Improving Performance of 802.11n Networks Using Various Rate Adaption Algorithms

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***Abstract* — In a WLAN subject to variable remote channel conditions, rate adjustment assumes a critical part to more productively use the physical connection. Rate adjustment is a MAC-layer instrument in IEEE 802.11 systems to guarantee proficient usage of fluctuating remote channel. Traditional 802.11 rate adjustment calculations depend on input from the recipient to accurately pick a sending rate, commonly as affirmations (Acks). Without such casings, novel strategies are needed for rate choice. In this paper, the accompanying progressed rate adaption calculations are exhibited:**

a. MAC-Layer Loss Differentiation based rate adaption algorithm
b. High TCP Performance rate adaption algorithm
c. Video-Aware Rate Adaption For HD Video Streaming

***Index Terms*—IEEE 802.11, WLAN, Rate Adaption, ARA Algorithm, DCF, Loss Differentiation, Automatic Rate Fallback.**

I. INTRODUCTION

The utilization of remote neighborhood (WLANs) in homes, work places, and open regions has been spreading rapidly. The overwhelming WLAN benchmarks have been characterized by the IEEE 802.11 working gathering, with their prosperity moved by the Wi-Fi Alliance [1] [2]. Most IEEE 802.11 WLAN gadgets utilize the dispersed Coordination Function (DCF) tagged in the standard [2] to arrange channel by the transporter sensing access with impact evasion . In DCF, when numerous edges are transmitted all the while by distinctive stations, an impact happens, which annihilates all the transmitted casings. To resolve impacts, the stations utilize a twofold opened exponential backoff calculation and retransmission plan. Two right to gain entrance methods are characterized in 802.11 DCF, the default fundamental access and the discretionary RTS/CTS access. Current WLAN items help more than one regulation sorts and information rates. For instance, in 802.11b, 4 information rates, 1 Mbps, 2 Mbps, 5.5 Mbps, and 11 Mbps, are upheld [3]. On the other hand, a higher information rate does not so much yield a higher throughput. When the channel condition is great, a higher information rate gives a higher throughput. In a practical WLAN environment, the channel condition can fluctuate progressively because of multi-way impedance, and developments of stations, and so forth. To oblige diverse channel conditions, rate adjustment (or auto rate) is normally utilized. This is acknowledged by rate adjustment calculations that modify the regulation mode and information rate to upgrade execution when channel condition changes.

Today, features overwhelm Internet activity and by 2015 it is anticipated that about 50% of the feature movement will be 3d or 2d High Definition (HD) [26]. A high portion of HD feature movement will be devoured by clients that get to Wireless Local territory Networks (Wlans) in homes, ventures or open spaces. This vision is energized by two noteworthy engineering patterns. In the first place, late feature streaming innovation benchmarks, for example, H.264/MPEG-4 section 10 AVC [27] lessen HD feature data transfer capacity necessities utilizing Variable Bit Rate (VBR) feature encoding. Second, the IEEE 802.11n [28] WLAN standard offers high remote physical-layer (PHY) information rates (up to 600 Mbps) utilizing Multiple-Input Multiple-Output (MIMO) reception apparatus advances. Notwithstanding these advances, the issue of streaming HD feature in Wlans is a long way from being explained. VBR advances lessen the normal feature streaming rate by effective encoding of moderate moving scenes. On the other hand, the top rate stays high as it is dictated by the full quality encoding of quick movement scenes.

In this paper, for the MAC-Layer based loss differentiation based method, a new auto rate algorithm calledloss-differentiating-ARF (LD-ARF) that is suitable for arealistic WLAN environment where both collision losses andlink error losses can coexist is discussed. Its effectiveness is demonstrated through extensive performance evaluations.

For High TCP Performance algorithm, an efficient and practical rate adaptation algorithm called Advanced Rate Adaptation Algorithm (ARA) is proposed and explained in detail. The key idea of ARA is to make use of the RTS control frame as the probe packet. RTS control frame has several characteristics that make it suitable for such use.

Next For HD streaming, VARA, a Video-Aware Rate Adaptation protocol is used, that optimizes wireless channel probing and PHY rate selection by exploiting the VBR streaming rate information of a video. VARA eliminates the channel probing impact on the video stream by scheduling the probes during the low streaming-rate periods. Furthermore, rather than aggressively trying to find the maximum PHY rate supported by the wireless

channel (like all existing 802.11 rate adaptation protocols), VARA selects the most reliable PHY rate that supports the near-future peak streaming rate. To further reduce the probing overhead, VARA monitors the Frame Error Rate (FER) and adapts probing frequency to the measured wireless channel variability.
The organization of the remainder of this paper is as follows. In Section II, a new loss differentiating ARF algorithm is proposed. The new algorithm involves MAC layer changes only. In Section III, several guidelines for designing an efficient rate adaptation scheme for IEEE 802.11 networks are given and explain the proposed algorithm and how ARA is implemented is explaned .In Section IV, the design of VARA and the multiplexing techniques are presented. In Section V, the conclusion of this paper is given.

II. DESCRIPTION OF LOSS-DIFFERENTIATING ARF ALGORITHM

measures.

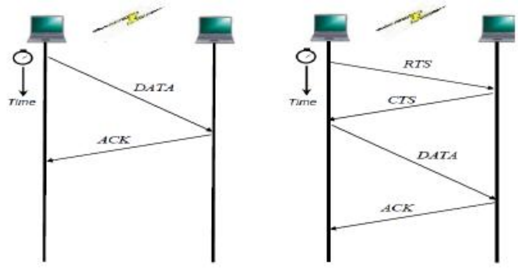

Figure 1. Basic and RTS/CTS access in 802.11 DCF

In this area, firstly, the real idea of this convention is assessed. At that point the LD-ARF calculation, which joins the misfortune separating MAC and the current ARF calculation, is proposed. The following segment will assess its execution.

