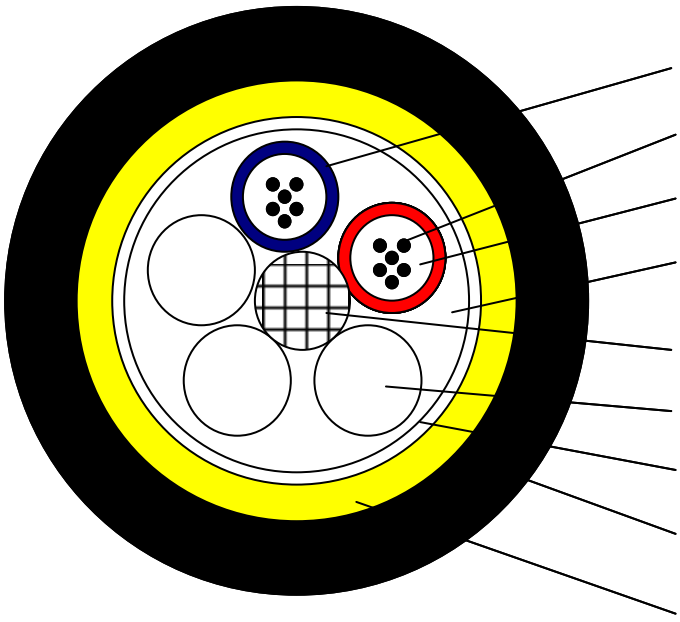
NEWLINK
Cabling Systems

NEW-9440006 & 12

6/12-Fiber ADSS Single mode



Features:

- ADSS (nonmetallic Cable)
- Applications: Aerial and Duct installations
- Singlemode

Product Description:

Technical specifications for Aerial and Duct Application Non-Metallic type cable. This specification covers the general requirements and performance of cable, which FOC offered including optical characteristics, mechanical characteristics and geometrical characteristics.

Optical fiber characteristics (FPC G.652 FIBER)

Item	Specification
Type of Fiber	Single mode
Fiber Material	Dope Silica
Attenuation Coefficient: • @1310nm • @1383nm • @1550nm • @1625nm	• ≤ 0.36 dB/km • ≤ 0.36 dB/km • ≤ 0.22 dB/km • ≤ 0.30 dB/km

Point Discontinuity:	≤ 0.05 dB
Cable Cut-off wavelength:	≤ 1260 nm
Zero-dispersion slope:	≤ 0.093 ps/(nm^2.km)
Chromatic dispersion • @ 1288 ~ 1339 nm • @ 1271 ~ 1360 nm • @ 1550 nm • @ 1625 nm	 • ≤3.5 ps/(nm. Km) • ≤5.3 ps/(nm. km) • ≤18 ps/(nm. km) • ≤22 ps/(nm. km)
PMDQ (Quadrature average*)	≤0.2 ps/km1/2
Mode field diameter @ 1310 nm	9.2±0.4 um
Core / Cladding concentricity error	≤ 0.5 um
Cladding diameter	125.0 ± 0.7 um
Cladding non-circularity	≤1.0%
Primary coating diameter	245 ± 10 um
Proof test level	100 kpsi (=0.69 Gpa), 1%
Temperature dependence 0oC~ +70oC @ 1310 & 1550nm	≤ 0.1 dB/km
PMDQ is a link of 20 cable sections (M) and a probability level of 0.01%	

Performance of Optical Cable

Cable bending radius:
- 10 x cable diameter (static)
- 20 x cable diameter (dynamic)

Application temperature range:
- Operating temperature range :-40^{o}C to +70^{o}C
- Storage / Transport temperature range :-50^{o}C to +70^{o}C
- Installation temperature range :-30^{o}C to +50^{o}C

Fiber coding

No. of fiber	1	2	3	4	5	6
Color	Blue	Orange	Green	Brown	Gray	White
No. of fiber	7	8	9	10	11	12
Color	Red	Black	Yellow	Violet	Pink	Aqua

Loose Tube (LT) & filler rod (FR) color code

Fiber No.	Element No.							
	1	2	3	4	5	6	7	8
6	LT	FR	FR	FR	FR	-	-	-
12	LT	LT	FR	FR	FR	-	-	-

Cable Structure and Parameter

No. of Fibers	Max. fiber number per tube	Total unit number (LT + FR)	Sheath thickness (nominal*)	Outer Diameter (nominal*)	Weight (approx.)
			mm	mm	Kg/km
6	6	5 (1LT + 4FR)	2.0	10.6	88
12	6	5 (2LT + 3FR)	2.0	10.6	89

FRP Diameter	Loose Tube Diameter	Loose Tube Thickness	Filler Rod Diameter
mm	mm	mm	mm
1.8	2.2	0.38	2.2
1.8	2.2	0.38	2.2

Test Requirements

No	Item	Test standard	Method	Acceptance criteria
1	Tensile test	IEC-794-1-E1	- Load: Short term: 1,500 N - Length of cable under load: 50 m	- Loss change ≤ 0.1 dB @1550 nm - No fiber break and no sheath damage.
2	Crush test	IEC-794-1-E3	- Load: 1,000 N/100 mm - Load time: ≥1min.	- Loss change ≤ 0.1 dB @1550 nm - No fiber break and no sheath damage.
3	Impact Resistance	IEC-794-1-E4	- Points of impact: 5 -Times of per point: 5 - Impact energy: 4.5 N.m - Radius of hammer head: 12.5mm	- Loss change ≤ 0.1 dB @1550 nm - No fiber break and no sheath damage.

			- Impact rate: 2 sec/cycle	
4	Repeated bending	IEC-794-1-E6	- Bending radius: 20 x cable diameter - Load: 150 N - Flexing rate: 3 sec/cycle - No. of cycle: 30	- Loss change ≤ 0.1 dB @1550 nm - No fiber break and no sheath damage.
5	Torsion test	IEC-794-1-E7	- Length: 1 m - Load: 150 N - Twist rate: 1 min/cycle - Twist angle: ±180° - No. of cycle: 10	- Loss change ≤ 0.1 dB @1550 nm - No fiber break and no sheath damage.
6	Water penetration test	IEC-794-1-F5	- Height of water: 1 m - Sample length: 3 m - Test time: 24 hours	- No water shall have leaked from the opposite end of cable.
7	Temperature cycling test	IEC-794-1-F1	- Temperature step: +20$_o$C→-40$_o$C→+70$_o$C →+20$_o$C - Time per each step: 12 hrs - Number of cycle: 2	- Loss change ≤ 0.05 dB/km@1550 nm - No fiber break and no sheath damage.
8	Compound Flow	IEC 794-1-E14	- Sample length: 30 cm - Temp: 70°C ± 2°C - Time: 24 hours	- No compound flow
9	Sheath High Voltage Test		- On line test - 9t KV (t-sheath thickness)	-No sheath breakdown

Ordering Information:

Part Number	Description
NEW-9440006	6-Fiber ADSS Singlemode Span = 100 meters (sells in 2Km reels only)
NEW-9440012	12-Fiber ADSS Singlemode Span = 100 meters (sells in 2Km reels only)

Cambium LINKPlanner User Guide

Version 4.3.7

Cambium Networks™

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List of Figures

CHAPTER 1

About This User Guide

The purpose of this user guide is to describe how to install and use Cambium LINKPlanner.

Cambium Networks provides the LINKPlanner application with the following products:

- ePMP (PTP mode), PTP 250, PTP 300, PTP 400, PTP 450, PTP 450i, PTP 500, PTP 600, PTP 650, PTP 700, PTP 800, PTP 810 and PTP 820 equipment.
- PMP 450, PMP 450i and ePMP equipment

Use LINKPlanner to help predict where and how equipment will work. It allows the network planner to answer these questions:

- Will each link transmit data fast enough for the user?
- Will each link be reliable enough for the user?
- Which Access Point will be best for a subscriber?

If any problems are experienced with LINKPlanner, see *Contacting Cambium*

Getting started

- To understand the concepts of LINKPlanner, see *LINKPlanner Concepts*
- If any problems are experienced with LINKPlanner, see *Contacting Cambium*.
- To install or upgrade the software, see *Installing LINKPlanner*.

How to use LINKPlanner

To perform a quick test of the feasibility of a planned link, follow the procedure described in:.

- *PTP Unlicensed Band Tutorial* - for ePMP (PTP mode), PTP 250, PTP 300, PTP 400, PTP 450, PTP 450i, PTP 500, PTP 600, PTP 650 and PTP 700 link planning.
- *PTP Licensed Band Tutorial* - for PTP 800, PTP 810 and PTP 820 link planning.
- *PMP Tutorial* - for PMP 450, PMP 450i and ePMP network planning.

If the resulting performance predictions look promising, plan the link in greater detail as described in *Using LINKPlanner*.

Supporting information

- For more information about link planning, such as path loss, path profiles and file formats, see *Background Information*.
- For licensing and third party information, see *Legal Notices*.
- For a history of LINKPlanner software changes, see *Changes to LINKPlanner*.
- For definitions of common terms, see *Glossary*.

General Information

Purpose

Cambium Networks documents are intended to instruct and assist personnel in the operation, installation and maintenance of the Cambium Networks equipment and ancillary devices. It is recommended that all personnel engaged in such activities be properly trained.

Cambium Networks disclaims all liability whatsoever, implied or express, for any risk of damage, loss or reduction in system performance arising directly or indirectly out of the failure of the customer, or anyone acting on the customer's behalf, to abide by the instructions, system parameters, or recommendations made in this document.

Contacting Cambium

Feedback on LINKPlanner

We appreciate feedback from the users of our documents. This includes feedback on the structure, content, accuracy, or completeness of our documents. Send feedback to support@cambiumnetworks.com.

You can receive help from the wider LINKPlanner community through the Cambium Community Forum: http://community.cambiumnetworks.com/t5/LINK-Planner/bd-p/forums_management_link_planner.

Cambium Networks

Support website: http://www.cambiumnetworks.com/support

Main website: http://www.cambiumnetworks.com

Sales enquires: solutions@cambiumnetworks.com

Support enquires: support@cambiumnetworks.com

Telephone number list:
http://www.cambiumnetworks.com/support/contact-support/

Address:

Cambium Networks Limited,
Linhay Business Park,
Eastern Road,
Ashburton,
Devon, UK,
TQ13 7UP

Reporting problems

If any problems are encountered when using LINKPlanner, follow this procedure:

1. Search this help document for a solution
   - In the Table of Contents
   - In the Index (Windows only)
   - In the Search (Windows only).
2. Ensure that the latest version of LINKPlanner software is installed (available at http://www.cambiumnetworks.com/linkplanner)
3. Search the release note for this version of the product (available at http://www.cambiumnetworks.com/linkplanner)
4. Ask your Cambium products supplier to help.
5. Escalate the problem to Cambium Networks Technical Support as follows:
   - Either: send an email to linkplanner.ptp@cambiumnetworks.com

- Or: Contact Cambium Support at http://www.cambiumnetworks.com/support/contact-support/open-a-support-case/

Warnings, cautions and notes

The following describes how warnings and cautions are used in this document and in all documents of this Cambium document set.

Warnings

Warnings precede instructions that contain potentially hazardous situations. Warnings are used to alert the reader to possible hazards that could cause loss of life or physical injury. A warning has the following format:

Warning text and consequence for not following the instructions in the warning.

Cautions

Cautions precede instructions and are used when there is a possibility of damage to systems, software, or individual items of equipment within a system. However, this damage presents no danger to personnel. A caution has the following format:

Caution text and consequence for not following the instructions in the caution.

Notes

A note means that there is a possibility of an undesirable situation or provides additional information to help the reader understand a topic or concept. A note has the following format:

Note text.

CHAPTER 2

Getting started

This section describes the main concepts of LINKPlanner and how to install the software:

- *LINKPlanner Concepts*
- *Installing LINKPlanner*

This section also contains quick tutorials for experienced Windows or Mac users. They describe how to create a project to analyze the performance of a single link.

- *Quick Tutorial - PTP Unlicensed Band* (for ePMP (PTP mode), PTP 250, PTP 300, PTP 400, PTP 450, PTP 450i, PTP 500, PTP 600, PTP 650 and PTP 700 links).
- *Quick Tutorial - PTP Licensed Band* (for PTP 800, PTP 810 and PTP 820 links).
- *Quick Tutorial - PMP* (for PMP 450, PMP 450i and ePMP networks).

LINKPlanner Concepts

NLoS and LoS

The Cambium Networks Series of point-to-point (PTP) wireless Ethernet bridges and point-to-multipoint (PMP) wireless broadband solutions are designed to operate in non-line-of-sight (NLoS) and line-of-sight (LoS) environments. Link planning and estimation enable a link of known quality to be installed. LINKPlanner uses path profile data to predict the data rates and reliability over each link, through adjustment of antenna height and RF power. When the link is installed, the mean path loss can be checked to confirm these predictions.

Architecture

The LINKPlanner is an application that runs on Windows or Macintosh. It performs the calculations from the ITU recommendations ITU-R P.526-10 and ITU-R P.530-12 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. Cambium provides a method for obtaining path profile data; see *Path Profiles*. Trees and buildings (obstructions) can modify this profile, and often the path must be surveyed to establish the correct estimation.

The main concepts of LINKPlanner are:

- **Project**: a set of data about the sites and links in a wireless network.
- **Network Site**: the location of a PTP outdoor unit and its antenna or a PMP Hub Site.
- **Subscriber Site**: the location of a PMP Subscriber Module outdoor unit and antenna.
- **Hub Site**: a location which contains one or more Access Point outdoor units and antennas.
- **Access Point**: an outdoor unit and antenna which connects to multiple Subscriber Modules.
- **Subscriber Module**: an outdoor unit and antenna at a customer or remote premises.
- **Link**: a wireless connection between two PTP sites or between an Access Point and a single Subscriber Module.
- **Path**: an alternative wireless link between two PTP units at different sites, when each site has multiple units.

Inputs and Outputs

The main inputs to LINKPlanner are:

- Site name, position, maximum antenna height and site definition; network or subscriber (input by the user).
- Details of the equipment and license restrictions (selected by the user).

- Required performance targets for each link or network (input by the user).
- Profile of the terrain along the path of each link (obtained using a Cambium tool).
- Details of any obstructions or reflections that may affect the performance of a link (obtained from maps, survey data and Google Earth(TM)).

The main output from LINKPlanner is a performance summary that shows how well the link is predicted to perform in response to the selected combination of inputs. It shows predicted and required throughput performance and availability at each end of the link.

User Interface

The following example shows the LINKPlanner *User Interface* for the "Tutorial" project, which models a PTP network linking three sites, one of which is also a Hub Site containing one Access Point, which is connected to two Subscriber Modules:

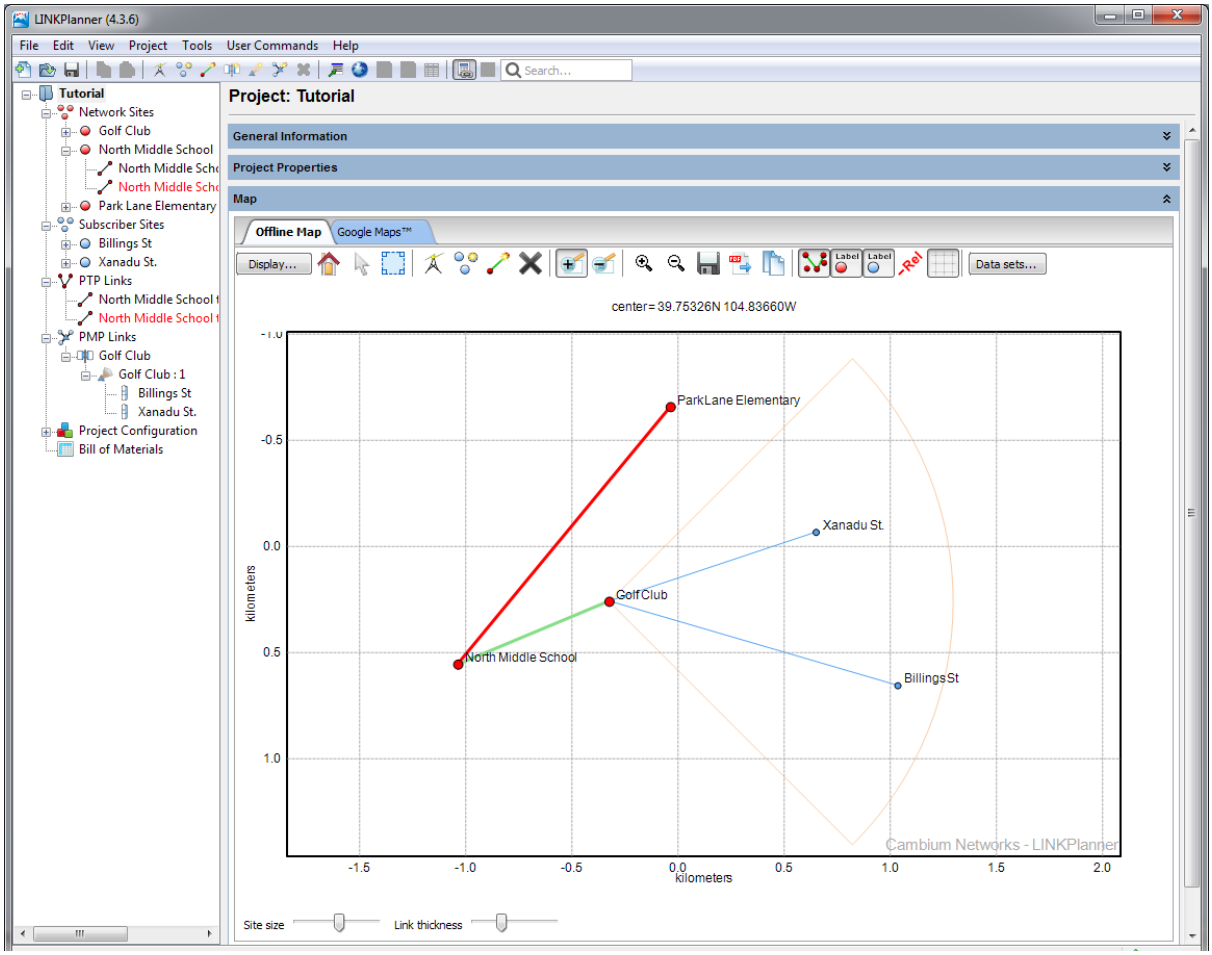


Figure 2.1: User Interface

Installing LINKPlanner

Windows Installation

If LINKPlanner is to be used with non-Roman character sets, then install one of these two fonts:

- Arial Unicode MS. This is optionally installed as part of Microsoft Office.
- Bitstream Cyberbit.

To install LINKPlanner in Windows:

1. Download and run LinkPlannerSetup.999.exe (where 999 is version identity).
2. The **“Welcome to the Cambium LINKPlanner Setup Wizard”** page is displayed. Click **Next**.
3. The **“Select Destination Location”** page is displayed. If a different folder is required, click Browse and choose the required folder. Click **Next** to continue.
4. The **“Select Start Menu Folder”** page is displayed. If a different folder is required for the shortcuts, click **Browse** and choose the required folder. Click **Next** to continue.
5. The **“Ready to Install”** page is displayed. If the Destination location and Start Menu folder are correct, click **Install**, otherwise click **Back**.
6. The installation progress page is displayed, followed by the **“Completing the Cambium LINKPlanner Setup Wizard”** page. Click **Finish**. Software installation is now complete.

Mac Installation

To install LINKPlanner on a Mac, open the ‘readme’ file provided and follow the instructions.

Quick Tutorial - PTP Unlicensed Band

This section is a quick tutorial for experienced Windows or Mac users. It describes how to create a project to analyze the performance of a single PTP link operating in an unlicensed frequency band (below 6 GHz) between two sites.

Before starting this tutorial, complete the following steps:

1. Install the software in the usual way. See *Installing LINKPlanner*.
2. Start the application.
3. Enter the correct details in the Options (Preferences) page. Ensure that Email address and Network Settings are correct. See *Options (Preferences)*.
4. Register with the path profile service. See *Options (Preferences)*.

There are three parts to this tutorial:

1. Create a project with two sites and one link. See *Creating Project, Sites and Link (Unlicensed Band)*.
2. Update the path profile for the link with obstructions. See *Updating Profile with Obstructions (Unlicensed Band)*.
3. Adjust the antennas at both ends of the link and confirm that the selected equipment meets the performance requirements. See *Adjusting Configuration and Requirements (Unlicensed Band)*.

Creating Project, Sites and Link (Unlicensed Band)

To create a project with two sites and one link:

1. Click **New Project**  .

   The *Project Page* is displayed

2. Enter Customer Information and Default settings for new links.

   Click **Save Project** 

   Save the project as **Tutorial.ptpprj**.

3. Click **New Network Site** 

   The *Add New Network Site* page is displayed. Enter this data:

   Name: North Middle School

   Maximum Height: 10 meters

   Latitude: 39.74828N

   Longitude: 104.84861W

   Description: Antenna mounted on school building

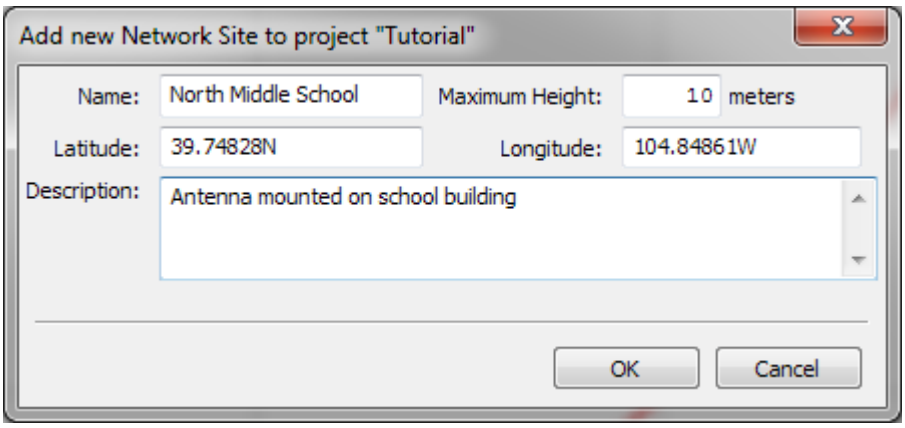


Figure 2.2: Inserting Site 1 (Unlicensed)

4. Click **New Network Site**

   The *Add New Network Site* page is displayed. Enter this data:

   Name: Park Lane Elementary

   Maximum Height: 10 meters

   Latitude: 39.75914N

   Longitude: 104.83700W

   Description: Antenna mounted in school yard

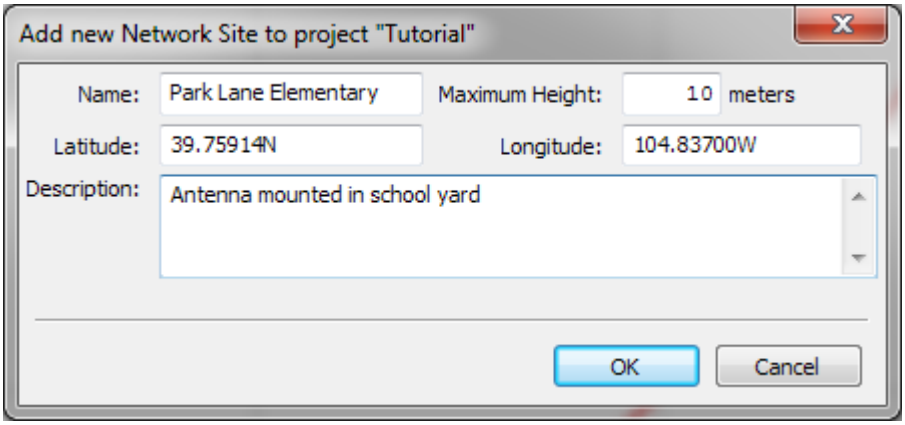


Figure 2.3: Inserting Site 2 (Unlicensed)

5. Click **New PTP Link**

   The *Add New PTP Link* page is displayed.

   Select the two sites to be linked: North Middle School and Park Lane Elementary.

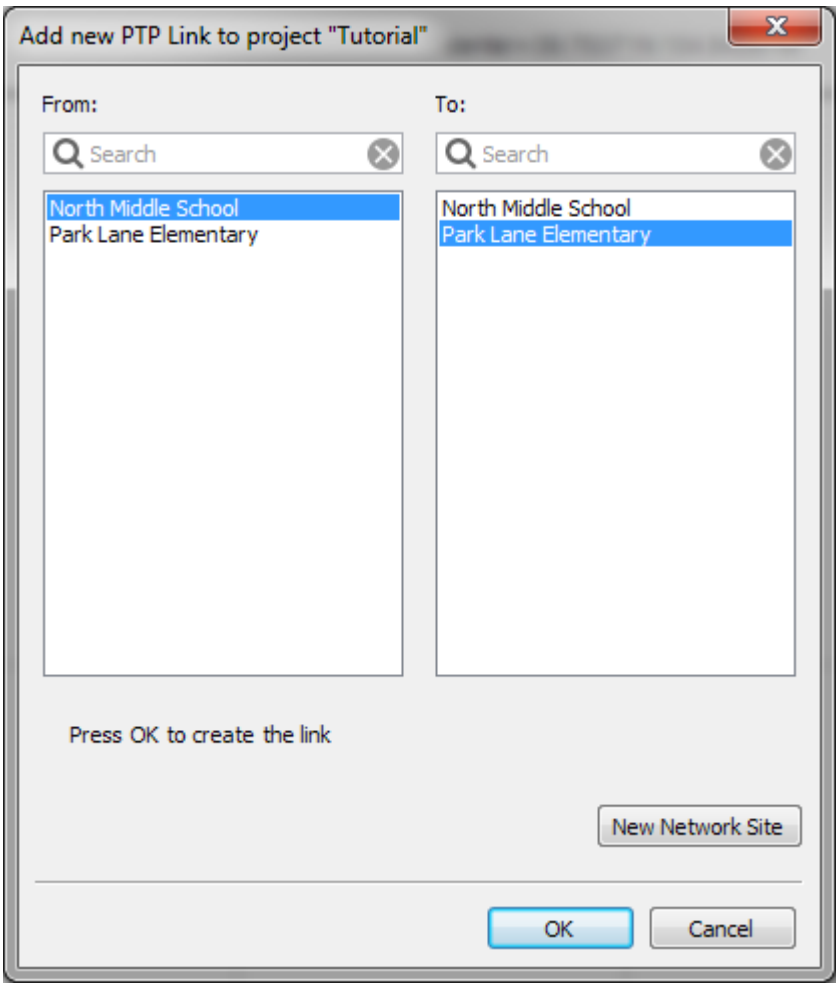


Figure 2.4: Inserting Link (Unlicensed)

If requesting path profiles automatically the profile request is sent to the Cambium Path Profiler and will automatically appear in the profile window.

6. If requesting profiles manually click **Project**, **Get Profiles**.

   The *Request Profiles* page is displayed. Tick the link “North Middle School to Park Lane Elementary” (if not already ticked).

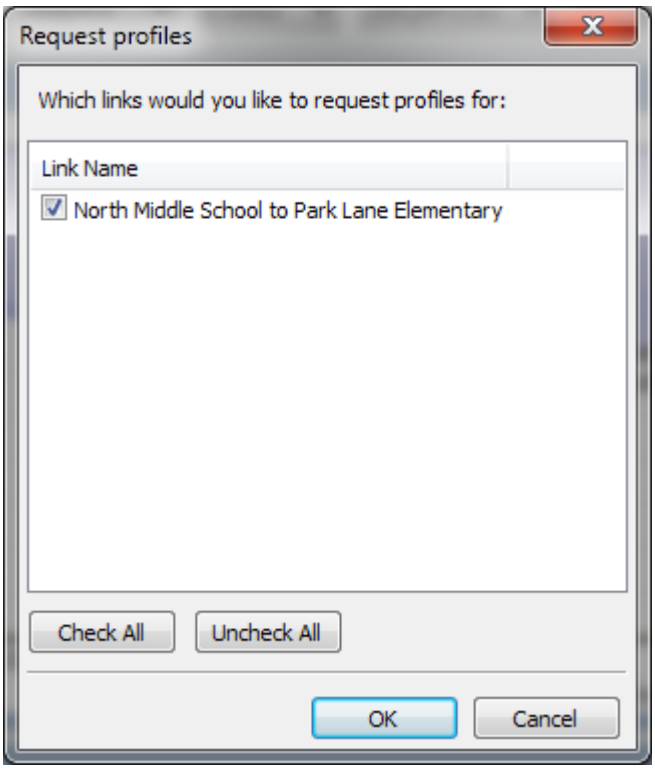


Figure 2.5: Requesting Profiles (Unlicensed)

The profile request is sent to the Cambium Path Profiler and will automatically appear in the profile window.

7. Configure the link equipment, see *Equipment (unlicensed bands)*:

   Band: 5.8 GHz

   Product: PTP 650

   Capacity: Full (Up to 450 Mbps)

   Regulation: United States

   Precise Network Timing: Disabled

   Bandwidth: 45 MHz

   E1/T1: None

   Optimization: IP

   Sync: Disabled

   Symmetry: Symmetric

   Dual Payload: Enabled

   Highest Mod Mode: 256QAM 0.81

   Lowest Ethernet Mode: BPSK 0.63 Sngl

   Master: North Middle School

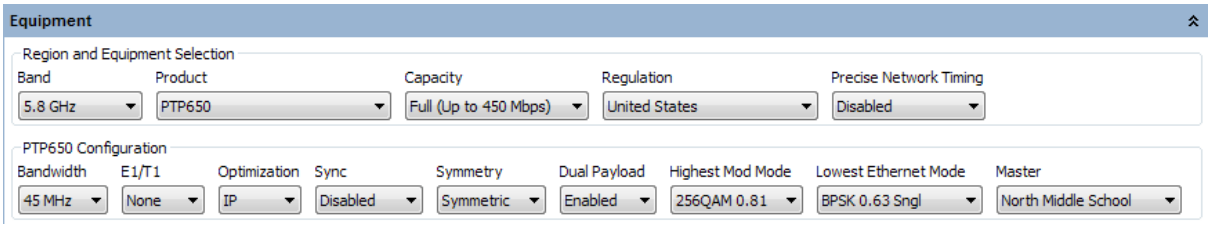


Figure 2.6: Link Equipment (Unlicensed)

8. Click **Save Project**

Updating Profile with Obstructions (Unlicensed Band)

Obtain the path profile for the link and update it with obstructions:

1. The profile in LINKPlanner will automatically appear in the profile window
2. Review the *Profile*.

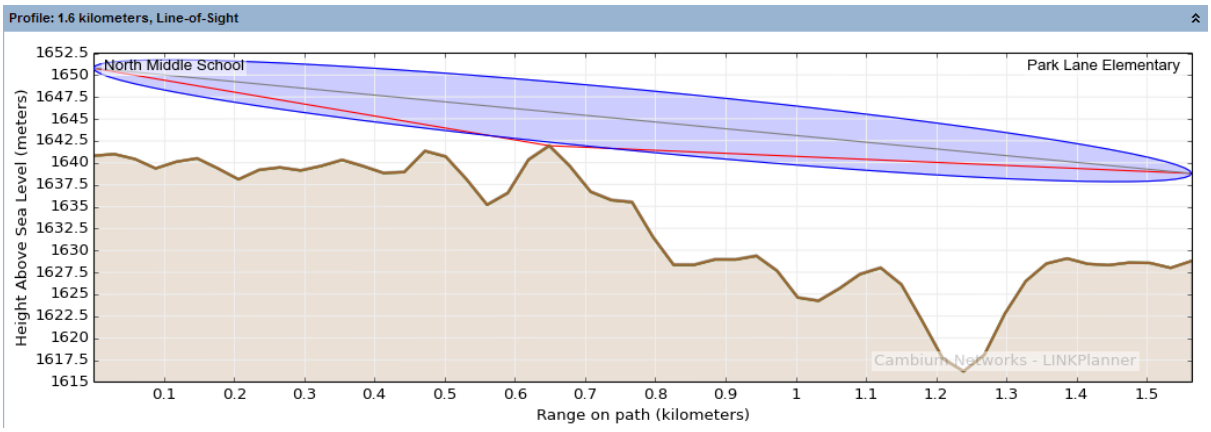


Figure 2.7: Path Profile (Unlicensed)

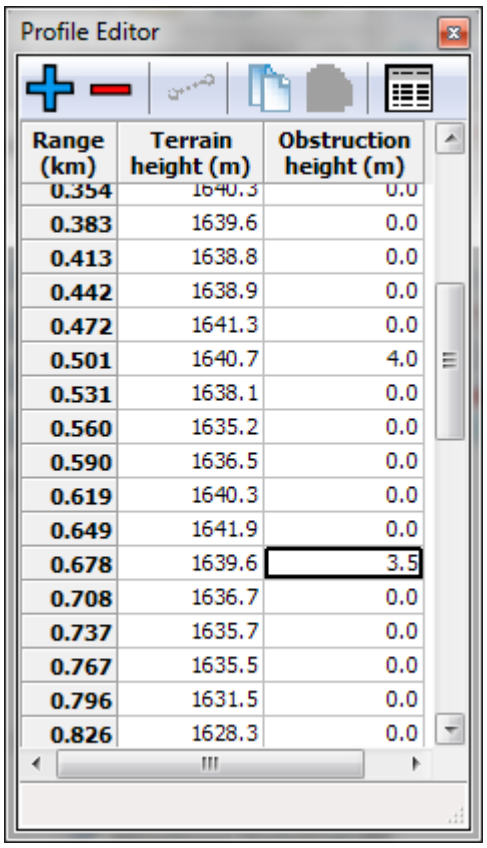
3. Check that the profile is accurate and identify any obstructions that may affect signal quality.

   The profile can be verified using Google Earth(TM), maps, GPS data and site visits. It is particularly important to verify the antenna heights, to measure interference and to identify obstructions near both ends of the Fresnel zone.

   For more information, see *Using Google Earth(TM)*.

4. Double-click on the profile. The Profile Editor is displayed. Enter a 4 meter high Obstruction at Range 0.501 km and a 3.5 meter high Obstruction at Range 0.678 km.

   The + and - buttons may be used to add and remove points. For more information, see *Updating Link Profiles*.



Range (km)	Terrain height (m)	Obstruction height (m)
0.354	1640.3	0.0
0.383	1639.6	0.0
0.413	1638.8	0.0
0.442	1638.9	0.0
0.472	1641.3	0.0
0.501	1640.7	4.0
0.531	1638.1	0.0
0.560	1635.2	0.0
0.590	1636.5	0.0
0.619	1640.3	0.0
0.649	1641.9	0.0
0.678	1639.6	3.5
0.708	1636.7	0.0
0.737	1635.7	0.0
0.767	1635.5	0.0
0.796	1631.5	0.0
0.826	1628.3	0.0

Figure 2.8: Profile Editor (Unlicensed)

5. Review the profile. Obstructions are shown in green.

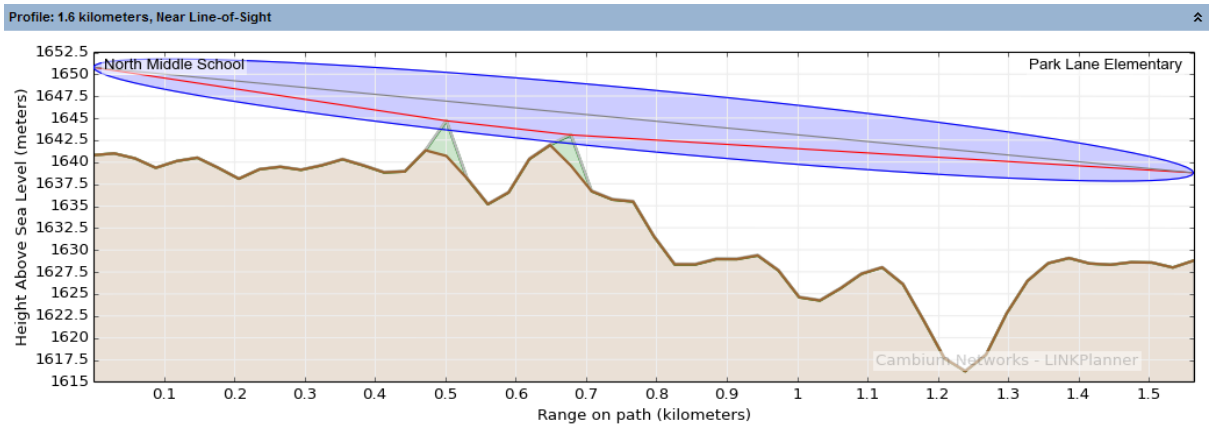


Figure 2.9: Path Profile with Obstructions (Unlicensed)

6. Click **Save Project**

Adjusting Configuration and Requirements (Unlicensed Band)

Adjust the antennas at both ends of the link and confirm that the selected equipment meets the performance requirements:

1. Adjust the Antenna Heights in the *Link Page* to given values and add Interference Density. Adjust the Interference Density to the required value.

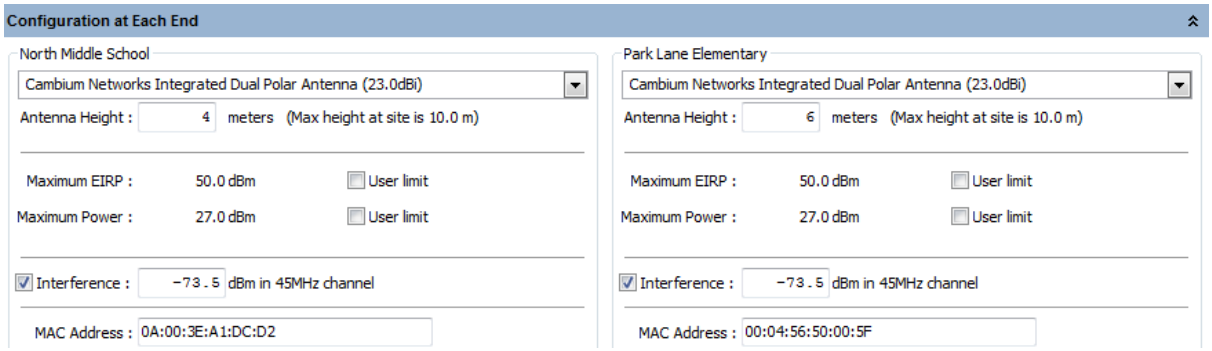


Figure 2.10: Adjust Both Ends of Unlicensed Link

2. Insert target values in the *Link Page* data rate boxes for Mean Throughput Required, Minimum Throughput Required and Minimum Throughput Availability Required.

   Observe that the predicted values are now red because they are less than required values.

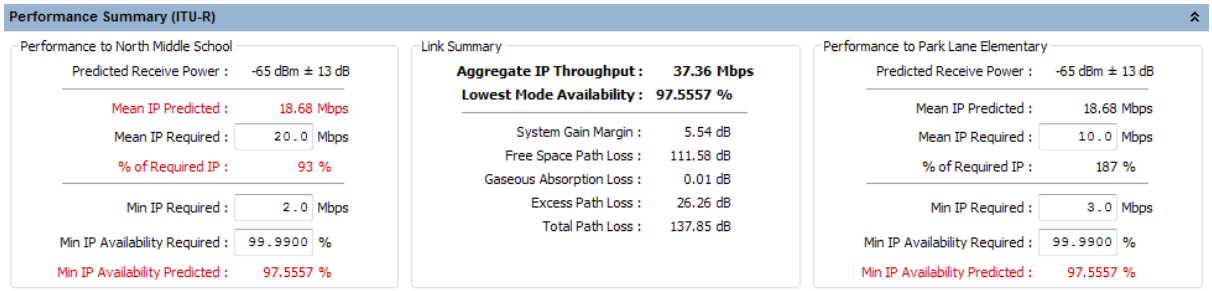


Figure 2.11: Performance Unacceptable at Both Ends of Unlicensed Link

3. Select different antennas and change Antenna Heights in the *Link Page*. Adjust User limits if required.

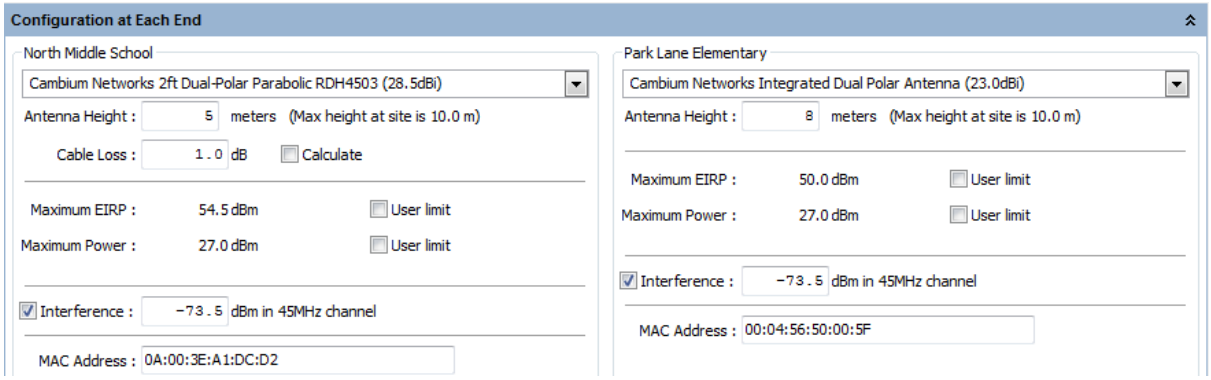


Figure 2.12: Adjust Both Ends of Unlicensed Link Again

4. Confirm that the predicted values are no longer red.

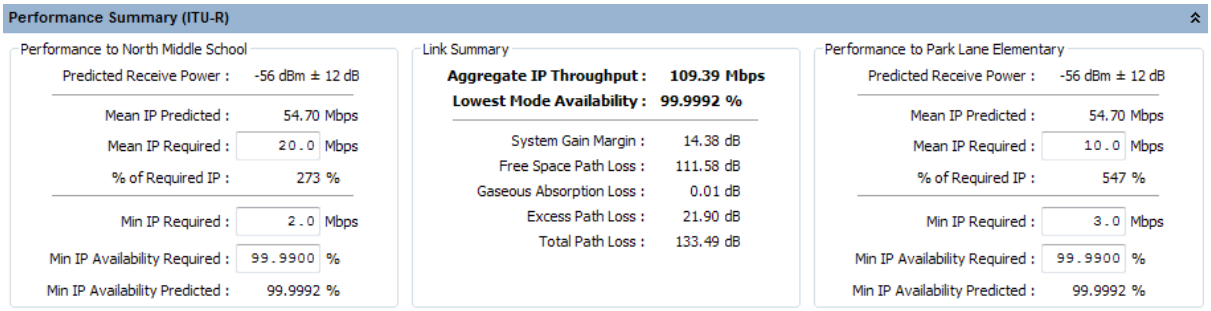


Figure 2.13: Performance Acceptable at Both Ends of Unlicensed Link

5. Click **Save Project**

Quick Tutorial - PTP Licensed Band

This section is a quick tutorial for experienced Windows or Mac users. It describes how to create a project to analyze the performance of a single PTP link operating in a licensed frequency band (6 GHz or greater) between two sites.

Before starting this tutorial, complete the following steps:

1. Install the software in the usual way. See *Installing LINKPlanner*.
2. Start the application.
3. Enter the correct details in the Options (Preferences) page. Ensure that Email address and Network Settings are correct. See *Options (Preferences)*.
4. Register with the path profile service. See *Options (Preferences)*.

There are three parts to this tutorial:

1. Create a project with two sites and one link. See *Creating Project, Sites and Link (Licensed Band)*.
2. Update the path profile for the link with obstructions. See *Updating Profile with Obstructions (Licensed Band)*.
3. Adjust the antennas at both ends of the link and confirm that the selected equipment meets the performance requirements. See *Adjusting Configuration and Requirements (Licensed Band)*.

Creating Project, Sites and Link (Licensed Band)

To create a project with two sites and one link:

1. Click **New Project**  .

   The *Project Page* is displayed

2. Enter Customer Information and Default settings for new links.

   Click **Save Project** 

   Save the project as **Tutorial2.ptpprj**.

3. Click **New Network Site** 

   The *Add New Network Site* page is displayed. Enter this data:

   Name: Wood Farm

   Maximum Height: 15 meters

   Latitude: 50.44138N

   Longitude: 003.77435W

   Description: Antenna mounted on roof

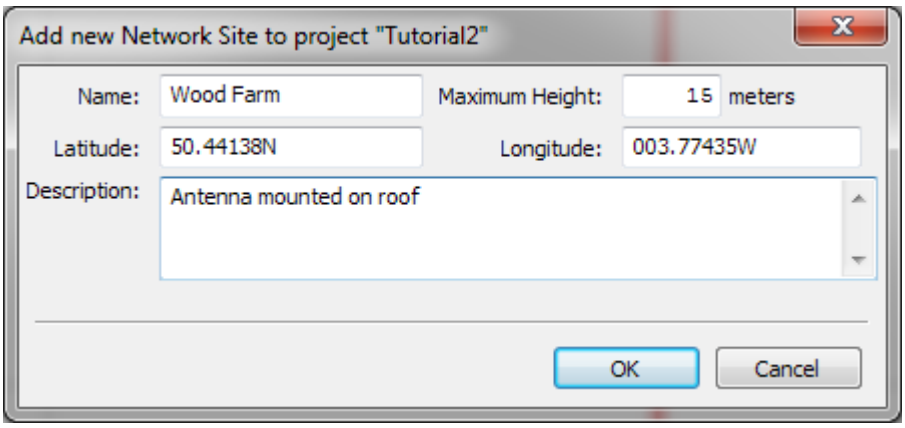


Figure 2.14: Inserting Site 1 (Licensed)

4. Click **New Network Site**

   The *Add New Network Site* page is displayed. Enter this data:

   Name: West Tower

   Maximum Height: 15 meters

   Latitude: 50.44840N

   Longitude: 003.77415W

   Description: Antenna mounted on tower

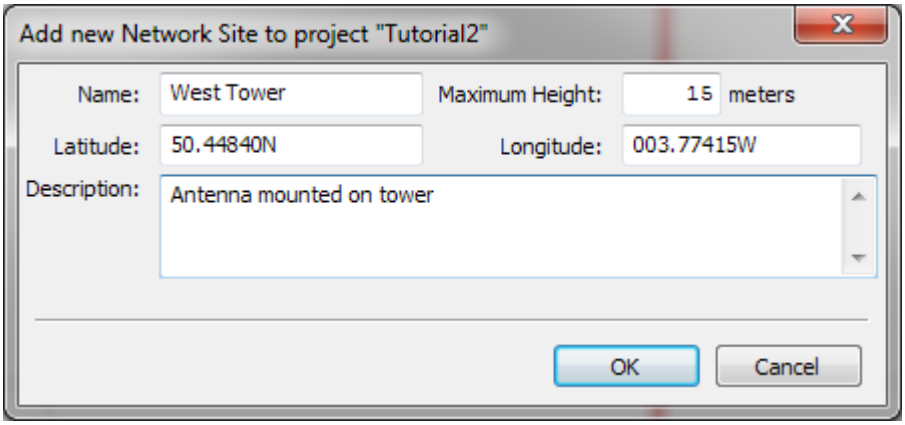


Figure 2.15: Inserting Site 2 (Licensed)

5. Click **New PTP Link**

   The *Add New PTP Link* page is displayed.

   Select the two sites to be linked: Wood Farm and West Tower.

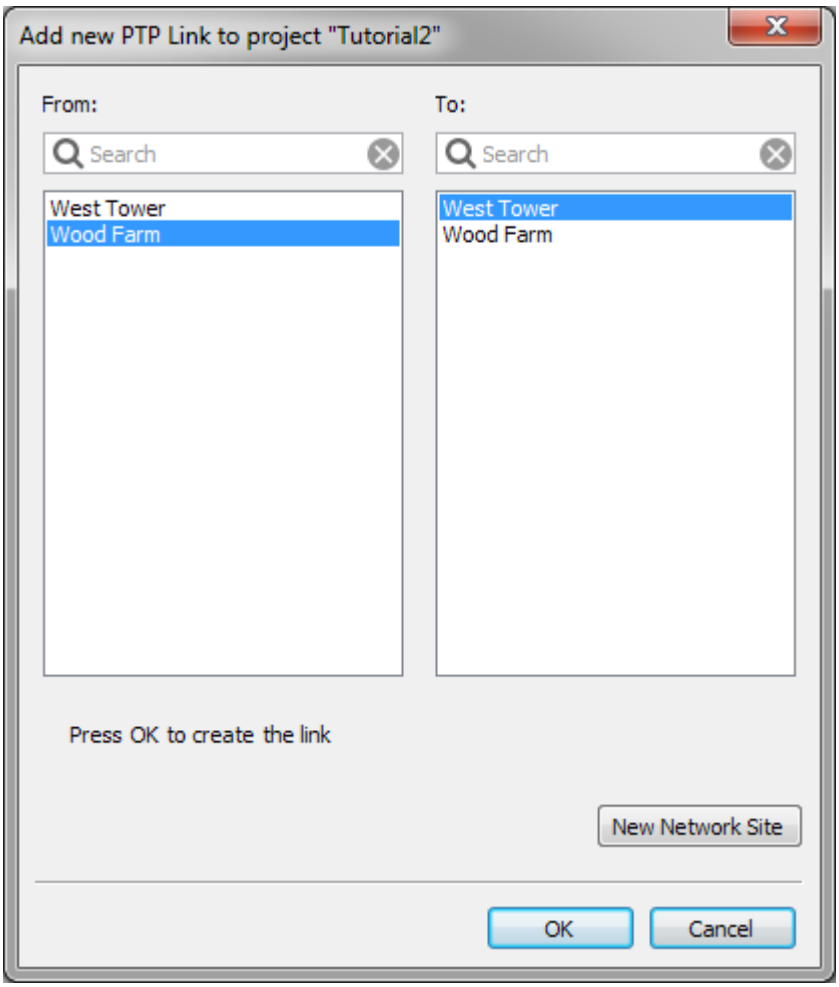


Figure 2.16: Inserting Link (Licensed)

If requesting path profiles automatically the profile request is sent to the Cambium Path Profiler and will automatically appear in the profile window.

6. If requesting profiles manually click **Project**, **Get Profiles**.

   The *Request Profiles* page is displayed. Tick the link “Wood Farm to West Tower” (if not already ticked).

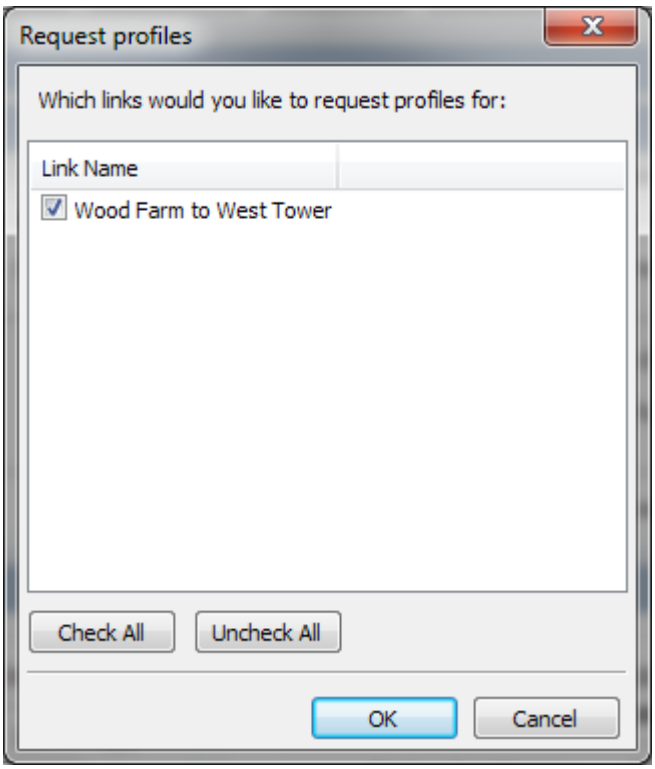


Figure 2.17: Requesting Profiles (Licensed)

The profile request is sent to the Cambium Path Profiler and will automatically appear in the profile window.

7. Configure the link equipment, see *Equipment (licensed bands)*:

   Band: 26 GHz

   Product: PTP26800 with ODU-A

   Regulation: ETSI

   Link Type: 1+0

   T/R Spacing: Preset to 1008 MHz

   Bandwidth: 56 MHz

   Modulation Mode: Adaptive

   Maximum Mod Mode: 256QAM 0.91 (368.65 Mbps)

   Minimum Mod Mode: QPSK 0.80 (77.15 Mbps)

   Polarization: Vertical

   ATPC: Disabled

   Hi: Wood Farm

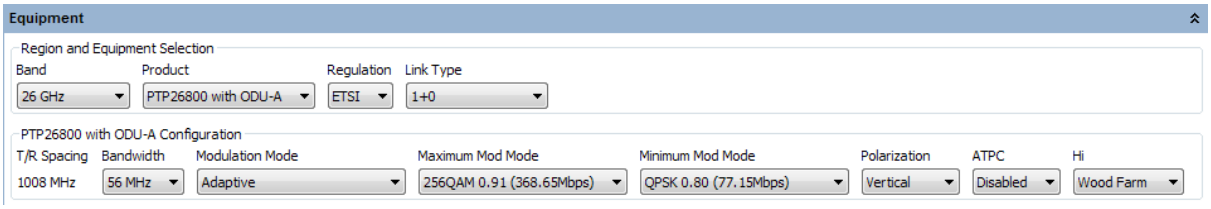


Figure 2.18: Link Equipment (Licensed)

8. Click **Save Project**

Updating Profile with Obstructions (Licensed Band)

Obtain the path profile for the link and update it with obstructions:

1. The profile in LINKPlanner will automatically appear in the profile window
2. Review the *Profile*.

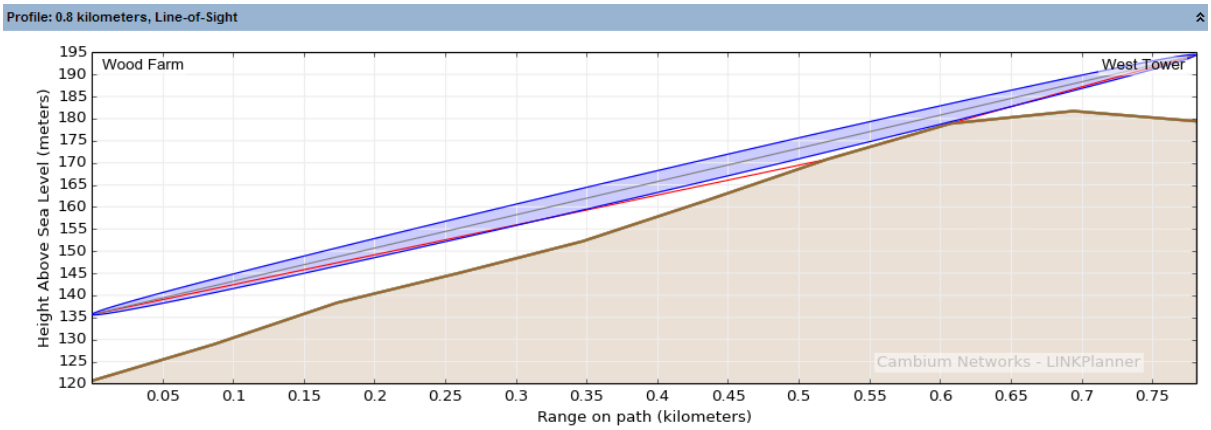


Figure 2.19: Path Profile (Licensed)

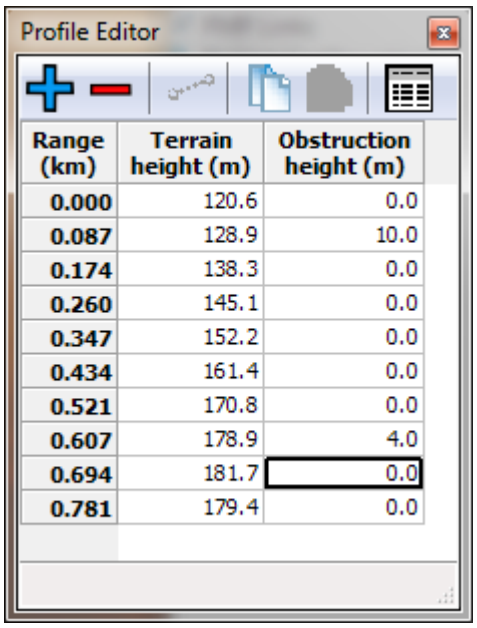
3. Check that the profile is accurate and identify any obstructions that may affect signal quality.

   The profile can be verified using Google Earth(TM), maps, GPS data and site visits. It is particularly important to verify the antenna heights, to measure interference and to identify obstructions near both ends of the Fresnel zone.

   For more information, see *Using Google Earth(TM)*.

4. Double-click on the profile. The Profile Editor is displayed. Enter obstructions as shown below.

   The + and - buttons may be used to add and remove points. For more information, see *Updating Link Profiles*.



Range (km)	Terrain height (m)	Obstruction height (m)
0.000	120.6	0.0
0.087	128.9	10.0
0.174	138.3	0.0
0.260	145.1	0.0
0.347	152.2	0.0
0.434	161.4	0.0
0.521	170.8	0.0
0.607	178.9	4.0
0.694	181.7	0.0
0.781	179.4	0.0

Figure 2.20: Profile Editor (Licensed)

5. Review the profile. Obstructions are shown in green.

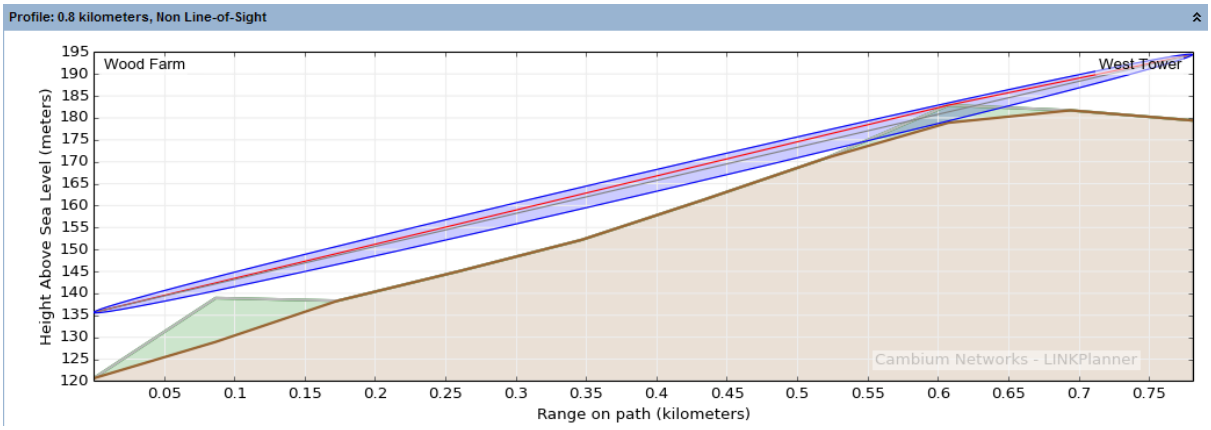


Figure 2.21: Path Profile with Obstructions (Licensed)

6. Click **Save Project**

Adjusting Configuration and Requirements (Licensed Band)

Adjust the antennas at both ends of the link and confirm that the selected equipment meets the performance requirements:

1. Adjust the Antenna Heights in the *Link Page* to given values.

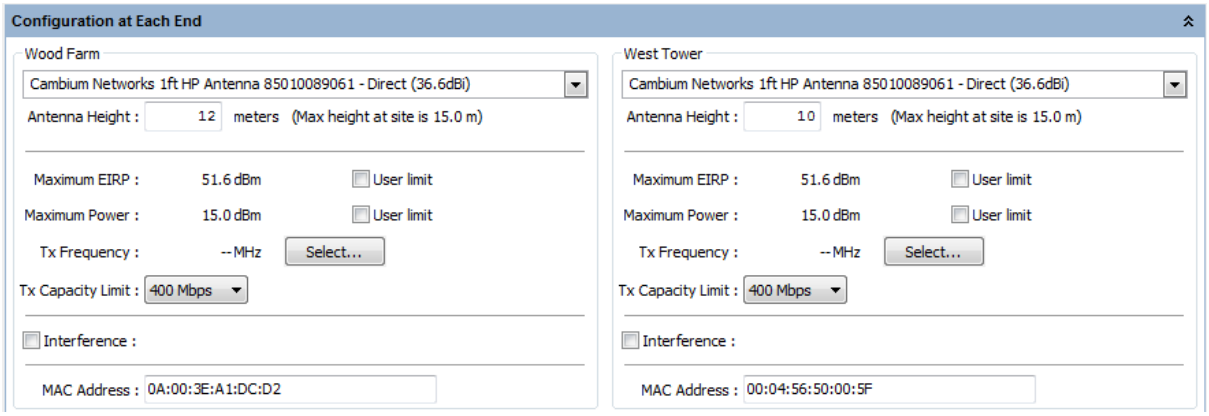


Figure 2.22: Adjust Both Ends of Licensed Link

2. Insert target values in the *Link Page* data rate boxes for Mean IP Required.

   Observe that the predicted values are now red because they are less than required values.

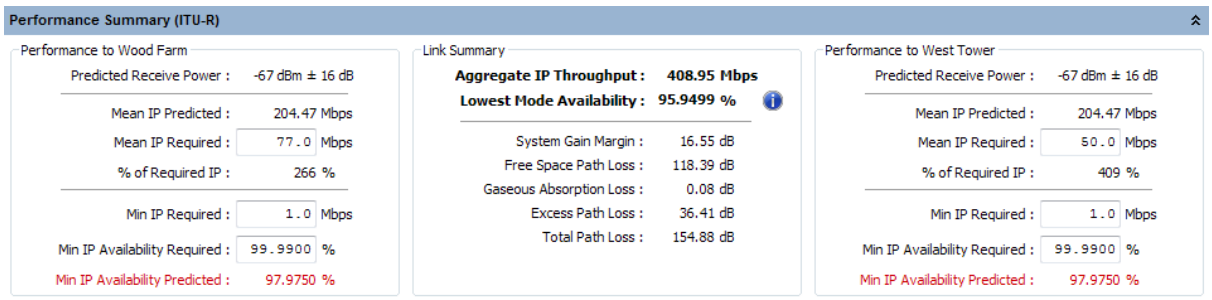


Figure 2.23: Performance Unacceptable at Both Ends of Licensed Link

3. Select different antennas and change Antenna Heights in the *Link Page*.

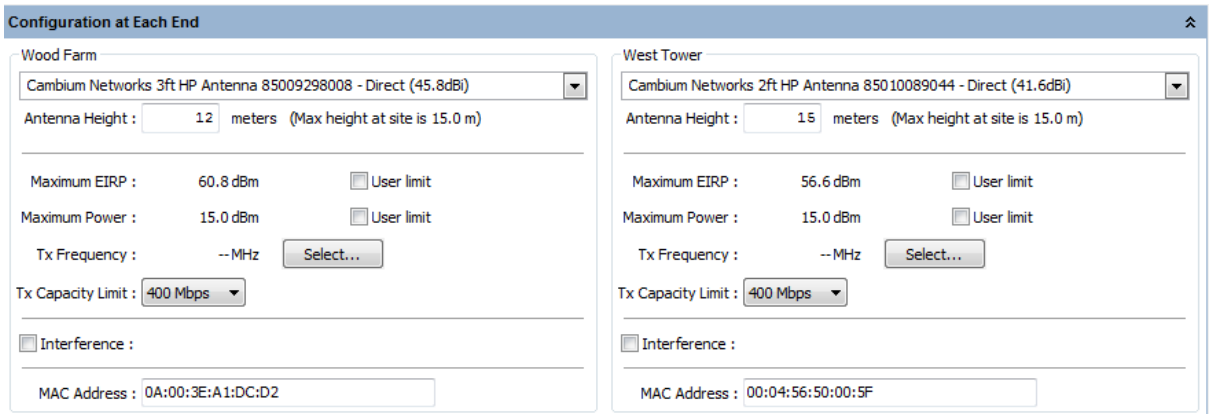


Figure 2.24: Adjust Both Ends of Licensed Link Again

4. Confirm that the predicted values are no longer red.

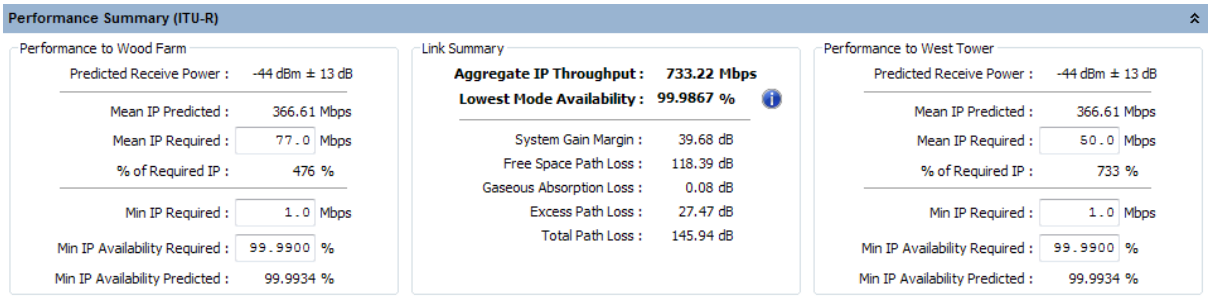


Figure 2.25: Performance Acceptable at Both Ends of Licensed Link

5. Click **Save Project**

Quick Tutorial - PMP

This section is a quick tutorial for experienced Windows or Mac users. It describes how to create a project to connect two Subscriber Modules to an Access Point on a Hub Site.

Before starting this tutorial, complete the following steps:

1. Install the software in the usual way. See *Installing LINKPlanner*.
2. Start the application.
3. Enter the correct details in the Options (Preferences) page. Ensure that Email address and Network Settings are correct. See *Options (Preferences)*.
4. Register with the path profile service. See *Options (Preferences)*.

There are three parts to this tutorial:

1. Create a project with one hub site, one Access Point and two Subscriber Modules. See *Creating Project, Access Points and Subscriber Modules (PMP)*.
2. Update the path profile for the link with obstructions. See *Updating Profile with Obstructions (PMP)*.
3. Adjust the antennas at both ends of the link and confirm that the selected equipment meets the performance requirements. See *Reviewing Performance and Adjusting Configuration (PMP)*.

Creating Project, Access Points and Subscriber Modules (PMP)

To create a project with one Hub Site, one Access Point and two Subscriber Modules:

1. Click **New Project**  .

   The *Project Page* is displayed

2. Enter Customer Information and Default settings for new links.

   Click **Save Project** 

   Save the project as **Tutorial_PMP.ptpprj**.

3. Click **New Network Site** 

   The *Add New Network Site* page is displayed. Enter this data:

   Name: Golf Club

   Maximum Height: 20 meters

   Latitude: 39.75093N

   Longitude: 104.84035W

   Description: Hub Site located at Golf Club

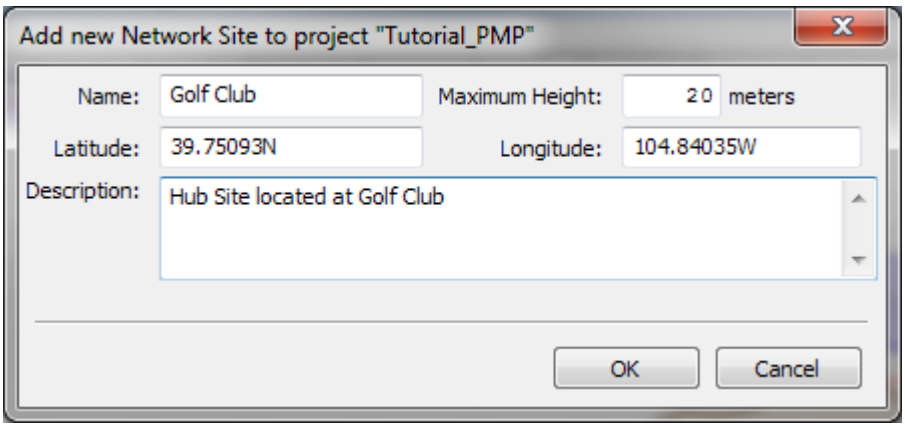


Figure 2.26: Inserting Hub Site Location

4. Click **New Hub**

   The *Add New Hub* page is displayed.

