



November 24, 2010xx

Path Analysis – XXXXXXXXXX

Ref Number: XXXXXXXX

Introduction

This report is an analysis of the proposed XXXXXXXXXX network between XXXXXXXX and XXXXXXXX. The primary aim was to investigate the frequencies and antenna sizes and heights needed to implement the links.

The coordinates of the sites are:

- XXXXXXXX, 31deg 27min 55.19sec S / 152deg 55min 07.36sec E
- XXXXXXXX, 31deg 28min 42.99sec S / 152deg 43min 55.14sec E and
- XXXXXXXX, 31deg 34min 44.53sec S / 152deg 47min 56.11sec E

The links are required to have a high performance at all times and hence it is crucial that combined multipath and rain fade link availability is maintained above 99.99%.

This report is a desktop analysis only and is subject to the availability of suitable frequencies, licensing requirements (if applicable) and physical site surveys.

The network diagram is shown in Figure 1.

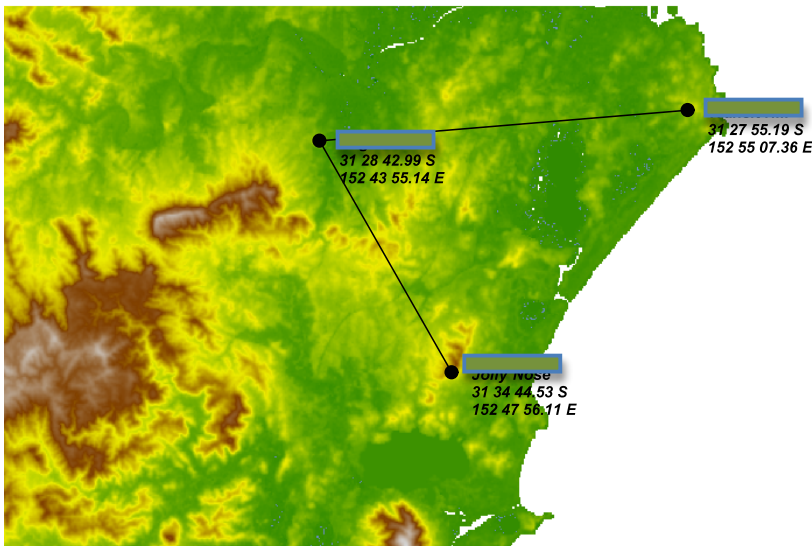


Figure 1: Network Diagram

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Results

In this analysis two microwave link prediction models were used namely the Barnett-Vigants model and the ITU-R model. Only the pathloss outputs from the Barnett-Vigants model are included in the report.

Predictions from the two common path profile models have been included. It is generally agreed that the Barnett-Vigants model provides a somewhat conservative prediction of performance, while the ITU-R model provides an estimate of typical performance excluding prediction variability. EmClarity recommends that a reader should comfortably assume that a link will perform in accordance or maybe slightly better than the Barrett-Vigants' predictions but should expect performance roughly "on average" in accordance with the ITU-R model.

The following tables 1 and 2 summarise the results with the links running in high performance 32QAM mode (approx 100Mbps) and QPSK mode (approx 40Mbps):

Link	Site Name	Antenna Size (m)	Site Name	Antenna Size (m)	Path Length (km)	Frequency (GHz)	Fade Margin (dB)	Rain-Fade + Multipath availability (%) Barnett-Vigants	Rain-Fade + Multipath availability (%) ITU
1	xxxxxx	1.2	xxxxxx	1.2	17.81	8	xxxxx	99.9967	99.9994
2	xxxxxx	0.6	xxxxxx	0.6	12.82	8	xxxxx	99.9900	99.9994

Table 1 – 32QAM mode

Link	Site Name	Antenna Size (m)	Site Name	Antenna Size (m)	Path Length (km)	Frequency (GHz)	Fade Margin (dB)	Rain-Fade + Multipath availability (%) Barnett-Vigants	Rain-Fade + Multipath availability (%) ITU
1	xxxxxx	1.2	xxxxx	1.2	17.81	8	xxxxx	99.9998	99.9999
2	xxxxx	0.6	xxxxx	0.6	12.82	8	xxxxx	99.9995	99.9999

Table 2 – QPSK mode

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Path Analysis

Link 1: xxxxx to xxxxx

The path analysis was done at 8GHz.

With a path length of 17.81km, lower frequency operation is more preferable in order to achieve good availability.

A rain rate of 50mm/hour has been used for the analysis but may be greater at times having less impact on the link operating at this low frequency.

Two model runs one operating at 100M and the other at 40M have been completed for comparison using 1.2m dish antenna at both ends.

Antenna heights were set at 16 and 20 meters above ground level at xxxxx and xxxxxx respectively, No Allowance for Trees and LOS has been considered and this should be confirmed by physical check.

Figure 2 provides the path profile.