A. Loss Differentiating MAC Protocol

The misfortune separating MAC layer convention is expected as an improvement of the 802.11 DCF. There are two right to gain entrance methodologies in DCF, fundamental and RTS/CTS. Figure 1 delineates the two right to gain entrance techniques. The alteration to the DCF in the new convention includes both essential and RTS/CTS access techniques. RTS/CTS is a noncompulsory emphasize in a 802.11 WLAN and it is helpful when the information casing size is extensive, the quantity of stations is huge, or there are concealed terminals. It is a 4-way handshake method as indicated in Figure 1. The misfortune separation system in the RTS/CTS access method is clear and the 4-way message trade grouping is not transformed: (i) If both the CTS and afterward the ACK edges are gotten at the sender, the transmission was effective. (ii) If the CTS edge is gotten however the ACK casing is not, the transmission has fizzled, in all probability because of a connection mistake. (iii) If the CTS edge is not gotten, probably a crash has happened. Since RTS and CTS are short and generally transmitted at a low rate, the misfortune separation can be very powerful. Essential access is the default get to in 802.11 DCF. It is a two-way handshake method (see Figure 1). As a rule, e.g., when there is no concealed terminal, the default essential access is more effective than RTS/CTS access. The misfortune separation for essential access is not as direct as that for RTS/CTS access. In the first essential access method, just when the got information casing is right, is an input message (ACK) sent. At the point when the got information casing is in blunder, the recipient does not give any reaction. As clarified beforehand, two reasons, i.e., a crash or connection blunders, may cause a mistaken edge gathering in the essential access technique, and the sender can't separate between these misfortune components and take

Thusly, a component must be consolidated so that the recipient can focus the reason for a fizzled gathering and advise the sender. One of the favorable circumstances of the new misfortune separating MAC layer convention is that the change to the standard DCF capacity has been minimized. No alteration to the PHY layer is required. In this way the convention is not difficult to execute.

B. Loss Differentiating Automatic Rate Fallback Algorithm

It has been clarified that when an impact happens, the information rate ought not be lessened. In this manner the adjustment to the ARF calculation is that the information rate is decreased just when a loss of information casing is brought about by connection slips

- If an *ACK* is received (the transmission is successful) or rate-up timer expires, then,
  counter_downrate= 0;
  counter_uprate++;
  If (*counter_uprate*≥N_{up})
  {
  physical rate is increased;
  counter_uprate= 0;
  rate-up timer is stopped.
  }

- If a *NAK* is received (a link error loss is detected), then,
  counter_uprate= 0;
  counter_downrate++;
  If (*counter_downrate*≥N_{down}) or the rate was just increased
  {
  physical rate is reduced;
  counter_downrate= 0;
  rate-up timer is started.

}

The Gilbert-Elliot channel model has been broadly used to model remote channels subject to blast mistakes. Estimations directed on the remote direct in an IEEE 802.11 WLAN demonstrate that the Gilbert-Elliot model gives a decent expectation of WLAN execution. To assess the execution of the proposed LD- ARF calculation under

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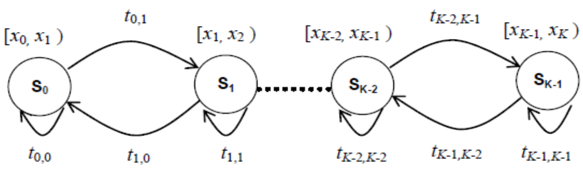
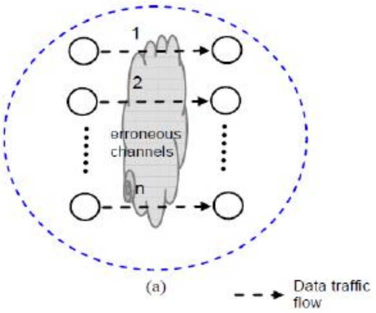
variable conditions and contrast and that of the ARF calculation, in this paper an augmentation model of the first Gilbert-Elliot model is utilized. It is a K-state Markov divert display as indicated in Figure 2. In the K-state show, the remote divert could be in one of the K states from S_0 to S_{K-1}. In each one state, Si, the relating SNR esteem at each one edge transmission is consistently taken from the scope of [xi, xi+1) db, where xi+1> xi. The visit time in each one state takes after an exponential appropriation (or if discrete time is utilized the comparable Geometric dispersion). This model is truly like the arbitrary walk model, which can be seen as the situation where the two imparting WLAN stations approach and leave haphazardly. In recreations, a 10-state channel model has been utilized. A modestly changing channel model has been viewed as where for each one state, Si,, the normal time span is 1 second, and the move probabilities ti,i-1=ti,i+1. For each one state, Si, the SNR values (in db) are consistently disseminated between [i, i+1]. Accordingly the conceivable SNR qualities created by this model are conveyed between 0 db and 10 db. IEEE 802.11b is utilized as a part of reproductions since it is the most generally utilized WLAN standard by a long shot. Additionally, its physical property has been settled in [11], [12], and [13]. Besides, the Wavelan-II item in which ARF was initially executed has comparable properties to 802.11b1. It is more serious to utilize the control parameter values given in Wavelan-II to analyze the execution of the auto rate calculations. In our reenactments for ARF and LD-ARF, this information rate is essentially circumvent.



