Transmission Control Protocol over Wireless LAN

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Abstract

802.11 standards based WLAN is one very successful technology in commerce. Huge number of WLAN has been deployed across the world. It?s very worthwhile to investigate link characteristics of WLAN and its effects to upper layers, especially TCP protocol which is used by numerous network applications. The 802.11 standard is firstly introduced in this section.

Index terms—

The factors of the 802.11 standard which affects link characteristics will be described in the following sub-sections, such as network architecture, medium access method, etc.

1 III.

Network architecture BSS (Basic Service Set) is the basic building block of 802.11 LAN. It includes two or more mobile stations which can directly communicate with each other through wireless medium.

One DS (Distribute System) can be used to interconnect multiple BSSs. In this situation, Each BSS has one special station—AP (Access Point). In addition to act as one station, AP also provides access to DS for other stations in this BSS.

The There is another network type in 802.11, Ad hoc Network. In ad hoc network, there is no DS. There is just one independent BSS and there is no station act as AP. Stations in ad hoc network communicate with each other directly or relaying by intermediate stations.

WLANs with different network architectures own very different link characteristics. The next section will describe how the two network types affect link characteristics in detail.

IV.

2 DCF and PCF

The To send a packet, a station X first listens to the channel for time T DIFS . If there is silence for T DIFS , X proceeds with the transmission (e.g., station A in figure 4); otherwise, X waits for the first TDIFS of silence after the current busy period, then backs off for a random interval (e.g., station C in figure 4). For each packet, X initializes a contention window size W to be W min . X sets a timer to a random integer uniformly distributed over 0, 1 ? W, and decrements it after every T slot period of silence, but suspends it if another station Y begins transmission -this suspension spans the acknowledgment as well (see below); when the timer reaches 0, X begins transmission of its packet (e.g., stations B, D and E in figure 4). Time is thus discretized by T slot to support back-off timers, and a transmission typically occupies multiple slots. The packet is transmitted in its entirety, even if there is a collision, since X does not do collision detection.

The receiver uses the CRC bits in each packet to check for collisions and, if no error is detected, sends an ACK (acknowledgment) after time T SIFS (SIFS is short inter-frame space; T SIFS < T DIFS). If the sender does not detect an ACK within an ACK-timeout, it enters a retransmit back-off: if W is smaller than the maximum window size W max (W=2^m*W min, m is the number of retransmission attempts), then W is doubled; X sets a timer to a value uniformly chosen from less than the new W, and retransmitted when this timer expires just as before. If retransmission time exceeds d, the packet is thrown away and new packet will be transmitted. Finally, a station must separate two consecutive packets by a random back-off, even if the channel is idle for DIFS after the first transmission (e.g., station B in figure 4.)

In the basic mode of DCF, back off is designed to avoid contention. The contention window size affects MAC layer's throughput. If it's too small, too many collisions happen; otherwise, stations idle for too much time and bandwidth is wasted. The contention window size also affects RTT of wireless link seen by upper layer.

In DCF, RTS/CTS is adopted to solve hidden station problem and to alleviate effects of possible collisions. RTS and CTS is short control message. They are used to acquire the channel for a period time by one station; other stations update their NAV (Network allocation Vector) according to received RTS/CTS and do not transmit frames in these periods. Thus only RTS/CTS may collide with each other; the adverse effect is much less than collisions among long data packets.

AP can also use PCF based on DCF as the medium access method. The PCF provides contentionfree frame transmission. The AP use Beacon frame which contains one DTIM element to begin one CFP (Contention-Free Period) and other stations update their NAV according information in beacon frame. In this period, AP polls other stations and other stations can not initiate data transmission. AP can send frame to other stations and if the station which is polled has packets to transmit, the station will transfer frame. The following figure is one example for frame transmission in PCF.

02

Figure 1: Introduction 02 .

