

# Investigation of WLAN

## 1 Pre-laboratory exercises

As an introduction to IEEE 802.11 WLANs and supplementary standards are available in background material for the laboratory works. Using also information from [IE<sup>3</sup>99b] available from the Communications laboratory, you should be able to do the pre-laboratory work. The material in the webpage provides the information in a more compact form, but from [IE<sup>3</sup>99b] has all the necessary information.

Questions:

1. What is the difference between IEEE 802.11, 802.11a, 802.11b, etc.?
2. Find out the frequency range of IEEE 802.11b in Europe. Explain using the spectrum mask shown in Figure 1, how IEEE 802.11 radio channels should be used to have as many channels as possible operating at the same time without causing interference to each other.

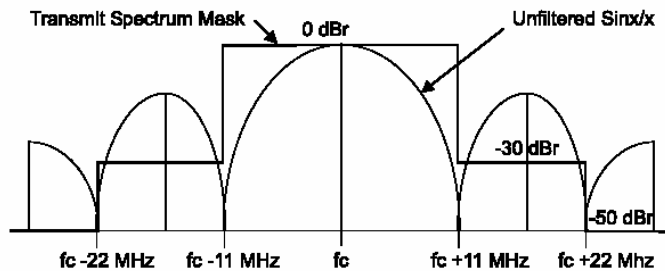


Figure 1 The transmit spectrum mask of a single channel in IEEE 802.11b [IE<sup>3</sup>99a, pp. 219].

3. What are the different physical layer options for IEEE 802.11b WLANs? Explain their properties concerning interference, security, and available data rates.
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).

**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 [ $\mu$ s]
DIFS	50
SIFS	10

## References

- [Bin99] Bing Benny, Measured Performance of the IEEE 802.11 Wireless LAN, 24<sup>th</sup> Conference on Local Computer Networks, October 17-20, 1999
- [Gas02] Gast, Matthew S., 802.11 Wireless Networks, The Definitive Guide, O'Reilly & Associates, 2002
- [IE<sup>3</sup>99a] IEEE Standard 802.11, 1999
- [IE<sup>3</sup>99b] IEEE 802.11 Handbook A designer's Companion
- [IE<sup>3</sup>99c] IEEE Standard 802.11b, 1999
- [IE<sup>3</sup>99d] IEEE Standard 802.11d, 2001
- [IE<sup>3</sup>99e] IEEE Standard 802.11f, 2003
- [IE<sup>3</sup>99f] IEEE Standard 802.11g, 2003
- [IRD03] [www.irda.org](http://www.irda.org), last visited 8.8.2003
- [ISO94] ISO/IEC 7498-1:1994 Information technology -- Open Systems Interconnection -- Basic Reference Model: The Basic Model
- [Kan04] Kantanen J., Investigation of Voice Traffic in Wi-Fi Environment, Master's thesis 2004

## 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