CHAPTER 2

Related Works

2.1 Classification of cross-layer design for wireless multimedia

In [11], the author classified cross-layer architectures for video transport over wireless networks into five categories:

1. **Top-down approach:** the higher-layer protocols optimize their parameters and the strategies at the next lower layer.
2. **Bottom-up approach:** the lower layers try to insulate the higher layers from losses and bandwidth variations.
3. **Application-centric approach:** the APP layer optimizes the lower layer parameters one at a time in a bottom-up (starting from the PHY) or top-down manner, based on its requirements.
4. **MAC-centric approach:** the APP layer passes its traffic information and requirements to the MAC, which decides which APP layer packets/flows should be transmitted and at what QoS level.
5. **Integrated approach:** strategies are determined jointly by all the open system interconnection (OSI) layers.

2.2 Transmission by signaling

The method Ivaylo Haratcherev [13] proposed is Application-centric approach according to classification of [11]. As Figure 2.1 shows, the system gets informations of SNR (Singal to Noise Ratio) from PHY layer and translates into throughput to video rate control in APP layer adjusting the compression ratio of video rate encoder. While the state of wireless network is unstable, SNR will rapidly decrease. Thus, if adjusting the encoded bit-rate of video encoder in real-time from streaming server, throughput can be controled. And the author calculates the highest throughput from different SNR and modulation (Figure 2.2). Then he adjusts modulation to get the optimal throughput by using radio rate control. In addition, the author designs channel state predictor and medium sharing predictor for different bit-rate videos and medium sharing interfaces. Channel state predictor determines whether channel is in static or dynamic (movement) state. And medium sharing predictor determines whether wireless network is a medium sharing interface. For example, medium sharing interface is like IEEE 802.11, and medium non-sharing interface is like satellite communication. As Table 2.1 shows, it can improve performance by different states for wireless video streaming.

But when the method, which uses SNR to translate throughput, is adopted, the response is too slow. Because the changing speed of SNR in real-time is too fast, the response of APP layer cannot follow it. The system must collect enough information of SNR in PHY layer, so that the bit-rate of conpression can be calculated by APP layer.

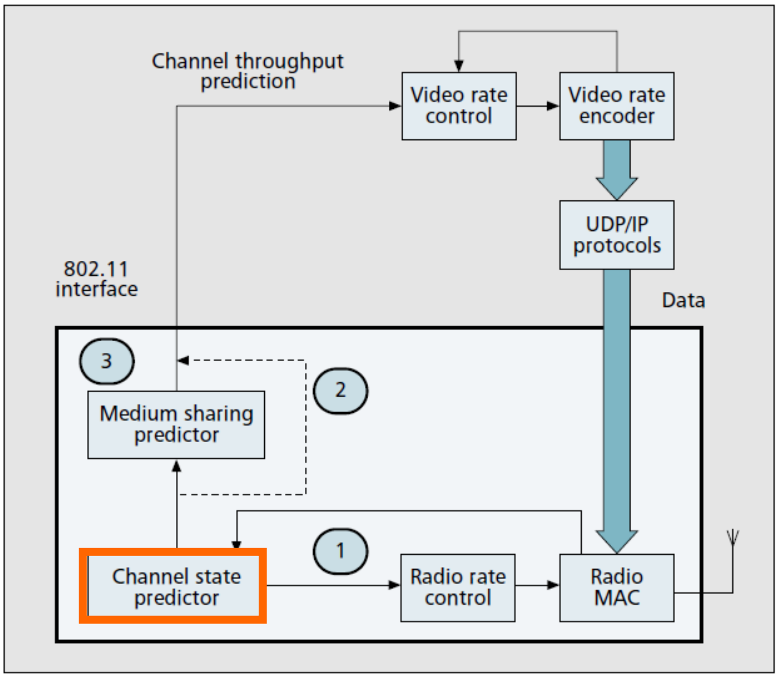

Figure 2.1: (1) Channel state prediction used for link adaptation; (2) channel throughput prediction without considering medium sharing; (3) channel throughput prediction considering medium sharing [13].