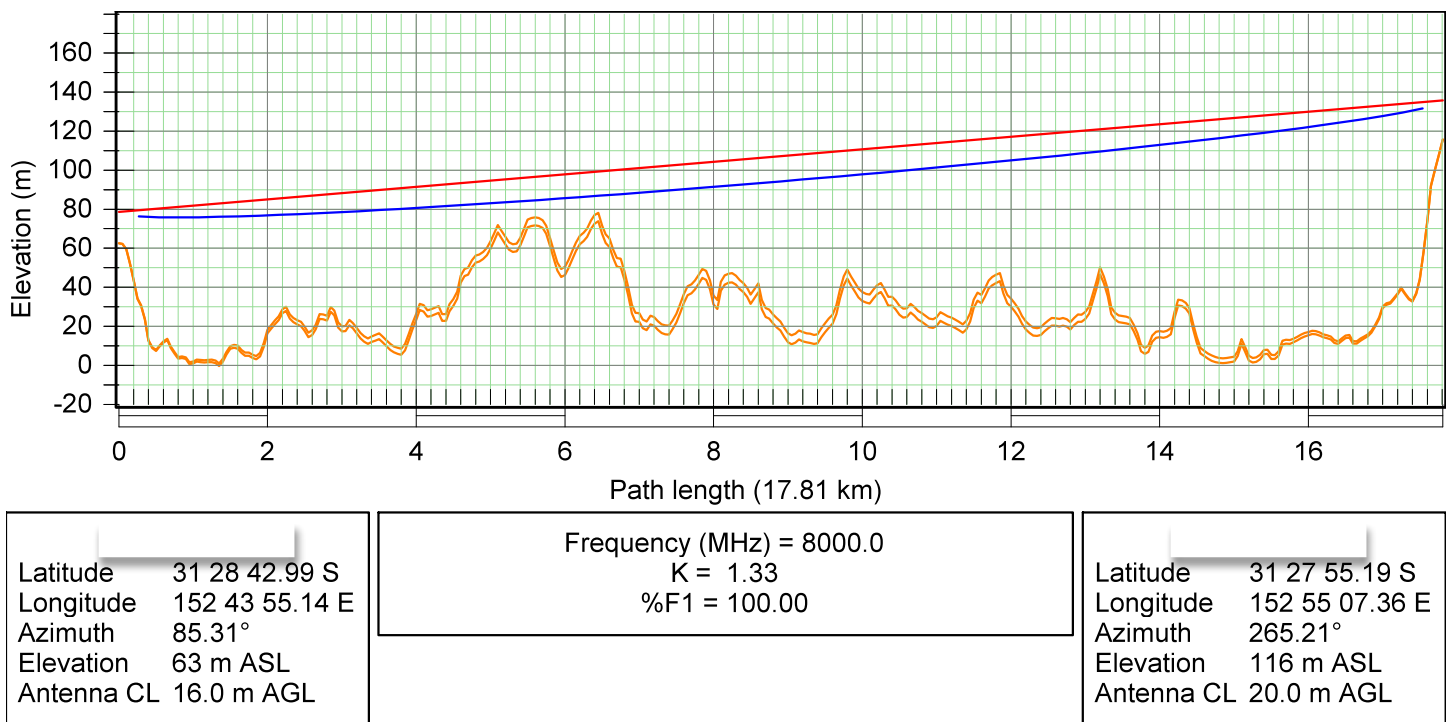


Figure 2: Path Profile

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Transmission details: xxxxxx to xxxxxx operating at 8GHz in 32QAM 100M (Full Duplex) with 1.2m dish at both ends

	xxxxx	xxxxxx
Latitude	31 28 42.99 S	31 27 55.19 S
Longitude	152 43 55.14 E	152 55 07.36 E
Easting (m)	474542.0	492277.5
Northing (m)	6517323.1	6518823.1
UTM zone	56S	56S
True azimuth (°)	85.31	265.21
Vertical angle (°)	0.12	-0.24
Elevation (m)	62.58	115.70
Antenna model	041K (TR)	041K (TR)
Antenna code	041k	041k
Antenna gain (dBi)	35.00	35.00
Antenna height (m)	16.00	20.00
Frequency (MHz)		8000.00
Polarization		Vertical
Path length (km)		17.81
Free space loss (dB)		135.54
Atmospheric absorption loss (dB)		0.19
Net path loss (dB)	65.73	65.73
Radio model	L80-100M	L80-100M
TX power (dBm)	xxxxx	xxxxx
EIRP (dBm)	xxxxx	xxxxx
TX channel assignments	8000V	8000V
RX threshold criteria	BER 10-6	BER 10-6
RX threshold level (dBm)	xxxxxx	xxxxx
Receive signal (dBm)	xxxxxx	xxxxx
Thermal fade margin (dB)	xxxxx	xxxxx
Dispersive fade occurrence factor		1.00
C factor		1.50
Average annual temperature (°C)		20.00
Fade occurrence factor (Po)		4.064E-002
Worst month multipath availability (%)	99.99519	99.99519
Worst month multipath unavailability (sec)	126.30	126.30
Annual multipath availability (%)	99.99837	99.99837
Annual multipath unavailability (sec)	515.32	515.32
Annual 2 way multipath availability (%)		99.99673
Annual 2 way multipath unavailability (sec)		1030.63
Polarization		Vertical
0.01% rain rate (mm/hr)		50.00
Flat fade margin - rain (dB)		xxxxx
Rain attenuation (dB)		xxxxxx
Annual rain availability (%)		99.99998
Annual rain unavailability (min)		0.08
Annual rain + multipath availability (%)		99.99672
Annual rain + multipath unavailability (min)		17.26