In the reproduction situations, all stations are soaked, yet it is accepted that the conclusions got from the reenactment results are pertinent to non-immersed stations also. Expect there is no shrouded terminal and the stations are close enough that when they transmit outlines at the same time, the ensuing impact demolishes the casings included. The information outline payload size is 1000 bytes. The information outline blunder rate, the information outline MAC header lapse rate (HLR), and the control outline mistake rates are dead set individually by their sizes, their rates, and the SNR qualities created from the 10-state channe model when the casing is sent.



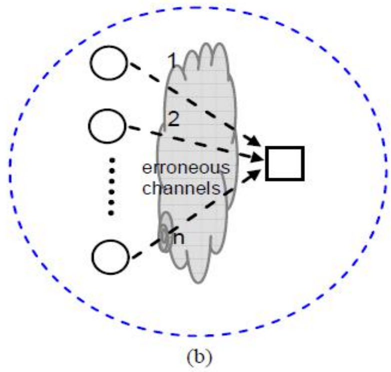
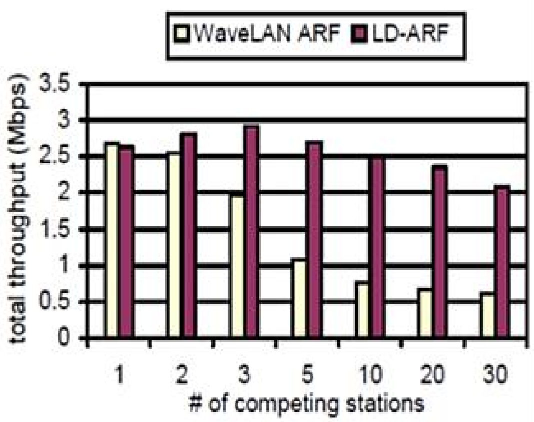


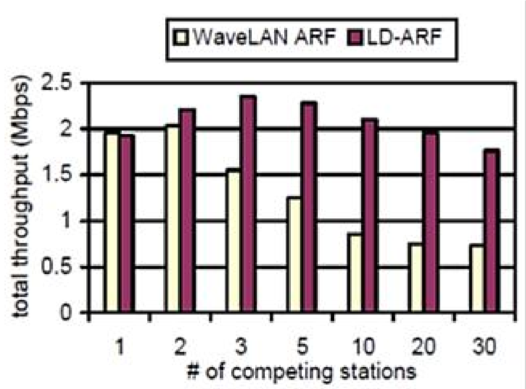
Figure 3. Two Different but performance equivalent WLAN topologies

The MAC header and body parts are transmitted at the same information rate. The essential rates for the control casings take after the principles given underneath. For a RTS outline transmission, its rate is the same as the sending station's information rate for an information outline. For ACK, NAK and CTS, their sending rates are the same as the rate utilized for the got information casing or RTS outline. Note that if the fundamental rate or the header part rate is lower than the information edge rate, the misfortune separating MAC convention can be more powerful. In this manner these settings may not yield the best execution for the LD-ARF. It is going to be demonstrated. The estimation of the rate-up clock was not suggested in [4]. As demonstrated in [7], over a wide range (from a few seconds to around one moment) the rate-up clock esteem does not have a critical effect on execution and the ensuing throughput is equivalent. In our reenactments, we don't put concentrate on this clock and essentially set its esteem to 10 seconds. A circumstance where all the WLAN connections encounter precisely the same channel state in the meantime (Scenario 1) is considered. It can be seen from Figure 3 that when there is stand out connection (i.e., one station sending activity), the two calculations produce comparative throughput. In any case, when there are numerous connections (i.e., various contending stations), the execution of the first ARF calculation debases significantly. At the point when the quantity of connections is 3, the execution change by the new LD-ARF over ARF is extremely noteworthy. At the point when the quantity of contending stations is huge, the new LD-ARF calculation yields more than twofold the throughput of the ARF calculation. In the accompanying situations, more reasonable circumstances where the channel conditions are autonomous are considered. In Scenario 2, each one connection encounters a channel condition that is resolved autonomously from the 10-state channel model. Figure 3 looks at the framework throughput of LD-ARF and ARF for fundamental access and RTS/CTS get to in Scenario 2. Like Scenario 1, when the quantity of contending stations is huge, the throughput change by the new LD-ARF calculation is more than 100%. Indeed so the LD-ARF can attain huge execution pick up over ARF.

