Dynamic Adaption of IEEE 802.11 WLAN Modes DCF and PCF

Akhil Kumar[1], Dilip Kumar[2], Nitin Yadav[3]
[1]Assistant Professor, Computer Science and Engineering/Starex University, Gurugram
[2,3]Teaching Associate, Computer Science and Engineering/Starex University, Gurugram
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***Abstract* - IEEE 802.11 is the most popular family of WLAN at the current time in the IT and communication world. It has two main common mode of operation and function: Distributed Coordinating Function (DCF) and other is called Point Coordinating Function (PCF). Both mode PCF and DCF types of IEEE 802.11 do not perform same(equally) well under all traffic scenarios. Their behavior increases depending upon current size of network as well as traffic load. The DCF mode is useful in the low traffic and they network have small in size and other mode PCF is suitable on high traffic load and to reduce contention in large size network. In this thesis, we have designed three protocols to dynamically adapt IEEE 802.11 MAC under varying load. One of them is designed to dynamically switch between either mode. Our Point Coordinating Function (DSP) observes network traffic to decide switching point and switches dynamically to suit current traffic load and network size. PRRS is our second contribution that aims to cut back polling overheads. The main problem or issue of polling scheme in PCF is their inefficiency when only a small number of nodes have data to send. An unsuccessful polling attempt causes unnecessary delays for station with data. We have presented network monitoring-based scheme that replaces simple Round Robin scheduling in PCF with our Priority Round Robin Scheduling (PRRS). Result shows extensive increase in output particularly once tiny fraction of node has information to transmit.**

***Index Terms*— Distributed Coordinating Function, Point Coordinating Function, Point Coordinating Function, Priority Round Robin Scheduling.**

1. INTRODUCTION

Wireless computing could be a quickly rising technology providing users with network property while not being bound off of a wired network. Wireless local area networks (WLANs), like their wired counterparts, are being developed to provide high bandwidth to users in a limited geographical area. WLANs area unit being studied as another to the high installation and maintenance prices incurred by ancient additions, deletions, and changes old in wired computer network infrastructures. Physical and environmental necessity is another driving factor in favour of WLANs.

The operational surroundings might not accommodate a wired network, or the network is also temporary and operational for a really short time, making the installation of a wired network impractical. Examples wherever this can be true embrace unintended networking desires like conference registration centres, campus classrooms, emergency relief centres, and tactical military environments. However, to satisfy these objectives, the wireless community faces sure challenges and constraints that don't seem to be obligatory on their wired counterparts.

1.1 Why IEEE 802.11 WLAN:

IEEE 802.11 normal is one in all the outstanding wireless native space network standards being adopted as a mature technology. The success of the IEEE 802.11 normal has resulted within the simple convenience of business hardware and a proliferation of wireless network preparation, in wireless LANs furthermore as in mobile ad hoc networks. Although IEEE 802.11 isn't designed for multihop accidental networks, the simple convenience has created it, most chosen macintosh.

1.2 Challenges of WLAN:

Various unique and on occasion fighting plan objectives must be considered for WLANs to ensure their business accomplishment.

1. Global activity: WLAN items should sell everywhere throughout the globe, in this manner, various national and widespread rules must be considered.
2. Easy to use: LANs mustn't need complicated management however rather work on a plug-and-play basis.
3. Investment Protection: plenty of cash has already been endowed into wired LANs. Hence

new WLANs must protect this investment by being inter operable with the existing networks.

4. Low Power: Devices imparting by methods for a WLAN are ordinarily additionally wireless gadgets running on battery control. Accordingly, WLAN must execute excellent power saving modes and power the board capacities.
5. Bandwidth: Bandwidth is one of the rarest assets in wireless systems. The transmission capacity that is accessible in the wireless systems is far lower than the wired connections.
6. Link Errors: Channel obscuring and obstacle cause interface blunders and these mistakes may at times be especially outrageous.
7. Robust transmission innovation: Compared to wired partners, WLANs work under predicament. In the event that they utilize radio transmission, various other electrical gadgets may interfere.
8. Safety, security and privacy: most vital concern is of safety and security. WLANs ought to be safe to work, particularly concerning low radiation. Furthermore, no users should be able to read personal data during transmission i.e., encryption mechanism should be integrated. The network ought to conjointly take under consideration user privacy.

1.3 IEEE Standard 802.11:

Many different and sometimes competing design goals have to be taken into account for WLANs to ensure their commercial success.

