Wireless Networking

Course code: CS4222/5422, Tutorial session: #5 (Solution)

Brief Instructions regarding the tutorial session

1. The attendance to tutorial sessions would contribute towards the determination of final grade
2. Please review the questions before coming to the tutorial session
3. Make an effort to solve the questions before attending tutorial. The teaching assistants will help in case of issues
4. The designated time for the tutorial session is one hour. Please contact the teaching assistants or the instructor if you need any further clarification regarding the tutorials outside the allocated period. Please send them an email.

Answer 1: a) Let us recall the formula for calculation of the free space path loss.

FSPL (dB) = $20\log_{10}(d) + 20\log_{10}(f) + 20\log_{10}((4 * pi)/c)$

d: distance between transmitter and receiver in meters
f: It is the frequency of the radio wave in the unit of hertz
c: it is the speed of light in meters per second

FSPL (865 MHz) = 140.7 dB, FSPL (2.4 GHz) = 149.6 dB

b) **Received Power (dBm) = transmitted power (dBm) + gains (dB) - losses (dB)**

The above states the formula for estimate the link budget, it accounts for the transmitted signal strength, various gains and losses in the system including the free space path loss. The link budget also leads us to understand the received signal strength.

Transmitting Device
Transmitted power is 20 dBm, antenna gain is 4 dBi, and the amplifier gain is 8 dB

Receiving Device
Receiving antenna gain is 12 dBi, cable losses is 4 dB

Let us look at all the gains: 4 dBi + 12 dBi + 8 dB
Let us look at all the losses: 4 + FSPL (865 or 2400 MHz)

Received Power (dBm, 865 MHz) = 20 dBm + 24 - 4 - FSPL (865 MHz)
= 20 + 20 - 140.7
= -100.7 dBm

Received Power (dBm, 2400 MHz) = 20 dBm + 24 - 4 - FSPL (2400 MHz)
= 20 + 20 - 149.6
= -109.6 dBm

Answer 2:

A) It is given that S/N = 100

The formula for estimating signal to noise ration in dB can be written as follows:

$10 \log_{10}(S/N) = 20$ dB

B) The strength of signal can be estimated to be = -110 dBm + 20 dB = -90 dBm

C)

B = 1 MHz
S/N = 100

$C = B * \log_2(1 + S/N)$
$= 1 * \log_2(1 + 100)$
= 6.65 Megabit/second

D)

Signal strength = -90 dBm
Noise floor = -95 dBm

SNR = 5 dB, 3.16 (ratio)

Capacity = 5 * $\log_2(1 + 3.16)$ = 5 * 2.057 = 10.283 Megabit/second

Answer 3:
A)
For streaming application, we need to continuously keep the radio active. Hence, a lower transmit/receive power would be preferred. Furthermore, the radio would transition less from idle state to one of active states. Hence, the larger time for the transition would not be detrimental. Hence, we would prefer radio blue.

Since, the application would likely transmit small amounts of information, infrequently (when object moves), and the movement is something that happens not at a regular interval. The radio will spend significant time in idle state. It should also be able to transition to active state quickly when movement is detected. Hence, we would prefer the red radio. High energy cost shouldn't ben much of an issue as the radio would remain active for a short period of time.

B) Radio duty cycle = active time/total time
= 100/1000 = 10 %