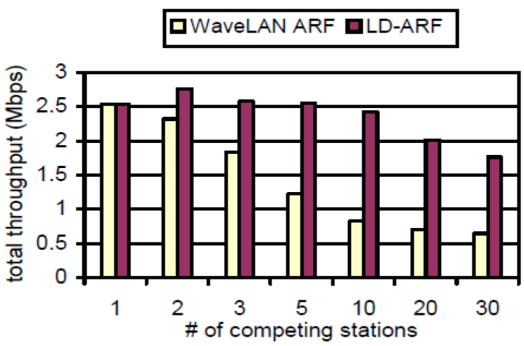


(a) Basic

Figure 4. Performance Comparision of Auto Rate algorithms-Scenario 1



(b) RTS/CTS



(a) Basic

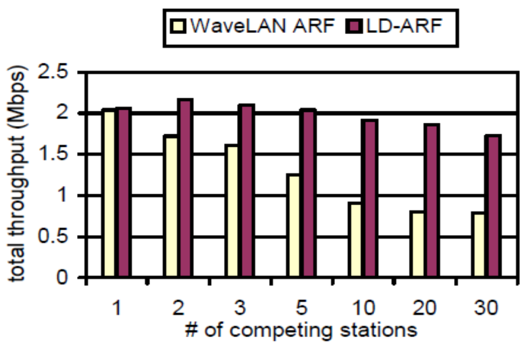


Figure 5. Performance Comparisons of Auto Rate algorithms-Scenario 2

III. DESIGN GUIDELINES AND ARA ALGORITHM

A. Design Guidelines:

- *Ability to Differentiate Frame Losses*

In IEEE 802.11 standard, RTS/CTS control casings trade is impaired of course to minimize overhead. Original rate adjustment plans treat all the casing misfortunes as from channel blurring and decline the information rate at whatever point the edge disappointment proportion achieves certain limit. In the event that an edge misfortune is created by impact, diminishing the information rate won't help take care of the issue yet exacerbate it. Lower transmission rate implies longer transmission time and more extensive show range, which will prompt more crashes and hence exacerbate things. A proficient rate adjustment plan ought to have the capacity to separate the casing misfortunes and react in like manner to these diverse reasons.

- *Ablility to Response to the Variation of Channel Fast*

A productive rate adjustment calculation ought to have the capacity to adjust the nature's domain changes quick, generally, the calculation may lose the chance to send the information outline at a higher rate or continue sending the information outline at a high rate where fruitful conveyance is impractical.

- *A Good Metric to Adjust Data Rate*

A percentage of the current rate adjustment plans alter the information rate by checking the continuous achievement and disappointment number. While this strategy is straightforward, it is not precise. As per RRAA, the likelihood to effectively transmit an information bundle taking after ten back to back victories is just 28.5%. What's more the likelihood of a disappointment in an information transmission after two continuous disappointments is just 36.8%. These insights demonstrate that the sequential achievement or back to back disappointment number ought not be utilized as the metric to conform transmission rate. Different plans utilize the sign to clamor proportion (SNR) as the marker to change the rate. Be that as it may, as per Sample Rate [23] and RRAA, SNR is NOT a decent marker of the channel condition and accordingly ought not be utilized as a part of the metric.

- *Compatibility with Current Commercial Product*

A functional rate adjustment plan ought to be good with current business item, which implies IEEE 802.11 standard can't be adjusted. A few existing rata adjustment plans [20], [21], [22] require the alteration of IEEE 802.11 standard and along these lines are not good with current business items. The over four rules provide for us some essential thoughts on the most proficient method to plan an effective and handy rate adjustment plan. The following area will talk about the proposed calculation in point of interest.

B. ARA Algorithm

In this area, a productive and down to earth rate adjustment calculation called Advanced Rate Adaptation Algorithm (ARA) is proposed and clarified in subtle element. The key thought of ARA is to make utilization of the RTS control outline as the test parcel. RTS control

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outline has a few qualities that make it suitable for such utilization. To begin with, it is little in size. As per the IEEE 802.11 standard, it is 20 bytes long. Contrasted with an ordinary information bundle, which is ordinarily bigger than 1000 bytes, a little parcel has a littler likelihood of impacting different parcels on account of its shorter transmission time. Second, RTS/CTS control outlines can save the data transmission. Consequently, a fizzled bundle transmission after a fruitful RTS/CTS trade must be created by channel corruption. ARA separates the edge misfortunes through the utilization of RTS control outline. At the point when an information outline transmission comes up short, a RTS control edge will be sent at the same rate as the fizzled casing. On the off chance that the CTS control edge can be gotten, then present channel condition has a high likelihood of supporting the current transmission rate. Consequently, the loss of the past information casing is created by crash. Then again, if the RTS/CTS trade is fruitful however the accompanying information casing falls flat, then the edge misfortune must be brought about by channel blurring. Through this strategy, ARA can correctly separate the edge misfortunes brought on by both channel blurring and impact. For the second rule, ARA utilizes a quick yet exact rate alteration instrument. As clarified above, if the RTS/CTS trade is fruitful yet the following information casing still falls flat, the disappointment is brought on by channel blurring. In this way, the information rate will be diminished because of such environment changes. On the off chance that the edge misfortune is brought on by crash, the transmission rate will stay unaltered. The rate change in ARA is quick yet exact given the condition that ARA can definitely focus the reason for casing misfortunes. The greater part of the current rate adjustment calculations utilize sequential achievement check or successive disappointment consider their metric to alter the information rate. In any case, this system is incorrect, as well as loses the chance to get the short addition time of solid sign. ARA utilizes RTS and the accompanying information casing to distinguish channel blurring and in this manner have the capacity to decline the transmission rate rapidly and unequivocally. ARA likewise utilizes the achievement tally to expand the information rate however it doesn't essentially need to be continuous. As expressed beforehand, the likelihood of a fruitful transmission after ten sequential achievement transmission is just 28.5%. By fulfilling the greater part of the rules showed in the above area, a proficient and reasonable rate adjustment calculation is proposed. Figure 6 demonstrates the state move graph for ARA.