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Transmission details: xxxxx to xxxxx operating at 8GHz in QPSK 40M (Full Duplex) with 1.2m dish antenna at both ends

	xxxxxx	xxxxxx
Latitude	31 28 42.99 S	31 27 55.19 S
Longitude	152 43 55.14 E	152 55 07.36 E
Easting (m)	474542.0	492277.5
Northing (m)	6517323.1	6518823.1
UTM zone	56S	56S
True azimuth (°)	85.31	265.21
Vertical angle (°)	0.12	-0.24
Elevation (m)	62.58	115.70
Antenna model	041K (TR)	041K (TR)
Antenna code	041k	041k
Antenna gain (dBi)	35.00	35.00
Antenna height (m)	16.00	20.00
Frequency (MHz)		8000.00
Polarization		Vertical
Path length (km)		17.81
Free space loss (dB)		135.54
Atmospheric absorption loss (dB)		0.19
Net path loss (dB)	65.73	65.73
Radio model	L80-40M	L80-40M
TX power (dBm)	xxxxxx	xxxxxx
EIRP (dBm)	xxxxxx	xxxxxx
TX channel assignments	8000V	8000V
RX threshold criteria	BER 10-6	BER 10-6
RX threshold level (dBm)	xxxxxx	xxxxxx
Receive signal (dBm)	xxxxxx	xxxxxx
Thermal fade margin (dB)	xxxxxx	xxxxxx
Dispersive fade occurrence factor		1.00
C factor		1.50
Average annual temperature (°C)		20.00
Fade occurrence factor (Po)		4.064E-002
Worst month multipath availability (%)	99.99976	99.99976
Worst month multipath unavailability (sec)	6.33	6.33
Annual multipath availability (%)	99.99992	99.99992
Annual multipath unavailability (sec)	25.83	25.83
Annual 2 way multipath availability (%)		99.99984
Annual 2 way multipath unavailability (sec)		51.65
Polarization		Vertical
0.01% rain rate (mm/hr)		50.00
Flat fade margin - rain (dB)		xxxxxx
Rain attenuation (dB)		xxxxxx
Annual rain availability (%)		100.00000
Annual rain unavailability (min)		0.00
Annual rain + multipath availability (%)		99.99984
Annual rain + multipath unavailability (min)		0.86

Link 2: Bago Reservoir to Jolly Nose

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Appendix

Definitions Table

dB	decibel (dB): unit of measure of loss or gain. Gain has a positive value, loss has a negative value, and is equal to $10 \cdot \log(P_{out}/P_{in})$
dBi	The unit of antenna gain is dBi. dBi means "Isotropic", a perfect POINT SOURCE, which radiates in a spherical manner. A perfect dipole radiates with a donut pattern, broadside to the long dimension of the dipole. It is a relative measurement to an ideal dipole that radiates in a perfect sphere.
dBm	(dB milliWatt) A signal strength or power level. 0 dBm is defined as 1 mW (milliWatt) of power into a terminating load such as an antenna or power meter. Small signals are negative numbers (e.g. -83 dBm).
Antenna Gain	The relative increase in radiation at the maximum point expressed as a value in dB above a standard, in this case the basic antenna, a $\frac{1}{2}$ -wavelength dipole (as in Two-Poles) by which all other antennas are measured. The reference is known as 0dBD (zero decibel referenced to dipole). An antenna with the effective radiated power of twice the input power would therefore have a gain of $10 \cdot \log(2/1) = 3\text{dBD}$.
FSL	Free Space Loss is defined as the loss a radio signal experiences when traveling through free space. The formula at 2.4 GHz is: $\text{FSL} = 104.2 + 20 \log D$ Where: D = Distance in miles Example: At 5 miles FSL is 118 dBFree
Polarisation	Antenna Polarity (e.g. Vertical or Horizontal)
Thermal Fade Margin	is defined as the difference between the received signal (in dBm) and the receiver sensitivity (in dBm) needed for error free reception. For example, if the received signal level is 71 dBm and the receiver sensitivity is 85dBm then the Fade Margin is: $-71\text{dBm} - (-85 \text{ dBm}) = 11 \text{ dB}$
Receive Signal	In telecommunications, received signal strength indication (RSSI) is a measurement of the power present in a received radio signal.
Receive Threshold	A received radio signal whose power is just above the noise level of the receiver. Also known as minimum detectable signal
Availability	Link availability is the percentage of time over a year that radio link will be operating satisfactorily. 5 Nines = 99.999% = Down 5 min / year 4 Nines = 99.99% = Down 53 min / year 3 Nines = 99.9% = Down 8.75 hrs / year 99.8% = Down 17.5 hours per year

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