

Canopy™ OFDM Backhaul Link Estimator

User Guide

BHOFDMLE-UG-en

Issue 6

July 2006

For use with both:

5.4GHz and 5.7GHz Canopy 30/60 Mbps Backhaul

5.4GHz and 5.7GHz Canopy 150/300 Mbps Backhaul

MOTOWI⁴



Trademarks, Product Names, and Service Names

MOTOROLA, the stylized M Logo and all other trademarks indicated as such herein are trademarks of Motorola, Inc.® Reg. U.S. Pat & Tm. Office. Canopy is a trademark of Motorola, Inc. All other product or service names are the property of their respective owners.

© 2006 Motorola, Inc. All rights reserved.

<http://www.motorola.com/canopy>

TABLE OF CONTENTS

1	Introduction.....	8
2	Path Loss Considerations	8
2.1	Free Space Path Loss.....	11
2.2	Excess Path Loss.....	12
2.2.1	<i>Fresnel Zone</i>	<i>12</i>
2.3	Fade Margin	13
2.4	Maximum Path Loss.....	14
2.5	Paths Over Sea or Very Flat Ground	14
3	Canopy 30/60 Mbps Backhaul and 150/300 Mbps Backhaul Equipment Features	15
4	Description of Path used in this User Guide.....	16
5	Path Data Availability	17
6	Canopy Backhaul Link Estimator	17
6.1	Path Input.....	18
6.1.1	<i>Link Wizard.....</i>	<i>20</i>
6.2	Main Screen	33
6.3	Path Visualisation.....	33
6.4	Link Loss Summary.....	35
6.5	User Throughput Summary	35
6.6	User Throughput Rates.....	37
6.6.1	<i>User Throughput Display for Canopy 150/300 Mbps Backhaul.....</i>	<i>37</i>
6.6.2	<i>User Throughput Display for Canopy 30/60 Mbps Backhaul.....</i>	<i>38</i>
6.7	Control Bar	40
6.7.1	<i>Save Path and Load Path</i>	<i>40</i>
6.7.2	<i>Clear Path.....</i>	<i>40</i>
6.7.3	<i>Straight Line</i>	<i>41</i>
6.7.4	<i>Defaults</i>	<i>41</i>
6.7.5	<i>Import Wizard</i>	<i>41</i>
6.7.6	<i>Utilities</i>	<i>45</i>
6.7.7	<i>Link Wizard.....</i>	<i>49</i>
6.7.8	<i>Help</i>	<i>49</i>
6.7.9	<i>Environmental Noise</i>	<i>49</i>
6.7.10	<i>Link Optimizations</i>	<i>50</i>

6.8	Path Profile.....	51
6.8.1	Path Profile Main Screen.....	51
6.8.2	Path Profile Helper.....	51
6.9	Link Symmetry	53
6.10	Worst Case analysis	53
6.11	Power Limits Summary	54
6.12	Antenna Heights.....	55
6.13	Local and Remote Antenna Type.....	55
7	Path Profiles.....	56
7.1	Path Profile E-mail	59
7.1.1	DAT file.....	60
7.1.2	PDF file.....	60
7.1.3	GPX.....	60
7.1.4	KML.....	60
8	Import File Formats	60
8.1	Micropath Comma Delimited File (*.txt)	60
8.2	Comma Delimited File (Length Height Obstruction) (*.csv)	61
8.3	ATDI ICS Telecom Comma Delimited Text File (*.txt)	61
8.4	Softwright TAP 4.3 (*.txt).....	61
8.5	Radio Mobile for Windows (*.txt).....	62
8.6	Pathloss Export (*.txt)	62
9	Example HTML Report	63
10	SRTM Technical Guide.....	69
11	Glossary	71

LIST OF FIGURES

Figure 1 - Free Space Path Loss at 5.8GHz	11
Figure 2 - Fresnel Radius for Zone 0.5	13
Figure 3 - Fade Margin vs Excess Path Loss for 99.99% Link Availability	14
Figure 4 - Propagation Over The Sea	15
Figure 5 - Opening Question.....	19
Figure 6 - Link Wizard - Page 1 – 150/300 Mbps Backhaul.....	21
Figure 7 - Link Wizard - Page 1 – Canopy 30/60 Mbps Backhaul	21

Figure 8 - Link Wizard - Page 2	22
Figure 9 - Latitude and Longitude Data Entry	23
Figure 10 - Link Wizard - Page 3	24
Figure 11 - Link Wizard - Page 4	25
Figure 12 - Link Wizard - Page 5	26
Figure 13 – Link Wizard – Page 5 with the Feed Loss Options	27
Figure 14 - Canopy Backhaul Link Estimator - Page 6	28
Figure 15 - Region Look Up	29
Figure 16 - Link Wizard - Page 7	30
Figure 17 - Link Wizard - Page 8	31
Figure 18 - Link Wizard - Page 9	32
Figure 19 - Main Screen.....	33
Figure 20 - Path Visualisation	34
Figure 21 - Link Loss Summary Information	35
Figure 22 - Data Rate Summary Information	36
Figure 23 - Canopy 150/300 Mbps Backhaul User Throughput Information	38
Figure 24 - Canopy 30/60 Mbps Backhaul User Throughput Information Symmetric Operation.....	39
Figure 25 - Canopy 30/60 Mbps Backhaul User Throughput Information Asymmetric Operation.....	39
Figure 26 - Control Bar.....	40
Figure 27 - Straight Line Drawing Example	41
Figure 28 - Path Import Wizard - Page 1	42
Figure 29 - Path Import Wizard - Page 2	43
Figure 30 - Path Import Wizard - Page 3	44
Figure 31 - Path Import Wizard - Page 4	45
Figure 32 - Utilities Button Box.....	46
Figure 33 - Conversion Screen	47
Figure 34 - Report Generator Screen	48
Figure 35 - Latitude and Longitude Conversion Page.....	49
Figure 36 - Environmental Noise.....	50
Figure 37 - Link Optimization	50
Figure 38 - Link Optimization	50
Figure 39 - Path Profile Entry.....	51
Figure 40 - Path Profile Helper.....	52

Figure 41 - Link Symmetry Selection	53
Figure 42 - Worst Case Analysis Selection	54
Figure 43 - Power Limit Summary Information.....	54
Figure 44- Antenna Height Adjustment	55
Figure 45 - Antenna Type Selection.....	56
Figure 46 - Path Profile Web Page	59

LIST OF TABLES

Table 1 - Aggregate Ethernet Throughput Rate vs Maximum Link Loss for Canopy 30/60 Mbps Backhaul 5x45 with Integrated Antennas	9
Table 2 - Aggregate Ethernet Throughput Rate vs Maximum Link Loss for Canopy 150/300 Mbps Backhaul 5x300 with Integrated Antennas	10

LIST OF EQUATIONS

Equation 1 - Path Loss.....	9
Equation 2 - Fresnel Zone Radius	12

ABOUT THIS USER GUIDE

NEW TO THIS ISSUE

This software release is a minor release of the Canopy Link Estimator to update the region codes available from the Link Wizard to support the 150/300 Mbps Backhaul in the 5.4 GHz band.

Interpreting Typeface and Other Conventions

This document employs distinctive fonts to indicate the type of information, as described in below:

Font	Type of Information
variable width bold	Selectable option in a graphical user interface or settable parameter in the web-based interface to a Canopy component.
constant width regular	Literal system response in a command-line interface.
<i>constant width italic</i>	Variable system response in a command-line interface.
constant width bold	Literal user input in a command-line interface.
<i>constant width bold italic</i>	Variable user input in a command-line interface.

This document employs specific imperative terminology as follows:

- *Type* means press the following characters.
- *Enter* means type the following characters and then press Enter.
- *Highlight* means click anywhere in a row of data to highlight the entire row.
- *Select* means use the mouse to click on or branch to the menu item that follows.

Getting Additional Help

To get information or assistance as soon as possible for problems that you encounter, use the following sequence of action:

1. Search this document, the user manuals that support the modules, and the software release notes of supported releases
 - a. in the Table of Contents for the topic.
 - b. in the Adobe Reader[®] search capability for keywords that apply.¹
2. Visit the Canopy systems website at <http://www.motorola.com/canopy>.
3. Ask your Canopy products supplier to help.
4. Gather information such as
 - the IP addresses and MAC addresses of any affected Canopy modules.
 - the software releases that operate on these modules.
 - data from the Event Log page of the modules.
 - the configuration of software features on these modules.

¹ Reader is a registered trademark of Adobe Systems, Incorporated.

5. Escalate the problem to Canopy systems Technical Support (or another Tier 3 technical support that has been designated for you) as follows. You may either
 - send e-mail to technical-support@canopywireless.com.
 - call 1 888 605 2552 (or +1 217 824 9742).

For warranty assistance, contact your reseller or distributor for the process.

Sending Feedback

We welcome your feedback on Canopy system documentation. This includes feedback on the structure, content, accuracy, or completeness of our documents, and any other comments you have. Please send your comments to technical-documentation@canopywireless.com.

1 Introduction

The Canopy 30/60 Mbps Backhaul and 150/300 Mbps Backhaul are designed to operate in Non-Line-of-Sight (NLoS) and Line-of-Sight (LoS) environments. Link planning and estimation enables a link of known quality to be installed. This involves the acquisition of path profile data and use of the Canopy Backhaul Link Estimator to predict the data rates and reliability over this path, through adjustment of antenna height and RF power. When the link is installed the mean path loss can be checked to confirm these data rates and reliability performance.

The Canopy Backhaul Link Estimator uses Microsoft Excel either on Windows or Macintosh. It performs the calculations from the ITU recommendations ITU-R P.526-9 and ITU-R P.530-10 to predict NLoS and LoS paths for anywhere in the world. Path profile data can be obtained in a number of different ways depending upon global location. Canopy Systems provide a method for obtaining path profile data, see section 7 "Path Profiles". Trees and buildings (clutter) will modify this profile and often the path must be surveyed to establish the correct estimation.

The Canopy Backhaul Link Estimator provides results specific to the Canopy 30/60 Mbps Backhaul and 150/300 Mbps Backhaul equipment, giving the data rates and reliability that can be expected given the specific design features of these products.

2 Path Loss Considerations

The path loss is the amount of attenuation the radio signal undergoes between the two ends of the link. The path loss comprises the sum of the attenuation of the path if there were no obstacles in the way (Free Space Path Loss), the attenuation caused by obstacles (Excess Path Loss), a margin to allow for possible fading of the radio signal (Fade Margin), and an allowance for the seasonal effects of foliage growth, to achieve a reliable link. This path loss must be lower than the equipment capability for the data rate required.

$$L_{\text{FreeSpace}} + L_{\text{Excess}} + L_{\text{Fade}} + L_{\text{Season}} < L_{\text{Capability}}$$

Where

$L_{\text{FreeSpace}}$	= Free Space Path Loss see section 2.1	dB
L_{Excess}	= Excess Path Loss see section 2.2	dB
L_{Fade}	= Fade Margin Requirement see section 2.3	dB
L_{Season}	= Seasonal Fading	dB
$L_{\text{Capability}}$	= Equipment Capability	dB

Equation 1 - Path Loss

Aggregate Ethernet Throughput Rate (Mbps)				Maximum path budget (dB)
Mode				
0-5km	0-40km	0-100km	0-200km	
3.60	3.34	2.98	2.52	166.5
8.10	7.52	6.70	5.67	161.3
10.80	10.03	8.93	7.56	159.2
16.20	15.04	13.40	11.34	154.6
24.29	22.56	20.10	17.01	150.1
32.39	30.08	26.80	22.68	144.7
36.44	33.84	30.15	25.51	142.8
42.51	39.48	35.17	29.76	138.1

Table 1 - Aggregate Ethernet Throughput Rate vs Maximum Link Loss for Canopy 30/60 Mbps Backhaul 5x45 with Integrated Antennas

Modulation Mode and Payload Type	Maximum Aggregate Data Rate (Mbits/s)²	Maximum path Budget (dB)
256QAM 0.81 dual	300.2	124.1
64QAM 0.92 dual	252.9	127.0
64QAM 0.75 dual	206.7	133.1
16QAM 0.87 dual	160.8	138.0
16QAM 0.63 dual	115.6	144.2
16QAM 0.63 single	57.8	148.3
QPSK 0.87 single	40.2	151.6
QPSK 0.63 single	28.9	155.6
BPSK 0.63 single	14.4	160.1
256QAM 0.81 single	150.1	129.0
64QAM 0.92 single	126.4	130.9
64QAM 0.75 single	103.3	136.7
16QAM 0.87 single	80.4	141.8

Table 2 - Aggregate Ethernet Throughput Rate vs Maximum Link Loss for Canopy 150/300 Mbps Backhaul 5x300 with Integrated Antennas

The equipment capability is given in Table 1 and Table 2. They give the Ethernet throughput rate vs link loss for Canopy 30/60 Mbps Backhaul and 150/300 Mbps Backhaul. Adaptive modulation will ensure that the highest throughput that can be achieved instantaneously will be obtained taking account of propagation and interference. Note the Ethernet throughput for Canopy 30 Mbps Backhaul is exactly half of the quoted throughput for Backhaul 60 Mbps and the Ethernet throughput for Canopy 150 Mbps Backhaul is exactly half of the quoted throughput for Backhaul 300 Mbps.

² Aggregate data rate in 40:40 mode for a 1km link length

The calculation given in Equation 1 needs to be performed to judge whether a particular link can be installed. When the link has been installed web pages provide information about the link loss currently measured by the equipment both instantaneously and averaged. The Canopy 30/60 Mbps Backhaul User Guide section 6.2 and Canopy 150/300 Mbps Backhaul User Guide section 6.2 describes this status.

2.1 FREE SPACE PATH LOSS

The Free Space Path Loss is the loss incurred along a Line of Sight path between the two end points of the radio link. Figure 1 gives a graph of the value in dB by range at the frequency used by Canopy 30/60 Mbps Backhaul and Canopy 150/300 Mbps Backhaul .

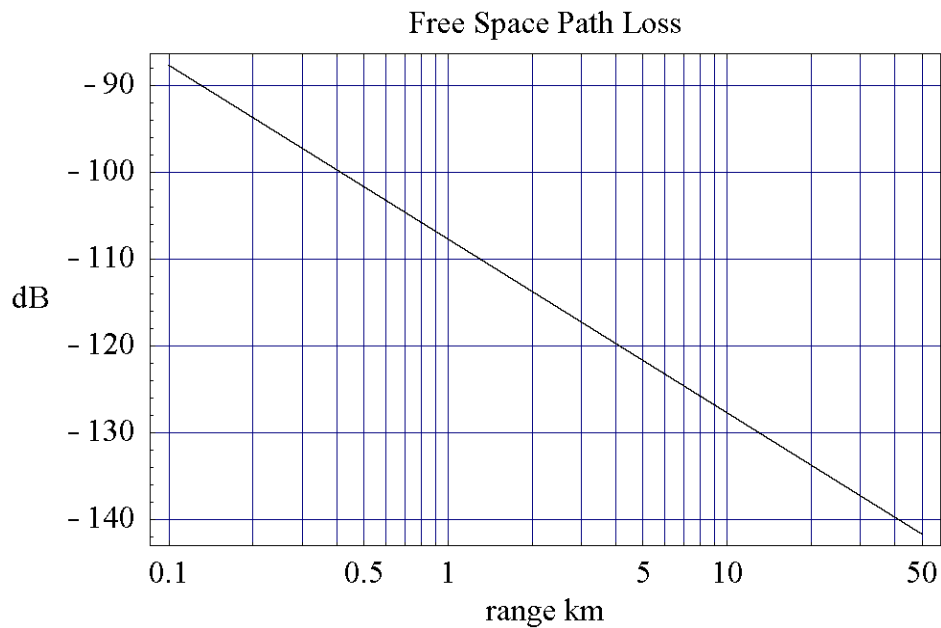


Figure 1 - Free Space Path Loss at 5.8GHz

2.2 EXCESS PATH LOSS

The Excess Path Loss is the loss incurred due to obstacles between the two end points of the radio link. This loss is best calculated using the Canopy Backhaul Link Estimator. Trees and foliage create a number of problems;

- they are often not marked on the path profiles — producing optimistic results,
- they are not completely solid — producing pessimistic results,
- they are responsible for seasonal variation.

