ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

IJESRT
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

RATE ADAPTATION IN IEEE 802.11 WIRELESS NETWORKS: A REVIEW

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DOI: 10.5281/zenodo.1199234

ABSTRACT

The Rate adaptation is the process which is very popular in our life and it plays a vital role in our day to day life. We all are dealing with rate adaptation directly or indirectly knowingly or unknowingly, whether you are posting a message on facebook or you are commenting on any one post, whether you are sending smiles on whatapps or replying, whether you know or don't now but at all these times you are dealing with rate adaptation. So in this way you may understand the importance of rate adaptation in our day to day life. These are the uses of rate adaptation in our daily life. Rate adaptation is nota new research area in wireless networks so the review has been limited to the IEEE 802.11 wireless networks.

The IEEE has given many transmission standards for the transmission of data and time to time has updated these standards. In the 1999, the IEEE has updated the standard of the IEEE 802.11 which is one of the most popular data transmission standards. The IEEE standard 802.11b provides the low cost solutions of wireless network problem.

Keywords: Rate adaptation, ARF, adapt, IEEE802.11.

I. INTRODUCTION

Rate adaptation is quite a challenging area as a lot of work has been done around the world and still many researches are running around the clock. Here is the chance to satisfy our excitements, as we all, in the day to day life, are dealing with rate adaptation directly or indirectly. Here is an opportunity to know how the things are executed in real time scenarios for transmitting the data from one source to the destination. But when it happens in the wireless medium, interest multiplies itself.

There are two generations of rate adaptation algorithms. In the first generation rate adaptation algorithms, Auto Rate Fallback (ARF) is the most popular and widely used method in the industry but it has not achieved the maximum throughput. The main reason of ARF is that it is not able to sustain in the both conditions i.e. the stable channel conditions and the unstable channel conditions. If somehow these obstacles may be removed, then the algorithm will perform in a better way in terms of stabilization. Rate adaptation is very vast for the discussion, which is not possible to carry out here, so the discussion will be normally focused near the IEEE 802.11 in wireless networks.

There has been an attempt to explore the existing algorithms which were widely used in the past. The attempt was to explore the algorithms in the new scenario and expel the performance as compared to today's scenarios and todays requirements. Computer science and Technology advancement is approaching the 5th generation of technology, everything is going to be compact and wireless. Here, the Wi-Fi plays a vital role in providing the excellent services. The 802.11b Wi-Fi is the emerging technology, and still the research is going on to explore the domain. There has been also an attempt to do something new from the history which has already been done, by adding new concepts and ideas, to get better results. The 802.11b Wi-Fi is the only primary source that satisfies most of the demands of the domain in the 5th generation.

This paper is organized as follows. In this paper the work has been reviewed which was carried out by various researchers on the research aspects of rate adaptation in wireless networks and their applications in various domains. In the second section of the paper, a literature review has been presented of various rate adaptation

ISSN: 2277-9655
Impact Factor: 5.164
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schemes in wireless networks towards providing of their real time scenarios. In the third section, conclusion about the solutions of the wireless networks problem has been carried out. In the fourth section of the paper, a discussion has been carried out, on the future work related to research towards issues of rate adaptation algorithms.

II. LITERATURE REVIEW

Author Mathieu La.et.al.,[1] have proposed ARF algorithm to provide low latency systems to improve the quality of both the short and long term adaptation. Algorithm is used for very low complexity while using the RBAR (Receiver Based Auto Rate), which are the incompatible changes of 802.11 Mac and Physical layer. The reasons for high speed networks are to speed up the data transmission, cost affectivity and less traffic in networks. They differ the transmission quality as per the transmission rules.

Algorithm is based on power consumption in mobile devices and throughput of transmission rates.
The advantage of this method is for low and high latency systems. Both work together for the optimization of RBAR (Receiver Based Auto Rate) if they are working for infrastructure networks. Disadvantage of this method is its non-suitability for all devices and performance is not so satisfactory and it's non compatibility for the different configuration transmission.

Wong.et.al. [2] have proposed the Robust Rate Adaption Algorithm (RRAA) which is used for short term losses and decision of loss ratio. They used filters for collision free networks when rate of ratio decreases. In this paper focus is on two key methodologies. First is for to provide the state of art for the rate adaption and second is to provide the robust rate adaption algorithms and improve the 802.11 standards. In the current scenario 802.11 standards does not give any feedback for receiver side but for the first approach they consider the art of rate adaption algorithms in which they see which layer is used for the data transmissions, what type of message is used, how can it be transferred, how the data is received and how they estimate the channel length.

