PERFORMANCE ANALYSIS OF TRAFFIC ORIENTED PCF IN WIRELESS LOCAL AREA NETWORK

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Abstract : Wireless networks are better than the wired networks they provide a low-cost alternative to the traditional system. Wireless LAN uses the IEEE 802.11 standard. There are basically to methods to access the medium – Distributed coordination function (DCF) and Point coordination function (PCF). To improve the PCF a large work is performed and new schemes were proposed like Modified PCF, Dynamic PCF, ICF, BD-PCF, MM Scheme, etc. The PCF transmit the single packet at a time in the uplink and downlink communication. The new scheme is proposed, TOPCF scheme which checks the load of the traffic. The TOPCF scheme's behavior is decided according to the number of packet at node. The proposed TOPCF scheme increases the throughput and decreases the delay in the WLAN. For PCF delay is 1158 µs while for TOPCF it is 599 µs for 50 nodes which is approximately 50% reduction in the delay. PCF gives 31.65 % throughput for the 50 nodes while for TOPCF it is 34.75 % which is higher than PCF. The TOPCF performs better than the PCF. So TOPCF scheme enhances the Quality of Services.

Index Terms - PCF, WLAN, QoS, Delay, TOPCF.

I. INTRODUCTION

The Wireless LAN is one of the rising technology providing users with network connectivity without a wired network. WLANs supply high bandwidth to users in a specified limited geographical area. The architecture of WLAN is the same as Local Area Network (LAN)'s except that the transmission happens via radio frequency (RF) or Infrared (IR) and not through physical wires [1]. These wireless technologies are playing an increasingly prominent role in the entire Internet infrastructure. IEEE 802.11 is most widely and rapidly used standard now days for its simplicity and robustness. As wireless medium is a shared medium, so as more and more devices demand the bandwidth, performance has become a crucial issue of concern [2].

1.1 Wireless Local Area Network (WLAN)

The architecture of WLAN is the same as Local Area Network (LAN) except that the transmission takes place via radio frequency (RF) or Infrared (IR) and not through physical wires/cables [21], [28], and at the MAC sub-layer, it uses different standard protocol. Wireless network allows nodes to communicate with each other wirelessly. WLAN provides connections to the IP networks and VoIP applications [22] already running over IP networks. Consequently, these two technologies are merged to incorporate VoIP over WLANs (VoWLAN) [4].

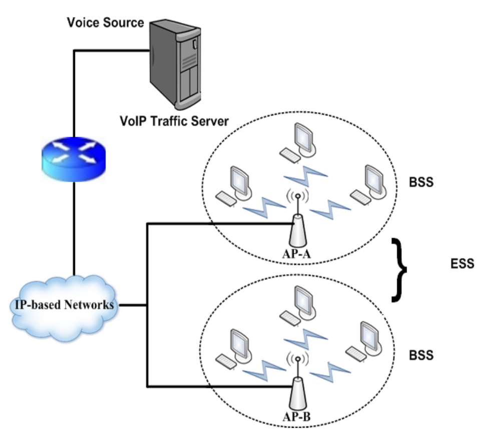

Fig.1.1. Voice over WLAN [1]

WLANs are an option to the high installation and upholding costs incurred by conventional additions, deletions, and changes experienced in wired LAN infrastructures. Wireless network allows nodes to communicate with each other wirelessly. It can be configured in two ways [1]:-

- Infrastructure mode.
- Infrastructure less mode

An infrastructure based wireless network has several nodes, called stations (STA) that are connected to access points (AP). Stations are the terminals with access mechanisms to the wireless channel and in radio contact with the AP. The stations and the AP both are within the same radio coverage area form a basic service set (BSS) [3]. In figure – 1.2 two BSSs – BSS1 and BSS2 are shown which are connected via a distribution system. A distribution system connects many BSSs to form a single network and extends the wireless coverage area. This network is called an extended service set (ESS) and has its own identifier, the ESSID.