It is recommended that they be treated as solid objects thus giving worst case results, and when the link is installed the mean path loss indicated should be given an allowance for the seasonal variation that will occur.

2.2.1 Fresnel Zone

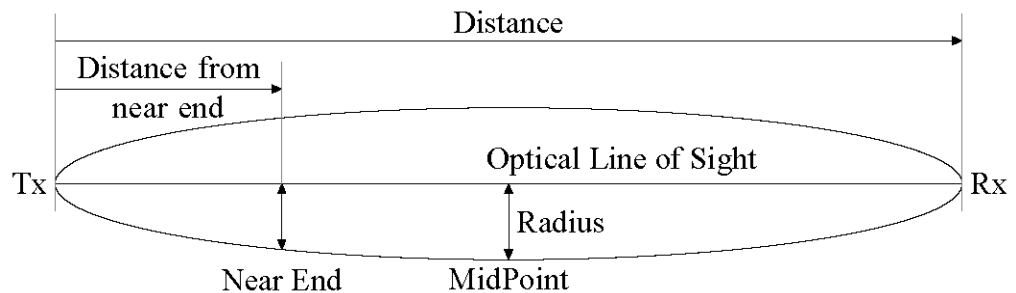
There is a theoretical area around the line of sight of an antenna, called the Fresnel Zone. Objects that penetrate the Fresnel Zone block some of the signal travelling from transmitter to receiver, causing the path loss to increase. The Fresnel radius at a point along the path is defined as follows::

$$\text{Fresnel Zone Radius} = 0.227 \sqrt{\frac{d1 \cdot d2}{d1 + d2}}$$

in metres where

$d1$ = distance from one end in metres

$d2$ = distance from the other end in metres



Equation 2 - Fresnel Zone Radius

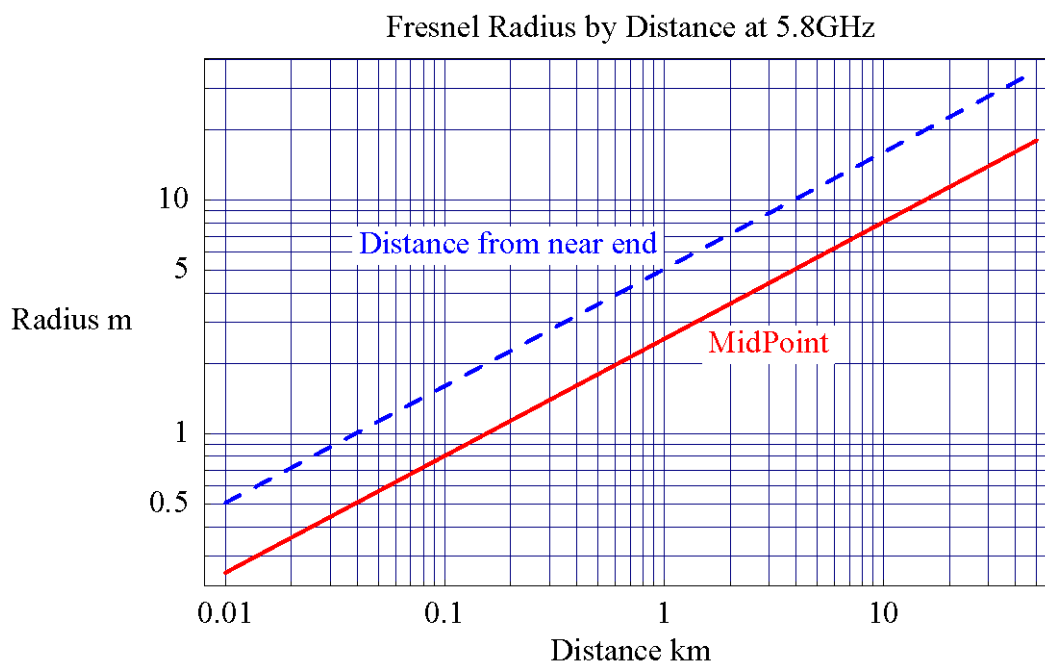


Figure 2 - Fresnel Radius for Zone 0.5

The two graphs in Figure 2 give the radius of the mid point of a link and also give the radius of any link near one end. Thus for a link longer than 1 km the radius of the Fresnel Zone at 100 meters is 1.7 meters. This is useful to know since the objects nearest the ends of the link tend to have a greater influence on the link losses than objects at the middle of the link. For a thorough understanding of the Fresnel Zone refer to ITU-R P.526-9.

2.3 FADE MARGIN

A Fade Margin needs to be applied to the link budget to take into account changes in the radio path caused by changes in objects surrounding or in the path. e.g. moving objects such as traffic or the changes in foliage brought on by seasonal change. The Fade Margin for NLoS links used in the calculation is a function of excess path loss, and is taken from Figure 3. The Fade Margin for LoS links is a function of location, path length, antenna heights, and spatial diversity and it is computed using ITU-R P.530-10. The estimation tool adds together the probabilities for the NLoS fading and the LoS fading.

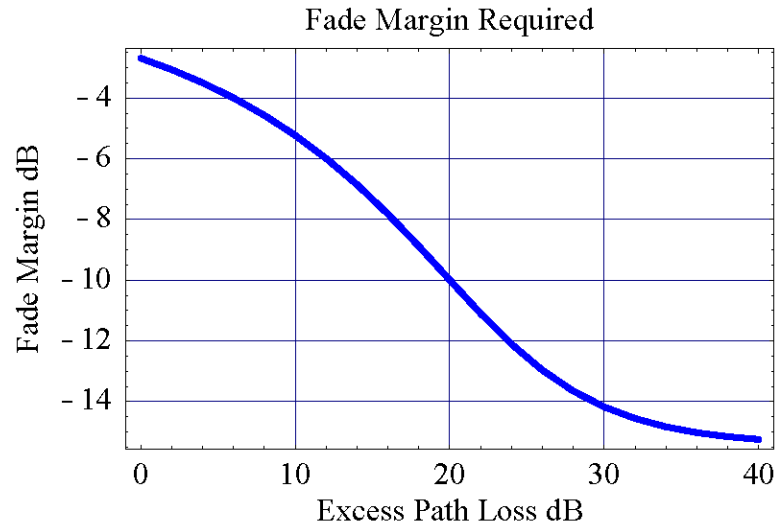


Figure 3 - Fade Margin vs Excess Path Loss for 99.99% Link Availability

2.4 MAXIMUM PATH LOSS

The Maximum Path Loss is the total path attenuation that the system can withstand and still maintain 99.99% availability. Due to different spectrum licensing conditions in different countries the Maximum Path Loss varies from country to country due to allowable output power differences. Table 1 and Table 2 gives the maximum loss that the equipment can withstand in each mode when deployed in a region³ that using a power of 25dBm. Deployment considerations may limit the maximum power which is used. An example is given in the Application Note: 'How to Deploy Canopy 30/60 Mbps Backhaul with Canopy' available from the Canopy Systems Web site. Also, there may be local interference sources from other users of the 5.8 GHz band.

2.5 PATHS OVER SEA OR VERY FLAT GROUND

Paths over the sea are subject to a special problem due to the very strong reflection from the water. This reflection can add an anti-phase signal to the direct wave and cancel it out completely. This may not happen all of the time because the effective curvature of the earth changes depending upon the temperature gradient in the atmosphere. This gradient can change and in certain circumstances causes the signal to travel a long way in ducts. Figure 4 illustrates the problem and the solution using Canopy 30/60 Mbps Backhaul or Canopy 150/300 Mbps Backhaul. The background of the diagram is shaded to illustrate the changing density and therefore refractive index. The upper antennas are in a signal inversion.

³ In other regions, the output power allowed may be lower than the 25 dBm assumed in the tables.

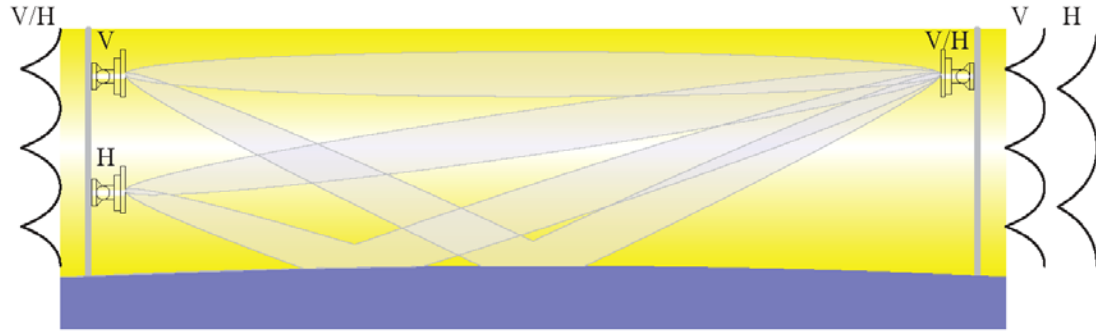


Figure 4 - Propagation Over The Sea

The signals pass from one antenna to the other through two paths. One path is the direct path and the other is reflected from the sea. The mean path loss of the two components is almost identical. The graph adjacent to the mast illustrates the signal level that will occur as an antenna is moved vertically on the mast. In this case the x-axis illustrates the amplitude received while the y-axis illustrates the height.

The polarisation selected for the antennas are single V and H polarisation on the left and a dual polarized antenna on the right. The two graphs on the right illustrate the signal received on each polarisation while on the left the individual antennas will receive the same signal level independent of polarisation but instead will only depend upon the height.

There is an optimum vertical spacing of the two antennas on the left which is found from the geometry of the two paths. The important parameters are the length of the path, the height of the right hand single antenna and to a lesser extent the height of the pair of antennas on the left. An allowance should normally be made for the apparent height of the middle of the path due to the mean radio curvature of the earth ($4/3$). This calculation is not yet a feature of the Canopy Backhaul Link Estimator.

3 Canopy 30/60 Mbps Backhaul and 150/300 Mbps Backhaul Equipment Features

There are some specific features of the Canopy 30/60 Mbps Backhaul and 150/300 Mbps Backhaul equipment which ensure that the product works as reliably as possible in LoS and NLoS environments. These are;

- Large System Budget for Long Range LoS or deep penetration in NLoS Applications,
- Space Time Coding to enable operation with reduced allowance for fade margin, in NLoS links this is effective using the integrated antenna, in long range LoS links this is most effective using separated antennas at one end of the link,

- Adaptive Modulation to ensure that the fastest instantaneous data rate is achieved in varying conditions,
- Use of a wide range of external antennas for difficult applications,
- Automatic Frequency Management to ensure that the optimum frequency is being used for communications in respect of interference, and
- Comprehensive measurements to ensure that a link will remain reliable after installation.

4 Description of Path used in this User Guide

The pictures in this handbook come from the path file Handbook.dat delivered in the installation. The Canopy Backhaul Link Estimator uses the methods of ITU-R P.526-9 (Deygout method) to calculate the excess path loss. This example path is 6 miles long with a major obstruction at 3 miles and two minor obstructions at 1.0 and 3.8 miles. See section 6.3 "Path Visualisation" for a pictorial representation of this path.

5 Path Data Availability

The accuracy of the results depends upon obtaining accurate path data. In the US this data is readily available from recent 1 arc second data (20m) obtained by NASA. In the rest of the world 30 arc second data (500m) is freely available but NASA is gradually providing 3 arc second data (50m) for the world between Latitudes 60 north and 60 south. (See section 7 "Path Profiles"). Even with accurate path data the losses over certain objects depends upon the curvature of the top of those objects. Nevertheless the tool gives a good idea of the performance to be expected and by doing a what/if analysis gives an inexperienced person a good feel for what Canopy Systems means by Non-Line-of-Sight.

6 Canopy Backhaul Link Estimator

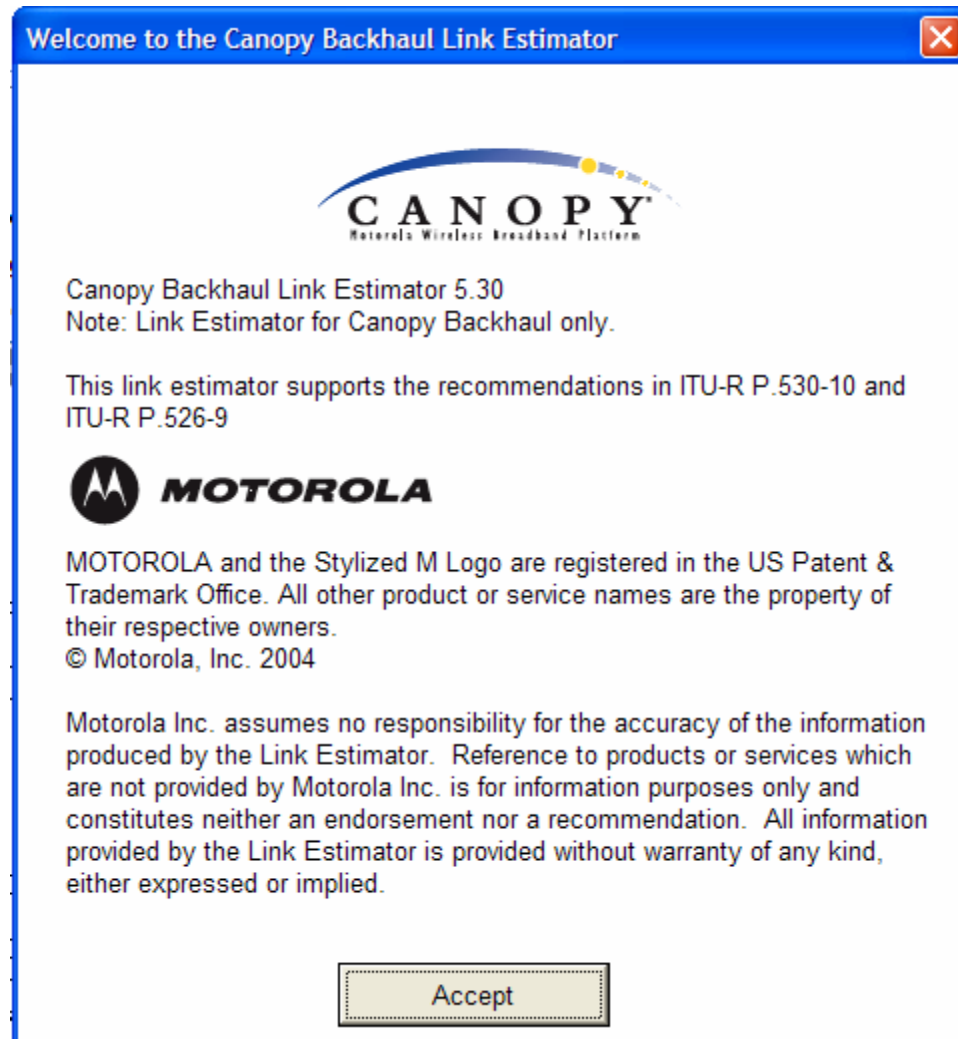
With the Canopy 30/60 Mbps Backhaul and 150/300 Mbps Backhaul equipment you are provided with a Canopy Backhaul Link Estimator to help predict where and how well the equipment will work. These instructions apply to the file Canopy Backhaul Link_Estimator_5v30.xls. The Canopy Backhaul Link Estimator performs calculations in accordance with ITU-R P.526-9 and ITU-R P.530-10.

