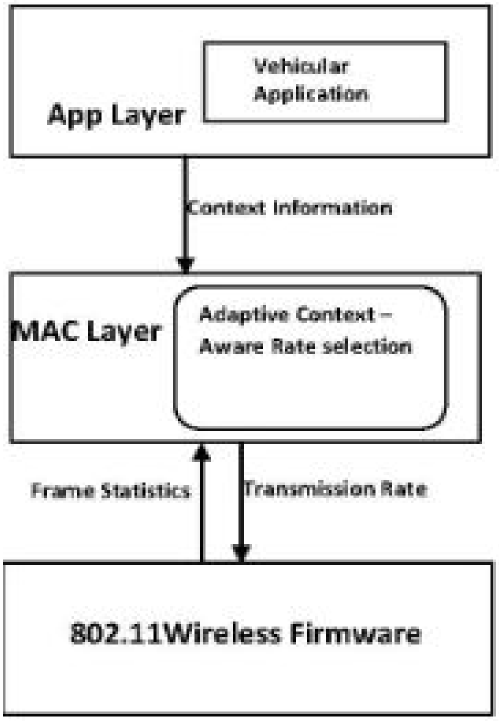

Figure 9. Overall structure of ACARS.

B. Design and implementation of Adaptive Rate Selection Algorithm

Our proposed algorithm is built on the fundamental principles of CARS as in [2]. We have evaluated a more realistic scenario in a mobile environment, taking into considerations issues such as path loss and shadowing effect which are prone to wireless and mobile environments.

Mathematical modeling and simulations were adopted to achieve these results. In CARS, shadowing was not considered, which was implemented in our simulation and results shows improvement better than CARS. In this implementation, ConstantSpeedMobility model was implemented where vehicles updates their velocity with respect to time and distance by calculating a random position and also schedules a timer to trigger the first movement if vehicle in not stationary.

VII. RESULT AND ANALYSIS

Throughput is one the most important metrics analysis that determines the true state of any network in terms of transmission and reception of packet. This can also be used to predict the signal strength of the network.

We have simulate in MATLAB existing popular rate adaptation algorithms to show the impact of context information on these rate algorithms. From our results, it shows that context information such as distance, speed, and number of vehicles has impact on the throughput and metric performances such as collision probability, delay, jitter, energy efficiency, success probability etc. On rate adaptation algorithms. We modeled the effect of distance on packet delivery probability using free space path loss in addition to shadowing effect and result shows that throughput performance of ACARS is better than all of the other rate algorithms as shown in figure 9.

This shows that ACARS is more robust than the others, since it performed better in the presence of shadowing which other rate algorithms could not perform. This was achieved by using a true PER as opposed to estimated PER used in [2] with addition of shadowing.

The efficiency of power and control of energy can be improved in wireless channel by two ways. The first is to reduce the transmission rate and the second is to reduce the communication range.These two ways of improving energy efficiency in wireless channel is shown in algorithm 2.Lowering the transmission rate is not always possible since some messages are required to be received within a specified time period, but reduction of transmission rate is the greatest change of increasing the throughout.

In this simulation, ACARS is robust that even in a communication range of 300 m, the energy efficiency still show a good result. It performed very well even at a high communication range that many literatures have not being able to achieve a very good signal with, good signal reception. Figure 9 shows that ACARS can adapt to power control and minimize usage of energy in mobile environments.

Collision rate or probability is controlled by the MAC layer using back- off counter. This decides when the next vehicle can transmit depending on the state of the medium, either idle or busy using $SIFS$ and $DIFS$ respectively. In figure 11, the rate of collision for all algorithms shows no much difference, that is why they all seems to overlap, but from vehicles greater than 100, ACARS has the lowest collision probability as seen in the plot.

VIII. DISCUSSION AND FUTURE WORK

In this section, we discuss some issues in implementing this research with a simulation tool as compared to when experimental analysis and measurements are do.

A. Robustness To Errors in Context Information

In [2], GPS device was used to supply information about the MN,but with the GPS outage in tunnels, tall building, etc. weight is reduced when this occurs and rate selection will be purely done using an exponentially moving average (EWMA).

We are rather interested in using the information available with only vehicles in communication range. This gives us the impact of context information with MN in range and those out of communication range in vehicular communication. We are studying the impact of pre and out-communication status of MNs.

