ITS413 – Quiz 3 Answers

Name: _____

ID: _____ Mark: _____ (out of 5)

Question 1 [marks]

Calculate the maximum possible throughput if a single IEEE 802.11 wireless LAN AP always has many frames to send to a single IEEE 802.11 wireless LAN client. You should assume:

- No other stations within range to interfere with the transmissions.
- No transmission errors.
- Only the AP is sending to the client (client is not sending data to AP).
- Integer backoff slots are chosen randomly from (0,CW] which means greater than 0 and less than or equal to current value of CW.
- IEEE 802.11 parameters as in table below.
- Assume the RTSThreshold is set such that all frames use the scheme given in the table.

Parameter	Value	Value	Value	Value
Data Rate	1Mb/s	10Mb/s	10Mb/s	1Mb/s
Scheme	Basic Access	RTS/CTS	Basic Access	RTS/CTS
Header size of DATA	60 bytes	40 bytes	25 bytes	50 bytes
Payload size of DATA	940 bytes	960 bytes	475 bytes	950 bytes
Time for ACK, RTS, CTS	100 µsec	100 µsec	100 µsec	100 µsec
Slot Time	20 µsec	20 µsec	20 µsec	20 µsec
SIFS	10 µsec	10 µsec	10 µsec	10 µsec
DIFS	50 µsec	50 µsec	50 µsec	50 µsec
CWmin	19	9	19	9
CWmax	319	159	319	319

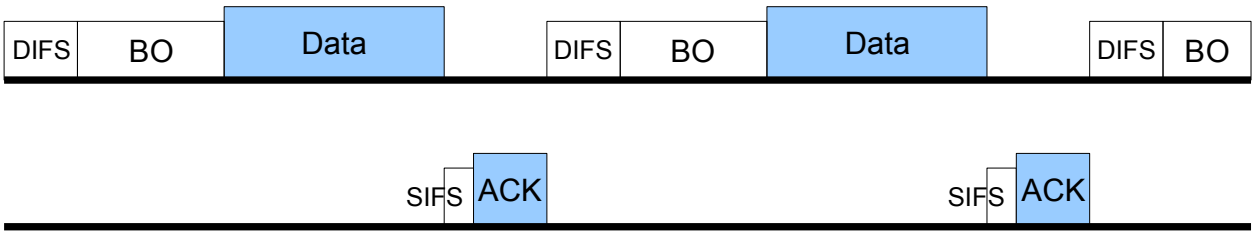
(These values do not match the real IEEE 802.11 values, but instead are chosen to make your calculations easier).

In your answer, draw a diagram illustrating the steps in the frame transfer. Show all your calculations. Diagram worth 1 mark; calculations and correct answer worth 4 marks.

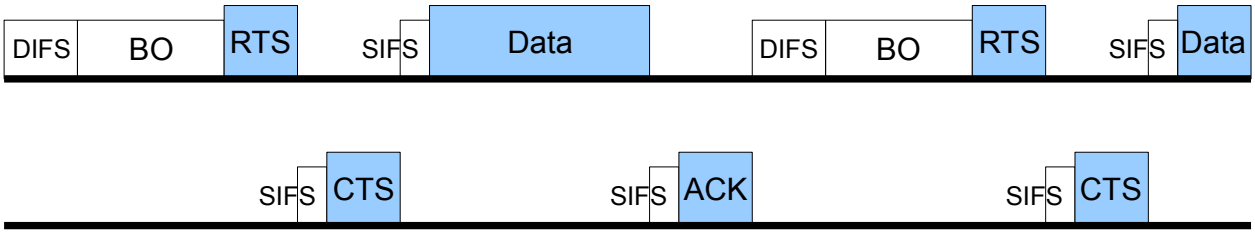
Answer

With only the AP transmitting (and no interference or errors), the AP will always be able to transmit (either DATA or RTS) immediately after a backoff. There will be no deference or retransmissions. Therefore the operation for Basic Access and RTS/CTS are illustrated below.

Basic Access



RTS/CTS



A general formula for the total time to successfully transmit one frame is:

$$T_{Basic} = DIFS + BO * SlotTime + t_{DATA} + SIFS + t_{ACK}$$

And for RTS/CTS:

$$T_{RTS} = DIFS + BO * SlotTime + t_{RTS} + SIFS + t_{CTS} + SIFS + t_{DATA} + SIFS + t_{ACK}$$

where t_X is the transmission time of frame X.

All values except CW and t_{DATA} are given in the table in the question:

$$t_{DATA} = \frac{8 * (Header + Payload)}{DataRate}$$

and:

$$BO = \frac{CWmin + 1}{2}$$

Note that BO is a random integer between 0 (exclusive) and $CWmin$ (inclusive). Therefore, the average value of BO will be is as calculated above.

The throughput is the rate at which the payload is delivered to the destination. On average, a single payload is delivered every T seconds:

$$Throughput = \frac{Payload}{T}$$

The acutal values under various conditions are given in the table below.

Parameter	Unit	Value	Value	Value	Value
Data Rate	Mb/s	1	10	10	1
Payload (DATA)	bytes	940	960	475	950
Header (DATA)	bytes	60	40	25	50
ACK	usec	100	100	100	100
RTS	usec	100	100	100	100
CTS	usec	100	100	100	100
SlotTime	usec	20	20	20	20
SIFS	usec	10	10	10	10
DIFS	usec	50	50	50	50
Cwmin	-	19	9	19	9
Cwmax	-	319	159	319	319
Cwaveage	-	10	5	10	5
T(Data)	usec	8000	800	400	8000
T(Basic)	usec	8360	1060	760	8260
T(RTS)	usec	8580	1280	980	8480
Throughput(Basic)	Mb/s	0.900	7.245	5.000	0.920
Throughput(RTS)	Mb/s	0.876	6.000	3.878	0.896