The Canopy Backhaul Link Estimator requires Microsoft Excel to operate. Macros must be enabled to allow the program to work (If you do not see the window showing the contents of figure 5 then macros have not been enabled. Check in the Excel menus that Excel-Tools-Macro-Security is set to Medium (PC only)). The Canopy Backhaul Link Estimator has been tested on Excel 97, Excel 2000 and Excel vX. The facilities provided are:

- Path profile entry.
- Obstruction entry.
- Saving and recalling paths.
- Path visualisation.
- Path loss.
- Link reliability.
- Average data rate.
- Outage prediction.
- Worst case analysis.
- Region adjustment.
- Maximum power adjustment.
- Maximum EIRP adjustment.
- Antenna and feeder type selection.
- Space diversity.
- Link Optimisations.
- Import wizard from other data sources.
- Profile helper.
- Link symmetry control.
- Power asymmetry.
- Latitude longitude path calculator.
- Other conversions.
- Output Report.

6.1 PATH INPUT

On opening the Canopy Backhaul Link Estimator you are presented with a splash screen with a standard disclaimer



After clicking on Accept, the following prompt is displayed:

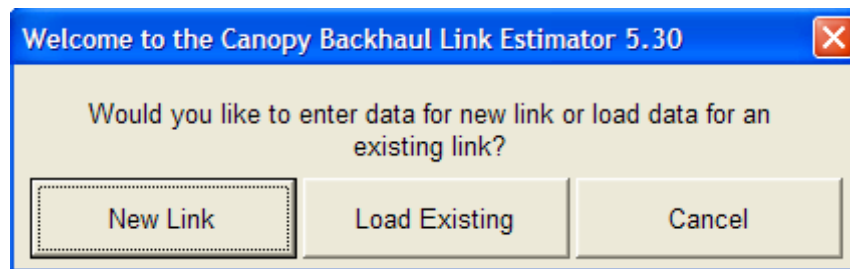


Figure 5 - Opening Question

New Link takes you to a nine step wizard (also available from 'Link Wizard' button on the data entry sheet) to set initial link parameters. (see Section 6.1.1 "Link Wizard").

Load Existing presumes that you have an existing path profile that you have saved on your hard disk from this Canopy Backhaul Link Estimator . (see Section 6.7.1 "Save Path and Load Path").

Cancel causes the program to continue from where you left off from previous Canopy Backhaul Link Estimator work using the saved workbook state.

6.1.1 Link Wizard

This wizard has nine pages which can be accessed in any order using the tabs. It may be necessary to enter the link wizard more than once before a satisfactory link estimation is obtained since some variables are only available in the wizard.

On the first page (Figure 6) a “Link Name”⁴ is specified and the “Product Type” and “Frequency Band” selected. The text indicates which version of software will be used to plan the link

Canopy Backhaul Link Estimator Link Wizard

Welcome to the Canopy Backhaul Link Estimator Link Wizard
You will be prompted to enter information about your link

Start by entering a link name, selecting the unit type and the frequency band.

Link Name & Unit Type
Enter the name of this link
Your Link Name

Select the Product Type
Canopy 300Mbps Backhaul

Select the Frequency Band
5.8 GHz (5.725 to 5.850 GHz)

Link Optimisation
☐ Optimise for TDM (E1/T1) ☒ Optimise for IP (Ethernet)

This link will be planned using 58300 software.

It is recommended that units are upgraded to the latest release of software. Check the website for details of the latest releases.

Link Name & Unit Type | Path Length | Site Heights | Local Site Antenna
Remote Site Antenna | Regulatory | Location | Customer Details | Summary

Cancel << Back Next >> Finish

⁴ This will appear at the top of the graph and also will be the default name for the saved data file.

Figure 6 - Link Wizard - Page 1 – 150/300 Mbps Backhaul

Figure 7 presents the alternative link optimisation options when an Canopy 30/60 Mbps Backhaul product type is selected. In this case the 5.4GHz frequency band is shown selected.



Canopy Backhaul Link Estimator Link Wizard

Welcome to the Canopy Backhaul Link Estimator Link Wizard
You will be prompted to enter information about your link
Start by entering a link name, selecting the unit type and the frequency band.

Link Name & Unit Type

Enter the name of this link

Your Link Name

Select the Product Type

Canopy 60Mbps Backhaul

Select the Frequency Band

5.4 GHz (5.470 to 5.725 GHz)

Link Optimisation

☐ Optimise for Latency ☒ Optimise for Throughput

This link will be planned using 5445 software.
It is recommended that units are upgraded to the latest release of software. Check the website for details of the latest releases.

Link Name & Unit Type Path Length Site Heights Local Site Antenna
Remote Site Antenna Regulatory Location Customer Details Summary

Cancel << Back Next >> Finish

Figure 7 - Link Wizard - Page 1 – Canopy 30/60 Mbps Backhaul

On the second page (Figure 8) select the units for distance and then enter the Path Length and the Path Increment. The increment is the step size of the path data.

Canopy Backhaul Link Estimator Link Wizard Step 2 of 9

On this page you enter information about the length of the path and path increment you want to use.

You may also obtain a path length from Latitude & Longitude data.

Distance Between Sites

Path Length Miles

Path Increment Miles

Distance Units

☒ Miles

☐ Km

Generate Path Length From Lat & Long

Link Name & Unit Type Path Length Site Heights Local Site Antenna

Remote Site Antenna Regulatory Location Customer Details Summary


Cancel << Back Next >> Finish

Figure 8 - Link Wizard - Page 2

The path length can be computed from the Latitude and Longitude information using the Latitude and Longitude data entry page (Figure 9) accessed by pressing the “Generate Path Length From Lat & Long” button. The Retain Existing Path Data check box must be unchecked to change the path length.

Note: Changing the path length will cause any existing path data to be lost.

Canopy Backhaul Link Estimator Link Wizard Step 7 of 9



On this page you need to provide the location of the link by Latitude & Longitude. This information is used to determine the terrain, local atmospheric conditions and the effect this has on propagation.

Location of this Link

Latitude

N

Degrees

50

Minutes

27

Second

3.69

50°27' 3.7"N

Longitude

W

3

46

31.7

3°46' 31.7"W

Latitude & Longitude Format

☒ Degrees Minutes Seconds

☐ Degrees (Decimal Minutes)

☐ Degrees (Decimal Degrees)

Remote Site Antenna

Regulatory

Location

Customer Details

Summary

Link Name & Unit Type

Path Length

Site Heights

Local Site Antenna

Cancel

<< Back

Next >>

Finish

Figure 9 - Latitude and Longitude Data Entry

Issue 6

Page 23 of 71

On page three (Figure 10) select the height units and then enter the local and remote site elevations Above Mean Sea Level (AMSL) and the antenna heights Above Ground Level (AGL). (These can both be adjusted later.)

Canopy Backhaul Link Estimator Link Wizard Step 3 of 9

On this page you enter information about the local and remote installation sites.

Enter the site elevations Above Mean Sea Level (AMSL) and the heights of the antennas Above Ground Level (AGL).

Local Site

Site Elevation (AMSL) 0.00 Feet

Antenna Height (AGL) 25 Feet

Remote Site

Site Elevation (AMSL) 0.00 Feet

Antenna Height (AGL) 25 Feet

Height Units

☐ Metres ☒ Feet

Link Name & Unit Type Path Length Site Heights Local Site Antenna


Remote Site Antenna Regulatory Location Customer Details Summary

Cancel << Back Next >> Finish

Figure 10 - Link Wizard - Page 3

On the fourth and fifth pages (Figure 11 and Figure 12) select an antenna type, if an external antenna is selected the feeder loss options become available (Figure 13).

Canopy Backhaul Link Estimator Link Wizard Step 4 of 9

 On this page you need to provide information about the local site antenna type (integrated or external) and feeder loss for external antennas. This page will calculate the feeder loss based on cable type and length.

Local Site

Antenna Selection

INTEGRATED - Built-in Antenna Dual Polar (23.5dBi)

Antenna Gain dBi


Link Name & Unit Type Path Length Site Heights Local Site Antenna

Remote Site Antenna Regulatory Location Customer Details Summary

Cancel << Back Next >> Finish

Figure 11 - Link Wizard - Page 4

Canopy Backhaul Link Estimator Link Wizard Step 5 of 9

 On this page you need to provide information about the remote site antenna type (integrated or external) and feeder loss for external antennas. This page will calculate the feeder loss based on cable type and length.

Remote Site

Antenna Selection

INTEGRATED - Built-in Antenna Dual Polar (23.5dBi)

Antenna Gain 23.5 dBi

Remote Site Antenna Regulatory Location Customer Details Summary

Link Name & Unit Type Path Length Site Heights Local Site Antenna

Cancel << Back Next >> Finish

Figure 12 - Link Wizard - Page 5

Canopy Backhaul Link Estimator Link Wizard Step 5 of 9

CANOPY
Motorola Wireless Broadband Platform

On this page you need to provide information about the remote site antenna type (integrated or external) and feeder loss for external antennas. This page will calculate the feeder loss based on cable type and length.

Remote Site

Antenna Selection

Antenna Gain dBi

Remote Site Feeder Loss

Cable Type ☒ Feet ☐ Metres

Cable ft X dB/ft = dB Feeder Loss

Losses may be higher if the cable is bent to the minimum bend radius or right angle connectors are used. Refer to manufacturers specifications for details.

Remote Site Antenna | Regulatory | Location | Customer Details | Summary

Link Name & Unit Type | Path Length | Site Heights | Local Site Antenna

Cancel << Back Next >> Finish

Figure 13 – Link Wizard – Page 5 with the Feed Loss Options

On page six (Figure 14) the regulatory options can be selected. Select the region and then if necessary enter a lower maximum EIRP or Power Limit if there are specific reasons for reducing power levels. The environmental noise is the amount of site noise in the 30 MHz channel bandwidth for Canopy 150/300 Mbps Backhaul and 10 MHz channel bandwidth for Canopy 30/60 Mbps Backhaul, expected at the antenna connector. This noise is assumed to be a constant power added to the thermal noise of the front end of the wireless. If mean power measurements from DFS are available then a close approximation is to use this value which will then be taken into account, this is only possible after link set up.

Canopy Backhaul Link Estimator Link Wizard Step 6 of 9

On this page you need to provide information about the local regulatory conditions.

Although the region codes below give an indication of the regulatory conditions, these should always be checked with the local regulatory authority.

Regulatory

Select Your Region: Region 7

Max EIRP Local Site: 48.5 dBm

Power Limit Local Site: 25 dBm

Max EIRP Remote Site: 51.8 dBm

Power Limit Remote Site: 25 dBm

In Band Environmental Noise: -144 dBm/10MHz

Region 7 : Regions where the regulatory conditions define a power limit of 25 dBm with DFS.

Note : The value Local Site power value will be used to perform the link estimations, but it is possible to use the Remote Site power by checking the Reverse Power check box on the Data Entry sheet

Remote Site Antenna | **Regulatory** | Location | Customer Details | Summary

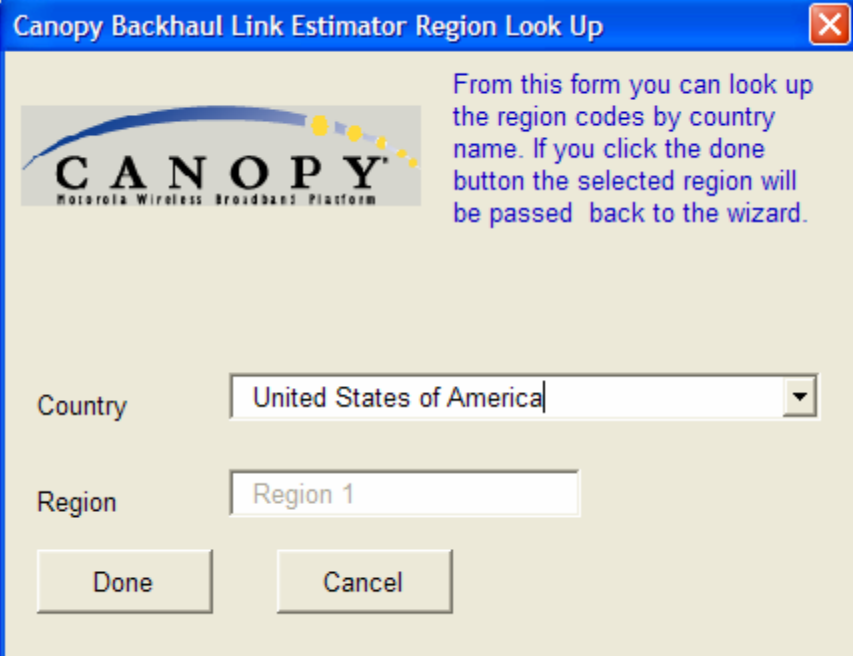
Link Name & Unit Type | Path Length | Site Heights | Local Site Antenna

Cancel | << Back | Next >> | Finish

Figure 14 - Canopy Backhaul Link Estimator - Page 6

When entering the regulatory information, the “Lookup Region” button⁵ provides access to a form with a drop down box of a list of countries (Figure 15). When a country is selected, the regulatory details for that country are obtained. Clicking the ‘Done’ button will transfer these details to the regulatory sheet of the link wizard.

⁵ The lookup feature is only available for products in the 5.8GHz frequency band.




The image shows a Windows-style dialog box titled "Canopy Backhaul Link Estimator Region Look Up". It features the Canopy logo (stylized "CANOPY" with "Motorola Wireless Broadband Platform" underneath) and a blue header bar. A text box on the right explains the function: "From this form you can look up the region codes by country name. If you click the done button the selected region will be passed back to the wizard." Below this, there are two input fields: "Country" with a dropdown menu showing "United States of America" and "Region" with a text box containing "Region 1". At the bottom are "Done" and "Cancel" buttons.

Figure 15 - Region Look Up

On page seven (Figure 16) the location is selected. This value will determine the constants used for long range fading. It is necessary to know the location of the link to an accuracy of 0.5° Latitude and Longitude because the likelihood of ducting varies across the globe.

Canopy Backhaul Link Estimator Link Wizard Step 7 of 9

 On this page you need to provide the location of the link by Latitude & Longitude. This information is used to determine the terrain, local atmospheric conditions and the effect this has on propagation.

Location of this Link

		Degrees	Minutes	Second	
Latitude	N	50	27	3.69	50°27' 3.7"N
Longitude	W	3	46	31.7	3°46' 31.7"W

Latitude & Longitude Format

☒ Degrees Minutes Seconds
☐ Degrees (Decimal Minutes)
☐ Degrees (Decimal Degrees)

Remote Site Antenna Regulatory **Location** Customer Details Summary

Link Name & Unit Type Path Length Site Heights Local Site Antenna

Cancel << Back Next >> Finish

Figure 16 - Link Wizard - Page 7

On page eight (Figure 17) the customer's details can be entered. These details will be output in the report summary.