IEEE 802.11 MAC features two techniques for activities: Distributed Coordinating Function (DCF) and Point Coordinating Function (PCF). DCF is CSMA/CA-based arbitrary access convention that utilizations irregular back-off to keep up a vital separation from the impact. PCF gives united arranged access to the channel. It includes a chain of question free period (CFP) and the contention time frame (CP). DCF guidelines are followed in the CP. In the CFP point coordinator (PC) reviews the center point one by one and offer access to the channel. New stations that need to get took on the review list, send the sales in CP.

a) World operation: Wi-Fi merchandise ought to sell altogether countries, therefore, many national and international frequency regulations have to be considered.
b) Low Power: Devices communication via a network (WLAN) wireless fidelity (Wi-Fi) local area network (LAN) are usually conjointly wireless devices running on battery power. Hence, Wi-Fi should implement special power saving modes and power management functions.
c) License-free operation: LAN operators do not want to apply for a special license in order to be able to use the product. Thus, the instrumentation should operate during a license-free band, such as the 2.4 GHz ISM band.
d) Information measure: Bandwidth is that the one in every of the foremost scarce resource in wireless net-works. The obtainable information measure in wireless networks is way but the wired links.
e) Link Errors: Channel attenuation and interference cause link errors and these errors could typically be terribly severe.
f) Robust transmission technology: Compared to wired counterparts, WLANs operate under difficult conditions. If they use radio transmission, many other electrical devices may interfere.

2. MAC SUBLAYER IN IEEE 802.11 WLAN

The IEEE standard 802.11 specifies the most famous family of WLANs in which many products are already available. Standard belongs to the cluster of 802.x computer network standards, e.g., 802.3 Ethernet or 802.5 Token Ring. This means that the quality specifies the physical and medium access layer tailored to the special necessities of wireless LANs, however offers an equivalent interface because the others to higher layers to maintain interoperability

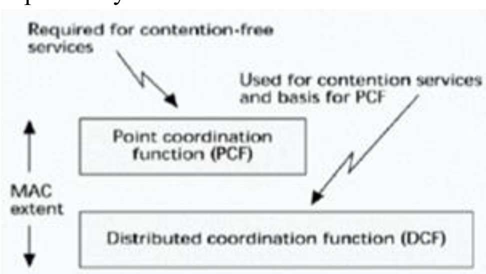

Figure 2.1: MAC Architecture

2.1 Scope of IEEE 802.11 standards:

1. The scope of this standard is to develop a medium access control (MAC) and physical layer (PHY) specification for wireless connectivity for fixed, portable, and moving stations within a local area.
2. The purpose of this standard is to provide wireless connectivity to automatic machinery, equipment, or stations that require rapid

deployment, which may be portable or hand-held, or which may be mounted on moving vehicles among space a neighborhood area. This customary additionally offers restrictive bodies a way of standardizing access to at least one or additional frequency bands for the aim of native space communication.

2.3 Purpose of IEEE 802.11 standard:

Primary goal of the quality was the specification of a straightforward and strong wireless local area network that offers time-bounded and asynchronous services. Furthermore, the MAC layer should be able to operate with the multiple physical layers, each of which exhibits a different medium sense and transmission characteristic. Candidates for physical layers were infrared and unfold spectrum radio transmission techniques.

Additionally features of the WLAN should include the support of the power management, the handling of hidden nodes, and the ability to operate worldwide.

2.4 Architecture Model:

The basic service set (BSS) is that the basic building block of the IEEE 802.11 design. A BSS is defined as a group of stations that are under the direct control of a single coordination function (i.e., a DCF or PCF) which is defined below. The geographical area covered by the BSS is known as the basic service area (BSA), which is analogous to a cell in a cellular communications network. Conceptually, all stations in a BSS can communicate directly with all other stations in a BSS.

An ad hoc network is a deliberate grouping of stations into a single BSS for the purposes of internetworked communications without the aid of an infrastructure network. Figure 2.1 is an illustration of an independent BSS (IBSS), which is the formal name of an ad hoc network in the IEEE 802.11 standard. Any station can establish a direct communications session with any other station in the BSS, without the requirement of channeling all traffic through a centralized access point (AP)