C. Implementation

ARA is actualized on Madwifi, which is an open source IEEE 802.11 gadget driver for Atheros cards in Linux and Freebsd. In this variant, ARA characterizes two limit parameters named (Ts = 8) and (Pth = 1), Ts is the edge used to expand the transmission rate. Pth is the edge used to start the RTS/CTS trade. In the event that an information transmission falls flat, ARA will enter a state where RTS/CTS trade strikes help separate the reason for this casing misfortune. It likewise holds two rate file sets, specifically rix and cix. rix is utilized to situated the current information transmission rate list and cix is utilized to set the current RTS transmission rate file. A rate list relates to the genuine transmission rate, for instance, in IEEE 802.11g, there are altogether 12 diverse transmission rates. Going from 1 Mbps to

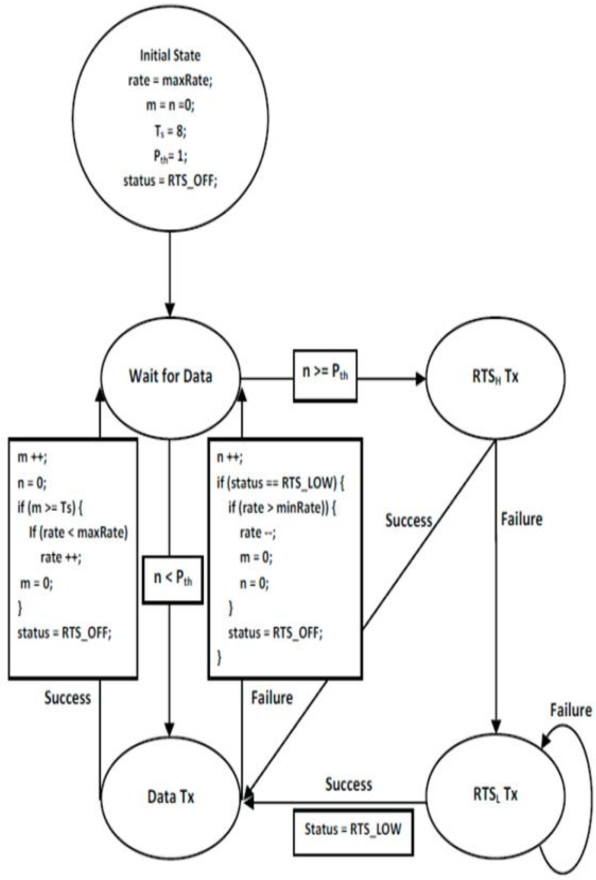

Figure 6. ARA Algorithm

54 Mbps and the rate file ranges from 0 to 11, separately. Toward the start of the state move, ARA sets the introductory rate to be the most extreme rate. It likewise instates variables m, n, and status. m is utilized to hold the quantity of casings being effectively conveyed at current transmission rate and n is the disappointment check. It must be brought up that despite the fact that n is the disappointment include; it is NOT utilized the rate alteration metric to decline the information rate. It is just utilized as a condition test to choose whether ARA needs to start RTS/CTS trade. status holds the current status: Rts_off and Rts_low. After the variables have been instated, ARA will sit tight for the impending information outlines. At whatever point an information edge is found in the transmission line, ARA will attempt to send the information without the assistance of RTS. On the off chance that the information is conveyed effectively, ARA will build m by 1 and reset n to 0. It will likewise reset status to Rts_off on the grounds that next edge will be transmitted without the assistance of RTS/CTS. At the point when m achieves the limit Ts and current transmission rate is not greatest rate, the rate will be expanded. In any case, if a transmission falls flat, ARA

will build n by 1. Note that right now, m is not reset on the grounds that whether outline disappointment is in fact brought on by channel corruption or not will be not known. At the point when n is equivalents to 1, it implies the past information transmission has fizzled. ARA will attempt to separate the reason for this disappointment. It will first send a RTS at the same rate as the fizzled information outline (cix = rix), indicated as Rtshtx. On the off chance that the comparing CTS can be gotten, a few things can be affirmed. In the first place, the channel condition may help the current transmission rate since RTS is transmitted at the same rate as the fizzled casing. Second, there is a high likelihood that the past casing misfortune is brought on by crash. Third, the transmission capacity has been held as a result of the fruitful trade of RTS/CTS. Since the reason for the past information outline misfortune is impact, it is not expected to change the transmission rate record rix. Achievement tally m will be continued on the grounds that the channel condition has not change. It must be called attention to that the length of the channel condition does not change, m ought not be changed. This is truly not quite the same as other rate adjustment plans and is one of the reasons why ARA is more proficient. Notwithstanding, it is still conceivable that the Rtshtx fizzled, this happens when the channel condition debases. Since RTS has a little size and has a low likelihood to impact, there is a high likelihood that the disappointment is created by channel blurring. To affirm this, ARA will send the RTS at the most reduced rate (cix = 0), indicated as Rtsltx, furthermore status will be set as Rts_low

As of right now, it has a high likelihood that Rtsltx will be transmitted effectively in light of the little size and powerful transmission rate. After the relating CTS has been gotten, the transfer speed has been saved for the following information parcel. Review that the information rate list rix is still not changed in the above steps. Thusly the information will in any case be transmitted utilizing the first rate. It is likely that this casing won't be conveyed effectively. Since the reason for this disappointment is unmistakably because of channel blurring, the transmission rate will be diminished and each variable is reset. ARA falls again to introductory state and the entire procedure rehashes.