For the second approach, they design the current guidelines for the data transmission. For the first guidelines they investigated decreasing the transmission rates for the several packet losses. For the second guidelines they investigated the use of probe packets to access for the possibility of new transmission rates. For the third approach they used consecutive approach for increase or decrease the transmission rates. For the fourth approaches they saw the smooth approach for transmission of long term and for the average performance.

The advantage of the practices is for developing collision free networks and to increase the performance. A need to improve the networks for WAN and mess networks was felt by the authors.

Malik Ahmad.et.al., [3] studied the smart rate and good throughput to reduce the packet size and make aware the passive measurement from the client side and increases the rate and reduces the messy networks. The smart rate architecture and design pattern were follows: First is Static collection in which the PER over the packet and rate space were collected. PER measurement section is a measure using LRC counter of packet fragments. Second is for volatile adaptivity purpose which is for the optimization of different algorithms for static verses highly variable. In which they investigate the estimation, Time scale dynamically in which rates are updated interval. Third is Sampling Algorithms in which he explores the rate and packet size space for PPER measurements. Fourth is physical packet error rate measurement in which the comparison of different measurements and intervals is done. Fifth is for throughput awareness of PPER, in which the measurement success rate of IP transmission is investigated.

The advantage of this is to test the smart rate in different channels and test the wireless for the one and multiple users. Drawbacks are that they require hardware which is not easily available and due to this they require more money and complex structure of the networks.

SaiidBiaz, et al.,[4] have proposed for the comparison of all channels and support for the differential rate adaption as per the channel conditions. Apart from survey of rate adaptation algorithms, some schemes are described in this paper. It's calculating the number of successful transmission data based on successive observation. Some of rate adaptation schemes require the use of RTS/CTS.

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There are two general possible causes of frame loss. First is Rate Adaptation Algorithms without Loss Differentiation in which they describe two groups: in first group they saw the frame loss based adaption and second is signal strength based adaption.

Some of the open issues in rate adaption for IEEE 802.11 networks:
First is limited measurement for realistic scenarios. Second is No performance comparison. Third is new rate adaption scheme: first in this they work on increasing effectiveness in both the high and low channels and fading collisions dominated and second is quick responsive transient channel dynamics. For this new rate adaption schemes are needed for the future purpose.

Advantage of the proposed paper is to discuss the works of all schemes and their simulations for different channels. Disadvantages are the ERA still needs more development and makes it effective under most of high networks and network traffic controls.

Sahel Alouneh, et al.,[5] have proposed and focused on enhancing the problem with the performance of 802.11MAC in Forward Error Correction (FEC) and retransmission of the performance of MAC. In this IEEE 802.11 MAC Level FEC is showing the MAC Protocol Data Unit (MPDU) format without Protocol Data Unit (MPDU) format. Second is Retransmission combining, in this they describe the retransmission combining mechanism. These are two proposed Retransmission combination:

1) Any erroneously received frame is not passed to the higher layer, which implies that when the MAC-level FEC is used, any RS-coded frame with uncorrectable RS block(s) will not be forwarded to the higher layer; and 2) there is no partial retransmission with 802.11, which implies that if any of RS blocks is not correct by the receiver, the sender should retransmit the whole frame again. Advantage of these proposed techniques is to increase the transmission and simulate the results using TCP/UDP traffic for more suitability of channels. For the future purpose, they used PHY frames for more accurate simulation of other proposed MAC in FEC.

Kamerman & Monteban, [6] have proposed the most well-known rate adaptation algorithm, which is used in Lucent Technologies Wave LAN-II networking devices. This is the first commercial rate adaptation algorithm which was used widely by the industry. That time it was taken on hands on by the industry.ARF(Auto Rate Fallback) simply based on the incremental approach. It is the earliest rate adaptation scheme for the IEEE standards 802.11 for the wireless networks. The algorithm is a transmitter based rate adaptation algorithm whose goal is to increase the throughput of the application level in the wireless networks.ARF (Auto Rate Fallback) always tried to get higher transmission rate after the fixed number of the threshold or the timer expired.

In ARF sender transmit the packet at the basic transmission rate and after a set (fix) number of successful transmissions of the packet or the timer expired, the ARF tried the get next higher transmission rate. ARF send the probe packet at new higher transmission rate, it the probe packet successfully transmitted, the transmission continued on the same rate. But the main drawback of auto rate fallback is that it is not stable in either of stable channel conditions or unstable channel conditions. It was not achieving the maximum throughput in the stable channel conditions. Because of his incremental approach, it always tried to achieve higher data transmission rate. In case of unstable, his performance needed to improve up to recognition to average rate adaptation scheme.