1

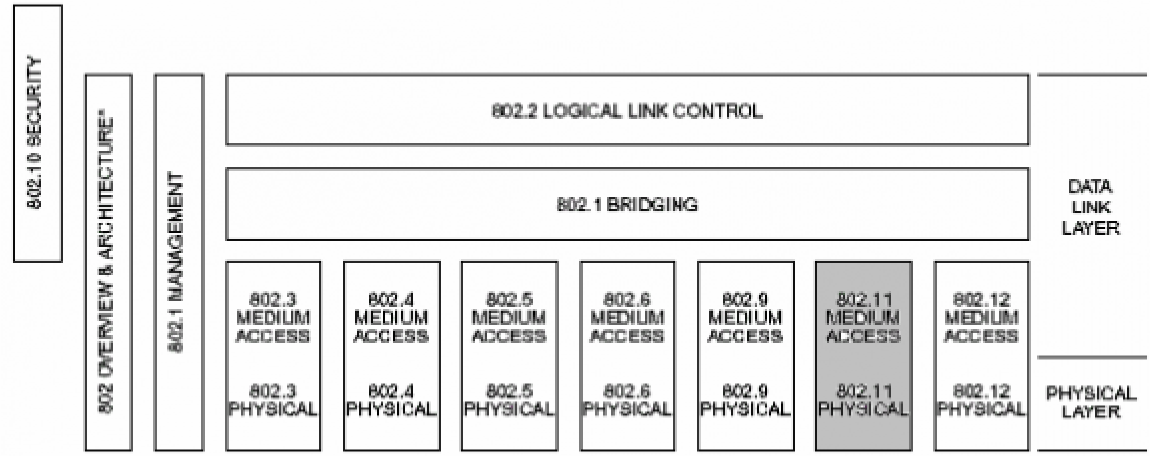

Figure 2: Figure 1 :

3

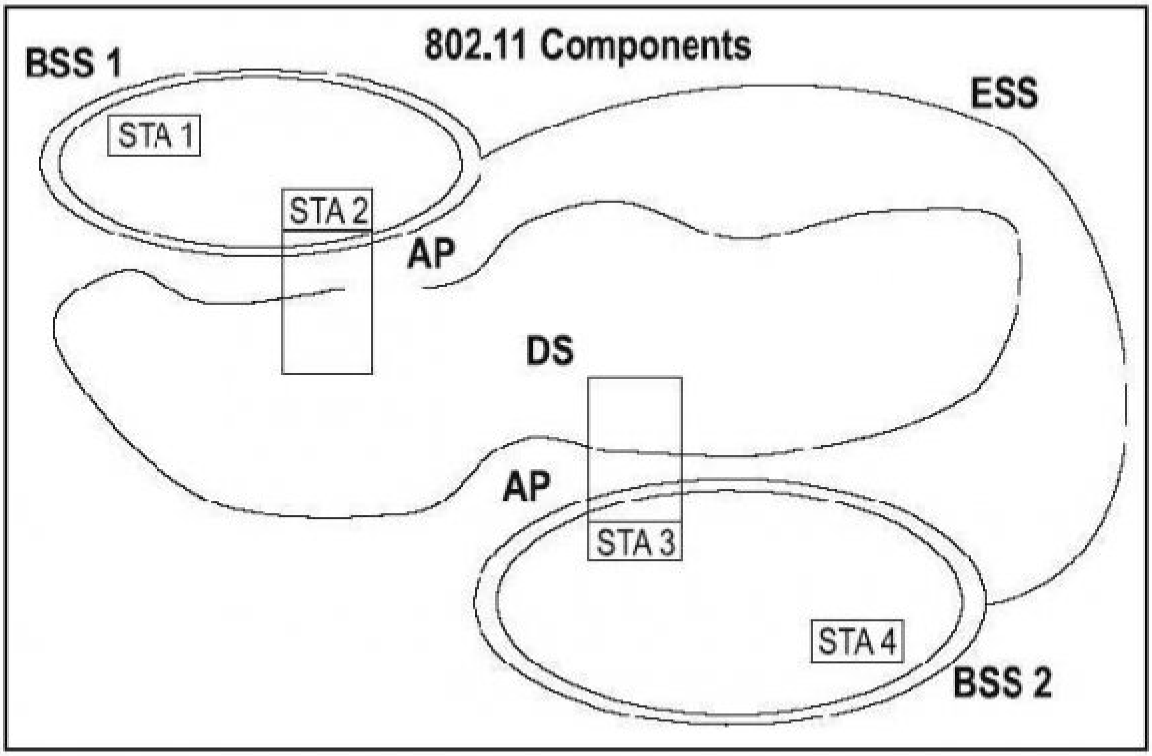

Figure 3: Figure 3 :