Medium	Static channel		Dynamic channel (movement)	
	Low-quality video	High-quality video	Low-quality video	High-quality video
No sharing	–	–	1	1 + 2
Sharing	(3)	3	1 + 3	1 + 3

Table 2.1: Configuration for different video streaming scenarios; the numbers refer to the paths in Figure 2.1.

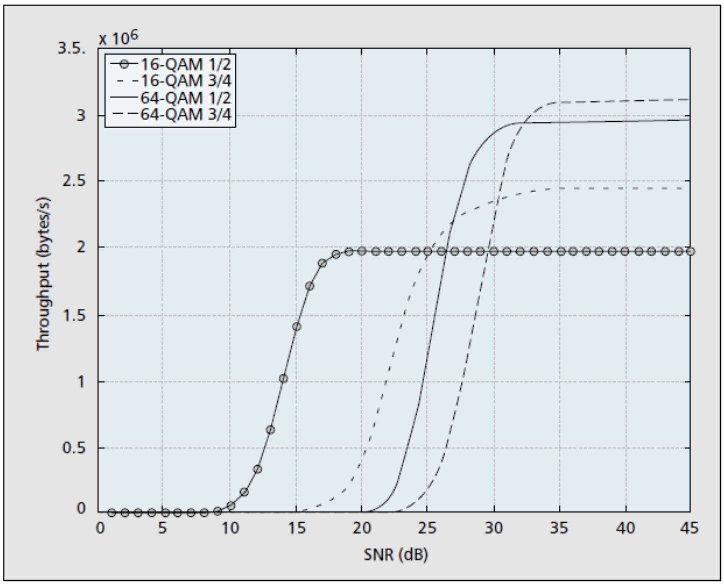

Figure 2.2: Throughput vs. SNR for some 802.11a modulation schemes [13].

2.3 Transmission by packet bursting

[9] proposed TS-DCF (Timestamp DCF). TS-DCF is designed for video streaming. The timestamp for video packet can be got by RTP (real time protocol) header (Figure 2.3). The packets of the same timestamp have the same type (I/P/B type) of video frame. Thus, TS-DCF transmits the same type of video frame by packet bursting (Figure 2.4). As classification of [11], TS-DCF is MAC-centric approach. In IEEE 802.11 DCF, if the station in the sender transmits a packet successfully, the station will receive an ACK, then waiting a backoff time for next transmission. Packet bursting doesn't have to wait the backoff time and continue the next transmission. But the station has to notify how many packets other stations transmit in a packet bursting first. While the transmission starts, packet bursting occupies the channel until the transmission finishes. TS-DCF is different from IEEE 802.11e EDCA. TS-DCF is motivated to realize MAC level semantic-based transmission for video applications. In EDCA, packet bursting is employed to increase medium utilization.

But using packet bursting can get higher delay time in wireless network with many collisions. In this situation, the delay time is higher than others without packet bursting.

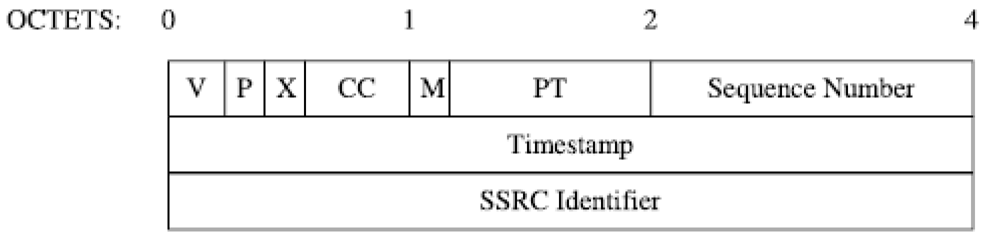

Figure 2.3: RTP header format.

