Link Budget Analysis for 802.11 wireless links
CS496A Independent Study in Wireless Networking

Calculated for ~6.5mi Link from Mt. Sugarloaf to Orchard Hill Tower
(Worst Case)*

Antenna – Parabolic Dish 24 dBi (HG2424G) to Parabolic Dish

Transmit power (TxP): 60mW (from Proxim card) = **17.782 dB**
Pigtail Loss (TxL): .4dB/ft * 19" = **.633dB** [1]
Cable Loss (TxL): **3.4dBi** [2]
Connector Loss (TxL): **.1dB** (approx .05dB per conn.) [1]
Transmit Antenna gain (TxG): **24dBi**

Free Space Loss (FSL):

FSL (dB) = 20*log (d) + 20*log (f) – *147.5* [4]
d = 6.5 mi = 10460 meters
f = 2.4 GHz = 2,400,000,000 Hz

FSL (dB) = 20*log (10460) + 20*log (2,400,000,000) – *147.5*
= **-94.1003 dB**

Miscellaneous losses* (ML): **~30 dB** [6]
(Fading, body loss, polarization mismatch, other losses...) (dB)

Receive Antenna gain (RxG): **24dBi**
Pigtail Loss (RxL): .4dB/ft * 19" = **.633dB** [1]
Cable Loss (RxL): **3.4dBi** [2]
Connector Loss (RxL): **.1dB** (approx .05dB per conn.) [1]

RxP = TxP + TxG – TxL – FSL – ML + RxG – RxL [5]

= 17.782 + 24 – (.633 + 3.4 +.1) – 94.1003 – 30 + 24 – (.633 + 3.4 +.1)
Received Power = -66.5843 dB

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Compared to Friis Equation: *final.pdf courtesy of Brian*

P_r (dB) = G_t (dB) + G_r (dB) + P_t (dB) – 20*log [(4*pi*R)/lambda]
R = 10460 meters
Lambda = .125

P_r (dB) = 24 + 24 + 17.782 – 20*log [(4*pi*10460)/.125]
P_r (dB) = -54.6546 dBm

Antenna – Yagi 14 dBi (HG2415Y) to Parabolic Dish

Transmit power (TxP): 60mW (from Proxim card) = **17.782 dB**
Pigtail Loss (TxL): .4dB/ft * 19" = **.633dB** [1]
Cable Loss (TxL): **3.4dBi** [2]
Connector Loss (TxL): **.1dB** (approx .05dB per conn.) [1]
Transmit Antenna gain (TxG): **14dBi**

Free Space Loss (FSL):

FSL (dB) = 20*log (d) + 20*log (f) – *147.5* [4]
d = 6.5mi = 10460 meters
f = 2.4 GHz = 2,400,000,000 Hz

FSL (dB) = 20*log (10460) + 20*log (2,400,000,000) – *147.5*
= **–94.1003 dB**

Miscellaneous losses* (ML): **~30 dB** [6]
(Fading, body loss, polarization mismatch, other losses...) (dB)

Receive Antenna gain (RxG): **24dBi**
Pigtail Loss (RxL): .4dB/ft * 19" = **.633dB** [1]
Cable Loss (RxL): **3.4dBi** [2]
Connector Loss (RxL): **.1dB** (approx .05dB per conn.) [1]

RxP = TxP + TxG – TxL – FSL – ML + RxG – RxL [5]

= 17.782 + 14 – (.633 + 3.4 +.1) – 94.1003 – 30 + 24 – (.633 + 3.4 +.1)
= –56.5843 dB

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Compared to Friis Equation: *final.pdf courtesy of Brian*

P_r (dB) = G_t (dB) + G_r (dB) + P_t (dB) – 20*log [(4*pi*R)/lambda]
R = 10460 meters
Lambda = .125

P_r (dB) = 24 + 14 + 17.782 – 20*log [(4*pi*10460)/.125]
P_r (dB) = –44.6546 dBm

REFERENCES

[1] Seattle Wireless
http://www.seattlewireless.net/index.cgi/PigTail#head-632bd9d765e1e5512710f7d3136a1e34a5fba151

[2] Upper Limit on Cable Loss ~ 6.8dBi per 100 feet
(this is for Commscope 400 series and we are using 600 series)
http://www.netgate.com/product_info.php?products_id=220

[3] Friis Transmission Equation (wikipedia)
http://en.wikipedia.org/wiki/Friis_Transmission_Equation

[4] Free Space Loss (wikipedia)
http://en.wikipedia.org/wiki/Free_space_loss
147.5 is referred to as "a constant that depends on the units used and details of the radio link"

[5] Link Budget Calculation
http://en.wikipedia.org/wiki/Link_Budget

[6] Constant (Rule of Thumb) to account for Multi-path fading and other losses. From page 2 under *'Multipath and Fade Margin'*
www.sss-mag.com/pdf/an9804.pdf

Document and calculations compiled by Tim Ireland.