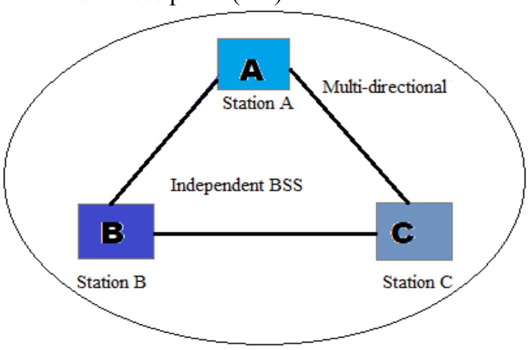

Figure 2.2: Sketch of an ad hoc network

3. PROBLEM ANALYSIS AND RELATED WORK

In this work we have focused on three problem areas that lead to performance degradation in IEEE 802.11 WLAN. One major problem with PCF that gets highlighted when small fractions of associated and pollable nodes in BSS are sending data, and rest are silent. This results in significant polling overheads that wastes the scare channel band-width. Second problem area is to define protocol for dynamic switching between two modes. Mean packet delays can be reduced by having DCF when less nodes have pending data and PCF otherwise. Third problem area is statically configured configuration parameters of PCF and DCF. Depending on the network configuration, the standard can operate far from the theoretical throughput limits.

3.1 Tuning of DCF:

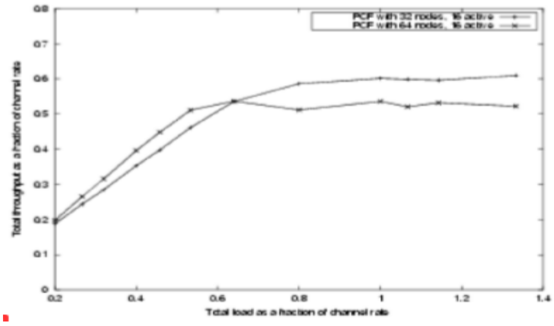

Figure 3.1: Effect of pulling overhead on network throughput.

The DCF mode of IEEE 802.11 exerts a CSMA/CA approach, which is in fact a 1-persistent random-access protocol with delay. Random access protocol works satisfactorily as long as network size is limited. Here by network size, we mean number of nodes that has pending data in BSS, i.e. in transmission range of central node. Load is defined as total bits transmitted by all stations in BSS per second. As network expands, competition for accessing shared wireless channel increases. This results in throughput degradation and more delay because of more collision and increased time spent for negotiating channel access. We need ordered way to schedule the channel access at high loads.

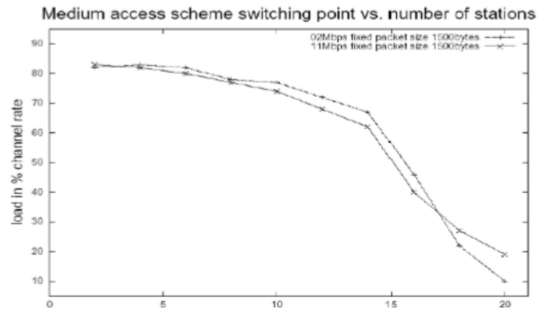

Figure 3.2: Extended learning to DCF

3.2 Related Work:

Evidently, there is almost no writing that oversees surveying overhead in PCF. Individuals have referenced the issue previously and there furthermore exist some proposed answers for arrangement with the issue. Other than that, individuals have depicted the essentialness of surveying for giving QoS administration in IEEE 802.11 WLAN. The new up and coming standard for QoS, IEEE 802.11 describes quick surveying based HCF ∗ that appoint time limited transmission opportunities to all stations. Visser have considered the impact of super frame length (CFP+CP), on the voice transmission over IEEE 802.11 in PCF mode.

3.2.1 Signaling Polling Information

Wolisz, have recognized a to some degree comparable issue and proposed arrangements dependent on certain and express flagging. As indicated by them, versatile hubs need to furnish the AP with appropriate surveying data, to diminish surveying overhead. Two techniques proposed by them for flagging surveying data is built over enhanced DCF.

1. Express Signaling: Node flag its transmission demand in the dispute time of the super frame by methods for a submitted short flagging edge.
2. Understood Signaling: Node exhibits by methods for the as of late transmitted casing that there are more bundles pending.

The main methodology included an extra overhead of the flagging bundle and the subsequent one requires a current edge structure to be altered.

3.2.2 STRP: Efficient Polling MAC

Oran Sharon and Eitan Altman propose STRP, an effective surveying MAC which endeavors the catch marvels and empowers synchronous surveying and transmission of the data parcel. Their proposition attempts to beat the wastefulness experienced (ineffective survey endeavors) when just piece of the stations has parcels to transmit by exploiting the catch marvels in the radio channel.

4. OPTIMIZING PCF MODE

4.1 Why PCF:

As of late, there has been an extending design towards PCs and workstations getting the chance to be flexible and versatile. Individuals need a similar administration quality as in the wired system. Future requests backing of voice and other continuous traffic. We trust PCF will better fulfil future needs. Existing investigations demonstrate the PCF capacity to give a superior nature of administration and backing of voice and constant traffic.