Canopy Backhaul Link Estimator Link Wizard Step 8 of 9

CANOPY
Motorola Wireless Broadband Platform

On this page details of the customer can be entered. This information is only used for report generation

Contact Name
Company Name
Address 1
Address 2
State/Province
Zip/Postal Code
Country
Phone
Cell Phone
E-Mail

Clear All


Remote Site Antenna Regulatory Location **Customer Details** Summary
Link Name & Unit Type Path Length Site Heights Local Site Antenna

Cancel << Back Next >> Finish

Figure 17 - Link Wizard - Page 8

On page nine (Figure 18) a summary of the settings is given to confirm your intention. You can now go “Back”, “Cancel” or “Finish” the wizard.

Canopy Backhaul Link Estimator Link Wizard Step 9 of 9

 This page summarises what you have just entered. If the data is correct press FINISH otherwise press BACK to correct.

When you press finish you will be returned to the main sheet.

Summary

Link Name	Your Link Name
Product Type	Canopy 300Mbps Backhaul
Software Load	58300
Frequency Band	5.8 GHz (5.725 to 5.850 GHz)
Path Length	0.5 Miles
Path Increment	0.025 Miles
Local Site Elevation	0.00 Feet
Local Antenna Height	25 Feet
Remote Site Elevation	0.00 Feet
Remote Antenna Height	25 Feet
Local Antenna Type	INTEGRATED - Built-in Antenna Dual Polar (23.5dBi)
Local Antenna Gain	23.5 dBi
Remote Antenna Type	INTEGRATED - Built-in Antenna Dual Polar (23.5dBi)
Remote Antenna Gain	23.5 dBi

Remote Site Antenna Regulatory Location Customer Details **Summary**

Link Name & Unit Type Path Length Site Heights Local Site Antenna

Cancel << Back Next >> Finish

Figure 18 - Link Wizard - Page 9

6.2 MAIN SCREEN

Figure 19 Shows the main Canopy Backhaul Link Estimator screen. A description of each section of the screen follows.

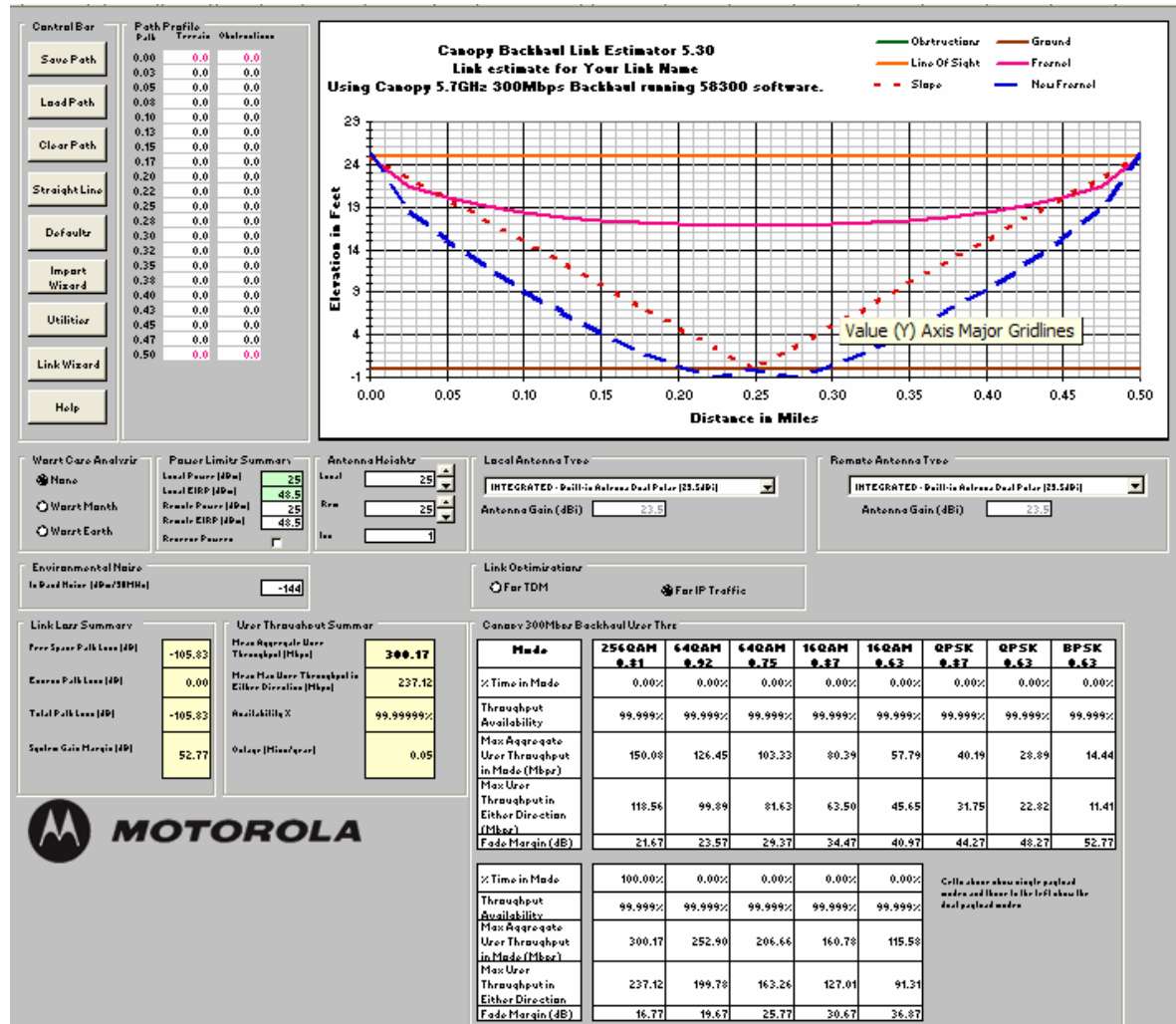


Figure 19 - Main Screen

6.3 PATH VISUALISATION

The "Path Visualisation" (Figure 20) shows a path of length 6 miles. The largest obstruction is shown at 3 miles and the smaller obstructions are shown at 1 and 3.8 miles. The terrain is shown in brown and the obstructions are in green. The orange solid line shows the line of sight between antennas. The red dashed line (called slope) shows the line of sight to the largest obstruction. The pink solid line shows the lower Fresnel Zone ($n = 0.5$) for the main path and the blue dashed lines show the sub paths.

As can be seen by the curvature of the brown line 4/3 Earth has been taken account. The display also shows the name of the path, the height units and the distance units.

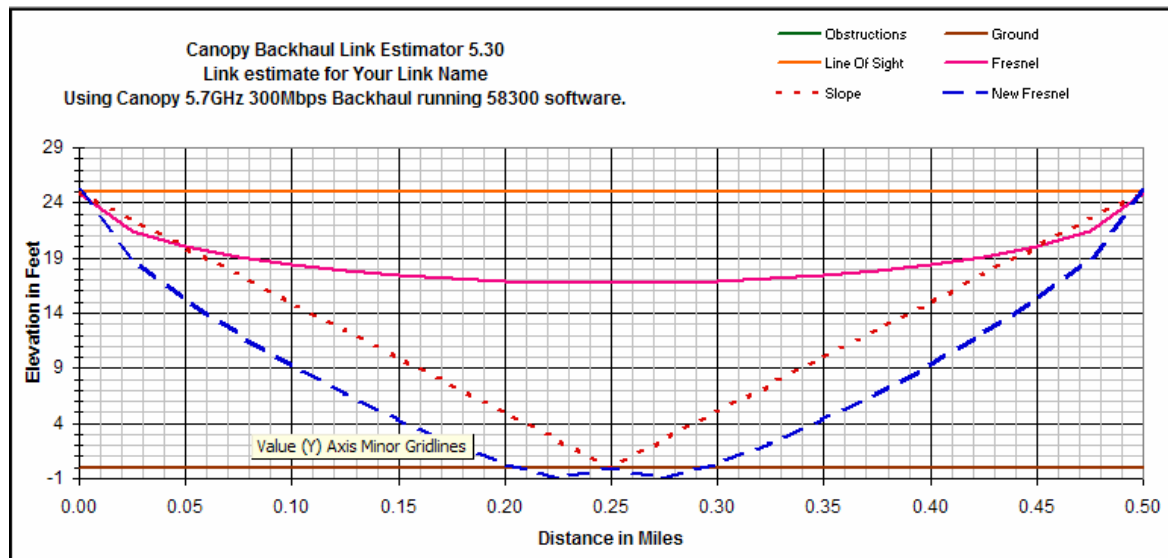


Figure 20 - Path Visualisation

The tool uses the methods of ITU P-526-7 (Deygout method) to calculate the excess path loss. This procedure searches for the major obstruction (at 3 miles) which obscures the link by the largest amount, i.e. the greatest percentage of Fresnel zone. It then takes the link in two parts and finds the greatest obstructions from one end to the major obstruction and from the major obstruction to the other end. As can be seen in Figure 21 this particular link gives an excess path loss of 14.93 dB

The main obstruction obscures nearly 50% of the Fresnel zone. The two secondary obstructions obscure about 25% of the secondary Fresnel zones. If there are no objects obscuring more of the primary or secondary zones then sufficient modeling has been achieved.

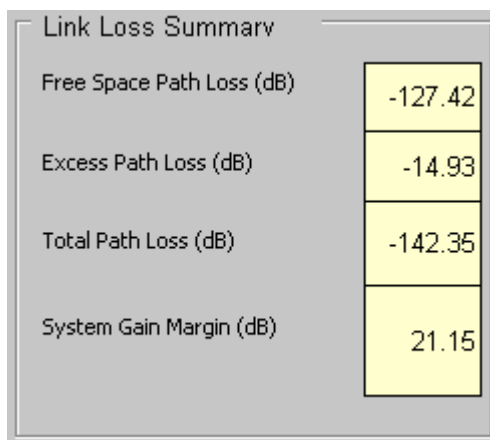
The tool is unlikely to give very accurate results due to the difficulty of obtaining accurate data. Even with accurate data the losses over certain objects depends upon the curvature of the top of those objects. Nevertheless the tool gives a good idea of the performance to be expected and doing what/if analysis gives an inexperienced person a good feel for what Canopy Systems means by non Line of Sight.

A further use of the tool is in predicting the fade margin required. Do not use these figures for other equipment which do not have fade mitigation techniques built in.

Simple adjustment of the antenna heights enable an assessment of the height required at each end of the link.

6.4 LINK LOSS SUMMARY

This summary (Figure 21) highlights the Free Space Path Loss component and the Excess Path Loss based upon the diffraction loss over the obstacles that cut the Fresnel zone number 0.5. The Total Path Loss and System Gain Margin is also given.



Free Space Path Loss (dB)	-127.42
Excess Path Loss (dB)	-14.93
Total Path Loss (dB)	-142.35
System Gain Margin (dB)	21.15

Figure 21 - Link Loss Summary Information

The link losses displayed here take into account “Worst Case Analysis” as described in section 6.10.

6.5 USER THROUGHPUT SUMMARY

This summary (Figure 22) shows the mean aggregate user data throughput that should be achieved, the radio availability for the most robust modulation mode and the corresponding outage in minutes per year.

User Throughput Summary	
Mean Aggregate User Throughput (Mbps)	89.50
Mean Max User Throughput in Either Direction (Mbps)	70.25
Availability %	99.99984%
Outage (Mins/year)	0.82

Figure 22 - Data Rate Summary Information

6.6 USER THROUGHPUT RATES

This area of the screen (**Figure 23**) shows the user data throughput rate for each mode, the time as a percentage spent in each mode, the throughput reliability for each mode and the link margin for that mode. In detail these are:

- 'Mode' stated as a modulation,
- '% Time in Mode' is the percentage of time spent in that mode and not in any other mode,
- 'Throughput Availability' is the percentage of time that the data throughput rates shown for each will be available
- 'Max Aggregate User Throughput in Mode (Mbps)'. These are the user data rates and give the maximum aggregate throughput achievable (sum of both directions). They are automatically adjusted for the range of the link being studied.
- 'Max User Throughput in Either Direction (Mbps)'. Applies to Canopy 150/300 Mbps Backhaul only. These give the maximum user throughput achievable in a single direction.
- 'Fade Margin (dB)' is the margin available for that mode.

The appearance of these tables is different for Canopy 150/300 Mbps Backhaul and Canopy 30/60 Mbps Backhaul.

6.6.1 User Throughput Display for Canopy 150/300 Mbps Backhaul

Canopy 150/300 Mbps Backhaul User Throughput								
Mode	256QAM 0.81	64QAM 0.92	64QAM 0.75	16QAM 0.87	16QAM 0.63	QPSK 0.87	QPSK 0.63	BPSK 0.63
% Time in Mode	0.00%	0.00%	2.90%	68.54%	4.14%	0.03%	0.01%	0.00%
Throughput Availability	4.057%	4.057%	27.286%	95.823%	99.965%	99.993%	99.999%	99.999%
Max Aggregate User Throughput in Mode (Mbps)	148.40	125.03	102.17	79.49	57.14	39.74	28.57	14.28
Max User Throughput in Either Direction (Mbps)	116.48	98.13	80.19	62.39	44.85	31.19	22.42	11.21
Fade Margin (dB)	-9.95	-8.05	-2.25	2.85	9.35	12.65	16.65	21.15
% Time in Mode	0.00%	0.00%	0.00%	4.06%	20.33%	Cells above show single payload modes and those to the left show the dual payload modes		
Throughput Availability	0.000%	0.000%	0.002%	4.057%	24.389%			
Max Aggregate User Throughput in Mode (Mbps)	296.80	250.06	204.35	158.97	114.28			
Max User Throughput in Either Direction (Mbps)	232.95	196.27	160.39	124.78	89.70			
Fade Margin (dB)	-14.85	-11.95	-5.85	-0.95	5.25			

Figure 23 - Canopy 150/300 Mbps Backhaul User Throughput Information

The display is split into two blocks, the upper block giving the throughputs in single payload modes and the lower block giving the throughput in dual payload modes. The adaptive modulation scheme in Canopy 150/300 Mbps Backhaul will always select the mode which gives the maximum data rate.

6.6.2 User Throughput Display for Canopy 30/60 Mbps Backhaul

The format of the display for Canopy 30/60 Mbps Backhaul will depend on the setting of "Link Symmetry". When the "Link Symmetry" is set to symmetrical (Section 6.9 "Link Symmetry") the data rates are as shown in Figure 24, whereas when the "Link Symmetry" is set to asymmetrical the data rates shown for each direction as shown in Figure 25.

Canopy 30/60 Mbps Backhaul User Throughput - Symmetric Operation								
Mode	64QAM 7/8	64QAM 3/4	64QAM 2/3	16QAM 3/4	16QAM 1/2	QPSK 2/3	QPSK 1/2	BPSK 1/2
% Time in Mode	39.95%	56.75%	2.88%	0.40%	0.01%	0.00%	0.00%	0.00%
Throughput Availability	39.953%	96.704%	99.584%	99.986%	99.997%	99.999%	99.999%	99.999%
Max Aggregate User Throughput in Mode (Mbps)	39.48	33.84	30.08	22.56	15.04	10.03	7.52	3.34
Fade Margin (dB)	-0.07	2.74	5.12	11.25	14.38	20.83	22.15	31.29

Figure 24 - Canopy 30/60 Mbps Backhaul User Throughput Information Symmetric Operation

Canopy 30/60 Mbps Backhaul User Throughput - Asymmetric Operation								
Mode	64QAM 7/8	64QAM 3/4	64QAM 2/3	16QAM 3/4	16QAM 1/2	QPSK 2/3	QPSK 1/2	BPSK 1/2
% Time in Mode	39.95%	56.75%	2.88%	0.40%	0.01%	0.00%	0.00%	0.00%
Throughput Availability	39.953%	96.704%	99.584%	99.986%	99.997%	99.999%	99.999%	99.999%
Max Aggregate User Throughput in Mode (Mbps)	37.74	32.35	28.75	21.56	14.38	9.58	7.19	3.19
User Throughput in Mode Local to Remote (Mbps)	25.16	21.56	19.16	14.37	9.59	6.39	4.79	2.13
User Throughput in Mode Remote to Local (Mbps)	12.58	10.79	9.59	7.19	4.79	3.19	2.40	1.06
Fade Margin (dB)	-0.07	2.74	5.12	11.25	14.38	20.83	22.15	31.29

Figure 25 - Canopy 30/60 Mbps Backhaul User Throughput Information Asymmetric Operation

6.7 CONTROL BAR

The control bar contains the main data management buttons (Figure 26).



