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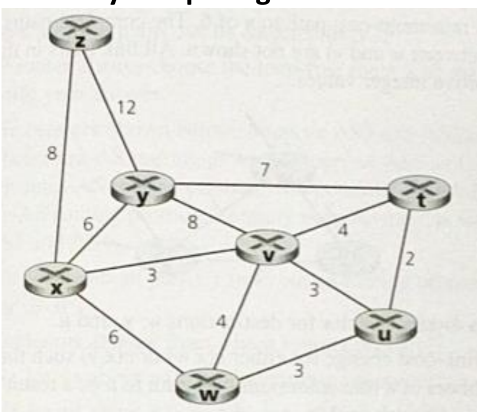
COMP 7005 – Assignment 3

Section A

P3. Consider the following network. With the indicated link costs, use Dijkstra's shortest-path algorithm to compute the shortest path from *x* to all network nodes. Show how the algorithm works by computing a table similar to Table 5.1.



Step	N'	D(t), p(t)	D(u), p(u)	D(v), p(v)	D(w), p(w)	D(y), p(y)	D(z), p(z)
0	x	∞	∞	3,x	6,x	6,x	8,x
1	xv	7,v	6,v		6,x	6,x	8,x
2	xvu	7,v			6,x	6,x	8,x
3	xvuw	7,v				6,x	8,x
4	xvuwy	7,v					8,x
5	xvuwyt						8,x
6	xvuwytz						

Section B

1. **Assume that you have been given the following information for a system link:**

   Frequency of operation = 2.45 GHz Transmit power = 15 dBm (Output power of the transmitting access point)   Connector + Cable loss = 3 dB (applied at both the transmit and receive ends)   Transmit/Receive antennae gain = 9 dBi   Receive power = Assume that the receiver gets the minimum required signal to meet its sensitivity specification (-50 dBm for a typical access point at 54 Mbit/s)   Distance = 1 Km.

   Determine the link budget for this system. Comment on whether or not this is enough of a margin for the system to function reliably.

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1. $T_x = 15\,dBm - 30 = -15\,dB$ Distance (d) = 1km → 1000 m

Frequency (f) = 2.4GHz → 2.45×10^9 Hz

$L_{CT}, L_{CR} = 3\,dB$

→ Connector + cable loss

G_T & G_R = 9 dBi

→ Transmitter & Reciever Antenna Gains

Reciever Sensitivity : −50dBm

Free Space Path Loss (L_P) = ?

Link Budget (RSL) = $P_T + G_T - L_P + G_R - L_{CT} - L_{CR}$

$$L_P = 20\log(d) + 20\log(f) + 20\log\left(\frac{4\pi}{c}\right) - G_T - G_R$$

$$L_P = 20\log(1000m) + 20\log(2.45 \times 10^9\,Hz) + 20\log\left(\frac{4\pi}{3\times10^8\,m/s}\right) - 9dBi - 9dBi$$

$$L_P = 82.225\,dB$$

$$RSL = -15dB + 9dBi - 82.225dB + 9dBi - 3dB - 3dB$$

$$RSL = -85.225\,dB + 30 = \boxed{-55.225\,dBm}$$

$$dB \rightarrow mW = \log_{10}^{(x/10)}$$

$$= -55.225/10 = -5.5225$$

$$= 10^{-5.5225}$$

$$RSL = \boxed{3.00 \times 10^{-6}\,mW}$$

RSL = −55.225 dBm < −50 dBm

→ The recieved power is less than the reciever sensitivity specification which can result in data being transmitted & detected at an unreliable rate. System will not work.

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2. A LinksysWRT-54G 802.11g (2.45 GHz) wireless base station/router transmits 20 mW into a monopole antenna (assume antenna gain = 1.5 dBi). The signal is received by a laptop with antenna gain -1.5 dBi. Express your answers to the following questions in both mW and dBm.

a) Estimate the received power at 200 m for free-space propagation
b) Estimate the received power at 2 km for free-space propagation.
c) Suppose that we need a minimum received power of -80 dBm for the receiver at the laptop to properly work. Determine whether the receiver will work at the distances in (a) and (b)
d) Now suppose that you replace the monopole antenna in the Linksys router by a parabolic dish antenna with gain 15 dBi. Repeat (a), (b), and (c).