   Select the Network Site to be used as a Hub Site: Golf Club.

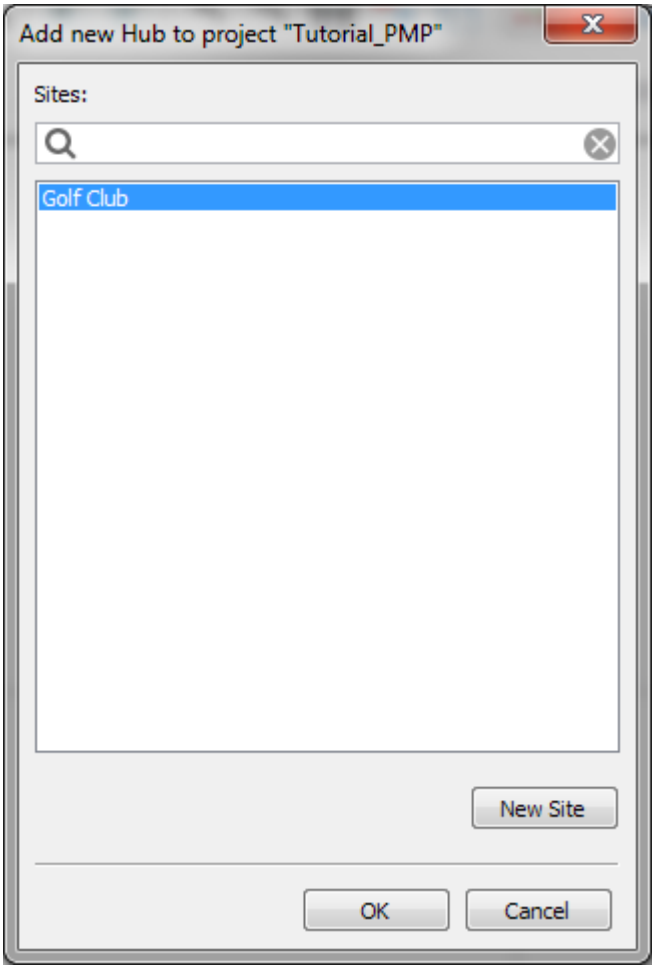


Figure 2.27: Create a Hub Site

The Hub Site is now added to PMP Links and automatically has one Access Point, Golf Club:1, assigned to it.

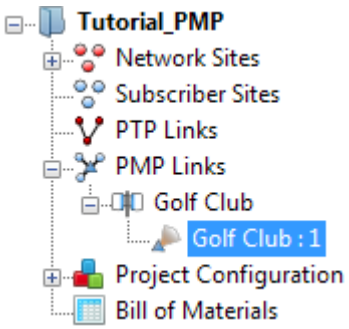


Figure 2.28: Navigation Tree with one Hub Site and One Access Point

5. Configure the Access Point, see *Access Point Equipment*:

   Band: 5.8 GHz

   Product: PMP450

   Country: United States

   Sync Input: Generate Sync

   Bandwidth: 20 MHz

   Color Code: 0

   Max Range: 2 miles

   Frame Period: 2.5 ms

   Downlink Data: 75 %

   Contention Slots: 3

   Broadcast Repeat Count: 0

   Total Virtual Circuits: 0 (read only)

   Antenna Selection: Cambium Networks 60 deg 5 GHz Sector Antenna (17.0 dBi)

   Antenna Height: 20m

   Cable Loss: 1.0 dB

   Antenna Azimuth: 90 degrees

   Antenna Tilt: 0 degrees

   EIRP: 36 dBm (read only)

   Power: 20 dBm

   SM Receive Target Level: -50 dBm

   Interference?: Tick, -90.0 dBm

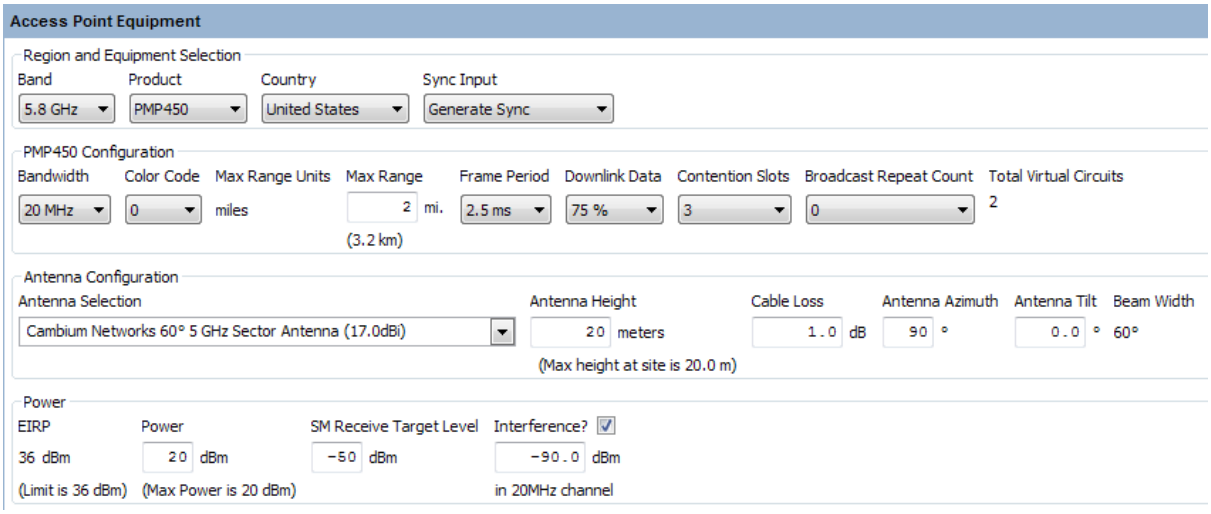


Figure 2.29: Access Point Equipment (PMP 450)

6. Click **New Subscriber Site**

   The *Add New Subscriber Site* page is displayed. Enter this data:

   Name: Billings Street

   Maximum Height: 10 meters

   Latitude: 39.74739N

   Longitude: 104.82459W

   Description: Corner of Billings Street and E. Montview Blvd

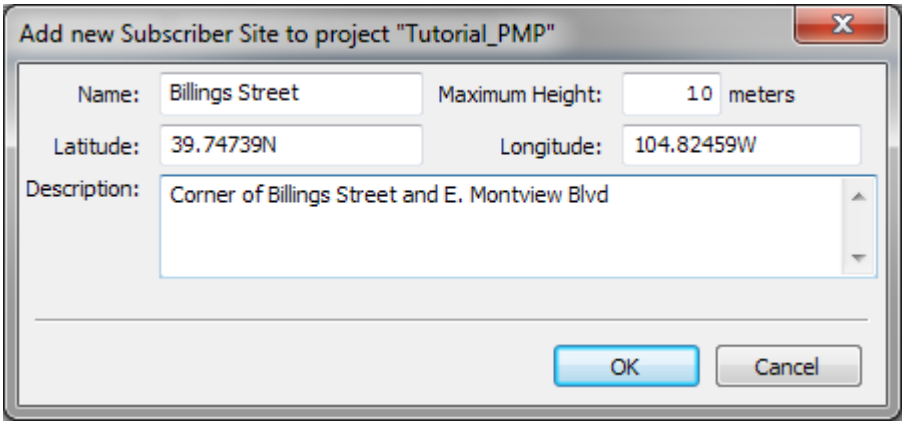


Figure 2.30: Inserting Susbcriber Site 1

7. Click **New Subscriber Site**

   The *Add New Subscriber Site* page is displayed. Enter this data:

   Name: Xanadu Street

   Maximum Height: 10 meters

   Latitude: 39.75385N

   Longitude: 104.82905W

Description: Customer on Xanadu Street

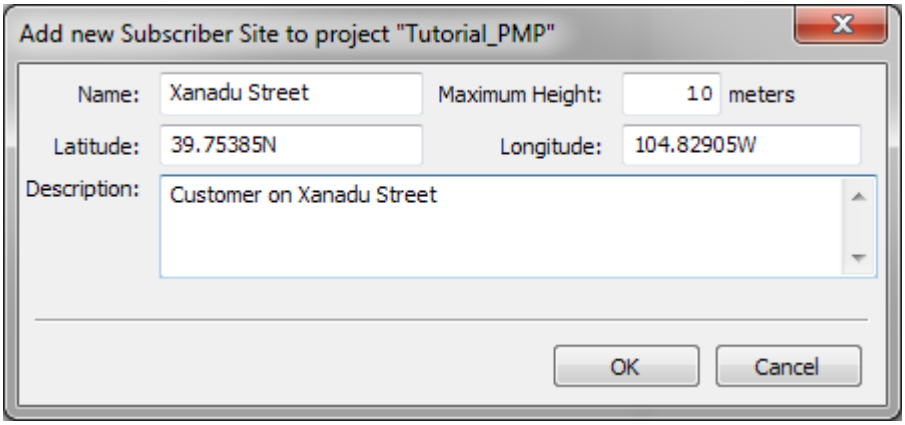


Figure 2.31: Inserting Susbcriber Site 2

8. Add Subscriber Modules to Access Point

   Select the Access Point from the Navigation Tree, see *Navigation Tree with one Hub Site and One Access Point*. In the Links to Subscriber Modules pane select **Add Subscriber Module**  , the *Add New Subscriber Site* is displayed. Select the Subscriber Sites to be connected to the Access Point.

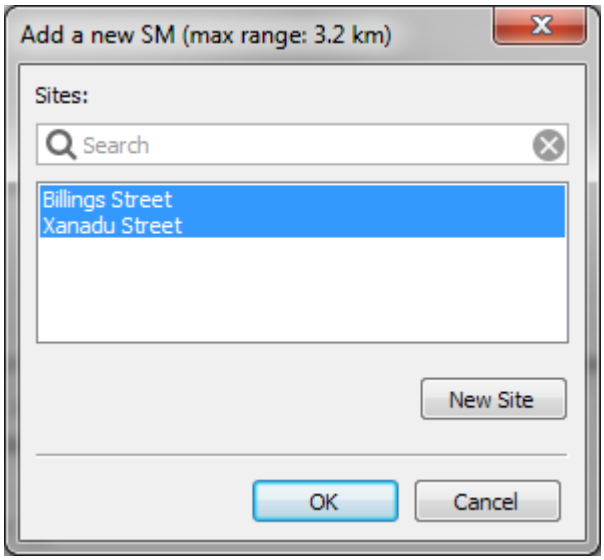


Figure 2.32: Add new Subscriber Modules to Access Point

The Subscriber Modules are now added to the Access Point and can be selected from the Navigation Tree.

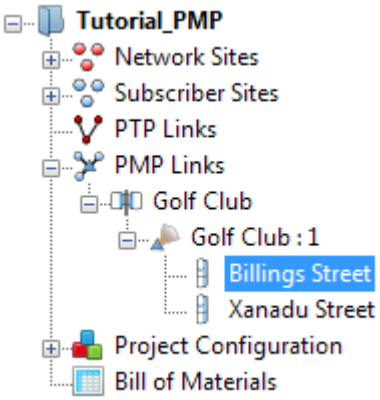


Figure 2.33: Navigation Tree with two Subscriber Modules on one Access Point

9. Configure the Subscriber Module, see *Subscriber Module Equipment*:

   Band: 5.8 GHz (read only)

   Product: PMP450

   Country: United States (read only)

   Bandwidth: 20 MHz (read only)

   Color Code: 0 (read only)

   Capacity: 20 Mbps

   High Priority Channel: Disabled

   Max Range: 2 miles (read only)

   Frame Period: 2.5 ms (read only)

   Downlink Data: 75 % (read only)

   Contention Slots: 3 (read only)

   Antenna Selection: Cambium Networks 55 deg Integrated Antenna (9.0 dBi)

   Antenna Height: 5m

   Antenna Azimuth: 286.2 degrees (read only)

   Antenna Tilt: 1.1 degrees (read only)

   AP Antenna Gain: 15.7 dBi (read only)

   EIRP 31 dBm (read only)

   Power: 22 dBm

   Interference?: Tick, -90.0 dBm

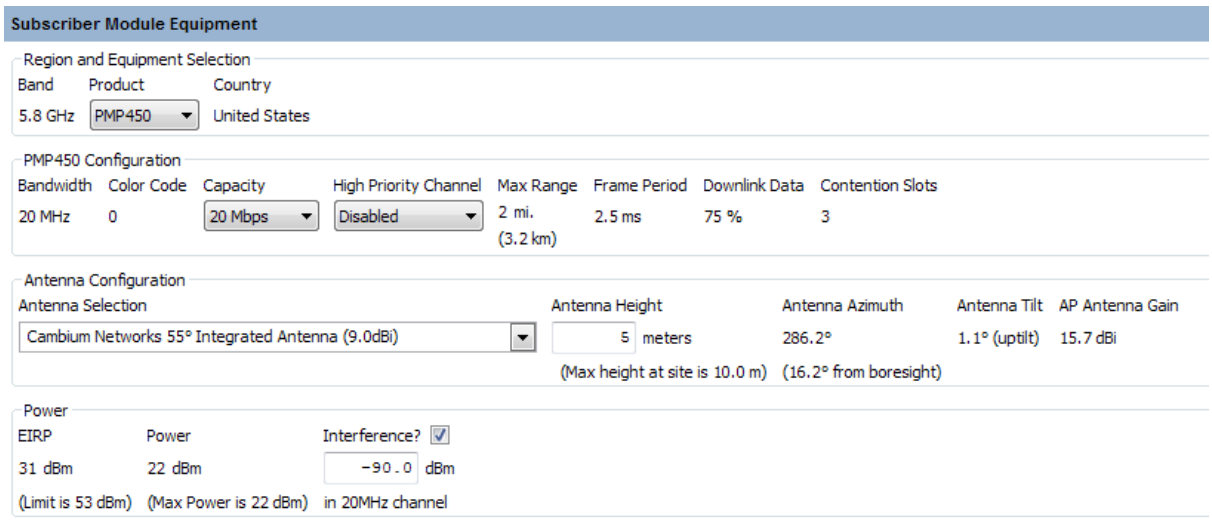


Figure 2.34: Subscriber Module Equipment (PMP 450)

10. If requesting profiles manually click **Project**, **Get Profiles**.

    The *Request Profiles* page is displayed. Tick the links “Golf Club : 1 to Billings Street” and “Golf Club : 1 to Xanadu Street” (if not already ticked).

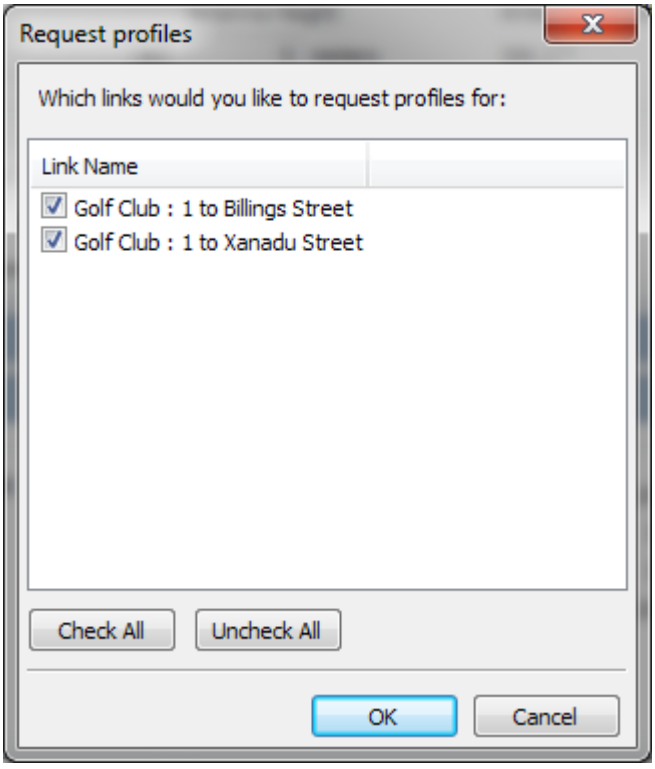


Figure 2.35: Requesting Profiles (PMP)

The profile request is sent to the Cambium Path Profiler and will automatically appear in the profile window.

8. Click **Save Project**

Updating Profile with Obstructions (PMP)

Obtain the path profile for the link between the Access Point and the Subscriber Modules and update it with obstructions:

1. The profile in LINKPlanner will automatically appear in the profile window
2. Review the *Profile*.

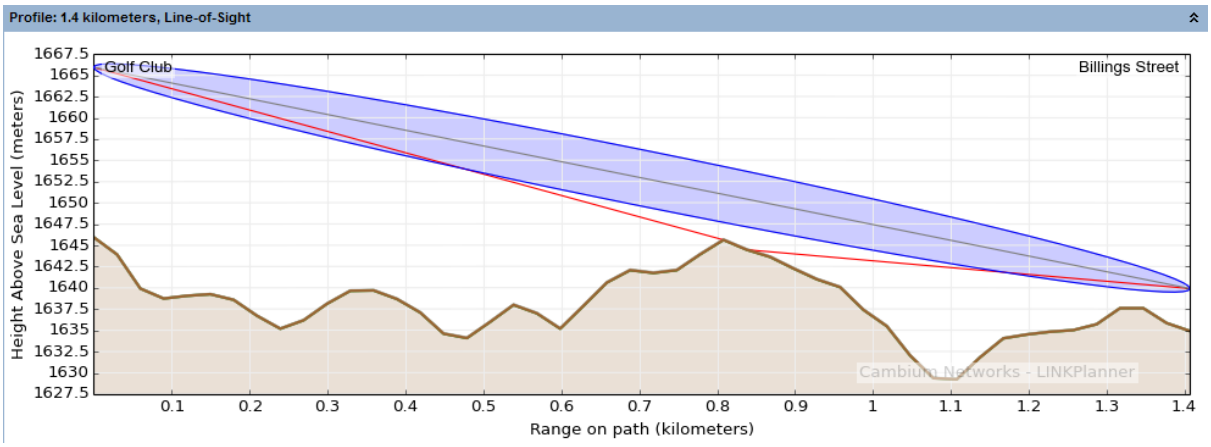


Figure 2.36: Path Profile (PMP)

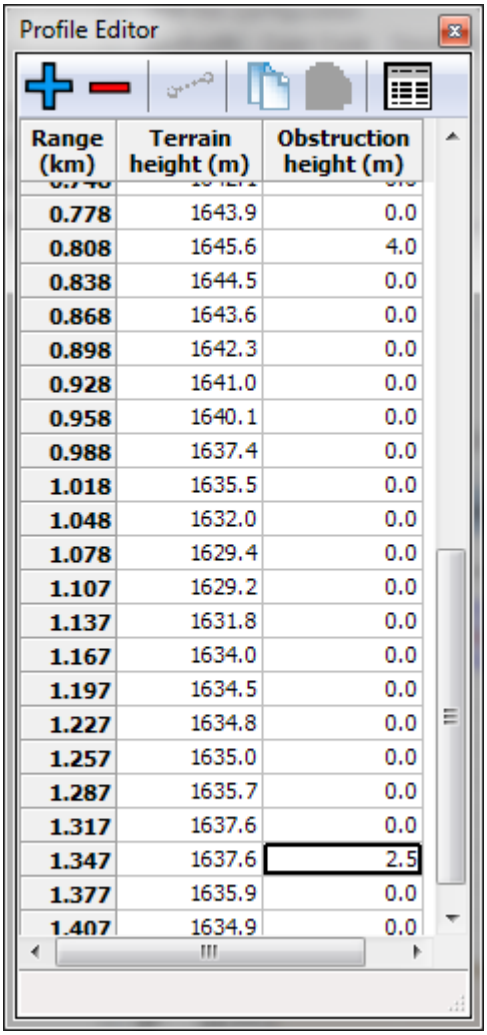
3. Check that the profile is accurate and identify any obstructions that may affect signal quality.

   The profile can be verified using Google Earth(TM), maps, GPS data and site visits. It is particularly important to verify the antenna heights, to measure interference and to identify obstructions near both ends of the Fresnel zone.

   For more information, see *Using Google Earth(TM)*.

4. Double-click on the profile. The Profile Editor is displayed. Enter a 4 meter high Obstruction at Range 0.808 km and a 2.5 meter high Obstruction at Range 1.347 km.

   The + and - buttons may be used to add and remove points. For more information, see *Updating Link Profiles*.



Range (km)	Terrain height (m)	Obstruction height (m)
0.778	1643.9	0.0
0.808	1645.6	4.0
0.838	1644.5	0.0
0.868	1643.6	0.0
0.898	1642.3	0.0
0.928	1641.0	0.0
0.958	1640.1	0.0
0.988	1637.4	0.0
1.018	1635.5	0.0
1.048	1632.0	0.0
1.078	1629.4	0.0
1.107	1629.2	0.0
1.137	1631.8	0.0
1.167	1634.0	0.0
1.197	1634.5	0.0
1.227	1634.8	0.0
1.257	1635.0	0.0
1.287	1635.7	0.0
1.317	1637.6	0.0
1.347	1637.6	2.5
1.377	1635.9	0.0
1.407	1634.9	0.0

Figure 2.37: Profile Editor (PMP)

5. Review the profile. Obstructions are shown in green.

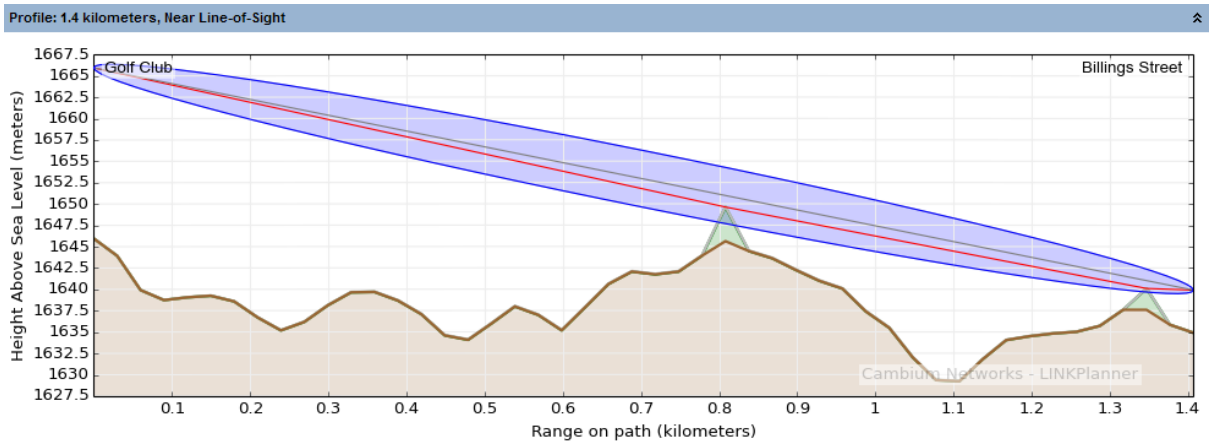


Figure 2.38: Path Profile with Obstructions (PMP)

6. Click **Save Project**

Reviewing Performance and Adjusting Configuration (PMP)

Review the performance of the link and adjust the antenna at the Subscriber Module, confirm that the selected equipment meets the performance objectives:

1. View the performance of the link between the Access Point and the Subscriber Module.
2. Insert the required performance objective of x6 (64QAM MIMO-B) at both ends of the link, using the Min Mod Mode Required field.
3. Set the Min Availability Required to 99.9% at both ends of the link

Observe that the Max Usable Mode values and Predicted Availability are now red because they are less than the required values.

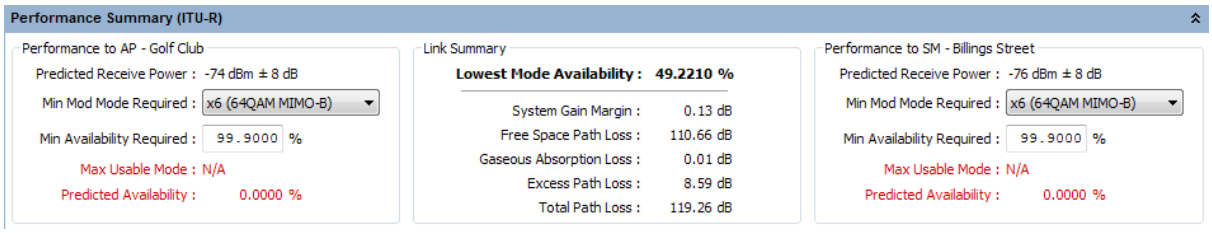


Figure 2.39: Performance Unacceptable at Both Ends of PMP Link

3. Select different antenna and change Antenna Height in the *Link Page*.

NOTE

If changing equipment parameters at the Access Point and Automatic Calculations are not enabled, **Calculate Now** will appear. Select this to update the parameters on all the Subscriber Modules, see *Project Toolbar* .

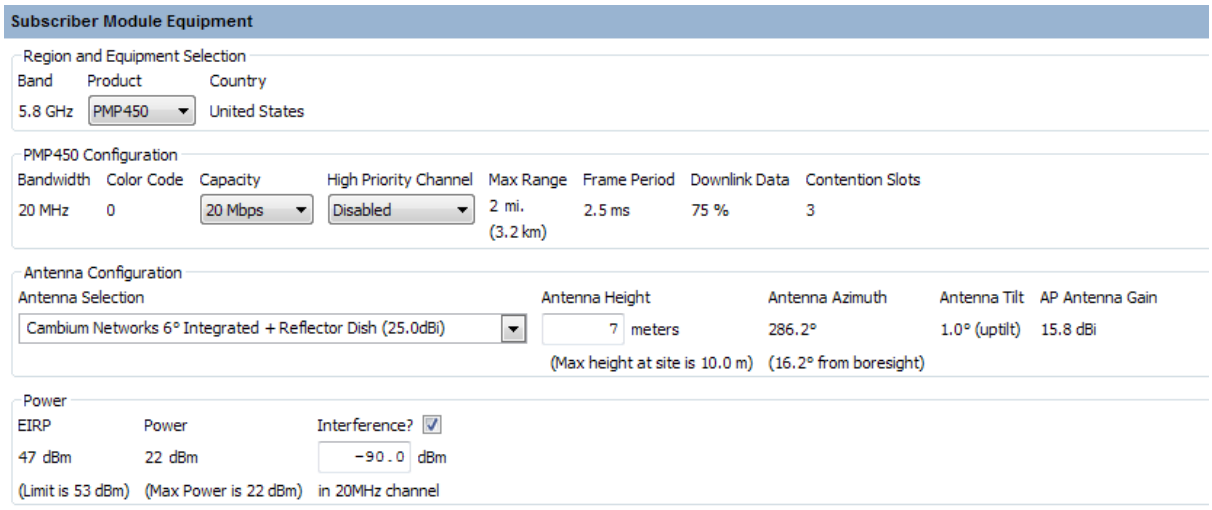


Figure 2.40: Adjust Both Ends of PMP Link

4. Confirm that the predicted values meet performance objectives.

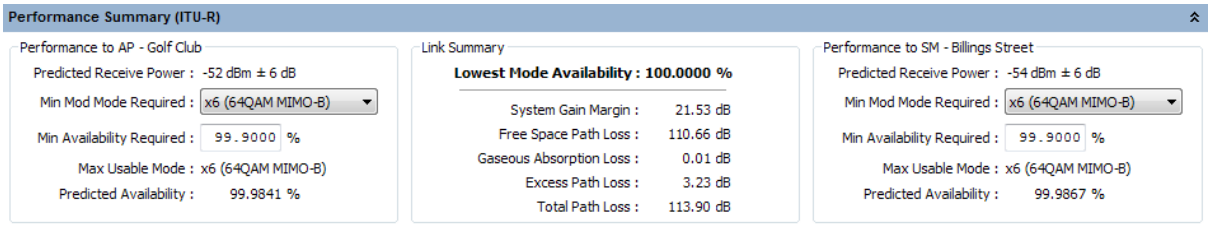


Figure 2.41: Performance Acceptable at Both Ends of PMP Link

5. Confirm the detailed performance parameters at each mode.

Performance Details

Common details

Mode:	256QAM	64QAM	16QAM	QPSK	256QAM	64QAM	16QAM	QPSK
MIMO Type:	MIMO-B	MIMO-B	MIMO-B	MIMO-B	MIMO-A	MIMO-A	MIMO-A	MIMO-A
Multiplier:	x8	x6	x4	x2	x4	x3	x2	x1

Performance to Access Point

Fade Margin (dB):	-1.3	7.8	13.8	20.7	-1.3	7.8	13.8	22.8
Mode Availability (%):	13.3627	99.9841	99.9885	99.9885	0.0006	0.0115	0.0115	100.0000
Receive Time in Mode (%):	13.3627	86.6214	0.0044	0.0000	0.0006	0.0109	0.0000	0.0000

Performance to Subscriber Module

Fade Margin (dB):	-2.5	8.5	14.4	20.8	-2.5	8.5	14.4	21.5
Mode Availability (%):	1.6817	99.9867	99.9885	99.9885	0.0000	0.0115	0.0115	100.0000
Receive Time in Mode (%):	1.6817	98.3050	0.0018	0.0000	0.0000	0.0115	0.0000	0.0000

Figure 2.42: Detailed Performance at Both Ends of PMP Link

6. Click **Save Project**

CHAPTER 3

Using LINKPlanner

LINKPlanner allows the planner to design both PTP and PMP networks in the same project, using many common functions.

To achieve this goal, follow this process:

1. Start the application and set options. See *Starting the Application*.
2. Build a project to model a PTP link or PMP network See *Projects*.
3. Enter details of all sites in the project. See *Sites*.
4. Plan a PTP link, see *Planning PTP links* or plan a PMP network, see *Planning PMP networks*
5. Adjust the link profile to allow for terrain height variance, obstructions and reflection. See *Adjusting Link Profiles*.
6. View the Bill of Materials for the project. See *Bill of Materials for Project*.
7. Manage the project, see *Project Configuration*.
8. Export and report project, network, site and link data. See *Exporting and Reporting*

Starting the Application

Start LINKPlanner. The Main Screen is displayed.

NOTE

Before using the application, set options (preferences in Mac). See *Options (Preferences)*.

Main Screen

The *Main Screen* consists of two panels:

- The left hand panel contains the *Project Navigation Tree*. This panel is blank until one or more projects are opened. See *Project Navigation Tree*.
- The right hand panel is for viewing and editing projects, sites and links. This panel initially displays information about the application, with links for opening new and recent projects.

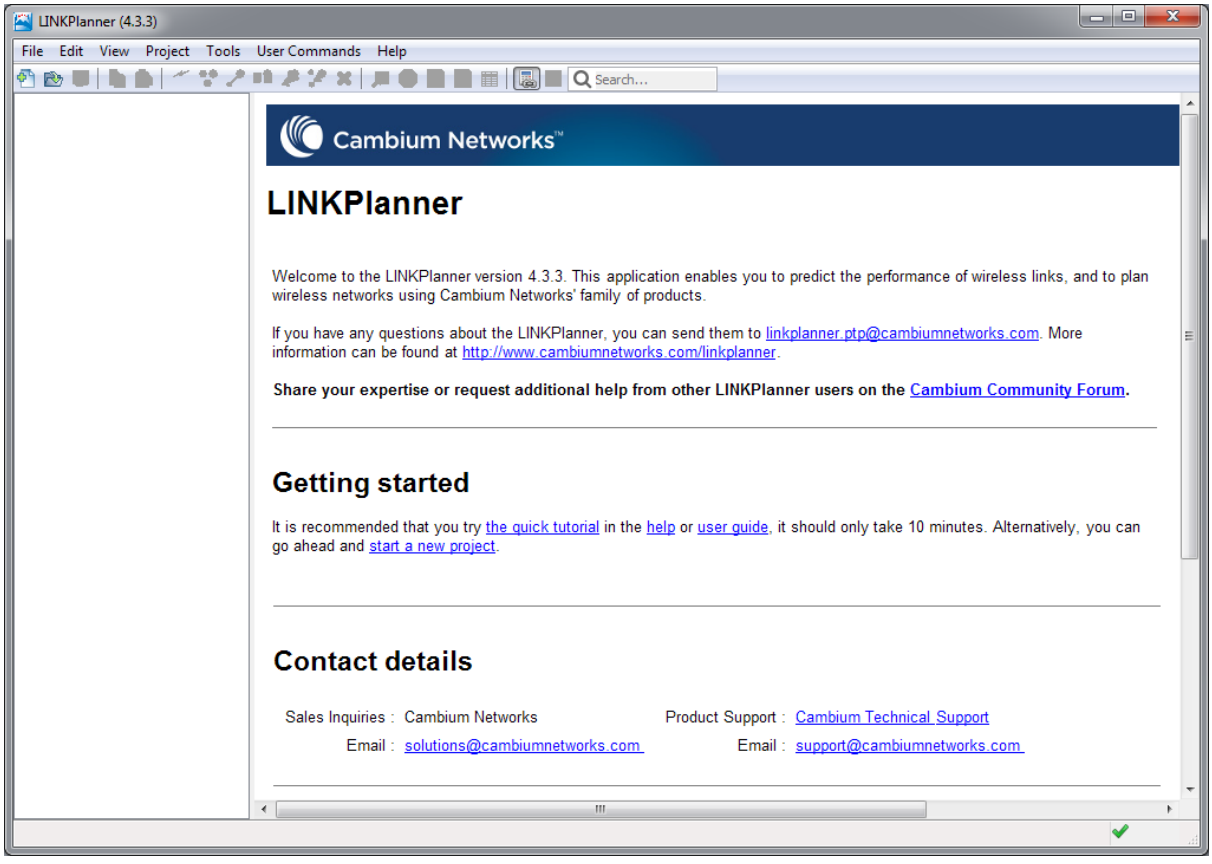


Figure 3.1: Main Screen

Options (Preferences)

Before using LINKPlanner, use the Options page (Preferences in Mac) to enter personal information, select units and choose network settings.

To open the Options/Preferences page:

- On Windows, click **Tools**, **Options**.
- On a Mac, open **Preferences**.

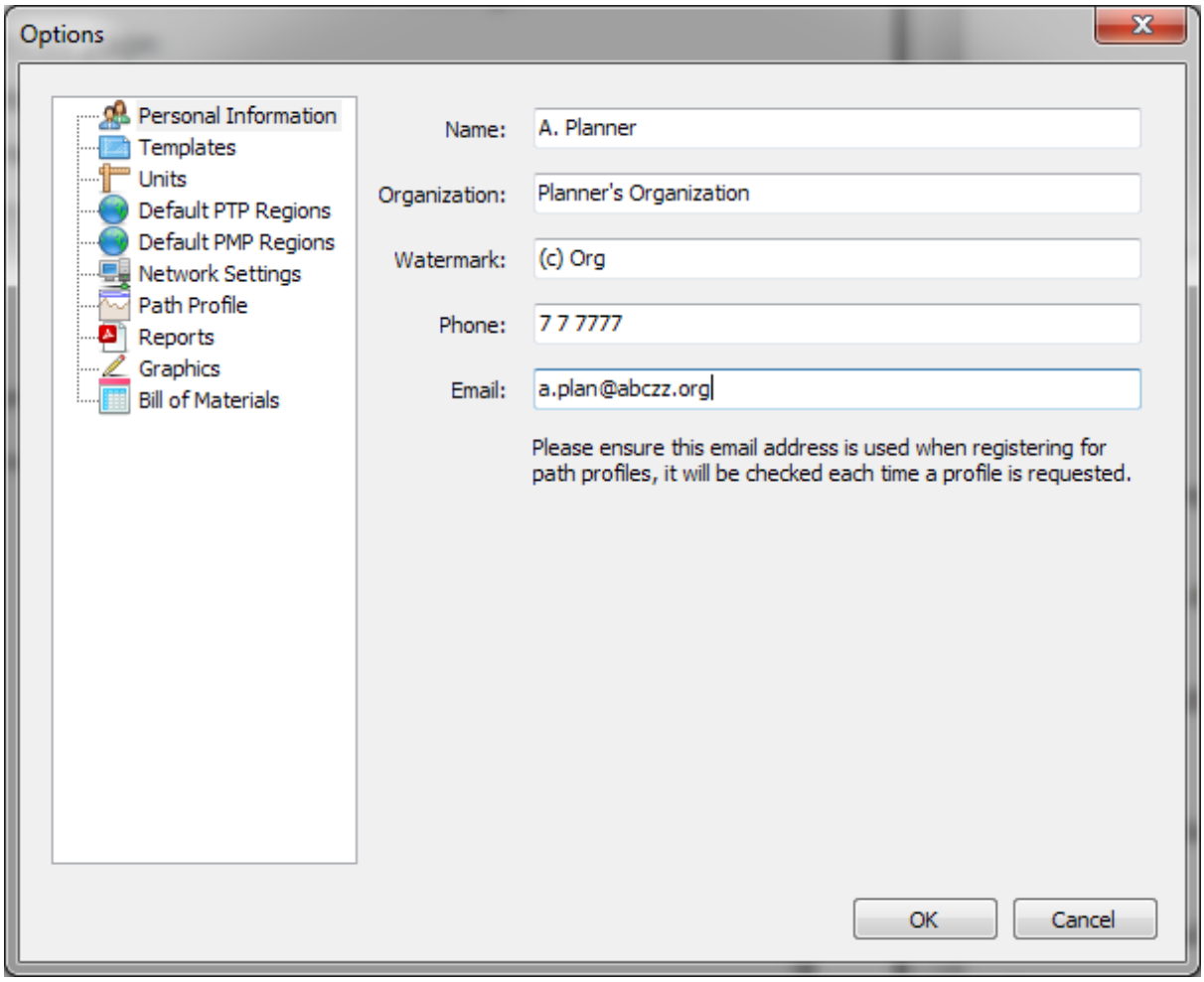


Figure 3.2: Options (Preferences) Page

Personal Information

Enter contact details for the person who prepares link plans on behalf of the customer. LINKPlanner uses the email address to obtain Path Profiles (see *Options (Preferences) Page*).

The **Watermark** can be used to insert additional watermark text on the path profile graph and the interactive map.

NOTE

When requesting profiles LINKPlanner will send information, including your contact details and path profile coordinates, to Cambium Networks. Cambium Networks stores this information on its servers so that we can provide the best possible customer service and sales support. Please see http://www.cambiumnetworks.com/privacy for more details.

Templates

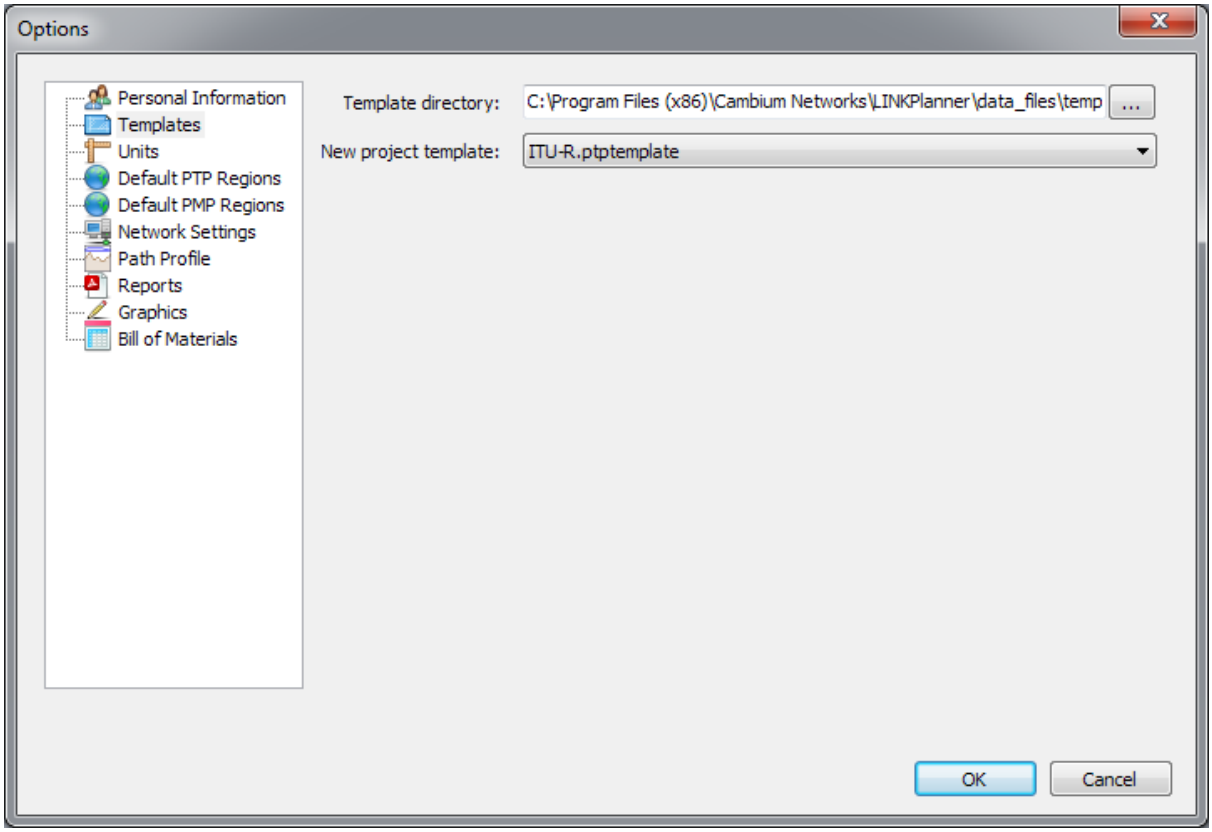


Figure 3.3: Templates Page

Choose the directory that contains the LINKPlanner templates and then select the default template that will be used when creating a new project.

If the 'New project template' is blank then new projects will use the in-built LINKPlanner template.

The default template directory contains the following pre-loaded project templates:

- ITU-R
- Vigants-Barnett

Select the appropriate option as the default template to ensure that all new projects are automatically configured for the required prediction model.

See *Project Templates* for details on creating new templates.

Units

Select the required units for Height, Length, Latitude and Longitude and the display format for the MAC Address. Enter the MAC Address either as 12 characters without any delimiters, or using any of the delimited formats.

Default PTP Regions or Default PMP Regions

Select the priority order for the default licenses for each region for PTP and PMP networks.

Network Settings

Select options for connecting to the network. The Get Profiles feature uses these settings, as described in *Obtaining Link Profiles*. LINKPlanner obtains proxy settings automatically from computer system settings. If network connection does not work when using the default settings, then enter the correct settings.

To test the settings, click on **Test network settings**. If the response is not "Network test succeeded!", review and correct the network settings.

The Proxy Password is not held or transmitted in a secure manner.

Path Profile

Registration is required to get profiles, click **Register with the path profile service** to go to the Cambium Support webpage. Sign in or register to get to the LINKPlanner Access Token page. Use the same email address entered in **Personal Information** and click **Generate New Token**. The Access Token is shown at the top of the page. An email containing an access token will also be sent to the email address given. Copy the access token and paste into the **Access token** box on the **Path Profile** page.

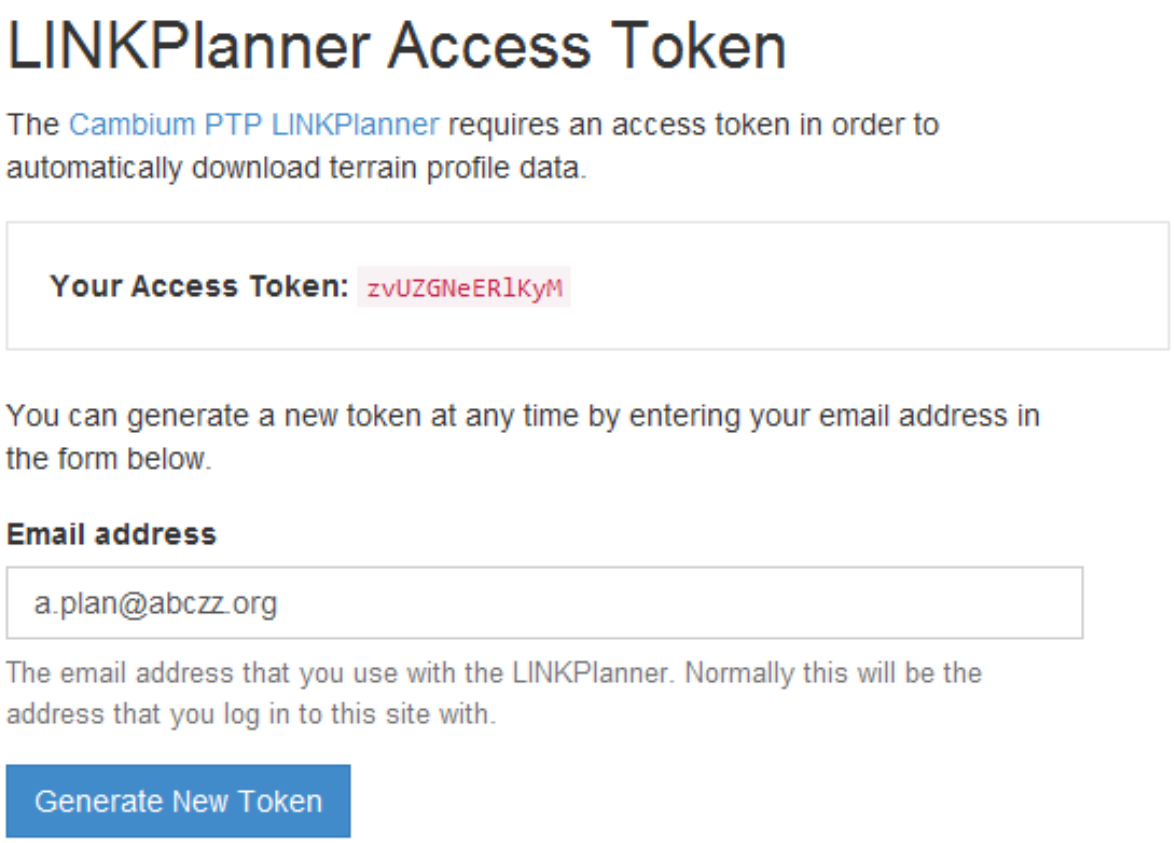


Figure 3.4: Access Token Page

To test the profile service, click on **Test Profile Service**. If the response is not "Access details are correct", check that the email address entered in **Personal Information** is the same as entered on the profile registration form and the access token has been copied correctly.

To choose when to get profiles click **Request profiles manually?**, otherwise profiles will be requested as soon as a link is created, if a network connection exists.

To choose not to display profile previews to nearby sites in the Google Earth export, untick **Profiles in KMZ/KML?**.

Reports

Select the required font and page size for LINKPlanner reports.

Select the option to generate detailed reports. This only applies to Hot Standby, where the detailed reports will give performance information for all paths. The standard reports will only provide information for the primary to primary path.

Select the option to hide sites without links. This will generate a report which only contains sites which are part of at least one link.

Graphics

Select the default line style and color for links and the default color for sites in the *Offline Map*.

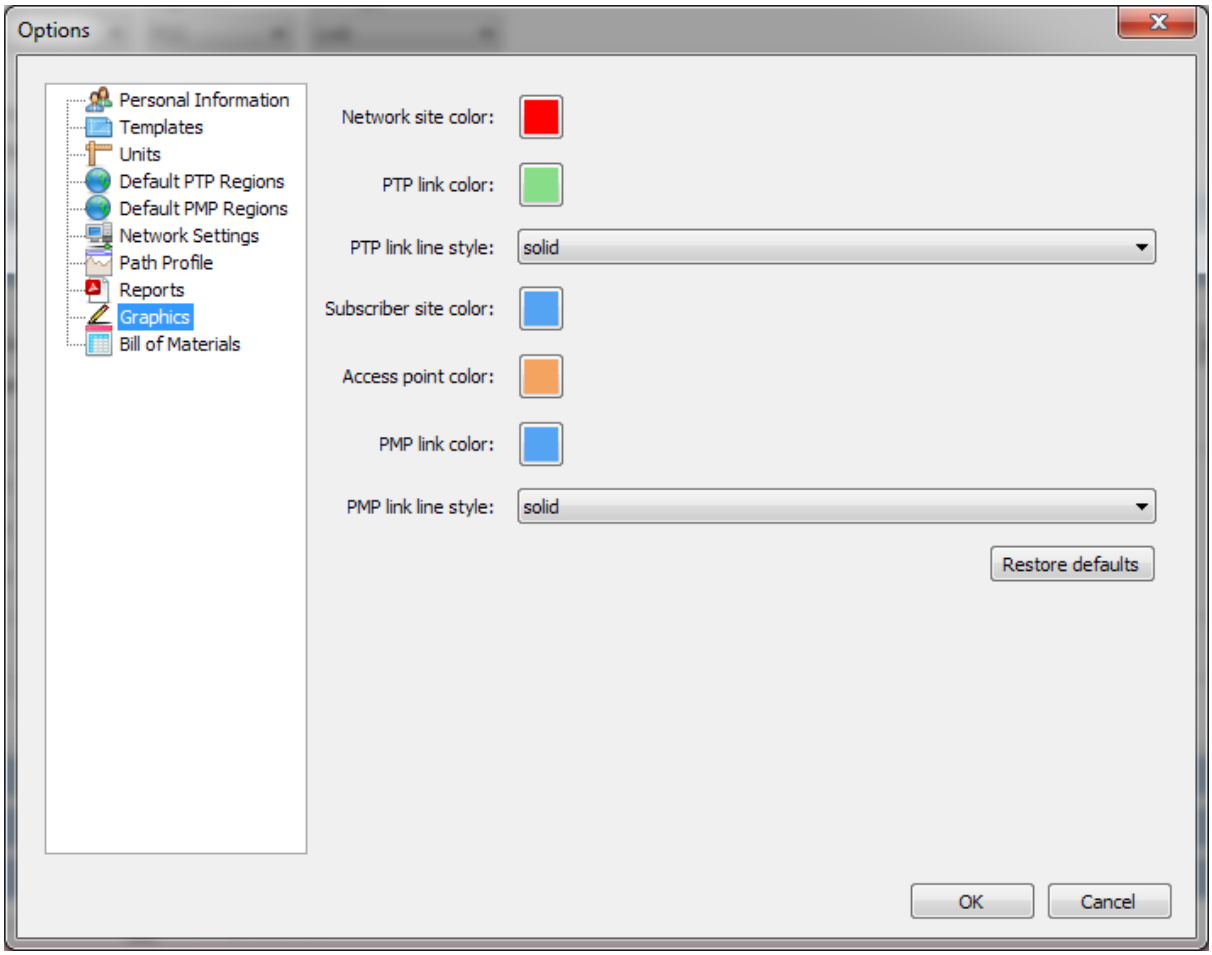


Figure 3.5: Graphics Page

Bill of Materials

Select the default region option for power leads for PTP. PTP 450 only supports Brazil, EU, UK and US. PTP 650 and Force 110 PTP only support the EU and US power leads. PTP 650 FCC and EU kits have defined line cords, RoW kits can have either EU or US line cords, select either EU or US to override the default country option. Select **Not Specified** to allow LINKPlanner to choose the default option for the country selected.

Select the default region option for power leads for PMP 450 Subscriber Modules.

To automatically add a default ODU or radio part number to the BOM, select **Add default ODUs?**. This only applies to PTP 800, PTP 810 and PTP 820 and will add the part numbers for the lowest sub-band pair for the frequency band, ensure that the correct frequencies are selected before ordering ODUs or radios.

Project Toolbar

The project toolbar, located above the main screen, allows easy access to a number of common functions:

Figure 3.6: Project Toolbar

Use the icons to access the following functions:

New Project - Create a new project

Open Project - Open an existing project

Save Project - Save the current project

Copy - Copy a Network Site, Subscriber Site, PTP link, PMP Hub, Access Point or Subscriber Module, select appropriate item before selecting Copy.

Paste - Paste a copied item into either the same project (duplicate) or a different project.

New Network Site - Create a new Network Site

New Subscriber Site - Create a new Subscriber Site

New PTP Link - Create a new PTP link

New Hub Site - Create a new Hub Site

New Access Point - Create a new Access Point

New PMP Link - Create a new link between an Access Point and a Subscriber Site

Delete - delete a network site, subscriber site, PTP link, PMP hub, Access Point or Subscriber Module, select appropriate item before selecting Delete.

Open in New Window - Creates a new window with the contents of the right hand pane, use to compare different links or window views side by side.

Export to Google Earth - Select at the project node to display all links. Select at the link level to display distance markers on the selected link, other links shown as at the project level.

Create Proposal Report - Select at the project node to generate a project level PTP Proposal Report, select at the PTP link level to generate a link specific report. Not available for PMP.

 Create Installation Report - Select at the PTP Link level to generate a PTP network level Installation Report, select at the PMP link level to create a PMP network level Installation Report. Select at the PTP link or Subscriber Module, to generate installation reports specific to the level selected.

 View in Spreadsheet - Only available at the Network Sites, Subscriber Sites, PTP Links, PMP Hub and Access Point node levels. Select to generate a spreadsheet of all parameters available in the list views at that level.

 Enable Automatic Calculation - only used in PMP mode. Select Enable Automatic Calculation to allow all changes at the Access Point level to be immediately cascaded to all connected Subscriber Modules.

Running in Automatic Calculation mode may make it slower to make multiple changes at the Access Point level depending on the number of Subscriber Modules connected.

 Calculate Now - only used in PMP mode and if Automatic Calculation is disabled. Select when all changes on an Access Point have been completed to refresh the Subscriber Module information.

Search box - enter name to highlight matching items in the navigation tree, enables easy location of sites or links in large projects.

Project Navigation Tree

When one or more projects are open, navigate between sites and links using the tree in the left hand panel. The following example shows one open project (*Navigation Tree*):

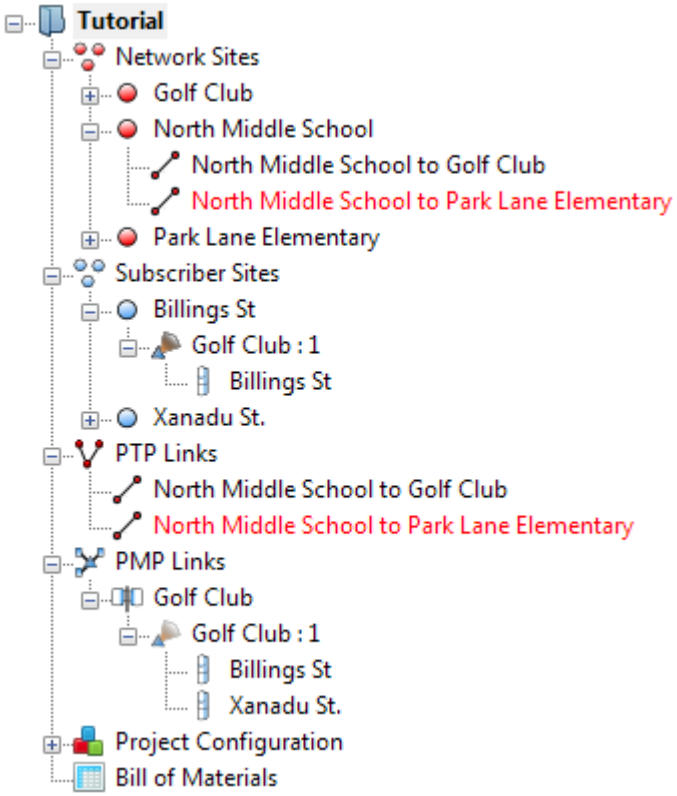


Figure 3.7: Navigation Tree

Use the + and - boxes to open and close each level: project, site (network or subscriber) and link (PTP or PMP). Click on a node to open it for viewing and updating.

The PTP 800, PTP 810 and PTP 820 products have different types of links which are differentiated using the link icon as follows:

- Link Type = 1+0
- Link Type = 1+1 Hot Standby
- Link Type = 1+1 Frequency Diversity
- Link Type = 2+0 Cross-Polar (ACAP)
- Link Type = 2+0 Co-Polar (ACCP)
- Link Type = 2+0 Spatial Diversity (PTP 820C Only)
- Link Type = 2+0 XPIC (CCDP)(PTP 810, PTP 820C and PTP 820G only)

The PMP links section has three levels which are differentiated as follows:

- Hub Site
- Access Point - each Hub Site contains one or more Access Points
- Subscriber Module - each Access Point can be connected to one or more Subscriber Modules

Project Node

To display the Project page, click on a project node, for example “Tutorial”. See *Project Page*. When a project name is displayed in bold in the navigation tree, it means that project details have been inserted or updated but not yet saved.

To save a project, click **File**, **Save** (or **Save As**), or click **Save Project**  . All project, site and link data is saved. The project name reverts to normal typeface when saved.

To see how many sites and links there are in a project hover the mouse over the project name in the navigation tree.

Sites Nodes

To display the list of all network sites within the project, click on the “Network Sites” node. A network site can be either a PTP end site or a PMP Hub or both. To display the list of all subscriber sites within the project, click on the “Subscriber Sites” node. For either site node list, see *Displaying the Sites List*.

Individual Site Node

To display the Site page, click on an individual site node from either Network Sites or Subscriber Sites, for example “North Middle School”. See *Site Page*.

PTP Links Node

To display the list of all PTP links within the project, click on the “PTP Links” node. See *Displaying PTP Links*.

Individual PTP Link Node

To display the Link page of a PTP link, click on an individual link node, for example “North Middle School to Park Lane Elementary School”. See *Link Page*. If the link name is displayed in red, it means that the performance of the link is not acceptable.

PMP Links Node

To display the lists of all Hub sites, Access Points and Subsciber Modules within the project, click on the “PMP Links” node. See *Displaying PMP Networks*.

Individual PMP Hub Node

To display the Hub page, click on an individual hub node, for example “Golf Club”. See *Hubs*.

Individual Access Point Node

To display the Access Point page, click on an individual access point node, for example “Golf Club:1”. See *Access Points*.

Individual Subscriber Module Node

To display the Subscriber Module page, click on an individual subscriber module node, for example “Billings St”. See *Subscriber Modules*.

Project Configuration Node

To edit custom antennas, TDD synchronization parameters, custom fields, link formatting rules and equipment templates, click on the “Project Configuration” node. See *Project Configuration*.

Bill of Materials Node

To view the Bill of Materials (BOM) for the whole project, click on the “Bill of Materials” node. For attribute descriptions, see *Bill of Materials for Link*.

User Interface Tips

Pages may be detached from the main window to allow multiple pages to be opened concurrently. To detach the currently open page, select the tool bar icon **Open in New Window**  .

Advanced User Interface Features are described in the following sections:

- *Copy and Paste*
- *Managing List Views*

Copy and Paste

The following items can be copied:

- Links
- Sites
- Access Points
- Subscriber Modules
- *Link Formatting Rules*
- *Path Profiles*

Copying Links and Sites

Individual items can be copied by selecting them in the Project Navigation Tree and then click either  or **Edit** - **Copy**

Multiple sites can be copied in the *Sites List*.

Multiple PTP links can be copied in the *PTP Links List*.

Multiple Access Points and Subscriber Modules can be copied in the *PMP Network Lists*

The Copy and Paste feature for PMP network items is recommended when duplicating items between projects, rather than within a project.

The following features are described with respect to PTP Links and Sites.

Individual sites and links can also be copied in the *Offline Map* by right-clicking the item and then click **Copy** from the pop-up menu.

 Custom antennas that are used by the link will be copied.

Pasting Links and Sites

The paste commands will be enabled when the clipboard contains LINKPlanner items and a project is active.

Click  or **Edit** - **Paste** to paste the contents of the clipboard. When links and sites are pasted into LINKPlanner they are compared against the items that

already exist in the active project. If the items are similar then the *Smart Paste Dialog* will appear.

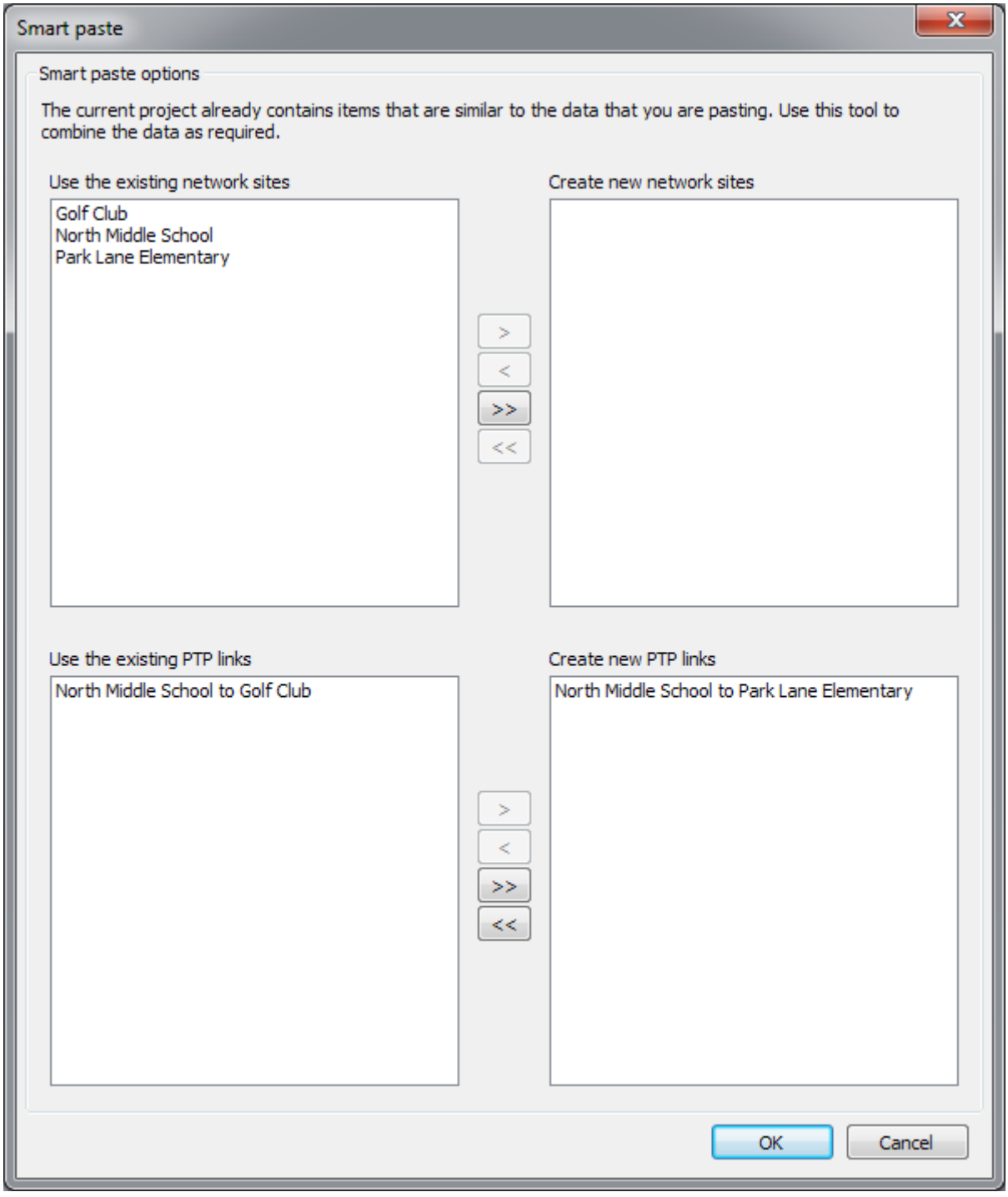


Figure 3.8: Smart Paste Dialog

The *Smart Paste Dialog* is used to merge the items that are in the clipboard with the existing project. Items in the left-hand lists will not be created in the project. If items are in the right-hand list then new links or sites will be created, even if they duplicate a site or link in the current project.

If you choose to create a new link, but use the existing sites, then the new link will be attached to the sites that already exist in the project.

NOTE Custom antennas that are used by the link will be automatically added to the destination project if they do not already exist.

WARNING TDD Sync settings will only be applied if the destination project does not already have links that support TDD Sync. Always review the TDD Sync settings after pasting.

Managing List Views

LINKPlanner uses list views in several places to summarize information and allow the user to manage the data in a single location. These include:

- Sites List, see *Displaying the Sites List*
- PTP Links List, see *Displaying PTP Links*
- PMP Links List, see *Displaying PMP Networks*
- Access Points, see *Hubs*
- Subscriber Modules, see *Access Points*

All of these lists can be managed in very similar ways, using the following features:

Customizing the list

The list display can be customized in the following ways:

- To change the column order, use click and drag on the column headings.
- To sort the list by any column, click in the column header.
- To select which fields are displayed in the list, right-click on the heading row and tick or untick fields in the drop-down list.

Editing List details

A number of attributes can be edited in some of the lists. To edit the attribute, select the item in the list and right-click on the cell that you wish to change. The *PTP Links Pop-up Menu* will appear. Choose **Edit <attribute-name>** (where the attribute name will be the name of the column heading). The same attribute can be edited for several items at the same time. If the new value is not valid for the other item settings (e.g. choosing a PTP250 product even though the band is set to 38 GHz) will result in a warning and the product value will not update.

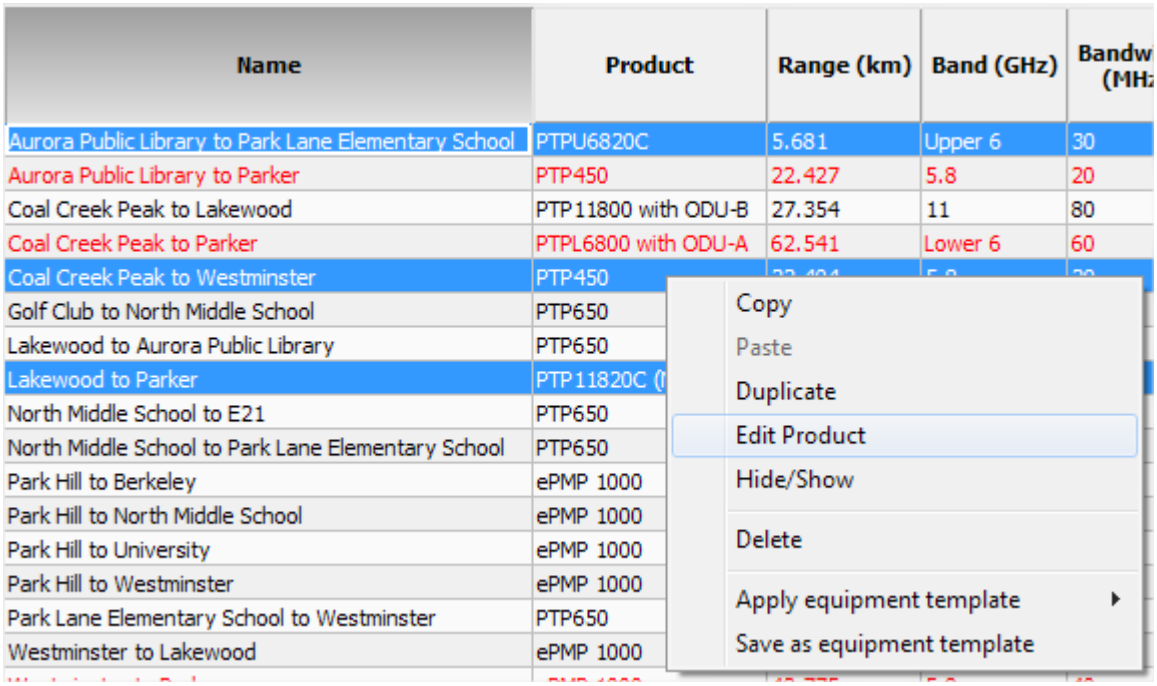


Figure 3.9: Editing a Property for Multiple Links

Deleting Items

The list can be used to delete items altogether. To delete an item, right-click over it and click **Delete**.

