Investigation of WLAN throughput

Pre-laboratory exercises

As an introduction to IEEE 802.11 WLANs and supplementary standards are available in background material for the laboratory works.

Questions:

1. What are the main differences between IEEE 802.11, 802.11a, 802.11b, 802.11n, 802.11ac? Hint: Concentrate on the physical layer differences, bandwidths, modulations, and other physical layer processing methods.

2. Find out the frequency range of IEEE 802.11 in 2.4 and 5.8 GHz in Europe. How many WLAN channels are available in these frequencies? How the 802.11n can create the channels in 5.8 GHz?

3. Explain using the spectrum mask shown in Figure 1, how IEEE 802.11 radio channels should be used to have as many channels at (2.4 GHz bandwidth) as possible operating at the same time without causing interference to each other.

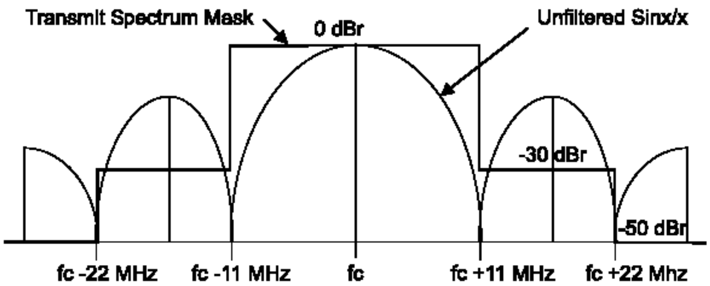

Figure 1 The transmit spectrum mask of a single channel in IEEE 802.11b [IE^{3}99a, pp. 219].

4. What are the structures of the following frames: MAC data, ACK, RTS and CTS frames?

5. Explain the different parts of the DSSS physical layer in IEEE 802.11. Present the PPDU frame structure.

6. Explain how the CSMA/CA channel sharing scheme works.

7. Consider that STA A wants to transmit a single frame to STA B. Present the frame exchange between STAs A and B when RTS/CTS is used/not used. Calculate the maximum throughput (use UDP SDU length 1470) achieved for UDP traffic using the information presented in Table 1. Calculate the throughput using both long and short preambles. Remember to take into account the time needed for the frame exchange (Table 2). Hint: for throughput computation you packet transmission time, that is time for transmitting 1470 bytes together with all the headers and to this

value you ass SIFS, ACK, DIFS and back off times. The resulting value is total time for transmitting 1470 bytes.

Table 1 Header information for an UDP packet in IEEE 802.11b.

Protocol		Overhead in bytes	Transmitted with data rate [Mbit/s]
UDP		8	11
IP		20	11
LLC		4	11
802.11b MAC	MAC	34	11
802.11b PHY	with short preamble	9 in preamble	1
		6 in header	2
	with long preamble	18 in preamble	1
		6 in header	1

Table 2 The most common interframe spaces in IEEE 802.11.

Interframe space	Time [μs]
DIFS	50
SIFS	10

8. Assume a voice is compressed to 64 kbit/s and a voice packet is created from the samples collected over 20 *ms*. How many bits are in one voice packet? How many packets a voice packet buffer may have if it has to comply with good, medium, or bad voice quality?

References

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[IE^{3}99e] IEEE Standard 802.11f, 2003
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ABBREVIATIONS

ACK	Acknowledgement
AP	Access Point
CSMA/CA	Collision Sense Multiple Access with Collision Avoidance
CTS	Clear to Send
DIFS	DCF Interframe Space
DSSS	Direct Sequence Spread Spectrum
IP	Internet Protocol
LAN	Local Area Network
LED	Light Emitting Diode
LLC	Logical Link Control
MAC	Medium Access Control
PCMCIA	Personal Computer Memory Card International Association
PDU	Protocol Data Unit
PPDU	PLCP PDU
RTS	Request to Send
SDU	Service Data Unit
SIFS	Short Interframe Space
SNR	Signal to Noise Ratio
STA	Station
UDP	User Datagram Protocol
WLAN	Wireless Local Area Network