Shaoen Wu et.al., [7] have proposed address issues on loss differentiated rate adaptation in wireless networks. They introduced the lowest data rate retransmission for the very first retransmission after packet loss. In traditional strategies, after a packet loss, retransmissions are often attempted with the same data rate. Their work analytically shows that retransmitting at the lowest data rate is more efficient, especially in poor SNR environment or when there is no knowledge of the loss cause (channel degradation or transmission collision). This scheme dubbed Loss Differentiated Rate Adaptation (LDRA) and extensively evaluated through simulations which is shown to perform better especially when network collision is heavy.

Shaoen Wu et.al,[7] concluded that Loss Differentiation Rate Adaptation measures channel conditions through the IEEE 802.11 periodic beacons and determines the most appropriate data rate. Channel conditions allow Loss Differentiation Rate Adaptation to correctly discriminate packet losses due to corruption from those due to collisions. For losses not related to collisions, the mobile node does not double its contention window. This

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Impact Factor: 5.164
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ability to discriminate significantly improves throughput. Additionally, retransmissions at the lowest data rate minimize the expected number of retransmissions after a loss and reduce both the delay and the delay jitter.

JongseokKim,et al., [8] addressed the issues on collision-aware rate adaptation for IEEE 802.11 for wireless networks, proposed a novel collision-aware rate adaptation scheme, called *CARA*, for IEEE 802.11 WLANs. The key idea of Collision Aware Rate Adaptation is that the transmitter station combines adaptively the Request-to-Send/Clear-to-Send (RTS/CTS) exchange with the Clear Channel Assessment (CCA) functionality to differentiate frame collisions from frame transmission failures caused by channel errors. Therefore, compared with other open-loop rate adaptation schemes, CARA (Collision Aware Rate Adaptation) is more likely to make the correct rate adaptation decisions. Through extensive simulation runs, they evaluate their proposed scheme to show that scheme yields significantly higher throughput performance than the existing schemes. The merits are reduced the collision effects, increasing transmission rate and reduction in transmission failures with high performance. The main demerits are Chanel errors & wastage of frames for the transmission.

Jongseok Kim, et al.,[8] concluded in this paper that the transmitter station combines adaptively the RTS/CTS exchange with the CCA functionality to differentiate frame collisions from frame transmission failures caused by channel errors. Therefore, compared with ARF, the most well-known and widely-deployed rate adaptation scheme in the commercial 802.11 WLAN devices, CARA is more likely to make the correct rate adaptation decisions. Moreover, CARA does not require any change to the current 802.11 standard, thus facilitating its deployment with existing 802.11 devices. The performance of CARA is evaluated via in-depth simulations over various scenarios in terms of network topology, data frame size, and wireless channel model. It is demonstrated that CARA significantly outperforms ARF in all the simulated multiple contending station environments, whereas the performance enhancement becomes more and more evident as the number of contending stations increases

IoannisPefkianakis, et.al.,[9] addressed the fundamental problem of the rate adaptation algorithm, All such algorithms are MIMO oblivious; they do not consider the characteristics of diversity-oriented, single-stream mode and the spatial multiplexing driven, double-stream mode. They proposed MiRA, a novel MIMO RA scheme that zigzags between intra and inter mode rate options. Their experiments show that MiRA consistently outperforms three representative rate adaptation algorithms, sample Rate, RRAA (Robust Rate Adaptation Algorithm) and Atheros MIMO RA, in static, mobility and collision settings. IoannisPefkianakis, et.al.,[9] have concluded that IEEE 802.11n compliant, programmable AP platform to study MIMO rate adaptation. Their research shows that, an 802.11n rate adaptation scheme must address MIMO related characteristics to do well. To this end, they propose MiRA, a new RA (Rate Adaptation) algorithm that explicitly adapts to the SS (Single-Stream) and DS (Double-Stream) modes in 802.11n MIMO systems. The key insight is that diversity-oriented SS mode and spatial multiplexing-driven DS mode exhibit different features and cannot be managed indistinctly. Existing RA solutions do not properly consider characteristics of SS and DS, thus suffering from severe performance degradation. In fact, even a fixed rate scheme may outperform them. In a nutshell, their work is among the first to examine MIMO RA in a practical setting using programmable 802.11n commercial hardware. They expect that their efforts would stimulate more community effort on MIMO RA to exploit the full capacity of MIMO communication.

Zanyu Chen et.al.,[10] have addressed the issues of a novel rate adaptation in IEEE 802.11 in wireless networks. Zanyu Chen et.al., [10] have proposed the multiple transmission rates and show the correlation b/w the physical & MAC layer and achieve maximum transmission efficiency. In this paper, they proposed a novel rate adaptation algorithm to tackle this problem. They utilized the maximum likelihood estimator to robustly predict the transmission statistics for each transmission rate. Then they exploited the cross-layer correlation between PHY and MAC to determine the transmission cost for each transmission rate. The goal of their design was to achieve the maximum spectral efficiency. Based on extensive simulation experiments, the proposed algorithm outperforms existing well-known algorithms.