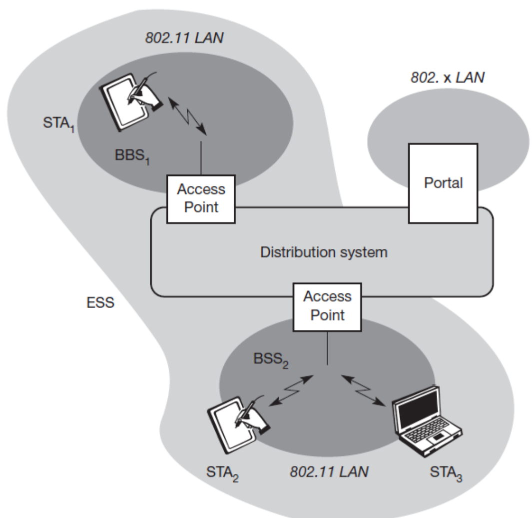

Fig. 1.2 Infrastructure-based WLAN [3]

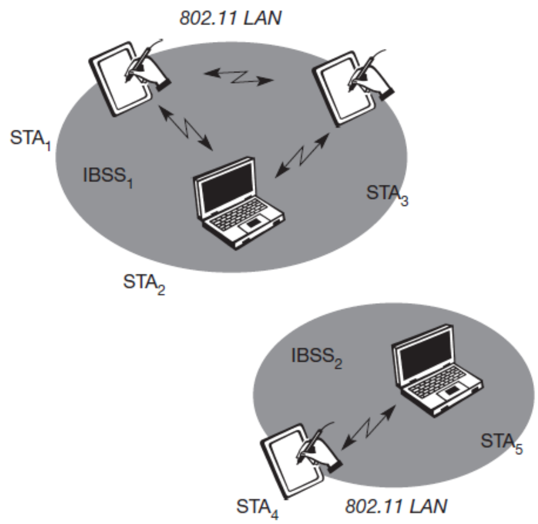

Fig. 1.3 Infrastructure less or ad-hoc WLAN [3]

IEEE 802.11 allows the architecture of ad-hoc networks between different stations by forming one or more independent BSSs (IBSS) [23], [24] as shown in figure 1.3. In this case, an IBSS comprises a group of stations using the same radio frequency. In figure 1.3 stations STA1, STA2, and STA3 are in the IBSS1, STA4 and STA5 in the IBSS2. It means that STA3 can communicate directly with STA2 but not with STA4. Several IBSSs can either be formed via the distance between the IBSSs or by using the different carrier frequencies [26], [26].

1.2 IEEE 802.11Protocol Architecture-

The IEEE 802.11 standard only covers the physical layer PHY and medium access layer MAC [3], [19]. The basic works of the MAC layer is to medium access, fragmentation of user data received from upper layers [20], and encryption. IEEE 802.11 defines two access methods in MAC Sub layer as shown in fig. 1.4 - Distributed Coordination Function (DCF) and Point Coordination Function (PCF).

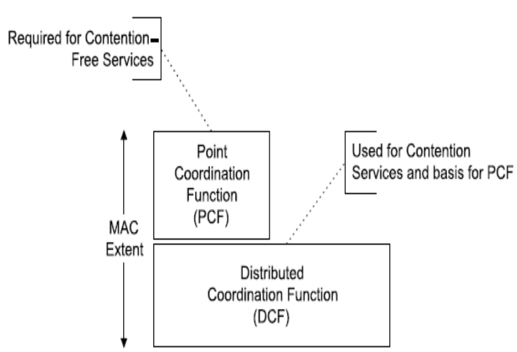

Fig.1.4. MAC Sub layer [5]

1.3 Wireless Channel Access Methods –

Wireless LAN standard 802.11 defines two modes for wireless channel access. These are distributed coordination function (DCF) and point coordination function (PCF) [6].

DCF mode is based on random access of channel that is best suited for non real-time traffic, that is, bursty traffic, and PCF mode is based on polling mechanism that is more suited for real-time traffic. Most of the early days WLAN devices do not support PCF mode. During early years of the DCF mode was supported in WLAN devices, but in recent years, the DCF as well as PCF mode is being recognized [32], [33].