NOTE

Deleting Hub sites and Access Points will delete all items connected below that point. A Hub site must contain at least one Access Point.

Projects

A project is a set of data about an individual wireless link or a wireless network. A project can contain two or more sites and PTP or PMP links between those sites. Projects are saved as .ptpprj files.

Building a Project

To build a project to model a network, follow this process:

1. Create the project. See *Creating, Saving and Viewing Projects*.
2. Enter project defaults. See *Project Page*.
3. If path data files (Hydra or PTP) are available, use them to create sites, links and profiles. See *Importing Path Data*.
4. Configure project templates. See *Project Templates*

Creating, Saving and Viewing Projects

New Projects

To create a new Project, either click **File**, **New Project (Ctrl+N)**, or click **New Project**  .

The Project page is displayed. See *Project Page*.

Saving Projects

Save the project by clicking **File**, **Save** (or **Save As**) or by clicking **Save Project**  .

Enter the required project name, for example **Tutorial.ptpprj** (*Project Node Tutorial in Navigation Tree*).

The filename is used as the project name in the navigation tree.

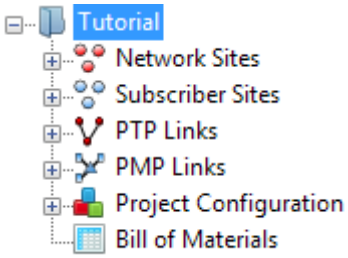


Figure 3.10: Project Node Tutorial in Navigation Tree

You can also save the project as a *template*.

Viewing and Updating Projects

Open existing projects in one of the following ways:

- Click **File**, **Open (Ctrl+O)**.
- Click **Open Project**  .
- Click **File**, **Recent Projects** and select from the list.

The Project page is displayed. See *Project Page*.

Two or more projects can be open concurrently, if required.

Project Page

Use this page to enter details of the project customer, define project level settings and view the sites and links on the project map.

General Information

Enter details of the customer for whom this plan is being prepared. Enter a description of the project. This information is optional, and is included in the reports.

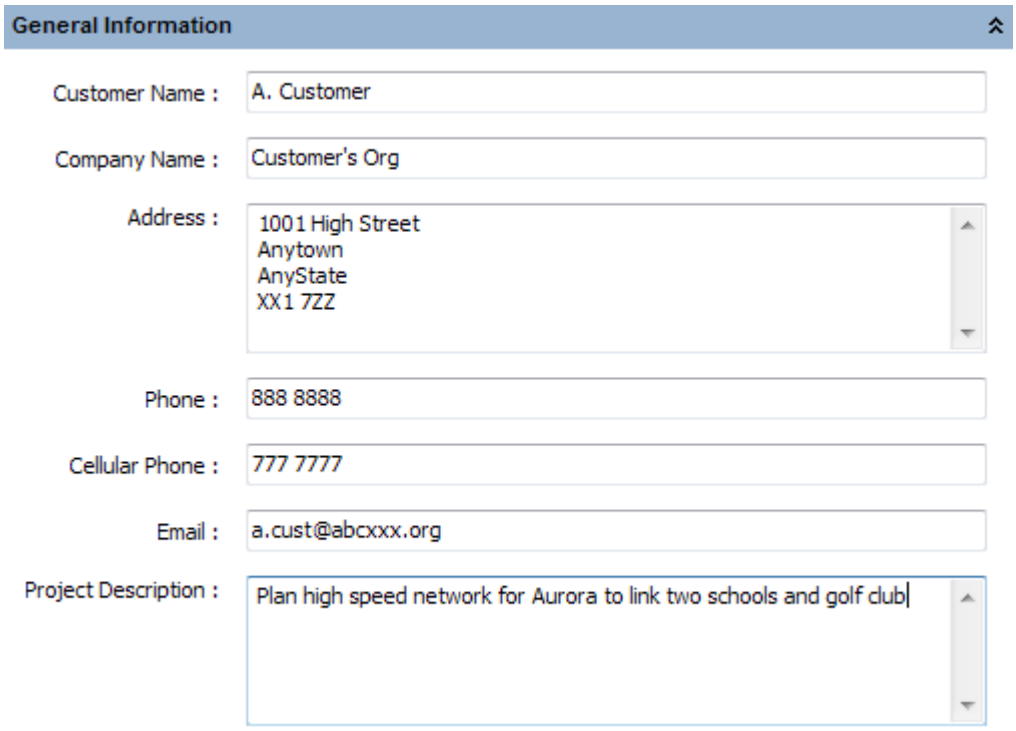


Figure 3.11: General Information

Project Properties

Set the prediction model that is used to calculate the link availability (see *Availability*), the default SM Antenna Height and the Sector Coverage for AP antennas (see *Creating and Deleting Subscriber Modules*). These parameters are stored with the project.

NOTE

When changing the default SM Antenna Height select **Yes** to apply the new height to all existing Subscriber Modules, or select **No** to only apply to new Subscriber Modules.

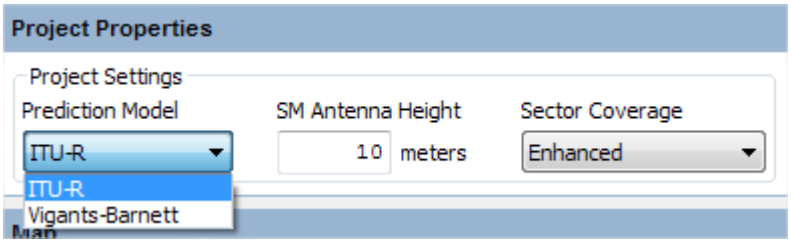


Figure 3.12: Project Properties

Map

There are potentially two types of map available, depending on the operating system and Internet access.

- *Offline Map* - available on all platforms
- *Google Maps* ™ - available on Windows providing that there is Internet access

The maps can be enabled/disabled through the **View** menu.

To easily find a site or link on the map, right-click on the item in the project navigation tree and select **Show in Map** from the pop-up menu.

Select the objects to show on the map from the **Display...** option on the Map toolbar, all objects are displayed by default, untick objects not required.

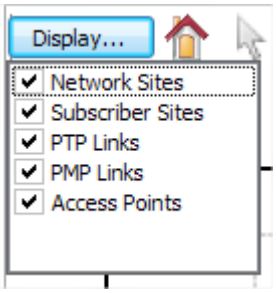


Figure 3.13: Map Display options

By default, link lines are colored to indicate whether or not their predicted performance meets requirements: red means performance is not acceptable, green means performance is acceptable. It is possible to alter the default colors in the *Graphics Page* along with the default line style. Additional formatting settings can be applied using *Link Formatting Rules*.

NOTE

Line styles do not change in the Google Map view.

Common Map Icons

The following icons are available in both map views.

NOTE

Icons appearance may depend on the operating system. Windows icons are shown.

Icon	Description
	Reset the zoom/pan for the map to fit the entire project
	Select a link or site
	Create a new network site. On the Google Maps view you must select the approximate location for the site before the new site dialog (*New Network Site Page*) is displayed
	Create a new subscriber site. On the Google Maps views you must select the approximate location for the site before the new site dialog (*New Network Site Page*) is displayed
	Create a new PTP link
	Delete the selected link or site
	Display all of the sites, even those which do not have any links associated with them
	Display the network site labels
	Display the subscriber site labels (not in Google Map)
	Display the path profile preview for existing links and possible links to nearby sites (not in Offline Map)

Offline Map

The Offline Map is a schematic plan of the sites and links that have been entered in this project. There are many functions that are supported through the Offline Map, see *Offline Map* for further details.

Google Maps

The embedded Google Maps view is available when LINKPlanner is running on Windows. The map can be used to view and edit the project. See Common Map Icons for more information.

NOTE

Large projects may experience poor performance due to the time that it takes to refresh the map. If the project is large, you may wish to disable the Google Maps view in the **Views** menu.

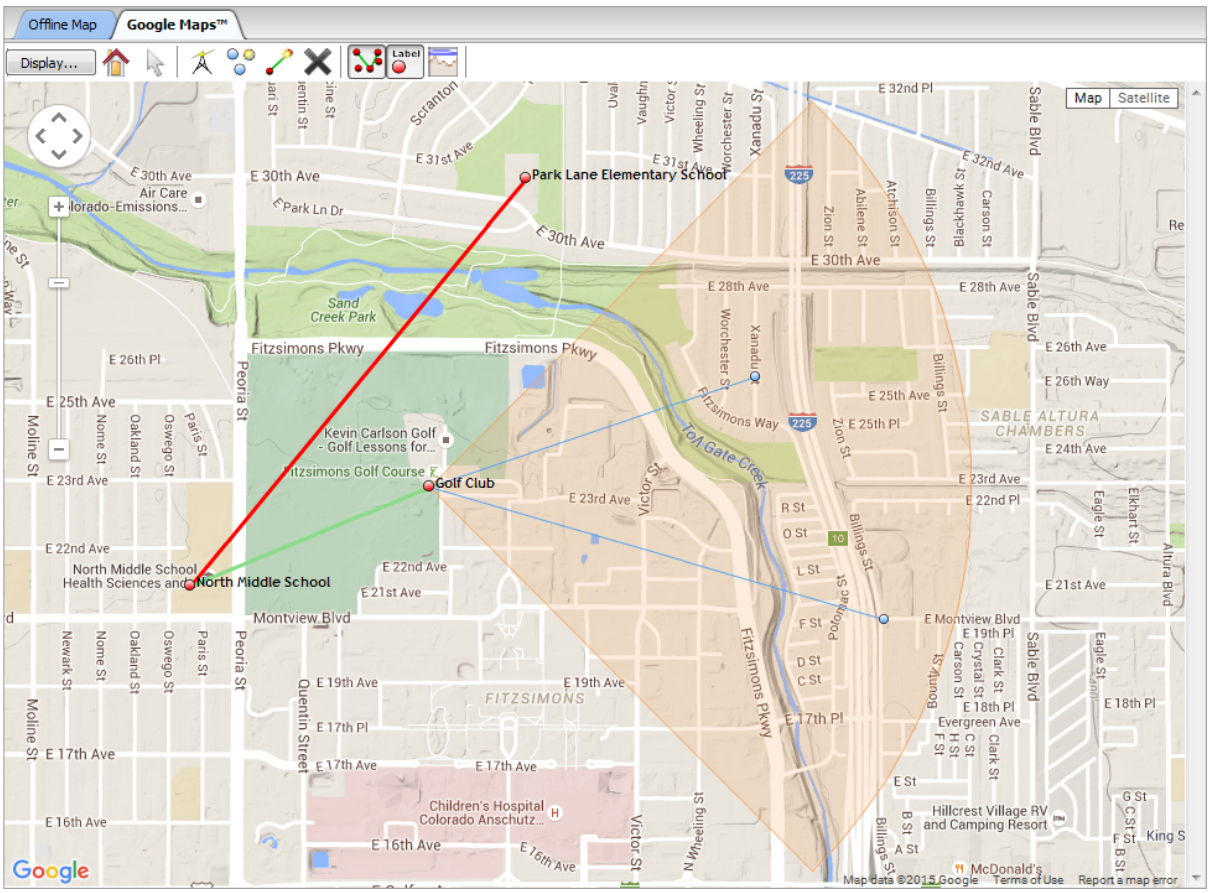


Figure 3.14: Google Maps ™

Google Earth

To export the link or project to Google Earth, on Windows or Mac, select either the link or the project node in the navigation tree and then select the Google Earth icon from the main toolbar.

NOTE

Google Earth must already be installed and requires Internet access.

Offline Map

The Offline Map is a schematic plan of the sites and links that have been entered in this project. The Offline Map supports many features that are also available through the project and equipment pages, but may be faster or easier to apply when viewing the map and surrounding sites. In addition to the features common to all map views, see Offline Map Icons for details on additional functions only available in the Offline Map.

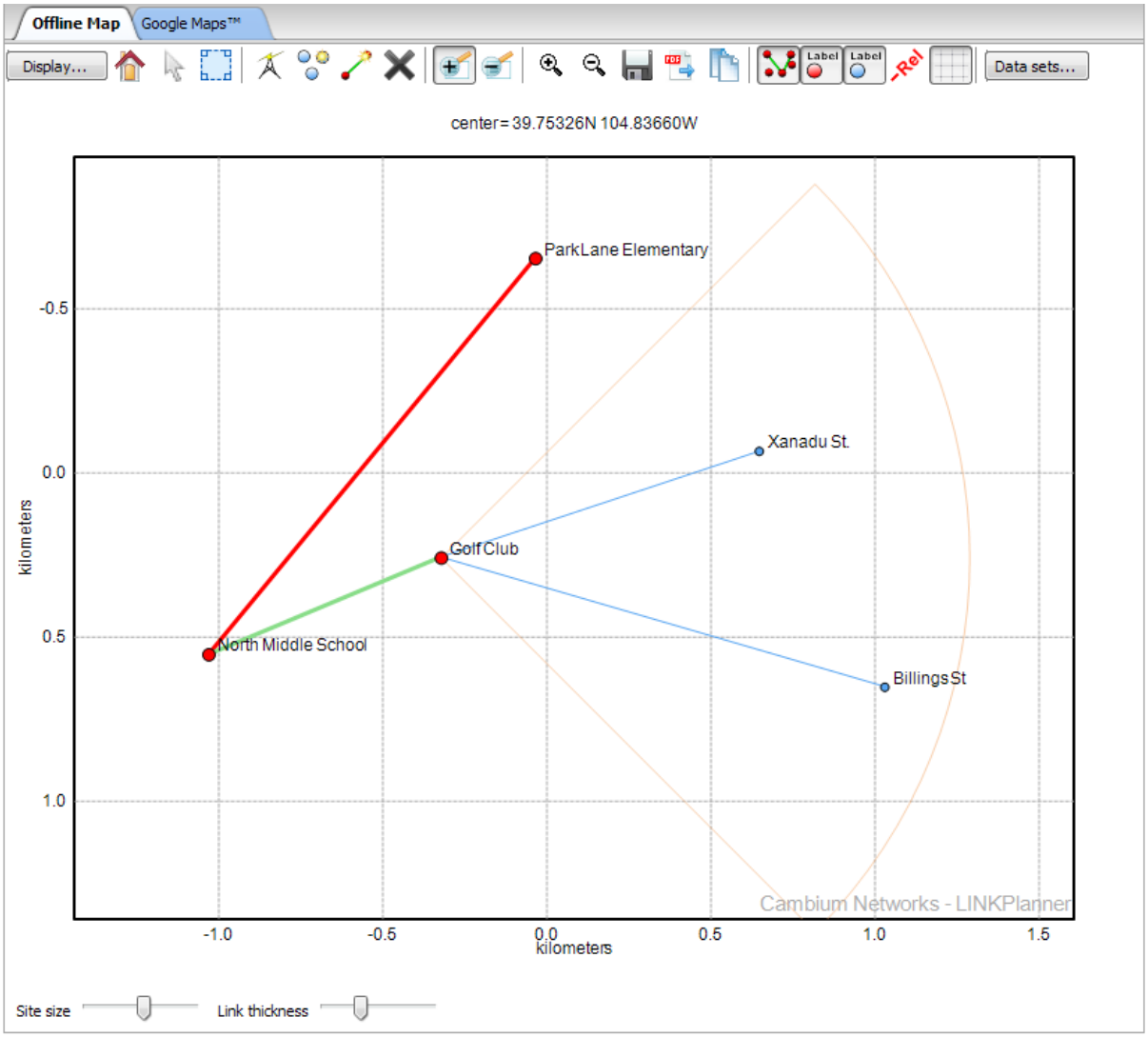


Figure 3.15: Offline Map

The size of the link lines and sites can be controlled using the sliders below the map. A circle is used as the default site marker. To change the marker shape, right-click on the site and click **Properties** from the pop-up menu. The *Site Properties Dialog* can then be used to alter the shape or to set a custom icon (*Custom Icons and Label Positioning*).

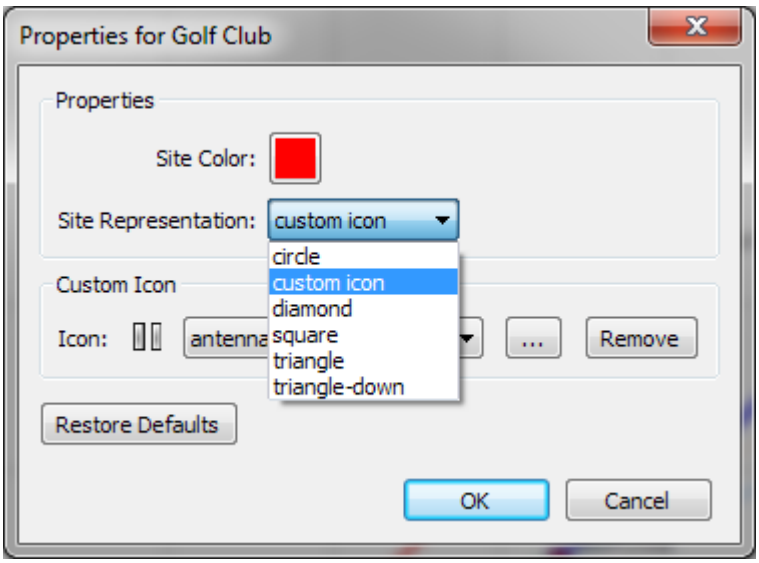


Figure 3.16: Site Properties Dialog

NOTE

Custom icons are not displayed in reports or PDF exports.

The site labels can be repositioned if necessary. Drag the label to the required location. To reset the label, drag it over the site marker.

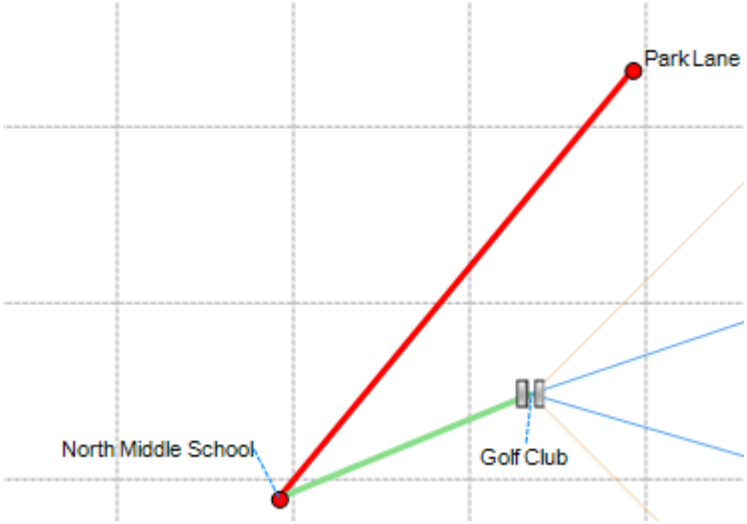
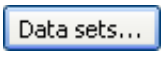


Figure 3.17: Custom Icons and Label Positioning

Offline Map Icons

NOTE

Icons appearance may depend on the operating system. Windows icons are shown.

Icon	Description
	Select area on the map
	Zoom in rectangle
	Zoom out rectangle
	Zoom in around the center of the map
	Zoom out around the center of the map
	Save the map to an image or PDF
	Export the map to a full-page PDF
	Copy the map to the clipboard
	Display the reason for error labels on links
	Display the background grid
	Plot datasets on the map (at present only the FCC Weather Radar sites are available)

Map Pop-Up Menu

The pop-up menu (*Offline Map Pop-up Menu*) can be used to access many functions, depending on the item selected. To display the menu, right-click on an item in the Offline Map. When running on a Mac, right-click may not be enabled, in which case hold down the control key whilst left-clicking on the item to display the menu.

- **Copy**: Copy the selected item
- **Paste**: Paste an item that has been copied
- **Duplicate**: Duplicate a PTP link
- **Edit**: Edit the item in a tear-off panel
- **Hide**: Hide the item from the map view
- **Delete**: Delete the item from the project
- **Change Sites**: Change the link to connect two different sites
- **Properties**: Access the properties dialog, *Site Properties Dialog*
- **Create link from here**: Create a PTP link from the selected network site
- **Create multiple links from here**: Create multiple PTP links from the selected network site
- **Create ring**: Create a ring of links between consecutive network sites

- **Create hub**: Create a hub from a network site, only one hub can be created per network site
- **Create Access Point**: Create an Access Point on a hub (only available if the selected item is a hub site), multiple Access Points can be created on the same hub.
- **Attach subscribers**: Attach subscribers to the selected Access Point only available from an Access Point coverage area).
- **Set Channel**: Choose from the list of channel options to change the frequency assigned to the Access Point (only available from an Access Point coverage area).

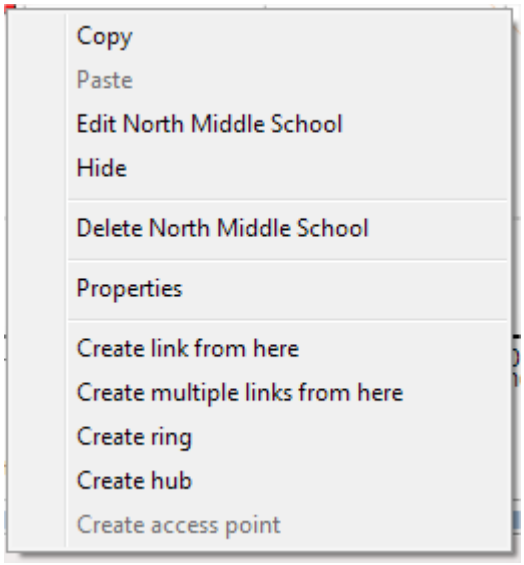


Figure 3.18: Offline Map Pop-up Menu

Editing items

The **Edit** command opens the tear-off window with the appropriate panel for the item. This window will float above the main LINKPlanner window until it is closed, allowing quick and easy viewing of the changes directly on the map.

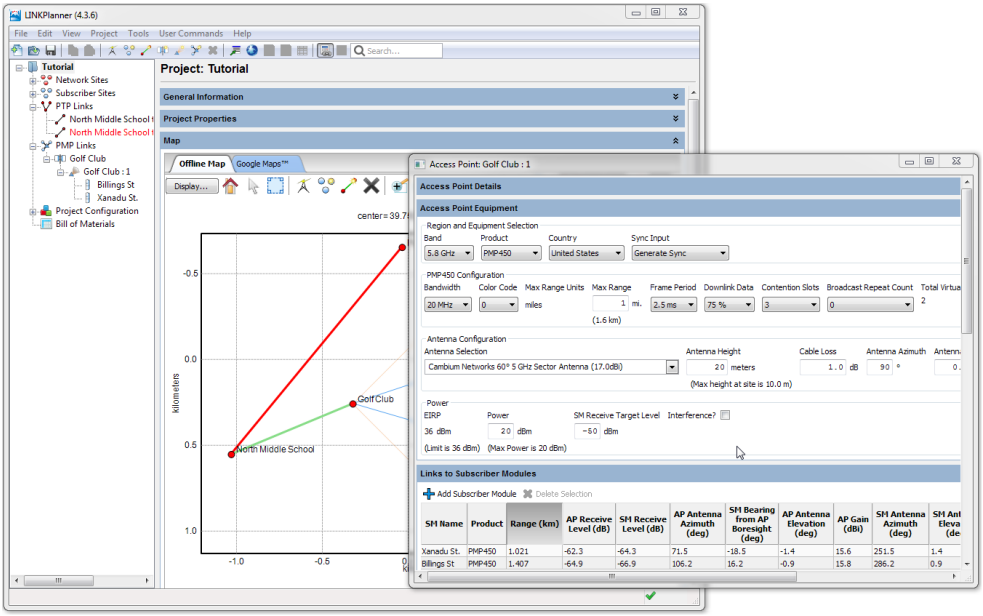


Figure 3.19: Edit Window Floating over Map

Creating Access Points

The first Access Point is added when the hub site is created and will use the default settings with an Antenna Azimuth of 0 degrees (North), subsequent Access Points will use the settings of the first Access Point. Configure the first Access Point, using the **Edit** option, see *Access Points*, before adding additional access points to the hub site. Additional Access Points will have their default Antenna Azimuth offset from the previous one by the beamwidth of the antenna.

Attaching Subscribers

The **Attach subscribers** command opens the **Add a new SM** dialog window, *New Subscriber Module Page*. This window displays the subscriber sites that are within range of the access point. Any subscriber sites that are not linked to an access point will be selected by default. Clicking OK in this dialog will create PMP links between the access point and the subscriber sites.

Map Selection Area

To define an area on the map, select the selection window icon  and draw an area on the map. To increase or decrease the size of the area, select one of the corners and drag to re-size. When the selection covers the items required, right-click to access the following menu options, which are defined in the above pop-up menu:

- Copy
- Hide
- Show

- Delete

Items will only be hidden or shown if they are entirely covered by the selection window, e.g. both ends of the link must be within the selection window to hide a link.

To show all hidden items, select **View**, **Show All** from the main toolbar.

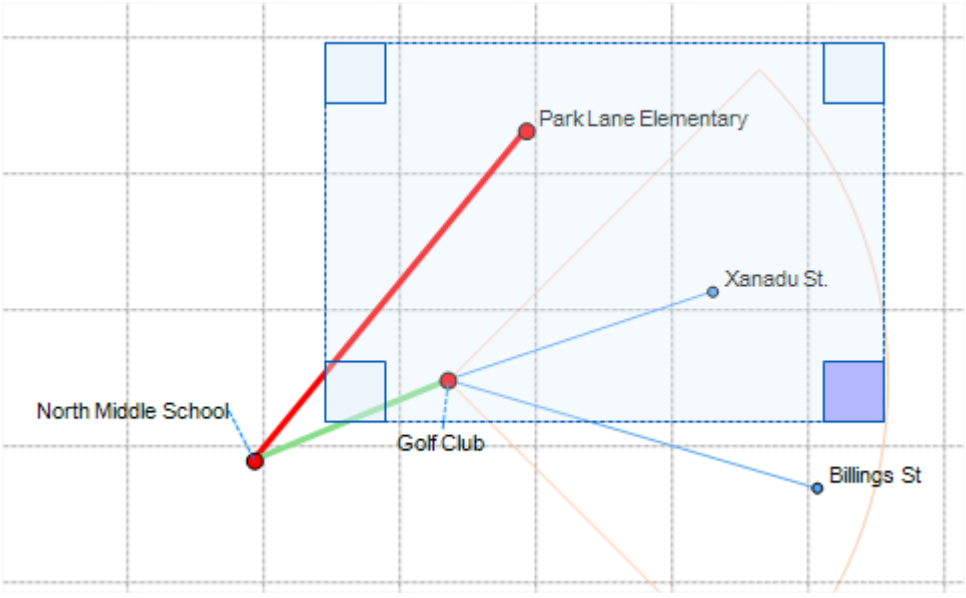


Figure 3.20: Map Selection Window

Importing Path Data

If path data is available in Hydra, PTP, csv or Pathloss files, it can be imported and used to populate a project with sites, links and profiles.

Before importing path data, create the project and enter defaults. Path data can then be imported from Hydra, PTP, csv or Pathloss.

Hydra files (.pth)

Hydra files contain data for sites, links, profiles and obstructions. Click **File**, **Import**, **Path from Hydra (.pth)**.

Hydra file formats are specified in *Import File Formats*.

CSV files (.csv)

CSV files contain data for profiles and obstructions. Click **File**, **Import**, **Path from csv**.

CSV file formats are specified in *Import File Formats*.

Pathloss files (.txt)

Pathloss files contain data for sites, links, profiles and obstructions. Click **File**, **Import**, **Path from Pathloss**.

Further information on Pathloss files can be found in *Import File Formats*.

Project Templates

Overview

A project template can contain all of the items that exist in a regular LINKPlanner project file, such as equipment templates, link formatting rules, sites, links and custom antennas. This means that when a new project is created from a template, all of these items already exist in the new file. This can be particularly useful when there are custom antennas that are required across multiple projects.

Saving a Project as a Template

Create the project in the normal manner and then click **File**, **Save As...**. The "Save As" dialog will appear. Change the 'Save as type' to 'LINKPlanner Project Template'(see and choose the destination and file name for the template, *Choosing the template file type*).

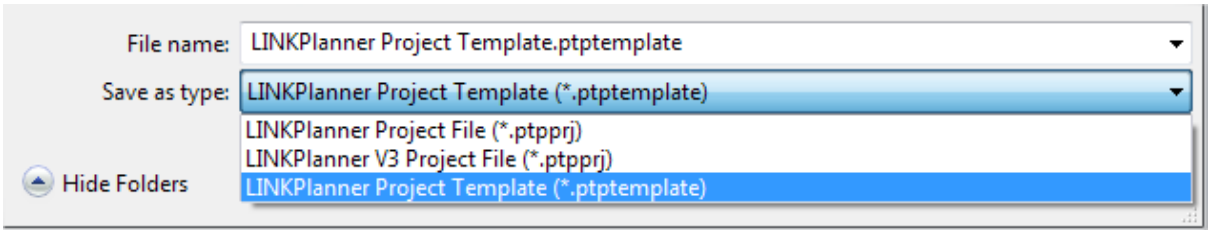


Figure 3.21: Choosing the template file type

Using a Project Template

To use a project template you need to select the template in the Options/Preferences page. See *Options (Preferences)* for information on how to set the default template.

Sites

Sites are locations that can be connected via PTP links or PMP links. A Project would normally contain at least two sites. Sites can be either **Network Sites**, used for PTP links and Hub Sites containing Access Points, or **Subscriber Sites**, used for the remote end of PMP links.

Identify all sites in the project, determine whether they are Network Sites or Subscriber Sites and obtain their latitude and longitude using the WGS84 frame of reference. Use tools such as:

- GPS during a site survey.
- Google Earth(TM): http://earth.google.com. This application must be downloaded and installed.
- Bing: http://www.bing.com/maps/.

When potential Sites have been identified and entered in LINKPlanner, the link profiles between those potential sites can be previewed in Google Earth(TM) to see which links are definitely line of sight (and therefore worth pursuing), or VERY non-line of sight (in which case they may not be worth pursuing). See “Previewing Link Profiles” in *Using Google Earth(TM)*.

Network Sites and Subscriber Sites are both created and managed using the same facilities within LINKPlanner and can be converted from one to the other, see *Displaying the Sites List*.

New Sites

Import sites from external files as described in *Copying or Importing Sites*, or create them in LINKPlanner as described in *Creating Sites*. Alternatively create new sites and links by importing link data as described in *Importing PTP Links from a Spreadsheet*.

Sites List

Display the list of sites in the project, as described in *Displaying the Sites List*.

Viewing and Updating Sites

When sites have been created, open them in the following ways:

- Single-click the site node in the Navigation tree.
- Double-click on the site in the Sites list.

The Site page is displayed. See *Site Page*.

Copying or Importing Sites

Site data can be brought into LINKPlanner from Google Earth(TM) (.KML) or from comma-separated files (.CSV). Before copying or importing sites, ensure that the correct project is open in LINKPlanner.

Copying or Importing Sites from Google Earth(TM) (.KML)

Site details can be copied or imported from Google Earth(TM). Locate the sites in Google Earth(TM) using address or zip code, then insert placemarks.

When a site is located using address or zip code, Google Earth(TM) inserts the placemark in the street adjacent to the building. To obtain precise latitude and longitude, move the placemark to the building where the antenna is mounted.

In Google Earth, create a folder and add all required placemarks to that folder. There are two ways to import those placemarks into LINKPlanner:

- Use copy and paste: Right-click on the folder (or if there is only one site, right-click on the placemark) and click **Copy**. In LINKPlanner, click **Edit**, then either **Paste Network Sites** or **Paste Subscriber Sites**.
- Import from KML/KMZ file: Right-click on the folder and click **Save Place As** to save it as a .kml or .kmz file. In LINKPlanner, click **File, Import**, then either **Network Sites from KML/KMZ** or **Subscriber Sites from KML/KMZ**.

Importing Sites from a Spreadsheet

Use this method when site information is in a spreadsheet. The required fields for each site are Name, Latitude and Longitude. The optional fields are Maximum Antenna Height and Description. The procedure is:

1. Import the data either by copy and paste, or by importing from CSV.
   - To import by copy and paste (*Importing From a Spreadsheet Using Copy and Paste*): select the data in the spreadsheet and click **Edit**, **Copy**; then in LINKPlanner, click **Edit**, then either **Paste Network Sites** or **Paste Subscriber Sites**.

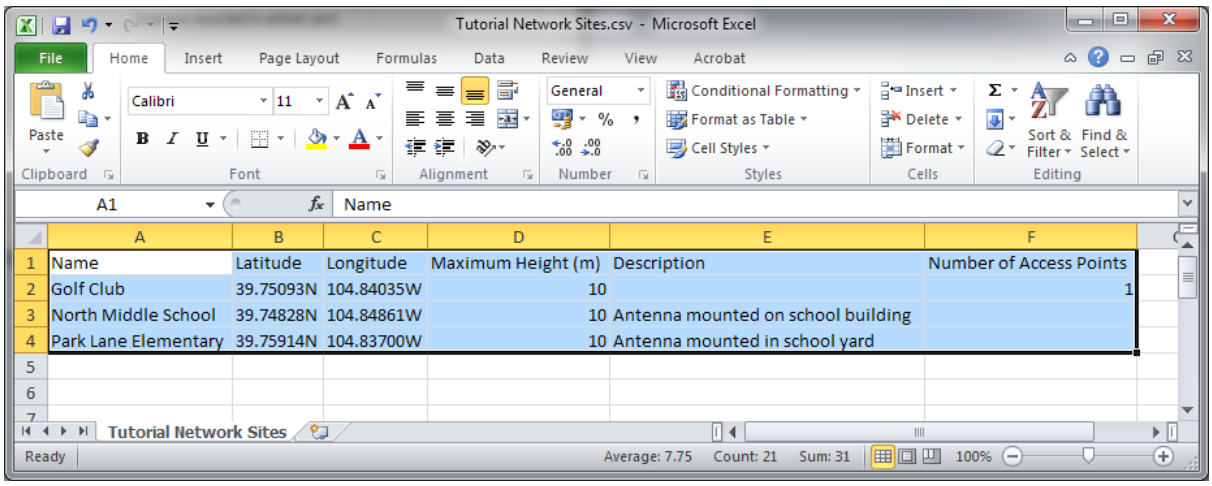


Figure 3.22: Importing From a Spreadsheet Using Copy and Paste

- To import from CSV: save the spreadsheet as a CSV (comma separated) file; then in LINKPlanner, click **File**, **Import**, **Sites from CSV**. The sites will import as Network Sites by default, to import the sites as Subscriber Sites, tick **Subscriber Sites?**.

2. Whichever method is used, the *Table Import Wizard* is presented:

   LINKPlanner attempts to detect the correct delimiter and encoding for each CSV file, but it does not always succeed. If the data is not displayed in the correct columns, specify a different delimiter or encoding.

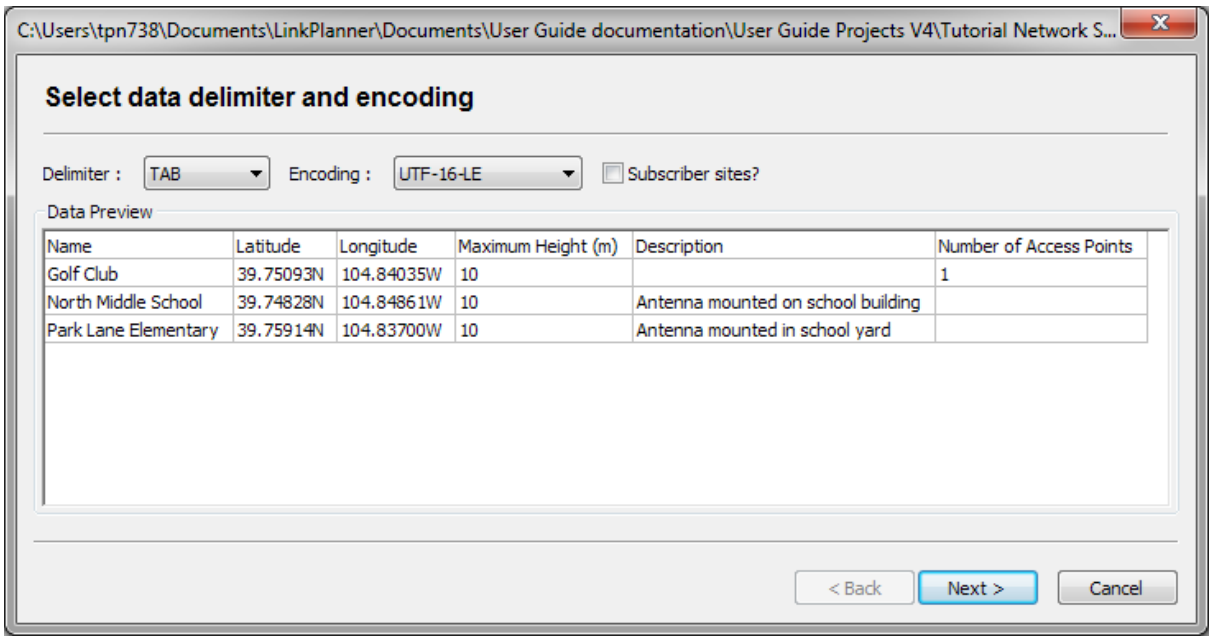


Figure 3.23: Table Import Wizard

3. Select the columns to be imported:

   If the first row contains column headings, tick **Skip first row**.

   For each column, select whether it should be used for the site Name,

Latitude, Longitude, Maximum Antenna Height, or Description. Ensure that unwanted columns are ignored (*Selecting Columns to be Imported*). The Maximum Antenna Height may be specified in feet or meters. Select multiple Description columns if required, but select the other columns once only.

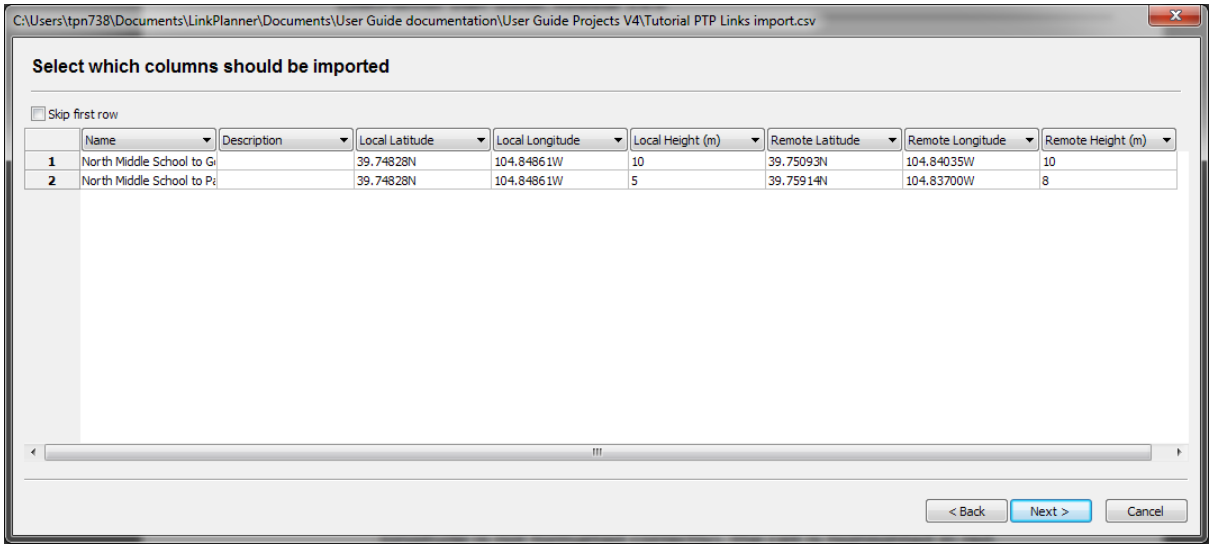


Figure 3.24: Selecting Columns to be Imported

4. Correct any values that cannot be imported:

   If LINKPlanner cannot interpret any of the values (for example, if a latitude or longitude is not formatted correctly), the cell is highlighted in red. Double-click in a red cell to edit it (*Value Cannot be Interpreted*).

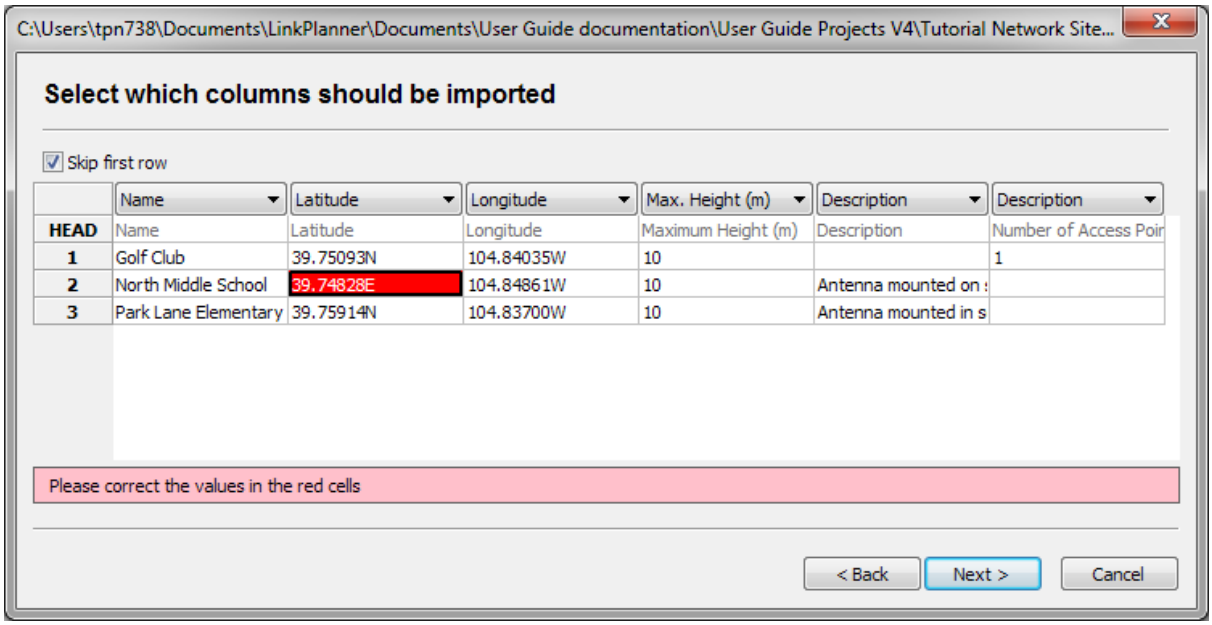


Figure 3.25: Value Cannot be Interpreted

5. Verify the map of newly imported sites:

The wizard displays a map of the new sites to confirm that the positions are correct (*Map of Newly Imported Sites*). If they are correct, press **Finish**.

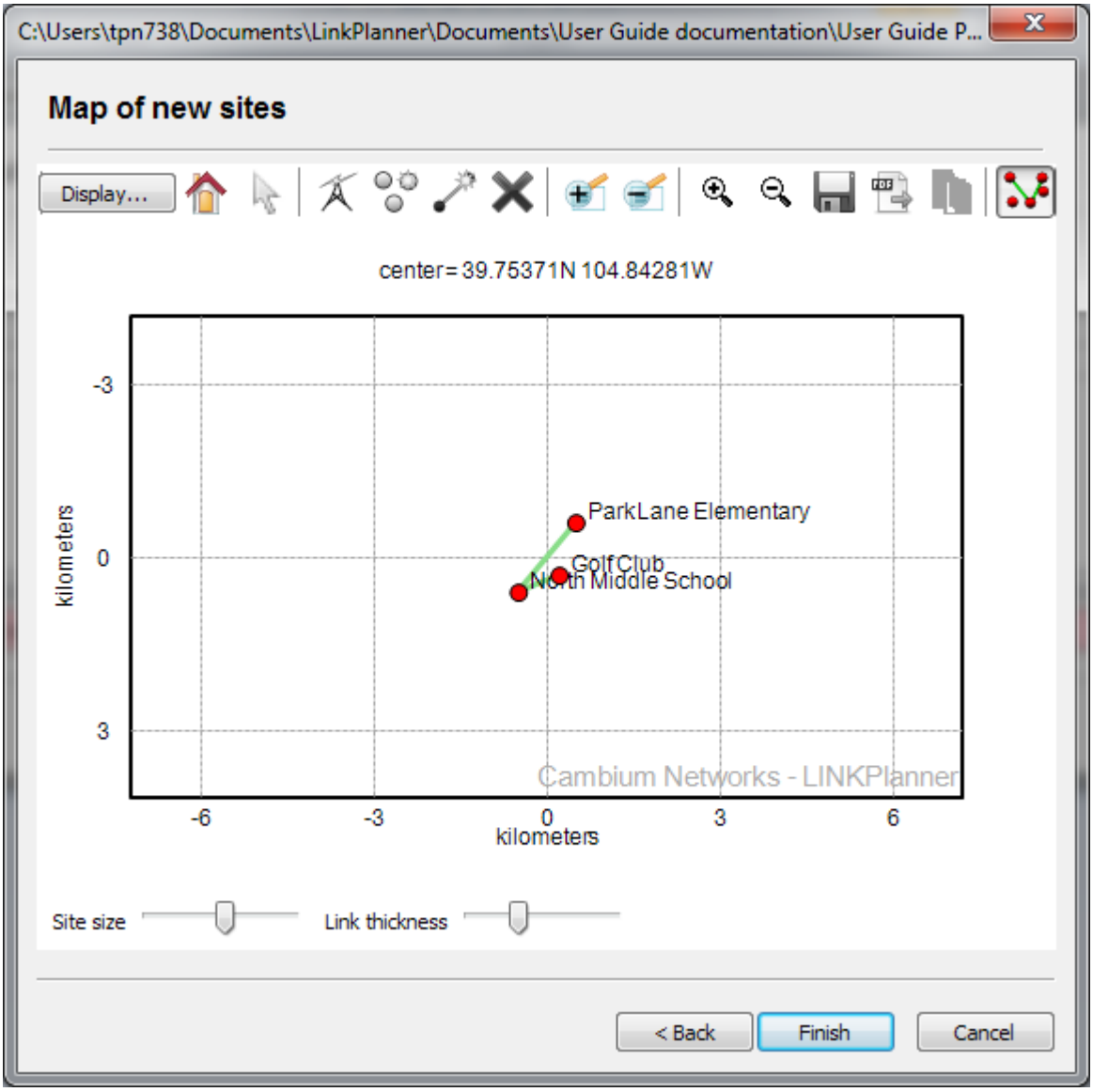


Figure 3.26: Map of Newly Imported Sites

NOTE

Use Google Earth(TM) to confirm the latitude and longitude from .csv files.

Accessing Imported Sites

When sites have been imported, access them from the Sites node in the navigation tree, as described in *Project Navigation Tree*.

Creating Sites

If sites cannot be imported, create them using the New Site page.

Locate the sites using Google Earth(TM) or Bing. Copy the latitude and longitude of each site.

To insert a Network Site in LINKPlanner, either click **Project**, **New Network Site** , or click **New Network Site** . To insert a Subscriber Site follow the same process selecting either **New Subscriber Site** or click the **New Subscriber Site** . The appropriate New Network Site or New Subscriber Site page is displayed. The following process is the same for both types of site.

The following is an example of a completed *New Network Site Page* page:

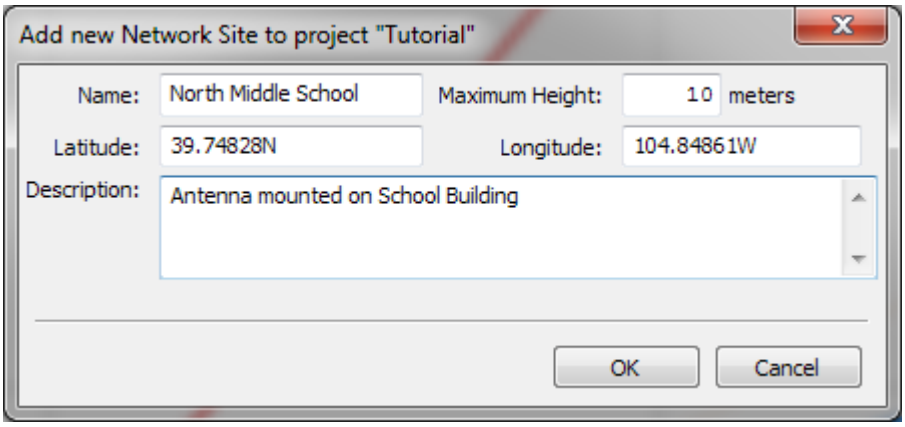


Figure 3.27: New Network Site Page

Name: Enter the site name.

Maximum Height: Enter the maximum antenna height (above ground) allowed at the site. The units are set in the Options/Preferences page (feet or meters).

Latitude and Longitude: The latitude and longitude must be in a format which can be understood and must use the WGS84 frame of reference. The following formats are supported:

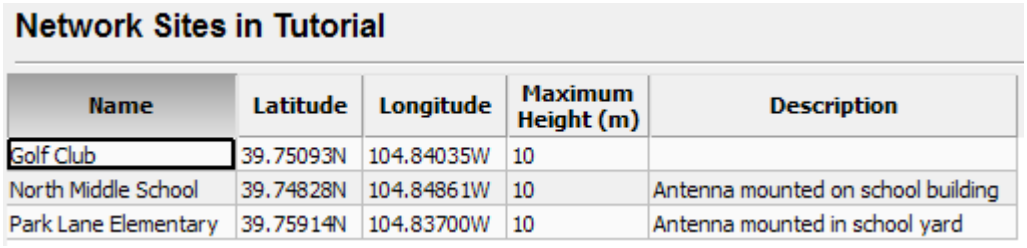
Format	Examples
Decimal degrees prefixed by sign to indicate point of Compass: + means North or East. - means South or West.	*+12.34567* *-12.34567*
Decimal degrees and point of Compass.	*12.34567N* *12.34567E*
Degrees, decimal minutes and point of compass.	*12:34.567S*
Degrees, minutes, decimal seconds and point of compass.	*12:34:56.7W*

WGS84 is used by Google Earth(TM) and all GPS equipment, but sometimes the GPS is set to some other frame of reference.

Description: Enter the site description.

Displaying the Sites List

When one or more network sites have been created, they appear in the *Network Sites List*. To display this list, click the **"Network Sites"** node in the navigation tree. The Network Sites list is displayed in the right hand panel. To display the subscriber sites, click the **Subscriber Sites** node in the navigation tree. The Sites lists for both Network Sites and Subscriber Sites can be viewed and modified in exactly the same way.



Network Sites in Tutorial

Name	Latitude	Longitude	Maximum Height (m)	Description
Golf Club	39.75093N	104.84035W	10	
North Middle School	39.74828N	104.84861W	10	Antenna mounted on school building
Park Lane Elementary	39.75914N	104.83700W	10	Antenna mounted in school yard

Figure 3.28: Network Sites List

Customizing the Sites list

The Sites list display can be customized in the following ways:

- To change the column order, use click and drag on the column headings.
- To sort the list by any column, click in the column header.
- To select which fields are displayed in the list, right-click on the heading row and tick or untick fields in the drop-down list.

Copying Sites

Select one or more sites that you wish to copy:

- On Windows, hold the **Ctrl** key when selecting.
- On OSX, hold the **Command** key when selecting (on some Apple keyboards, this key also has an Apple logo).

Once you have selected the sites, right-click in the Sites list and choose **Copy** from the *Sites Pop-up Menu*.

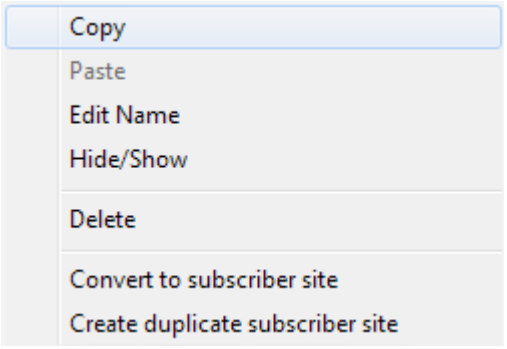


Figure 3.29: Sites Pop-up Menu

Hide/Show Sites

The Sites list can be used to hide sites from the the map view. To hide a site from the map view, or to show a hidden site, right-click over it and click **Hide/Show** from the *Sites Pop-up Menu*.

Sites that are hidden will have their icon shown in grey in the project navigation tree.

Deleting Sites

The Sites list can be used to delete sites altogether. To delete a site, right-click over it and click **Delete Sites** from the *Sites Pop-up Menu*.

Editing Site details

Site Name and Description can be edited directly in the Sites list. To edit any other Site attribute, double-click on the Site and update it in the *Site Page*.

Converting and Duplicating Sites

Sites can be converted from Network Sites to Subscriber Sites or from Subscriber Sites to Network Sites. Right-click on the site in the Project Navigation Tree and select **Convert to ...**, see *Converting or Duplicating Network and Subscriber Sites*. To convert multiple sites select all sites in the appropriate site list, see *Displaying the Sites List* and then right-click to access the same menu option.

To duplicate a Network Site as a Subscriber Site or a Subscriber Site as a Network Site, right-click on the site in the Project Navigation Tree and select **Create duplicate ...**, see *Converting or Duplicating Network and Subscriber Sites*. To duplicate multiple sites select all sites in the appropriate site list, see *Displaying the Sites List* and then right-click to access the same menu option.

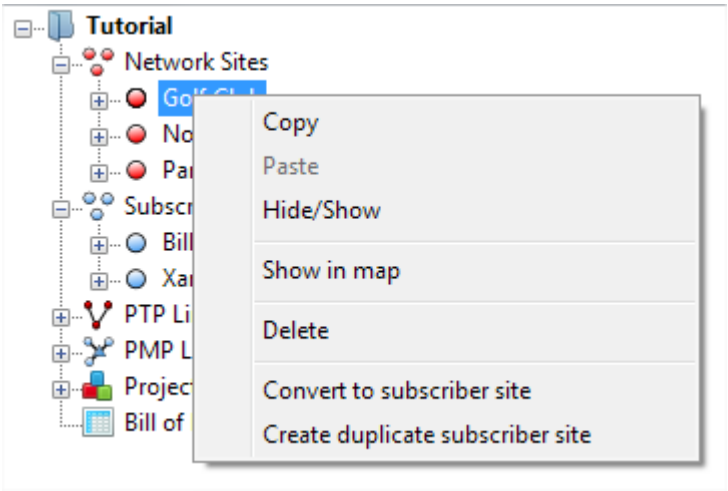


Figure 3.30: Converting or Duplicating Network and Subscriber Sites

NOTE If a site already has links or Access Points attached to it, these will be deleted if a site is converted rather than duplicated.

Site Page

Use this page to view and update the details of an existing site.

Details

View and update the Name, Maximum Height, Latitude, Longitude and Description. For field definitions, see *Creating Sites*.

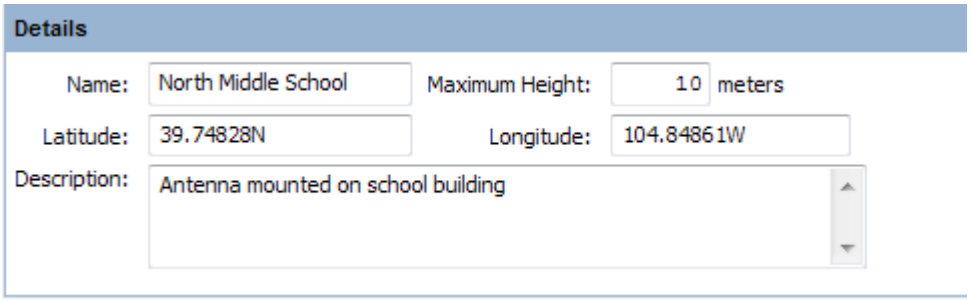


Figure 3.31: Details in Site Page

Links

For a network site this is a list of PTP links that have been defined between this site and other sites in the project. For a subscriber site this is a list of PMP Links that have been defined between this subscriber site and Access Points in the network.

To add or remove columns to the list, right click and tick or untick columns. If the link is displayed in red, it means that the predicted performance of the link is

below requirements. Double-click on a link to open the Link page to evaluate the link, as described in *Link Page* for PTP links or *Subscriber Modules*.

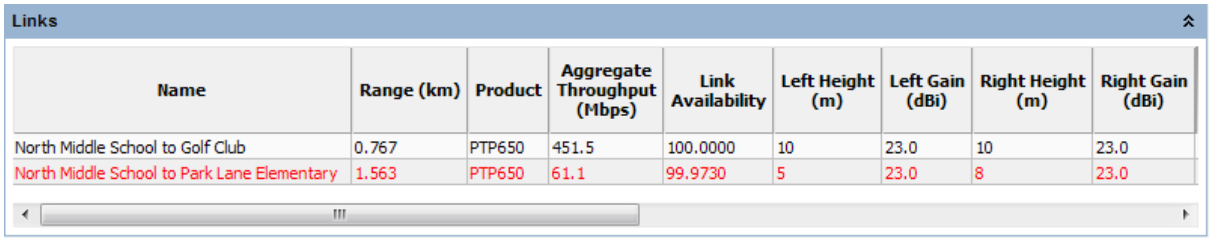


Figure 3.32: PTP Links in Site Page

Links Graph

This is a map of the sites and links in the project. Link lines are colored to indicate whether or not their predicted performance meets requirements: red means performance is not acceptable, green means performance is acceptable.

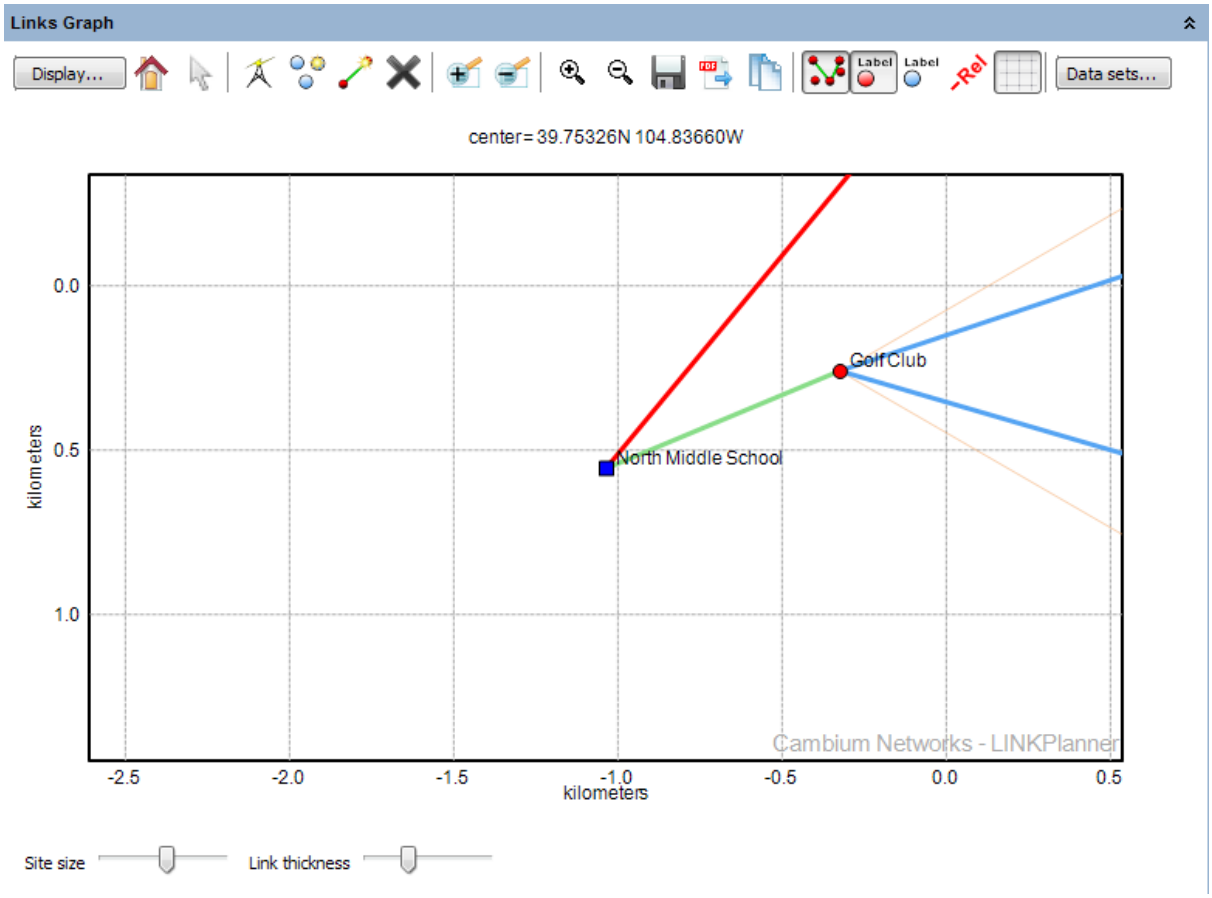


Figure 3.33: Links Graph in Site Page

Display Properties

Select the site color and style or icon for this site to be used in the map displays.

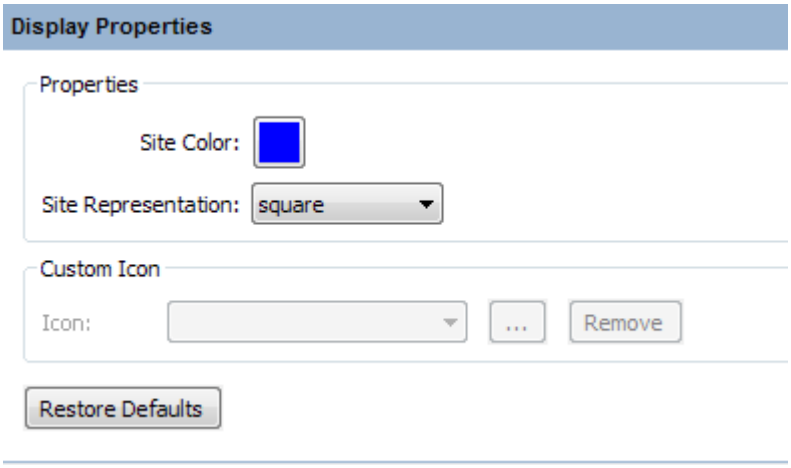


Figure 3.34: Display Properties in Site Page

Profiles

Profiles are a visualization of the path between two end points, e.g. between two sites for a PTP link or between an Access Point and a Subscriber Module for a PMP link. Profiles are normally automatically requested and populated into the link as soon as it is created, however they can be also be requested manually if required, see *Obtaining Link Profiles*.

Once a profile is available it can be modified to allow for local obstructions and correct any terrain height if necessary, see *Adjusting Link Profiles* and *Link Profile Adjustment Examples* .

Obtaining Link Profiles

NOTE

The Request Profiles process will send information, including your contact details and path profile coordinates, to Cambium Networks. Cambium Networks stores this information on its servers so that we can provide the best possible customer service and sales support. Please see http://www.cambiumnetworks.com/privacy for more details.

To register for the path profile service click **Tools, Options (Preferences in Mac), Path Profile**, (see *Options (Preferences)*) for details on registering for the profile service.

If the **Request profiles manually?** box is ticked then follow Steps 1 - 3 below, otherwise the profiles are requested as soon as a link is created.

Profile requests are processed in the background and automatically populated into the project, however when a profile request is being processed an activity wheel is shown in the bottom right hand corner of the window. Right click on this wheel to open a progress window and view the progress of the profile requests, if required.

To cancel obtaining any further profiles click **Cancel All** and any profile requests still pending will be cancelled.

If a request fails, then the profile will show as “Failed” and an error message will be shown on the Error tab. Any profile which fails will need to be re-submitted, when the appropriate corrective action has been taken. To re-submit a profile, follow Steps 1 - 3 below.

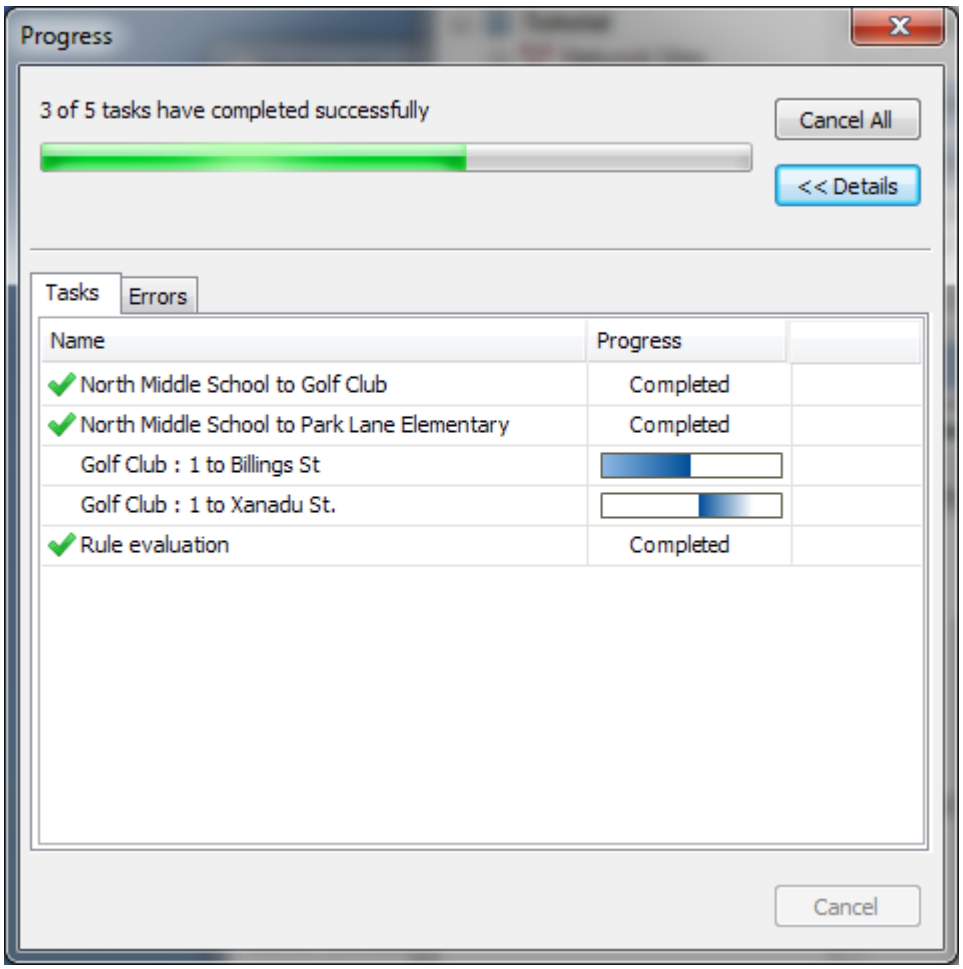


Figure 3.35: Progress Page

To obtain profiles manually, follow these steps:

1. Click **Project**, **Get Profiles**:

   If LINKPlanner cannot connect to the network, it responds to the Get Profiles request by displaying an “Internet configuration failed” message. If this happens, then review and update the HTTP Proxy settings, as described in *Options (Preferences)*.

2. The *Request Profiles Page* is displayed:

   The links that do not yet have profiles are ticked by default. The links that already have profiles are unticked by default. Tick them if the profiles require update.

