Vidun Jayakody - Assignment 6

1. Access Points use beacon frames in 802.11.

   (a) (10 points) Describe the role of the beacon frames.

   Beacon frames in 802.11 networks are like periodic broadcasts from access points, sharing vital network details such as SSID, supported data rates, and timing. They sync device clocks, help find nearby networks, manage power use, and handle traffic efficiently for better network performance.

2. In wireless communication, the hidden terminal problem is when two devices cannot hear each others' transmission because of a barrier in between them. We use ACKs, DIFS/SIFS, and (optional) RTS/CTS techniques in 802.11 to address this and other wireless problems.

   (a) (15 points) Suppose an 802.11b device is configured to use RTS/CTS, and it wants to send a 1,500 byte frame to the access point. Suppose that an ACK frame is 38 bytes long. Suppose all other devices are idle at this time. Ignoring propagation delays, calculate the the time required to transmit the frame and receive the acknowledgement. Here is some useful information for 802.11b:

   i. DIFS is 50 μs (i.e., microsecond, or 10^{-6} seconds).
   ii. SIFS is 10 μs.
   iii. RTS frame size is 20 bytes.
   iv. CTS frame size is 14 bytes.
   v. Transmission rate is 11 Mbps (Mega bits per second).

   We can calculate the transmission time for the RTS frame as follows:

$$\text{RTS Time} = \frac{\text{RTS Size in bits}}{\text{Rate in bits/sec}} = \frac{20 \times 8 \text{ bits}}{11 \times 10^6 \text{ bits/sec}}$$

   Similar calculations can be made for the CTS frame, the Data frame, and the ACK frame. The interframe spaces, DIFS and SIFS, are added where protocol dictates.

$$\begin{aligned}
\text{DIFS} &= 50 \times 10^{-6} \text{ seconds} \\
\text{SIFS} &= 10 \times 10^{-6} \text{ seconds} \\
\text{RTS Time} &= \frac{20 \times 8 \text{ bits}}{11 \times 10^6 \text{ bits/sec}} \\
\text{CTS Time} &= \frac{14 \times 8 \text{ bits}}{11 \times 10^6 \text{ bits/sec}} \\
\text{Data Frame Time} &= \frac{1500 \times 8 \text{ bits}}{11 \times 10^6 \text{ bits/sec}} \\
\text{ACK Time} &= \frac{38 \times 8 \text{ bits}}{11 \times 10^6 \text{ bits/sec}}
\end{aligned}$$

   The total round trip time (RTT) can then be calculated as:

$$\text{RTT} = \text{DIFS}+\text{RTS Time}+\text{SIFS}+\text{CTS Time}+\text{SIFS}+\text{Data Frame Time}+\text{SIFS}+\text{ACK Time}$$

Substituting the calculated times:

$$\text{RTT} = 50\times10^{-6}+\frac{160}{11\times10^6}+10\times10^{-6}+\frac{112}{11\times10^6}+10\times10^{-6}+\frac{12000}{11\times10^6}+10\times10^{-6}+\frac{304}{11\times10^6}$$

After simplifying and adding all the terms, we find that the RTT is approximately:

$$\text{RTT} \approx 1.223 \text{ milliseconds}$$