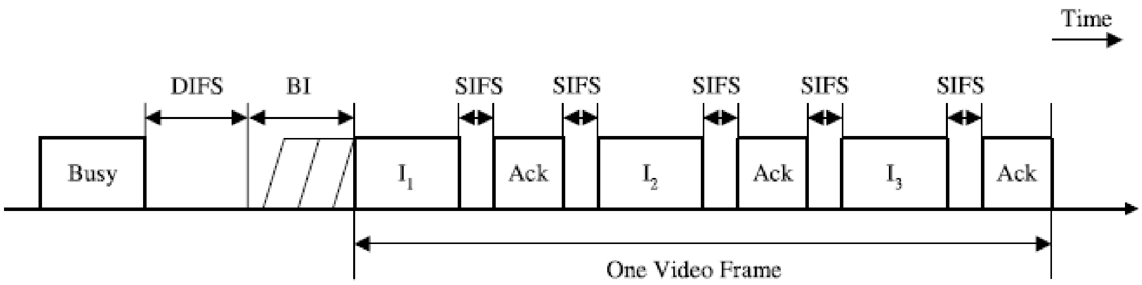

Figure 2.4: Transmission diagram of TS-DCF.

2.4 Transmission by TAR

Time-based Adaptive Retry (TAR) mechanism [4] is proposed by CMU Advanced Multimedia Processing Lab. According to classification of [11], TAR is MAC-centric approach. TAR improves the retransmission mechanism for video packet in DCF. If collisions occur in backoff interval, the count of collisions is calculated by retry counter. If the transmission fails and retry count reaches to maximun, the packet is discarded. The author uses time limit instead of retry count, and calculates different deadline of each packet from APP layer to MAC layer. Discard the packet while deadline is due. This saves the waiting time of packet. As Figure 2.5 shows, the method of conventional 802.11 is as fallows. If retry count is greater than N (retry limit), discard the packet. But the method of TAR is as fallows.

If current time is greater than retransmission deadline, discard the packet.

As Figure 2.6(a) shows, if the waiting time is greater than the time of the 3rd retransmission, continue the retransmission. And as Figure 2.6(b) shows, if the waiting time is less than the time of the 3rd retransmission, discard the packet. The advantage is limiting the time of deadline for each packet by cross-layer. If the packet is more important, give the packet a longer deadline.

Using TAR can improve the performance, but TAR is not suitable to IEEE 802.11e. If TAR can use multi-level queue for IEEE 802.11e, the performance can be improved more.

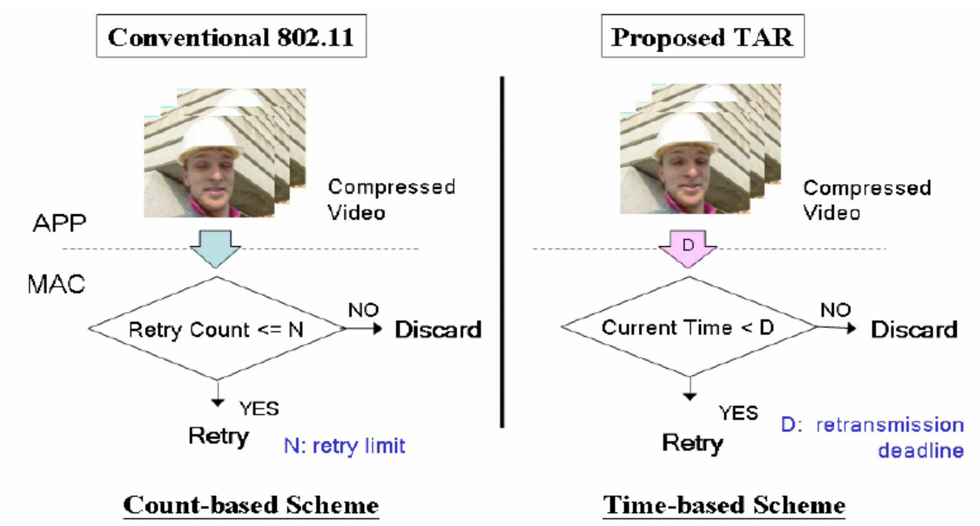

Figure 2.5: Main idea of TAR [4].