Figure 26 - Control Bar

The following Shortcut keys are supported:

- F1 Help
- CTRL-Q Straight Line
- CTRL-W Link Wizard
- CTRL-S Save Path Profile
- CTRL-I Import Wizard
- CTRL-D Default
- CTRL-R Clear Path Data
- CTRL-U Utilities
- CTRL-O Run Report

6.7.1 Save Path and Load Path

The "Save Path" and "Load Path" buttons are used to Save and Load path data to disk. After pressing one of these buttons you will be presented with your operating systems standard folder/file navigation tool.

6.7.2 Clear Path

The "Clear Path" button will clear your path data. All other data will stay intact.

6.7.3 Straight Line

When entering a long path, needing many points, the straight line feature can be useful. If a group of terrain cells are selected pressing the “Straight Line” button will adjust the points between to form a straight line. You will need to select at least three points on the path to draw a straight line (Figure 27).

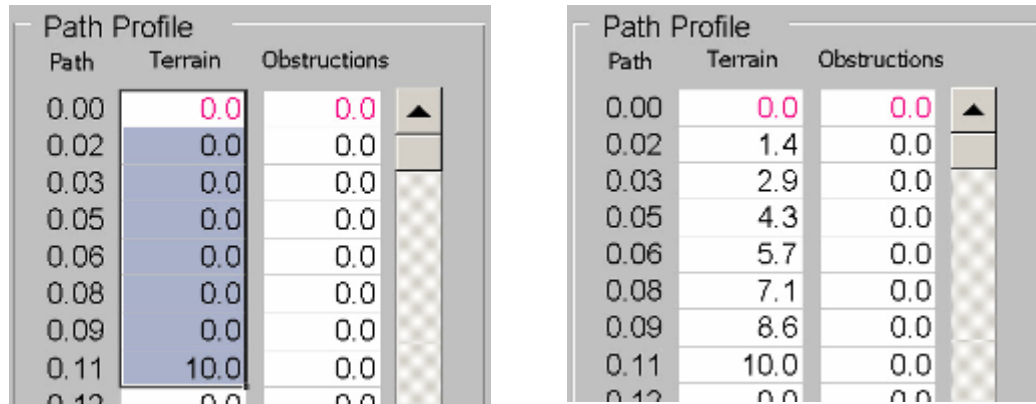


Figure 27 - Straight Line Drawing Example

6.7.4 Defaults

The “Defaults” button will return the Canopy Backhaul Link Estimator to the factory defaults state (i.e. the state when the Canopy Backhaul Link Estimator is first opened).

6.7.5 Import Wizard

The “Import Wizard” (Figure 28) provides a facility to import path profiles produced by other tools or in Canopy Systems format.

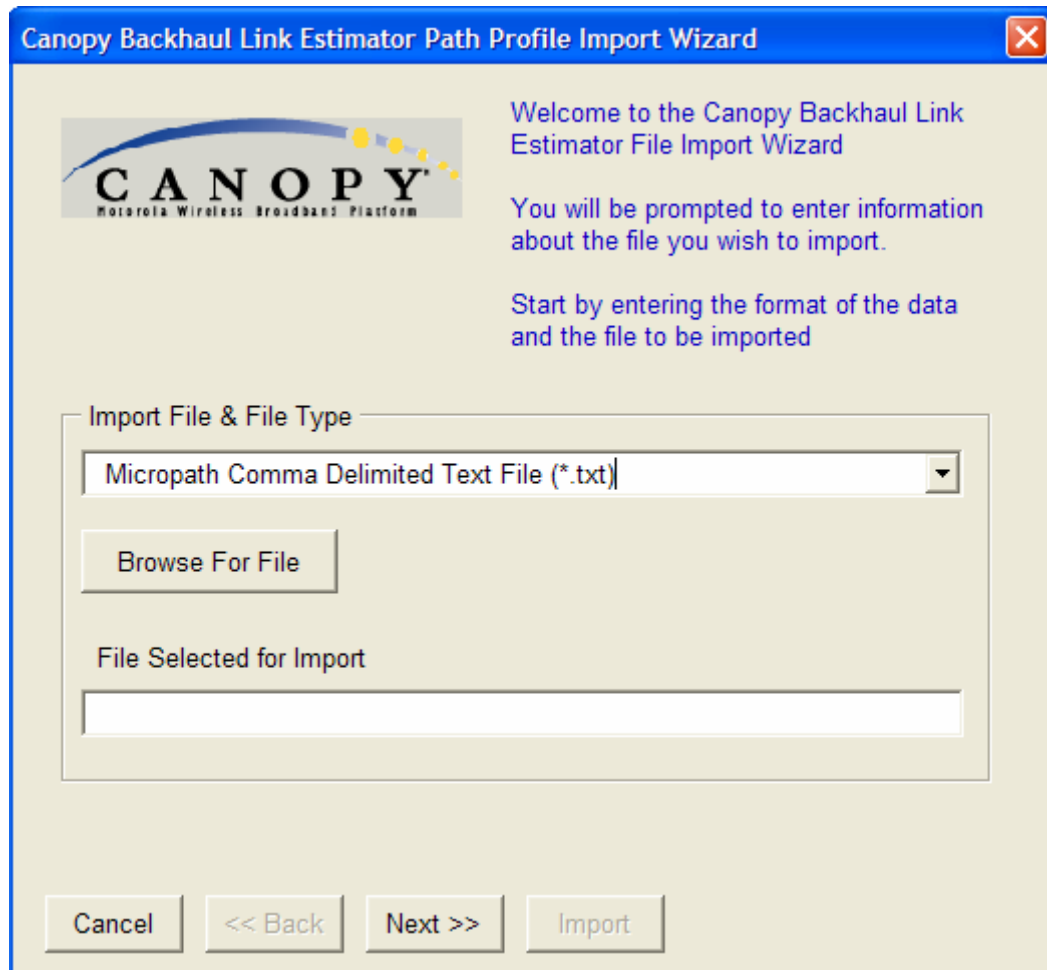



Figure 28 - Path Import Wizard - Page 1

The following file formats are supported:

- Micropath Comma Delimited File (*.txt)
- Comma Delimited File (Length Height Obstruction) (*.csv)
- ATDI ICS Telecom Comma Delimited Text File (*.txt)
- Softwright TAP 4.3 (*.txt)
- Radio Mobile for Windows (*.txt)
- Pathloss Export (*.txt)

Example files are provided as part of the Canopy Backhaul Link Estimator package. The formats of these files are shown in section 8 "Import File Formats". The import wizard has three pages for format and file selection (Figure 28), unit entry (Figure 29) and link name (Figure 30).

Canopy Backhaul Link Estimator Path Profile Import Wizard Step 2 of 4



On this page you need to specify the height and distance units used in the import file.

Height Units

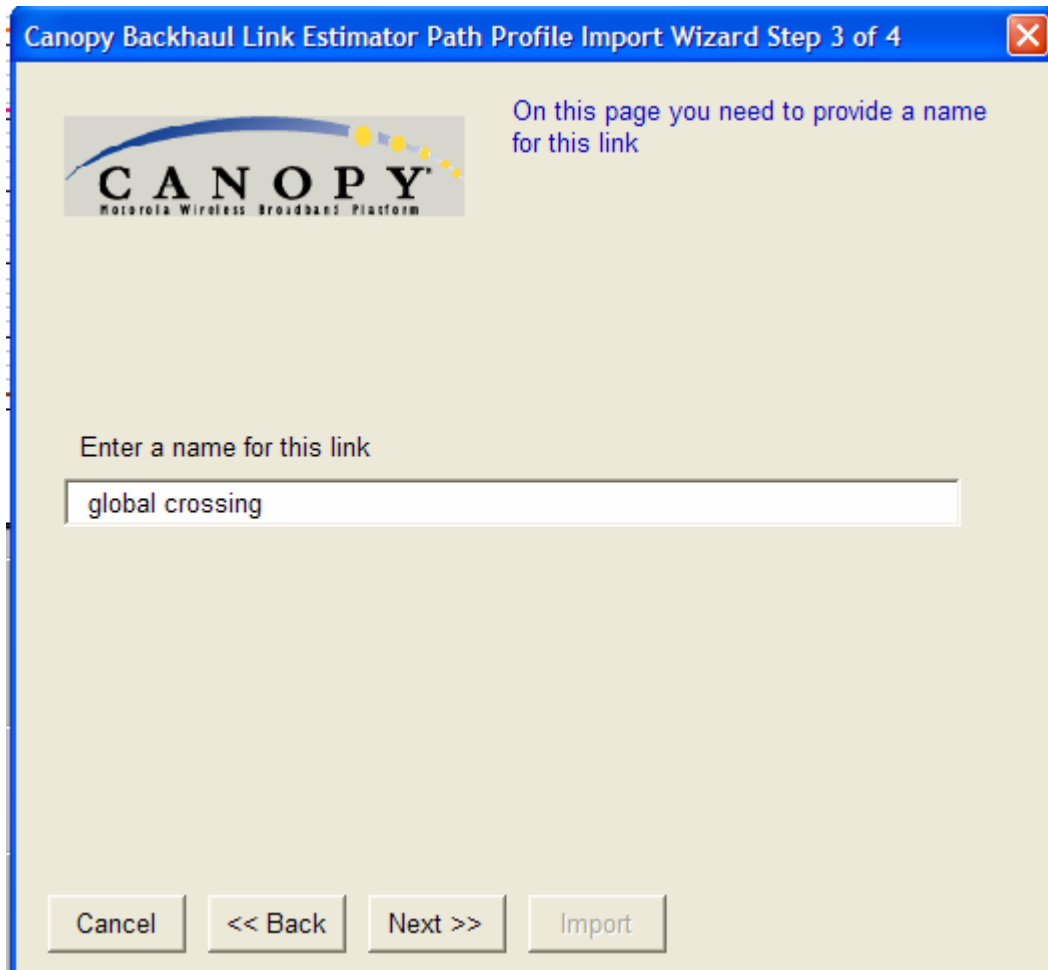
☒ Feet ☐ Metres

Distance Units

☒ Miles ☐ Km

Cancel << Back Next >> Import

Figure 29 - Path Import Wizard - Page 2



The image shows a software window titled "Canopy Backhaul Link Estimator Path Profile Import Wizard Step 3 of 4". The window has a blue title bar with a close button (X) in the top right corner. Inside the window, there is a Canopy logo (stylized "CANOPY" with "Motorola Wireless Broadband Platform" underneath) on the left. To the right of the logo, the text reads: "On this page you need to provide a name for this link". Below this text, there is a text input field with the label "Enter a name for this link" above it. The input field contains the text "global crossing". At the bottom of the window, there are four buttons: "Cancel", "<< Back", "Next >>", and "Import".

Figure 30 - Path Import Wizard - Page 3

The final page (Figure 31) has a summary of the selections made and data is imported by pressing the import button. All previous path information will be lost once import starts.

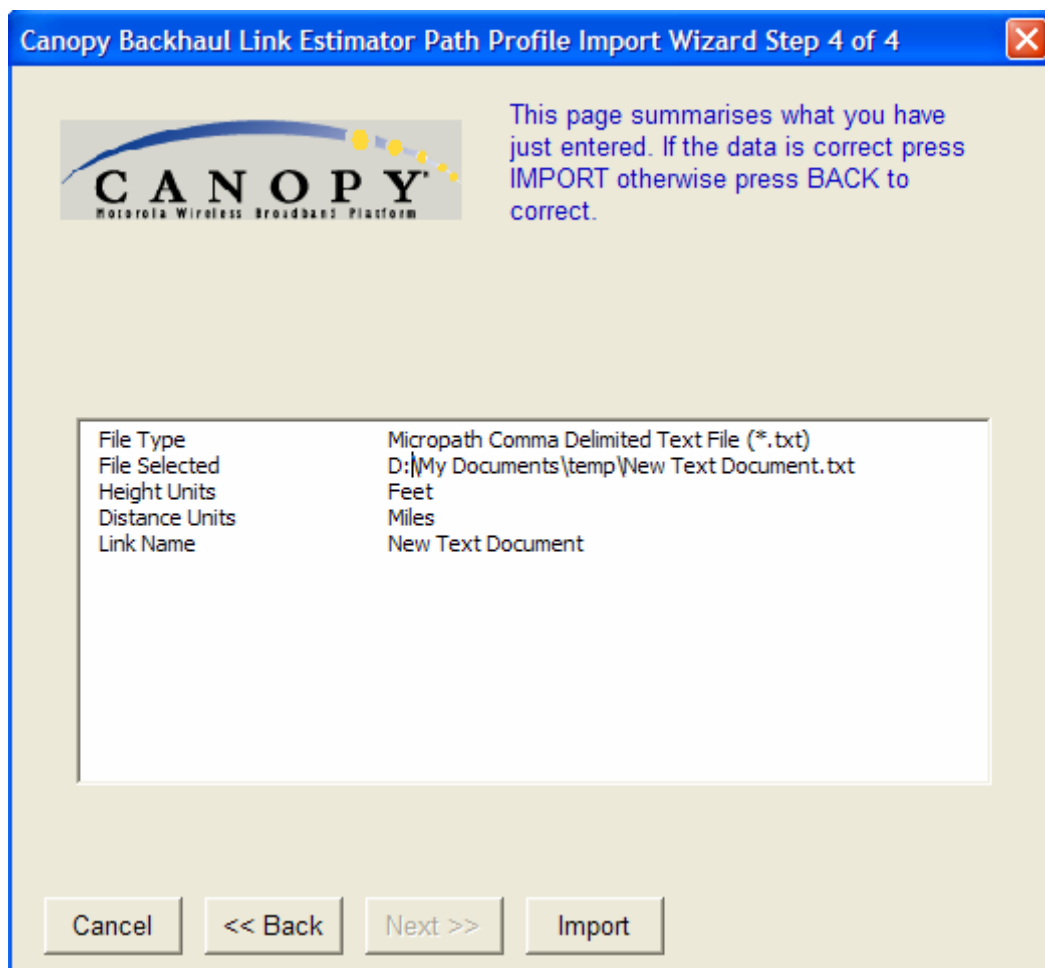


Figure 31 - Path Import Wizard - Page 4

6.7.6 Utilities

Pressing the “Utilities” button brings up the utilities button box (Figure 32).