C. Doppler Effect and Fading

Doppler effect is the corresponding changes in frequency produced as a result of moving object at significant speeds. It is usually heard when an emergency vehicle passes an observer at a high speed .Although this is one of the factors that affects mobile communication.

Fading occurs when distance between either a V2V or a V2I varies. As vehicles acting as transmitter moves away from the server, it results to fading of signals because packets will be dropped result to errors in received packets. Both of these effects were not implemented in our simulation. We are investigating the impact of shadowing and fading on vehicular networks.

IX. CONCLUSION

In this paper, we showed that other existing rate adaptation algorithms underutilize wireless link capacity in vehicular environments, by introducing an adaptive context aware rate selection (ACARS) algorithm that adapts to wireless and mobile channels with both path loss and shadowing effect and gives more realistic results and improvements compared to other algorithms.

In this simulation, other algorithms, could only perform well in the presence of path loss, but could not for shadowing except ACARS. Path loss is not effective in a practical scenario but only on ideal scenarios, this is because the value of α chosen as 2 from literature cannot always be 2 in all cases, it can take values between (2-4). Our algorithm performed better because it works well in the presence of both path loss and shadowing which other algorithms cannot perform well.

We have shown:

- The effect of context information on packet delivery;
- How data rates can adapt to fast link changing conditions as vehicles moves at varying speed;
- The performance of ACARS in a congested environment where the wireless nodes contend for medium access;
- The performance of ACARS with power control and access point coordination

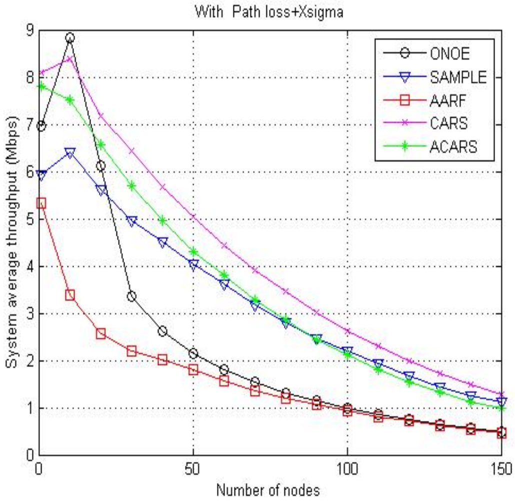

Figure 10. Impact of shadowing on Rate algorithms .

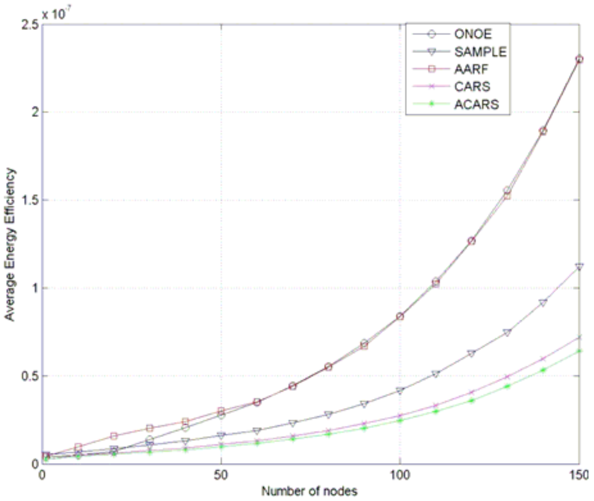

Figure 11. Impact of fading process on Rate algorithms.

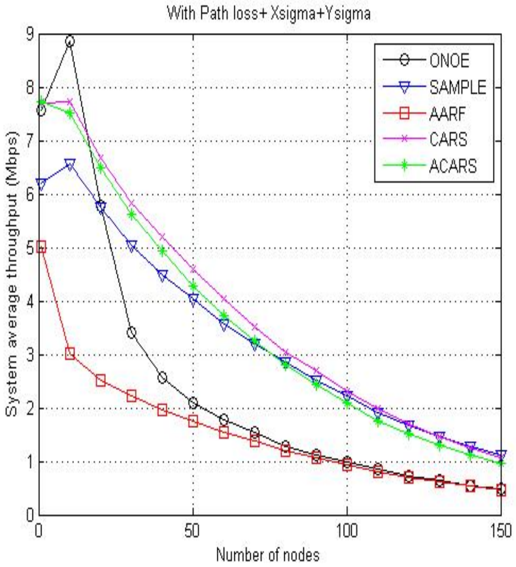

Figure 12. Effect of fading process on energy efficiency.

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