The DCF mode of channel access is based on carrier sense multiple accesses with collision avoidance (CSMA/CA) [27]. The timing diagram of DCF scheme is shown in Figure 1.5. In the DCF access mode, control to the access of channel is distributed between all the stations. The DCF access method is based on the CSMA/CA principle in which a host, wishing to transmit, senses the channel to check whether it is free or not. On finding the channel free, the host waits for a random amount of time before transmitting [7].

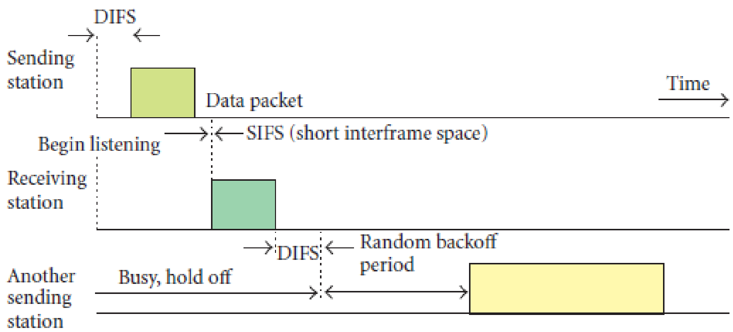

Fig. 1.5 DCF [6]

In the PCF mode of operation, the access of the wireless channel is centralized by a polling-based protocol controlled by the central point called point coordinator (PC). The access point (AP) [29], [30], [31] serves as PCs. The PCF is shown in figure 1.6. The PCF mode provides contention-free service to the wireless stations. In the PCF mode of channel access, a frame is divided in two parts: one is contention-free period (CFP) and another is contention period (CF). The PC denotes the start of the contention-free period by sending a special frame called beacon frame that contains the list of poll able stations and other polling management information. The CFP is repeated after a defined fixed interval. The CFP and CP jointly make a super frame [6].

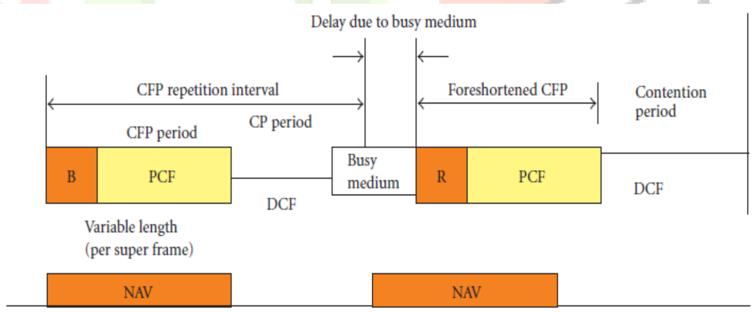

Fig. 1.6 PCF [6]

After transmitting the beacon, the PC starts polling the stations one by one in the order indicated in the beacon frame. In CFP, if the centre point PC has a data packet to send to a station, it sends the polling packet on the data packet, and if the PC does not have data to send to station, then it transmits only a polling packet. The polled station now responds by sending the uplink ACK packet and sends any uplink data on the ACK packet. If polled station does not have any data packet to send in the uplink, then it just sends a null packet in response to the poll performed by PC.

1.4 Inter Frame Space –

The space between the different frames is called the Inter frame space (IFS). In another words, IFS is the space between the two consecutive frames. The IFSs are as following [3] –

1) SIFS (Short Inter Frame Space)
2) PIFS (PCF Inter Frame Space)

3) DIFS (DCF Inter Frame Space)

The research paper is divided in five sections. In first section the brief idea of WLAN, WLAN Mode, IEEE 802.11 etc. is given. In second section the previous work has been discussed. In third section the new medium access scheme is proposed. In fourth section result is given. In last section conclusion is given.