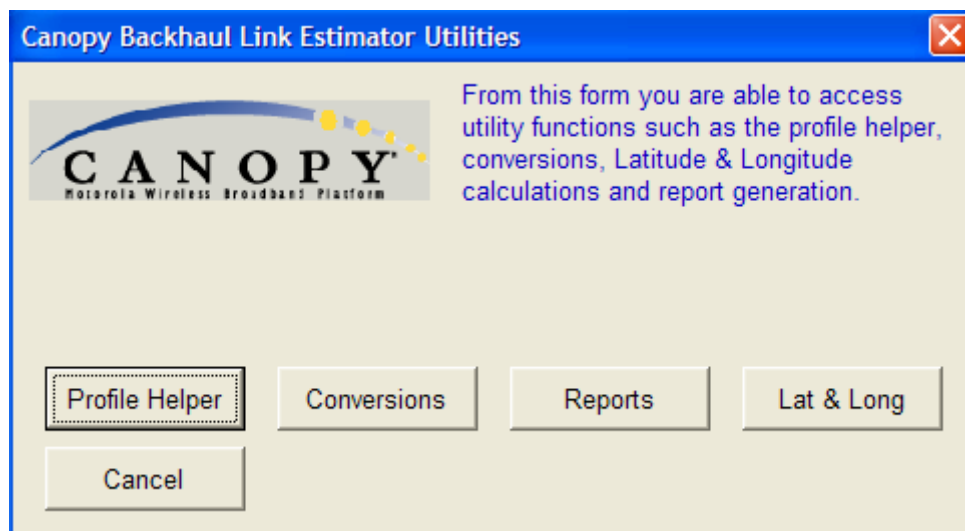


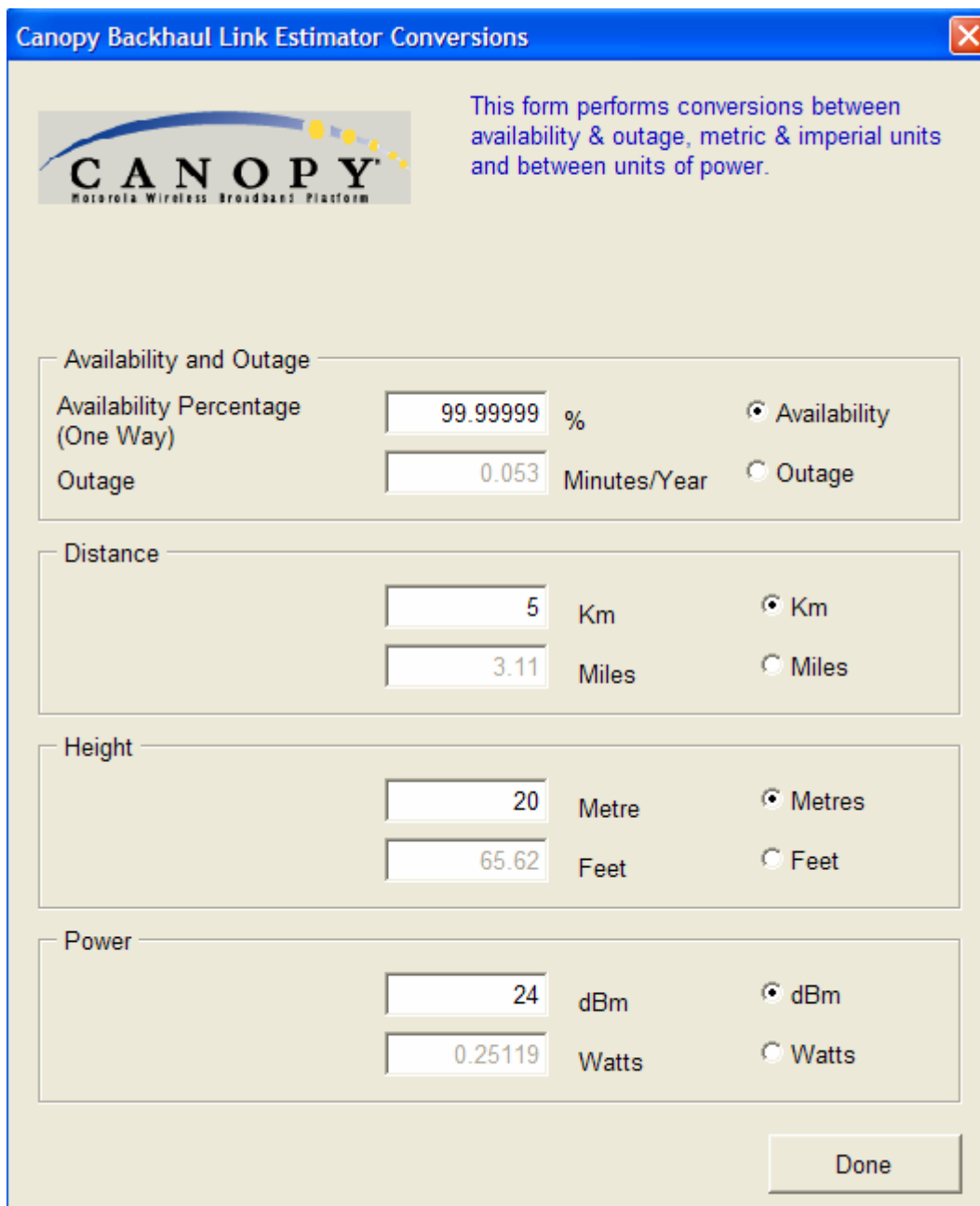
Figure 32 - Utilities Button Box

Profile Helper

Pressing the "Profile Helper" button will take you to the "Profile Helper" tab described in section 6.8.2 "Path Profile Helper".

Conversions

Pressing the "Conversions" button will pop up a conversion screen (Figure 33) giving you utilities to convert availability/outage, distance, height and power.



The image shows a software window titled "Canopy Backhaul Link Estimator Conversions". It features the Canopy logo (Motorola Wireless Broadband Platform) and a description: "This form performs conversions between availability & outage, metric & imperial units and between units of power." The window is divided into four sections: "Availability and Outage", "Distance", "Height", and "Power". Each section has input fields for values and radio buttons to select the units.

Availability and Outage

Availability Percentage (One Way): 99.99999 % ☒ Availability

Outage: 0.053 Minutes/Year ☐ Outage

Distance

5 Km ☒ Km

3.11 Miles ☐ Miles

Height

20 Metre ☒ Metres

65.62 Feet ☐ Feet

Power

24 dBm ☒ dBm

0.25119 Watts ☐ Watts

Done

Figure 33 - Conversion Screen

Reports

Pressing the "Report" button brings up the report generator screen (Figure 34). The report generator is used to produce reports in HTML format. An example HTML report is shown in section 9 "Example HTML Report".



The image shows a software dialog box titled "Canopy Backhaul Link Estimator Report Generation". It features the Canopy logo (Motorola Wireless Broadband Platform) and instructional text: "From this form you are able to generate an output report in HTML format." and "The output format can be customised by selecting the check boxes." The form includes a "Planner" section with a "Link planned by" text box containing "Some One". Below is a "Report Options" section with three checked checkboxes: "Include Lat/Long Data", "Include Customer Contact Details", and "Include Optional Notes". A text area below these options contains the instruction: "You can include some user specific text here, like notes about obstructions close to the Local or Remote sites." At the bottom are "Cancel" and "Generate Report" buttons.

Canopy Backhaul Link Estimator Report Generation

CANOPY
Motorola Wireless Broadband Platform

From this form you are able to generate an output report in HTML format.

The output format can be customised by selecting the check boxes.

Planner

Link planned by

Report Options

☒ Include Lat/Long Data

☒ Include Customer Contact Details

☒ Include Optional Notes

You can include some user specific text here, like notes about obstructions close to the Local or Remote sites.

Figure 34 - Report Generator Screen

Lat and Long

Assistance with installation and survey can be achieved by using the 'Lat & Long' button. This screen enables input of the latitude and longitude of the two locations and it returns the range and direction for each end of the link. The Latitude and Longitude may be entered in a number of common methods.

Canopy Backhaul Link Estimator Latitude and Longitude

This form gives path length and bearings based on Latitude and Longitude.

CANOPY
Motorola Wireless Broadband Platform

Local Site

	Degrees	Minutes	Seconds	
Latitude	N	50	27	3.69 50°27' 3.7"N
Longitude	W	3	46	31.7 3°46' 31.7"W

Lat & Long Format

☐ Degrees (Decimal Minutes)
☒ Degrees Minutes Seconds
☐ Degrees (Decimal Degrees)

Remote Site

	Degrees	Minutes	Seconds	
Latitude	N	50	31	25.3 50°31' 25.3"N
Longitude	W	3	44	27.9 3°44' 27.9"W

Results

Path Length is 5.24 Miles or 8.44 Kms

Azimuth from Grid North - Local Site to Remote Site is 16.74 Degrees

Azimuth from Grid North - Remote Site to Local Site is 196.77 Degrees

Cancel

Done

Figure 35 - Latitude and Longitude Conversion Page

6.7.7 Link Wizard

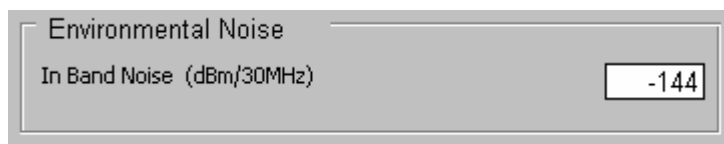
Pressing the "Link Wizard" button will start the link set up wizard described in section 6.1.1 "Link Wizard".

6.7.8 Help

Pressing the "Help" button will display this document in PDF form.

6.7.9 Environmental Noise

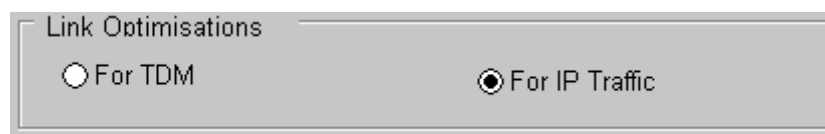
The environmental noise is the amount of in-band site noise in the 30 MHz channel bandwidth for Canopy 150/300 Mbps Backhaul and 10 MHz channel bandwidth for Canopy 30/60 Mbps Backhaul, expected at the antenna connector. This noise is assumed to be a constant power added to the thermal noise of the front end of the wireless.

**Figure 36 - Environmental Noise**

6.7.10 Link Optimizations

This feature is operates differently for Canopy 30/60 Mbps Backhaul and 150/300 Mbps Backhaul.

The Canopy 150/300 Mbps Backhaul optimizations allow the user to select between the TDM (E1/T1) mode in which the traffic is always symmetrical or the IP (Ethernet) mode, where the traffic symmetry varies according to load.

**Figure 37 - Link Optimization**

The Canopy 30/60 Mbps Backhaul optimizations allow the user to select between the low latency mode or high throughput modes. Canopy 30/60 Mbps Backhaul allows the user to trade off Packet Latency⁶ against Ethernet throughput.

**Figure 38 - Link Optimization**

⁶ It should be noted that low latency mode is only supported on symmetric wireless links.

6.8 PATH PROFILE

6.8.1 Path Profile Main Screen

In this area (Figure 39) the detailed path characteristics are entered. Changes can be seen on the path visualisation, where the terrain is identified in brown and obstructions are identified in green. If the scroll bar is present then it enables movement to a different area of the profile.

Path Profile		
Path	Terrain	Obstructions
0.00	5.0	0.0
0.20	0.0	0.0
0.40	0.0	0.0
0.60	0.0	0.0
0.80	0.0	0.0
1.00	0.0	14.0
1.20	0.0	0.0
1.40	0.0	0.0
1.60	0.0	0.0
1.80	0.0	0.0
2.00	3.0	0.0
2.20	3.0	0.0
2.40	3.0	0.0
2.60	3.0	0.0
2.80	3.0	0.0
3.00	3.0	15.0
3.20	3.0	0.0
3.40	3.0	0.0
3.60	3.0	0.0
3.80	3.0	5.0
4.00	3.0	0.0
4.20	0.0	0.0
4.40	0.0	0.0
4.60	0.0	0.0
4.80	0.0	0.0
5.00	0.0	0.0

Figure 39 - Path Profile Entry

6.8.2 Path Profile Helper

The “Profile Helper” (Figure 40) is intended to be an aid for the generation of profiles when a list of data is available, particularly if it can be pasted from a text file.

The “Profile Helper” is particularly useful when managing the data from very long paths.

The “Profile Helper” is accessed by selecting the appropriate tab at the bottom of the screen or by pressing the “Profile Helper” button on the “Utilities” page.

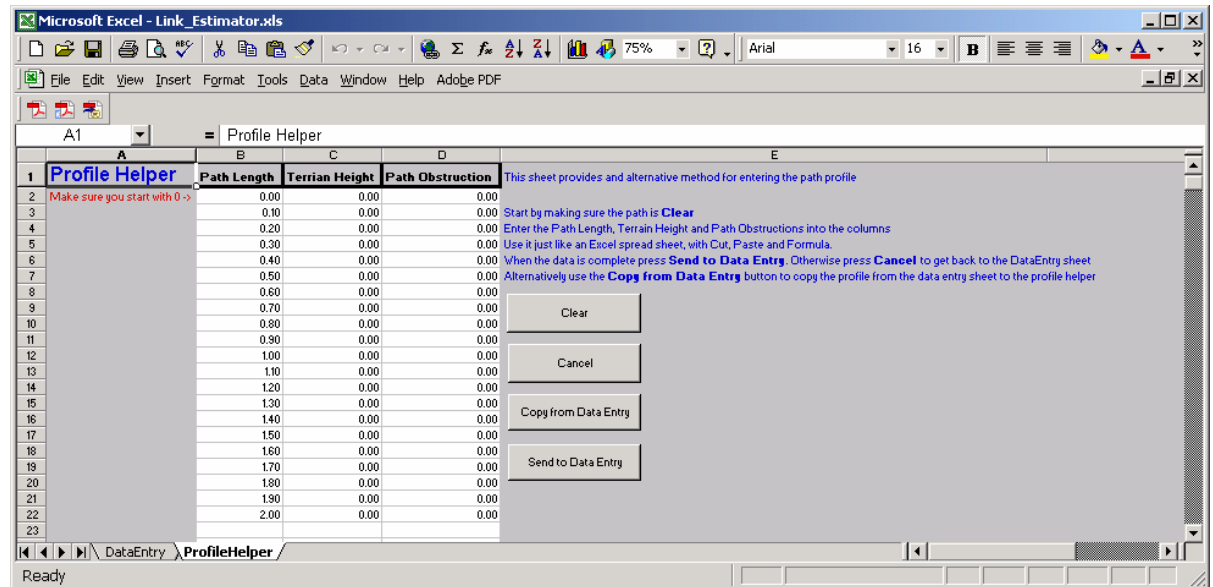


Figure 40 - Path Profile Helper

This worksheet has four buttons:

- “Clear” this causes all data in the profile helper to be cleared.
- “Cancel” that takes you back to the “Data Entry” sheet.
- “Copy from Data Entry” which transfers the profile from the “Data Entry” sheet to the Profile Helper.
- “Send to Data Entry” sends the current path “Data Entry” sheet to the “Profile Helper”.

To use the helper, paste or type a path profile into the three columns for Path Position, Terrain Height and Path Obstruction, remembering to start the path at a path position of 0. The important features of the path profile are the high points; however ensure that if you only insert the high points accurately there are some appropriate low points between the high points. The path position does not need to increment linearly but may give an odd looking picture on the path visualisation.

6.9 LINK SYMMETRY

In this area the link can be selected as 1:1 or 2:1, this represents the data throughput in each direction.

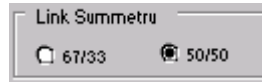


Figure 41 - Link Symmetry Selection

This mode is only available for Canopy 30/60 Mbps Backhaul. Symmetry selection for Canopy 150/300 Mbps Backhaul is automatic when in IP mode.