NOTE

Requesting a new profile for an existing link will overwrite all current information including obstructions.

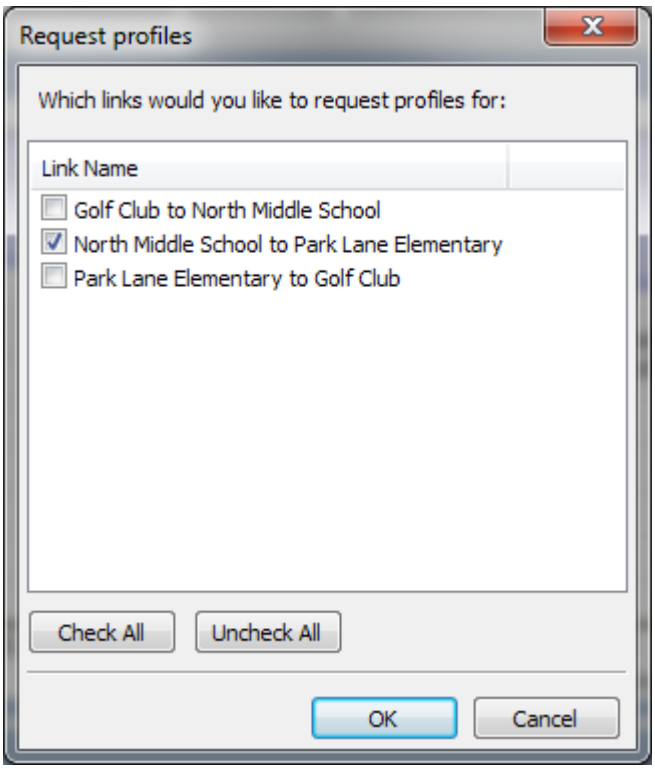


Figure 3.36: Request Profiles Page

3. Click **OK** to obtain profiles:

   LINKPlanner automatically sends the requests to the Cambium Networks Path Profile system. For background information, see *Path Profiles*.

Adjusting Link Profiles

Link planners need to verify and adjust link profiles for the following reasons:

- To enter accurate estimates of antenna heights.
- To correct the average terrain heights provided by the Path Profiler.
- To allow for obstructions in the link path (usually trees).
- To allow for the effect of reflection when the link path is over water.

The process for each link is:

1. View the link in the Google Earth(TM) aerial photograph (if it is available), as described in *Using Google Earth(TM)*.
2. Obtain the most accurate possible data at the two ends of the link, as described in *Verifying Link Ends*.
3. Obtain the most accurate possible data at the high points, as described in *Verifying High Points*.
4. Update the profiles as described in *Updating Link Profiles*.

For examples of how Cambium link planners use a map, Google Earth and surveys to adjust link profiles, see *Link Profile Adjustment Examples*.

Using Google Earth(TM)

The link profile can be viewed as a Google Earth(TM) aerial photograph (if it is available). Air photographs help the planner to identify potential obstructions and estimate their heights and positions.

Viewing Links and Sites in Google Earth(TM)

To view a link, select the link in the LINKPlanner navigation tree, then click **Google Earth** .

The aerial photograph is displayed, zoomed into and centered on that link, as shown in the following example (*Google Earth(TM) Aerial Photograph with Distances Shown*):

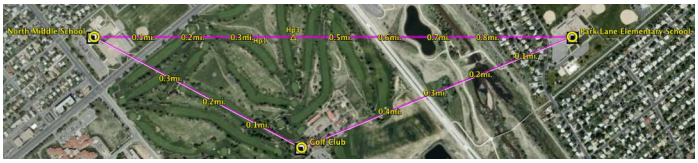


Figure 3.37: Google Earth(TM) Aerial Photograph with Distances Shown

To view a site, select the site in the LINKPlanner navigation tree, then click **Google Earth** .

The aerial photograph is displayed, zoomed into and centered on that site, with links displayed.

Previewing Link Profiles

To preview link profiles in Google Earth(TM), click on a Site (as represented by a yellow circle). A 'bubble' opens up which contains the link profiles to up to 10 adjacent sites. This feature is useful when potential Sites have been identified and entered in LINKPlanner. The link profiles between those potential sites can be previewed in Google Earth(TM) to see which links are definitely line of sight (and therefore worth pursuing), or VERY non-line of sight (in which case they may not be worth pursuing).

Distance and Zoom in Aerial Photographs

Zoom into areas of the photograph where obstructions may be present, as shown here (*Google Earth(TM) Aerial Photograph (Zoomed)*):

Figure 3.38: Google Earth(TM) Aerial Photograph (Zoomed)

The distance along the line is displayed, negating the need for the ruler to be used. On long links the distance resolution increases or decreases with the zoom.

The maximum resolution presented is 0.1 km or 0.1 miles depending upon the LINKPlanner Length preference/options set.

Color Code in Aerial Photographs

Magenta lines - LoS links: The magenta lines represent LoS links between sites.

White lines - links with no profiles: The white lines represent LoS links for which LINKPlanner has no profiles.

Magenta transparent area - ground Fresnel zone: The magenta transparent area represents the projection of the Fresnel cigar shaped tube on the ground. Obstructions can be easily compared with this Ground Fresnel zone to establish their significance. The zoomed example photograph shows a tree at 0.26 miles (0.42 km) that is wider than the Fresnel zone and thus, if it is high enough, is of significance. The shadows and general size suggest that it may be 30 ft (9.2 m) high.

Blue translucent area - vertical Fresnel zone: The blue translucent shaded area represents the Vertical Fresnel zone as seen from the air (*Fresnel zone representation in Google Earth*). It has no thickness and so may not be seen when the observer is immediately above the link.

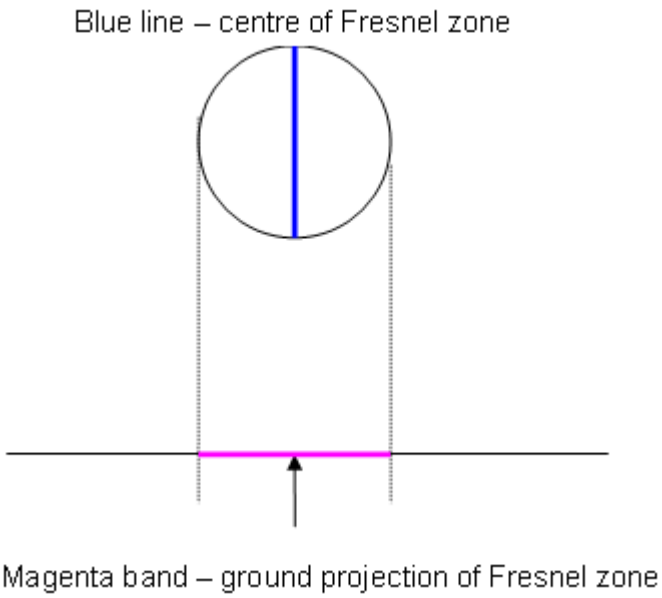


Figure 3.39: Fresnel zone representation in Google Earth

High Points in Aerial Photographs

Hp1-3 identify points which have the greatest significance to the excess path loss of the link. Hp1 has the greatest significance while Hp2 is the largest effect on the left hand side of the link and Hp3 is the largest effect on the right hand side of the link.

When an obstruction is identified, with practice, the height of the obstruction can be estimated and quickly added to the profile using the range markers and the

profile editor.

Verifying Link Ends

As the Fresnel zone is smaller near the transceivers, obstructions near the ends of the link have a greater impact on performance than obstructions near the center of the link. It is therefore vital to obtain the most accurate possible survey data at the two ends of the link. The planner needs to answer the following questions:

- Does the path profile (from the Path Profiler) show the correct ground height near the ends of the link path?
- Are there any obstructions near the ends of the link path?
- How high is the antenna?

To obtain approximate answers, use a map and Google Earth(TM): an example is described in *Verifying a Link End Using a Map and Google Earth*.

To obtain more reliable answers, visit the site and survey the end of the link: an example is described in *Verifying a Link End Using a Survey*.

Verifying High Points

The Google Earth photograph displays high points on the link path as “Hp1”, “Hp2” and so on. These are points at which the link path is very close to the ground and so prone to obstruction. It is therefore vital to obtain the most accurate possible survey data at these high points. The planner needs to answer the following questions:

- Does the path profile (from the Path Profiler) show the correct ground height near the high points?
- Are there any obstructions near the high points?

To obtain approximate answers, use a map and Google Earth(TM): an example is described in *Verifying a High Point Using a Map*.

To obtain more reliable answers, visit and survey the high point: an example is described in *Verifying a High Point Using a Survey*.

Updating Link Profiles

When link profiles have been verified, they must be updated. To update a profile, select the link in the navigation tree to view the Link Page. The *Profile Visualization Chart* must be updated to include obstructions and, if the path is over water, to allow for reflection, see *Unlicensed Band Reflection Editor*.

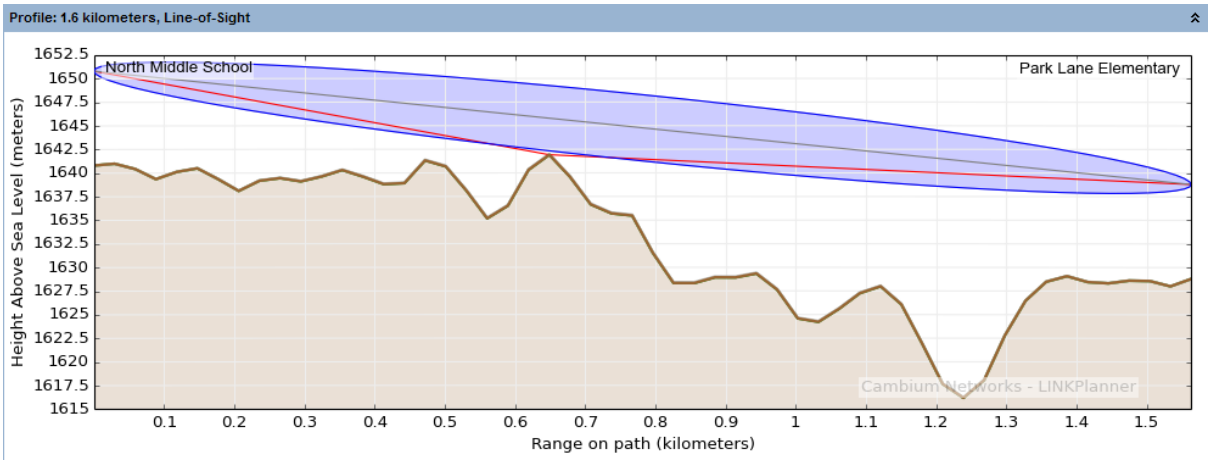


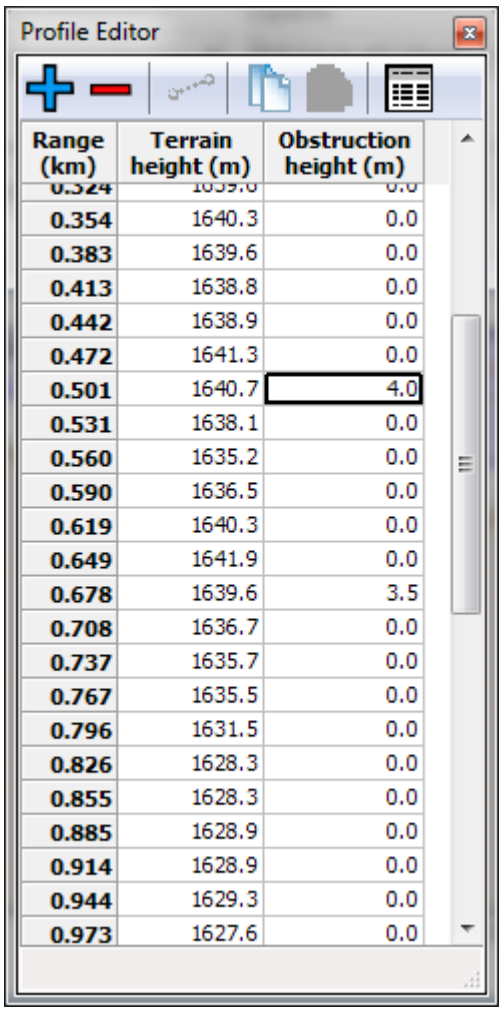
Figure 3.40: Profile Visualization Chart

Obstructions

Double-click on the Profile visualization chart. The *Profile Editor* page is displayed. Enter or update the Range or Obstruction height as required. For example, enter a 4 meter high Obstruction at Range 0.501 km and a 3.5 meter high Obstruction at Range 0.678 km.

If necessary, make allowances for forests and tall buildings:

- An obstruction of roughly constant height (for example a forest) may extend over two or more points. To enter such an obstruction, select all the affected Obstruction Height cells, type a value and press Enter. For example, if a forest with 12 m high trees extends from Range 1 km to 1.2 km, select the Obstruction Height cells for this range, type 12 and press Enter.
- If a tall building partially obstructs the Fresnel zone by cutting vertically into one side, treat it as though it cuts horizontally into the bottom of the Fresnel zone. For example, if it extends 3 meters into the right hand side of the zone, enter it as a 3 m high obstruction.



Range (km)	Terrain height (m)	Obstruction height (m)
0.354	1640.3	0.0
0.383	1639.6	0.0
0.413	1638.8	0.0
0.442	1638.9	0.0
0.472	1641.3	0.0
0.501	1640.7	4.0
0.531	1638.1	0.0
0.560	1635.2	0.0
0.590	1636.5	0.0
0.619	1640.3	0.0
0.649	1641.9	0.0
0.678	1639.6	3.5
0.708	1636.7	0.0
0.737	1635.7	0.0
0.767	1635.5	0.0
0.796	1631.5	0.0
0.826	1628.3	0.0
0.855	1628.3	0.0
0.885	1628.9	0.0
0.914	1628.9	0.0
0.944	1629.3	0.0
0.973	1627.6	0.0

Figure 3.41: Profile Editor

The Profile is updated to represent the trees as green points above the terrain.

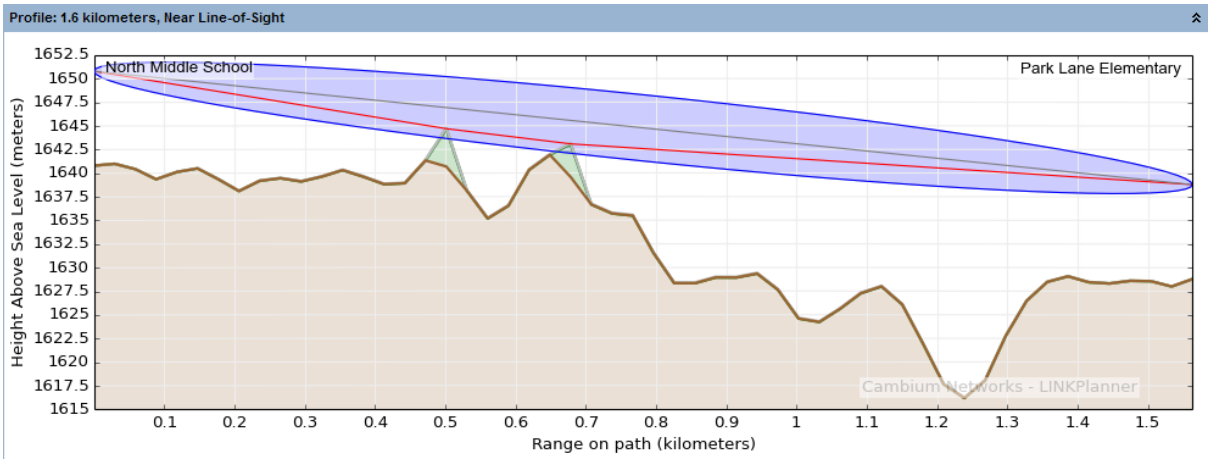


Figure 3.42: Profile Updated With Tree Obstructions (in green)

Adding new points

If you would like to add an obstruction in between two of the existing profile

points, you can add a new point using the Add Point button.

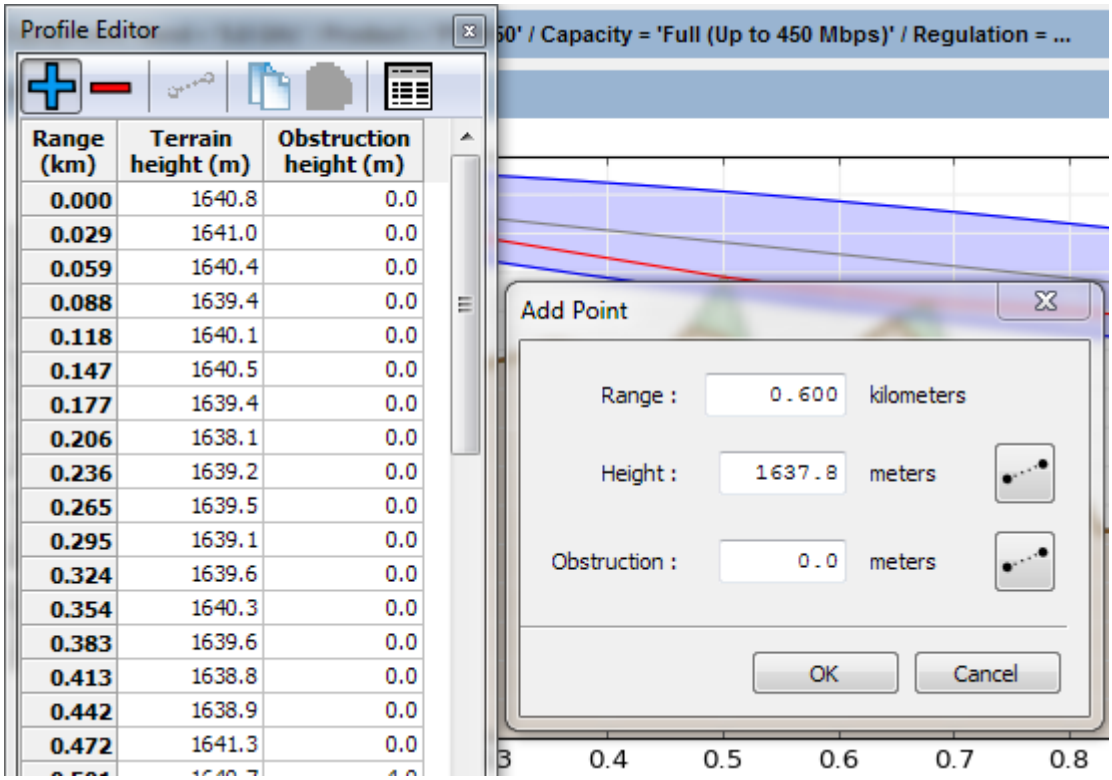


Figure 3.43: Adding a Profile Point

You need to specify the range along the path, the terrain height at that point, and the obstruction height. For either of the heights, you can press the Estimate height button to enter a height based on the points either side of the new one.

Deleting points

You can remove points from the profile by selecting them and pressing the Delete Points button. Any points except the first and last may be deleted.

Editing multiple points

Some types of obstruction, for example forests, may extend for some distance along the path. These can be represented in the profile by editing multiple points.

To set the same height for multiple points, select those points and type the new height. When you press Return, that height will be entered for all those points.

To adjust the heights for multiple points so that there is a constant gradient, set the heights at either end of the range, then select the range and click the Straight Line button .

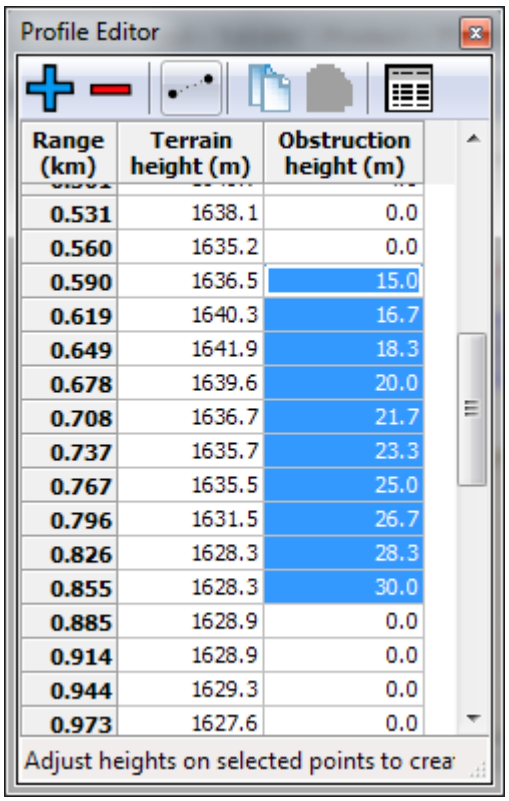


Figure 3.44: Setting a Constant Gradient

Copy a Path Profile

There are two methods for copying a path profile:

- Right-click on the *Profile Visualization Chart* and choose **Copy** from the pop-up menu
- Open the *Profile Editor* and click 

Pasting a Path Profile

There are two methods for pasting a path profile:

- Right-click on the *Profile Visualization Chart* and choose **Paste** from the pop-up menu
- Open the *Profile Editor* and click 

LINKPlanner will use the units that are defined in the header row of the path profile data when a profile is pasted. If the header row is missing or if the units are not recognized then the preferred units will be used.

Clipboard | Font

A1 | Range (km)

	A	B	C	D
1	Range (km)	Terrain height	Obstruction height (m)	
2	0	1646	0	
3	0.0294	1645.4	0	
4	0.0589	1642.2	0	
5	0.0883	1642.9	0	
6	0.1177	1644.8	0	
7	0.1471	1644	0	

Figure 3.45: Path Profile Units

Editing a Profile as a Spreadsheet

Open the *Profile Editor* and click  . Once you have made the appropriate changes to the profile, copy the information and paste it back into LINKPlanner (see *Pasting a Path Profile*).

Link Profile Adjustment Examples

These examples show how Cambium link planners use a map, Google Earth and surveys to adjust link profiles.

The original path profile for the point-to-point link from Addislade Farm to Yelland Cross Farm is built using the PTP Path Profiler data:

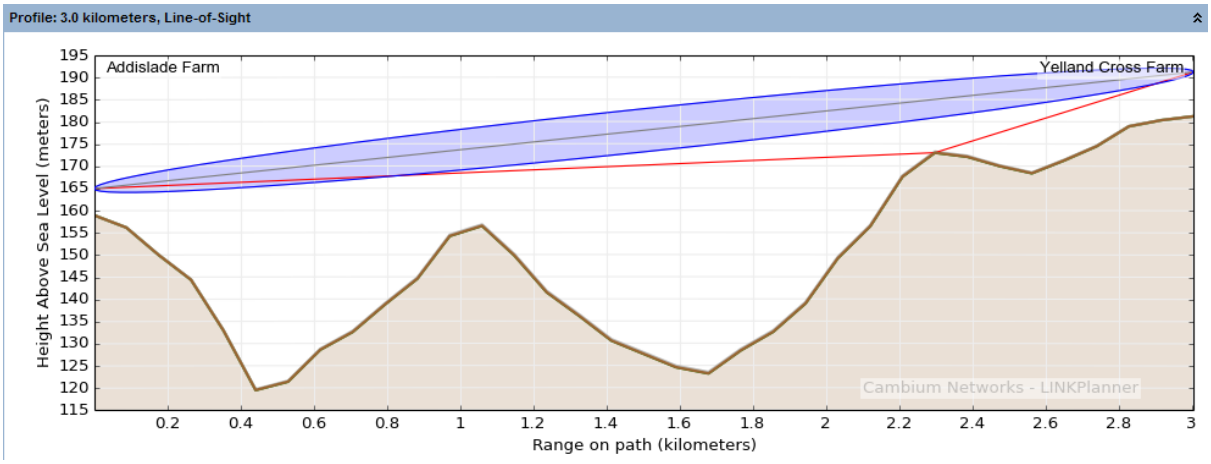


Figure 3.46: Original path profile

We verify the link ends and the high points as described in the following examples:

- *Verifying a Link End Using a Map and Google Earth*

- *Verifying a Link End Using a Survey*
- *Verifying a High Point Using a Map*
- *Verifying a High Point Using a Survey*

These methods are applied to both link ends and to all high points in the link path. The resulting path profile is shown here:

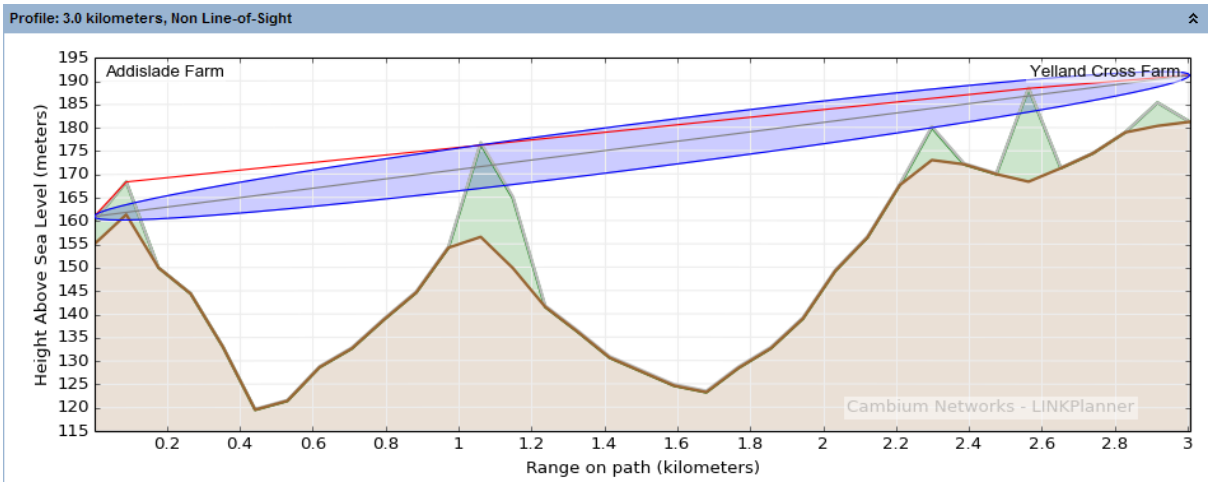


Figure 3.47: Adjusted path profile

Verifying a Link End Using a Map and Google Earth

This is an example to show how Cambium link planners use a map and Google Earth(TM) to estimate the height of the terrain and obstructions near one end of a test link. We use the following aids:

- Path Profiler data imported into LINKPlanner.
- LINKPlanner, open at the Link Profile and Profile Editor.
- An accurate topographic map with contours at 10m intervals.
- The Google Earth aerial photograph zoomed in on the end of the link.

1. Path Profiler returned the following profile for the start of a link path:

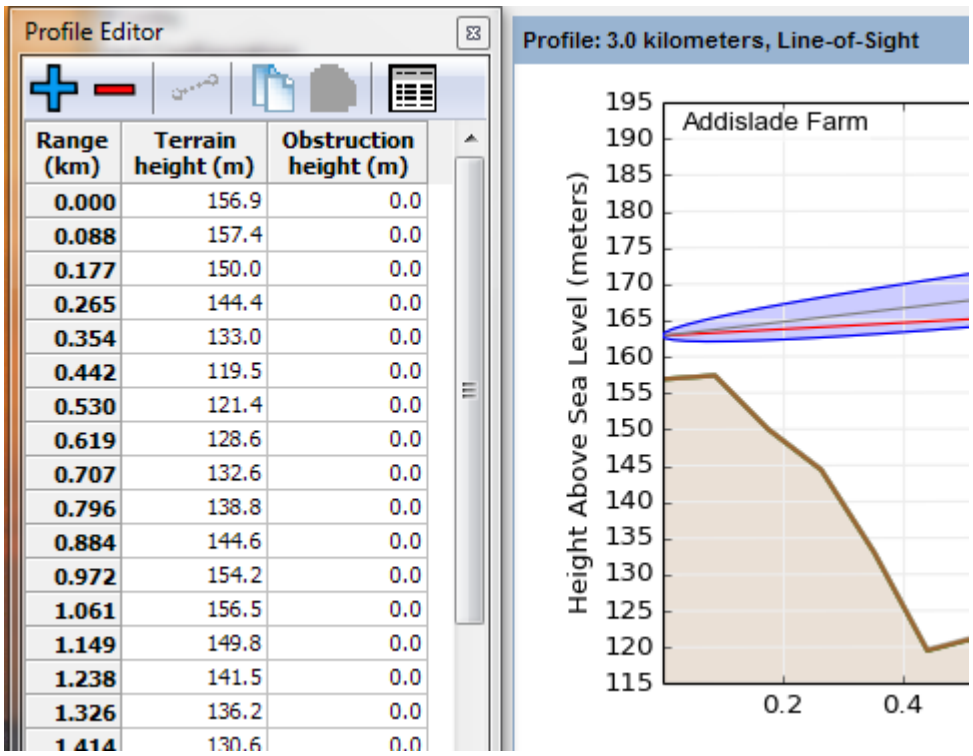


Figure 3.48: Unadjusted profile near antenna site

The first 0.1 km of this link must be examined in more detail.

2. We examine the map of the site:

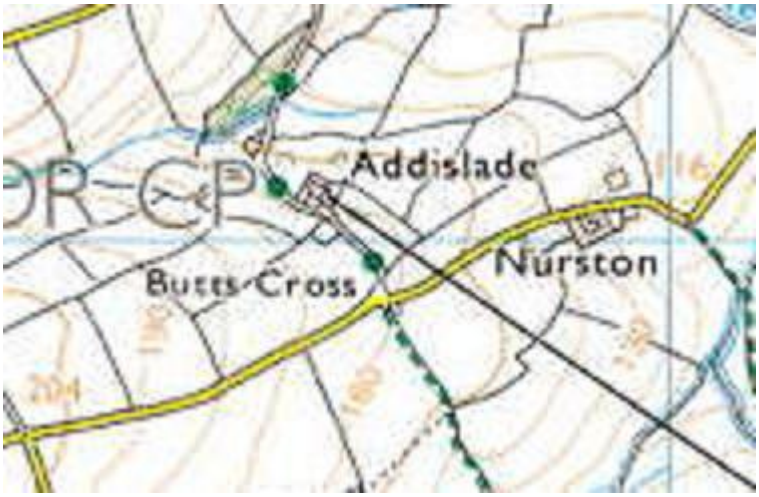


Figure 3.49: Map of Addislade

The antenna site is just below the 160 m contour, so the path profile height 156.9 m at range 0 km is probably correct. However, the 160 m contour curves around and crosses the link path at two points in the first 0.1 km of the link. This means that the path profile height of 157.4 m at range 0.088 km is too low. We estimate that the terrain height at this point is 162 m.

3. We examine the Google Earth air photograph of the link end. This reveals some potential obstructions:

- Just in front of the antenna - a building and some bushes, estimated height 6 m.
- At 0.1 km from the antenna - a row of trees, estimated height 8 m.
- These obstructions and the higher ground are annotated in this Google Earth photograph:

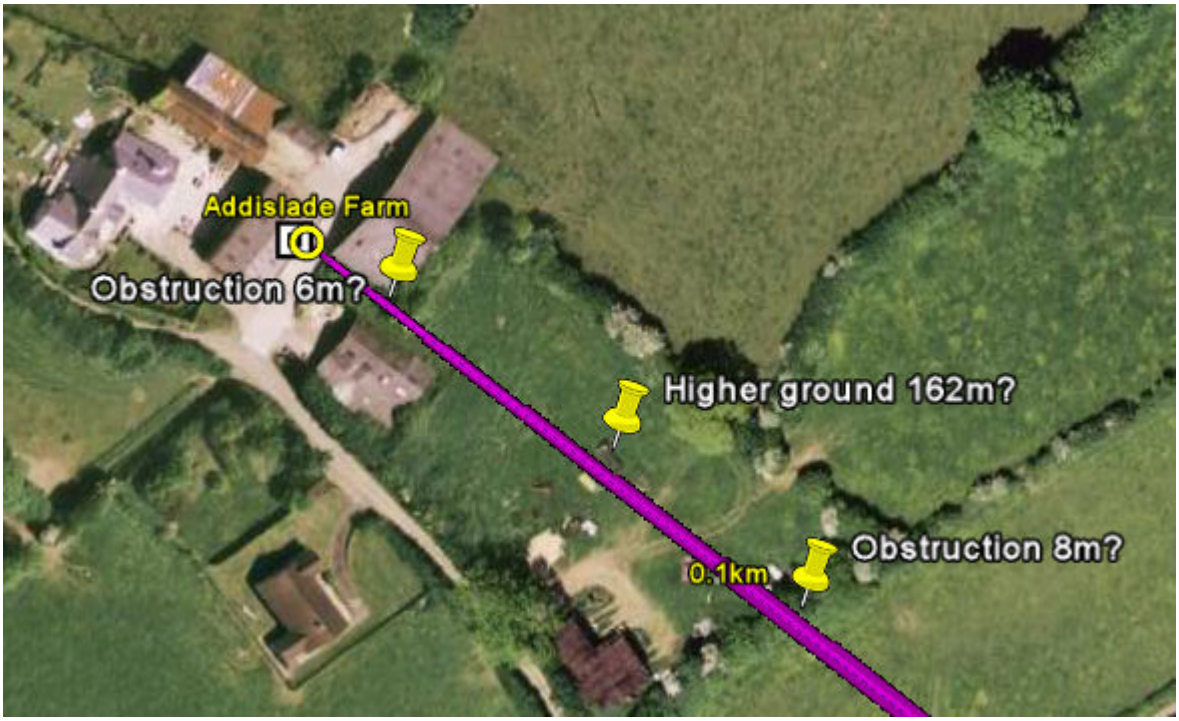


Figure 3.50: Obstructions and higher ground near Addislade

4. We enter estimates for these obstructions and the higher ground in the Profile Editor:

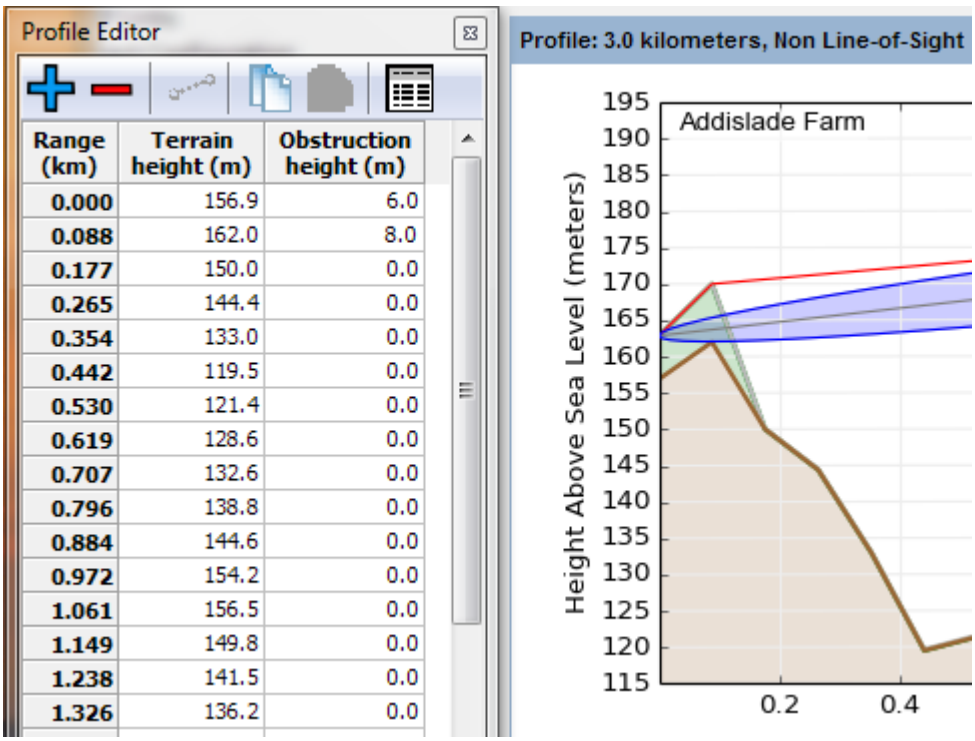


Figure 3.51: Profile Updated with Map and Google Earth Results

Our conclusion is that the Fresnel zone may be severely obstructed at this site. This must be confirmed by conducting a survey, as described in *Verifying a Link End Using a Survey*.

Verifying a Link End Using a Survey

This is an example to show how Cambium link planners use a site survey to refine their estimates of the terrain and obstructions near one end of a test link. This builds on the previous example *Verifying a Link End Using a Map and Google Earth*.

We use the following survey aids:

- Map, path profile, Google Earth(TM) aerial photo
- Barometric GPS receiver
- Clear plastic ruler
- Surveyor’s tape measure
- Pocket calculator
- Binoculars

We follow these steps:

1. We use the barometric GPS receiver to verify terrain height.

   Because air pressure may change frequently, the GPS receiver must be recalibrated near every survey site, at a point with a known altitude. The

map shows a suitable point for calibration, where the road crosses the 160m contour near the site, as annotated on this Google Earth photograph:

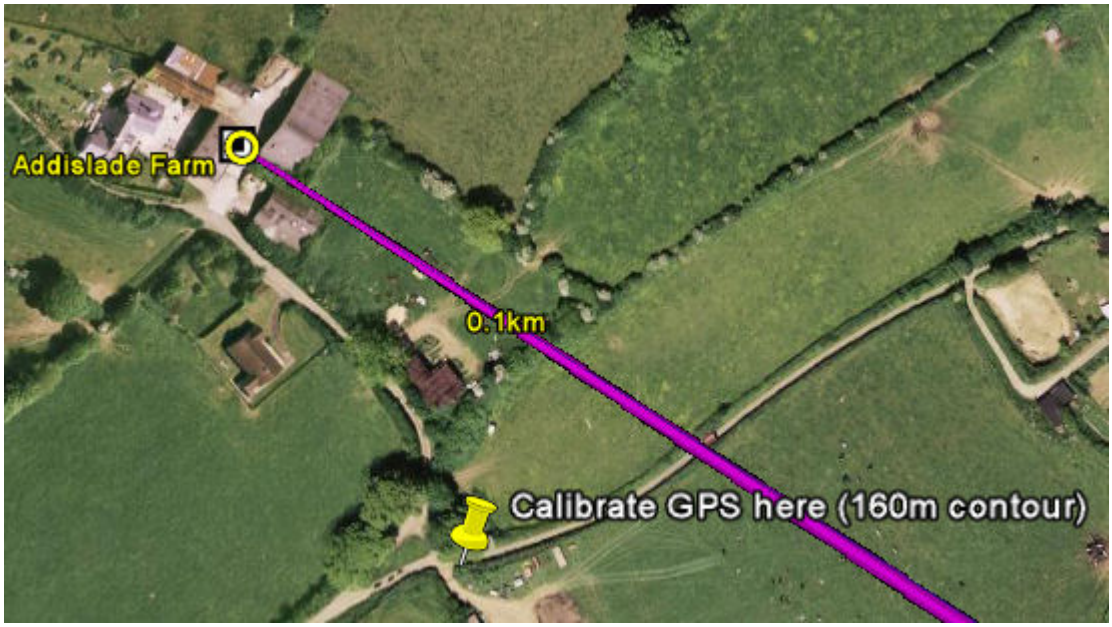


Figure 3.52: GPS Calibration Point

We calibrate the GPS at this point.

2. We go to the antenna site.

   Standing at the foot of the antenna (or of the building on which the antenna is mounted), we record the terrain height from the GPS: 155m.

3. We estimate the height of the antenna above ground level. The antenna height used in LINKPlanner is to the center line of the antenna, therefore the radius of the antenna should be taken into account.

   The following height estimation methods can be used:

   Method 1: If it is safe (and permissible) to do so, go to the highest accessible point on the antenna and measure its height using the GPS receiver.

   Method 2: If the antenna is on a building, estimate the height of each storey and count the number of storeys from the ground to the antenna.

   Method 3: Ask a colleague to stand under the antenna and estimate the number of times the colleague's height would be needed to reach the antenna height.

   Method 4: Stand a measured distance away from the antenna (d2), hold the ruler at eye level and arms length (d1), measure the height above ground of the antenna as viewed through the ruler (h1), then calculate the height of the antenna (h2) using this formula (see illustration):

   $$h2 = h1 * (d2/d1)$$

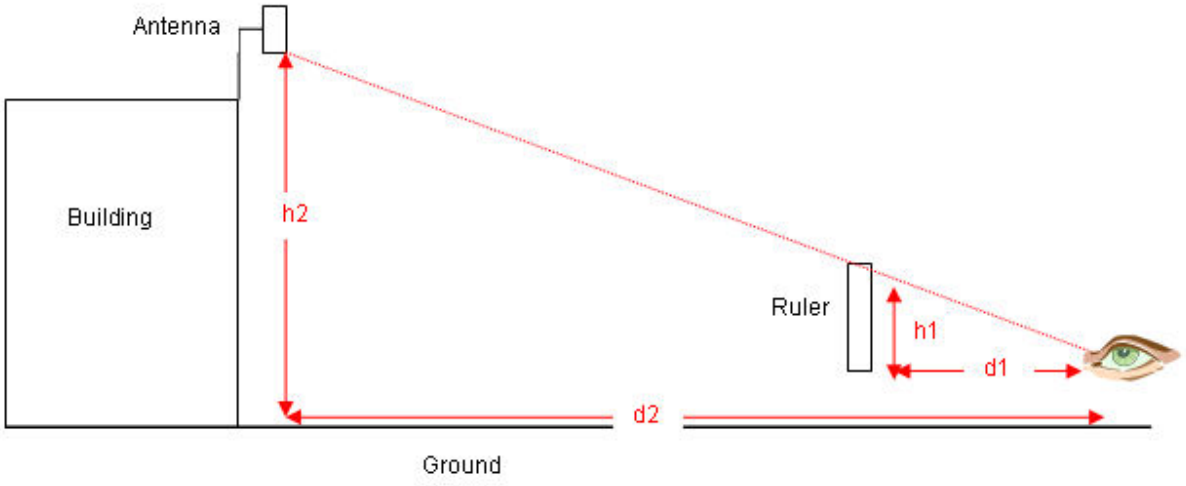


Figure 3.53: Using a ruler to estimate height

We record the estimated antenna height: 10m.

NOTE

This method can also be used to estimate the height of trees and other potential obstructions. If it is not possible to measure the distance d2, use the map to estimate it.

4. We examine the potential obstructions and high points that were found on the air photograph:

   A building and some bushes immediately in front of the antenna: The building proves to be just clear of the link path and is not recorded as an obstruction. The bushes are on the link path, so we use the ruler method to estimate and record their height: 5 m.

   Higher ground at 0.088 km from the antenna: We go as near to this higher ground as we can and take the GPS reading: 161.4 m.

   A row of trees at 0.1 km from the antenna: This row of trees cuts through the link path. We identify the tree that is on the path and use the ruler method to estimate and record its height: 7 m.

   These obstructions and the higher ground are annotated in this Google Earth photograph:

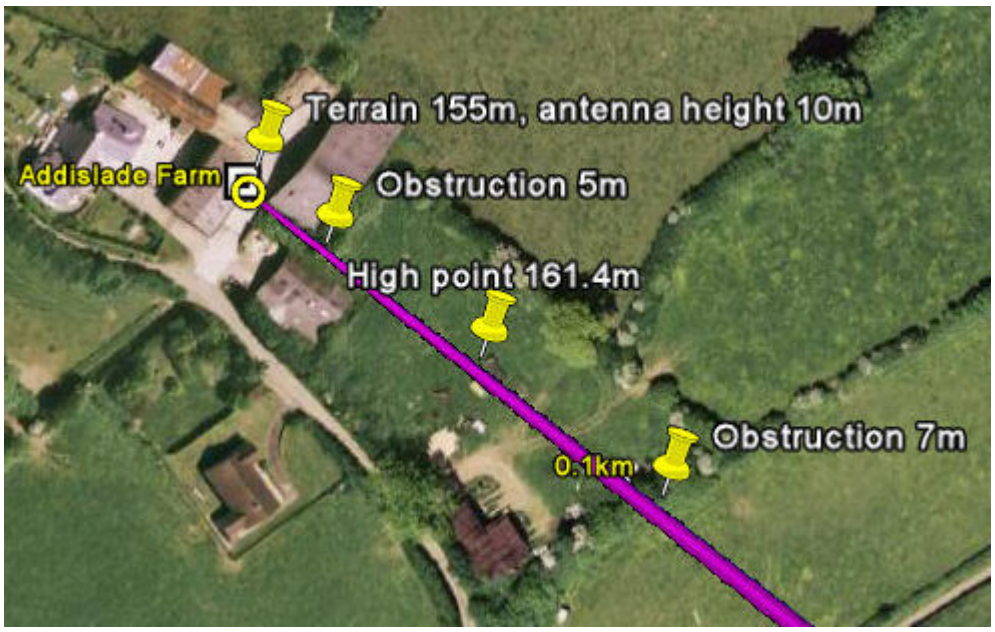
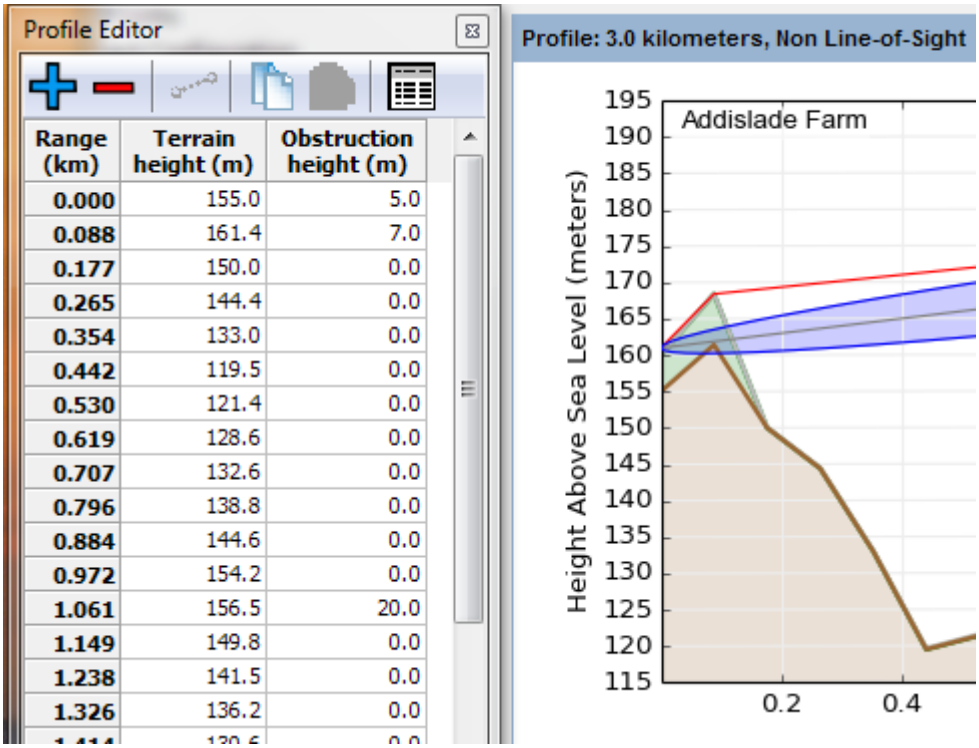


Figure 3.54: Results of site survey at Addislade

CAUTION

Link planners must allow for the possibility that tree growth or new buildings may cause new obstructions in the future. If the potential obstructions are deciduous trees, allow for seasonal changes in foliage.

5. When we return to the office, we update the profile with these results:



Range (km)	Terrain height (m)	Obstruction height (m)
0.000	155.0	5.0
0.088	161.4	7.0
0.177	150.0	0.0
0.265	144.4	0.0
0.354	133.0	0.0
0.442	119.5	0.0
0.530	121.4	0.0
0.619	128.6	0.0
0.707	132.6	0.0
0.796	138.8	0.0
0.884	144.6	0.0
0.972	154.2	0.0
1.061	156.5	20.0
1.149	149.8	0.0
1.238	141.5	0.0
1.326	136.2	0.0

Figure 3.55: Profile updated with site survey results

We now have a more accurate profile of the link end. This will help us to optimize the link and achieve acceptable data throughput.

Verifying a High Point Using a Map

This is an example to show how Cambium link planners use a map and Google Earth(TM) to estimate the height of the terrain and obstructions near one high point of a test link. We use the following aids:

- Path Profiler data imported into LINKPlanner.
- LINKPlanner, open at the Link Profile and Profile Editor.
- An accurate topographic map with contours at 10m intervals.
- The Google Earth aerial photograph zoomed in on the high point.

We follow these steps:

1. Path Profiler returned the following profile for the high point at range 1.061 km:

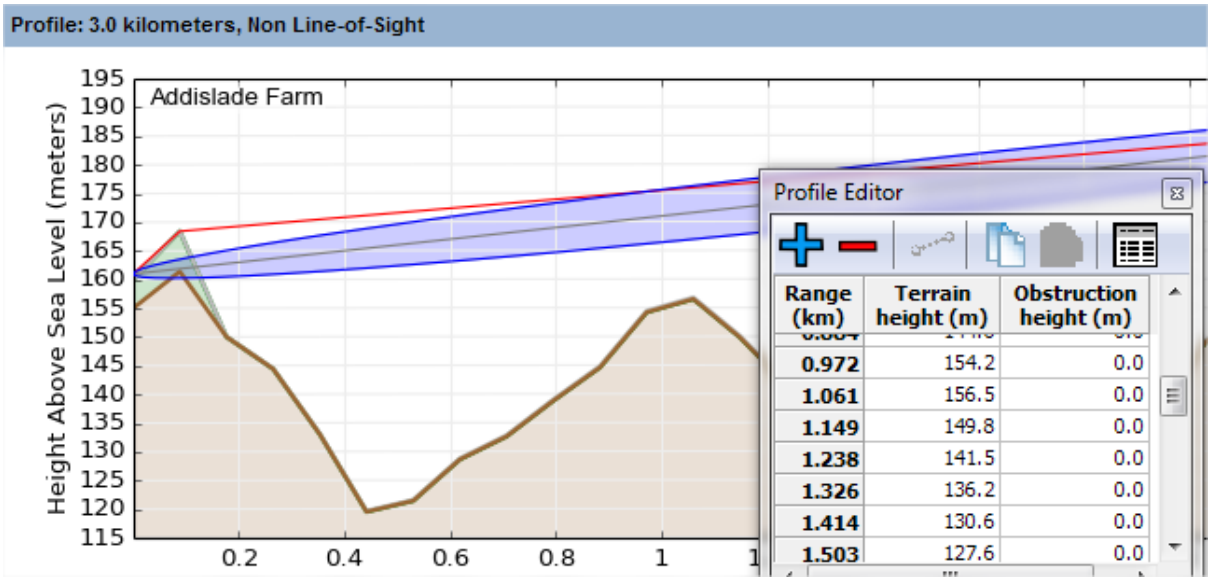


Figure 3.56: Unadjusted profile near high point

2. We examine the map of the high point. This reveals that the link path is between the 150 m and 160 m contours:

Figure 3.57: Map of Hp1

The path profile height 156.5 m at range 1.061 km is probably correct. However, the map shows a clump of trees surrounding the high point - a potential obstruction.

3. We enter an estimate of 25 m for the height of the trees in the Profile Editor:

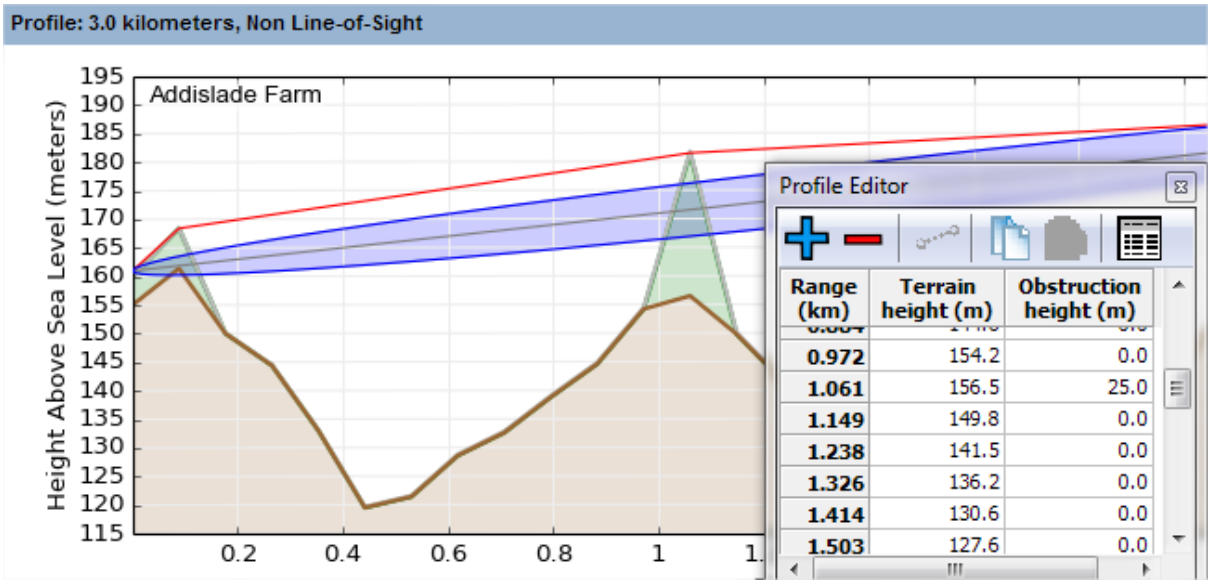


Figure 3.58: Estimated obstruction height near Hp1

Our conclusion is that the Fresnel zone may be severely obstructed at this high point. This must be confirmed by conducting a high point survey, as described in *Verifying a High Point Using a Survey*.

Verifying a High Point Using a Survey

This is an example to show how Cambium link planners use a high point survey to refine their estimates of the terrain and obstructions near high points. This builds on the previous example *Verifying a High Point Using a Map*.

We use the following survey aids:

- Map, path profile, Google Earth(TM) aerial photo
- Barometric GPS receiver
- Clear plastic ruler
- Surveyor's tape measure
- Pocket calculator
- Binoculars

We follow these steps:

1. We use the barometric GPS receiver to verify terrain height.

   Because air pressure may change frequently, the GPS receiver must be recalibrated near every high point, at a point with a known altitude. The map shows a suitable point for calibration, where the road crosses the 150 m contour near the high point, as annotated on this Google Earth photograph:

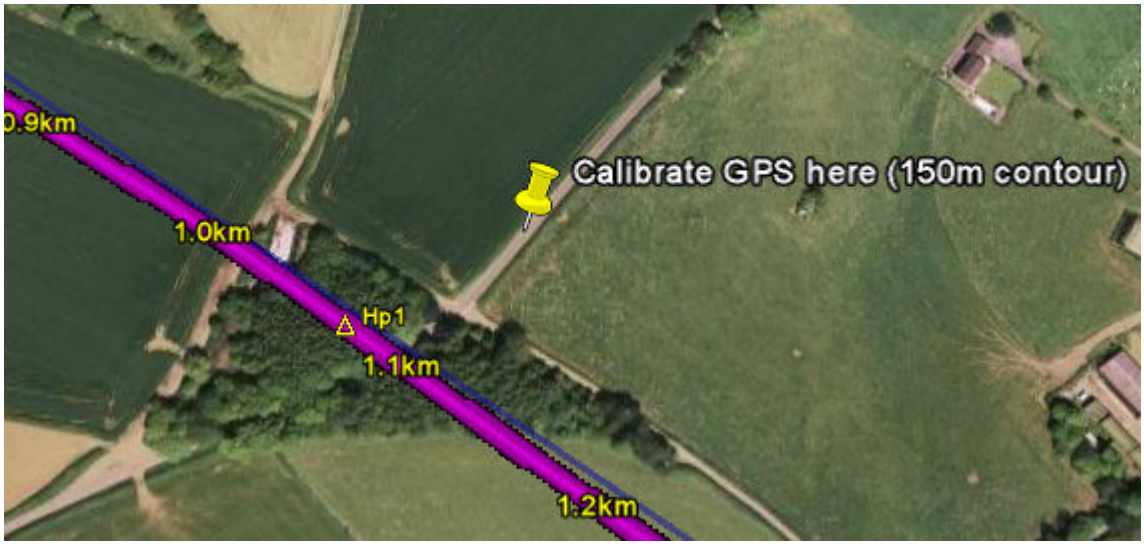


Figure 3.59: GPS Calibration Point near Hp1

   We calibrate the GPS at this point.

2. We go to the high point (or as near to it as possible) and record the terrain height from the GPS: 156 m.
3. We go to a place where we can observe the trees from a measured (or estimated) distance.

   We estimate the height of the highest trees in the clump using the ruler method, as described in *Verifying a Link End Using a Survey*. We record the height of the highest trees: 20 m. We also record the height of the trees at the edge of the clump: 15 m.

4. When we return to the office, we update the profile with these results:

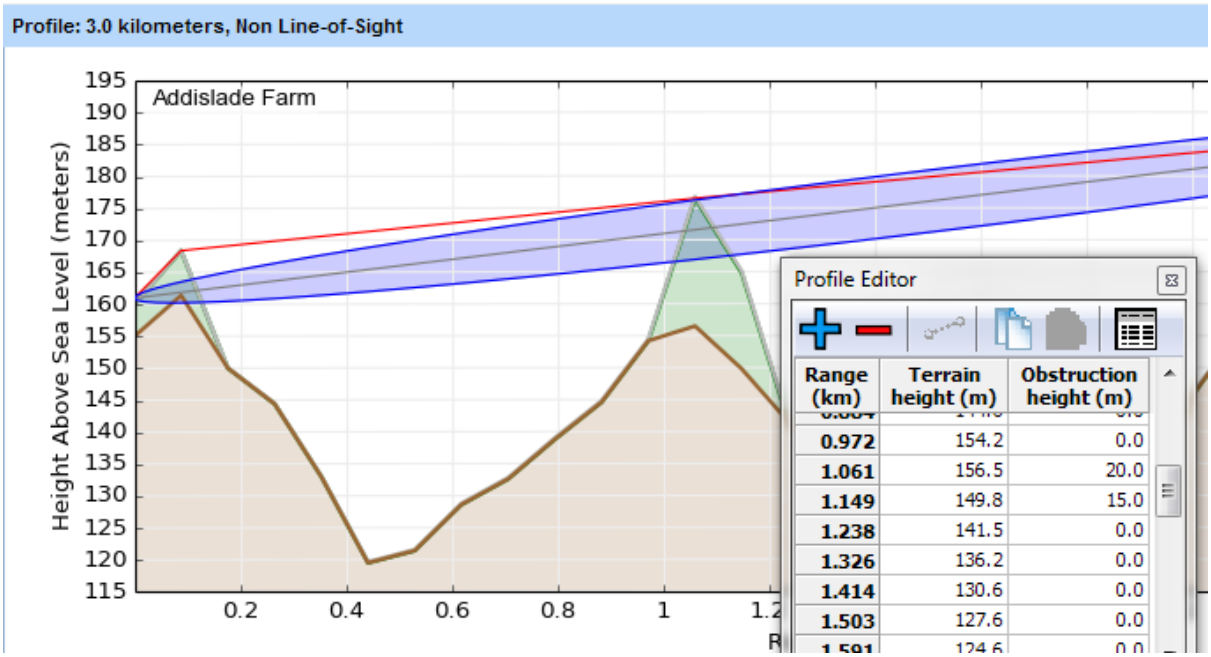


Figure 3.60: Profile updated with Hp1 survey results

We now have a more accurate profile of the high point. This will help us to optimize the link and achieve acceptable data throughput.

Bill of Materials for Project

LINKPlanner automatically calculates the Bill of Materials (BOM) from the project configuration data. The Bill of Materials for the project is split into three sections:

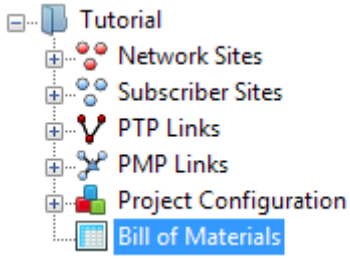
- **PTP Network BOM** - contains an aggregated list of all equipment required to support the PTP links in the network
- **PMP Network BOM** - contains an aggregated list of all the Hub site and Access Point equipment required to build the network side of the PMP network
- **PMP Subscriber Modules BOM** - contains an aggregated list of all the equipment required for the Subscriber Modules in the PMP network

Optional items, for example the power supply unit and rack mount kit for PTP 800, can be added to the BOM at the individual link level, see *Bill of Materials Optional Extras* . The project BOM contains the list of part numbers and associated quantities for the complete project (*Bill of Materials for Project*). It includes all the main components required to install the project as configured in LINKPlanner, including antennas, ODUs, modems (PTP 800 or PTP 810 only), upgrade keys, cabling, lightning protection and GPS sync boxes (if required). It also includes all optional extras, which have been specified at the link level, cables, accessories and spares, comsearch, installation & mounting, link protection, long waveguide, power, security and warranty & support contract.

NOTE

When designing two links to run in parallel with a single dual polar antenna at each end, please use the 2+0 Cross-Polar option, otherwise the BOM lists two dual polar antennas, two waveguides, two RMKs and two ODUs for each link end. This results in the dual polar antennas being duplicated in the BOM; only one is required at each end.

To view the project BOM, click “Bill of Materials” from the navigation tree:



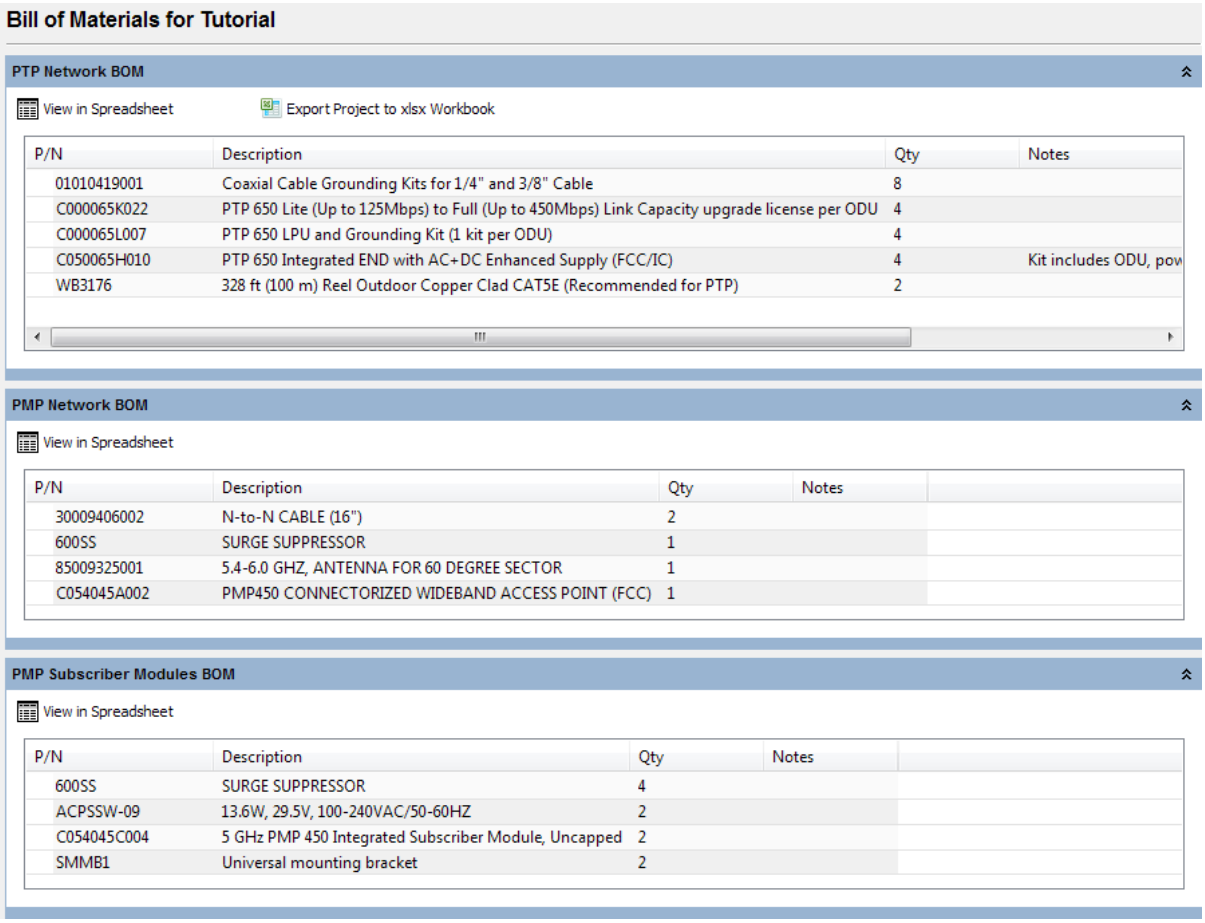


Figure 3.61: Bill of Materials for Project

P/N: The Cambium part number. If the component is not supplied by Cambium, this is set to '(no part number)'.

Description: Description of the components.

Qty: Quantity required.

Notes: Displays information about certain items, such as whether they are obsolete. This information can be edited at the individual link level.

NOTE

For instructions on how to view and save the BOM for an individual PTP link, see *Bill of Materials for Link*, for an Access Point, see *Bill of Materials for Access Point* , for a Subscriber Module, see *Bill of Materials for Subscriber Module* .

Viewing & saving the project BOM file

To view the project BOM in Excel, click Export Project to xlsx Workbook , this will create a multi-sheet Excel workbook with a separate sheet for each of the PTP Network, PMP Network and PMP Subscriber Modules BOMs and an individual sheet for the BOM for each PTP Link in the project. The first sheet in the workbook is an

index to each of the individual worksheets. Once in the spreadsheet the file can be saved as normal.

To create a CSV for an individual section of the BOM, click View in Spreadsheet  while viewing the section of the project BOM required. Once in the spreadsheet the file can be saved as normal.

All numeric only part numbers consist of 11 digits, if the number displayed is only 10 digits the part number should start with a zero.