D. Evaluation

- *Static Station in a Collision Free Network*

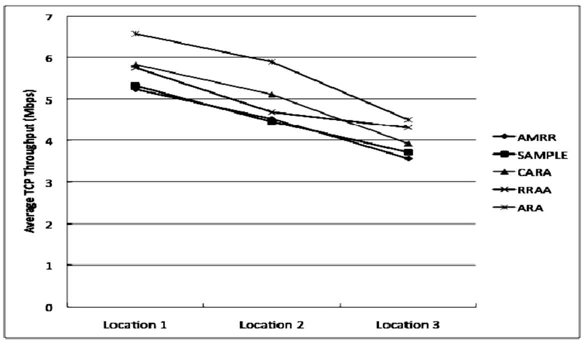

Figure 7. TCP Throughput for a Static Station in a Collision Free Network

- Static Station in a Collision Dominated Network

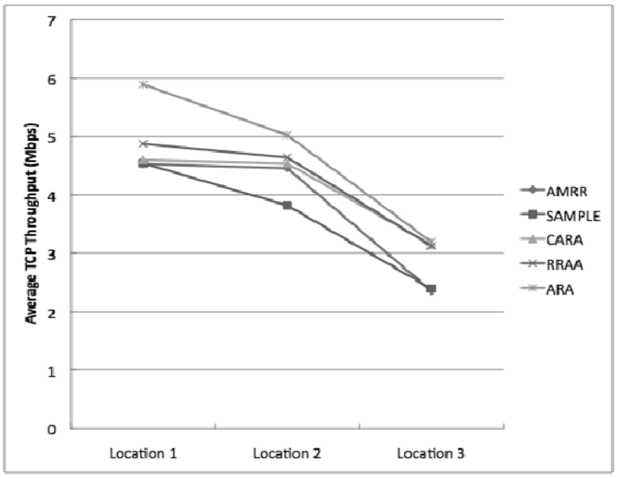

Figure 8. TCP Throughput for a Static Station in a Collision Dominated Network

- *Mobile Station in a Collision Free Network*

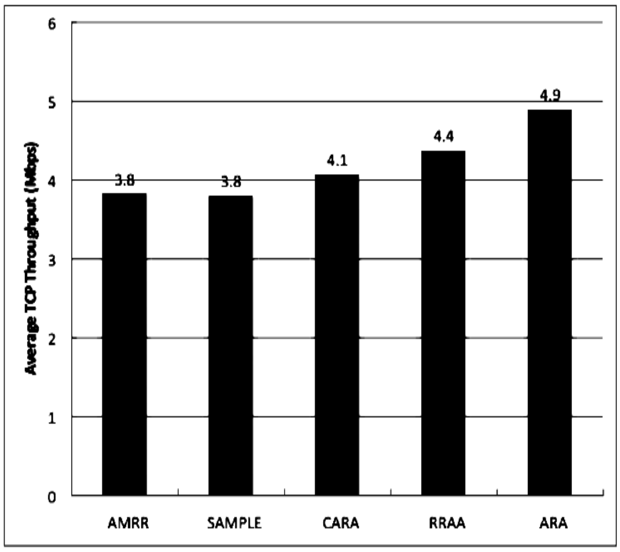

Figure9. TCP throughput for a Mobile Station in a Collision Free Network

- Static Station in Campus network

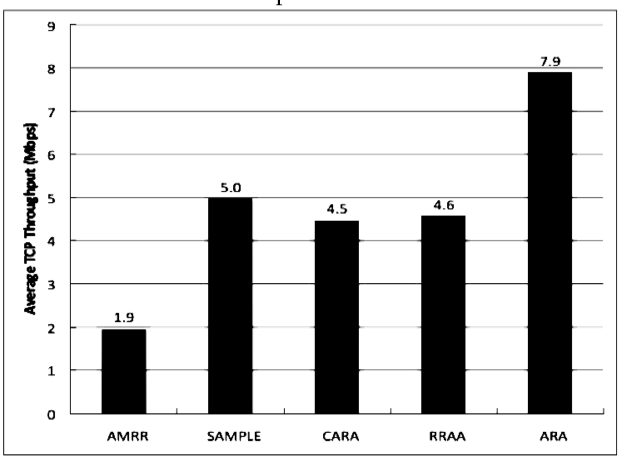

Figure 10. TCP Throughput for a Static Station in Campus Network

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IV. VARA DESIGN

VARA is a cross-layer, feature mindful PHY rate adjustment convention. Its essential thought is to utilize a feature streaming rate waveform from the application layer to guide the adjustment of the remote PHY rate. For any put away feature in a remote home system feature server, such a waveform can be effortlessly produced with a play once more amid feature recording. VARA partitions time into variable-sized windows. For every window, VARA endeavors to discover a PHY rate that yields limit over the crest feature streaming rate in the window. VARA adjusts the window sizes to consider the remote channel variability and testing overhead. First and foremost, Algorithm 1 figures the measure of the following window focused around past estimations of channel variability taken amid the current window. At that point, Algorithm 2 refines this size to fulfill rate prerequisites of the examining that Algorithm 3 may run amid the following window. In the event that the PHY rate of the current window can't help the top feature streaming rate of the following window, Algorithm 3 tests the remote channel for a suitable PHY rate. Toward the start of the following window, Algorithm 1 sets the PHY rate found amid the past steps. In the following sub-segments, it is portrayed in more detail the operations of these three calculations.

A. Algorithm 1: window size and PHY rate adaptation

Algorithm 1 is the "expert" calculation that conjures algorithms 2 and 3. Algorithm 1 is conjured α seconds before the end of the current window. The parameter α is a framework set parameter and is sufficiently high to incorporate the calculations and probingsdepicted underneath. Window size adjustment. Calculation 1 registers the measure of the following window focused around the remote channel variability of the current window. Ln_{total} be the total number of MAC frames (including MAC re-transmissions) transmitted during the current window. The channel variability is computed as the variance var(L) of a set of N Frame Error Rate (FER)values, where $L = \{l_1, ..., l_N\}$. The i-th FER valuel_i, is the fraction of lost MAC frames within the i-th block of c transmitted MAC frames during the current window.

