CEG5103/EE5023 – Wireless Networks
Part 1: Tutorial 2 – Answers

1. (a) Given R = 16 kbps, 512 bit packets and λ = 1/20 packets/s:

The packet transmission time, T_{txm} = 512 / (16 x 10^3) = 32 x 10^{-3} seconds

The traffic carried per terminal, $A = \lambda \, . \, T_{txm}$ = (1/20) x (32 x 10^{-3}) = 1.6 x 10^{-3} erlang

Max. traffic carried with n terminals = n x 1.6 x 10^{-3} = 1/(2e)

$$\therefore \quad n = \left\lfloor \frac{1}{2e} \times \frac{1}{1.6 \times 103} \right\rfloor = \lfloor 114.9742 \rfloor = 114$$

(b) For the case of slotted Aloha, then we have:

Max. traffic carried with n terminals = n x 1.6 x 10^{-3} = 1/e

$$\therefore \quad n = \left\lfloor \frac{1}{e} \times \frac{1}{1.6 \times 10^{-3}} \right\rfloor = \lfloor 229.9485 \rfloor = 229$$

(c) For pure Aloha, the prob. of successful transmission is:

$P(0) = \exp\left(-2T_{txm}\lambda_{\max}\right)$
Since $\lambda_{\max} = 1/2T_{txm}$ then $P(0) = \exp\left(-2T_{txm} \times (1 / 2T_{txm})\right) = 1 / e$,
$\therefore$ Ave. no. of retransmissions = 1 / $P(0) = e = 2.718$

Similarly, for slotted Aloha:

$P(0) = \exp\left(-T_{txm}\lambda_{\max}\right)$
Since $\lambda_{\max} = 1/T_{txm}$ then $P(0) = \exp\left(-T_{txm} \times (1 / T_{txm})\right) = 1 / e$,
$\therefore$ Ave. no. of retransmissions = 1 / $P(0) = e = 2.718$

2. Advantages of persistent CSMA:
   The terminal will keep listening to the medium when it senses the medium busy. Then it will capture the channel immediately after the medium becomes idle. Thus, 1-persistent CSMA will have good channel utilization when traffic is light. The p-persistent CSMA works better when traffic is heavy.

   Disadvantages of persistent CSMA:
   When traffic is heavy, 1-persistent will bring more collisions because it is highly possible that more than one terminal sense the medium and immediately transmits after the medium becomes idle.

   Advantages of non-persistent CSMA:
   It can reduce the collisions by waiting for a random time to sense the medium again after it senses the medium is busy. It is especially useful when traffic is heavy.

   Disadvantages of non-persistent CSMA:
   It may waste the channel by waiting for an unnecessary random time to sense the medium again due to light traffic.

   Therefore, choose 1-persistent CSMA when traffic is light, and non-persistent CSMA or p-persistent CSMA when traffic is heavy.

3. Due to RTS/CTS packets the overhead of data transmission increases. If we have small DATA packets then it is not worth using the RTS/CTS packets which may increase the overhead. However, if the DATA packets are bigger in size and the channel is heavily loaded then using RTS/CTS can prove effective.

4. (a) If a terminal has a packet ready to transmit, it will sense the medium first. If the medium is idle for DIFS, it will transmit RTS, then wait for the CTS from the receiver. Therefore, the earliest time for the receiver to send CTS message is:

DIFS + (RTS + Prop.) + SIFS
$3\alpha + (5\alpha + \alpha) + \alpha = 10\alpha$.

Assumes use of DIFS before RTS, and SIFS elsewhere.

(b) When the sender receives the CTS from the receiver, it waits for SIFS, and then sends its data packet. Therefore, the shortest time for receiver to send the ACK signal is:

DIFS + (RTS + Prop.) + SIFS + (CTS + Prop.) + SIFS + (Data + Prop.) + SIFS
$3\alpha + (5\alpha + \alpha) + \alpha + (5\alpha + \alpha) + \alpha + (100\alpha + \alpha) + \alpha = 119\alpha$

Note that we should include the propagation delay also.

(c) This is to give priority to some packets. For example after transmitting the DATA packets the receiver should be allowed to send ACK packets without any collisions. To accomplish this, we transmit the ACK packets immediately after SIFS time interval before any other node can transmit and interrupt the ACK packet.

(d) No. SIFS is the turnaround time required to change from transmit (receive) mode to receive (transmit) mode. Thus, it is compulsory to have finite SIFS time.