Zanyu Chen et.al.,[10] have concluded that the joint correlation between PHY and MAC is exploited in order to evaluate the performances of available MCSs. Their decision strategy was to achieve the maximum spectral efficiency. They evaluated the performances of the proposed approach as well as several existing algorithms through extensive simulations. The scenarios they consider included different topologies, fading channels, mobility, and various contending nodes. Experimental results showed the proposed algorithm outperforms exiting algorithms in all scenarios.

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III. CONCLUSION

In this paper, review was carried out on the various aspects of the Rate Adaptation in Wireless Networks and its application in various domains. Further, for comparative analysis are view was carried out. After the review of various aspects of rate adaptation, it was concluded that rate adaptation algorithms with loss differentiation approach are more suitable in the current scenarios of the society as they provide more reliable services and high throughput. It does not mean that the first generation rate adaptation algorithms are not effective but the review revealed that due to changes in the scenarios and the current expectations, those algorithms need to be modified according to the current scenario issues and current scenario demands so that they can perform better as per today's expectations.

IV. FUTURE WORK

Based on the above discussions, work in this domain may be extended to direct research towards issues of rate adaptation algorithms. Maximizing throughput, making channel conditions more reliable, cost effectiveness and fast transmission are the few areas where the need is felt to improve. Encryption technique is needed to make a highly secure system and also workout to reduce the seek time

V. REFERENCES

[1] Mathieu Lacage, Mohammad HosseinManshaei, and Thierry Turletti "IEEE 802.11 Rate Adaptation: A Practical Approach" published by MSWiM'04, October 4-6, 2004, Venezia, Italy. Copyright 2004 ACM 1-58113-953-5/04/0010.
[2] Starsky H.Y. Wong, Hao Yang "Robust Rate Adaptation for 802.11 Wireless Networks", published MobiCom'06, September 23–26, 2006, Los Angeles, California, USA. Copyright 2006 ACM 1-59593-286-0/06/0009.
[3] Malik Ahmad Yar Khan, Darryl Veitch "SmartRate: new dynamic rate adaptation algorithm for 802.11wirelessnetworks" published 978-1-4577-0351-5/11/ 2011 IEEE .
[4] SaiidBiaz and Shaoen Wu "Rate Adaptation Algorithms for IEEE 802.11 Networks: A Survey and Comparison" pub. 978-1-4244-2703-1/08/$25.00 ©2008 IEEE.
[5] Sunghyun Choi, YoungkyuChoi"IEEE 802.11 MAC-Level FEC Scheme with Retransmission Combining" pub. 1536-1276/06$20.00 2006 IEEE.
[6] A. Kamerman and L. Monteban, "Wavelan-ii: a high-performance wireless lan for the unlicensed band," *Bell Labs Technical Journal*, vol. 2, no. 3, pp. 118–133, 1997.
[7] Shaoen Wu, SasdBaiz "Loss Differentated Rate Adaptation in Wireless Networks" pub.in Technical Report,Dept. of Computer Science and Software Engineering ,AubumUniversity,USA, CSSE07,2007.
[8] JongseonKim,SeongkwanKim,SunhgyunChoi,DajiQiao"CARA: Collision-Aware Rate Adaptation for IEEE 802.11 WLANs" published by 0-7803-6599-2/01/$10.00 _ c 2001 IEEE.
[9] IoannisPefkianakis, Starsky H.Y Wong Hao Yang, Songwu Lu "MIMO Rate Adaptation in 802.11n Wireless Networks" pub.in MobiCom 10 Sept20-24,2010,Chicago,Illinois,USA,2010.
[10] Zanyu. Chen, Tsungnan Lin, Pochiang Lin "A Novel Rate Adaptation in IEEE 802.11 Wireless Networks" pub. In 978-4244/10@2010IEEE.
[11] "IEEEstandards for information technology-telecomunications and information exchange between systems local and metropolitan area network-specific requirements part II: Wireless Lan medium access control(mac) and physical layer(phy) specifications", IEEEstd 802.11-2012(Revision of IEEE std 802.11-2007),pp 1-2793,2012.
[12] J. C. Bicket, "Bit-rate selection in wireless networks," Master's thesis, Department of EECS, MIT, February 2005. SampleRate.
[13] Xin-Wei Yao, Wan-Liang Wang , Shuang-Hua Yang , Yue-Feng Cen," Bio-inspired self-adaptive rate control for multi-priority data 4 transmission over WLANs", Elsevier B.V. All rights reserved

CITE AN ARTICLE

Datta, V. (n.d.). RATE ADAPTATION IN IEEE WIRELESS NETWORKS: A REVIEW. *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY*,*7*(3), 379-384.