Project Configuration

The Project Configuration node of the navigation tree contains the following:

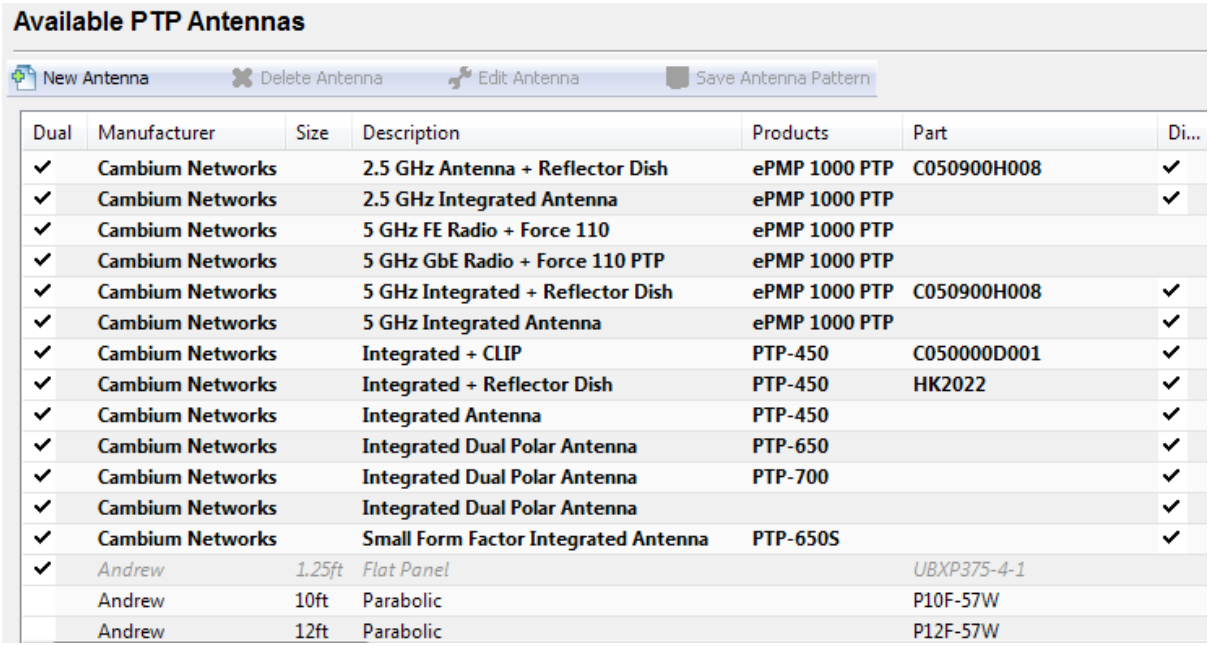
- **PTP Antennas**, **Access Point Antennas**, **Subscriber Module Antennas**: View lists of available antennas. For Unlicensed PTP and Subscriber Modules, create, edit and delete custom antennas. See *Available Antennas*.
- **TDD Sync**: Manage the global parameters for TDD synchronization of unlicensed PTP Links and assess the number of interferers. See *TDD Synchronization List*.
- **Custom Fields**: Insert, delete and view custom fields for a project, site, link or end. Custom fields are a way of adding functionality to LINKPlanner.
- **Link Formatting**: Insert, delete and edit link formatting rules for PTP Links. The rules can be used to control the style and visibility of PTP links when exporting to different formats or when viewing the PTP Links in the map. See *Link Formatting Rules*.
- **PTP Equipment Templates**: Create, delete and edit the equipment templates for PTP Links. The templates are used to set the default configuration settings for new and existing PTP links. See *Equipment Templates*.
- **PMP Equipment Templates**: Create, delete and edit the equipment templates for access points. The templates are used to set the default configuration settings for new and existing access points. See *Equipment Templates*.
- **Channel Plans**: Create, delete and edit channel plans for PMP networks. The channel plans are used to allocate frequencies to each Access Point from a given list and define a color for each frequency which is displayed on the AP sector in the Offline Map. See *Channel Plans*.
- **BOM Estimator**: Create, delete and edit BOM Estimates for PTP Links and PMP Access Networks. Quickly configure different link types and access networks to determine which items are required in the Bill of Materials. See *BOM Estimates*.

Available Antennas

To view the list of available antennas, select the appropriate list from the following options:

- **PTP Antennas**
- **Access Point Antennas**
- **Subscriber Module Antennas**

The *Available PTP Antennas* page is displayed in the right hand panel. The column headings vary slightly between the lists.



Dual	Manufacturer	Size	Description	Products	Part	Di...
✓	Cambium Networks		2.5 GHz Antenna + Reflector Dish	ePMP 1000 PTP	C050900H008	✓
✓	Cambium Networks		2.5 GHz Integrated Antenna	ePMP 1000 PTP		✓
✓	Cambium Networks		5 GHz FE Radio + Force 110	ePMP 1000 PTP		
✓	Cambium Networks		5 GHz GbE Radio + Force 110 PTP	ePMP 1000 PTP		
✓	Cambium Networks		5 GHz Integrated + Reflector Dish	ePMP 1000 PTP	C050900H008	✓
✓	Cambium Networks		5 GHz Integrated Antenna	ePMP 1000 PTP		✓
✓	Cambium Networks		Integrated + CLIP	PTP-450	C050000D001	✓
✓	Cambium Networks		Integrated + Reflector Dish	PTP-450	HK2022	✓
✓	Cambium Networks		Integrated Antenna	PTP-450		✓
✓	Cambium Networks		Integrated Dual Polar Antenna	PTP-650		✓
✓	Cambium Networks		Integrated Dual Polar Antenna	PTP-700		✓
✓	Cambium Networks		Integrated Dual Polar Antenna			✓
✓	Cambium Networks		Small Form Factor Integrated Antenna	PTP-650S		✓
✓	*Andrew*	*1.25ft*	*Flat Panel*		*UBXP375-4-1*	
	Andrew	10ft	Parabolic		P10F-57W	
	Andrew	12ft	Parabolic		P12F-57W	

Figure 3.62: Available PTP Antennas

If the antenna pattern is stored in LINKPlanner then when the antenna is selected the **Save Antenna Pattern** will be highlighted. To save the antenna pattern click and select the required folder and if necessary adjust the default filename. Not all antennas have antenna patterns stored within LINKPlanner.

PTP Unlicensed and Subscriber Module Antennas Only

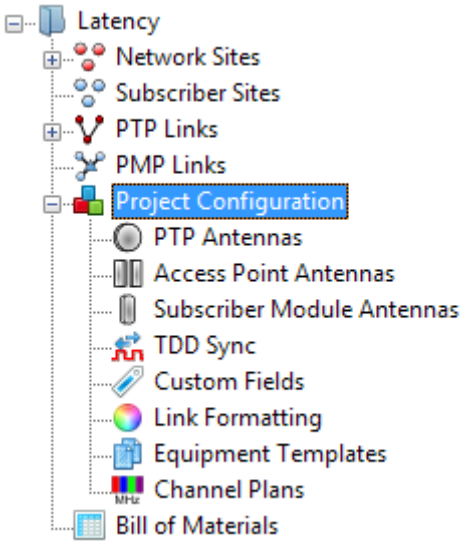
If the required antenna is not in the list, click New Antenna and enter the details in the User Defined Antenna page. New antennas can only be added in the unlicensed PTP band and for Subscriber Modules. At present the licensed PTP band and Access Points only support Cambium antennas.

To delete a new antenna, click Delete Antenna, this feature is only available for new antennas created by the user.

To edit antenna details, click Edit Antenna and change the details in the Edit Antenna page. This feature only applies to unlicensed PTP band and Subscriber Module antennas.

TDD Synchronization List

When TDD Syncnronization is enabled for one or more PTP links in the project(as described in *Link Description and Equipment*), they appear in the *TDD Synchronization List*. To display this list, click the “TDD Sync” node in the navigation tree.



The list is displayed in the right hand panel. If the TDD Sync node is selected when none of the links in the project are Sync enabled, the following message is displayed:

This project has no synchronized links

Use the TDD Sync list to adjust the Maximum Burst Duration and Frame Duration.

Before a data rate can be considered accurate it needs to be valid. If the TDD synchronization settings are invalid, the link is displayed with a pink background and Aggregate Throughput is set to zero.

NOTE

In order to observe both the individual link and the TDD synchronization parameters together, try opening the *TDD Synchronization List* in a new window.

TDD Synchronization in Latency

Maximum Burst Duration (µs) : 1088 Frame Duration (µs) : 2500 (1)

Longest same-phase path : 49.007 km (estimated best frame duration: 2618 µs)

Number of interfering paths : 4

Synchronized Links

Name	Range (km)	Burst Duration (µs)	Actual Burst Duration (µs)	Frame Duration (µs)	Slave RX-TX Gap (µs)	TDD Frame Offset (µs)	Phase 1 End	Phase 2 End
Point A to Point C (8 km)	8.000	1088	1088	2500	136	15	Point A	Point C
Point A to Point B (0.1 km)	0.100	1088	1088	2500	162	15	Point A	Point B
Point A to Point D (48.3 km)	48.350	1088	1088	2500 (invalid)	0 (invalid)	0	Point A	Point D

Figure 3.63: TDD Synchronization List

The Maximum Burst Duration and Frame Duration possibilities are affected by the Bandwidth selected for each link. The number in the brackets for each of the drop down lists is the number of links NOT satisfied by the value selected:

Maximum Burst Duration: Adjusting this value while reviewing the Burst Duration in the table will help to give a view on the RF efficiency of the link. If the

Burst Duration in the table is not the same as the Maximum Burst Duration (indicating poor RF Efficiency) either change the Maximum Burst Duration or change the bandwidth of the link on the Link page (as described in *Link Description and Equipment*).

Frame Duration: Adjusting the frame duration to a large enough value to ensure that there are no same phase interfering paths is the most probable requirement. The number of interfering paths may take a few moments to calculate for large networks and thus the number is obscured by a progress bar during this recalculation. A larger value for Frame Duration reduces the number of interfering paths. These interfering paths only refer to the timing considerations and do not take into account any propagation factors of path length or obstructions.

The TDD Synchronization list can be saved as a CSV or Excel file by selecting View in Spreadsheet  , see *TDD Synchronization List*.

Custom Fields

Use Custom Fields to add information, e.g. status, to sites, links and ends. Different types of Custom Fields can be created:

- **New Project Field** - field name and value are displayed in the General Information section of the Project page, see *General Information*.
- **New Network Site Field** - field name and value are displayed in the Details section of the Network Site page, see *Details in Site Page* and shown in the Network Sites list.
- **New Subscriber Site Field** - field name and value are displayed in the Details section of the Subscriber Site page, see *Details in Site Page* and shown in the Subscriber Sites list.
- **New PTP Link Field** - field name and value are displayed in the Link Description section of the PTP link page, see *Link Description* and shown in the PTP links list. PTP Link Fields can also be selected as link properties in the Link Formatting rules, see *Link Formatting Rules*.
- **New Hub Field** - field name and value are displayed in the Details section of the Hub page, see *Hub Details* and shown in the Hubs list view.
- **New Access Point Field** - field name and value are displayed in the Access Point Details section of the Access Point page, see *Access Point Details* and shown in the Access Point list view.
- **New Subscriber Module Field** - field name and value are displayed in the Subscriber Module Details section of the Subscriber Module page, see *Subscriber Module Description* and shown in the Subscriber Modules list view.

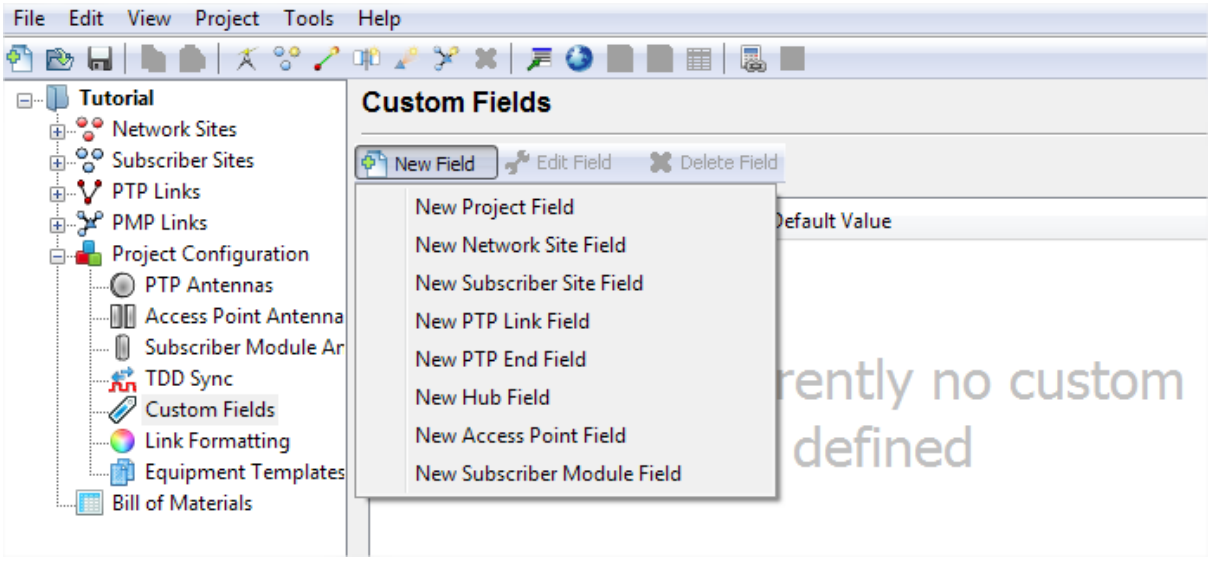


Figure 3.64: New Custom Field Options

Creating a Custom Field

To create a new custom field select one of the above options and the **Create custom field** window is displayed.

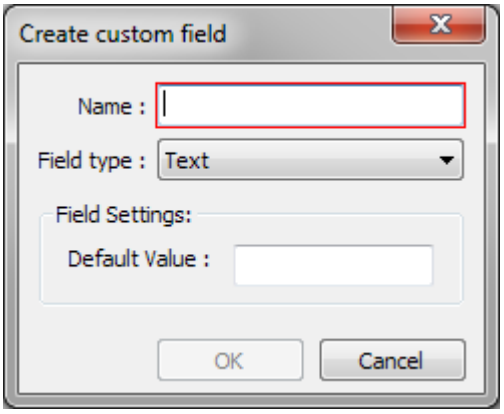


Figure 3.65: Create Custom Field

Enter a Name and then select the Field Type from the following options:

- **Text** - Field only has one value. Enter the value for the field in the Default Value box.
- **Yes/No** - Field can take the value of Yes or No. Select Yes or No as the Default Value.
- **List** - Field will display a list of values. Add or delete items in the list by selecting "+" or "-", in the Choices section. Enter the option for the default value. To change from the default option for a particular location, select another option from the list, which will then be highlighted, see *Custom Field List Option*.
- **Choice** - Field will display one value out of a list of values, see *Custom Field*

Choice Option. Add or delete items in the choices by selecting “+” or “-”, in the Choices section. Enter the option for the default value. To change from the default option for a particular location, select another option from the drop down list, see *Custom Field Choice Option*.

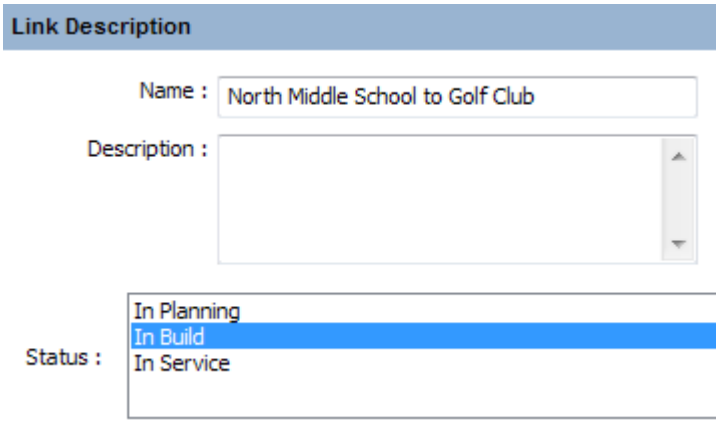


Figure 3.66: Custom Field List Option

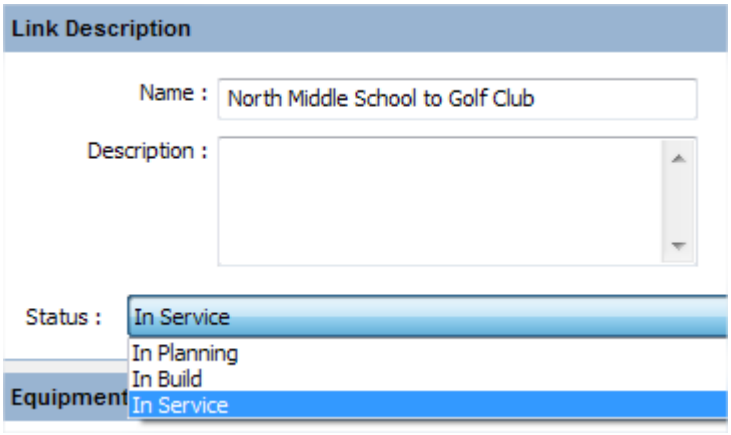


Figure 3.67: Custom Field Choice Option

Link Formatting Rules

Link formatting rules can be defined for both PTP and PMP links. Link formatting rules are used to control the color, style and visability of links in the project. They can also be used to exclude links from reports and project exports e.g. Google Earth (kmz/kml) files. Each rule is tested against the links in the project. If the rule evaluates to “true” for the link, then the rule actions are applied.

The rules are applied in the order that they are defined in the Link Formatting List. To change the order of the items, drag and drop them at the new location.

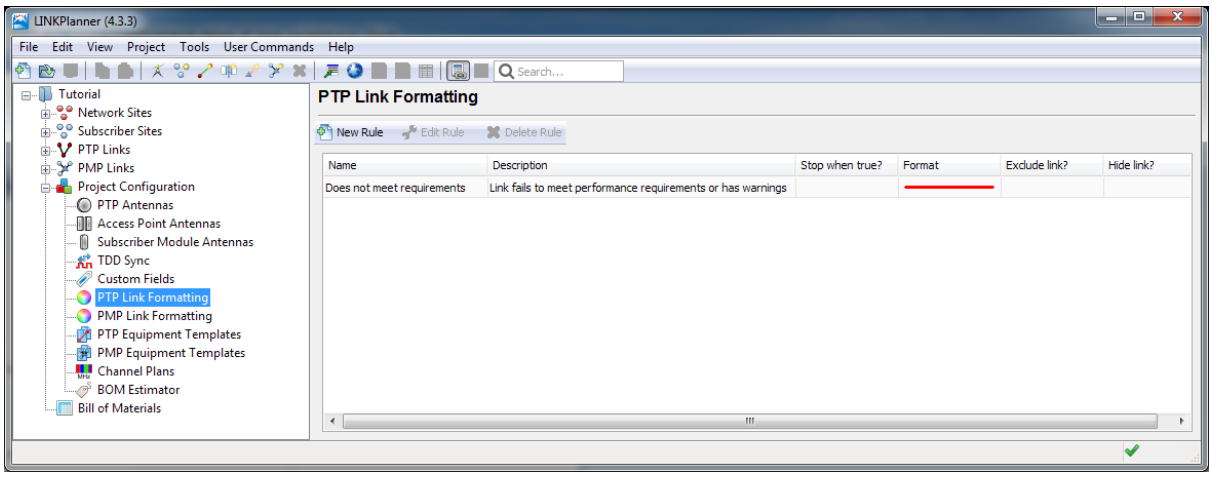


Figure 3.68: Link Formatting Page

Creating a Rule

To create a new rule click the appropriate node in the *Navigation Tree*. The **PTP Link Formatting** node is used to define the rules for PTP links and the **PMP Link Formatting** node is used to define the rules for PMP links. When the link formatting panel appears click on the 

button. The *Rule Editor* will appear.

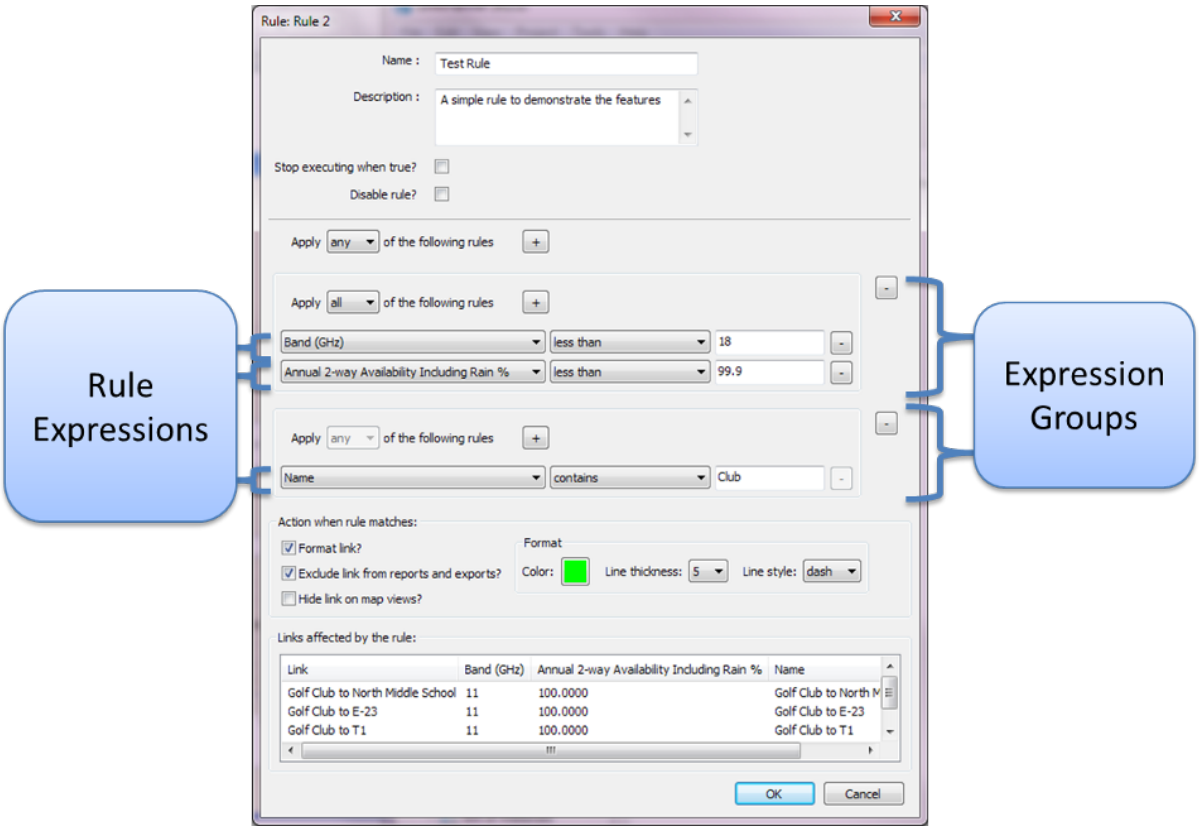


Figure 3.69: Rule Editor

Basic Rule Settings

Option	Description
Name	The rule name
Description	A description of the rule behavior (optional)
Stop executing when true?	If ticked, then any rules that come after this rule in the formatting rules list will not be tested against the link
Disable rule?	If ticked then the rule is not tested against any links in the project

Rule Groups and Expressions

The rule can consist of a number of **Expression Groups**. Each group can contain one or more **Rule Expressions**. Within a group you can choose to test that:

- **All** of the expressions are successful (boolean AND)
- **Any** of the expressions are successful (boolean OR)

You can also choose to test that **All** or **Any** of the expression groups are successful.

Click on the **+** or **-** buttons to add and remove the **Rule Expressions** and **Expression Groups**.

The individual expressions are used to test properties of the link. The *Rule Expression* consists of the link property a predicate and a value to test against.

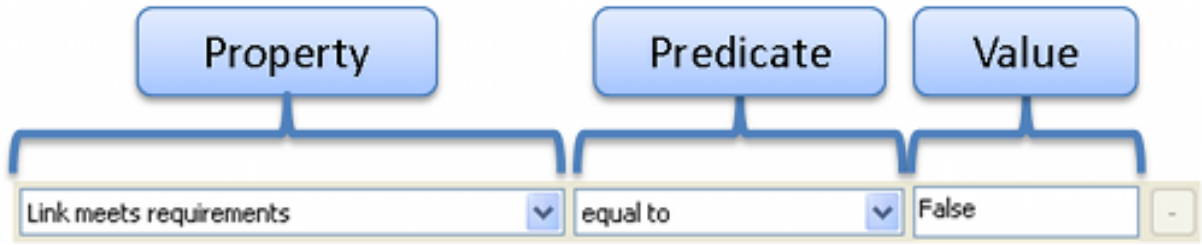


Figure 3.70: Rule Expression

The **property** list contains many of the link and site attributes that can be viewed in either the PTP Links panel (see *Displaying PTP Links*) or the PMP Links panel (see :doc: *displaying_pmp_network*). Where possible, the test value is converted to a number before the rule is evaluated. All text-based comparisons are case-sensitive.

When the rule expressions are modified, the rule is tested against the links in the project. Any links that match the rule conditions are displayed in the **Links affected by the rule** list.

Several different actions can be set for links that match the rule.

Rule Actions

Option	Description
Format link?	Apply additional formatting to the link
Color	The color of the link. If the color is set to white then the default color will be used.
Line thickness	The thickness of the link line on the offline map. If left blank then the default line thickness will be used.
Line style	The line style used when displaying the link in the offline map. If left blank then the default line style is used.
Exclude link from reports and exports?	Links will not appear in the reports or in any export formats (e.g. Google Earth kml/kmz)
Hide link on map views?	Links will not appear in any of the maps

Copying Link Formatting Rules

One or more formatting rules can be copied from the Link Formatting list. Select one or more rules that you wish to copy:

- On Windows, hold the **Ctrl** key when selecting.
- On OSX, hold the **Command** key when selecting (on some Apple keyboards, this key also has an Apple logo).

Once you have selected the rules, right-click in the Link Formatting list and choose **Copy** from the *Formatting Rules Pop-up Menu*.

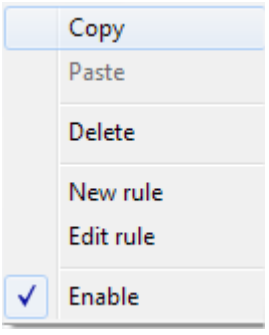


Figure 3.71: Formatting Rules Pop-up Menu

Pasting Link Formatting Rules

If the clipboard contains any link formatting rules then the paste commands will be enabled. Click or **Edit** - **Paste** to paste the formatting rules into the current project.

Equipment Templates

Equipment Templates can be defined for PTP links and access points. The default Equipment Template will be used to configure each new PTP link or access point in the project. If the project does not contain an appropriate equipment template

then a default template will be generated when required. This will then become the default equipment template.

A project can contain multiple equipment templates and, when combined with *Project Templates*, they make it very easy to create many links or access points with a common starting configuration.

Existing links or access points can be configured with a template making it easy to quickly change the configuration of one or more items (see Applying an Equipment Template).

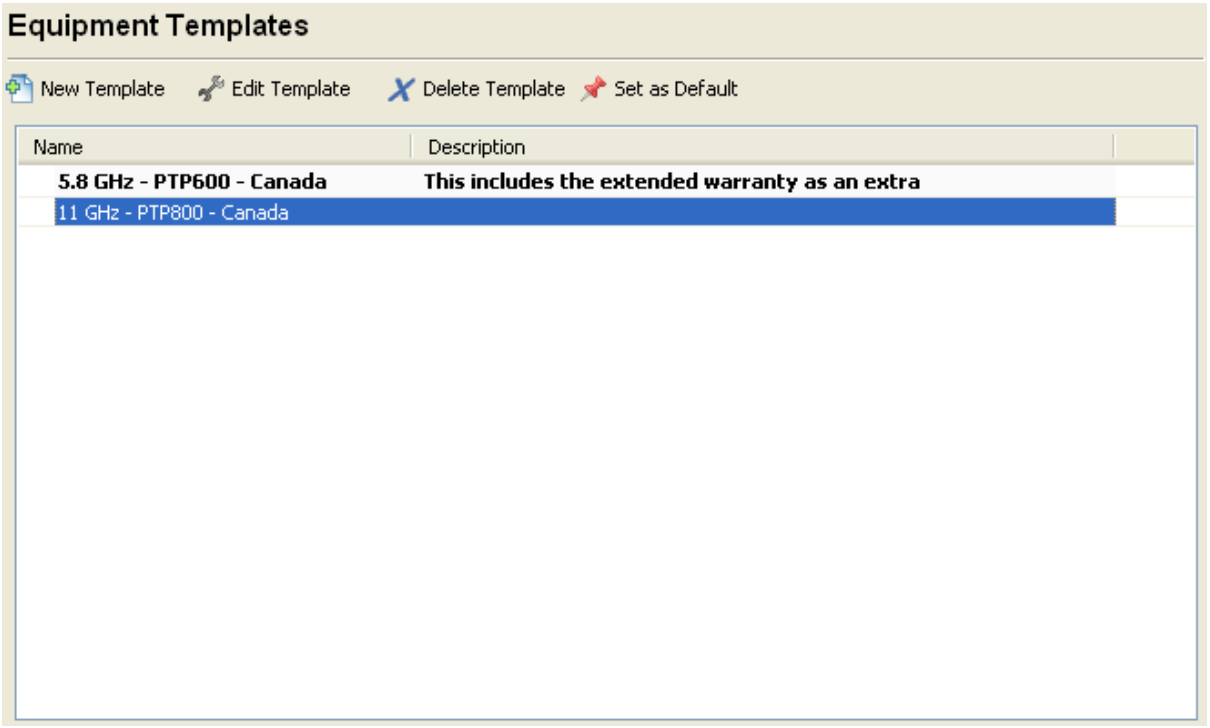


Figure 3.72: Equipment Templates Page

Creating a Template

To create a new equipment template click the appropriate node in the *Navigation Tree*. The **PTP Equipment Templates** node is used to define the templates for PTP links and the **PMP Equipment Templates** node is used to define the templates for access points. When the template panel appears, click on the **New Template** button. The *Equipment Template Editor* will appear. Note that the dialog will show a panel similar to the PTP link panel or the access point panel as appropriate.

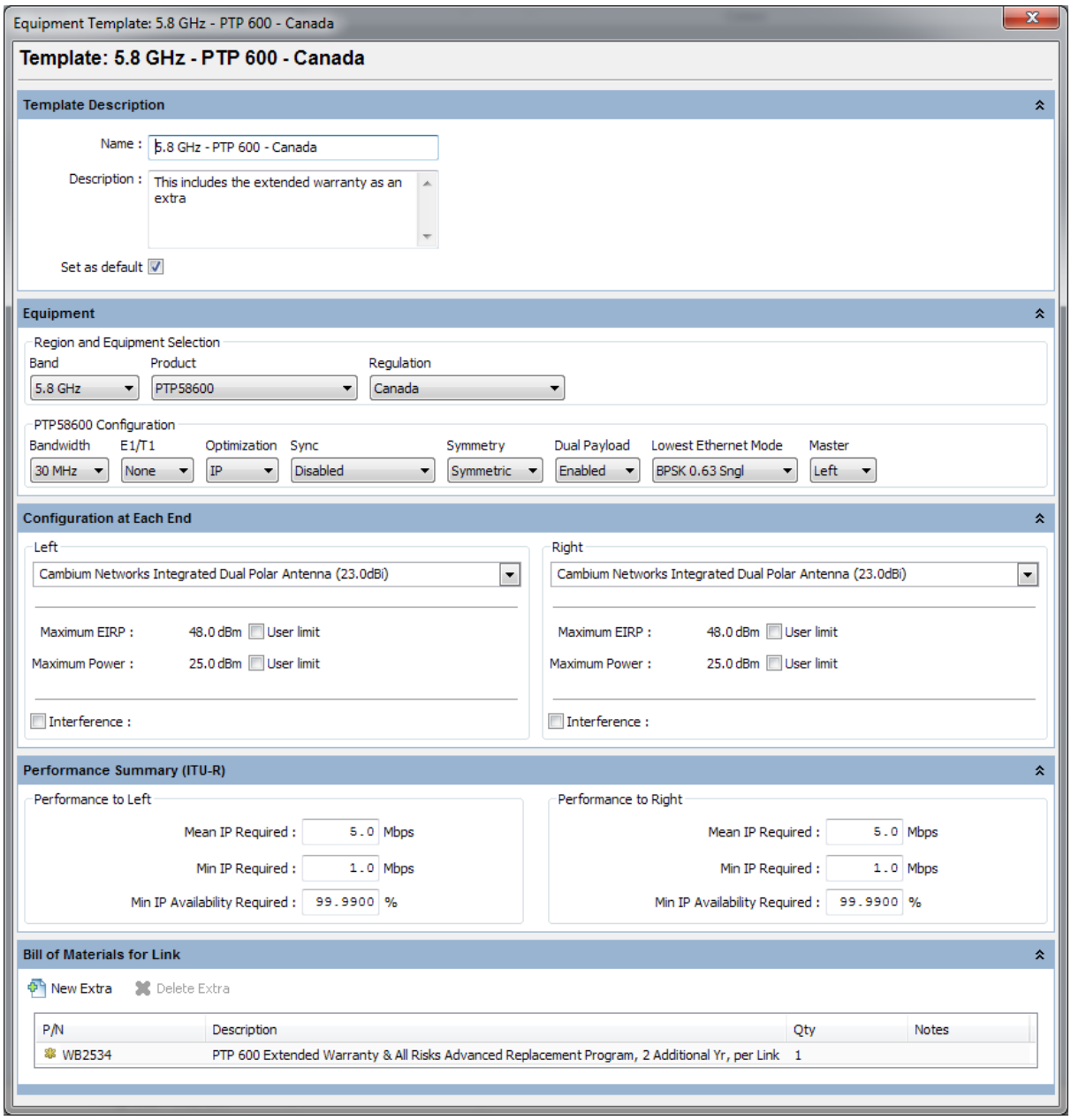


Figure 3.73: Equipment Template Editor

The equipment template can be configured in the same manner as a regular link or access point. Note that for PTP links, only the Primary to Primary path or Link A can be configured for 1+1 and 2+0 links. The other paths or Link B will be configured with the same parameters as the Primary to Primary path or Link A.

Optional extras can be added to the template. Any item that uses the template will then include the extras.

Setting the Default Equipment Template

The default equipment template will be used to configure any new links or access points. There are three ways to set the default equipment template.

First, navigate to the *Equipment Templates Page* and select the appropriate

template in the equipment template list. Then follow one of the steps listed below:

- Click 

- Edit the template and tick **Set as default**
- Right-click on the template and choose **Set as default** from the *Equipment Templates Pop-up Menu*

Creating a Template from an Existing PTP Link or Access Point

An equipment template can be created using the settings of an existing link or access point. For PTP links, navigate to the **PTP Links** page and select the appropriate link. For access points, select the access points from the **Access Points** table under the PMP Links page or on a Hub page. Next, right-click and click **Save as equipment template** from the pop-up menu.

Applying an Equipment Template

An existing equipment template can be applied to one or more links or access points. To do this navigate to one of the table views such as the **PTP Links** page or the **Access Points** table on the **PMP Links** page, then select the items that require a new template. Right-click on one of the selections to display the *Links Pop-up Menu*. Click **Apply equipment template** and then choose the appropriate equipment template from the sub-menu.

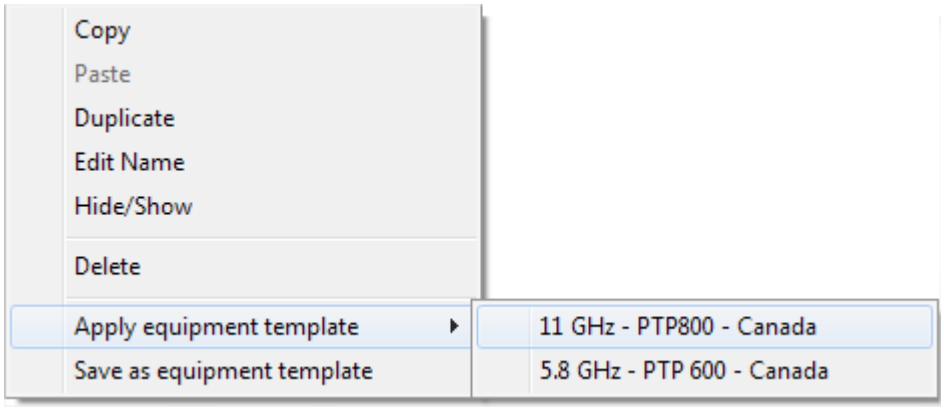


Figure 3.74: Links Pop-up Menu

Editing a Template

To edit a template, either:

- Select the template in the list and then click **Edit Template**
- Double-click a template in the equipment template list

Deleting Templates

One or more equipment templates can be removed from the project. Select one or more templates:

- On Windows, hold the **Ctrl** key when selecting.
- On OSX, hold the **Command** key when selecting (on some Apple keyboards, this key also has an Apple logo).

Once you have selected the templates, either click the **Delete** button or right-click in the Equipment Template list and choose **Delete** from the *Equipment Templates Pop-up Menu*.

Figure 3.75: Equipment Templates Pop-up Menu

Copying Equipment Templates

One or more equipment templates can be copied from the Equipment Templates list. Select one or more templates that you wish to copy:

- On Windows, hold the **Ctrl** key when selecting.
- On OSX, hold the **Command** key when selecting (on some Apple keyboards, this key also has an Apple logo).

Once you have selected the templates, right-click in the list and choose **Copy** from the *Equipment Templates Pop-up Menu*.

Pasting Equipment Templates

If the clipboard contains any equipment templates then the paste commands will be enabled. Click or **Edit** - **Paste** to paste the equipment templates into the current project.

Channel Plans

Channel Plans only apply to PMP networks. Use the Channel Plans to define a group of channels to be used within a PMP network. Allocate colours to each channel to show a visualization of the frequency plan in the Offline Map. This is a quick and easy way to spot potential issues.

To create an individual channel plan select **New Channel Plan** and a row will be added to the Channel Plan. Set the **Band**, **Product**, **Country**, **Bandwidth** and **Raster** from the drop down lists. Then choose the frequencies for each channel from the drop down list in each channel. The list of available frequencies for subsequent channels is dependent on the previous frequencies selected.

If required increase or decrease the number of channels required.

To set the color for each Channel, either right click on the Channel and choose **Color** or select the Channel and then click on **Color** from the toolbar.

To automatically create rows for the product configurations in the project file click on **Create Plans**. A row for each Band, Product, Country and Bandwidth combination will be added to the Channel Plan list.

To delete a Channel Plan click on **Delete Channel Plan**.

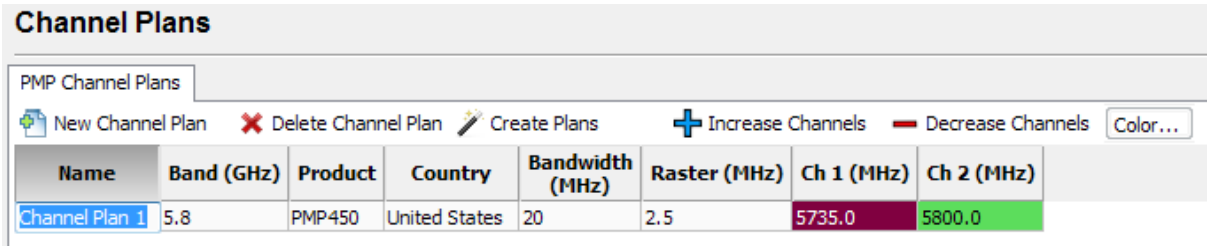


Figure 3.76: Channel Plan Menu

BOM Estimates

BOM Estimates can be used to quickly generate the Bill of Materials for a range of PTP link types and PMP Access Networks, without having to fully define and configure individual PTP links or layout the access network.

NOTE

Retired products are not available in the estimates. IRFU and long waveguide links, as well as the TDM Modules for PTP 810 links cannot be estimated at this time.

Always use the latest version of LINKPlanner before generating a BOM Estimate to ensure that the latest available parts are used. When updating LINKPlanner check that all existing configurations are still as required. If parts have been retired, removed or updated, existing configurations will update automatically to the latest parts or change to default parts, if the previous part has been removed or made obsolete.

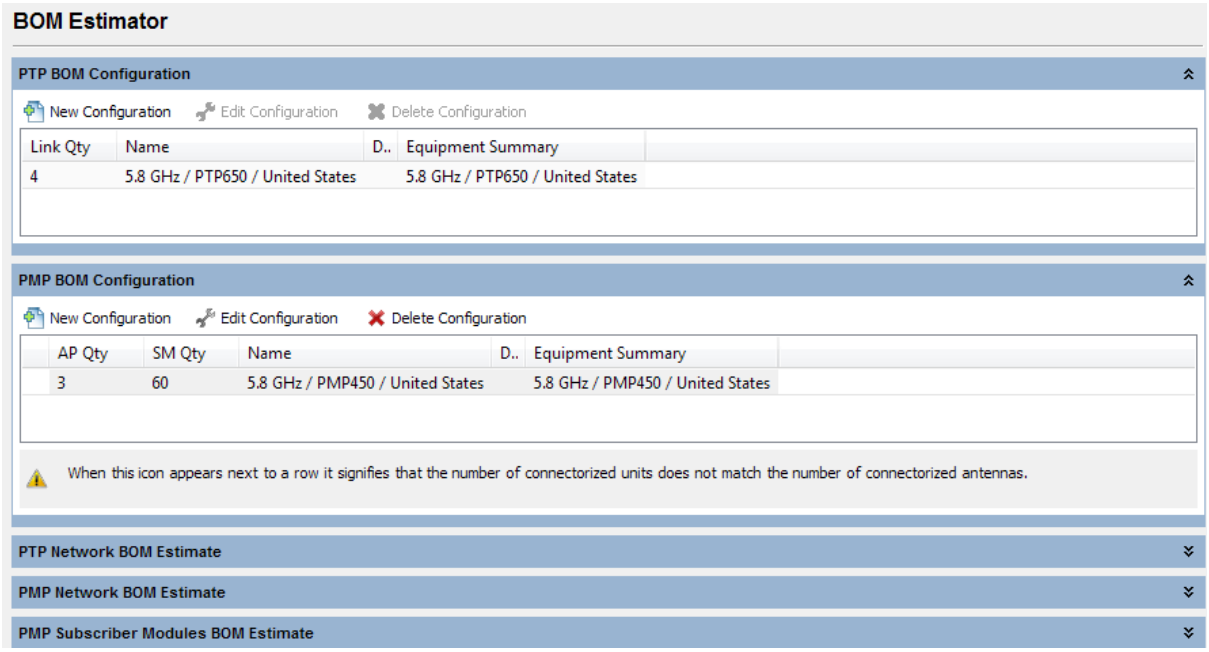


Figure 3.77: BOM Estimator Panel - Configuration

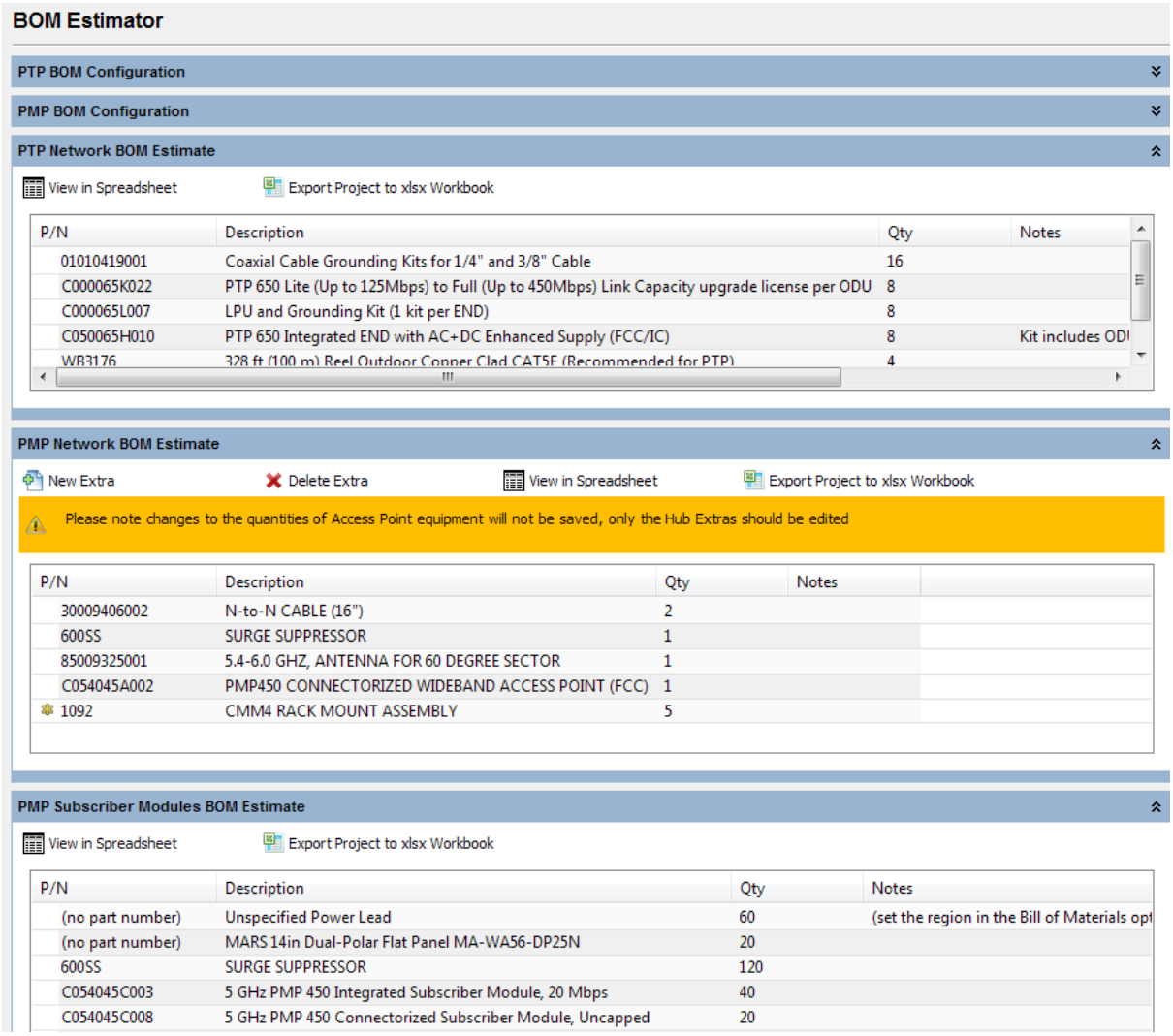


Figure 3.78: BOM Estimator Panel

Creating a PTP Estimate

Click on the **New Configuration** button in the **PTP BOM Configuration** panel to create an initial estimate and display the *BOM Estimate Dialog for PTP*. The dialog shows a reduced set of options for configuring a PTP link. Only options which can impact the BOM are available.

NOTE

Link types that result in multiple paths, such as 1+1 Hot Standby, are all configured through the single page. The secondary antenna selection will appear in the end panel when required.

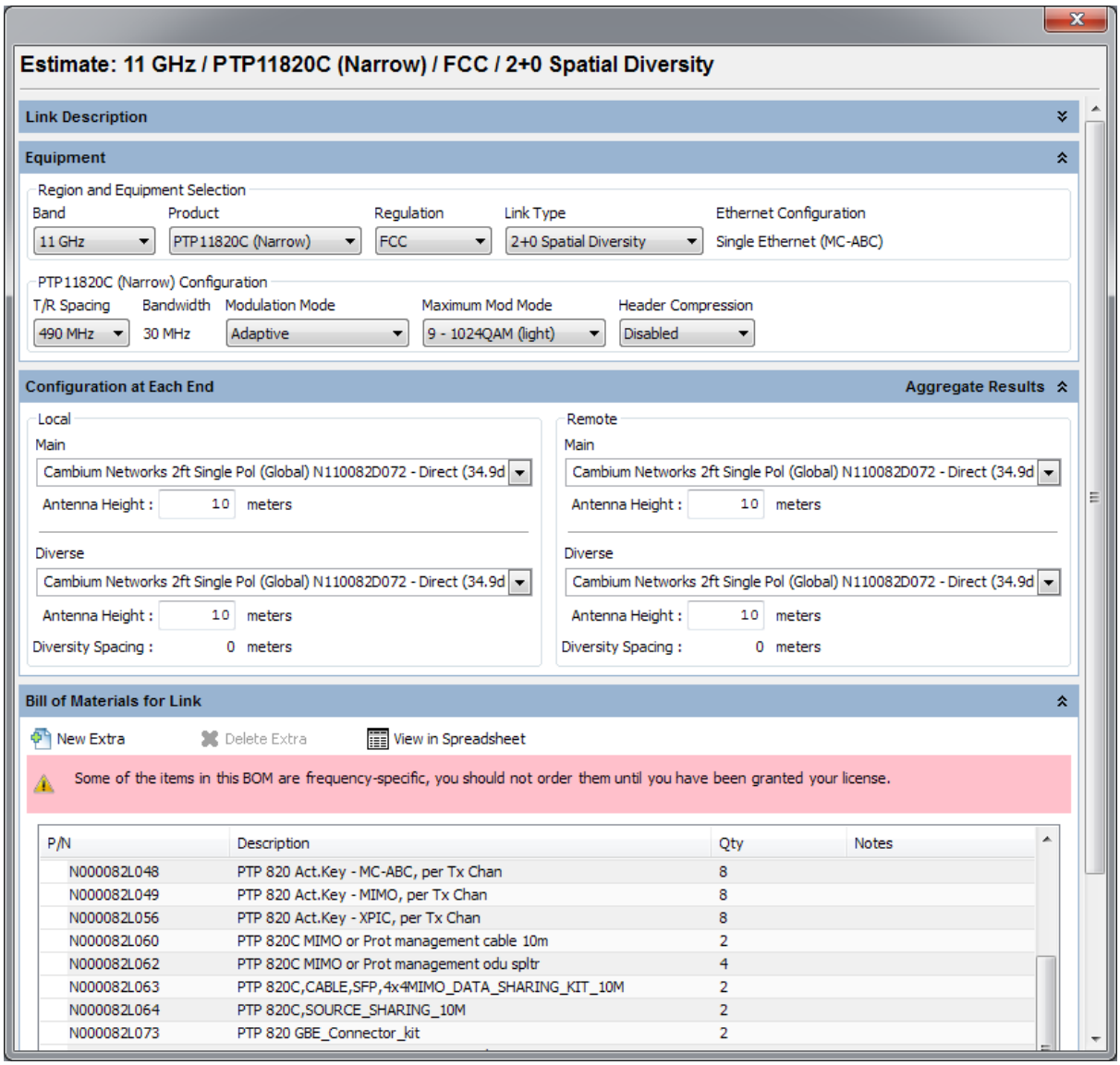


Figure 3.79: BOM Estimate Dialog for PTP

The estimate name defaults to a summary of the equipment configuration. The name and description can be changed in either the estimate dialog or through the **PTP BOM Configuration** table (*Editing the Estimate Description*). The item quantity can be edited in the **PTP BOM Configuration** table (see *Editing the Quantity*). To return to the default estimate name simply delete the current text.

Figure 3.80: Editing the Estimate Description

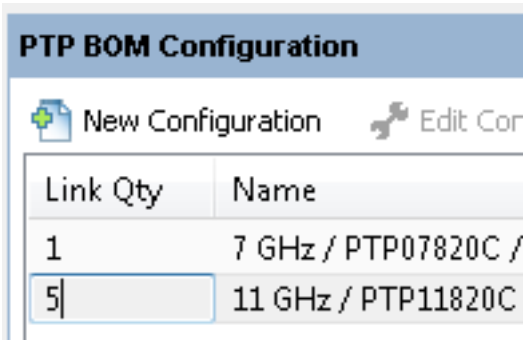


Figure 3.81: Editing the Quantity

The **Bill of Materials for Link** section in the PTP BOM Estimator Dialog shows the equipment required for the single link. The **PTP Network BOM Estimate** shows the equipment for each estimate multiplied by its link quantity to give an overall BOM Estimate for the PTP network design.

NOTE

Items which come in multi-packs are shown as the number of individual items. To get the total number of packs required, divide the quantity by the pack size.

Creating a PMP Estimate

Click on the **New Configuration** button in the **PMP BOM Configuration** panel to create an initial estimate and display the *BOM Estimate Dialog for PMP*. The dialog shows a reduced set of options for configuring an Access Point in the top part of the panel. Only options which can impact the BOM are available.

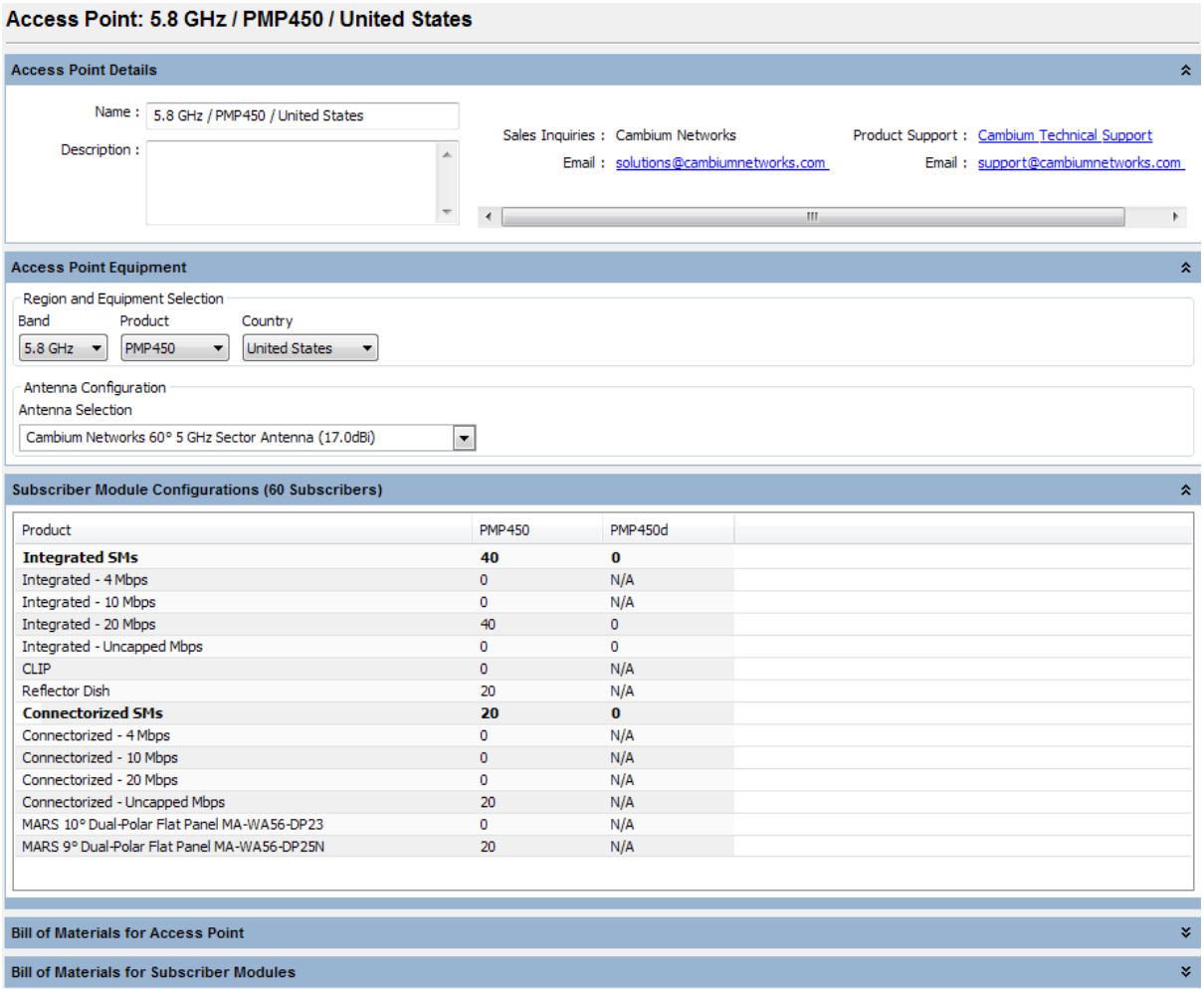


Figure 3.82: BOM Estimate Dialog for PMP

In the next section allocate all the Subscriber Modules required on this access network. These are for all the access points of this type, not per access point. Select the number of Integrated and Connectorized SMs required. For the integrated SMs select the number and type of antenna enhancements from the available list. For the connectorized SMs select the number of each type of external antenna required.

The headings in **bold** show the total number of integrated and connectorized SMs selected and the total number of subscriber modules allocated is shown in brackets in the section header and in the **SM Qty** column of the **PMP BOM Configuration**.

NOTE

A warning will be shown if the number of external antennas is not the same as the number of connectorized subscriber modules. If a custom antenna is deleted from the **Subscriber Module Antennas** list it will automatically disappear from the BOM Estimator.

The estimate name defaults to a summary of the Access Point equipment configuration. The name and description can be changed in either the estimate dialog or through the **PMP BOM Configuration** table in the same way as for PTP

Estimates. The number of Access Points can be edited in the AP Qty column of the **PMP BOM Configuration** table, however the number of Subscriber Modules can only be changed by editing the number of integrated and connectorized SM options.

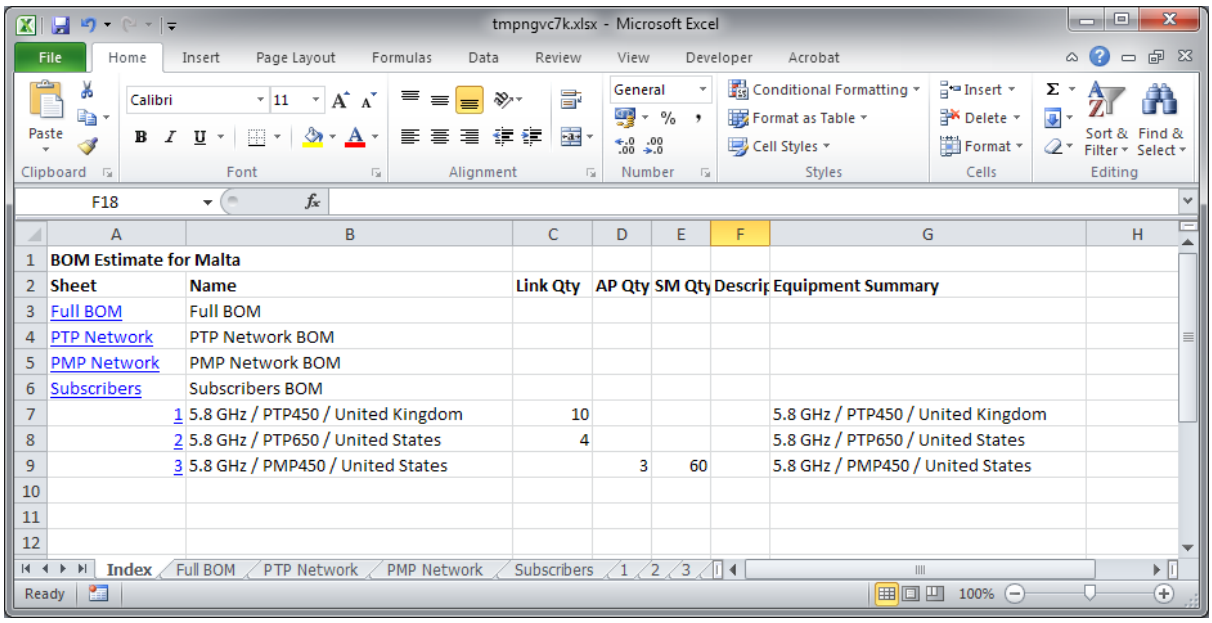
The **Bill of Materials for Access Point** section in the PMP BOM Estimator Dialog shows the equipment required for the single access point and the **Bill of Materials for the Subscriber Modules** shows the equipment required for all the subscriber modules allocated for this access point network.

The **PMP Network BOM Estimate** shows the network equipment for each PMP estimate multiplied by its AP quantity to give an overall PMP Network BOM Estimate for the design. To add additional equipment at the hub sites, select **New Extra** on the **PMP BOM Network Estimate** header and add the required parts from the list of optional extras, then set the quantities for each part. Only the quantities for the optional extras will be saved as changes with the project, changes to quantities of the AP items at this level will not be stored. The **PMP Subscriber Modules BOM Estimate** shows the total subscriber module equipment for all PMP estimates to give an overall PMP Subscriber Module BOM Estimate

Exporting the BOM Estimate as a Spreadsheet

The BOM for all of the estimates for each of the BOM types (PTP, PMP Network and PMP Subscriber Modules) can be exported as a spreadsheet. To do this, click  Export Project to xlsx Workbook, on any of the BOM Estimate panels. This will open a spreadsheet containing the estimates for the project. The spreadsheet will consist of the following, (see *Estimate Spreadsheet*):

- an index sheet
- a sheet containing the full BOM for all of the estimates, both PTP and PMP
- a sheet containing the BOM for all PTP estimates
- a sheet containing the BOM for all PMP Network estimates
- a sheet containing the BOM for all PMP Subscribers
- individual sheets for each estimate configuration.



	A	B	C	D	E	F	G	H
1	**BOM Estimate for Malta**							
2	**Sheet**	**Name**	**Link Qty**	**AP Qty**	**SM Qty**	**Descrip**	**Equipment Summary**	
3	Full BOM	Full BOM						
4	PTP Network	PTP Network BOM						
5	PMP Network	PMP Network BOM						
6	Subscribers	Subscribers BOM						
7	1	5.8 GHz / PTP450 / United Kingdom	10				5.8 GHz / PTP450 / United Kingdom	
8	2	5.8 GHz / PTP650 / United States	4				5.8 GHz / PTP650 / United States	
9	3	5.8 GHz / PMP450 / United States		3	60		5.8 GHz / PMP450 / United States	
10								
11								
12								

Figure 3.83: Estimate Spreadsheet

Exporting and Reporting

Site and Link data can be exported in CSV or KML format, as described in *Exporting Data*.

Reports can be created in PDF format for the currently open and selected project, as described in *Creating Reports*.

Exporting Data

Data can be exported in CSV or KML format for the currently open and selected project.

PTP Links (CSV)

To view the PTP link details in Excel, click the “PTP Links” node in the navigation tree and click **View in Spreadsheet**  .

To export the link details to a CSV file, click **File**, **Export**, **PTP Links (csv)**. The CSV file can then be incorporated into a spreadsheet to enable further analysis and costing of the project.

Network Sites (CSV)

To export details of all Network sites to a CSV file, click **File**, **Export**, **Network Sites (csv)**.

Subscriber Sites (CSV)

To export details of all Subscriber sites to a CSV file, click **File**, **Export**, **Subscriber Sites (csv)**.

PTP Links from this site (CSV)

To export details of all PTP links from a single site to a CSV file, click **File**, **Export**, **PTP Links from this site (csv)**.

Hubs (CSV)

To view the Hubs in Excel, click the “PMP Links” node in the navigation tree and click **View in Spreadsheet**  under **Hubs**.

To export details of all Hubs to a CSV file, click **File**, **Export**, **Hubs (csv)**. The CSV file can then be incorporated into a spreadsheet to enable further analysis and costing of the project.

Access Points (CSV)

To view the Access Points in Excel, click the “PMP Links” node in the navigation tree and click **View in Spreadsheet**  under **Access Points**.

To export details of all Access Points to a CSV file, click **File**, **Export**, **Access Points (csv)**. The CSV file can then be incorporated into a spreadsheet to enable further analysis and costing of the project.

Subscriber Modules (CSV)

To view the Subscriber Modules in Excel, click the "PMP Links" node in the navigation tree and click **View in Spreadsheet**  under **Subscriber Modules**.

To export details of all Subscriber Modules to a CSV file, click **File**, **Export**, **Subscriber Modules (csv)**. The CSV file can then be incorporated into a spreadsheet to enable further analysis and costing of the project.

Google Earth(TM) (KML)

To export details of a single site to a KMZ/KML file, click **File**, **Export**, **Google Earth (kmz/kml)**. The KMZ/KML file can then be used to view the project sites in Google Earth(TM).

Performance Chart Data (csv)

To export the data behind the PTP performance charts to a csv file, click **File**, **Export**, **Performance Chart Data (csv)**. This generates a four column table of Link Name, Site Name, Availability and Throughput, which can then be post processed as required.

FCC License Coordination

To export the information required for submission to the FCC Licensing Coordination body, click **File**, **Export**, **FCC License Coordination**. The information will be exported to a CSV file, in the format required by Comsearch. This is only available for licensed band PTP links.

PTP 450 / PMP 450 Configuration Files

To export the configuration files for PTP 450 and PMP 450 sites, click **File**, **Export**, **PTP450/PMP450 Configuration Files**. The information for all PTP 450 and PMP 450 sites will be exported to the selected folder and stored in separate sub-folders for PTP and PMP links. All PTP/PMP 450 ends must have a MAC Address before being exported, (see *Configuration at Each End (one end shown)* for PTP links, *Access Point Details* for Access Points and *Subscriber Module Description* for Subscriber Modules).

The configuration files exported from LINKPlanner only contain information defined within LINKPlanner, including location details and equipment configuration, such as country, bandwidth, transmit power, antenna gain, downlink data, control slots etc.

Site names which contain non-ASCII characters will not be included in the configuration file, as they cannot be displayed in the product.

PTP 450 / PMP 450 FCC Device Registration

To export the information required to register the Radio Locations for 3.65 GHz devices on the FCC website, click **File**, **Export**, **PTP450/PMP 450 FCC Device Registration**. The information will be exported to a CSV file in the order required by the online process for each AP and SM in the project.

There are a number of columns where the information is not directly available from the usual project fields. To include the information for these columns into the CSV file use the Custom Fields functionality to create fields for each column heading, see *Custom Fields*. For the Access Points it is recommended to configure the fields at the Hub as the information will usually be the same for a given location, any information entered for an individual AP will overwrite the Hub data for the same field. For Subscribers configure the fields at the Subscriber Module level. The Custom Fields must use exactly the same names as in the column headers in the csv, as shown below:

- FCC ASR Number
- City
- County/Borough/Parish
- State
- Support Structure Type

To automatically create these fields at the PTP End, Hub, Access Point and Subscriber Module level, click **Tools**, **Create FCC Device Registration Fields**.

Creating Reports

Reports can be created in PDF format for the currently open and selected project. There are four categories of report:

- PTP Proposal reports offer a general overview. Options are **Project** or **PTP Link**.
- PTP Installation reports contain detailed configuration and performance parameters. Options are **Project** or **PTP Link**.
- PMP Proposal reports offer a general overview. Options are **Project**, **Hub** or **Access Point**.
- PMP Installation reports contain detailed configuration and performance parameters for the PMP Links to Subscriber Modules. Options are **Project**, **Hub**, **Access Point** or **PMP Link**.

Installation reports contain ordered lists of field settings. These are very useful when completing the Installation Wizard of the ODU web interface.

PTP Proposal Reports

To obtain a PTP Proposal report, open the required page from the navigation tree (PTP Links list, or PTP Link), then choose to preview or create the report:

- To preview, click **Proposal Report PDF** 
- To create as a PDF, click **File, PTP Proposal Reports** and one of **Project** or **PTP Link**.

The **Project** proposal report consists of a project summary (customer details, network map, list of links and BOM) and plans of each link (path profile, throughput, link summary, performance charts, climatic factors & losses and BOM).

The **PTP Link** proposal report consists of a project summary, path profile, throughput, link summary, performance charts, climatic factors & losses and BOM.

PTP Installation Reports

To obtain a PTP Installation report, open the required page from the navigation tree (PTP Links list or PTP Link), then choose to preview or create the report:

- To preview, click **Installation Report PDF** 
- To create as a PDF, click **File, PTP Installation Reports** and one of **Project** or **PTP Link**.

The **Project** installation report consists of a project summary (customer details, network map, list of PTP links and BOM) and details of each PTP link (link summary, path profile, link configuration, site installation notes, detailed throughput data and regulatory conditions).

The **PTP Link** installation report consists of details of one PTP link (link summary, path profile, link configuration, site installation notes, detailed throughput data, regulatory conditions and BOM).

PMP Proposal Reports

To obtain a PMP Proposal report, open the required page from the navigation tree (PMP Links list, Hub, or Access Point), then choose to preview or create the report:

- To preview, click **Proposal Report PDF** 
- To create as a PDF, click **File, PMP Proposal Reports** and one of **Project**, **Hub** or **Access Point**.

The **Project** proposal report consists of a project summary (customer details, network map, list of Access Points, a BOM for PMP Network Equipment and a BOM for Subscriber Equipment). This is followed by a Hub report for each Hub in the project, which in turn includes the details for each Access Point.

The **Hub** proposal report consists of a project summary, a Hub Summary including a network map for the Hub, list of Access Points, and a BOM for the Network Equipment. This is followed by an Access Point report for each Access Point on the Hub.

The **Access Point** proposal report consists of a project summary, an Access Point Summary, a Subscriber Module Summary, detailed throughput data for the Access Point, a BOM for the Access Point Equipment and a BOM for the Subscriber Module Equipment.

PMP Installation Reports

To obtain a PMP Installation report, open the required page from the navigation tree (PMP Links list, Hub, Access Point or Subscriber Module), then choose to preview or create the report:

- To preview, click **Installation Report PDF** 
- To create as a PDF, click **File, PMP Installation Reports** and one of **Project**, **Hub**, **Access Point** or **PMP Link**.