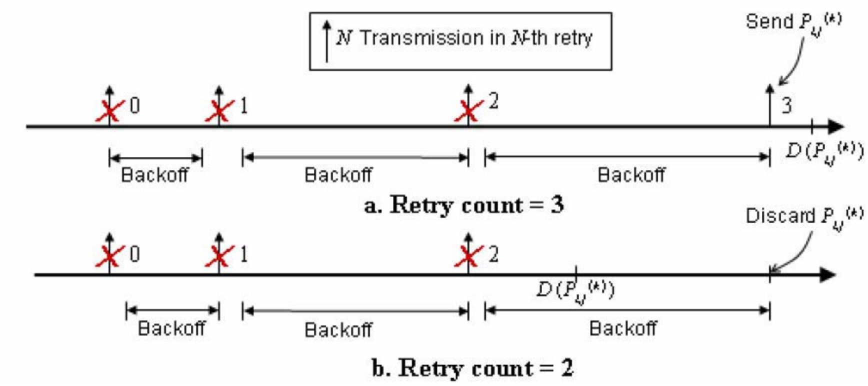

Figure 2.6: Example of the TAR process [4].

2.5 Transmission by classification of video slice

[15] classified different video slices for H.264/AVC to different ACs (Access Categories) for IEEE 802.11e. According to classification of [11]. The method is MAC-centric approach. As Figure 2.7 shows, The author classifies five types of video slice in NAL (Network Abstration Layer) for H.264/AVC. They are Parameter set infomation, IDR (Instantaneous Decoding Refresh) picture slice and Parition A/B/C, and then the auther maps them to different NRI (Indication of NAL Referentce) values. Finally, he uses mapping algorithm maps into different ACs. As Table 2.2 shows, The author puts the different data into the different ACs, and compares with EDCA and DCF. He puts the different video slices for H.264 streams into different ACs, but H.264 streams and background data are put into different ACs in EDCA. Finally, because there is only a queue in DCF, all data must be put in a queue.

The system improves performance by classification of video slice mapping into different ACs, but the system still uses retry limit for retransmission as Table 2.2 shows. According to IEEE 802.11e using multi-level queue, the probability of collisions is higher than IEEE 802.11. Besides the collisions in different nodes, there are virtual collisions in different queues. While using retry limit in backoff interval, the waiting time of packets may get a longer time. Thus, this will waste too much time in backoff interval.

Cross-layer Architecture	AIFS (μs)	CW_{min}	CW_{max}	Queue length	Max retry limit
Parameter set information (AC3)	50	7	15	50	8
IDR and partition A (AC2)	50	15	31	50	8
Partitions B and C (AC1)	50	31	1023	50	4
Background traffic (AC0)	70	31	1023	50	4
EDCA					
H.264 streams (AC2)	50	15	31	50	8
Background traffic (AC0)	70	31	1023	50	8
DCF	DIFS(μs)				
All traffic	50	31	1023	50	8

Table 2.2: 802.11 (IBSS) MAC parameters [16].