PHY rate adaptation. Algorithm 1 compares the calculated channel capacity,ρ_c, with the peak streaming rate, ρ' , returned by Algorithm 2. If ½c exceeds ½0, the PHY rate r_c of the current window will be used in the next window. Otherwise, Algorithm 3 is called to probe the channel and determine the appropriate PHY rate to use. Once the PHY rate of the next window is determined, Algorithm 1 sets it at the beginning of the next window

Algorithm 1: Rate Adaptation

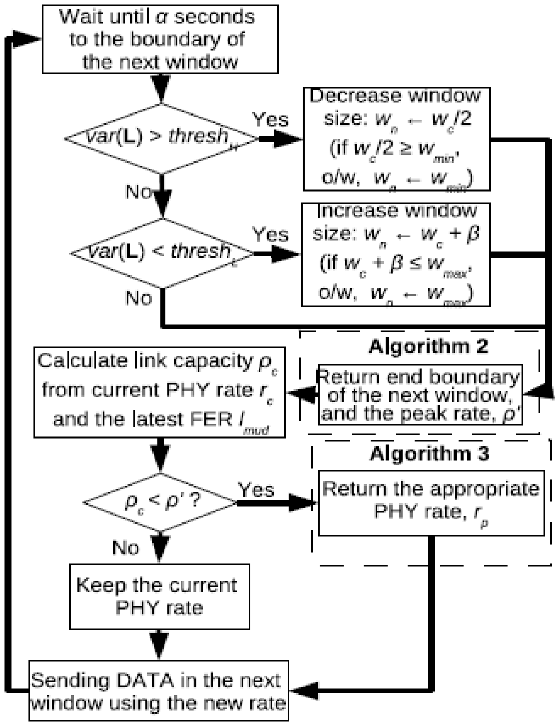

Figure 11. Algorithm 1 Rate Adaptation

B. Algorithm 2: Window Size Refinement

Algorithm 2 refines the size of the next window computed by Algorithm 1 to handle the probing overhead. Since probing only occurs near the end boundary of the window, the position of the end boundary should be carefully chosen to minimize the impact of probing on video streaming performance. Let b_n be the end boundary of the next window computed by Algorithm 1. Based on the streaming rate before b_n, Algorithm 2 calculates a probing window size η that cansupport all probing packets. More specifically, η is computed to satisfy the following:

$$\int_{b_n-\eta}^{b_n} f(t)\,dt > \eta_p\,(P_{802.11})\,(|R| - 1)$$

where f(t) is the video streaming rate at time t, η_p is the number of ongoing data frames used for probing at each PHY rate, $P_{802.11}$ is the average WLAN frame size used for video streaming, and R is the set of 802.11n PHY rates. The average video streaming rate ½*a* from time $b_n - \eta$to $b_n$should also satisfy:

$\rho_a < \rho_u$

The maximum rate requirement ½u exists to ensure that the probing overhead will not cause the rate to exceed the peak video streaming rate ½0 of the next window. Such probing overhead causes capacity penalty. The average capacity penalty in our testbed is 20%. Let h be the average capacity penalty caused by probing, then:

$$\rho_u = \frac{1}{1+h}\rho'$$

If (5) is not satisfied, Algorithm 2 moves the end boundary of the next window in steps of » seconds until it is satisfied. If the current window size was increased by Algorithm 1, Algorithm 2 moves the end boundary later; otherwise it moves it earlier.

C. Algorithm 3: Channel Probing

Algorithm 3 probes the channel when the capacity ρ_c of the current window cannot support the peak streaming rate ρ' of the next window.

Amid operation, an IEEE 802.11n framework must select among 16 PHY rates, that incorporate both SDM and STBC MIMO modes. Calculation 3 decreases examining overhead by lessening the quantity of tested PHY rates. This is attained by utilizing the property that FER is an expanding capacity of PHY rate inside every MIMO 802.11n mode (STBC or SDM). This thus intimates that, for either STBC or SDM mode, the limit as a capacity of PHY rate has a solitary greatest.

Algorithm 3 tests each of SDM and STBC modes independently as takes after. To begin with, it decides the testing bearing by examining a PHY rate one stage lower and a PHY rate one stage higher than the current rate r_c. For each one rate it utilizes certain examining, i.e., it sends n_p back to back information edges of the continuous activity at that PHY rate and measures the FER. At that point it utilizes Equation (1) to figure the comparing limit. On the off chance that both limits are lower than the limit ρ_c of r_c, Algorithm 3 furnishes a proportional payback r_c onthe grounds that it yields most extreme limit for this mode. Something else, if the lower (higher) step rate gives higher limit than ρ_c, Algorithm 3 keeps testing all rates at lower (higher) steps one by one until it discovers one with a limit higher than the top rate prerequisite ρ'. In the event that no such rate is discovered, Algorithm 3 yields the PHY rate of most extreme limit. At last, Algorithm 3 thinks about the limits of the two PHY rates found for SDM and STBC modes and comes back to Algorithm 1 the PHY rate whose limit surpasses ρ' and has a lower FER (i.e., it is more vigorous). On the off chance that none of these two limits surpass ρ' Algorithm 3 comes back to Algorithm 1 the PHY rate of higher limit between thetwo.