6.10 WORST CASE ANALYSIS

In this area the Worst Month results can be selected for display. In the ITU-R P.530-10 standard the propagation reliability varies dependent upon the time of the year. Many operators will want to design the link for the worst month rather than the year. When “Worst Month” is selected the “Data Rate Summary” (Figure 41) displays the availability and outage for the Worst Month. This is highlighted by a change in cell colour and a change of legend to Mins/month.

Variations in atmospheric refractive conditions cause changes in the effective Earth’s radius from its median value of approximately $4/3$ for a standard atmosphere (see Recommendation ITU-R P.310). When the atmosphere is sufficiently sub-refractive, the radio path will be bent in such a way that the Earth appears to obstruct the direct path between transmitter and receiver, giving rise to the kind of fading called diffraction fading. This fading is the factor that determines the antenna heights. By selecting “Worst Earth” the link estimator will change the value of the earth’s curvature to a value that occurs 0.1% of the time. The value used for the earth’s curvature varies with range. It is not necessary to check this on short links but with long links it can become critical. On long links “Worst Earth” should be selected to ensure that the 0.1% value of the earth’s curvature does not completely block the link. When “Worst Earth” is selected the summary reliability numbers in the “Data Rate Summary” area are blanked as they are not relevant for 0.1% of the time.

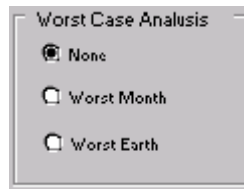


Figure 42 - Worst Case Analysis Selection

6.11 POWER LIMITS SUMMARY

The “Power Limits Summary” (Figure 43) gives the selected power outputs and EIRP for each end of the link. By default the local site power is used to determine the data rate and reliability of the link where the local and remote powers are the same. The power and EIRP setting cannot be adjusted here and can only be changed using the ‘Link Wizard’. If the antenna gains are different and the regulatory regime is for a maximum EIRP (hence different Tx powers) then it will be necessary to know the data rate and reliability of the link in each direction. This can be done by checking the ‘Reverse Powers’ check box which changes the direction being analysed. The direction is shown highlighted in green. (If the Local and Remote Power are the same, changing this will have no effect.)

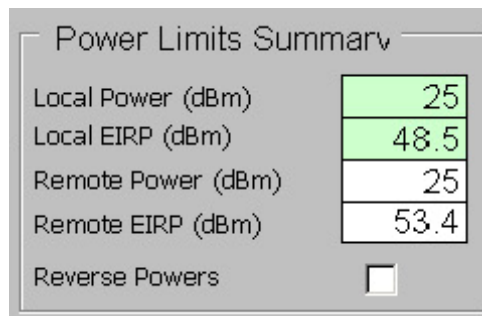


Figure 43 - Power Limit Summary Information

Note: Link estimates are made on the lower of the calculated power or 25 dBm. For example if the user enters an EIRP limit in the “Link Wizard” of 53dBm (New Zealand), using integrated antennas. This equates to a unit output power of 29.5dBm. In this case the “Power Limit Summary” will display a unit power level of 29.5 dBm and EIRP level of 53 dBm. However the Canopy Backhaul Link Estimator will use 25 dBm (this is indicated in the report output). If the user then selects a Andrew 6ft Parabolic, P6F-52 (37.6dBi) antenna, the power output from the unit drops to 16.4dBm and in this case the estimates are made at 16.4dBm.

6.12 ANTENNA HEIGHTS

The antenna height can be adjusted at each end of the link to see the effect upon the average data rate, minimum data rate and outage. The values can be adjusted using the up and down arrows or by entering a value (Figure 44). The step size for the up and down arrows can be adjusted by entering a value in the height increments boxes.

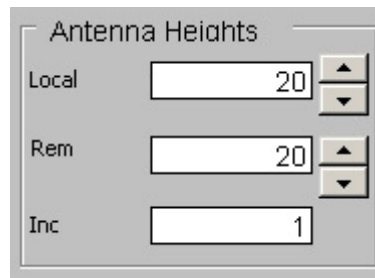
A screenshot of a software dialog box titled "Antenna Heights". It contains three rows of controls. The first row is labeled "Local" and has a text input field containing the number "20", followed by two small square buttons with upward and downward arrows. The second row is labeled "Rem" and has a text input field containing the number "20", followed by two similar square buttons. The third row is labeled "Inc" and has a text input field containing the number "1".

Figure 44- Antenna Height Adjustment

6.13 LOCAL AND REMOTE ANTENNA TYPE

This provides a facility to evaluate different antennas for each end of the link (Figure 45). From the drop down boxes, different antennas may be selected for the local and remote sites from an approved list⁷. If an external antenna is selected, the Feeder Loss is displayed; if the external antenna is single polar then Spatial Diversity is displayed. The feeder loss can be adjusted directly on the Data Entry sheet, or alternatively it can be adjusted using the 'Link Wizard', where the feeder type and length can be entered for automatic calculation of the loss, see figure 10. The Spatial Diversity can be entered as a value or zero (no space diversity), the estimator implements ITU-R P.530-10 for the improvement in reliability obtained.

⁷ For countries that follow FCC approval.



Figure 45 - Antenna Type Selection

The ability to investigate the antenna gain required is enabled as well as making a selection of an antenna from the approved list. The feeder type and length can also be entered. This must be done using the “Link Wizard” described in section 6.1.1 “Link Wizard”.

7 Path Profiles

In order to obtain an accurate link estimate where the path impinges on the Fresnel zone an accurate height profile of the path is required. In some parts of the world this path profile can be obtained from other propagation prediction packages such as MicroPath, PathLoss, ATDI ICS Telecom, Softwright TAP and Radio Mobile. Also, Canopy Systems have produced a web based utility (Figure 46) that creates path profiles, which can be directly imported into the Link Estimator.⁸

The web address can be found at the following address:

<http://motorola.canopywireless.com/support/linkestimator>

Prior to use it will be necessary to have:

- User name and password which is obtained through your sales director
- The latitude and longitude of the local and remote end of the wireless link in decimal format to WGS 84
- An email address to which an email containing the path profile files can be delivered.
- The heights above ground level of the local and remote end of the link.
- A filename that is used to names the path profile files that are returned via email.
- Contact information including name, company and telephone number.

⁸ This is a complete file in the sense that it includes the Latitude and Longitude. Most of the imports from other software do not address this problem and thus it is important to correct the Latitude and Longitude in the link estimator for translated files.

Location can now be entered in a number of new formats in addition to the decimal format. These are:-

- 'ddd:mm:ss.sP' eg. 50:33:20.6N,
- 'ddd:mm.mmmP' eg. 50:33.33.9N, and
- 'ddd.dddddP' eg 50.55345N.

The Web site requires input of Height and Range units, these are used for the link estimator's use of this path. The Antenna Heights are referenced to ground level, they are adjustable in the link estimator. The number of points divided by the range of the link gives the resolution along the path of the link. The link name is displayed on the graphical display of the link estimator. The Filename gets '.dat' appended to it. The Contact Name enables Canopy Systems to know who is requesting path profiles. The Company Name and Phone is for similar purposes. The Email address is the place where the path profile will be delivered usually in a few minutes after pressing 'Send Form'.

Checks that should be made on loading the path profile are:-

- Is the ground height at each end of the link what is given by the tool?
- Are any over water segments of the path accurate? Inaccuracies in these are caused by the method of survey, which is radar on board a satellite. The ground return is dispersive in angle which ensuring that some power goes back to the satellite. A water return in calm conditions can be reflected in one direction away from the satellite, which introduces errors. Sometimes very large.

There are three data sources used in these profiles. The lowest resolution is global and is in 30 arc second steps (900 meter) using 1 meter vertical resolution. The middle resolution covers most of the land area between 61 degrees North and 61 degrees South, it has 3 arc second resolution steps (90 meter) using 1 meter vertical resolution. The highest resolution is for the United States only, it has 1 arc second resolution steps and also has 1 meter vertical resolution.

The vertical accuracy is claimed by NASA to be 10 meters RMS, it is noticeable that the middle resolution is has less noise than the highest resolution and yet it comes from the same radar scans (February 2000 Shuttle Radar Topography Mission SRTM). This is because each data point is an average of 9 points from the highest resolution. The low resolution data was obtained from many different sources.

See Section 10 for a technical guide to SRTM. Which acknowledges NASA and the University of Maryland's work.

Support

[Support Home](#)
[Knowledge Base](#)
[Software Updates](#)
[Document Library](#)
[Community Forum](#)
[Canopy Training](#)
[Online Tools](#)
[Marketing Kit](#)
[Contact Support](#)
[Motorola Global Support](#)

Channel Member Login

The Canopy Channel Member Site features a full complement of sales, marketing, training and promotional resources to support members in realizing new sales of the Canopy wireless broadband platform.

You must be sponsored by your Canopy Distributor or the Canopy Sales Team for access.

Please contact your Distributor for more information.

[Enter Channel Area](#)

More

[MOTOw4](#)
[Technical Support](#)
[Contact Us](#)

Path Profiler

Motorola Canopy Path Profiler

This form is used to input the local and remote locations for a link. After submitting the values the server will compute the land profile for input into the [Link Estimator](#). It does not give any path obstructions such as buildings or trees. These are best inserted into the [Link Estimator](#) walking the high points of the path with a GPS, alternatively in some countries aerial photography is available which enables insertion of trees at locations along the path.

After *submitting* the form the server will return a text file which must be saved as a `.dat` file for input into the link estimator.

Location can now be entered in a number of new formats in addition to the decimal format. These are:-

- 'ddd:mm:ss.sP' eg. 50:33:20.6N,
- 'ddd:mm.mmmP' eg. 50:33.339N, and
- 'ddd.dddddP' eg 50.55345N.

where d=degrees, m=minutes, s=seconds and P=point of compass as one of the letters 'NnSsEeWw'. The geodetic reference for this data is the [WGS84 EGM96 geoid](#).

Latitude and Longitude of the target local and remote locations can be found from many places on the web including www.multimap.co.uk. However, the best method of determining the local and remote site positions is using a GPS.

The Length units can be in Miles or Kilometers and the Height units can be in Meters or Feet. Once chosen here, these values will be used in the Link Estimator. The Height of the Local and Remote antennas Above Ground Level (AGL) can be specified here and modified in the Link Estimator. (Hover help is available for many items on the form.)

	Latitude (90N to 90S)	Longitude (180E to 180W)	Antenna Height (AGL)
Local:	<input type="text"/>	<input type="text"/>	<input type="text"/>
Remote:	<input type="text"/>	<input type="text"/>	<input type="text"/>
Path resolution:	Number of data points <input type="text" value=""/> <input type="button" value="Auto"/>		
Units:	Height Units: <input type="text" value="Meters"/> Range Units: <input type="text" value="Kilometers"/>		
Link Name:	<input type="text"/>		
Filename:	<input type="text"/>		
Contact Name:	<input type="text"/>		
Company Name:	<input type="text"/>		
Phone:	<input type="text"/>		

Figure 46 - Path Profile Web Page

7.1 PATH PROFILE E-MAIL

After submitting the link parameters to the path profiler server. The server generates detailed path profile data. The data is returned via an email. The email has three files attached:

7.1.1 DAT file

The DAT file is a Canopy Systems proprietary format file suitable for loading into the Canopy Systems Link Estimator.

7.1.2 PDF file

A graphical representation of the link profile, useful for a quick visualisation of the path.

7.1.3 GPX

The file enables checking the path using a GPS, Expert GPS or Terrabrowser software.

7.1.4 KML

KML, or Keyhole Markup Language, is an XML grammar and file format for modeling and storing geographic features such as points, lines, images, and polygons for display in Google Earth.

Using the KML data along with Google Earth allows the position of the Local and Remote points to be checked as well as the terrain.

With Google Earth installed, clicking on the KML open Google Earth at the link location. The link will be displayed by a white line indicating the LOS path and a purple line showing the path across the ground. The highest points (HP1 to HP3) along the path are also displayed so that they can be checked. The display of these features can be controlled from the temporary places menu.

8 Import File Formats

The OS Link Estimator can import profile data files in a number of common formats. The supported formats are detailed in the subsections below.

8.1 MICROPATH COMMA DELIMITED FILE (*.TXT)

Micropath export format

```
0.00,1719.2,,0.00
0.20,1722.5,,0.00
0.40,1722.5,Tree,75.00
0.60,1712.7,,0.00
0.80,1709.4,Tree,75.00
```

Where the data is columns with column 1 giving the path increments, the second giving terrain height, the third giving obstruction labels and the fourth giving the obstruction height.

Where there is no obstruction label the column has no entry but is still comma separated.

8.2 COMMA DELIMITED FILE (LENGTH HEIGHT OBSTRUCTION) (*.CSV)

Canopy Systems CSV (comma separated variables) — can be created by the user using Excel or a text editor;

```
0,1719.2,0
0.2,1722.5,0
0.4,1722.5,75
0.6,1712.7,0
0.8,1709.4,75
0.99,1712.7,0
1.19,1702.8,75
```

Where the data is columns with column 1 giving the path increments, the second giving terrain height and the third giving obstructions.

8.3 ATDI ICS TELECOM COMMA DELIMITED TEXT FILE (*.TXT)

ATDI export — created with ICS Telecom

```
LONGITUDE or X,LATITUDE or Y,ALTITUDE,DTM STEP,DISTANCE (m),DIST
RAY/GROUND (m),ELLIPSOID (m),DIST
ELLIP./GROUND (m),EARTH DELTA (m)
274100,62350,182,50,0.00,7,0.00,7.00,0
274100,62300,182,50,50.00,7,1.61,5.39,0
274100,62250,178,50,100.00,11,2.27,8.73,0
274100,62200,172,50,150.00,17,2.78,14.22,0
274100,62150,164,50,200.00,25,3.20,21.80,0
```

Where the data is columns with column 1 giving the longitude, the second giving latitude, the third giving terrain height, the fourth the path increments, fifth giving distance of ray to ground, sixth giving the ellipsoid, seventh giving distance ellipsoid to ground and the eighth giving the earth delta. The first row is expected to contain the headings and is ignored during the import.