4.2 Solution methodology:

As we said earlier in section 3.5 our proposed solutions are based on a network monitoring layer. We have only modified the PC functionality; rest nodes work as usual. At present network monitoring layer does very simple job of classifying nodes as active node and passive node on the basis of observed traffic. Figure 4.1 shows solution model at PC. We start with explaining Priority Round Robin Scheduling (PRRS) that aims to reduce polling overheads. PRRS replaces simple round robin scheduling in PCF with priority round robin scheduling. On observing results of PRRS, we design a protocol to further enhanced its performance by dynamically adapting CFP repetition interval. We have discussed CFP adaption algorithm after showing the simulation results of PRRS, in chapter 6.1. Dynamic Switching Protocol (DSP) is our next proposed protocol that aims at exploiting coexistence power of PCF and DCF and merges better half of both modes. We have suggested various criteria to decide switching point for dynamically switching between two modes PCF and DCF

4.3 Result Summary

PRRS shows better results than PCF with RRS, especially when less than 75% node have pending data to send. It suffers from higher delays when percentage of active nodes reaches 75% and more. We have discussed possible reason for this in section 4.4. DSP requires extensive experimentations. We have seen improvements in both throughput and mean delay.

We have used different CFP repetition intervals, while experimenting with PRRS. We varied the parameter in accordance with number of nodes in network. In next chapter we will show effect of this parameter on PCF performance

5. CONCLUSION

IEEE 802.11 MAC needs powerful adaption to improve its presentation. Static arranged MAC execution digresses a great deal from as far as possible. We have proposed a system observing the based way to deal with surmised the system size and burden and progressively adjust MAC. Our methodology includes almost no overhead and carefully pursues the standard, without requesting any change in existing casing organizations and access techniques. The best thing about our methodologies is that they include only one extra system checking layer at a passageway (PC) and rest all station usefulness stays unaltered.

PRRS that replaces basic Round Robin Scheduling in PCF fundamentally defeats the effectiveness of the surveying plans particularly when a little division of stations has information to transmit and when the traffic burden is moderate. We have accomplished around 10% to 15% improvement in throughput. By decreasing ineffective surveying endeavors when a couple of hubs in BSS have information to transmit, it lessens mean bundle delays. This makes it progressively reasonable for taking care of continuous information and interactive media traffic.

DSP that characterizes the convention for dynamic exchanging among PCF and DCF opens another way to misuse conjunction of DCF and PCF mode and to blend better 50% of both the modes. We have likewise given different approaches to estimated size and traffic load, for characterizing perfect exchanging focuses. Our concept of conveyed DSP would build the system limit and upgrade execution in an impromptu system.

We have demonstrated the requirement for dynamic adaption of CFP reiteration interim for guaranteeing both better throughput and decency. Around 10-20% throughput variety is seen by utilizing an alternate arrangement. Our CFP Adaption convention achievement completely adjusts the CFP rate to suit the present system load. CFP adjusted PCF has accomplished execution practically near or far and away superior to statically designed PCF.

6. SUGGESTIONS FOR FUTURE RESEARCH

Our present rendition of PRRS presents slightly more postponements for certain hubs when the quantity of dynamic hubs∗ approaches the absolute number of hubs. We have to execute an administration separation instrument to needs hubs that have not been surveyed in CFP, to send an information bundle in CP. There is a need to investigate the elective Bi-level criticism booking approach. Regardless of whether Bi-level criticism booking is adequate, when we need different input planning, how to change the number of levels in criticism planning progressively relying on the ebb and flow traffic burden and system estimate, and so on., are as yet open for research and further experimentation.

A confined variant of DSP needs a superior estimation of traffic burden to characterize exchanging focuses. We have proposed different options for that, however, there is a need to broadly investigate these choices and do thorough examinations. Structuring the dispersed variant of DSP is an extraordinary test in itself. It requires a vigorous convention for the bunching of hubs and PC determination. Numerous security-related issues∗ should be settled for conveying appropriated DSP.

CFP Adaption algorithm is only an initial move towards dynamic adaption of setup parameters. The calculation should be refined further. Utilizing the system checking layer, we have to structure a convention for adjusting other design parameters like least CW estimate, RTS/CTS edge, and so forth. CFP Adaption algorithm is just a first step towards dynamic adaption of configuration parameters. Algorithm needs to be refined further. Using the network monitoring layer, we need to design protocol for adapting other configuration parameters like minimum CW size, RTS/CTS threshold, etc.

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