II. Literature Survey

In [9], Point Coordination Function (PCF) with Signaling Scheme was proposed. IEEE 802.11 is the first protocol from the family of IEEE 802.x protocols that has been built to provide support for traffic with real time constraints. Based on a centralized polling scheme the high overhead is assumed to lead a high delay with low variance and a dramatic decrease in overall throughput [9]. A Round robin scheduler is used for all stations sending audio packets. Station with no audio traffic will not be polled during the Contention Free Period. If not all stations can be polled during a super frame interval due to the given CFP length restriction, the scheduling will restart at the next station that could have been polled in the last interval.

To improve the PCF a signaling scheme was introduced [9]. This scheme avoids unsuccessful polling attempts. The AP might use the information available from higher layers in the audio frames. For example, RTP provides an SSRC identifier to distinguish different audio flows. The access point might use this identifier to classify individual audio flows. RTP provides a marker bit and header extensions to carry payload dependent information like frame boundaries. Using this mechanism, lead to an explicit in band signaling. Audio frames are sent during the PCF. When the frame ends, the next polling attempt by the access point fails and the AP removes the station from its polling list. When the station restarts sending the audio packets, the first packet is sent in DCF mode of operation. The centralized scheduler detects the continuation of the audio flow and reassigns the station automatically to its polling list. This scheme avoids the unsuccessful polling.

In [4], the Modified PCF was proposed. Modified PCF [4] uses a distributed polling protocol (DPP) for real-time traffic. It is a substitute of the centralized polling scheme as used in the standard PCF. During the CFP, the modified PCF contains two transmission periods: the distributed polling protocol period (DPPP) and the real-time traffic downlink period (RTDP). The wireless stations send real-time traffic through the DPPP whereas the PC sends the same through the RTDP. A wireless station has to be in the polling list only if it has real-time data to transmit. To enter the polling list, the station sends an association request to the AP during the CP. To confirm that the station has been added to the polling list, the PC returns the polling-ID and transmission order assignment. Every station in the polling list maintains a counter, which is used to count the number of transmissions or the number of idle periods in the medium. A station will identify its turn to transmit a packet when the counter equals its transmission order as determined by the PC. It divides uplink transmission of CFP into intervals by which there is no polling overhead.

One another Modified PCF was introduced in [10]. In PCF the stations access the channel in Round Robin manner. To improve the PCF the modified PCF is proposed [10]. In M-PCF, stations access the channel in a hub-poll manner. In CP, if new stations contend for the channel successfully, the centre adds it into its polling list allots a polling sequence number for it and broadcast to other stations. In CFP, the centre polls the first station in its polling list. The second station is allowed access automatically after the first one without centre polling. But if no admission control is used as in PCF, it is very likely that too many users will use the higher priority class.

In [11], Dynamic PCF was discussed. The Dynamic PCF classify the network traffic into VoIP traffic and best effort, giving higher main concern to VoIP traffic by permitting only VoIP traffic to be sent during the CFP.

In [12] the M-M Scheme was proposed. The M–M scheme multiplexes the downlink VoIP packets into a larger multicast packet to decrease WLAN overheads. The downlink VoIP traffic first goes through a MUX in the voice gateway. The MUX replaces header of each voice packet with a compacted mini-header, which merges multiple packets into a single multiplexed packet, afterwards multicasts the multiplexed packet to the WLAN through the AP using a multicast IP address. All VoIP stations are set to be able to receive the packets on this multicast channel. The withdrawal is executed by a DEMUX at the receiver.

In [13], the Distributed Point Coordination Function (DPCF) was proposed. DPCF scheme which extends the process of the Point Coordination Function (PCF) defined in the IEEE 802.11 Standard to work over wireless networks without infrastructure. A station operates in three possible modes master, idle and slave. Any station which seizes the channel transmits its data and also forms a temporary dynamic cluster. Cluster membership is impulsive and soft binding: there are no clear relationship and disassociation processes and a station belongs to a cluster as long as it can receive the beacons broadcast by the master. As in the PCF, in any case, once a station is polled by the master, it may transmit a data packet to any other slave without routing all the data through the master. An inactivity mechanism is considered in DPCF to shun from the transmission of needless polls when there are no more data packets to be transmitted.