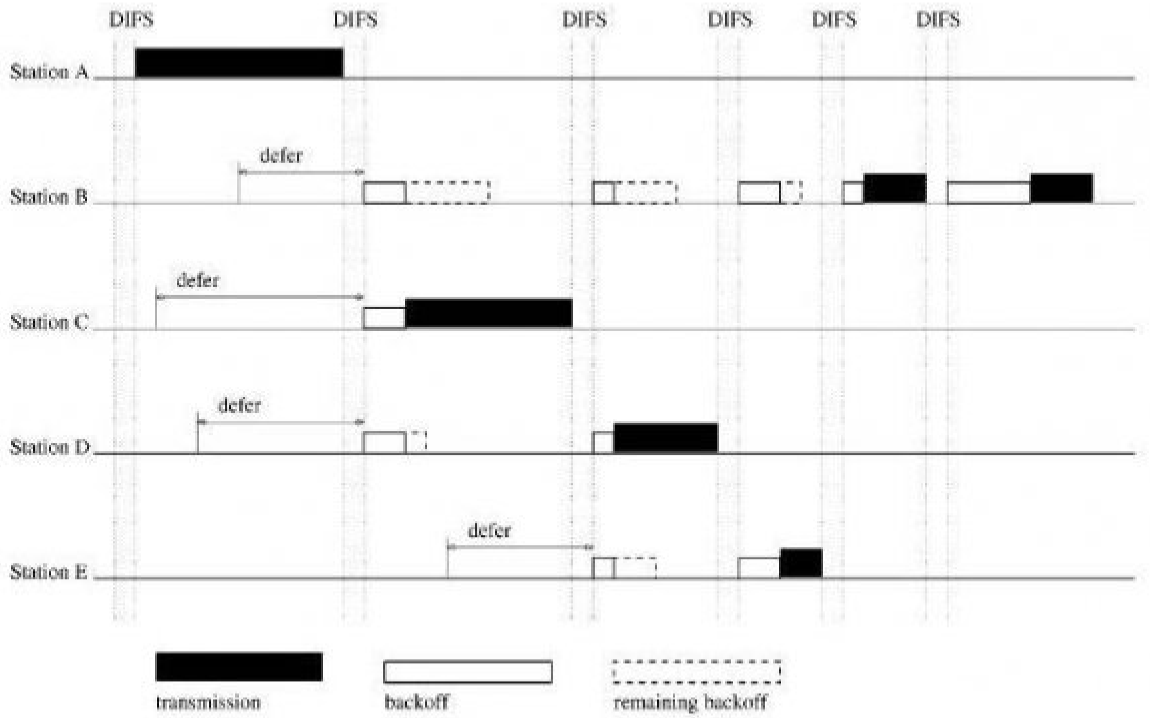
DIFS
DIFS
DIFS
DIFS
DIFS
DIFS
Station A
Station B
Station C
Station D
Station E
defer
defer
defer
defer
transmission
backoff
remaining backoff

Figure 4:

	802.11 MAC Layer		
802.11 PLCP	802.11a PLCP	802.11b PLCP	802.11 PHY Layer
802.11 PMD	802.11a PMD	802.11b PMD	

Figure 2 : The 802.11 Standard

Each physical layer includes two sub-layers, PLCP and PMD. PLCP is one convergence procedure to map MAC PDU into a frame format designed for radio transceiver of corresponding PMD layer. PMD layer interacts with PLCP layer and provides the actu to transmit data on medium. The following tabl summarizes the technical details of different PM layers of 802.11.

Table 1 : PMD details of 802.11

	802.11	802.11b	802.11a
Frequency	2.4G	2.4G	5G
PHY	FHSS, DSSS,IR	DSSS	OFDM
Data Rate (Mbps)	DSSS: 1, 2 FHSS: 0.5-4.5 IR: 1, 2	1, 2, 5.5, 11	6, 9, 12, 18, 24, 36, 48, 54
Channel	4	4	8

*[Note: *IR physical layer is seldom used in practice.]*

Figure 5:

Figure 6:

[Mishra et al.] *An Empirical analysis of the IEEE 802.11 MAC Layer Handoff Process*, Arunesh Mishra , Minho Shin , William Arbaugh . `citeseer.nj.nec.com/541775.html`

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