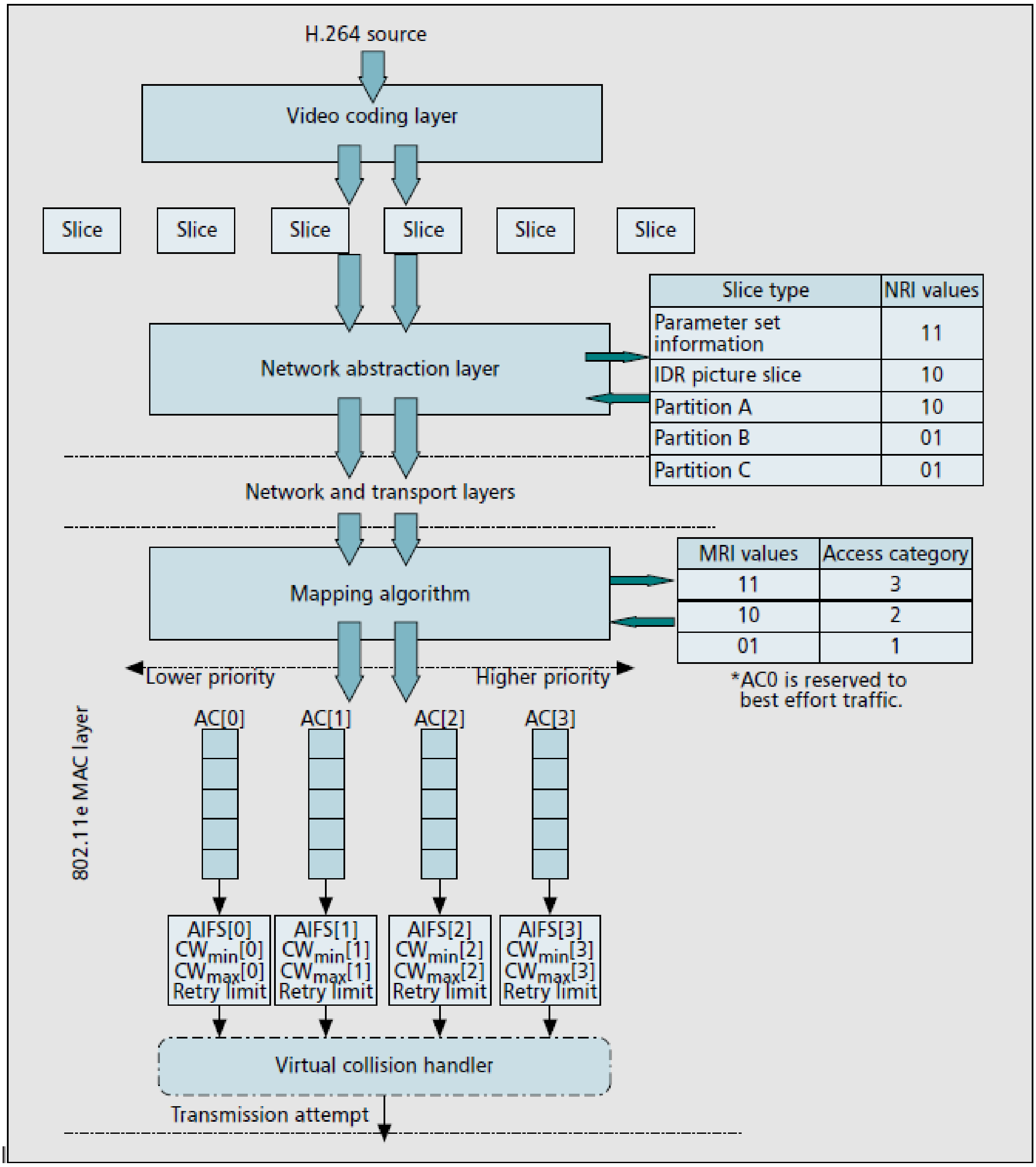

Figure 2.7: Cross-layer QoS architecture [16].

2.6 Summary

[11] classified five class cross-layer designs for wireless multimedia. [13] proposed transmission by signaling for Application-centric approach. [9] proposed TS-DCF by packet bursting. And [4] proposed TAR instead of retry limit. Finally, [15] proposed classification of

different video slices mapping into different ACs. At next chapter, we proposed MAC-centric cross-layer design for video streaming. Our goal is improving performance of transmission for video streaming in wireless network with many collisions.