F15 NET3900

Modules 3,4 Assignment

Instructions:

Please show all your calculations for numerical answers.

The grade for each question is shown next to the question number.

Note the provided slide references.

Please submit this assignment via Bb, email or via paper to me at a lecture or lab.

The solutions will be posted to Bb following the due date.

This assignment is due by midnight Sunday Sept. 27.

1/6. Briefly explain the following terms:

a) EIRP

The radiated power from an antenna in the direction which provides the maximum power.

(EIRP: Equivalent/Effective Isotropic Radiated Power)

b) BSSID

MAC address of the radio

When multiple VAP/SSIDs are configured each VAP will have a different, but related MAC for the radio.

c) SSID

Name of the wireless network which is carried in the Beacon message.

The client uses this information to make a connection decision

d) dBm

absolute power level expressed in decibels relative

It is the power in dB when power is expressed in mW

e) dB

relative power level such as gain and loss expressed in decibels

f) hidden node

two wireless clients that can't hear each other but can hear the AP to which they are associated. This situation can lead to message collisions and reduced throughput.

2/2. Explain the difference between passive RF gain and active RF gain?

(Ref: Module 4, slide 20)

Active gain: when additional power is provided to achieve gain such as a power amplifier.

Passive gain: due to shaping or focusing the power from an antenna possibly by adjusting its physical shape.

3/3. Consider a Wi-Fi radio setup as shown in the diagram. The radio sends a 40 mW signal to an RF amplifier. The RF amplifier has an active gain of 6 dB and sends the signal to an antenna over a cable with a loss of 3 dB. The antenna has a passive gain of 4 dBi.

(Ref: Module 4, slides 23 and 31)

a) What is the EIRP at the antenna in dBm?

Note: The transmitted power at the antenna is the transmitted power at the Radio + all the gains – all the losses. All values must be expressed in decibels (dBm, dB, dBi)

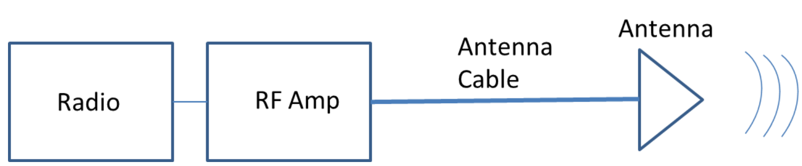
- convert radio signal to dBm = 16 dBm from 10logP or from table on slide 23

EIRP = 16 dBm + 6 dB – 3 dB + 4 dBi = 23 dBm

b) What is the EIRP at the antenna in mW?

Note: Power in dBm = 10 $\log_{10}$ (Power in mW)

23 dBm=10logP(mW) therefore P=200 mW.



4/2. Consider an Aruba AP with an EIRP of 20 dBm as shown in the Figure. A user with a Wi-Fi Smartphone is standing 20 feet away from the Access Point. There is a wall between the AP and the wireless client. The wall attenuation/loss is 4 dB. The Free Space Path Loss (FSPL) between the AP and the wall is 55 dB. What is the received signal strength at the wireless client in dBm?

Apply the same notes and references as in question 3. You may also find Module 4 slides 13 and 14 useful.

This question can be interpreted in a couple of ways.

A) The smartphone and next to the wall:

Prx = Ptx – Loss(Wall) – FSPL

Prx = +20 dBm -4 dB – 55 dB

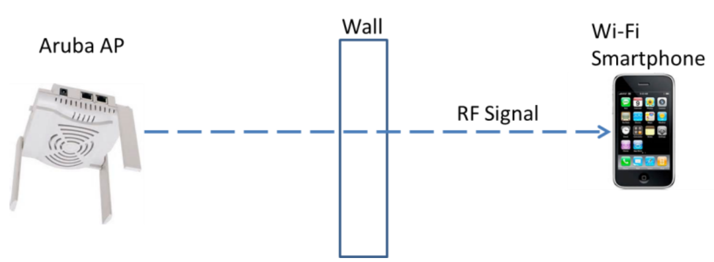
Prx = -39 dB The receive power at the smartphone is -39 dBm or 125 microWatts.

B) The wall is mid way between the AP and the smartphone. This adds 6 dB of attenuation to the FSPL.

Prx = Ptx – Loss(Wall) – FSPL – 6dB

Prx = +20 dBm -4 dB – 55 dB – 6 dB

Prx = -45 dB The receive power at the smartphone is -45 dBm or 32 microWatts.



5/5. A typical message transmission is shown in the Figure. The message has the following fairly typical parameters for an 802.11a frame.

PHY rate: 54 Mbps

DIFS (DCF Interframe Spacing): 34 us

Average Contention Window: 65 us

PHY Header: 20 us

Data Frame Duration = DataFrameSize(bits) / PHY rate (This is a good approximation)

SIFS (Short Interframe Spacing): 16 us

ACK: 24 us

(Ref: Supplement Module 3,4; slides 23,24)

a) Calculate the Data Throughput for a typical message size of 512 Bytes. Show your detailed calculations.

First calculate the Data Frame Duration (DFR)

DFR = (8* 512) bits / 54 Mbps = 76 usec

Throughput = #DataBitsperFrame / TotalFrameDuration

= (8 x 512) bits / (34+65+20+76+16+24) us

= 4096 bits / 235 usec

= 17.5 Mbps

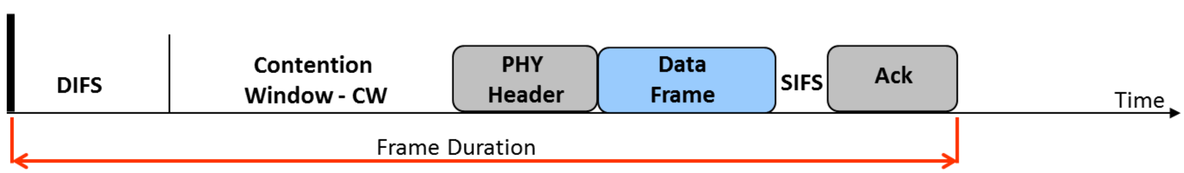
b) The Data Throughput is at what percentage of the PHY rate. You can consider this the throughput efficiency.

%eff = 100% x 17.5 Mbps / 54 Mbps

= 32%

c) Why is the Data Throughput lower than the PHY rate.

The 802.11 protocol overheads are very high relative to the data frame duration.



6/2. A user is 15 feet away from the Access Point. The user now moves away from the AP so that (s)he is now 30 feet away. How much RF gain is required to maintain the same received signal strength at the user and why?

(Ref: Module 4, slide 24)

Apply the 6 dB rule.

The Free Space Path Loss increases by 6 dB when the distance is doubled.

Therefore a gain of 6 dB is needed to compensate.

FYI, this can be achieved by increasing the transmit power level or antenna gain.