The **Project** installation report consists of a project summary (customer details, network map, list of Access Points and BOM). This is followed by a Hub report for each Hub in the project, which in turn includes the Access Point and details of each PMP link, see the sections below for details on each lower level report.

The **Hub** installation report consists of a project summary (customer details, network map of the hub area, list of Access Points and BOM). This is followed by an Access Point report for each Access Point on the Hub and details of each PMP link.

The **Access Point** installation report consists of a project summary, Access Point Summary, installation notes for the Access Point, network map of the Access Point area, detailed throughput data for the Access Point, BOM and details of each PMP link.

The **PMP Link** installation report consists of details of one PMP link (link summary, path profile, installation notes for the Subscriber Module, Performance reports and BOM).

CHAPTER 4

Planning PTP links

The goal of PTP link planning is to ensure that each direction of the link will perform to an acceptable level, measured by the Throughput and Availability values in the *Performance Summary* section of the *Link Page*. To allow LINKPlanner to predict Throughput and Availability, the planner must enter the variables that affect link performance, such as: band, region, equipment, antenna, height, terrain, obstructions and reflection.

To achieve this goal, follow this process:

1. Start the application and set options. See *Starting the Application*.
2. Build a project to model a PTP link (or network). See *Projects*.
3. Enter details of all sites in the project. See *Sites*.
4. Define the links between sites, create profiles of those links and update the profiles with details of obstructions. See *Links*.
5. Adjust the link profile to allow for terrain height variance, obstructions and reflection. See *Adjusting Link Profiles*.
6. Confirm that the link will perform to an acceptable level, measured by the Throughput and Availability values in the *Performance Summary* section of the *Link Page*.
7. Export and report project, site and link data. See *Exporting and Reporting*
8. If TDD Synchronization is required, see *Setting TDD Synchronization*
9. If Hot Standby Protection is required, see *Setting Hot Standby Protection (1+1)*
10. If 2+0 Antenna Sharing is required, see *Setting 2+0 Antenna Sharing*
11. If ODUs are to be mounted indoors or at the base of the tower, see *Long Waveguide*
12. If Spatial or Frequency Diversity is required, see *Setting Diversity*

Links

Define the links between sites, obtain profiles of those links and enter link details. The process for each link is:

1. Create a new link by either importing from a spreadsheet as described in *Importing PTP Links from a Spreadsheet* or by connecting existing sites as described in *Creating PTP Links*.
2. Display the list of links in the project and open the new link, as described in *Displaying PTP Links*.
4. Enter the variables that affect performance, such as band, region, equipment, antenna and height. See *Link Page*.

For more information on improving the performance of links, see *Optimizing E1 or T1 Latency*, *Setting TDD Synchronization*, *Setting Hot Standby Protection (1+1)*, *Setting 2+0 Antenna Sharing* and *Long Waveguide*.

Importing PTP Links from a Spreadsheet

Use this method when PTP link information is in a spreadsheet. The required fields for each link are Name, Local Latitude, Local Longitude, Remote Latitude and Remote Longitude. The optional fields are Description, Local Antenna Height and Remote Antenna Height (*Link Data in a Spreadsheet*).

NOTE

The PTP link import file only imports the coordinates and heights, which is different from the format in which PTP links are exported from LINKPlanner as the export contains all the detailed link parameters. An exported PTP link CSV file cannot be imported directly back into LINKPlanner, without being edited to reduce it to the required columns.

The procedure is:

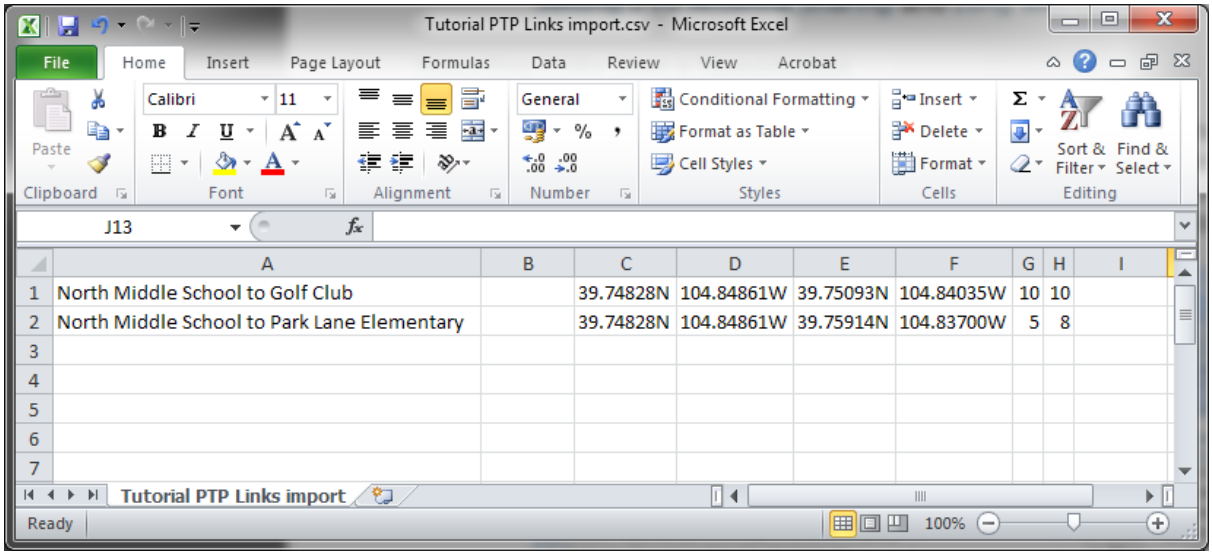


Figure 4.1: Link Data in a Spreadsheet

1. Import the data from a CSV file.

   To import from CSV: save the spreadsheet as a CSV (comma separated) file; then in LINKPlanner, click **File**, **Import**, **PTP Links from CSV**.

2. The *Table Import Wizard* is presented:

   LINKPlanner attempts to detect the correct delimiter and encoding for each CSV file, but it does not always succeed. If the data is not displayed in the correct columns, specify a different delimiter or encoding.

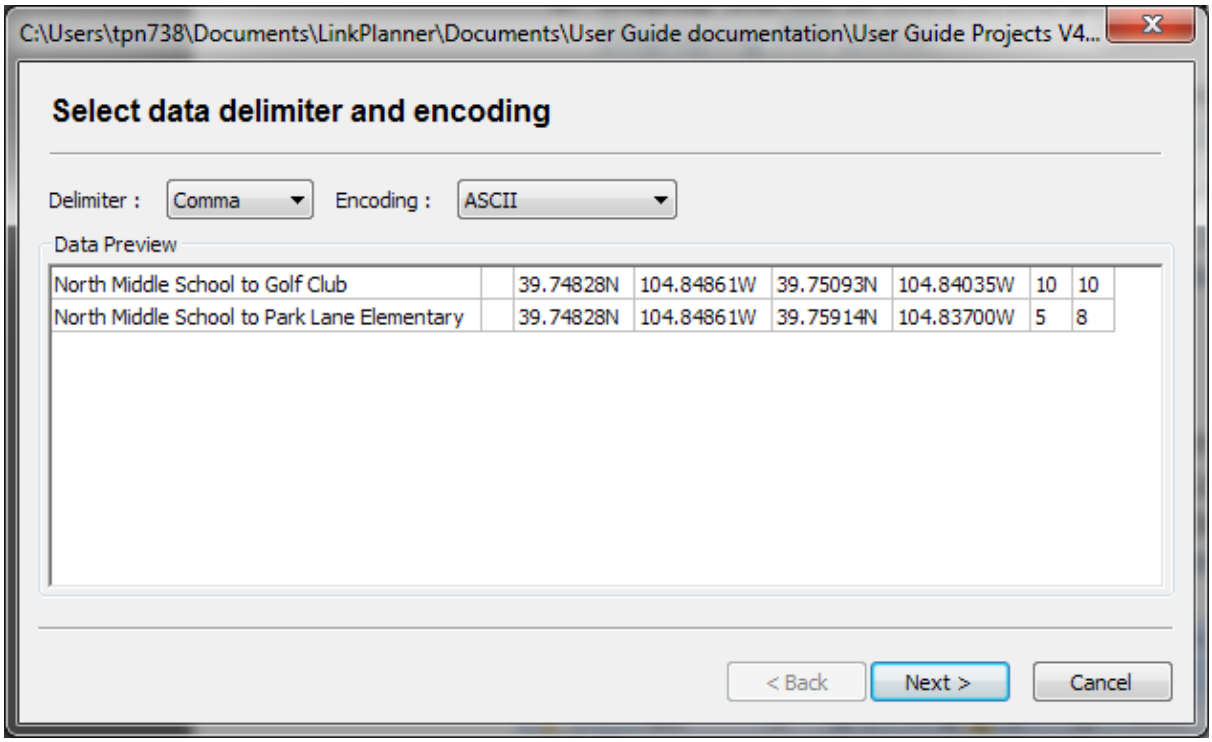


Figure 4.2: Table Import Wizard

3. Select the columns to be imported:

   If the first row contains column headings, tick **Skip first row**.

   For each column, select the correct attribute for the data in the column. Ensure that unwanted columns are ignored (*Selecting Columns to be Imported*). The antenna height values may be specified in feet or meters. Select multiple Description columns if required, but select the other columns once only.

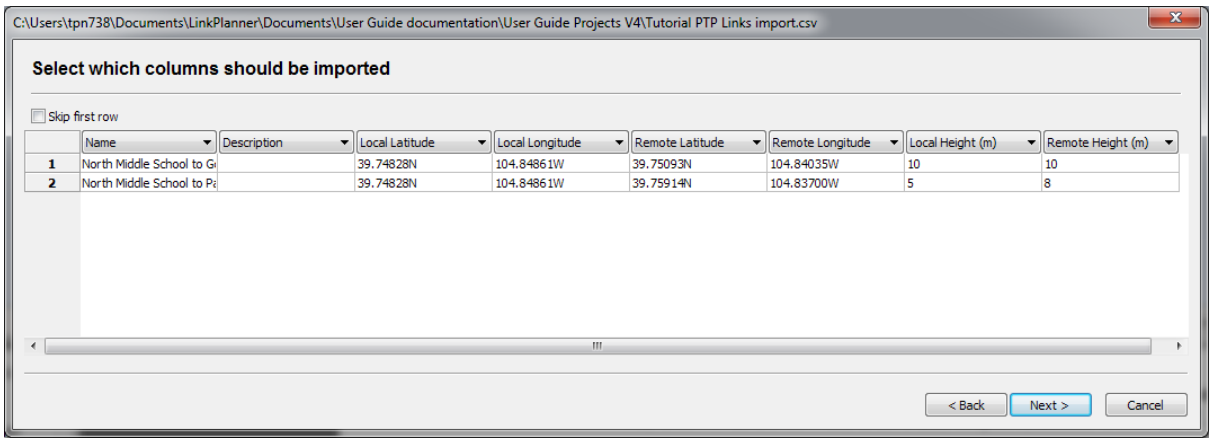


Figure 4.3: Selecting Columns to be Imported

4. Correct any values that cannot be imported:

   If LINKPlanner cannot interpret any of the values (for example, if a latitude or longitude is not formatted correctly), the cell is highlighted in red. Double-click in a red cell to edit it (*Link Value Cannot be Interpreted*).

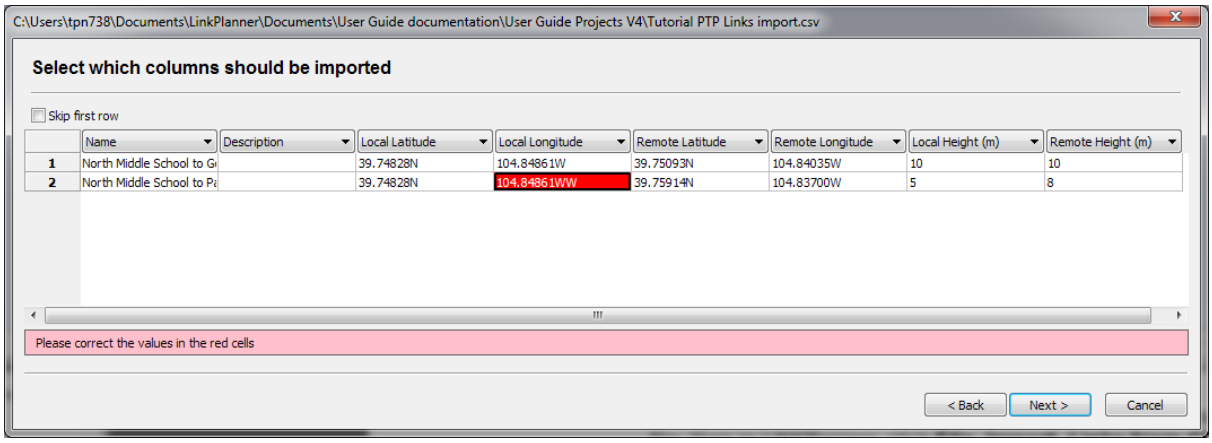


Figure 4.4: Link Value Cannot be Interpreted

5. Verify the map of newly imported links:

   The wizard displays a map of the new links and sites to confirm that the positions are correct (*Map of Newly Imported Sites and Links*). If they are correct, press **Finish**.

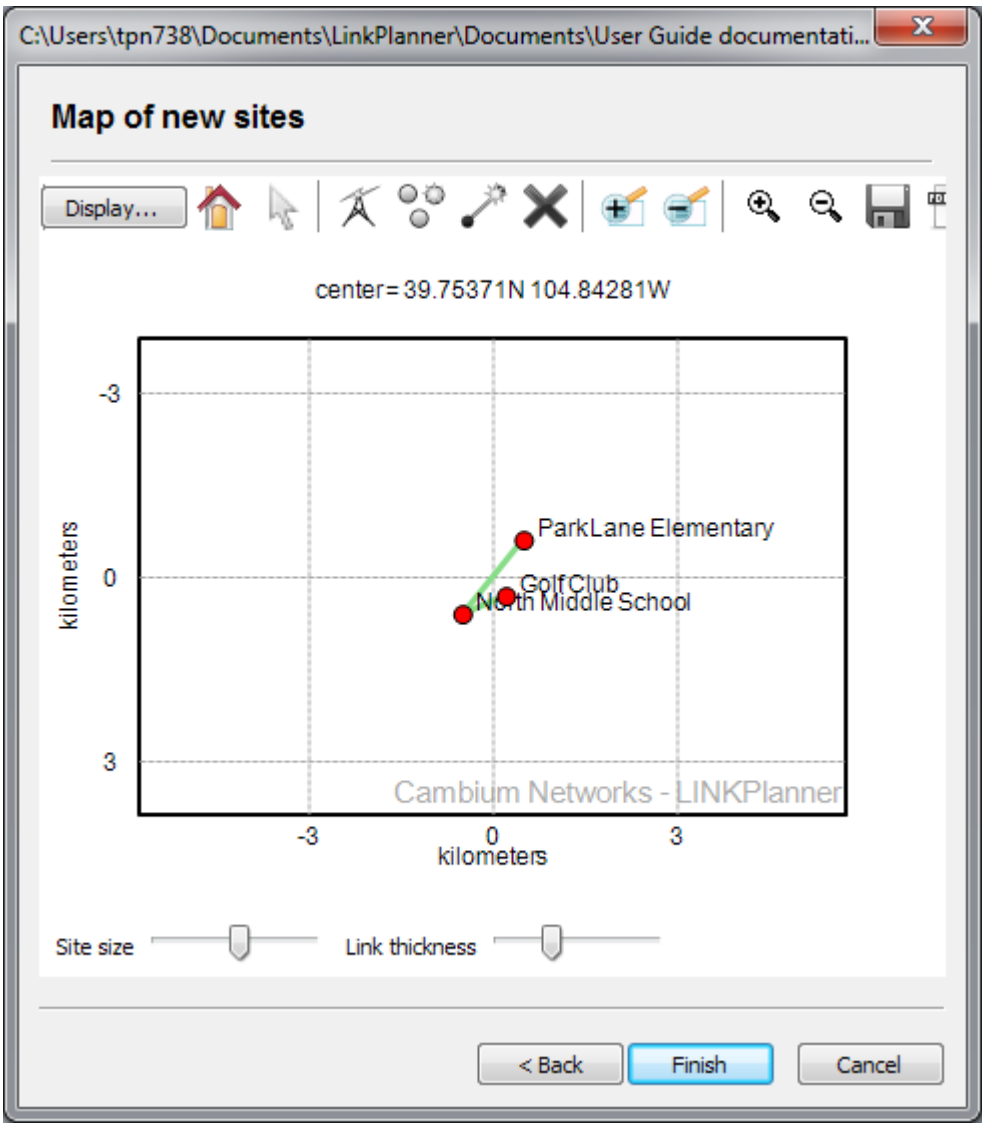


Figure 4.5: Map of Newly Imported Sites and Links

6. Merge Duplicate Data:

   If any of the links or sites are similar to those that already exist in the project then a dialog appears to assist in merging the data (see *Merging Duplicate Data*). Items in the left-hand lists mean that the existing links or sites will be used. Items in the right-hand lists will result in new links and sites being created, even though they are similar to the existing links or sites.

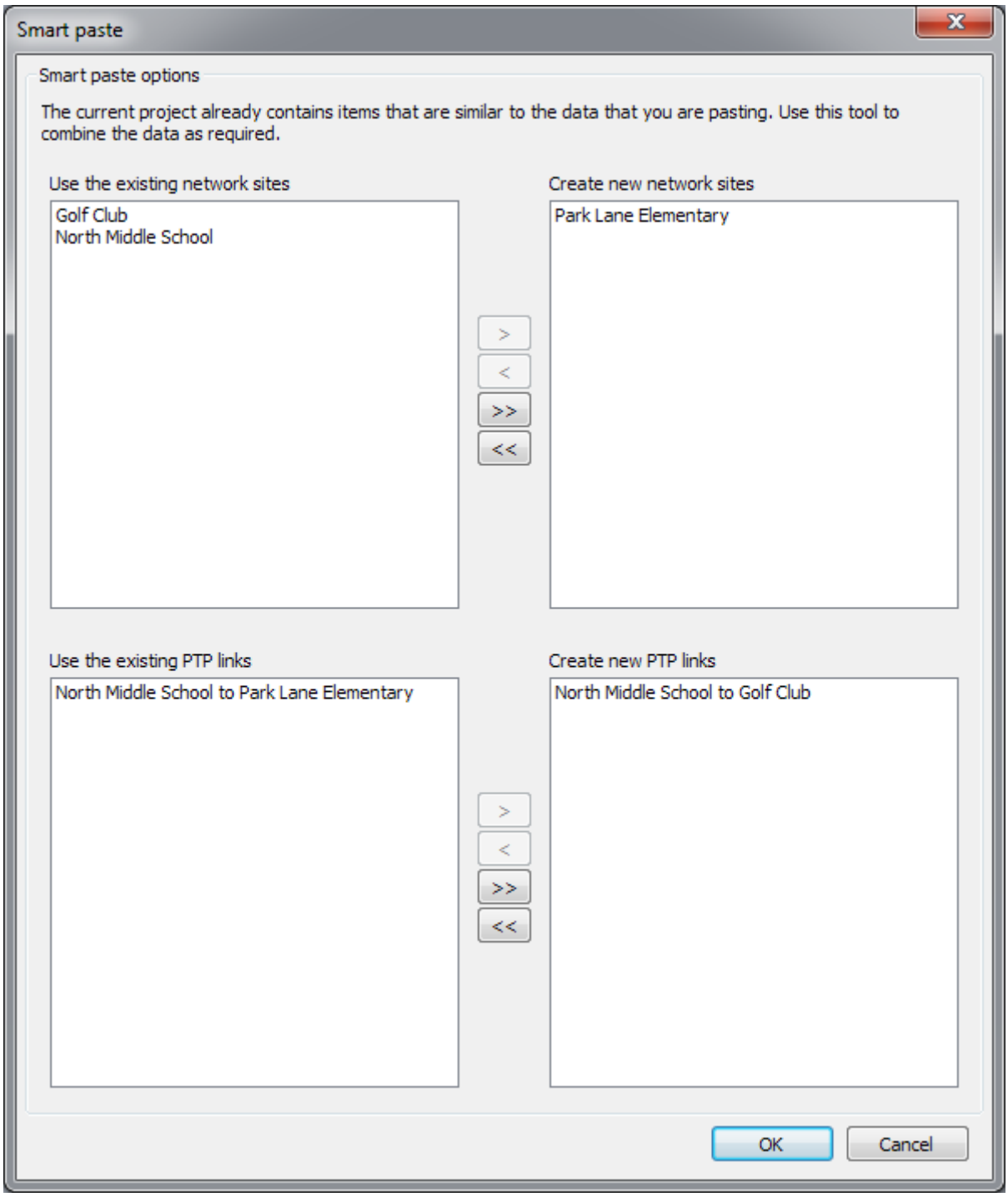


Figure 4.6: Merging Duplicate Data

NOTE

- Sites are considered equal if they are within 1 meter of an existing site

Pasting Links from Spreadsheet Data

Use this method when link information is in a spreadsheet. The required fields for each link are Name, Description, Left Latitude and Longitude and Right Latitude and Longitude. The data does not need to contain any column headings and any invalid data is ignored.

The procedure is:

1. Import the data either by copying from either a tab-delimited file or from a spreadsheet.
    - To import from a spreadsheet, select the data and click **Edit**, **Copy**; then in LINKPlanner, click **Edit**, **Paste PTP Links**.

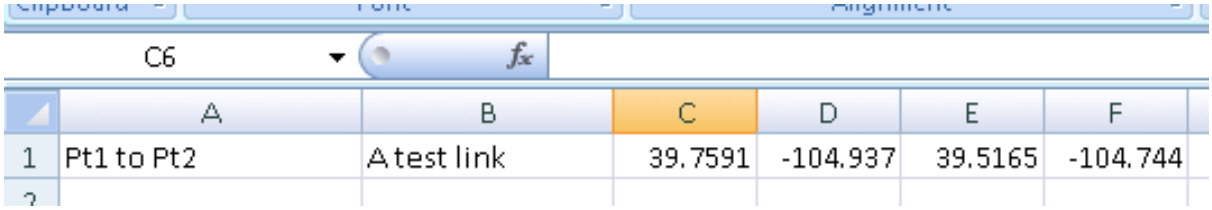


Figure 4.7: Importing Links From a Spreadsheet

NOTE

- Any invalid data will be ignored
- The end names will be created by splitting the link name on the word “to” if possible
- The coordinates are assumed to be a decimal number with negative values for South and West
- If any of the sites being pasted are within 10 meters of an existing site then the existing site will be used instead

Creating PTP Links

To create a new PTP Link, either click **Project**, **New PTP Link (Ctrl-L)**, or click **New PTP Link**  . The New PTP Link page is displayed.

This is an example of a completed *New PTP Link Page*:

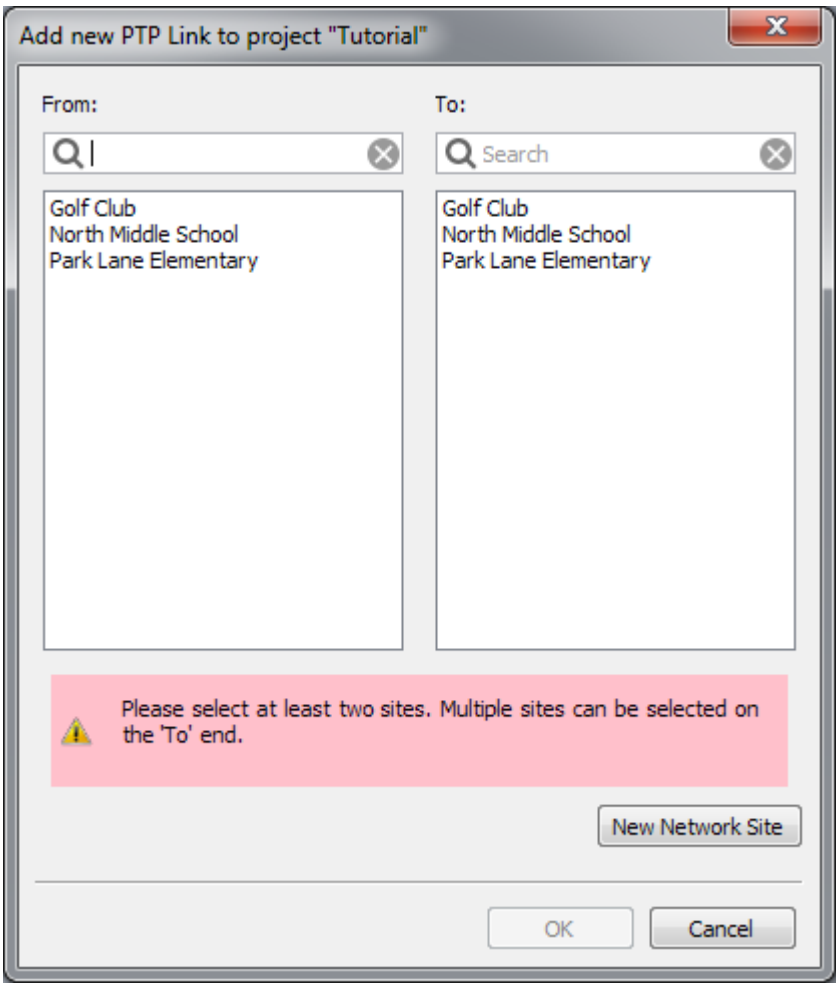


Figure 4.8: New PTP Link Page

Two lists of the available sites to be connected are displayed. The search fields narrow the choice when there is a large number. Select one network site from each list and hit **OK**. The PTP link is made between those two locations and the PTP Link page is displayed.

Multiple PTP links can be selected from the **To** list if required.

- On Windows, hold the **Ctrl** key when selecting.
- On OSX, hold the **Command** key when selecting (on some Apple keyboards, this key also has an Apple logo).

Displaying PTP Links

When one or more links have been created, they appear in the PTP Links list and can be opened in the Link Page. To display this list, click the **"PTP Links"** node in the navigation tree.

PTP Links in Tutorial

Name	Range (km)	Product	Band (GHz)	Regulation	Bandwidth (MHz)	Left Max EIRP (dBm)	Aggregate Throughput (Mbps)	Left Max Power (dBm)
North Middle School to Golf Club	0.767	PTP650	5.8	United States	45	47.0	451.5	24.0
North Middle School to Park Lane Elementary	1.563	PTP650	5.8	United States	45	50.0	61.1	27.0

Figure 4.9: PTP Links List

By default, if the link is displayed in **red**, it means that the predicted performance of the link is below requirements. It is possible to alter the default colors in the *Graphics Page*. Additional formatting settings can be applied using *Link Formatting Rules*.

Customizing the PTP Links list

The PTP Links list display can be customized in the following ways:

- To change the column order, use click and drag on the column headings.
- To sort the list by any column, click in the column header.
- To select which fields are displayed in the list, right-click on the heading row and tick or untick fields in the drop-down list.

Copying Links

To select one or more links for copying:

- On Windows, hold the **Ctrl** key when selecting.
- On OSX, hold the **Command** key when selecting (on some Apple keyboards, this key also has an Apple logo).

When links have been selected, right-click in the PTP Links list and choose **Copy** from the *PTP Links Pop-up Menu*.

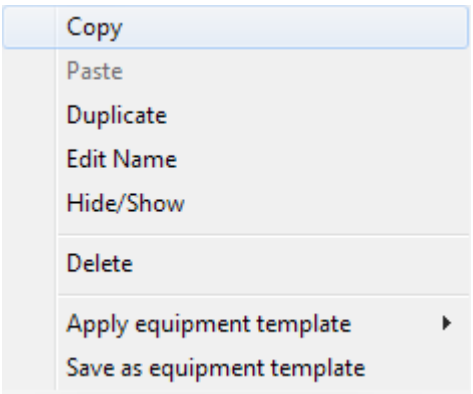


Figure 4.10: PTP Links Pop-up Menu

Duplicating Links

To duplicate links, select one or more links and choose **Duplicate** from the *PTP Links Pop-up Menu*. The new versions will have the same attributes as the original links.

Deleting Links

The Links list can be used to delete links altogether. To delete a link, right-click over it and click **Delete Links** from the *PTP Links Pop-up Menu*.

Editing Link details

A number of link attributes can be edited in the Links list. To edit the link attribute, select the link in the list and right-click on the cell that you wish to change. The *PTP Links Pop-up Menu* will appear. Choose **Edit <attribute-name>** (where the attribute name will be the name of the column heading). The same attribute can be edited for several links at the same time. If the new value is not valid for the other link settings (e.g. choosing a PTP250 product even though the band is set to 38 GHz) will result in a warning and the product value will not update.

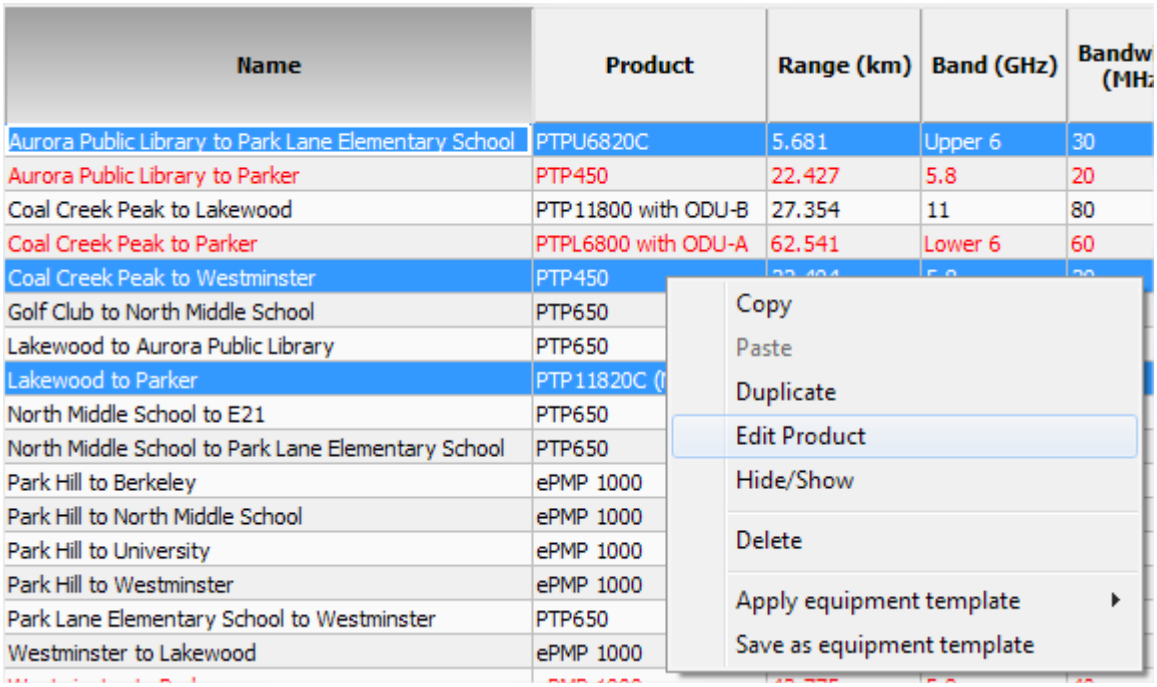


Figure 4.11: Editing a Property for Multiple Links

To edit any other Link attribute, open the link using one of the following methods:

- Single-click the link node in the Navigation tree.
- Double-click on the link in the Links list.

The *Link Page* is displayed.

Link Page

Use the Link page to evaluate the performance of a Link by selecting different combinations of the variables that affect performance, such as band, region, equipment, antenna and height. The results are displayed in the Performance Summary and Performance Details sections.

Before using this page, ensure that the following requirements are defined for both ends of the link:

- Mean Throughput Required (Mbps).
- Minimum Throughput Required (Mbps).
- Minimum Throughput Availability Required (%).

The Link page includes the following features:

- Each section begins with a blue title bar. Click on this bar to open or close the section.
- The numeric data entry fields can be incremented or decremented in steps by using the up and down arrow keys. Use this feature to evaluate the impact of step changes on link performance.
- If a field is highlighted in pink, its value is out of the permitted range.

The Link page contains the following sections:

- *Link Description and Equipment*
- *Profile*
- *Configuration at Each End*
- *Performance Summary*
- *Performance Details*
- *Bill of Materials for Link*

Link Description and Equipment

Link Description

Enter the Name and Description of this link. The default contact information for Cambium Networks will be shown. When the link profile has been received the information will change to show the Sales Contact information for the location of the link. To update this information click **Refresh**.

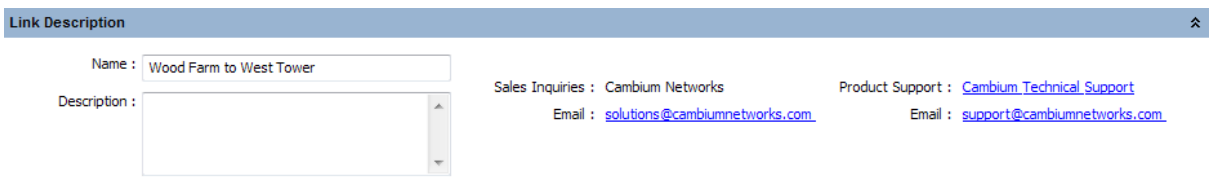


Figure 4.12: Link Description

Equipment (unlicensed bands)

Select the equipment, regulation and optimization method for this link. The fields that are displayed in the “Equipment” box will change depending on the type of equipment selected. For example, when a PTP 600 is selected, the E1/T1 field is displayed.

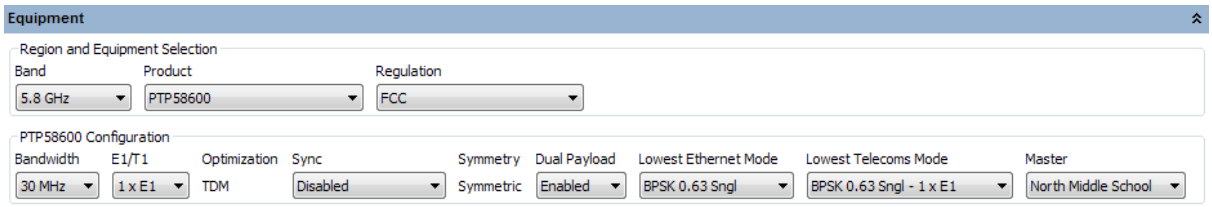


Figure 4.13: Equipment (unlicensed bands)

Region and equipment

Band: Select the frequency band used by the link.

Product: Select the PTP bridge product. For PTP 650S select PTP 650 Product, Full Capacity key and Small Form Factor Antenna. For PTP 650L plan the performance as for PTP 650S limiting the bandwidth to 5 or 10 MHz, or up to 30 MHz with the upgrade key.

Capacity: (PTP 650 and PTP 700 only) Select the capacity variant required.

Regulation: Select the regulation that applies to the region in which the link is located.

Encryption Variant: (PTP 250, PTP 450 and PTP 450i only.) Select the encryption option for the link, used for product selection only.

Precise Network Timing: (PTP 650 and PTP 700 only) Select Enable to add license key for IEEE1588 and Synchronous Ethernet to BOM. Precise Network Timing is added by default for PTP 650S. Select Disable to carry telecoms traffic.

ePMP PTP Mode: (ePMP only) Select the operating mode required. Select **ePTP**, where available, for low latency and/or Adaptive Symmetry.

Configuration

Bandwidth: Select the channel bandwidth.

E1/T1: (PTP 300, 500, 600, 650 or 700). If the link is to carry telecoms traffic, select the number of E1 or T1 links required. For more information, see *Optimizing E1 or T1 Latency*.

Optimization: (PTP 300, 400, 500, 600, 650 or 700). Select the optimization for the link, either for IP Traffic or TDM Traffic. If TDM is enabled, the link is optimized automatically for TDM traffic/latency.

Sync: (PTP 300, 500, 600, 650 or 700). Defaults to Disabled. If TDD Synchronization is required, select the required Sync option. For more

information, see *Setting TDD Synchronization* and *TDD Synchronization List*.

Symmetry: (PTP 300, 400, 500, 600, 650 or 700). Select the link operation (Adaptive, Symmetric, 2:1, 3:1 or 5:1 - options are dependent on Product and other configuration settings).

Dual Payload: (PTP 300, 400, 500, 600, 650 or 700). Allow dual-payload modulation modes for better throughput.

Highest Mod Mode: (PTP 650 and PTP 700 only) Select the highest modulation mode for the Ethernet traffic to limit the maximum throughput rate, default is 256 QAM 0.81 (no limit). Dual or Single will be automatically selected depending on the setting for **Dual Payload**.

Maximum Mod Mode: (ePMP, PTP Mode only) Select the highest modulation mode for the Ethernet traffic to limit the maximum throughput rate, default is MCS15.

Lowest Ethernet Mode (PTP 600 only), **Lowest Data Mode** (PTP 650 and 700 Only): Select the lowest modulation mode for the Ethernet traffic to achieve the required throughput rate, default is BPSK 0.63 Single.

Lowest Telecoms Mode (PTP 300, 500 or 600), **Lowest TDM Mode** (PTP 650 and 700): When a link is configured for E1 or T1 telecoms traffic, select the lowest modulation mode to achieve the required latency. For more information, see *Optimizing E1 or T1 Latency*.

Modulation Mode: (PTP 300, 400, 500, 600, 650 or 700). When using the PTP 250 product, select the modulation mode to be used by the equipment.

Color Code: (PTP 450 and 450i only). Select the Color Code for the link (information only).

Frame Period: (PTP 450 and 450i only). Select the Frame Period.

Downlink Data: (PTP 450 and 450i only). Set the proportion of the link to be used for throughput from the Master to the Slave.

DL/UL Ratio: (ePMP only). Select the required DL/UL Ratio, where DL is the proportion of the link to be used for throughput from the Master to the Slave.

Master: Select which site is the master.

Gb Ethernet Port: (ePMP only). Select whether each end of the link requires equipment with a GbE port instead of an FE port (the FE port will limit the maximum throughput if selected at either end of the link). Select Gb Ethernet Port at the Master if the link has to be synchronized.

When TDD synchronization is enabled for a link, the link will show zero data rate until a valid set of global options are selected in the *TDD Synchronization List*

Equipment (licensed bands)

Select the equipment, regulation and configuration for this link.

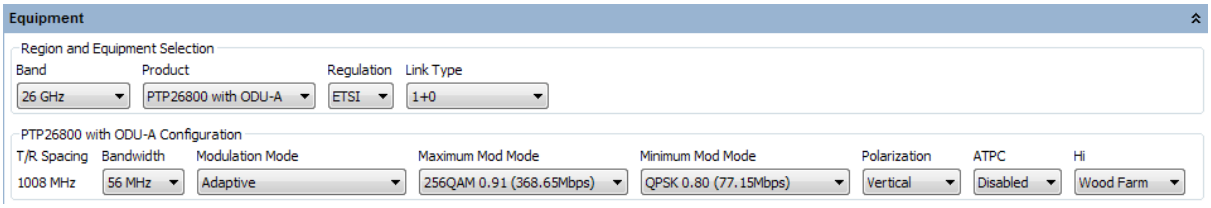


Figure 4.14: Equipment (licensed bands)

Region and equipment

Band: Select the frequency band used by the link.

Product: Select the PTP bridge product using either ODU-A, ODU-B or IRFU where available for PTP 800 and PTP 810. For further information on the two ODU types see *PTP 800 Series User Guide* or *PTP 810 Series User Guide*.

Regulation: Select the regulation that applies to the region in which the link is located.

Link Type

- Defaults to **1+0** for a basic single link configuration.
- If using Hot Standby or Spatial Diversity equipment click **1+1 Hot Standby** (for PTP 820C Spatial Diversity click on **2+0 Spatial Diversity**), for more information, see *Setting Hot Standby Protection (1+1)* and *Setting Diversity*.
- If using Frequency Diversity click **1+1 Frequency Diversity** (PTP 810 Only - not available with FCC regulations), see *Setting Diversity*.
- If using 2+0 Antenna Sharing click either **2+0 Cross Polar (ACAP)**, **2+0 Co-Polar (ACCP)** or **2+0 XPIC (CCDP)** (only the Co-Polar variant is available for the IRFU with PTP 800 and XPIC is only available for PTP 810, PTP 820C and PTP 820G and on LOS links), for more information, see *Setting 2+0 Antenna Sharing*.

Capacity Key: (PTP 810 only) Select the capacity key for the link. When this is changed the list of available bandwidths and modulation modes may also change. For 2+0 links select the capacity required for the aggregate link, this will automatically be divided equally between the two individual links.

Ethernet Configuration: (PTP 820C Only) Select the required Ethernet Configuration for 2+0 Link Types. Single Ethernet (MC-ABC) restricts the capacity to < 1 Gbps based on the capability of a single Ethernet connection. To access the full capacity of the radio link, select one of the Multiple Ethernet Options, which require additional Ethernet connections to the radio.

Configuration

T/R Spacing: Select the difference between transmit and receive frequencies (MHz).

Bandwidth: Select the channel bandwidth.

Modulation Mode: Select the modulation mode to be used by the equipment. If **Adaptive** is selected then additional fields are displayed (not available for PTP 810).

Maximum Mod Mode: Select the maximum modulation mode that the equipment will use in adaptive mode. Only displayed when **Adaptive** modulation is selected.

Minimum Mod Mode: Select the minimum modulation mode that the equipment will use in adaptive mode. Only displayed when **Adaptive** modulation is selected (not available for PTP 820).

Polarization: Select the antenna polarization to be used (Horizontal or Vertical).

ATPC: Select whether the link will be configured with ATPC enabled or disabled. In some bands and regulations it is compulsory to use ATPC, in which case it will not be possible to disable the function. For PTP 800 it is recommended to Enable ATPC for shorter links to optimize the power control function. For PTP 810 this option is called **APC** and it is recommended to leave it disabled.

Hi: Select which site is the nominated Hi end for the link. This site will only have access to the higher end of the frequency range and the other end of the link will only have access to the lower frequencies in the band.

Header Compression: (PTP 820 Only) Select the level of header compression required.

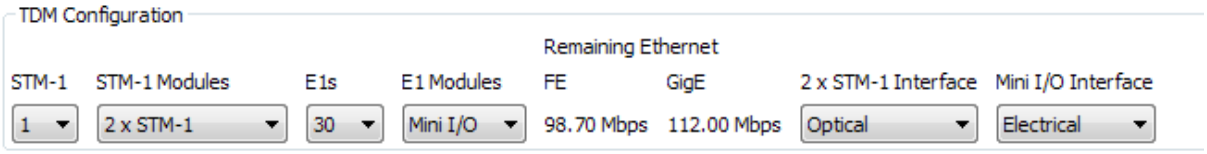


Figure 4.15: TDM Equipment Configuration (PTP 810 Only)

TDM Configuration (PTP 810 Only)

Select the STM-1, E1/T1 and associated modules for this link, see *TDM Equipment Configuration (PTP 810 Only)*.

STM-1: Select the number of STM-1 to be passed across the wireless link. Limited to a maximum of 2 for 1+0 or 1+1 Link types or 3 for 2+0 Link Types.

STM-1 Modules: Only displayed if STM-1 is greater than zero. Select the extra module(s) required to terminate the STM-1 on the front panel of the MMU. In a 1+0 this may be **None**, if the STM-1 is being passed between the East and West modem in a Dual 1+0 configuration.

E1s (or T1s): Select the number of E1 or T1 circuits to be carried across the wireless link. These may arrive at the front panel of the MMU as an STM-1 before being multiplexed / demultiplexed onto the wireless link. If the regulation is ETSI, E1 will be displayed, if the regulation is set to FCC or Canada, T1 will be displayed. Some values of E1 (or T1) are not supported for a given modulation and bandwidth due to timing restrictions and are not shown in the selection list for the given modulation and bandwidth.

TDM Modules: Only displayed if E1 or T1 is greater than zero. Select the extra module(s) required to terminate the E1 or T1 circuits on the front panel of the MMU. This may be **None** if there are sufficient ports on the MMU Master I/O card or if the E1 or T1 are being passed between the East and West modems in a Dual 1+0 configuration.

Remaining Ethernet: Displays the amount of Ethernet traffic which is potentially available in addition to the TDM requirements, using either one of the Fast Ethernet MMU Models or one of the GigE MMU Model configurations. Which MMU Models are actually available is dependent upon the configuration of STM-1, E1 or T1 and the extra modules selected, see *Configuration at Each End* to set the MMU Model.

2 x STM-1 Interface: Only displayed if one of the 2 x STM-1 modules has been selected for either STM-1 or E1/T1. Select either an optical or electrical interface.

Mini I/O Interface: Only displayed if the Mini I/O module has been selected for either STM-1 or E1/T1. Select either an optical or electrical interface.

TDM Configuration (PTP 820G Only)

Select the E1/T1 required for this link

TDM Type: Defaults to None, if TDM is required select either E1 or T1.

E1s (or T1s): Select the number of E1 or T1 circuits to be carried across the wireless link. In 2+0 configurations the maximum of 16 is shared between the two paths.

Profile

This section contains a visualization of the path between the two sites (*Profile with Trees*).

In this example, a 12m high tree at 22.904 km and and an 8.0 m high tree at 24.912 km enter the Fresnel zone and alter the slope.

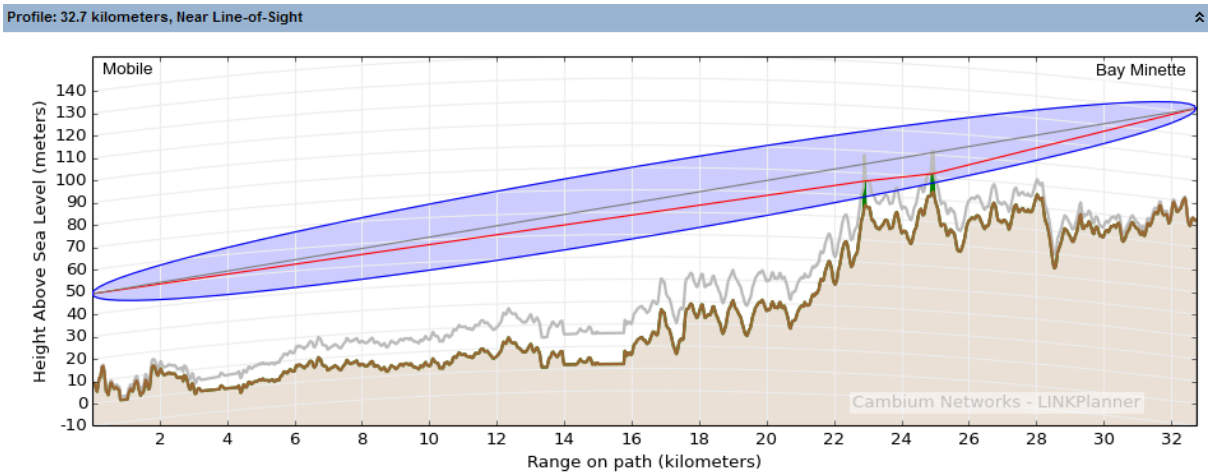


Figure 4.16: Profile with Trees

Color code used in the profile:

- Brown: terrain.
- Green: obstructions (such as trees or buildings).
- Red: line of site from the antennas to the largest obstruction (called “slope”).
- Blue: the Fresnel zone.
- Grey: the profile worst case which occurs up to 0.01% of the time. Sometimes known as Worst Earth curvature (Ke).

To update the profile to allow for terrain height, obstructions and water reflections, see *Adjusting Link Profiles*.

The Fresnel zone shown is a visualization of $F_{0.6}$ or $0.78F_1$, which is shown for guidance when setting antenna heights for path clearance. It is not used directly in the diffraction loss calculations.

When planning high availability links (better than 99.99%) the antenna heights should be set to ensure that the grey line does not penetrate into the Fresnel zone shown.

To view the profile in Google Earth(TM), click the **Google Earth** toolbar icon . For more information, see *Using Google Earth(TM)*.

Path to display: (PTP 820C 2+0 SD Only) Choose the path to display from the following options:

- **Main**: the main path using the antenna heights defined for the main antenna at each end
- **Main to Diverse**: the path between the local main antenna height and the remote diverse antenna height
- **Diverse to Main**: the path between the local diverse antenna height and the remote main antenna height

An additional shortcut menu is available by right-clicking on the profile which will give access to the following items:

Copy: selecting this option copies the profile information. It can then be pasted into another link or into an Excel spreadsheet or text editor, see *Updating Link Profiles*.

Paste: this option is only available if a profile has previously been copied either from another profile or from a spreadsheet, see *Updating Link Profiles*.

Edit Profile: selecting this option displays the Profile Editor, see *Updating Link Profiles*.

Edit Reflection Parameters: selecting this option displays the Reflection Editor, see *Updating Link Profiles*.

Reverse Link: Selecting this option will reverse the ends on the link, for example a link “End A to End B” will become “End B to End A”, with associated changes to the Link Description and report titles. All properties associated with an end will move with the end, for example antenna and power configurations and Master/Slave or Hi/Lo settings.

Configuration at Each End

Use this section to evaluate different antenna configurations at each end of the link. Enter data about the antenna, transmission power and interference density (at both ends). In response, the Performance Summary section is updated automatically to show the effect upon the Mean Throughput, Minimum Throughput and Availability. The two ends are each divided into three parts:

- Data that affects both transmission and reception: Antenna, Diversity Spacing, Antenna Height and Cable Loss.
- Data that affects transmission only: Maximum EIRP, Maximum Power.
- Data that affects reception only: Interference Density.

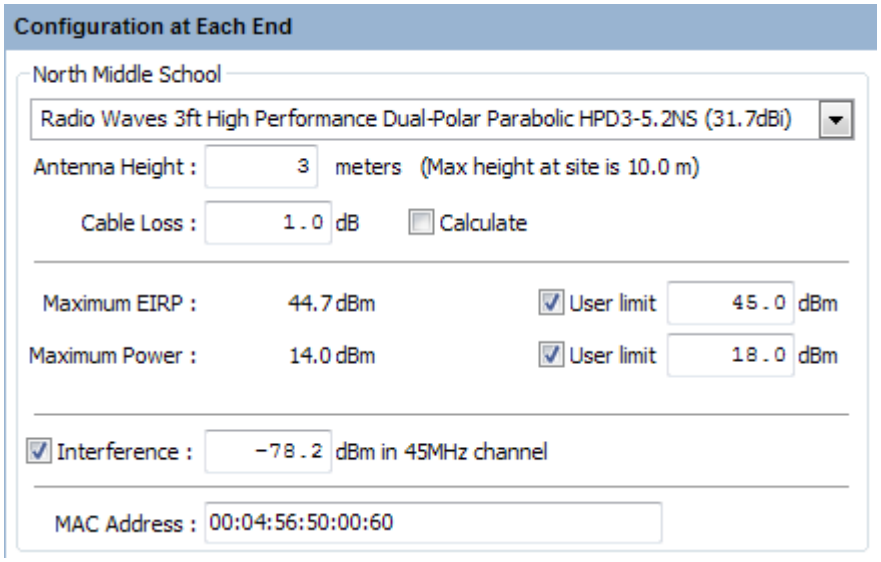


Figure 4.17: Configuration at Each End (one end shown)

Antenna: Select the required antenna from the drop-down list. The list can be sorted by any column by clicking the column heading. If operating in the

unlicensed band and the required antenna is not in the list, click **Other...** and enter the details in the User Defined Antenna page. Antennas may also be viewed, created, edited and deleted from the *Available Antennas* page. Licensed band antennas may only be viewed, at present only Cambium supplied antennas are supported at these frequencies.

Antenna Height (meters): This is the height of the antenna AGL, not the height above the building on which it is mounted. The Profile visualization is automatically updated in response to changes in Antenna Height.

Diversity Spacing (meters): When in the unlicensed band this field is only displayed if a single polar external antenna is selected, see *Setting Diversity*.

Cable Loss (dB): This field is not displayed for INTEGRATED antennas. If a non-integrated antenna is used, power may be lost in the cable connection between the radio and the antenna, therefore the Cable Loss must be estimated. To enter Cable Loss: either enter the estimated loss in the dB field; or tick the Calculate box, select the type of cable or waveguide that connects the radio to the antenna (EWP52, EWP63, LFD4.5-50, LMR400, LMR500 or LMR600), and enter the length. In response, the dB field is automatically updated.

Maximum EIRP (dBm): The maximum available Equivalent Isotropic Radiated Power. The default value is determined by the Band, License, Product and Antenna. If a lower user-defined limit is required, tick the User Limit box and enter the value. In response, the default Maximum EIRP is automatically reset to the User Limit.

Maximum Power (dBm): The maximum available transmission power. The default value is determined by the Band, License, Product and Antenna. If a lower user-defined limit is required, tick the User Limit box and enter the value. In response, the default Maximum Power is automatically reset to the User Limit.

Interference (dBm): This is the amount of site noise in the selected channel bandwidth, 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. The bandwidth displayed depends on the bandwidth selected in the Equipment Settings box (in this example it is 15 MHz). To enter Interference, tick the box and update the default value. If the link has been set up and mean power measurements from DFS are available, then use these measurements.

MAC Address: This is an optional field where the MAC Address can be recorded. It is required when exporting PTP 450 configuration files.

Licensed bands

For links operating in licensed bands, the following additional attributes are displayed:

Feeder Loss: This replaces the Cable Loss field in the unlicensed band. The licensed band equipment uses a flexible waveguide, which is of a fixed length and the feeder loss is automatically entered when a non-integrated antenna is used. This field is also used to display other fixed losses, for example the coupler loss in the Protected Hot Standby mode. When using a common non-integrated antenna in Hot Standby this field will show the sum of the feeder loss and coupler loss.

To change the automatic feeder loss click **Edit** and enter any additional loss in the **Other Losses** field. The Flexible Waveguide Loss can be deselected, which will remove it from the loss calculation and will also remove the associated Flex Waveguide equipment item from the BOM. In a Hot Standby configuration any Coupler Loss cannot be edited by the user. Once any changes are made to the Losses panel, **Feeder Loss** will change to **User Defined Feeder Loss**. If an IRFU has been selected **Feeder Loss** will change to **Maximum Feeder Loss** and will show the maximum loss for either transmit or receive, this is usually the loss on receive at that end. The loss on transmit is incorporated into the Maximum EIRP value.

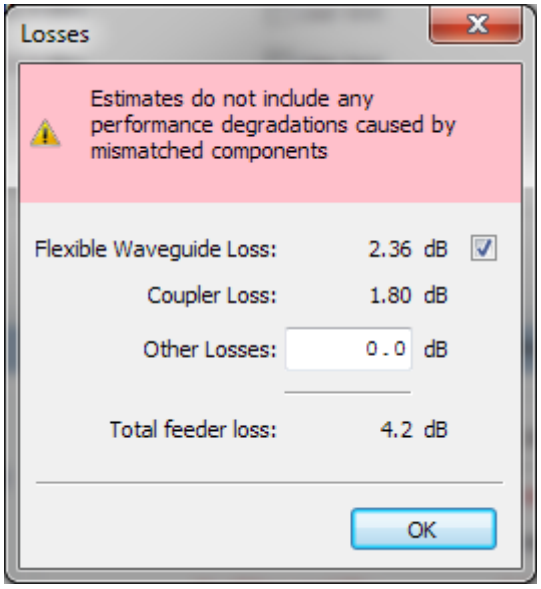


Figure 4.18: Additional Feeder Losses in Licensed Band

NOTE

If ODUs are to be mounted indoors or at the base of the tower, or the IRFU has been selected, please see *Long Waveguide*, instead of using this Losses option.

Diverse Antenna: (PTP 820C 2+0 SD Only) Select the required diverse antenna from the drop down list.

Diverse Antenna Height: (PTP 820C 2+0 SD Only) Set the height of the diverse antenna.

Diverse Feeder Loss: (PTP 820C 2+0 SD Only) The amount of feeder loss on the diverse end of the link.

Tx Frequency: To change transmit frequencies at either end of the link, click on **Select...**. The *Select Transmit Frequencies* dialog is displayed. The end of the link which has been selected as **Hi** will shower the higher frequencies in the band, warnings will be displayed for 2+0 if the two Tx Frequencies at the same end of the link are not both in the same part of the band.

If an IRFU has been selected there is also an option to change the **Synthesizer Step Size**, unless the band is Lower 6 GHz, which operates on a fixed frequency plan. At Upper 6 GHz or 7 GHz the options are 5, 50, 100, 125 and 250 kHz and at

11 GHz the options are 125 and 250 kHz, in both cases the default is 250 kHz. As the filters are tuned to order, a wider range of frequency options are possible with the IRFU, but may not be available from every regulator. Please check local regulatory requirements when selecting frequencies.

Click **Clear Selection** to remove specific frequencies from the list, the BOM will go back to the default ODU part numbers - before ordering make sure that these are set to the correct part numbers by choosing the appropriate frequencies.

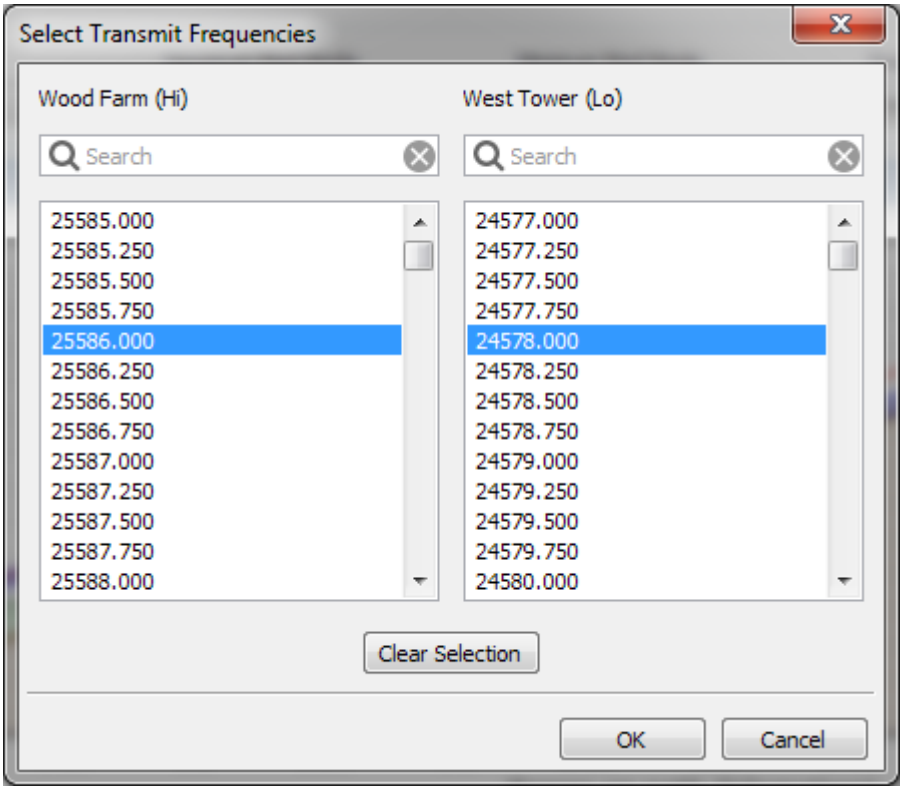


Figure 4.19: Select Transmit Frequencies

Diversity Separation (PTP 810 Only) When 1+1 Frequency Diversity is selected two Tx Frequency selections will be available at each end of the link. When both frequencies have been selected the Diversity Separation will show the difference between the two frequencies. Separations of greater than 500 MHz will not give any further increase in the improvement factor, see *Setting Diversity*.

Tx Capacity Limit: (PTP 800 Only) Select the limit that must be applied to data throughput capacity at this end of the link (Mbps). When this is changed, the Throughput data in the Performance Summary section at the OTHER link end may change automatically.

MMU Model: (PTP 810 only.) Select the type of MMU to use for the link.

NOTE

Selection of MMU model is dependent on the TDM configuration, additional modules and Ethernet throughput required. Refer to the *PTP 810 Series User Guide* for further details.

Performance Summary

This section shows how well the link is predicted to perform in response to the selected combination of the variables, such as band, region, equipment, antenna and height. It shows throughput performance at each end of the link.

If the predicted Throughput and Availability values fall below the required values, they are displayed in red (*Performance Summary*). If they meet or exceed the required values, they are displayed in black. In the following example, the predicted values at North Middle School are displayed in red because they fall below requirements, but the predicted values at Park Lane Elementary School are displayed in black because they exceed requirements:

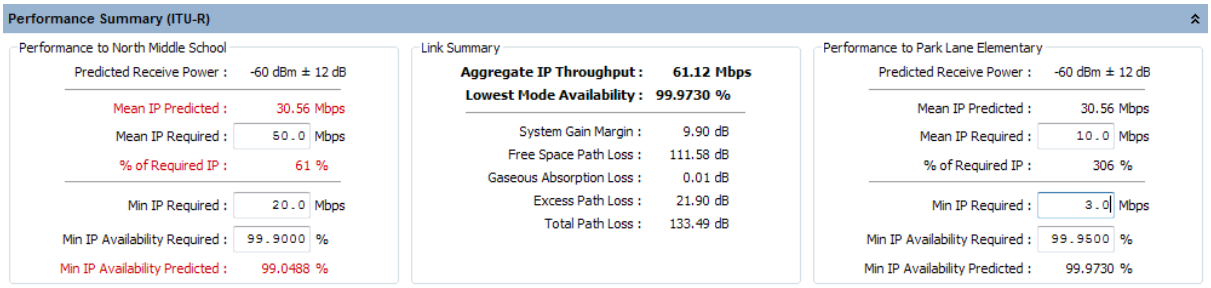


Figure 4.20: Performance Summary

Performance to each Site

This summary is a prediction of the Receive Power, Throughput and Availability at each end of the link, based on the equipment and performance data entered. Enter the required values in the data entry fields for comparison with the predicted data.

Predicted Receive Power: The predicted receive power and associated tolerance level at this end of the link. The tolerance is the sum of two components, a fixed value which is dependent on the equipment performance over temperature and a variable value which is proportional to the amount of Excess Path Loss. When using adaptive modulation the receive power shown is the maximum for the link, which corresponds to the lowest selected modulation mode and Maximum Power. If the link is operating in a higher modulation mode, the normal operating receive power of the link may be lower, especially in the unlicensed band or when using the ODU-B in the licensed band.

Operational Power: In licensed band when ATPC (APC) is set to **Enabled** the Receive Power displayed is the Operational Power. When ATPC (APC) is enabled the Maximum Power may be reduced depending on the link conditions, resulting in lower measured receive powers, which can vary over time. The value shown is a typical value at the high end of what may be achieved. The tolerance levels shown are the same as given for the Predicted Receive Power.

Mean throughput of the planned link in one direction:

Mean IP Predicted (Mbps): The mean Ethernet throughput capability, calculated from the data entered.

Mean IP Required (Mbps): Enter the required mean Ethernet throughput capability.

% of Required IP: IP Predicted expressed as a percentage of IP Required.

Minimum throughput of the planned link in one direction:

Min IP Required (Mbps): Enter the required minimum Ethernet throughput capability.

Min IP Availability Required (%): Enter the required minimum availability of the link.

Min IP Availability Predicted (%): The minimum availability of the link, calculated from the data entered, for the lowest equipment data rate.

The **Min IP Availability Predicted (%)** may be higher than the **Lowest Mode Availability** if the **Min IP Availability Required** is set to a value greater than the data rate supported by the **Minimum Mod Mode**.

If **ePMP ePTP Mode**, **PTP 250** or **Adaptive Symmetry** is selected the capacity achieved in each direction of the link is variable, depending on the load presented. Which direction of the link will take the maximum load is unknown therefore the values presented in the **Performance to Each Site** are those of the symmetrical case. Values for the peak throughput in a either direction can be found in *Performance Details*.

Operating Conditions

This option is only available when the ePMP, PTP 250 or PTP 820 products are selected. The throughput of these products is more dependent upon frame size than the other PTP products and this option allows the user to select different frame sizes and view the impact on the throughput.

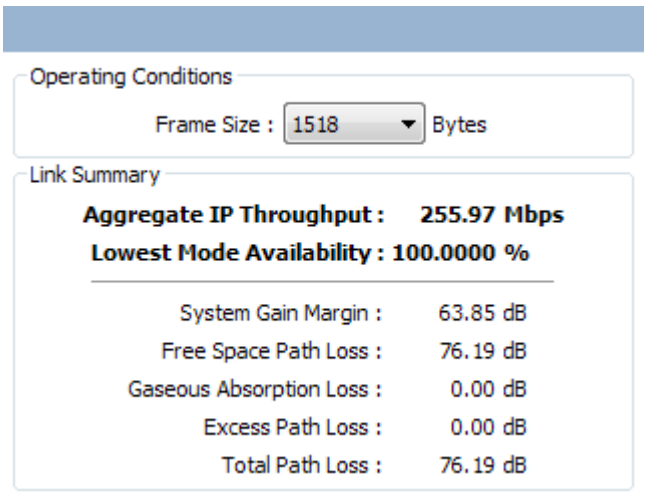


Figure 4.21: Operating Conditions for PTP 250

The throughput displayed in the Performance Summary, as well as in the Performance Details, is for the frame size selected. The frame size options are the standard RFC2544 sizes of 64, 128, 256, 512, 1024 and 1518 bytes. There is also an option to select a pre-determined mixed traffic option called Tolly Mix, which is based on the following combination of packet sizes:

- 55% of packets at 64 bytes
- 5% of packets at 78 bytes
- 17% of packets at 576 bytes
- 23% of packets at 1518 bytes

Link Summary

This summary 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 0.6. The Total Path Loss and System Gain Margin are also given.

Aggregate Throughput (Mbps): The sum of the Mean IP Predicted at both ends.

Lowest Mode Availability (%): This is the availability of basic link operation. This is equivalent to the availability of the most robust modulation or better in both link directions.

FCC 99.95%: This is only shown when using PTP 800 or PTP 820 in either of the FCC regulations and adaptive modulation. It shows the modulation mode for the minimum payload capacity required by the FCC and the two-way availability at that mode. In order to meet FCC Part 101 regulations the link must be planned to have an availability better than 99.95% at the minimum payload when operating in adaptive mode.

System Gain Margin (dB): This is the margin in dB above which the ratio of (mean wanted receive level) to (mean interference plus thermal noise), or “C to (I + N)”, for the worst link direction is above the level required for basic link operation for the most robust modulation.

Free Space Path Loss (dB): The amount that the signal would be attenuated if travelling through a vaccuum.

Mean Atmospheric Loss (dB): The amount of attenuation due to oxygen and water in the atmosphere.

Excess Path Loss (dB): The amount of attenuation due to obstructions in the path. If the path is completely line-of-sight, this will be zero.

Maximum Excess Path Loss (dB): (PTP 820C 2+0 SD Only) The maximum amount of attenuation due to obstructions on the Main, Main to Diverse or Diverse to Main paths. To achieve the full diversity improvement shown in the Predicted Availability ensure that this value is zero.

Total Path Loss (dB): The sum of Free Space, Mean Atmospheric and Excess Path Loss.

Performance Summary when TDM is selected

If the equipment is PTP 300, 500, 600, 650 or 700 and one or more E1 or T1 channels have been selected, then additional fields appear in the Performance Summary section (*Performance Summary with E1/T1*):

- E1/T1 Availability Predicted
- E1/T1 Availability Required
- E1/T1 Availability
- E1/T1 1-way latency

For more information, see *Optimizing E1 or T1 Latency*.