D. *Evaluation*

In this section, we experimentally evaluate VARA's performance using our MIMO 802.11n wireless testbed. We first show that compared to the default auto rate adaptation protocol, VARA significantly reduces packet loss and achieves perfect, or close-to-perfect, video quality in terms of PSNR. We then show that VARA can efficiently adjust windows and schedule probing for different window sizes and video streams. Finally, we show that our multiplexing strategies improve the support for multiple simultaneous video streams.

VARA in Static Environment

VARA's performance against the default auto rate of the RT2880 Ralink cards (the legacy rate adaptation algorithm) in a static environment is compared. Therefore, both the AP and the clients are placed in fixed locations. Locations L1, L2, and L3 are selected to yield different wireless channel qualities. L1 has the best, L3 the worst. Table I shows the properties of different HD movie clips used in this experiment. Panda1080p represents the high streaming rate video, while Panda720p and MonsterAliens represent the medium and low streaming rate videos, respectively. Each experiment run consists of two back-to-back streaming of each HD video between the AP and each client location, first using VARA and then auto rate. Each run is repeated five times and the average. At the best channel quality location L1 auto rate supports all videos perfectly with zero loss. However, at location L2 it cannot support Panda1080p, the highest rate video. In contrast, VARA supports all videos perfectly at both locations L1 and L2. In L3, auto rate cannot support any of the videos perfectly. In contrast, VARA supports all videos perfectly except Panda1080p. This is expected because Panda1080p has a higher peak rate (26.12Mbps, Table I) than the maximum capacity of L3. With Panda1080p VARA achieves a 2% burst loss lasting for two seconds during the peak rate period, while auto rate results in a burst loss of 35% lasting for six seconds during the peak rate period. It has been found that even a burst loss rate as small as 12%, as Panda720p suffers, can cause a significant degradation of video quality. In terms of subjective video quality, although a video with a PSNR of 25dB to 30dB could still be acceptable, it demonstrates obvious jitters, blocking and blurring. A video with a PSNR around 40dB is considered as a high quality video without any observable defect. It is observed that VARA achieves perfect PSNR3 for two videos, and increases PSNR about 50% for the high rate video over auto rate.

VARA in a Mobile Environment

Performance of VARA is now evaluated when the channel condition changes more drastically. A controlled mobility scenario is used where a client moves along the path L4-L5-L6 at walking speed.FERs and capacities are first measured at these locations by sending UDP packets in different PHY rates. Table II shows the averages of these two quantities over five experiment runs. As the client moves from L4 to L5 and then to L6, the FER of a particular PHY rate changes.

For example, when 39Mbps PHY rate is used and when the client moves to L4, L5 and to L6, the FER increases from 0, to 45% and to 59%, respectively. At the same time, the capacity decreases. Then an experiment is performed in which a client moves with the same mobility pattern using VARA and auto rate while the *Panda720p* HD movie clip is being streamed. VARA computes different window sizes when the client is in different locations. Window size increases as the variation of FER is small when the current PHY rate is used. (It is worth noting that a large FER does not necessary mean a large FER variation.) When the end boundary of each window approaches, VARA evaluates if thecurrent PHY data rate can provide the capacity large enough for the peak rate of the next window

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TABLE I
HD MOVIE CLIPS PROPERTIES

Data Rate	19.5	26	39	52
L4	-	-	0, 30.34	98.5, 0
L5	-	0.12, 19.24	0.45, 10.27	0.79, 0.02
L6	0, 16.75	0.49, 5.89	0.59, 3.92	-

TABLE II
AVERAGE FER & CHANNEL CAPACITY

Movie Name	Average rate	Peak rate	Variance
Panda1080p	10.26	26.12	28.71
Panda720p	5.96	15.94	10.82
MonsterAliens	5.06	14.64	5.22

V. CONCLUSION

In this paper the issue experienced by the current auto rate calculations in IEEE 802.11 Wlans with different stations producing substantial activity has been explored. Another LD-ARF calculation with misfortune separation capacity is proposed to more precisely perform the rate adjustment methodology. Examinations with the first ARF demonstrate that more than 100% change in throughput can be attained by LD-ARF when the quantity of contending stations is huge.

This paper investigates the current delegate rate adjustment plans and partitions them into two eras. The original plans do not separate the casing misfortunes and treat all the misfortunes as being brought on by channel debasement and subsequently perform ineffectively in an environment where there are many crashes. The second era plans separate the casing misfortunes and perform much better than the original plans in the blockage predominant system. In any case, while most second era rate adjustment plans may separate edge misfortunes brought on by channel debasement, they cannot decisively separate the casing misfortunes created by crash. This paper proposed a rate adjustment calculation called Advanced Rate Adaptation (ARA) that can decisively separate edge misfortunes brought on by both channel debasement and impact. In the investigation, ARA is contrasted with other agent rate adjustment conspires in both controlled investigations and field test. ARA beats other rate adaption conspires in many situations. In the field test, through a facilities remote system, ARA gives 300% throughput change over a portion of the original rate adjustment plans and 78% throughput change over second era rate adjustment plans.

Supporting HD VBR feature in Wlans is an opportune and testing issue. Despite the fact that WLAN innovations, for example, 802.11n MIMO help high remote PHY rates, it has been demonstrated that in practice the examining overhead of existing condition of the craftsmanship 802.11n PHY rate adjustment conventions can be inconvenient to feature execution.

Our remote rate adjustment convention (VARA) addresses this issue by adjusting the recurrence and timing of remote examining to the feature streaming rate and the remote channel varieties. Three novel Shifting procedures to productively multiplex HD features by minimizing top total streaming rate, blackout time and blackout territory were additionally proposed.

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