8.4 SOFTWRIGHT TAP 4.3 (*.TXT)

Softwright TAP export format

Elevation Data Points

Test Link

42 40 22.10 N 84 32 14.90 W NAD 27

Path from Point A to Point B

Azimuth 177.8538°

Max Distance 18.6304 mi

DIST(mi)	ELEV(ft)	AZIMUTH	
0.0000	867.4512	177.8538°	0000001
0.1000	873.7765	177.8538°	0000001
0.2000	864.6915	177.8538°	0000001

0.3000	864.4267	177.8538°	0000001
0.4000	853.7549	177.8538°	0000001
0.5000	868.6268	177.8538°	0000001
0.6000	869.2807	177.8538°	0000001
0.7000	863.2444	177.8538°	0000001
0.8000	873.6597	177.8538°	0000001
0.9000	880.0432	177.8538°	0000001
1.0000	874.2274	177.8538°	0000001

8.5 RADIO MOBILE FOR WINDOWS (*.TXT)

Radio Mobile for Windows

Version 6.0

** Left site data **

Name

Antenna height (m)

** Right site data **

Name

Antenna height (m)

** Link data **

Frequency (GHz)

Earth curvature factor

** Path Profile **

Records:	Distance(km)	Elevation(m)	Color(0-15)	Height(m)
PathLoss(dB)	[Latitude(°)	Longitude(°)	Xmap Ymap
RadioBeamElevation(m)	Clearance(m)	FirstFresnel(m)	Ratio]

Start

Locsite

10

Remsite

40

5.75

1.33331675899808

0000.000	0886.0	0	0	000.0
0000.068	0886.0	0	0	000.0
0000.137	0885.0	0	0	088.6
0000.205	0886.0	0	0	098.4
0000.274	0885.0	0	0	094.6
0000.342	0884.0	0	0	096.7
0000.410	0883.0	0	0	098.3

8.6 PATHLOSS EXPORT (*.TXT)

Terrain Data Pathloss Example

	Local	Remote
Latitude	50 01 20.80 N	50 59 40.60 N
Longitude	082 31 11.80 W	082 32 49.20 W
True azimuth (°)	220 47 27.55	040 46 41.82
Calculated Distance (mi)		2.531
Profile Distance (mi)		2.531
Datum		WGS 1984
UTM zone	17N	17N
Easting (km)	350.576	347.877
Northing (km)	3100.620	3097.570

Elevation (ft)	29.53	13.12
Distance (mi)	Elevation (ft)	GroundStructure (ft)
0.000	29.53	AG
0.020	29.53	AG53.0 ft Tree - Start of Range
0.040	29.53	AG
0.068	29.53	AGEnd of Range
0.080	29.53	AG
0.100	29.53	AG
0.136	29.53	AG52.0 ft Tree
0.140	29.53	AG
0.160	29.53	AG
0.180	29.53	AG
0.200	29.53	AG25.0 ft Building
0.200	29.53	AG54.0 ft Tree
0.240	29.53	AG
0.260	29.53	AG
0.280	29.53	AG
0.300	29.53	AG30.0 ft Building
0.320	29.53	AG
0.340	29.53	AG
0.360	29.53	AG
0.380	29.53	AG
0.400	29.53	AG54.0 ft Tree
0.420	29.53	AG
0.440	29.53	AG
0.460	29.53	AG
0.480	29.53	AG

9 Example HTML Report



Canopy Backhaul Link Estimator Configuration Worksheet

20 Feb 2006

Summary

Link Name	Handbook
Customer Name	Motorola

Link Type	Near Line of Sight
Maximum Obstruction Height	0.00 Feet
Link Distance	6.00 Miles
Free Space Path Loss	-127.42 dB
Excess Path Loss	-14.93 dB
User Throughput Expectation	Aggregate 89.50 Mbps assuming Canopy 5.7GHz 300Mbps Backhaul running a 58200 software load
RF Frequency Band	5.8 GHz (5.725 to 5.850 GHz)

Installation Notes

Bearing to REMOTE from LOCAL 16.7° from True North

Bearing to LOCAL from REMOTE 196.8° from True North

Predicted Receive Power -55.97 dBm to -74.93 dBm

Predicted Link Loss -132.87 dB to -151.83 dB

Perform the following checks during the installation

1. Check with a GPS that you are installing at the correct location.
2. Check carefully the direction to the other end of the link. Either use a corrected compass or use the GPS waypoint feature about 300meters from the installation location.
3. Keep directing the antenna until the correct Receive Power is achieved. This should ensure that you are not peaking on a sidelobe of the antenna.
4. An hour after disarming check that the mean value for the link loss is as predicted.

Local Site

Hardware Platform	Canopy 5.7GHz 300Mbps Backhaul Integrated
Antenna Type	INTEGRATED - Built-in Antenna Dual Polar (23.5dBi)

Antenna Gain	23.5 dBi
Antenna Height	20 Feet AGL
Local Site Position	50°27' 3.7" N 3°46' 31.7" W
Local Site Elevation	5.0 Feet AMSL
Feeder Cable	N/A
Feeder Length	N/A
Feeder Loss	N/A
Spatial Diversity	N/A

Remote Site

Hardware Platform	Canopy 5.7GHz 300Mbps Backhaul Connectorized
Antenna Type	Andrew 2ft Para, P2F-52 (29.4dBi)
Antenna Gain	29.4 dBi
Antenna Height	20 Feet AGL
Remote Site Position	50°31' 25.3" N 3°44' 27.9" W
Remote Site Elevation	5.0 Feet AMSL
Feeder Cable	LMR600 (7.3 dB/100 ft)
Feeder Length	13.699 Feet
Feeder Loss	1 dB
Spatial Diversity	5 Feet

Link Throughput & Availability

User Throughput Expectation	Aggregate 89.50 Mbps
User Effective Throughput Rate Upstream	70.25 Mbps

User Effective Throughput Rate Downstream	19.25 Mbps
Link Symmetry	50:50
Availability	99.99984%
Outage	0.82 Minutes/Year
Link Optimisation	Optimised for IP Traffic
Worst Case Analysis	Not Selected

Modulation	User Aggregate Throughput (Mbps)	Fade Margin (dB)	Throughput Availability
256QAM 0.81 Dual	296.80	-14.85	0.000%
64QAM 0.92 Dual	250.06	-11.95	0.000%
64QAM 0.75 Dual	204.35	-5.85	0.002%
16QAM 0.87 Dual	158.97	-0.95	4.057%
256QAM 0.81 Single	148.40	-9.95	4.057%
64QAM 0.92 Single	125.03	-8.05	4.057%
16QAM 0.63 Dual	114.28	5.25	24.389%
64QAM 0.75 Single	102.17	-2.25	27.286%
16QAM 0.87 Single	79.49	2.85	95.823%
16QAM 0.63 Single	57.14	9.35	99.965%
QPSK 0.87 Single	39.74	12.65	99.993%
QPSK 0.63 Single	28.57	16.65	99.999%
BPSK 0.63 Single	14.28	21.15	99.999%

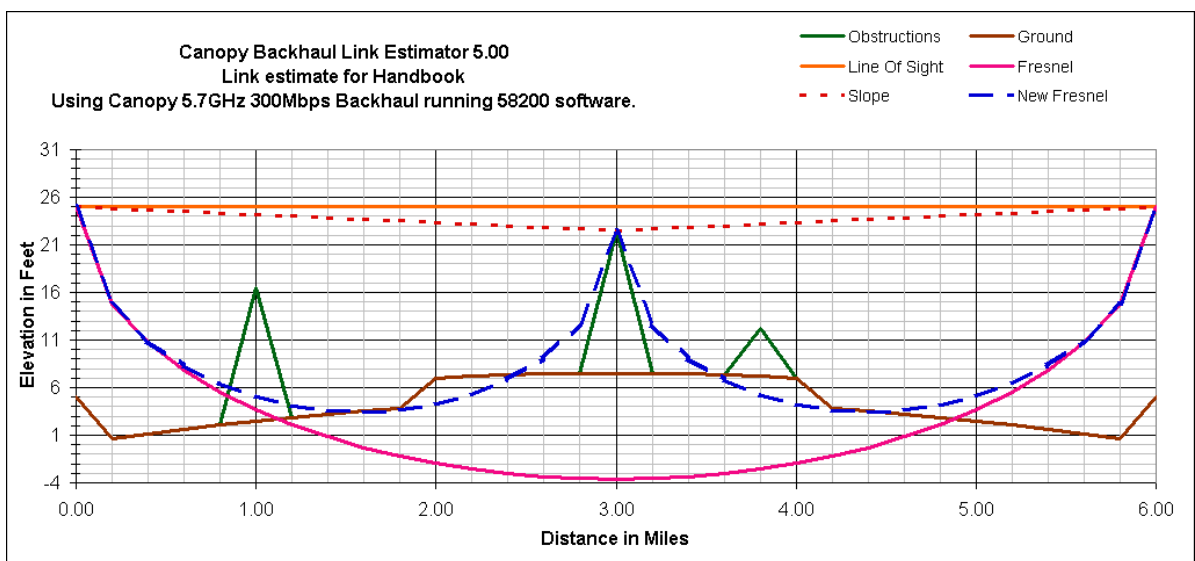
Regulatory Conditions

Region Code	Region 1
-------------	----------

Max EIRP	48.5 dBm
Output Power	25 dBm
In Band Environmental Noise	-144 dBm/30MHz

The calculations for this link estimate were made assuming an output power of 25 dBm in the lowest modulation mode

Terrain Profile



Customer Contact Information

Contact Name Motorola Engineer

Company Name Motorola

Address 1

Address 2

State/Province

Zip/Postal Code

Country

Phone

Cell Phone

E-Mail

Other Notes

You can include some user specific text here, like notes about obstructions close to the Local or Remote sites.

This link estimator supports the recommendations in ITU-R P.530-10 and ITU-R P.526-9

This link was planned by Some One on 20 January 2006 12:05:50 using the Canopy Backhaul Link Estimator.



Motorola Inc. assumes no responsibility for the accuracy of the information produced by the Link Estimator. Reference to products or services which are not provided by Motorola Inc. is for information purposes only and constitutes neither an endorsement nor a recommendation. All information provided by the Link Estimator is provided without warranty of any kind, either expressed or implied.

**MOTOROLA and the Stylized M Logo are registered in the US Patent & Trademark Office. All other product or service names are the property of their respective owners.
© Motorola, Inc. 2004**

10 SRTM Technical Guide

Shuttle Radar Topography Mission (SRTM) Technical Guide

Global Land Cover Facility

University of Maryland Institute for Advanced Computer Studies
University of Maryland Department of Geography

Introduction

The Shuttle Radar Topography Mission (SRTM) obtained elevation data on a near-global scale to generate the most complete high-resolution digital topographic database of Earth. SRTM consisted of a specially modified radar system that flew onboard the Space Shuttle Endeavour during an 11-day mission in February of 2000. SRTM is an international project spearheaded by the National Geospatial-Intelligence Agency (NGA) and the National Aeronautics and Space Administration (NASA).

Data Set Overview

The Global Land Cover Facility provides SRTM data at three resolutions:

- 1 arc-second/30-meter DEM of the United States
- 3 arc-second/90-meter DEM of the world
- 30 arc-second/1km SRTM-GTOPO30 product corrected by GTOPO30 30 arc-second DEM

These comprise the initial edition of the SRTM data set, per the USGS standard. USGS plans to process the data to a higher level to account for missing land values and negative values in water bodies. This “finished” SRTM product is anticipated in Fall 2004, whereupon GLCF will update its holdings accordingly.

Processing Characteristics

The Global Land Cover Facility editions of SRTM data are available in six layers (Table 1). The processing for each of the editions is diagrammed in Figure 1.

Table 1: GLCF SRTM Editions

Resolution	Projection	Coverage
1 arc-second/ 30-meter	Geographic	Native USGS Tiles
	UTM	WRS-2 Path/Row
3 arc-second/ 90-meter	Geographic	Native USGS Tiles
	UTM	WRS-2 Path/Row
1 Kilometer	Geographic	Native USGS Tiles
	Geographic	Global

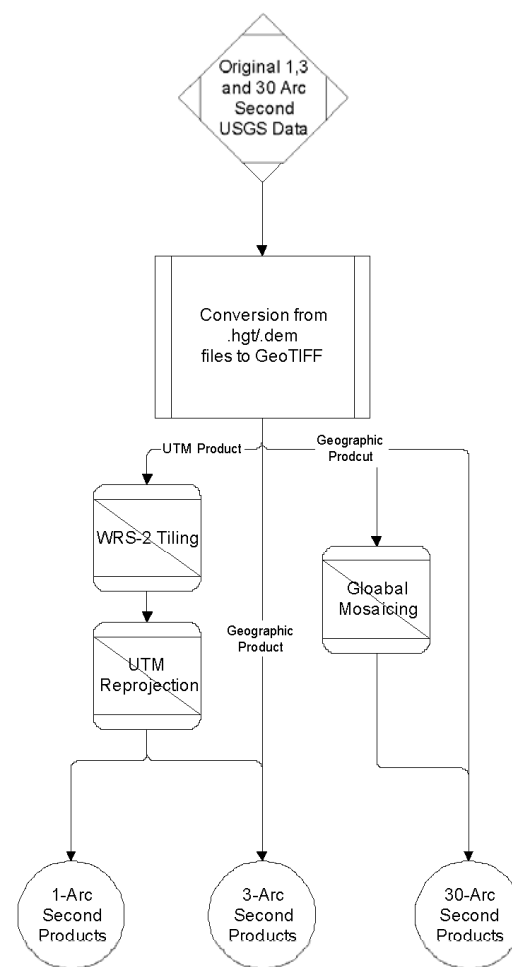


Figure 1: Processing Conducted for Each Edition of the GLCF SRTM Data Sets

Per Figure 1, all editions were initially converted to GeoTIFF. The 1 and 3 arc-second editions were then made available in their native USGS format and were also tiled to the Landsat WRS-2 reference schema (and reprojected to UTM). The global 30 arc-second product was the result of mosaicing the USGS native

files, which are also available from GLCF. The last step in the processing will really occur in Fall 2004 when the same procedure is conducted with the "Finished" USGS product.

Data Properties (Geographic Coordinates):

All elevations are in meters referenced to the [WGS84 EGM96 geoid](#) and the horizontally georeferenced to the WGS84 ellipsoid using a geographic projection. The naming scheme is tied with the geographic coordinates of the data content. For example, the coordinates of the lower-left corner of tile N40W118.tif are 40 degrees north latitude and 118 degrees west longitude. The output GeoTIFF files for the 3 arc-second product are 1201*1201 in size, and those of the 1 arc-second product are 3601*3601 in size. All GeoTIFF files are 16-bit GeoTIFFs.

Data Properties (UTM Coordinates):

The elevation data of the UTM datasets are referenced to the WGS84 EGM96 geoid, and horizontally georeferenced to the WGS-84 ellipsoid using a UTM projection. The center longitude of each file decides which UTM zone it should be in. And the center latitude of each file decides the North/South UTM zoning. The naming scheme is tied with the WRS-2 system. For example, p15r33_utm.tif contains the data for Path 15, Row 33 of the WRS-2 system, which is the Washington-Baltimore region. This WRS-2 conversion for SRTM data is meant to support data synthesis with the Landsat GeoCover dataset also available from the GLCF website. The GeoCover dataset is also in the WRS-2 convention, however, due to satellite mechanics, the Landsat imagery actually taken may have a shift up to 5 kilometers. Therefore, GLCF SRTM-UTM dataset was generated with a 7.5-km data-buffer around the WRS2 tile.

Data Coverage

The respective coverages for each of the data products is outlined in the below three diagrams (Figures 1,2,3).

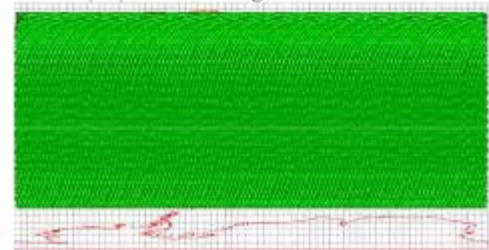
US 30-m (UTM, LL) coverage:



Global (LL, UTM) 90-m coverage:



Global (LL) 1-km coverage:



Figures 2,3,4: GLCF SRTM Product Coverages.

Please email glcf@umiacs.umd.edu with all questions concerning the derived SRTM products. All questions concerning the SRTM sensor itself should be directed to the NASA SRTM project (see the below link).

Primary Links

- National Aeronautics and Space Administration Jet Propulsion Laboratory SRTM Project:
<http://www2.jpl.nasa.gov/srtm/>
- United States Geological Survey SRTM Project:
<http://srtm.usgs.gov/>
- Landsat 7 WRS-2 Web Site:
<http://landsat.gsfc.nasa.gov/documentation/wrs.html>

11 Glossary

ATDI	Advanced Topographic Development & Images Ltd.
BPSK	Binary Phase Shift Keying
CD	Compact Disc
CSV	Comma Separated Variables
DFS	Dynamic Frequency Selection
EIRP	Equivalent Isotropic Radiated Power
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FEC	Forward Error Correction
ITU	International Telecommunications Union
NLoS	non-Line-of-Sight
USA	United States of America