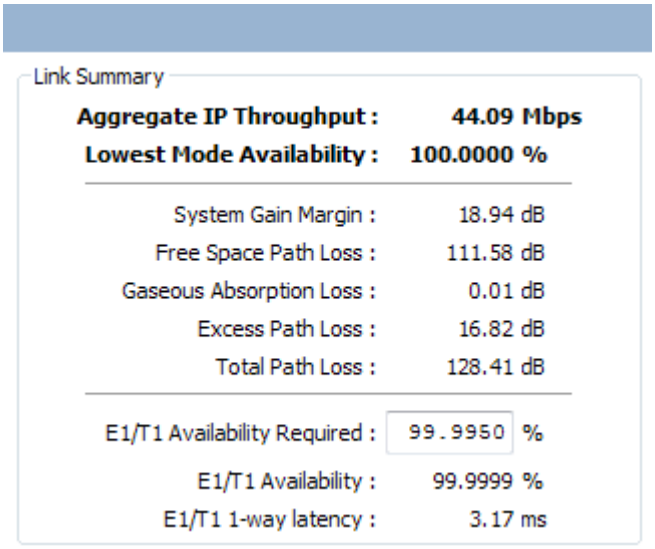


Figure 4.22: Performance Summary with E1/T1

If the equipment is PTP 810 or PTP 820G then additional fields appear in the Performance Summary section (*Performance Summary with TDM for PTP 810*):

- STM-1 Carried (PTP 810 Only)

- E1 Carried
- TDM Availability Required
- TDM Availability Predicted

If the Regulation selected is either FCC or Canada (or T1 TDM Type has been selected for PTP 820G), then E1 will be replaced by T1. The Availability Required is used in the same way as the Min IP Availability Required. The Availability Predicted is the two way availability of the link.

NOTE

When operating with a fixed modulation mode the Availability Predicted for the TDM circuits will be the same as the Link Availability.

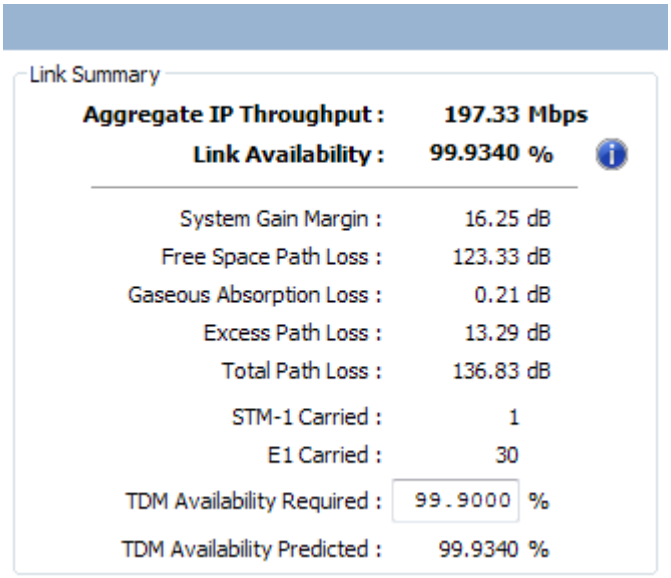


Figure 4.23: Performance Summary with TDM for PTP 810

Link Summary additional information for PTP 800, PTP 810 or PTP 820

If the equipment is PTP 800, PTP 810 or PTP 820, additional information is available via the  icon. Select the icon to view a new window showing the detailed breakdown of the availability calculations, see *Detailed Availability Information (ITU Model)*. This allows the information to be viewed during planning without having to produce a proposal report.

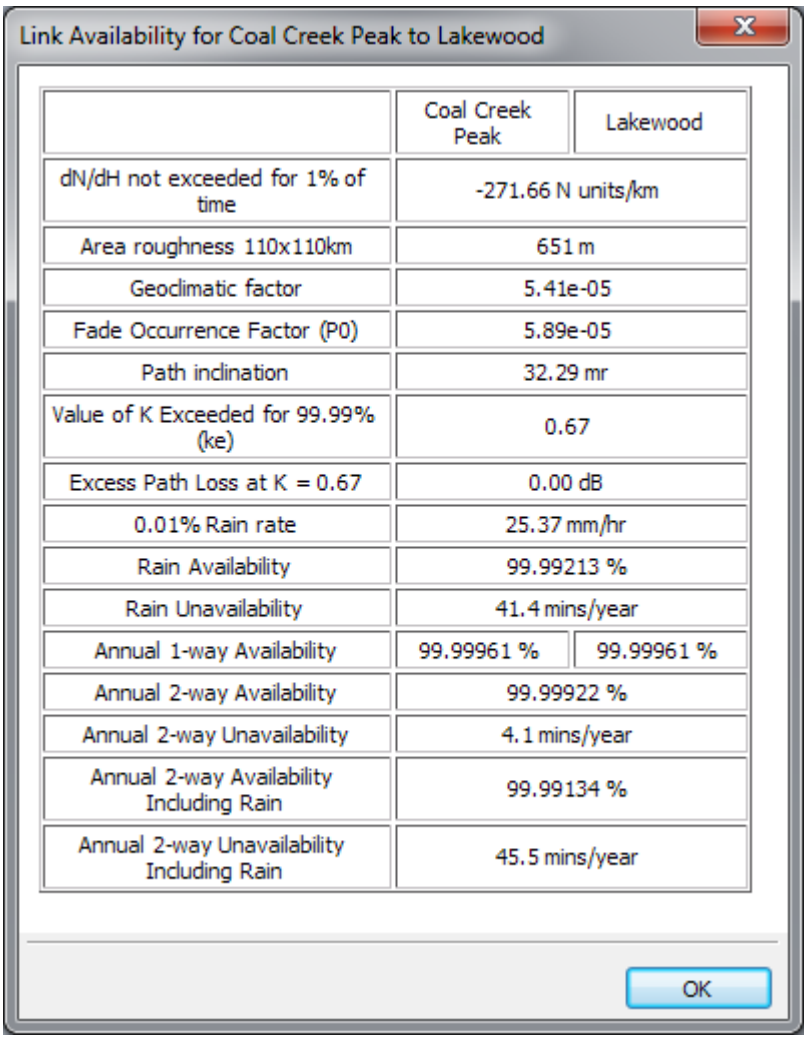


Figure 4.24: Detailed Availability Information (ITU Model)

This window shows detailed information for Link Availability when in fixed modulation mode or for Lowest Mode Availability when Adaptive Modulation has been selected. When the ITU prediction model has been selected, see *Availability*, the parameters are as displayed in *Detailed Availability Information (ITU Model)* and described below:

dN/dH not exceeded for 1% of time: Point refractivity gradient in the lowest 65m of the atmosphere not exceeded for 1% of an average year. This data is provided in 1.5 deg grid form by the ITU and the value is a bilinear interpolation for the mid point of the path.

Area roughness 110 x 110 km: the standard deviation of terrain heights (m) within a 110 x 110 km area.

Geoclimatic Factor: Calculated from the point refractivity gradient and area roughness according to ITU-R P530-12.

Fade Occurrence Factor (P0): The intercept of the deep-fading distribution with the percentage of time-axis for multipath fading. This parameter is dependent on the Geoclimatic Factor, path length, path inclination, frequency and altitude of lower antenna, calculated as given in ITU-R P530-12.

Path Inclination: Absolute difference in antenna height above mean sea level (m) divided by path length (km), given in mrad.

SD Improvement Factor: Only visible if Spatial Diversity has been selected. The improvement factor is based on the diversity spacing and calculated in accordance with ITU-R P530-13. This factor is limited at 200, as the conditions required to achieve a better improvement factor will already achieve 100% availability, see *Setting Diversity*.

FD Improvement Factor: Only visible if Frequency Diversity has been selected. It is a similar parameter to the SD Improvement Factor and is based on the diversity separation. It has the same range of values, see *Setting Diversity*.

Value of K Exceeded for 99.99% (ke): This value is taken from ITU-R P.530 Figure 2, the value of ke exceeded for approximately 99.99% of the worst month in a continental temperature climate and is often referred to as “Worst Earth Curvature”. The impact of this value on the terrain height is shown by the grey line on the path profile (*Profile with Trees*).

Excess Path Loss at K = ke: This value shows the amount of excess loss that will occur on the link during the time when the K value drops to that shown above. This may occur for up to 0.01% of the time, but is not taken into account in the availability calculations. Links which require at least 99.99% availability should ensure that this value is 0 dB, by selecting appropriate antenna heights to give sufficient clearance.

0.01% Rain rate: Calculated using ITU-R P837-5, which uses a matrix of rain values for the globe with a 1.25 degree resolution. These values are bi-linearly interpolated for the Latitude and Longitude of the center of the path.

Rain Availability: The availability of the given rain rate with the system gain margin calculated using ITU-R P530-12.

Rain Unavailability: The amount of time the link is predicted to be unavailable due to rain.

Annual 1-way Availability: The annual availability due to clear air multipath effects in a single direction, shown for each end of the link. This also accounts for any obstructions on the path.

Annual 2-way Availability: The sum of both 1-way unavailabilities, expressed as availability.

Annual 2-way Unavailability: The amount of time the link is predicted to be unavailable due to multipath effects.

Annual 2-way Availability Including Rain: The sum of the Rain Unavailability and the Annual 2-way Unavailability, expressed as availability.

Annual 2-way Unavailability Including Rain: The total time the link is predicted to be unavailable.

When using the Vigants - Barnett prediction model the first five parameters are replaced by the following terms, for further information on the Vigants - Barnett model see *Availability* :

Terrain Roughness: Standard deviation of terrain height along the path profile, excluding the ends of the path.

Climatic Factor: Derived from the atmospheric conditions maps for the mid point of the path.

C Factor: Calculated from the Terrain Roughness and the Climatic Factor.

Temperature: The temperature is taken from the ESATEMP data. This data is provided in 1.5 deg grid form by the ITU and the value is a bilinear interpolation for the mid point of the path.

Performance Details

This section contains more detail about the predicted performance of the link. The data can either be displayed in chart or tabular form.

Charts

The following charts show the variability in percentage of time availability with capacity, for each direction in the link. When the cursor is moved over the chart the area is highlighted in blue and the chart is annotated with throughput, availability (given as a percentage) and unavailability (given as a unit of time). The throughput given is the maximum throughput at that availability.

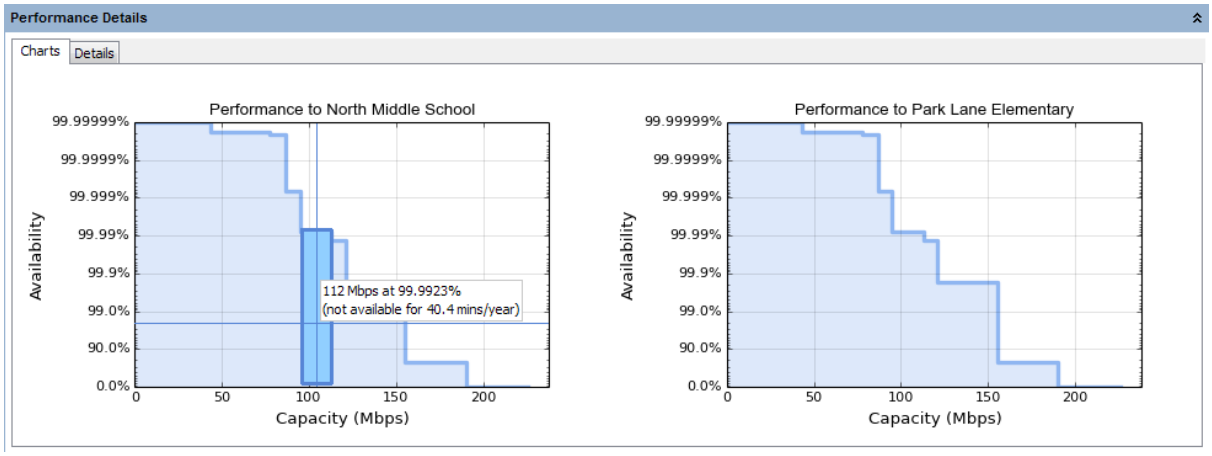


Figure 4.25: Performance Charts

When **Dual Payload** is enabled the availability shown is the sum of **Receive time in Mode** for all single and dual payloads with a **Max IP Throughput** greater than or equal to the given capacity level.

If **ePMP**, **PTP 250**, or **PTP 820** are selected the capacity shown in both the charts and the table is for the given frame size selected.

If **ePMP Enhanced PTP Mode**, **PTP 250** or **Adaptive Symmetry** is selected the capacity achieved in each direction of the link is variable, depending on the load presented. The charts cannot predict the load for each direction of the link and therefore present data for two conditions, see *Performance Charts for Adaptive Symmetry*.

- When traffic is only being sent in one direction the other direction has no load on it and a peak throughput can be achieved in a single direction at a given time.
- When one direction of the link is saturated the maximum throughput in the other direction balances that load and provides a symmetrical throughput in each direction, for identical link conditions. In this case the values shown in the Performance Summary section.

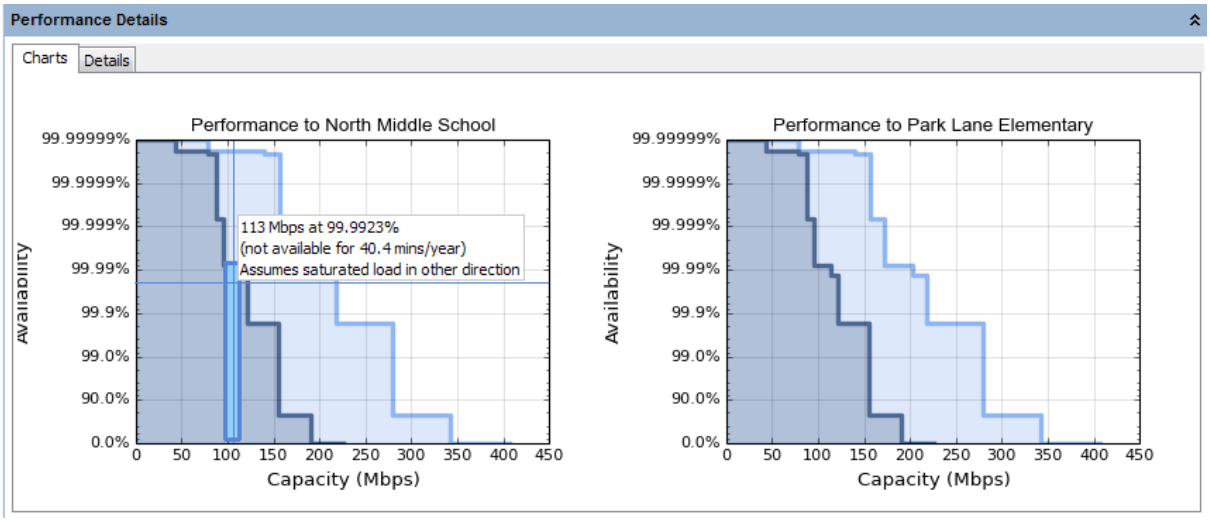
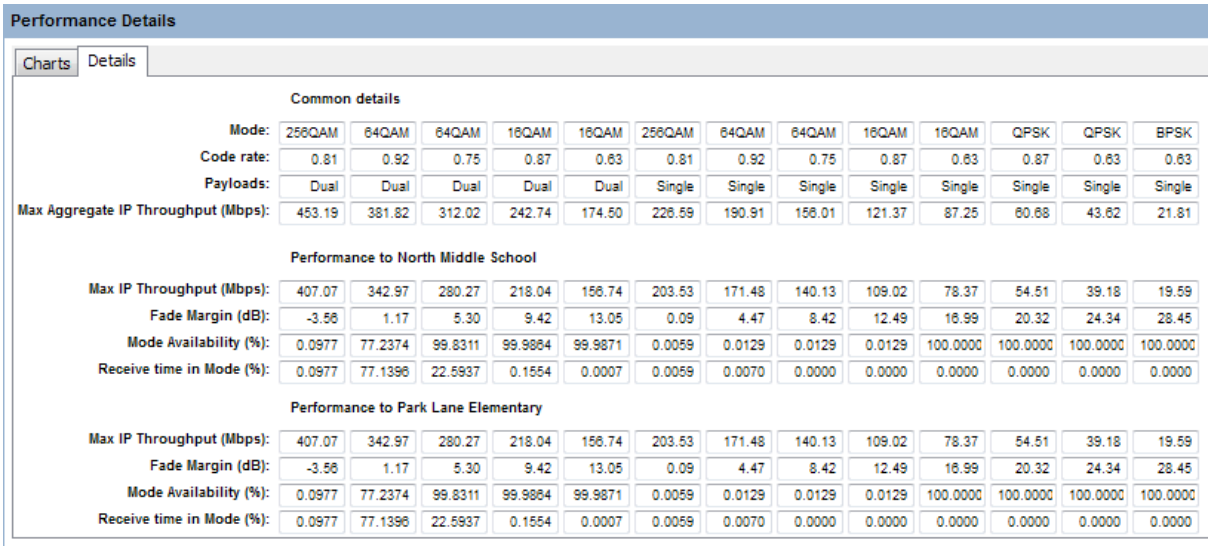


Figure 4.26: Performance Charts for Adaptive Symmetry

- high capacity, which can only be achieved in this direction assuming there is no load in the other direction.

- symmetrical capacity, which can be achieved assuming a saturated load in the other direction. This capacity can be achieved simultaneously with the equivalent load shown on the opposite direction of the link.

Table



Performance Details

Charts | Details

Common details

Mode:	256QAM	64QAM	64QAM	16QAM	16QAM	256QAM	64QAM	64QAM	16QAM	16QAM	QPSK	QPSK	BPSK
Code rate:	0.81	0.92	0.75	0.87	0.63	0.81	0.92	0.75	0.87	0.63	0.87	0.63	0.63
Payloads:	Dual	Dual	Dual	Dual	Dual	Single	Single	Single	Single	Single	Single	Single	Single
Max Aggregate IP Throughput (Mbps):	453.19	381.82	312.02	242.74	174.50	226.59	190.91	156.01	121.37	87.25	60.68	43.62	21.81

Performance to North Middle School

Max IP Throughput (Mbps):	407.07	342.97	280.27	218.04	156.74	203.53	171.48	140.13	109.02	78.37	54.51	39.18	19.59
Fade Margin (dB):	-3.56	1.17	5.30	9.42	13.05	0.09	4.47	8.42	12.49	16.99	20.32	24.34	28.45
Mode Availability (%):	0.0977	77.2374	99.8311	99.9864	99.9871	0.0059	0.0129	0.0129	0.0129	100.0000	100.0000	100.0000	100.0000
Receive time in Mode (%):	0.0977	77.1396	22.5937	0.1554	0.0007	0.0059	0.0070	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Performance to Park Lane Elementary

Max IP Throughput (Mbps):	407.07	342.97	280.27	218.04	156.74	203.53	171.48	140.13	109.02	78.37	54.51	39.18	19.59
Fade Margin (dB):	-3.56	1.17	5.30	9.42	13.05	0.09	4.47	8.42	12.49	16.99	20.32	24.34	28.45
Mode Availability (%):	0.0977	77.2374	99.8311	99.9864	99.9871	0.0059	0.0129	0.0129	0.0129	100.0000	100.0000	100.0000	100.0000
Receive time in Mode (%):	0.0977	77.1396	22.5937	0.1554	0.0007	0.0059	0.0070	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Figure 4.27: Performance Details

Common Details

MCS: (ePMP Only) The Modulation Coding Scheme Number

Mode: The modulation technique used.

Code Rate: The code rate for the specified Mode (not available for PTP 820, PTP 450 or PTP 450i).

Profile: (PTP 820 Only) The profile number of the modulation mode.

MIMO Type: (PTP 450 and 450i Only) The MIMO method used.

Payloads: (ePMP, PTP 300, 400, 500, 600, 650 or 700) Indicates whether the payload mode is Single or Dual.

Multiplier: (PTP 450 and 450i Only) Indicates the relative capacity capability of the different modes.

Max. Aggregate IP Throughput (Mbps): The maximum aggregate throughput achievable (sum of both directions). This field is automatically adjusted for the range of the link being studied.

STM-1 Carried: This row is only displayed if the equipment is PTP 810.

E1/T1 Carried: This row is only displayed if the equipment is PTP 600, PTP 650, PTP 700, PTP 810 or PTP 820G and one or more E1 or T1 channels have been selected. It indicates the number of E1 or T1 channels supported in each modulation mode. For PTP 600, PTP 650 or PTP 700 it is set to “Timing” for those modulation modes that are below the Lowest Telecom Mode selected in the Equipment section, for more information, see *Optimizing E1 or T1 Latency*.

Performance to each end

Max. IP Throughput (Mbps): The maximum user throughput achievable. For modulation modes below **Lowest Ethernet Mode** this value will be set to zero and no contribution from these modulation modes will be included in the ** Mean IP Predicted**.

Fade Margin (dB): The margin available to each end in the specified Mode.

Mode Availability (%): The percentage of time that the data throughput rate shown for each end will be available.

Receive Time in Mode (%):The percentage of time used to receive data in the specified Mode.

When **PTP 250** or **Adaptive Symmetry** is selected the values shown in the **Performance to each end** section of the table assume that there is no load in the opposite direction of the link.

Bill of Materials for Link

LINKPlanner automatically calculates the Bill of Materials (BOM) for the required components of the planned link. The link BOM contains the list of part numbers and associated quantities for the link. Optional items can be added to the list. The link BOM can be saved as a CSV or Excel file by clicking **View in Spreadsheet** .

NOTE

Part numbers for PTP 650L are not included in the BOM. Replace PTP 650S parts with equivalent PTP 650L part numbers and add capacity license key if appropriate. Ignore any range upgrade license key for PTP 650S, this is not required for PTP 650L.

To view the link BOM, open the Link page and scroll down to the ” *Bill of Materials for Link*” section.

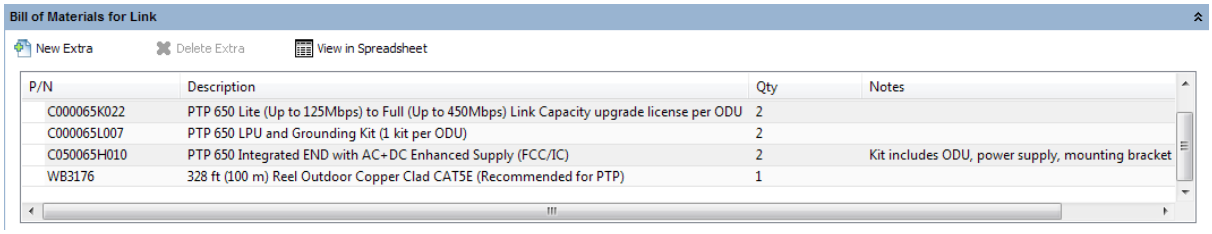


Figure 4.28: Bill of Materials for Link

P/N: The Cambium part number. If the component is not supplied by Cambium, this is set to ‘(no part number)’.

Description: Description of the components.

Qty: Quantity required.

Notes: By default this displays information about certain items, such as whether they are obsolete, or to prompt for additional required information, such as frequencies for the IRFU. This field can be edited to allow additional information to be added to the item. The default text is returned if the edited text is deleted. When information is displayed in the Notes field, items will only be aggregated at the Project Level BOM if the Notes field contains identical information as well as being the same part number.

A warning triangle is displayed on the far left of a line if additional information is required in the Notes field or in the configuration. A star denotes optional extras which have been added to the automatic BOM items and a star with a warning triangle is an optional extra which requires additional information to be included in the note.

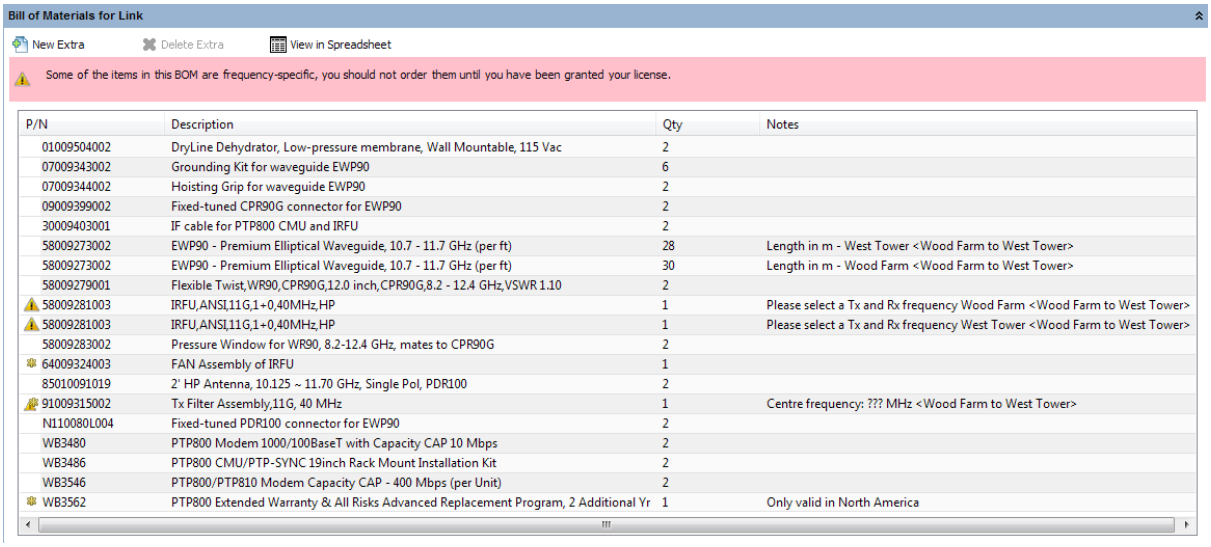


Figure 4.29: Bill of Materials Icons

To add additional items to the BOM, click **New Extra** 

. A list of optional extras for the given product will be displayed. The list of items will vary depending upon the product selected. To add an item to the BOM highlight the option required and click **OK**. The item will appear in the main list, where the quantity can be adjusted by selecting the number in the **Qty** column and adjusting as required. To delete an optional item from the BOM list, highlight the item and click **Delete Extra** 

.

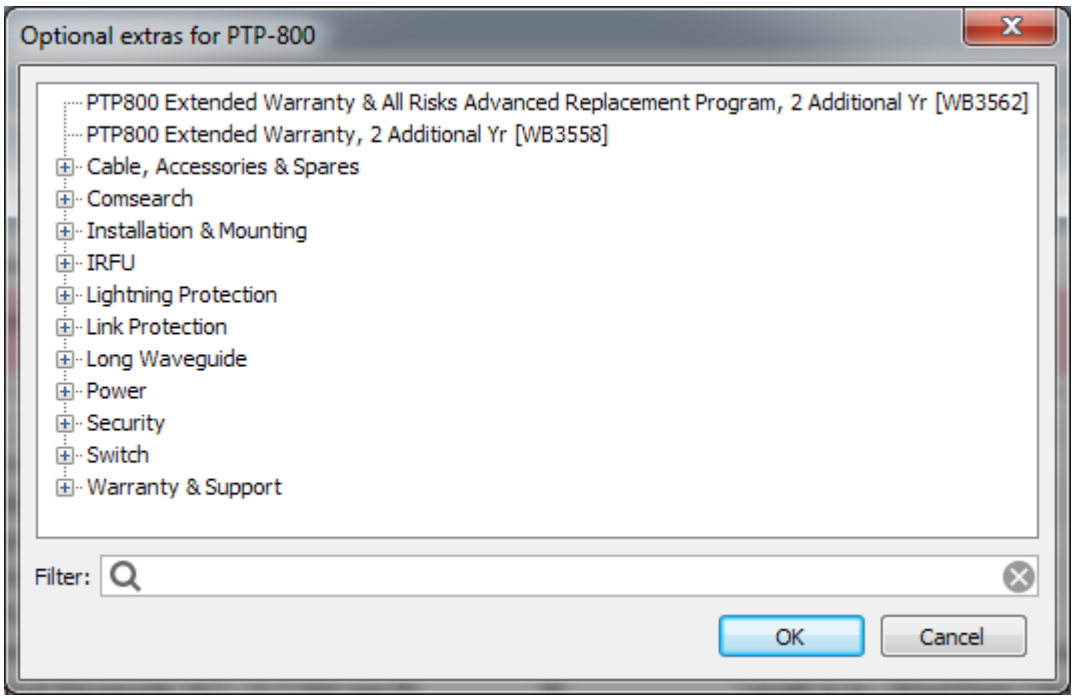


Figure 4.30: Bill of Materials Optional Extras

The groups and extras will vary depending on the chosen product.

The individual items at the top of the list give quick access to the most popular optional extras. To access more options, expand the list topics.

Accessories: Additional accessories.

Antennas: (PTP820 Only) Additional PTP 800 antenna options.

Cable, Accessories & Spares: This allows items such as additional cable, optical splitters, PTP Sync, E1/T1 splitters etc. to be added to the order.

Capacity Keys: PTP 810 capacity key licenses and upgrades.

Capacity Licenses: PTP 300, PTP 500 and PTP 650 license upgrades.

Comsearch: Allows FCC Frequency Coordination or Protection Services to be added to the order.

GPS Synchronization: (PTP 450 Only). Optional GPS Modules can be included with the order.

Installation & Mounting: Optional installation, grounding and mounting kits can be included with the order.

IRFU: This option is only available for the PTP 800 series and allows upgrade kits and field replaceable items to be specified for IRFU links.

Kits: PTP 650 alternative ODU and power supply kits.

Licenses: PTP 650 additional license options.

License Keys: PTP 820 license keys and capacity upgrades.

Lightning Protection: Lightning protection options.

Link Protection: This option is only available for the PTP 800 and PTP 820 series and allows additional cabling and splitter options to be specified for a 1+1 Protected Link.

Long Waveguide: This option is only available for the PTP 800 series and allows additional options for the mounting components when using long feeder runs either for the **Long Waveguide** option or for **IRFU**.

Modem Base Modules: PTP 810 base modules.

Modem Expansion I/O Modules: PTP 810 expansion modules.

Modem Spare Modules: PTP 810 spare modules.

NMS: PTP 820 Network Management System parts

Power: This allows AC/DC power supplies and country specific mains leads and PIDU to be included with the order.

Security: There is a range of different encryption options available, depending upon the product selected.

Switch: A range of switch options.

Warranty & Support: Additional warranty options are available to extend the warranty by 1, 2 or 4 years. Also annual PTP software support contracts are available, depending upon the number of links required.

To filter the list of optional extras, enter a part number or description in the Filter field.

NOTE

For instructions on how to view and save the BOM for the entire project, see *Bill of Materials for Project*.

Viewing & saving the link BOM file in MS Excel

To view the link BOM in Excel, click **View in Spreadsheet**  while viewing the link BOM. Once in the spreadsheet the file can be saved as normal.

NOTE

All numeric only part numbers consist of 11 digits, if the number displayed is only 10 digits the part number should start with a zero.

Advanced Features

To improve the performance of links additional features are available in certain PTP products.

For PTP 300, 500, 600, 650 or 700

- Optimize E1 or T1 latency, see *Optimizing E1 or T1 Latency*

For PTP 300, 500, 600, 650 or 700

- Use TDD Synchronization, see *Setting TDD Synchronization*. For further background information giving an overview of Time Division Duplex, see *TDD Overview* or for an overview of TDD Synchronization, see *TDD Synchronization Overview*.

For PTP 800, 810 or 820

- Enable Hot Standby Protection, including Spatial Diversity, see *Setting Hot Standby Protection (1+1)*
- Use 2+0 Antenna Sharing, see *Setting 2+0 Antenna Sharing*

For PTP 800, or 810

- Installing IRFUs indoor, see *Long Waveguide*

For PTP 800

- Installing ODUs indoor or at the base of the tower, see *Long Waveguide*

For all PTP products (except ePMP, PTP 450, PTP 450i and PTP 820S)

- Use Diversity, including Reflections, see *Setting Diversity*

Optimizing E1 or T1 Latency

When a number of E1 or T1 channels are selected in the *Link Description and Equipment* section, the LINKPlanner is able to predict the latency for those channels. The latency is displayed in the Link Summary section of the *Performance Summary*.

The latency depends on a number of factors which may be out of the user's control, such as the link range and radar detection requirements. It also depends on the number of telecoms channels selected, the channel Bandwidth, and the Lowest Telecoms Mode. By adjusting these values, it may be possible to improve the latency.

The Lowest Telecoms Mode or Lowest TDM Mode selection determines which modulation modes will be allowed to carry telecoms data. Lower modulation modes will only carry timing information. The product will then optimize the latency for that modulation mode. For more information, see the section titled "Telecoms Circuits" or "TDM bridging" in the appropriate product User Guide, which can be downloaded from https://support.cambiumnetworks.com/files.

In the LINKPlanner, the *Lowest Telecoms Mode* selection box lists the modulation modes and their ability to carry the selected telecoms payload. If the mode would be unable to carry that payload, it displays "Timing". Otherwise it displays the selected channels.

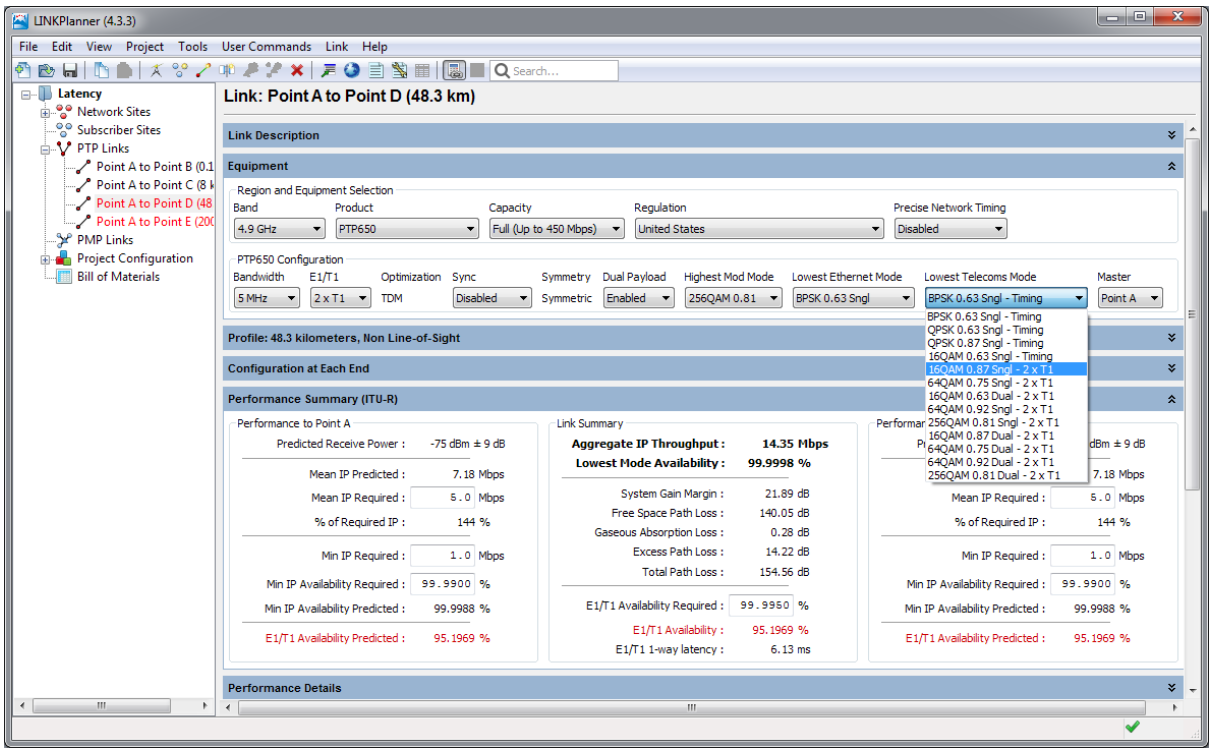


Figure 4.31: Lowest Telecoms Mode

In this example, **16QAM 0.87 Sngl** is the first modulation mode capable of carrying the 2 T1 channels - the lower modes can only carry timing information. However, by selecting a higher modulation mode, the latency may be reduced (potentially at the expense of the E1/T1 Availability, if the selected modulation mode does not have a high enough availability)

When E1/T1 is selected, the *Performance Details* display will also gain an extra row which indicates whether the mode will be carrying E1/T1 payloads, or timing data only.

Setting TDD Synchronization

TDD synchronization settings involve adjustment of an individual link in the Equipment Pane of a link and of the global parameters in the TDD Sync node in the navigation tree. For a more detailed understanding of TDD Synchronization, see *TDD Synchronization Overview*.

NOTE

When TDD synchronization is enabled for a link, the link will show zero data rate until a valid set of global options are selected in the *TDD Synchronization List* and a warning will be displayed in the TDD Synchonrization Sub-Panel

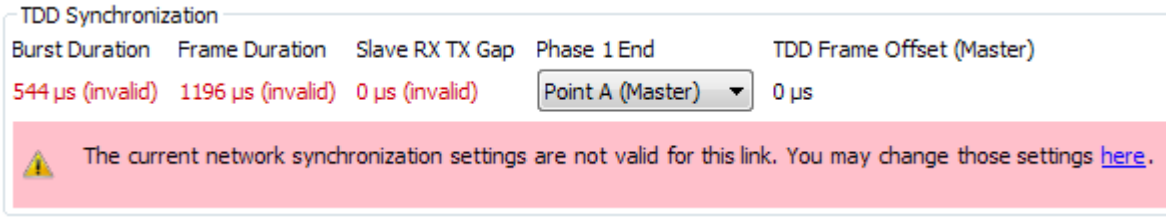


Figure 4.32: TDD Synchronization Error Message

The process for setting TDD synchronization is:

1. Enable TDD synchronization in the Equipment section of the Link page, as described in *Link Description and Equipment*.

   The *TDD Synchronization* Sub-Panel is displayed. Use it to display and adjust the TDD settings for the individual link.

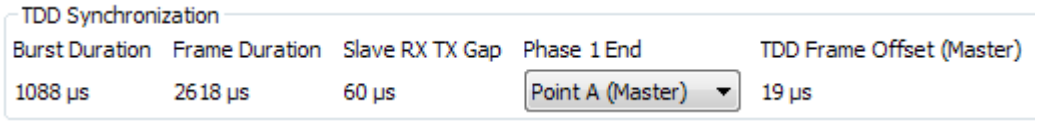


Figure 4.33: TDD Synchronization

   Phase 1 End: In a hub and spoke arrangement there are several links emanating from one tower. Each link on that tower normally needs to be set to the same phase. In a simple network this will be setting each Phase 1 End to the hub end. If there is more than one hub in a network then it may be necessary to have some towers set for all of the links to be Phase 2 at the hub or Phase 1 at the outstations. This is achieved by setting the Phase 1 end to the opposite ends of the links from the hub end.

2. Set the Maximum Burst Duration and Frame Duration, as described in *TDD Synchronization List*.

TDD Overview

Cambium PTP unlicensed band links consist of a Master unit and a Slave unit. The links use a duplexing scheme known as Time Division Duplex (TDD). To activate TDD Synchronization, see *Setting TDD Synchronization*.

TDD operates by only allowing one end of the link to transmit at any one time. This allows both link directions to operate on the same radio frequency. This differs from Frequency Division Duplex (FDD), where each end can transmit and receive simultaneously but this requires the two directions to operate on different frequencies, thereby increasing the spectral requirements.

TDD operates in a cyclic fashion, with the transmissions alternating between the two ends. The cycle of events is as follows:

1. Master transmits a burst
2. A delay occurs as the Master burst travels over the air
3. Slave receives the burst

4. A delay as the Slave processes the burst
5. The slave transmits a burst
6. A delay as the slave burst travels over the air
7. Master receives the burst
8. A delay as the Master processes the burst
9. Master transmits a burst

One cycle is called a Frame. The cycle period is called the Frame Duration. This is shown in *Basic TDD Frame*. For purposes of illustration, the delays in this diagram have been exaggerated.

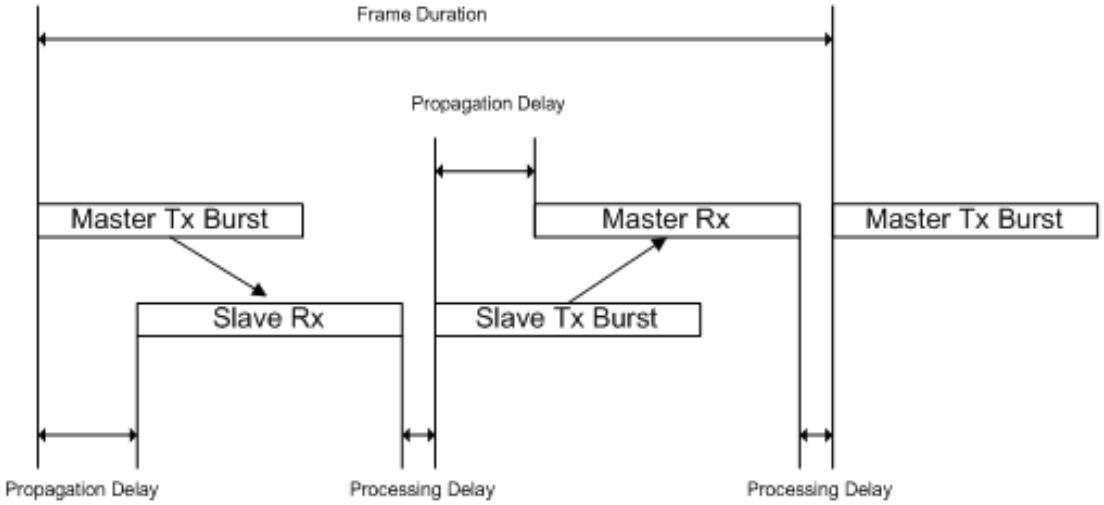


Figure 4.34: Basic TDD Frame

The size of the burst depends on the configuration of TDM mode, IP mode and link symmetry.

TDM Mode

If the PTP link is carrying TDM traffic (E1s or T1s), it is desirable to keep the burst as short as possible in order to minimize latency. However, with shorter bursts, a greater proportion of the frame is taken up by the radio propagation delay and the burst processing delay thus reducing throughput. So, in TDM mode, the PTP link reduces the burst size as far as possible whilst still maintaining the throughput required for the configured number of E1s and T1s. The result is that burst sizes are greater for longer links.

IP Mode

If the PTP link is carrying IP traffic only, it is often desirable to increase throughput at the expense of latency. In IP mode therefore, the PTP link maximizes burst size. This makes the propagation delay and processing delay proportionately smaller making the frame more efficient.

Symmetry

The system can be configured to give more or less of the frame to a particular direction. Possible values are:

- **Symmetric**: Equal burst size for both link directions. Each link direction has the same maximum throughput.
- **Adaptive**: This mode is only available in IP mode. The size of the burst effectively adapts to the traffic being offered from the network and is independent of the size of the burst in the other link direction. As the offered traffic level increases in a given direction, the size of the burst increases in that direction in order to increase frame efficiency and therefore throughput. As the offered traffic level decreases in a given direction, so the size of the burst in that direction decreases. This allows the other link direction to take a greater proportion of the frame if required.
- **2:1 (PTP 600, PTP 650 only)**: Master Tx Burst is twice the size of Slave Tx Burst. Maximum throughput in the direction towards the Slave is twice the Maximum throughput in the direction towards the Master.
- **3:1 (PTP 300/500 only)**: Master Tx Burst is three times the size of Slave Tx Burst. Maximum throughput in the direction towards the Slave is three times the Maximum throughput in the direction towards the Master.
- **1:2 (PTP 600, PTP 650 only)**: Slave Tx Burst is twice the size of Master Tx Burst. Maximum throughput in the direction towards the Master is twice the Maximum throughput in the direction towards the Slave.
- **1:3 (PTP 300/500 only)**: Slave Tx Burst is three times the size of Master Tx Burst. Maximum throughput in the direction towards the Master is three times the Maximum throughput in the direction towards the Slave.

Summary

The frame duration is dependent on:

- Burst size.
- Propagation delay (link length).
- System processing delays.

The burst size is dependent on configuration:

- In TDM mode, the burst sizes are minimized as far as possible in order to reduce latency.
- In IP mode, the burst sizes are maximized in order to increase throughput. As processing delay and propagation delay are fixed (for a given link length), larger bursts are more efficient as a greater proportion of the frame is being used to carry data.

TDD Synchronization Overview

The performance of any radio is dependent on the level of electromagnetic interference to which it is subjected. This is also the case for the PTP Outdoor

Units (ODUs).

PTP ODUs are installed as pairs to form a Point to Point radio link. In an ideal radio environment, any individual ODU will receive transmissions only from the paired ODU at the other end of the link. However, when multiple links are installed, an ODU may also be subjected to interference from the transmission of an ODU which is part of another link. This is depicted in *Interference Between ODUs*, which shows an example concentrating specifically on ODU A as an interferer. Both ODU C and ODU D are subjected to interference from ODU A.

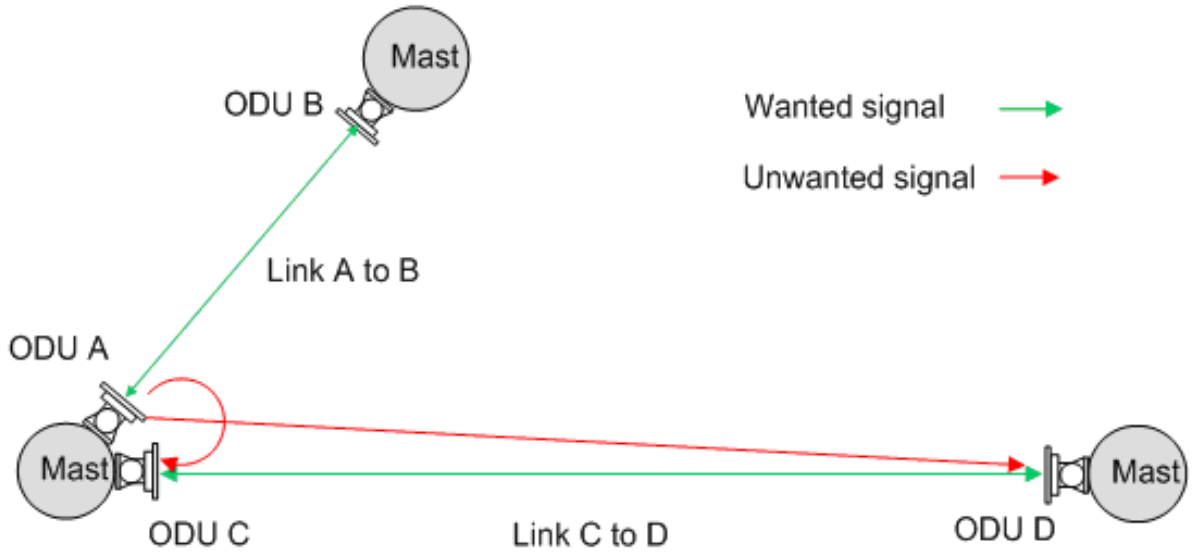


Figure 4.35: Interference Between ODUs

Interference between units on the same mast is the most problematic due to their close proximity. The problem becomes worse when the angular separation between links (see *Separation of PTP 600 Units on a Mast*) is small. This can be alleviated by using the following techniques:

- Increasing the separation between the victim's receive frequency and the interferer's transmit frequency. With limited spectrum, this becomes more difficult with increasing numbers of links.
- Increasing the physical separation between the interferer and the victim. *Separation of PTP 600 Units on a Mast* vertically separated on a mast.
- Reducing the transmit power of the interfering radio. However, this may affect the performance of the interferers own link in the direction away from the common mast.

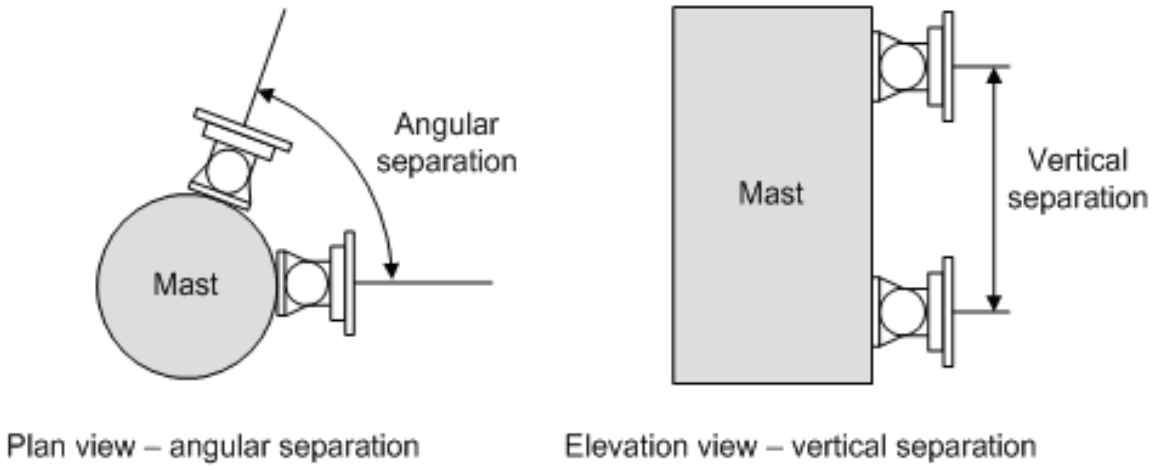


Figure 4.36: Separation of PTP 600 Units on a Mast

The techniques for minimizing interference on a common mast are described in documents PTP 600 Series Deploying Collocated Units and PTP 300/500 Series Planning Guide for Collocation. If these techniques do not reduce interference sufficiently, then TDD synchronization should be considered.

TDD synchronization works by aligning the frames of all links in the network thereby eliminating interference between those ODUs which are configured to operate on the same phase of the TDD cycle. To understand this, it is first useful to consider the TDD frames of the two links shown in *Separation of PTP 600 Units on a Mast* with synchronization disabled.

Unsynchronized Links

When the frames of two links are unsynchronized, the transmission from one ODU may overlap the receive frame of any another ODU. *Unsynchronized Frames* shows the frames of the two links “A to B” and “C to D”. The diagram focuses on ODU A as the interferer. It can be seen that the transmission from ODU A is overlapping the receive period of both ODU C and ODU D. As well as the frames not being aligned, the frame duration of link “C to D” is longer than that of link “A to B”. This is because the propagation delay of this link is longer. This means that the size of the overlap will vary from frame to frame. This is illustrated by the overlap period with ODU D Rx being longer in the first frame than in the second frame.

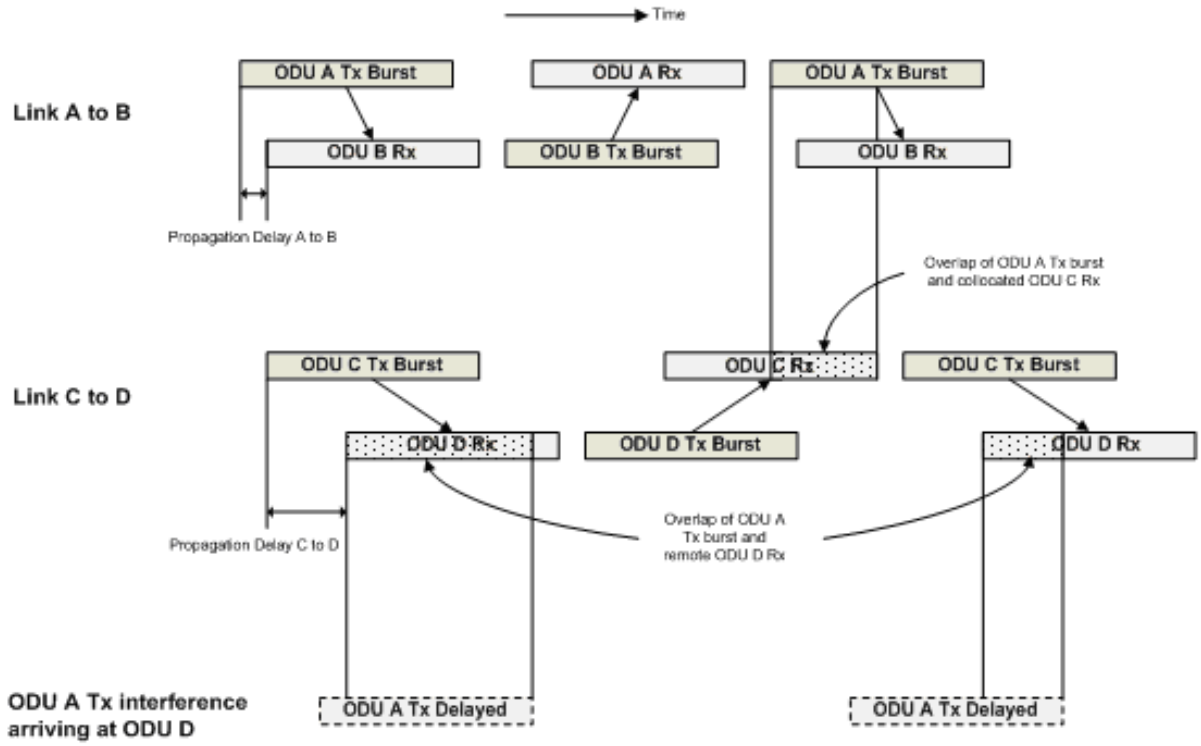


Figure 4.37: Unsynchronized Frames

Synchronized Links

The primary advantage of TDD synchronization is that the network can be configured such that the transmit burst of an ODU does not overlap the receive burst of a collocated ODU. This eliminates the most problematic interference mechanism.

Taking the same example pair of links, *Synchronized Frames* shows the two links with TDD synchronization enabled. The start of each frame now occurs at the same point in time. This is achieved by the use of a GPS synchronization box which injects a pulse into the Master ODU every second. One GPS synchronization box is required for each Master ODU and the pulse occurs at the same point in time for every GPS synchronization unit in the network. The Master ODU then offsets the center of its frame relative to the pulse by a configurable delay. The intention of this delay is to allow the Master to be configured to transmit on either Phase 1 (which is when the pulse aligns with the center of the Master transmit burst) or Phase 2 (which is when the center of the Master transmit burst is delayed by half the frame duration relative to the pulse). The default is for Masters to be on Phase 1 which is suited to the common case of collocating Master ODUs at “hub” sites.

In *Synchronized Frames*, collocated ODUs A and C transmit on Phase 1, i.e. the 1 pulse per second aligns with the center of the transmit burst. The remote ODUs B and D transmit on Phase 2, 180 degrees out of phase with ODU A and C.

The result of TDD synchronization is that the receive period of ODU C never overlaps with the transmission burst from the collocated ODU A - and vice versa. Also, the receive period of remote ODU B never overlaps with the transmission

burst from remote ODU D - and vice versa. However, the receive period of the remote ODU D still overlaps with the transmission from ODU A. In fact, they are now perfectly aligned. This highlights the key result of TDD synchronization which is that half of the network interference mechanisms are eliminated, or more precisely, the interference between units operating on the same phase of the TDD cycle is eliminated.

In order to eliminate interference between units which are on the same phase but which are NOT collocated, the propagation delay of the victim link and the interference path needs to be considered. This leads to the optimization of three parameters:

- Burst Duration
- Frame Duration
- slaveTxRxGap

Burst Duration and Frame Duration are self explanatory and are shown in *Synchronized Frames*. The parameter slaveRxTxGap is also shown in *Synchronized Frames* and allows the frames of shorter links to stretch to that of the longest link in order to keep a common network frame duration. This highlights a key disadvantage of TDD synchronization in that the efficiency of shorter links reduce to those of the longer links. Also note that adaptive frame structures are no longer possible. In fact, only symmetrical frame structures are supported when TDD synchronization is enabled.

Optimization of these parameters as well as the configuration of phase using Link Planner is discussed in *Setting TDD Synchronization*.

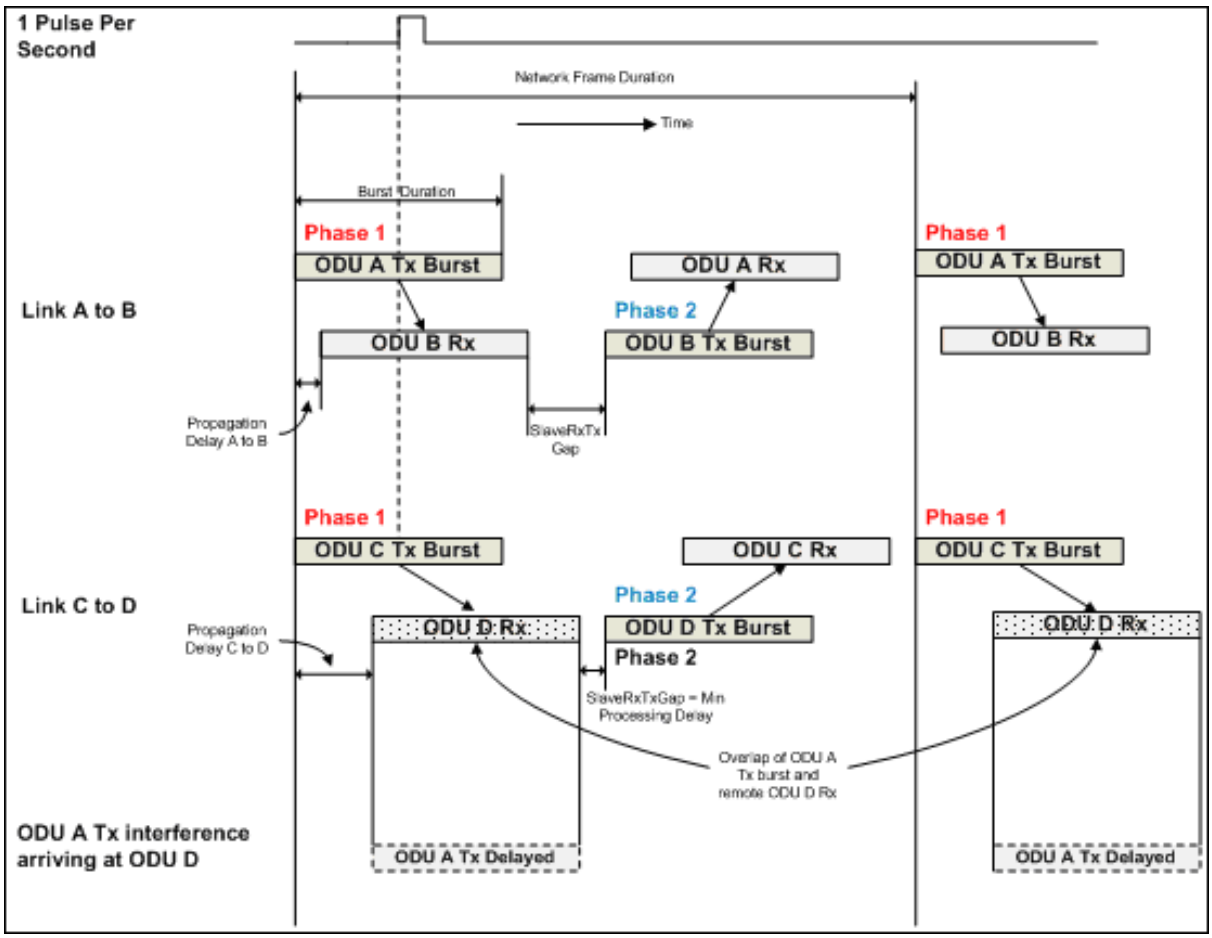


Figure 4.38: Synchronized Frames

Setting Hot Standby Protection (1+1)

Hot Standby is available on PTP 800, PTP 810 and PTP 820 links and involves configuring two units at each end of the link to operate as primary and secondary (standby) units. For a more detailed understanding of 1+1 Hot Standby, see the appropriate product User Guide.

Hot Standby can be enabled as described in *Link Description and Equipment*. Once enabled, the Project Navigation Tree shows the link node and then the four paths as sub-headings to the main link, as shown in *Navigation Tree for Protected (1+1) link*.

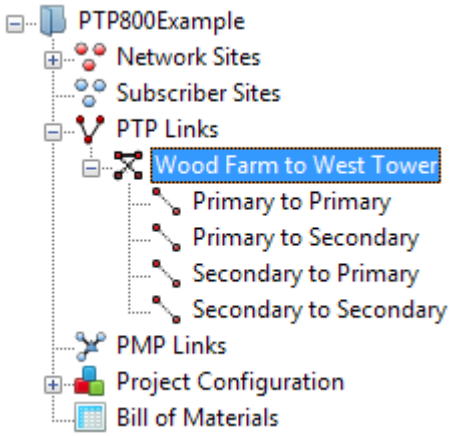


Figure 4.39: Navigation Tree for Protected (1+1) link

The link node gives access only to the Link Description, Equipment Selection and Bill of Materials aspects of the link configuration, see *Link Node Information for Protected (1+1) link*. To access all other sections of the Link Page select one of the four paths, e.g. **Primary to Primary**.

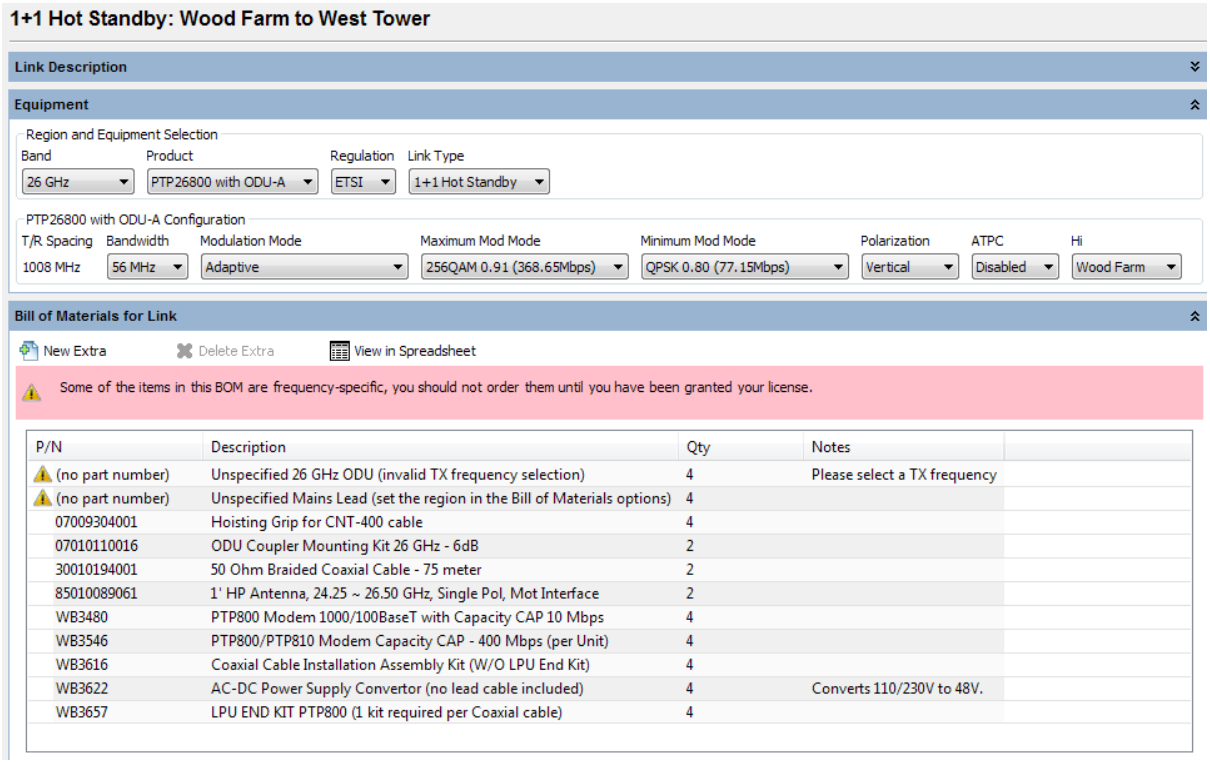


Figure 4.40: Link Node Information for Protected (1+1) link

Hot Standby Configuration at Each End

Select the required path for the protected link. In addition to the normal parameters as described in *Link Description and Equipment*, links operating Hot Standby have the following additional attribute displayed:

Antenna Configuration: There are up to 4 options which can be selected to match the possible configurations for Hot Standby when using an ODU Product or PTP 820.

- **Common Antenna - 1+1 Symmetric Coupling**
- **Common Antenna - 1+1 Asymmetric Coupling** - default setting
- **Redundant Antennas** - PTP 800 Only
- **Spatial Diversity**, see *Setting Diversity*

There are 5 options which can be selected to match the possible configurations for Hot Standby when using an IRFU product.

- **Equal Splitter** - default setting
- **Equal Splitter MHSB Ready**
- **Unequal Splitter**
- **Unequal Splitter MHSB Ready**
- **Spatial Diversity**, see *Setting Diversity*

The primary and secondary parameters at each end can be configured as described in *Configuration at Each End*, by selecting the following paths:

- **Primary to Primary**
- **Primary to Secondary**
- **Secondary to Primary**
- **Secondary to Secondary**

Although the parameters can be configured through either the primary or secondary interface, some parameters are common to both configurations at the same end of the link. Any changes made to either primary or secondary configuration will automatically be reflected in the other configuration at that end of the link.

Antenna Type: If one of the common antenna protection options has been selected this value will be the same for both primary and secondary. If the redundant antennas or spatial diversity option have been selected then a different antenna can be chosen for primary and secondary. If using an FCC regulation Cat B, Cat B1 or Cat B2 antennas can be used as a receive only diverse antenna in locations where a Cat A primary antenna is required. In such locations these antennas must not be used for transmit, see *PTP 800 Series User Guide* or *PTP 810 Series User Guide* for further details on the correct way to commission the PTP 800 and PTP 810 modems for use with these antennas.

Antenna Height: If one of the common antenna protection options has been selected this value will be the same for both primary and

secondary. If the redundant antennas or spatial diversity option have been selected then a different antenna height can be chosen for primary and secondary.

Diversity Spacing: This field is only shown when the **Antenna Configuration** is set to **Spatial Diversity** and it shows the difference in height between the Primary and Secondary antennas. Improvement in availability will only occur when this value is greater than zero, see *Setting Diversity*.

Feeder Loss: This field will incorporate the coupler loss in addition to any waveguide loss. Any User Defined additional loss which has been included will be the same for both primary and secondary remote antennas for any of the common antenna protection options, but can be different for primary and secondary if the redundant antennas or spatial diversity option have been selected. The symmetric coupler will have the same loss for both primary and secondary, whereas the asymmetric coupler has a lower loss for the primary and higher loss for the secondary. For the IRFU the losses will always be defined by the more complex Losses spreadsheet as described in *Long Waveguide*, as the losses are not the same for both transmit and receive.

Maximum EIRP: The EIRP will often be different for the primary and secondary, in the majority of cases the primary will have the higher value. If the secondary has a higher value than the primary, a warning will be shown on the display, as this might violate the terms of the license.

The IRFU only transmits through the Primary Antenna and Feeder System, therefore for Spatial Diversity using an IRFU, the EIRP is calculated using the Primary Antenna Gain and Feeder Losses. The Secondary Maximum EIRP and Maximum Power will be the same as for the Primary and there are no separate User Limits for the Secondary. The receive path uses the Secondary Antenna Gain and Feeder Losses.

Maximum Power: This field can be set independently for primary and secondary, unless using IRFU Spatial Diversity or PTP 810.

PTP 810 only supports a single transmit power setting during installation. It also supports a setting for coupler loss, which when using a common antenna is the difference in coupler loss between the primary and secondary path. For Spatial Diversity the coupler loss is any additional loss due to lower antenna gain and feeder loss on the secondary path. The coupler loss is shown on the Installation Report. The Secondary Maximum EIRP and Maximum Power are calculated from the Primary Maximum Power and there are no separate User Limits for the Secondary.

Tx Frequency: This value will always be the same for primary and secondary.

Tx Capacity Limit: PTP 800 Only. This field can be set independently for primary and secondary.