In [14] Bi-directional PCF (BD-PCF) was proposed. In this scheme the polled station can then acknowledge the reception of the data packet, by sending a data packet of equal duration of the downlink data packet to the AP. If the polled station has no data to transmit, it only acknowledges (ACK) the data packet, or responds with a null packet whether the AP launched a poll packet because of no data for the station. Since the period of uplink transmissions is predetermined by the period of downlink transmissions, the transmission time of stations in the polling list can be known in advance, from the data packets buffered for these stations at the AP. The AP can uphold the information related to the duration of the last downlink data packet sent to each station in the polling list, with a record. Similarly, each station can have knowledge of the duration of the last uplink data packet transmitted to the AP. Hence, the AP can approximate a proper extent of a CFP interval, based on own information on downlink packets and the polling list. After estimating the CFP interval, all stations revise their NAVs with CFP Max-Duration when the beacon is transmitted. With the CFP-Max Duration and the time gone to accept ACK, the station can determine the sleep period and position its wake-up timer at the commencement of CP.

In [15] Isochronous Coordination Function (ICF) was proposed. The ICF scheme says that at the commencement of an ICF cycle, the AP of a BSS broadcasts an ICF-poll frame. The ICF-poll frame is a single control frame engaged to poll the active stations concurrently while allowing them to self-adjust the transmission time slots in an adaptive mode. A status vector (SV) is incorporated in the ICF poll frame which is basically a sequence of polling bits, one for each admitted voice station. In each ICF cycle, voice stations transmit in assigned time-slots. Consecutive time-slots are divided by an SIFS period. Based on its polling position and the status of other stations, as indicated by the SV in the ICF-poll frame, an active station determines its time slot in the ICF cycle. In the SV, a "1" polling bit indicates that the equivalent station may broadcast a voice packet in the present cycle. Due to the inadequate number of time slots in an ICF cycle, all stations may not be polled, so a capable polling list management is implemented by using cyclic polling queue. A poll frame is broadcasted so that active stations can self adjust the transmission losses.

In [6] the Modified ICF was proposed. In Modified ICF the access point receives data from several downlink streams and joint into a single larger downlink packet. In the MICF scheme, at the start of an ICF cycle, the stations will send the uplink voice packets according to the entries in the Status Vector. When uplink broadcast is absolute, the AP will sense whether the channel is open for SIFS time interval or not. If it is free, then it will transmit the downlink voice packets. The downlink VoIP traffic goes through a MUX and replaces headers of each voice packet with a compacted mini-header of 2 bytes, which combines multiple packets into a single multiplexed packet then multicasts the multiplexed packet to the WLAN through the AP using a multicast IP address. The withdrawals performed by a DEMUX at the receiver. In modified-ICF employs multiplexing in downstream by which MAC layer overheads are reduced along with ICF in uplink traffic but in MICF there is no multiplexing in uplink phase and delay because of multiplexing of several packets.

In [7] the 2-Buffered Packet ICF was proposed. The 2-Buffered Packet ICF decreases the delay in WLAN using TDMA like time slots for transmission of voice packets. Two packets transmitted to the station in 2 - Buffered Packet ICF by AP in one time slot. It reduces delay by employing ICF but it transmits 2-packets in uplink and downlink broadcasts. It results in delay due to storage of packets. Also in [8] 3- Buffered Packet ICF was proposed similar to the 2 Buffered Packet ICF.

III. PROPOSED TRAFFIC ORIENTED PCF

To overcome the drawbacks of the PCF scheme, the Traffic Oriented PCF (TOPCF) scheme is proposed in this work. In this scheme the PCF works according to the Traffic load in the network.