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2. Linksys 802.11g → 2.45 GHz → 2.45×10^9 Hz

$P_T = 20 mW$

$G_T = 1.5$ dBi dB - mW : $\log_{10}(x/10)$

$G_R = -1.5$ dBi

a) Distance (d) = 200 m

Friis Equation : $P_R = P_T \left(\frac{G_T G_R}{L_P} \right)$

$L_P = 20\log(d) + 20\log(f) + 20\log\left(\frac{4\pi}{c}\right) - G_T - G_R$

$L_P = 20\log(200m) + 20\log(2.45 \times 10^9 Hz) + 20\log\left(\frac{4\pi}{3\times10^8}\right) - 1.5dBi - (-1.5dBi)$

$L_P = 86.246$ dB → 421308285.4 mW

$P_R = 20mW \left(\frac{(1.41mW)(0.71mW)}{421308285.4 mW} \right)$

$\boxed{P_R = 4.74 \times 10^{-8} mW}$

mW → dBm = 10 Log (x)

$P_R = 10 Log(4.74 \times 10^{-8} mW)$

$\boxed{P_R = -73.24 dBm}$

b) Distance (d) = 2km → 2000 m $P_R = P_T \left(\frac{G_T G_R}{L_P} \right)$

$L_P = 20\log(d) + 20\log(f) + 20\log\left(\frac{4\pi}{c}\right) - G_T - G_R$

$= 20\log(2000m) + 20\log(2.45 \times 10^9 Hz) + 20\log\left(\frac{4\pi}{3\times10^8}\right) - 1.5dBi - (-1.5dBi)$

$L_P = 106.245$ dB → 4.21×10^{10} mW

$P_R = 20mW \left(\frac{(1.41mW)(0.71mW)}{4.21\times10^{10} mW} \right)$

$\boxed{P_R = 4.76 \times 10^{-10} mW}$ → 10 log (mW) $\boxed{P_R = -93.22 dBm}$

10 log (4.76×10^{-10})

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c) Receiver Sensitivity : $-80\,dBm$

With the result of :

a) $P_R = -73.24\,dBm$ @ 200m $> -80\,dBm$
b) $P_R = -93.22\,dBm$ @ 2km. $< -80\,dBm$

The minimum receive signal is set to be sensitive at $-80\,dBm$, and having the propogation set to a distance of 200m would result in a higher data transmit / receive rate (stronger signal) than at 2km. Solution from a) will work since the signal power over the network is stronger than RSL min whereas the solution from b) does not provide enough sufficient power.

d) Since "Antenna" in Linksys Router → At Transmitter

$G_T = 15\,dBi \rightarrow 31.62\,mW$

d a) $G_R = -1.5\,dBi \rightarrow 0.71\,mW \quad d = 200m$
$P_T = 20\,mW$

$$L_P = 20\log(d) + 20\log(f) + 20\log\left(\frac{4\pi}{c}\right) - G_T - G_R$$
$$= 20\log(200m) + 20\log(2.45\times10^9\,Hz) + 20\log\left(\frac{4\pi}{3\times10^8}\right) - 15\,dBi - (-1.5\,dBi)$$
$$L_P = 72.75\,dB \rightarrow 18836490.89\,mW$$

$$P_R = P_T\left(\frac{G_T G_R}{L_P}\right) \rightarrow 20\,mW\left(\frac{(31.62\,mW)(0.71\,mW)}{18836490.89\,mW}\right)$$

$$\boxed{P_R = 2.38\times10^{-5}\,mW}$$

$\rightarrow 10\log(x)$
$10\log(2.38\times10^{-5}\,mW)$

$$\boxed{P_R = -46.23\,dBm}$$

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d b) $d = 2km \rightarrow 2000m$
$P_T = 20mW$
$G_T = 15dBi$
$G_R = -1.5dBi$

$L_P = 20\log(d) + 20\log(f) + 20\log\left(\frac{4\pi}{c}\right) - G_T - G_R$
$= 20\log(2000m) + 20\log(2.45\times10^9 Hz) + 20\log\left(\frac{4\pi}{3\times10^8}\right) - 15 - (-1.5)$
$L_P = 92.742 dB \rightarrow 1880182473 mW$

$P_R = P_T\left(\frac{G_T G_R}{L_P}\right) \rightarrow 20mW\left(\frac{(31.62mW)(0.71mW)}{1880182473 mW}\right)$

$\boxed{P_R = 2.39\times10^{-7} mW}$

$dB \rightarrow mW \rightarrow 10\log(x) \rightarrow 10\log(2.39\times10^{-7}mW)$

$\boxed{P_R = -66.22dBm}$

dc) Receiver Sensitivity : -80dBm
with the result of:
da) $P_R = -46.23dBm$ @ 200m $> -80dBm$
db) $P_R = -66.22dBm$ @ 2km $> -80dBm$

By replacing the monopole antenna ~~that~~ changes the gain from 1.5dBi → 15dBi, you can see that ~~both~~ solutions provide a result in higher data transmit/receive rate which means we improved the signal rate for both solutions no matter what propagation distance is set to. Both solutions will work.