With the introduction of bidirectional transmissions, the admittance to the WLAN channel for a station in the polling list to be approved for one SIFS interval after receiving the data packet from the AP. The polled station can then acknowledge the response of the data packet, by sending a voice packet to the AP. Now if the station has the more than five packets to send than three packets are transmitted in one slot, otherwise one packet is transmitted. By sending two packets, the station can send more data in less time to the AP. If the polled station has no data to transmit, it only acknowledges (ACK) the voice packet, or replies with a null packet whether the AP sent poll packet because of no data for the station. Therefore, the polling overhead can be minimized when the AP has downlink data for the stations in the polling list.

The improvement which is done in the work is that in every time slot assigned to AP, it sends three packets in downlink packet to the stations when it has more than five packets otherwise it transmit only one packet. The slots are separated by SIFS. The same happens in uplink traffic the station after getting time slot for transmission, the station sends three packets in one time slot to the AP in case when more than five packets at station otherwise one packet by station. The D1, D2, D3 etc. has the data packet either three packets or one packet depending on the total packet present at the AP and stations. The criteria of six packets or more is taken, which reduces the number of cycles for sending uplink and downlink data.

IV. Result Analysis

The results are obtained for the nodes in the WLAN from 5 to 50 for Traffic Oriented PCF. From the results, it is clear that the increase in the node decreases the delay in the network. For 5 nodes the delay is 2450 µs while when the nodes are 50 then delay becomes 599 µs. The throughput decreases with increase in the number of nodes. For 5 nodes throughput is 91.67% while for the 50 nodes the throughput is 34.75%.

The PCF delay and the PCF throughput graphs are shown in the fig 4.1 and 4.2.

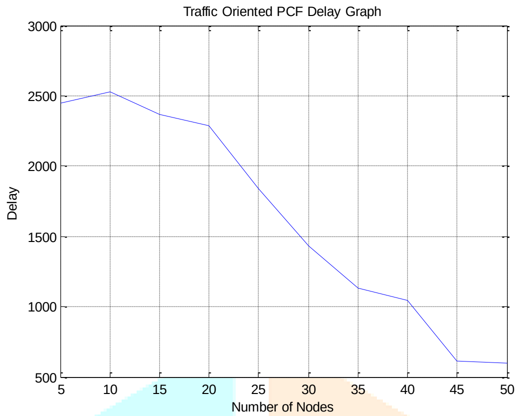

Fig. 4.1 Delay Graph for TOPCF

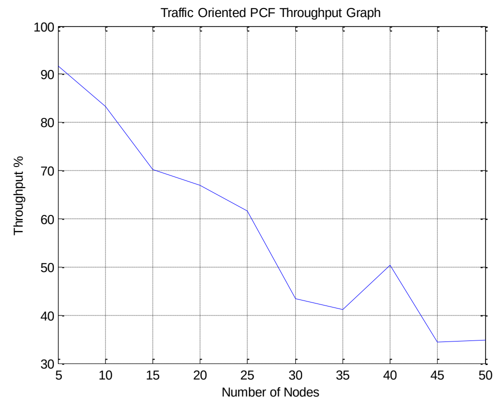

Fig. 4.2 Throughput Graph for TOPCF

V. Conclusion

The fast growing number of the wireless users has increased the value of WLAN. The demand of WLAN oriented users is increasing day by day. A lot work is performed to enhance the quality of services of WLAN. The QoS is increasing day by day due to the lot of research work in the WLAN.

In this work the Traffic Oriented PCF is proposed to overcome the limitations of PCF. The PCF transmit the single packet at a time in the uplink and downlink communication. The proposed TOPCF scheme checks the load of the traffic. If the station / AP has more than 5 packets than three packets are transmitted otherwise single packet is transmitted. The double behavior is used according to the number of packet at node. The proposed TOPCF scheme increases the throughput and decreases the delay in the WLAN. For PCF delay is 1158 µs while for TOPCF it is 599 µs for 50 nodes which is approximately 50% reduction in the delay. PCF gives 31.65 % throughput for the 50 nodes while for TOPCF it is 34.75 % which is higher than PCF. The TOPCF gives the better results than the PCF. So TOPCF enhances the Quality of Services.

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