Link MMU Model: PTP 810 Only. This value will always be the same for primary and secondary.

Interference: This value will always be the same for primary and secondary.

Hot Standby Bill of Materials

The Bill of Materials is displayed at the link node level and shows the full set of equipment required for both the primary and secondary units. For PTP 800, Hot Standby can be operated with either in-band or out-of-band management. If out-of-band management is required then additional items may be required to make up a full set of equipment, which can be selected via the **New Extras** 

icon, see *Bill of Materials Optional Extras*.

Hot Standby Performance Summary

The performance summary information is shown separately for each path and can be accessed by selecting the appropriate path, for example **Primary to Secondary**, from the navigation tree. The required performance parameters can be set independently for each path and are defined in the usual way, see *Performance Summary*.

If the predicted performance of the primary to primay path is below requirements, then the main link node will be displayed in **red**. If the performance of any of the other paths is below requirements then the associated sub-path in the navigation tree will be shown in **red**, but will not affect the annotation of the link node, the map display or the link table . If a particular path is not considered relevant to the performance of the link, it can be “switched off” by setting the following:

- **Mean IP Required** to 0.1 Mbps
- **Min IP Availability Required** to 0.0000%

For PTP 800 and PTP 810 Spatial Diversity improvement is only applied to the lowest configured modulation mode, therefore it will always be included in the **Link Summary** parameter **Lowest Mode Availability**. It will usually also be included in the **Min IP Availability Predicted**, however if the **Min IP Required** is greater than that supported by the **Minimum Mod Mode**, there will be no spatial diversity improvement included in the **Min IP Availability Predicted**. If IRFU is selected with Spatial Diversity the **Secondary to Secondary** performance is not relevant as the transmit path is always through the primary antenna.

Hot Standby Reports

There are two levels of report available in Hot Standby. By default a standard report is produced, which concentrates on the performance of the primary to primary link or a detailed report can be produced which details all four paths.

When the protected link option is selected for the first time by a user the following message is displayed allowing the user to choose the type of report.

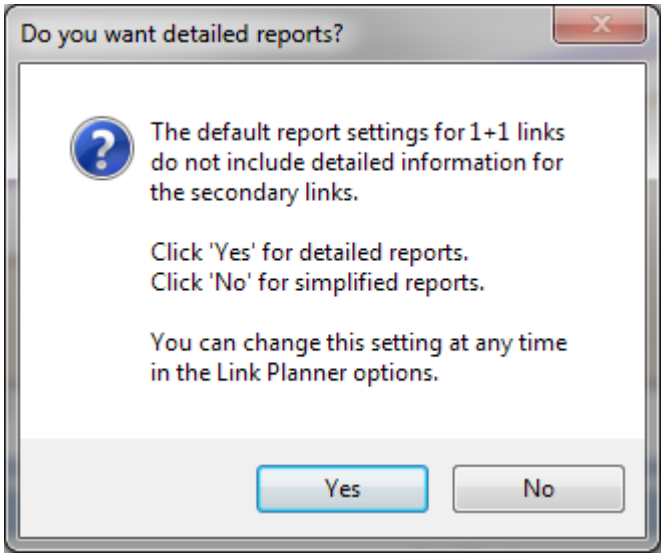


Figure 4.41: Detailed Reports Information Message

The type of reports can be changed at any time by clicking **Tools, Options, Reports** and then selecting or deselecting the **Generate detailed reports** option.

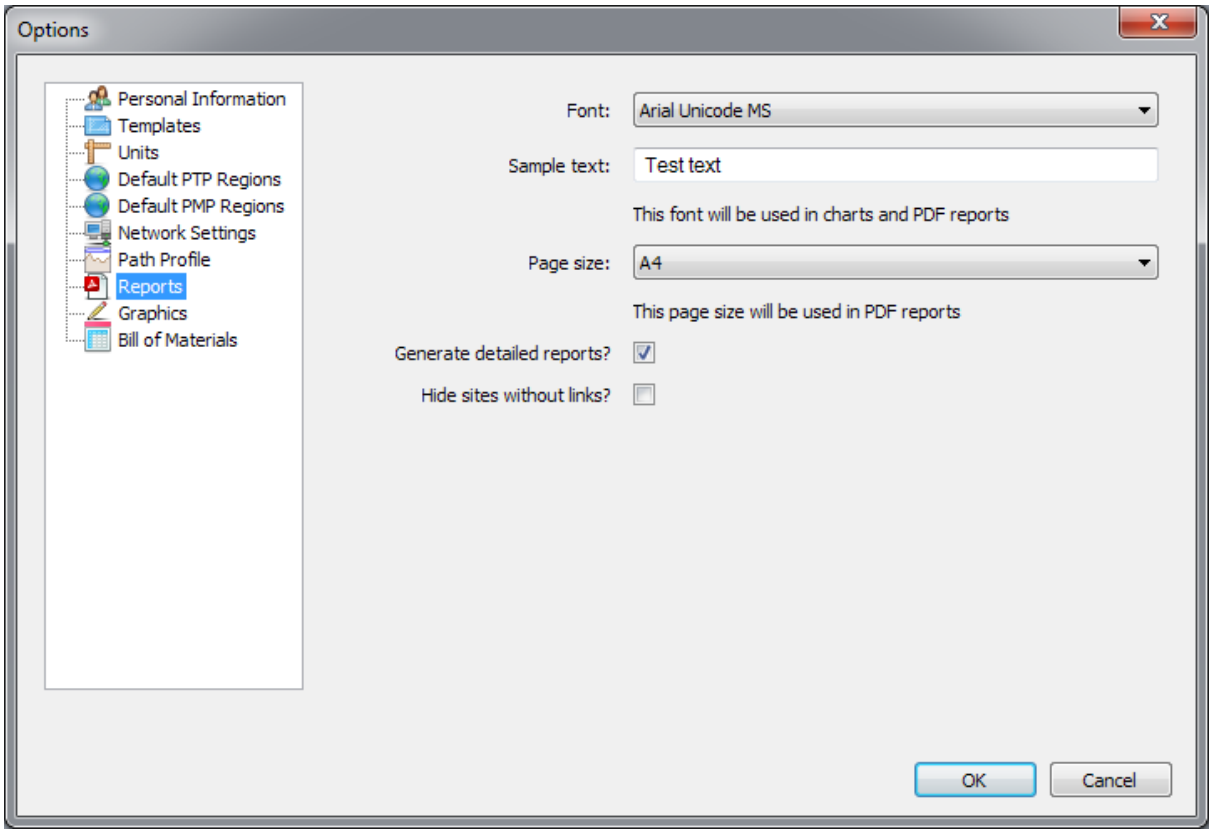


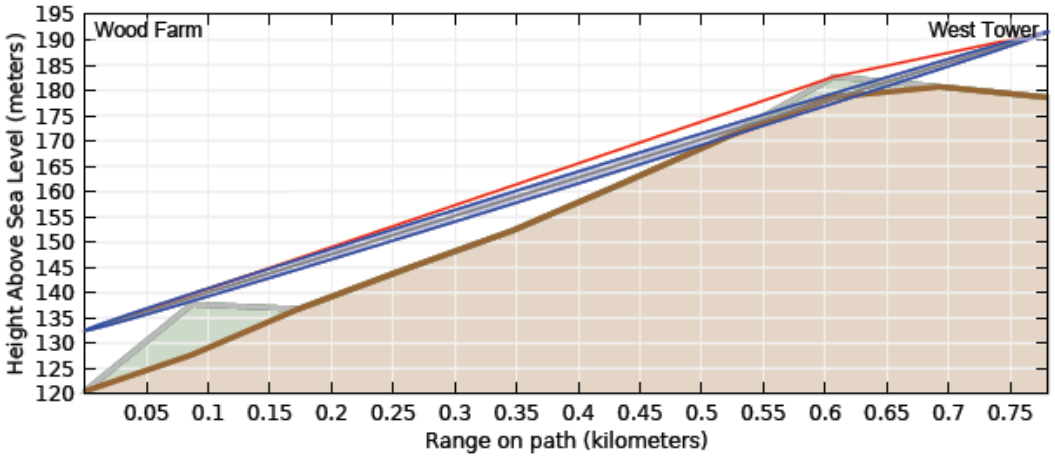
Figure 4.42: Detailed Reports Selection

The proposal and installation reports are created for a given link, not path, in the usual way, see *Creating Reports*. The level of detail presented will depend upon the detailed reports selection and which product is selected. The standard reports only show performance information for the primary to primary path. If a common antenna has been selected, or the link is PTP 810, only one set of installation notes will be produced for each end of the link, any parameters which might be different between the primary and secondary units will be clearly specified. This includes the predicted receive power at both the primary and secondary units at one end from the primary unit at the other end. If redundant antennas or spatial diversity have been selected separate installation notes will be produced for the primary and secondary units for PTP 800, as several parameters are likely to be different. PTP 810 will still show a single section for each end, but include all parameters which might be different.

The detailed reports contain both installation and performance information for each of the path combinations, with the significant changes outlined in the following sections.

Detailed Proposal Report

The throughput information for each end of the link and the link summary information is shown for each of the paths.



Performance to Wood Farm				
	Primary to Primary	Primary to Secondary	Secondary to Primary	Secondary to Secondary
Mean IP	362.5 Mbps	348.3 Mbps	348.3 Mbps	310.0 Mbps
IP Availability	99.97940 % for 1.0 Mbps	99.92844 % for 1.0 Mbps	99.92844 % for 1.0 Mbps	99.75181 % for 1.0 Mbps

Performance to West Tower				
	Primary to Primary	Primary to Secondary	Secondary to Primary	Secondary to Secondary
Mean IP	362.5 Mbps	348.3 Mbps	348.3 Mbps	310.0 Mbps
IP Availability	99.97940 % for 1.0 Mbps	99.92844 % for 1.0 Mbps	99.92844 % for 1.0 Mbps	99.75181 % for 1.0 Mbps

Figure 4.43: Proposal Report Performance Information for Protected (1+1) Link

For both sets of performance information the primary to primary notation refers to the left end to right end of the link, in this example Wood Farm to West Tower.

For the Performance to West Tower the information is shown for the perfomance received at West Tower when:

- Primary to Primary - both Wood Farm and West Tower are set to primary.
- Primary to Secondary - Wood Farm is set to primary and West Tower is receiving a signal on its secondary unit.
- Secondary to Primary - Wood Farm is transmitting on its secondary unit, whilst West Tower is still receiving on its primary unit.
- Secondary to Secondary - both Wood Farm and West Tower are using their secondary units

Detailed Installation Report

The initial sections of the report (link summary, path profile and link

configuration) are shown for the primary to primary path. For PTP 800 the site installation notes are given for both the primary and secondary units at each end of the link, however for PTP 810 it is given as a single report for each end, showing any difference in primary and secondary parameters as required. The **BNC Target Voltage** and **Predicted Receive Power** are given for both the primary and secondary units with the other end of the link operating on primary.

If the values are required to verify the secondary to secondary path, then the **Predicted Receive Power** can be estimated quite closely for the common antenna configuration. The **BNC Target Voltage** can be derived from the received signal level using the RSSI voltage table given in *PTP 800 Series User Guide* or *PTP 810 Series User Guide*. Assuming that the same power level is used for both primary and secondary then the impact will be as follows:

- Symmetric Couplers - no change in predicted receiver power
- Asymmetric Couplers - the predicted receive power will drop by 5.4 dB compared with the secondary receive power level.

If the transmit powers are different for primary and secondary then the offset will have to be adjusted according to the difference. Equally if different antennas are used for primary and secondary the predicted receive power for the secondary to secondary path will be changed (with respect to the primary to primary path) by the sum of the difference in antenna gains at each end of the link.

For both PTP 800 and PTP 810 the performance information is given for all four paths, in a similar manner to the detailed proposal report.

Setting 2+0 Antenna Sharing

2+0 antenna sharing is available on PTP 800, PTP 810 and PTP 820 links. How to configure 2+0 depends on the product and whether an outdoor or indoor RFU is used:

- PTP 800, PTP 810, PTP 820S and PTP 820G require two RFUs at each end of the link to operate either through a common coupler to a single antenna or a dual polar antenna to provide two parallel links between two sites.
- 2+0 Co-Polar with an IRFU combines the two paths through an additional circulator to a single antenna, removing the loss of the coupler.
- PTP 820C requires a single RFU and either an OMT or splitter with a single polarity antenna.

For a more detailed understanding of 2+0 Antenna Sharing, see the appropriate product User Guide.

2+0 antenna sharing using outdoor RFUs is not available for some bands, regulations, T/R spacings or bandwidths, for PTP 800 and PTP 810, see the product User Guide for further information. For PTP 820 ensure that the two pairs of frequencies are in the same sub-band.

2+0 antenna sharing can be enabled as described in *Link Description and Equipment*, for 2+0 Co-Polar (ACCP), 2+0 Cross-Polar (ACAP) and 2+0 XPIC (CCDP)

(PTP 810 or PTP 820 Only). For PTP 800i with IRFU the only option is 2+0 Co-Polar, all 3 options are available for PTP 810i with IRFU, with the 2+0 Cross-Polar and 2+0 XPIC using dual polar antennas. Once enabled, the Project Navigation Tree expands to show a link node and its two associated links **Link A** and **Link B**. The 2+0 Cross-Polar is shown in *Navigation Tree for 2+0 Cross-Polar link*.

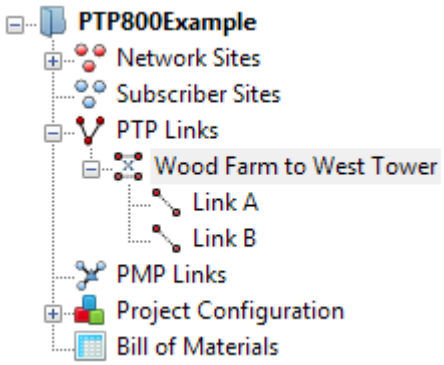


Figure 4.44: Navigation Tree for 2+0 Cross-Polar link

It is differentiated from the 2+0 Co-Polar, which is shown in *Navigation Tree for 2+0 Co-Polar link*, by the 'x' between the parallel lines in the link icon.

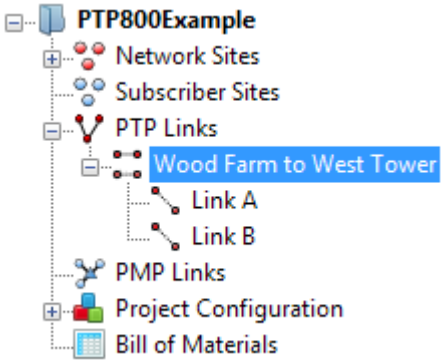


Figure 4.45: Navigation Tree for 2+0 Co-Polar link

The 2+0 XPIC configuration, which is shown in *Navigation Tree for 2+0 XPIC link*, is differentiated by the 'XPIC' between the parallel lines in the link icon.

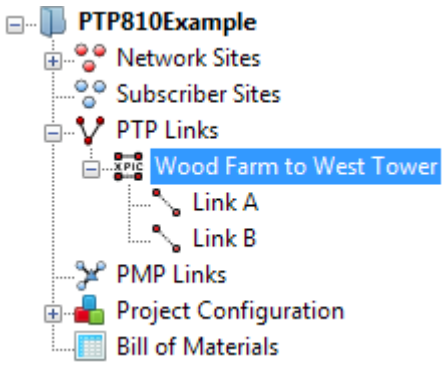


Figure 4.46: Navigation Tree for 2+0 XPIC link

For PTP 800 the link node gives access only to the Link Description, Region and Equipment Selection and Bill of Materials aspects of the link configuration, see *Link Node Information for PTP 800 2+0*. PTP 810 and PTP 820 also display all Equipment parameters, the Performance Summary and Performance Details for the aggregated link, see *Link Node Information for PTP 810 2+0*. For PTP 810 and PTP 820G the number of STM-1 (PTP 810 Only) and E1 or T1 circuits is configured for Link A and Link B at the link node level and cannot be changed at the lower levels. Click either **Link A** or **Link B** to configure the individual path settings.

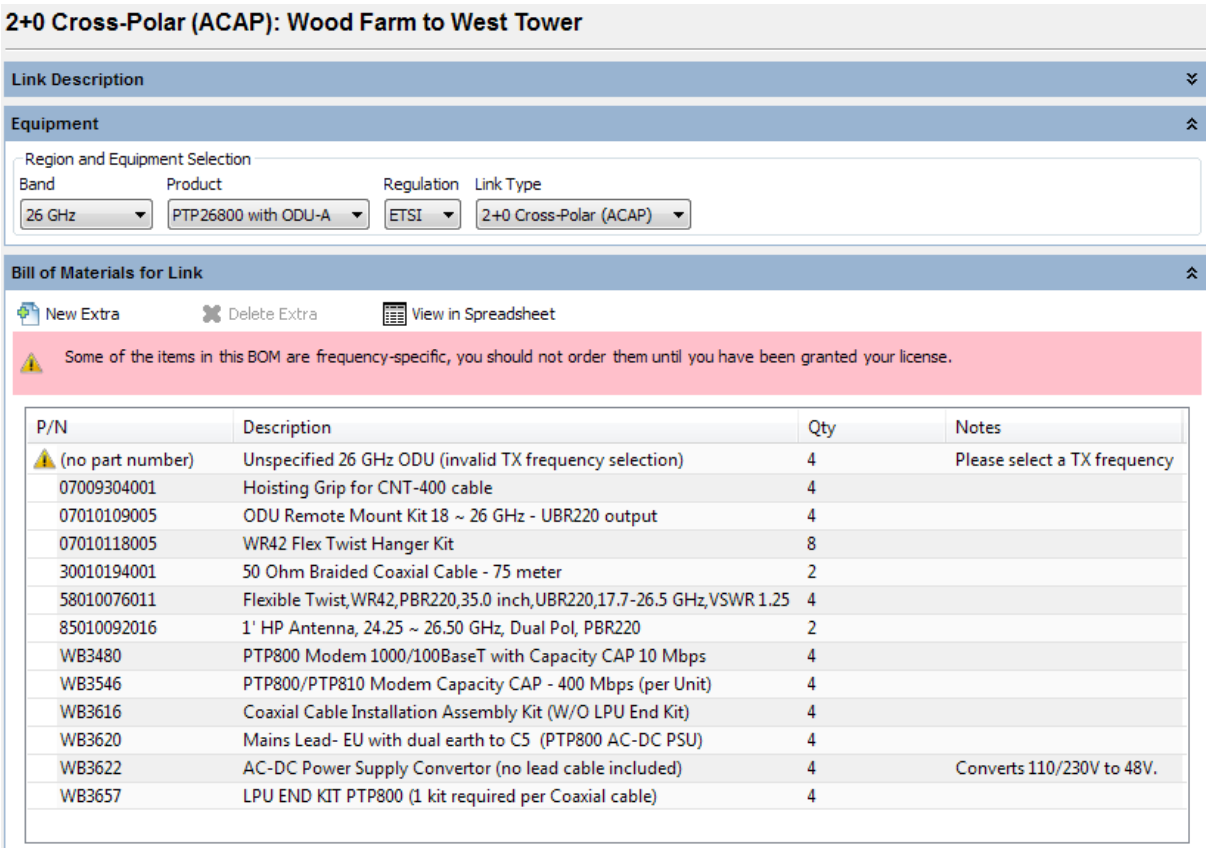


Figure 4.47: Link Node Information for PTP 800 2+0

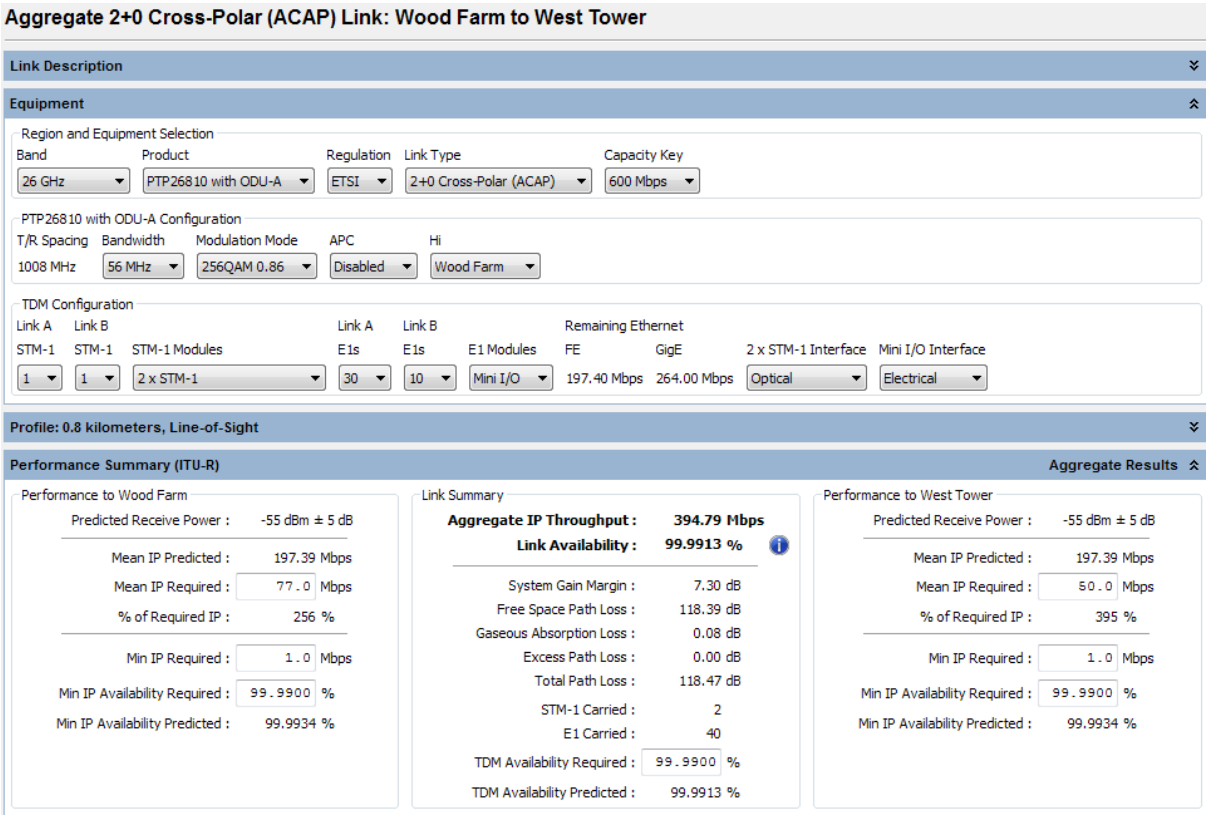


Figure 4.48: Link Node Information for PTP 810 2+0

2+0 Equipment Configuration

The Region and Equipment Selection information is repeated from the link node configuration for all products. The **Link Type** and **TDM Configuration** (PTP 810 and PTP 820G only) cannot be changed at this level, however the other parameters can be changed and any changes will be reflected in the other link. For PTP 800 click either **Link A** or **Link B** to set up the product section of the equipment configuration, for PTP 810 and PTP 820 this is also repeated from the link node configuration. For PTP 800 the product configuration settings can all be changed independently for Link A and Link B with the exception of the Polarization, which is shared for the 2+0 Co-Polar option and is reversed from Link A to Link B when 2+0 Cross-Polar is selected. For PTP 810 and PTP 820 the product configuration information is all shared, with the following exception:

- Polarization, which operates the same as for PTP 800, also being reversed from Link A to Link B when 2+0 XPIC is selected.

For PTP 810 and PTP 820 2+0 XPIC only supports bandwidths of 28 MHz or greater. For PTP 810 2+0 XPIC also only supports Fixed Modulation Modes of 64 QAM or higher. XPIC is only valid on LOS links, if the link has any Excess Path Loss the Throughput and Availability predictions will be set to zero. The link must be LOS in order to achieve the required polarization discrimination for XPIC operation.

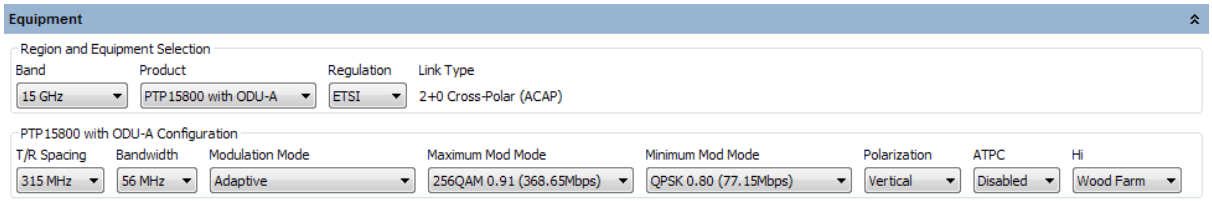


Figure 4.49: Equipment (2+0)

2+0 Configuration at Each End

The Configuration at Each End panel includes the following additional attribute for the PTP 800 and PTP 810 ODU products:

Antenna Configuration: There are 2 options which can be selected to match the possible configurations for 2+0 Cross-Polar and 2+0 XPIC

- **Common Dual Polar Antenna (Direct Mount)** - default setting
- **Common Dual Polar Antenna (Remote Mount)**

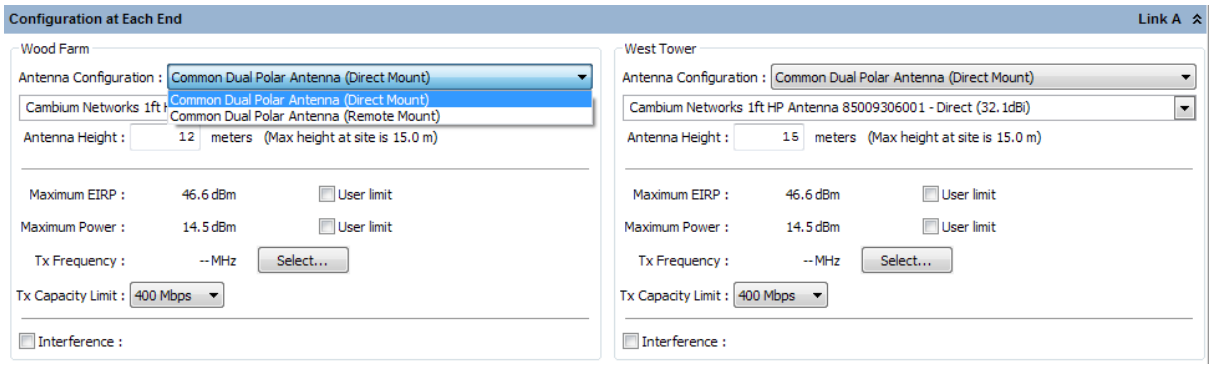


Figure 4.50: Configuration at Each End for 2+0 Cross-Polar

There are also 2 options available for 2+0 Co-Polar with PTP 800. PTP 810 and PTP 820 only support symmetric coupling and the Antenna Configuration selection is not shown.

- **Common Antenna - Symmetric Coupling** - default setting
- **Common Antenna - Asymmetric Coupling**

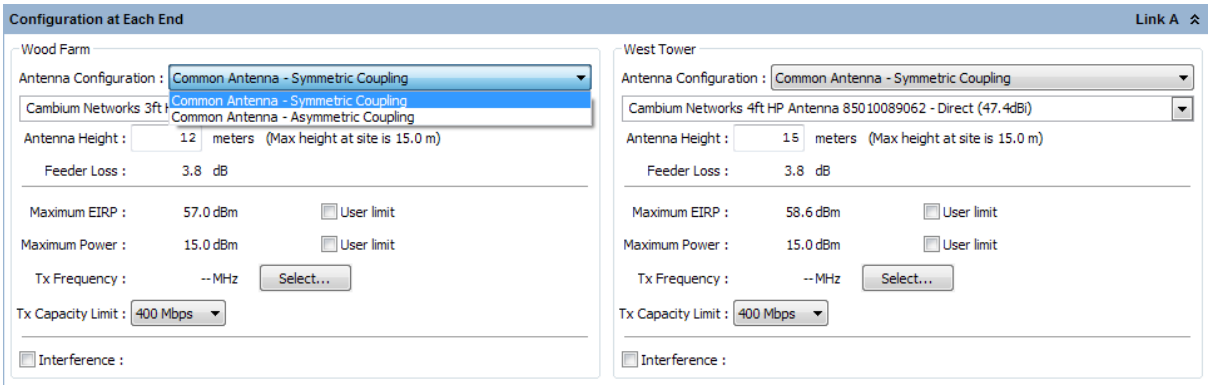


Figure 4.51: Configuration at Each End for 2+0 Co-Polar

The parameters at each end for each link can be configured as described in *Configuration at Each End*. Although the parameters can be configured through either Link A or Link B, some parameters are common to both links. Any changes made to either link configuration will automatically be reflected in the other configuration.

Antenna Type: The antenna type will always be the same for both links.

Antenna Height: The antenna height will always be the same for both links.

Feeder Loss: This field will always be the same for both links. In the case of 2+0 Co-Polar this field will incorporate the coupler loss in addition to any waveguide loss, for an ODU. The symmetric coupler will have the same loss for both links (maximum 4.5 dB), whereas the asymmetric coupler has a lower loss for Link A (maximum 2 dB) and higher loss for Link B (maximum 7.4 dB). For an IRFU, Link B will only incorporate additional circulator losses of up to 0.7 dB compared to Link A, when using 2+0 Co-Polar and will have the same loss for both Link A and Link B when using 2+0 Cross-Polar or 2+0 XPIC.

Maximum EIRP: This field can be set independently for the two links.

Maximum Power: This field can be set independently for the two links.

Tx Frequency: This field must be different for Link A and Link B for 2+0 Co-Polar and 2+0 Cross-Polar. When using 2+0 Cross-Polar adjacent channels may be used and also for PTP 820 2+0 Co-Polar. When using PTP 800 and PTP 810 2+0 Co-Polar adjacent channels may be selected but are not preferred and a warning will appear, see *Select Transmit Frequency 2+0 Co-Polar Adjacent Channel Error*. 2+0 XPIC uses the same Tx Frequency for both links and hence the value will always be the same for both links.

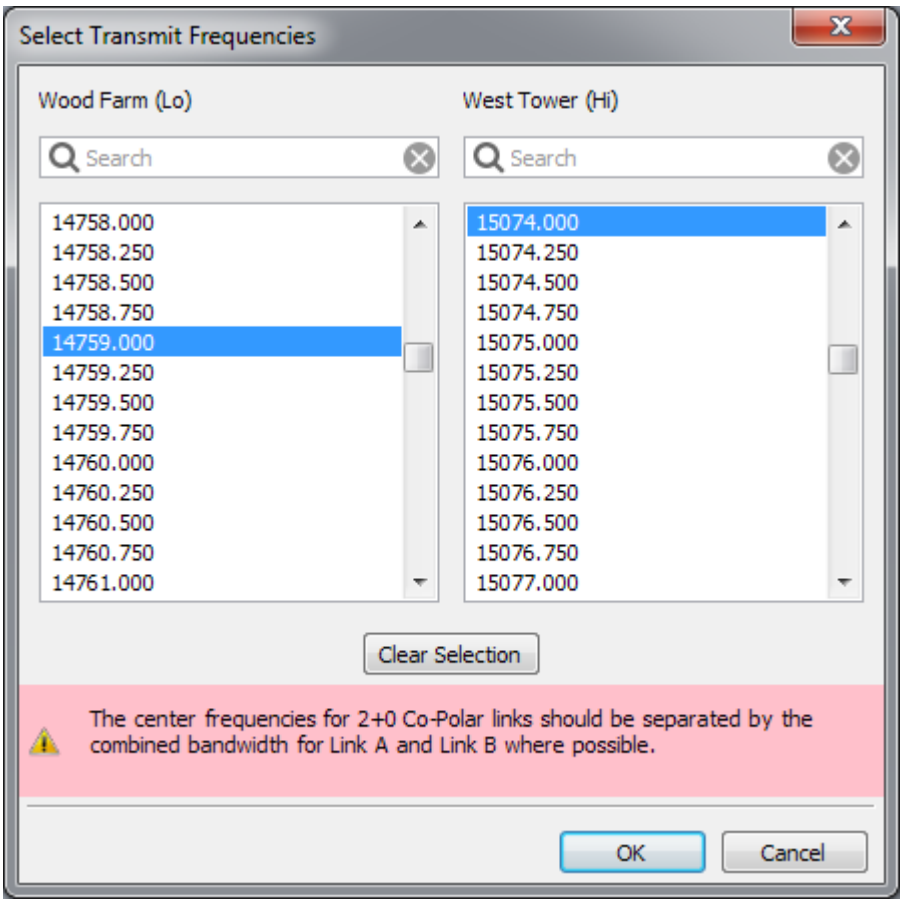


Figure 4.52: Select Transmit Frequency 2+0 Co-Polar Adjacent Channel Error

Tx Capacity Limit: PTP 800 Only. This field can be set independently for the two links.

MMU Model: PTP 810 Only. The MMU model will always be the same for both links at the same site, but can be different at each end of the link.

Interference: This field can be set independently for the two links.

2+0 Bill of Materials

The Bill of Materials is displayed at the link node level and shows the full set of equipment required for both Link A and Link B.

2+0 Performance Summary

The performance summary information for each link is shown on the link page for Link A and Link B. For all products the required performance parameters can be set independently for each link and are defined in the usual way, see *Performance Summary*. For PTP 810 and PTP 820 the aggregate performance summary is also available at the link node level, where the parameters are defined in the usual way. If the predicted performance of either link is below requirements, then the main link will be displayed in **red**. PTP 810 and PTP 820 links will display the main link in **red** if the aggregated performance is below requirements, even if Link A and Link B satisfy their requirements.

2+0 Reports

The reports for 2+0 configurations are created at the link node level in the usual way, see *Creating Reports*. PTP 800 reports contain the performance and installation information for both links. In the installation report, where the equipment is common to both Link A and Link B, the information in the installation notes is only given for Link A. PTP 810 and PTP 820 reports contain the performance of the aggregate link and the installation information required for both links.

Long Waveguide

In a PTP 800 system the ODUs are normally installed either directly to the back of the antenna or via a short length of flexible waveguide, however in some instances it is required to install the ODUs either indoors or at the base of the tower. Alternatively a purpose built indoor RF unit (IRFU) may be used. These types of installation require the use of long lengths of elliptical waveguide, which incurs additional loss.

When using long waveguides performance degradations can occur due to mismatched components. LINKPlanner does not take into account such errors and care should be taken when planning this type of link. Please consult your Cambium Regional Technical Manager or Sales Representative for further guidance on planning and deploying these types of links. The performance impacts are more severe when using the ODU's and hence there are also constraints on the modes of operation when using an ODU, which are not relevant to the IRFU.

When selecting an IRFU product the use of long waveguide is automatically included for all product types and provides the detailed losses form, in some cases it may also restrict the antenna selection.

When selecting an ODU product there is a specific long waveguide feature, which is enabled by selecting either 6 or 11 GHz bands, ODU-A and the FCC regulation, see *Link Equipment for Long Waveguide*. It is only available for 1+0 and 1+1 Link Types. The long waveguide option can be configured at either end individually or at both ends of a link, by selecting either the appropriate end or "both" in the Long Waveguide drop down menu.

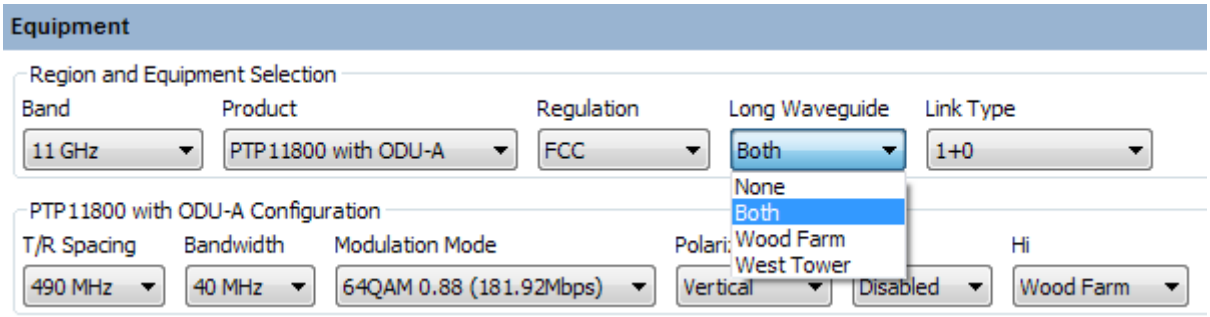


Figure 4.53: Link Equipment for Long Waveguide

The use of adaptive modulation is not supported when using the long waveguide feature. The 10 MHz bandwidth supports fixed modulation modes up to 128 QAM and the 30 or 40 MHz bandwidths support fixed modulation modes up to 64 QAM.

Long Waveguide Configuration at Each End

The long waveguide feature, when used with ODU's, can only be used with remote high performance antennas which have a VSWR of 1.06 or lower. When using the IRFU this restriction is lifted with the exception of the 10 MHz bandwidth at 6 GHz. The list of available antennas may therefore be reduced from that used in a normal installation.

To adjust the amount of Feeder Loss click on **Edit**, see *End Equipment for Long Waveguide*.

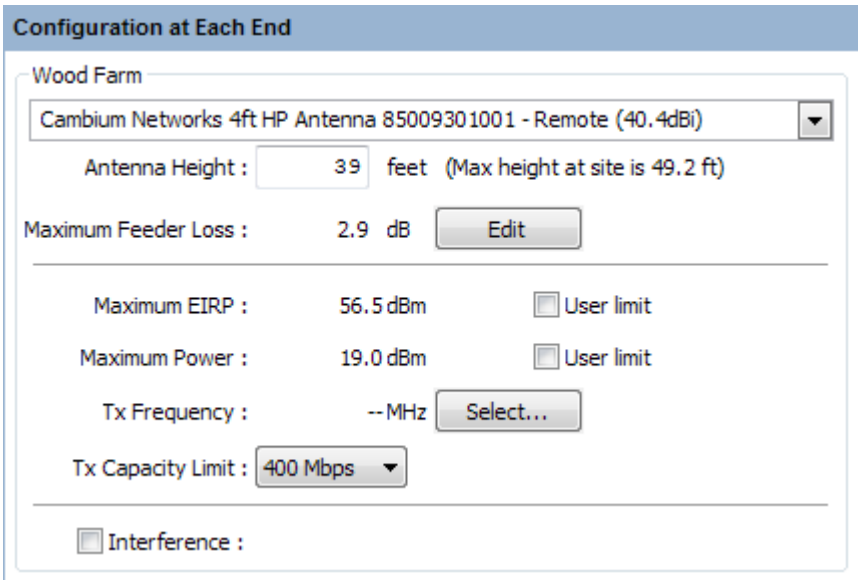


Figure 4.54: End Equipment for Long Waveguide

The *Losses (Long Waveguide)* dialog is displayed. Select the appropriate length of Flexible Waveguide from the drop down list. Enter lengths for each of the distances involved and LINKPlanner will calculate the total loss or set all the lengths to zero and enter the total loss of the waveguide run, or use a combination of the two calculations to account for the total loss in the feeder run. The installation excess is a value used to account for the required length of elliptical waveguide to be ordered, but is not used in the installed loss calculation.

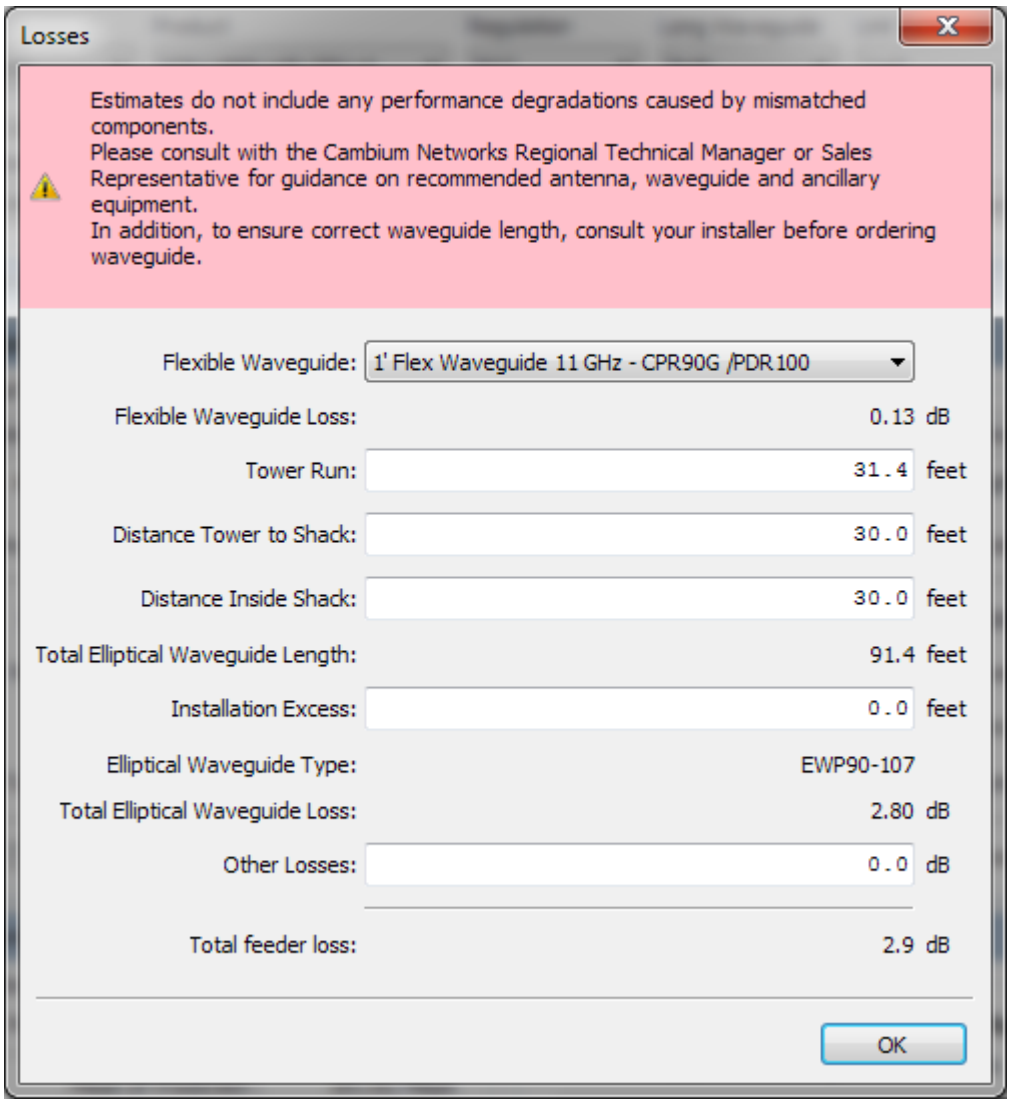


Figure 4.55: Losses (Long Waveguide)

When using an IRFU a similar dialog is displayed *Losses (Long Waveguide for IRFU)*. The user definable parameters are all the same as for the ODU version, however there are internal losses in the branching unit which are different for transmit and receive and vary depending upon the product type. This results in different amounts of loss in the transmit and receive directions which are shown separately at the bottom of the dialog box.

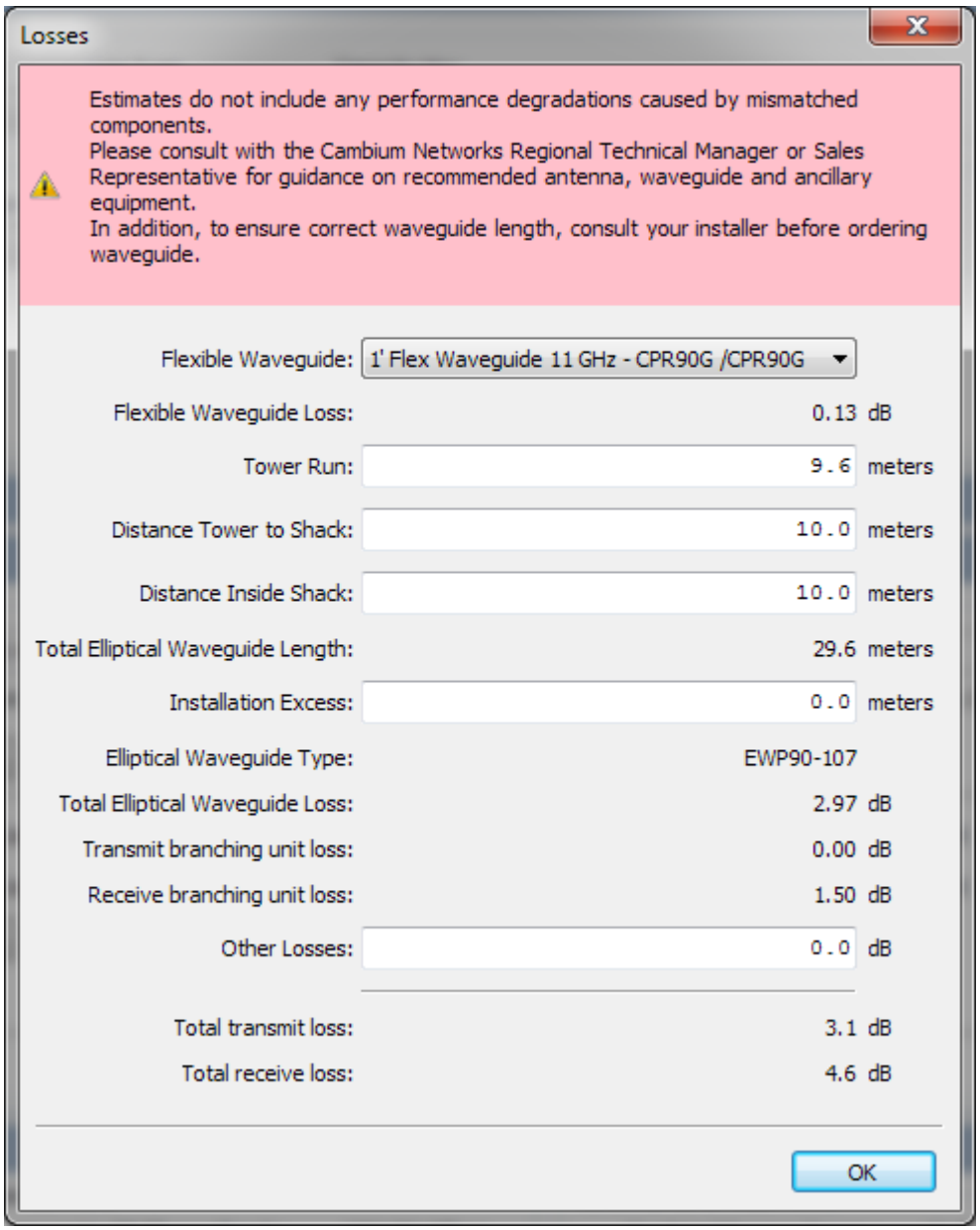


Figure 4.56: Losses (Long Waveguide for IRFU)

Long Waveguide Bill of Materials

The Bill of Materials for this type of installation contains a number of additional items to support a long run of elliptical waveguide, including a distribution manifold and dehydrator. A 2-port distribution manifold is included by default, to include a 4-port version, click **New Extras** New Extra and the **Long Waveguide** section, see *Bill of Materials Optional Extras*.

Setting Diversity

Diversity is a method where the same digital information is sent or received over more than one path between the transmitting site and the receiving site, in order to reduce outages and hence achieve better performance of the link. There are several methods to achieve diverse paths and the two that are used in the Cambium PTP products are space diversity (all products except ePMP, PTP 450, PTP 450i and PTP 820S) and frequency diversity (PTP 810 only).

Space Diversity

In some cases it is necessary to add a second (diverse) antenna to improve the long term performance of the link. Diverse antennas are used to solve two different phenomena, which both cause reflections to be experienced at the antenna. The placement of the second antenna should be such that when one antenna is experiencing a null or faded signal, the other antenna is experiencing a good signal. The choice of antenna separation distance (which is always a vertical separation) is dependent on the mechanism which is causing the reflections.

- **Tropospheric Multipath** (one example of which is ducting) is where there are many reflections arriving at the antenna and the angles are not constant over time. In this case larger separations are preferred and the availability calculation will show the improvement which can be achieved for a given antenna separation. In general increasing the separation will improve the availability and decreasing the separation will reduce the availability. This will be more obvious in geographic locations which are prone to high levels of tropospheric multipath, in more benign areas the amount of antenna separation has little impact on the amount of diversity gain. The separation distance recommended by the LINKPlanner reflection editor is not for use in combating tropospheric multipath.
- **Reflection mitigation** Two separate antennas are also used to protect against reflections from objects, most commonly those over water. In this instance the reflections follow the laws of geometry and specific separation distances are required to overcome them. It is therefore important in this case to ensure that the antennas use the separation distances recommended by the LINKPlanner reflection editor, see *Unlicensed Band Reflection Editor*.

Some links may require spatial diversity to combat tropospheric multipath and provide protection from reflections over water. In this case use the multiplier factor to increase the separation to suit the spatial diversity requirements, but at the same time maintain the required geometrical separation.

Reflections over Water

If the path is over water, it is necessary to detect whether mitigation techniques are necessary, and if they are, to calculate the optimum vertical separation for the diversity antennas. To do this, click **Link, Edit Reflection Parameters**. Tick the “Enable Reflection Mitigation” box (*Unlicensed Band Reflection Editor* or *Licensed Band Reflection Editor*) to enable the calculation and display a visualization of the reflection on the Profile chart. The Reflection Surface Height (blue line with gray ends) will normally be aligned with the height of the reflecting surface, if it isn’t

adjust the Reflection Surface Height until the line aligns with the height of the reflecting surface.

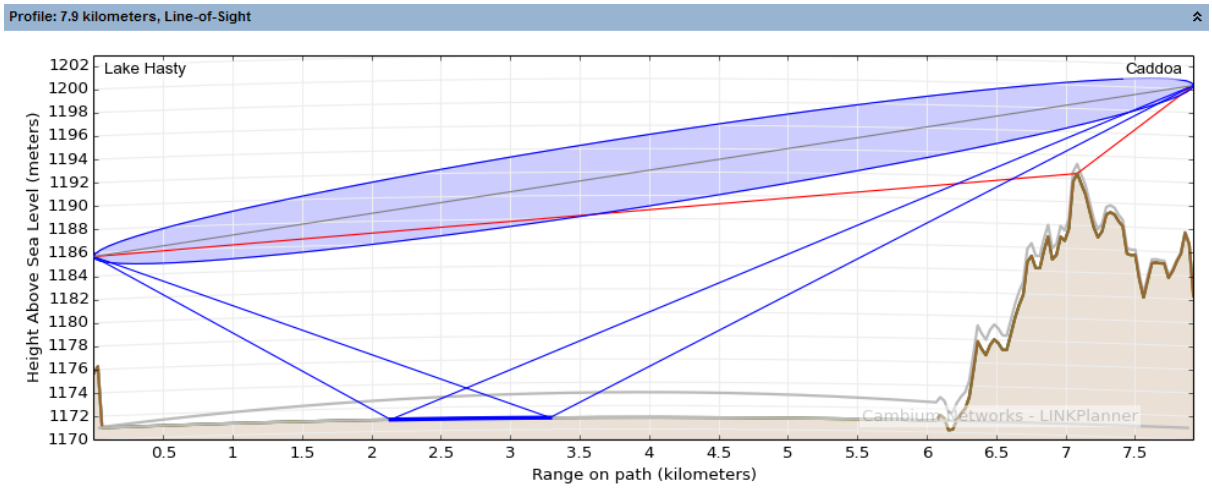


Figure 4.57: Profile with Reflection Visible

If the reflected paths have an unobstructed route to both ends of the link, as shown in *Profile with Reflection Visible* then mitigation techniques are required. The simplest technique is to obstruct the reflected path, on this link the path can be obstructed by lowering the Caddoa antenna (*Profile with Reflection Obscured*). This makes diversity spacing unnecessary for reflection mitigation, because the reflection path is obscured by the hill in front of the Caddoa antenna.

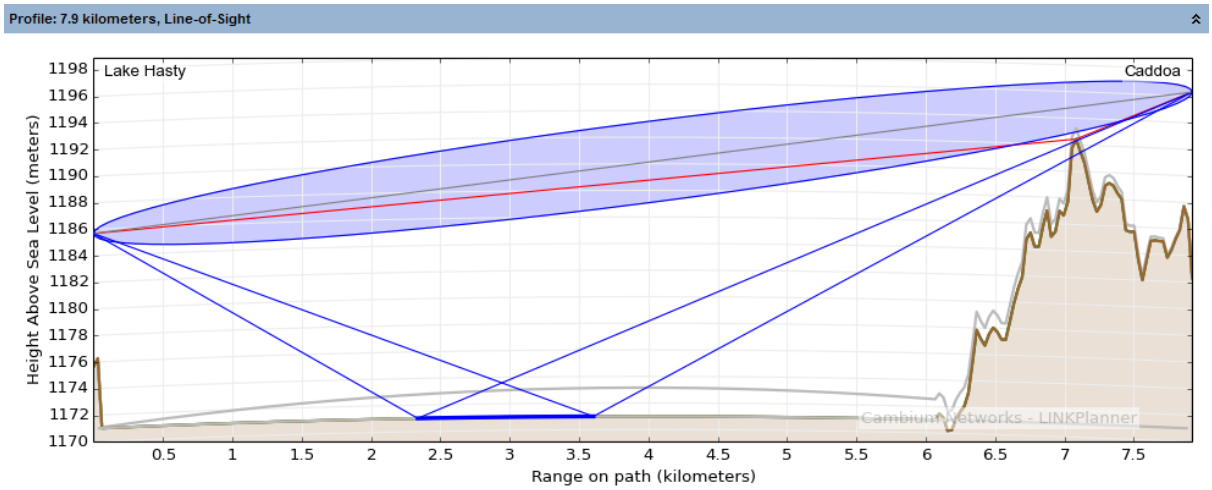


Figure 4.58: Profile with Reflection Obscured

If the reflected path cannot be easily obstructed then spatial diversity will be required.

CAUTION

LINKPlanner does not adjust the reliability of the link based upon the possible reflection, but a link that suffers reflection

can have very bad performance if the mitigation has not been applied.

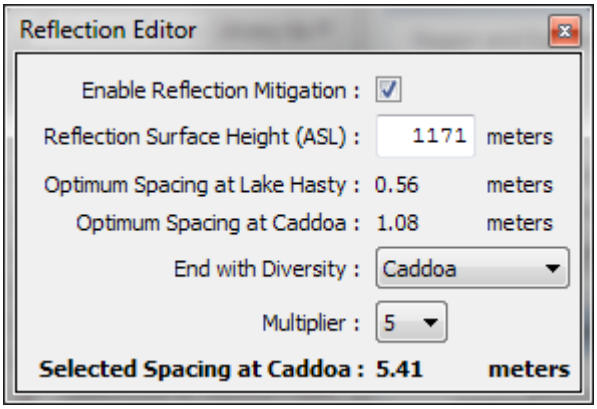


Figure 4.59: Unlicensed Band Reflection Editor

Unlicensed products use both Tx and Rx diversity and therefore diversity should only be applied at one end of the link. The reflection editor shows the **Optimum Spacing** at each end, see *Unlicensed Band Reflection Editor*. The optimum spacing may be different for each end of the link. Choose the end of the link to apply the diversity spacing based on the physical constraints of the towers.

The optimum spacing is the smallest spacing that will cancel the reflection, however it may not be possible to install the antennas at this separation, depending on the size of antennas selected and mounting points available. If a larger separation is required choose a **Multiplier** from the pull down list to give a suitable spacing shown as the **Selected Spacing**. In the example above, the Multiplier is set to 5 to give a spacing of 5.41 meters, which is easily achievable without much cable loss.

The unlicensed band radios are mounted to external antennas to provide diversity spacing. The **Optimum Spacing** requires the minimum cable length and hence the minimum additional loss from the single radio unit to both antennas. When using a larger multiplier the antennas are further apart and require longer cables to connect from the radio to the two antennas, increasing the additional loss.

For unlicensed products set the Multiplier, then transfer the resulting Spacing value to the Configuration Diversity Spacing, as described in *Configuration at Each End*. If diversity is to be applied at both ends of the link, the Diversity Spacing at each end of the link should be entered as half the value given for each end by the Reflection Editor.

Licensed band products only use Rx diversity and therefore diversity must be applied at both ends of the link using the full diversity spacing values given, see *Licensed Band Reflection Editor*. Licensed band products have a radio for each antenna which can be directly mounted to the antenna, hence there is no difference in performance if a larger separation is required. If a Multiplier is to be used, select the value from the pull down list to give a suitable **Required Spacing** at each end of the link. Subtract the diversity spacing from the Primary antenna height to give the height required for the Secondary antenna.

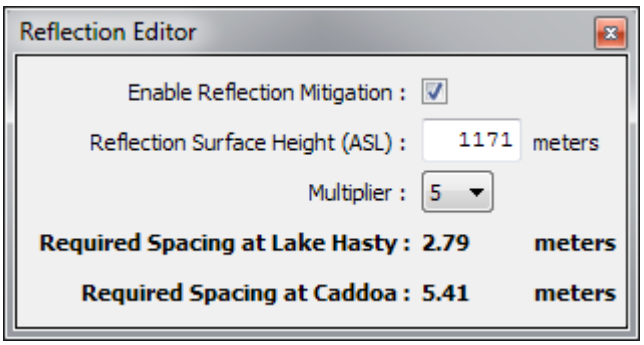


Figure 4.60: Licensed Band Reflection Editor

For more information about reflections, see *Paths Over Sea or Very Flat Ground*.

Multipath Reflections

For reflections due to multipath, the problem is not easily solved deterministically because there are a very large number of reflections. LINKPlanner shows the improvement in availability when you select a second antenna and define a separation between the two. If you increase the spacing, the availability increases. If you decrease the spacing, the availability decreases. Adjust the combination of antenna size, antenna height, and antenna spacing to meet the availability requirements.

Configuring Spatial Diversity in LINKPlanner

The PTP equipment operates differently in the licensed (6 GHz and above; PTP 800, PTP 810 and PTP 820G) and unlicensed bands (below 6 GHz; PTP 250, PTP 300, PTP 400, PTP 500, PTP 600, PTP 650). This affects the way in which the equipment may be deployed for space diversity.

Unlicensed

The unlicensed equipment uses two transmit chains for all configurations and hence when two spatially separated antennas are used both the main and diverse antennas are transmit and receive. This means that spatial diversity improvement gain can be achieved in both directions of a link by deploying separate antennas at just one end of the link.

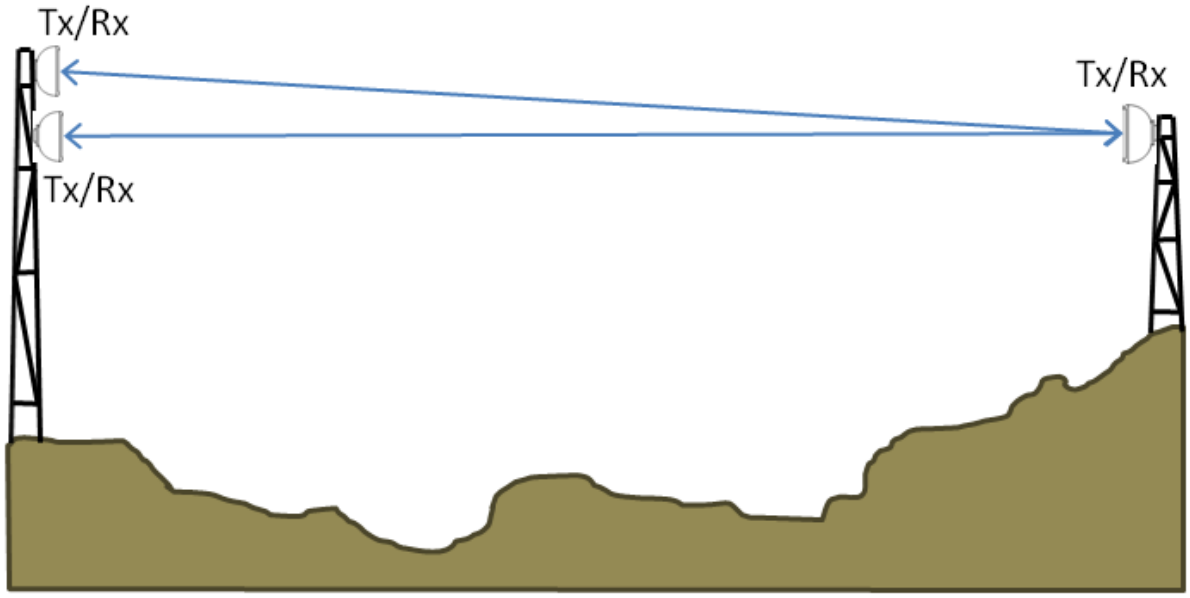


Figure 4.61: Space Diversity Deployment (unlicensed bands)

In the unlicensed band spatial diversity is automatically applied when a single polarity antenna is selected. The default spacing is set to 5m (16.4 ft), this can be adjusted to suit the local conditions and the availability requirements. If the diversity spacing is set to 0, no additional benefit will be added to the availability. When a single polarity antenna type is selected, a quantity of two per end is included in the BOM. The two antennas at the same end of the link need to be installed on opposite polarities to match the dual polarity unit at the opposite end of the link.

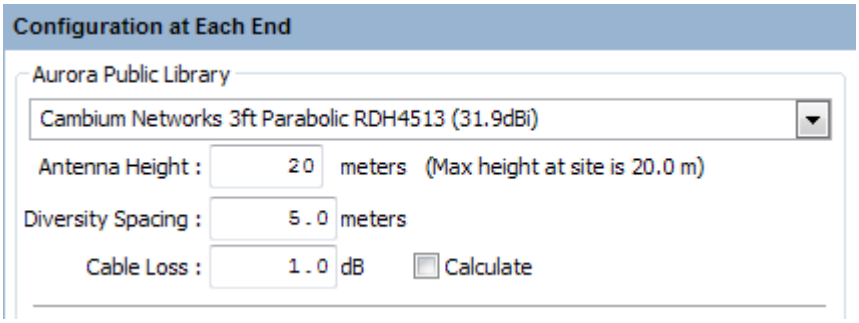


Figure 4.62: Configuration of Space Diversity (unlicensed bands)

Licensed

The licensed band equipment only has a single transmit chain and therefore only the main antenna is transmit and receive, the diverse antenna is receive only. To achieve spatial diversity gain improvement in both directions of the link, antenna separation is required at both ends of the link. If diversity is only deployed at one end of the link, the availability of the link will be dictated by the non-diverse direction.

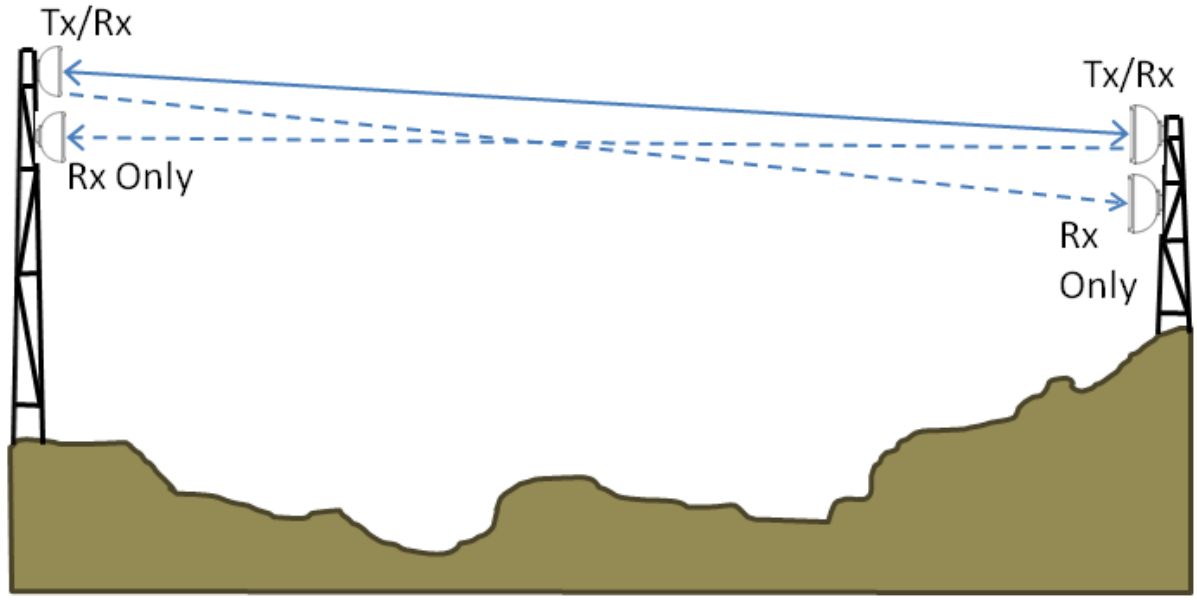


Figure 4.63: Space Diversity Deployment (licensed bands)

In the licensed band (except for PTP 820C) spatial diversity is achieved in combination with 1+1 Hot Standby Protection. To configure a link to use space diversity, set the **Link Type** to **1+1 Hot Standby** and at both ends of the link set the **Antenna Configuration** to **Spatial Diversity**. Set the Primary and Secondary antenna heights at each end of the link to the heights required and the **Diversity Spacing** value will automatically update to show the difference in antenna height of the primary and secondary antennas. Adjust the heights of the two antennas to give the required availability. Check the Excess Path Loss of the Primary to Primary, Primary to Secondary and Secondary to Primary paths to ensure that all paths are LOS.

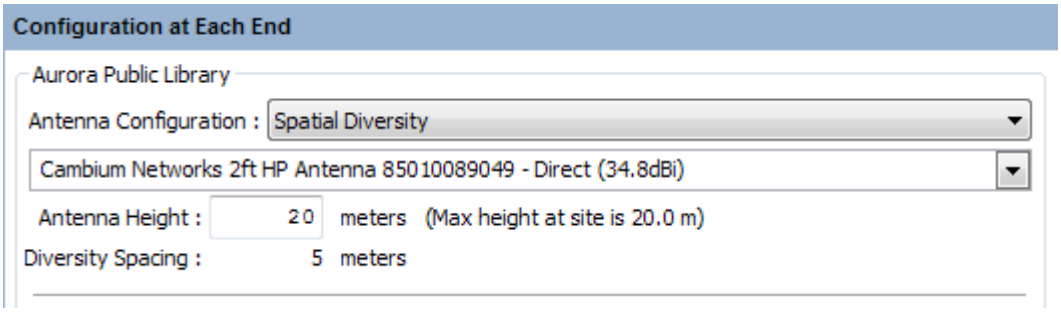


Figure 4.64: Configuration of Space Diversity (licensed bands)

If the spatial diversity link is configured with ODUs (as opposed to IRFU) then both antennas have the potential to be Tx /Rx antennas if the end fails over from primary to secondary. The choice of secondary antenna in this case needs to take into account that it may not be receive only or the link must be configured not to switch over the transmit on failure, for further information see the User Guide for the product.

If the link is configured with IRFUs the transmit chain from both modems is connected to the primary antenna and the secondary antenna is receive only.

For further information on setting spatial diversity for PTP 800, PTP 810, and PTP 820G products, see *Setting Hot Standby Protection (1+1)*.

For PTP 820C to configure a link to use space diversity, set the **Link Type** to **2+0 Spatial Diversity** and then set the antenna type and height for both Main and Diverse at each end of the link in the **Configuration at Each End** section. In the 2+0 configuration only the Main antenna will transmit and therefore the only valid paths between the two ends are Main to Main, Main to Diverse and Diverse to Main, to view these paths on the Path Profile set **Path to display** to the required option, see *Profile*.

NOTE

For PTP 820C there are several cables required between the two radios at each end of the link, which have a maximum cable length of 20m. This restricts the maximum allowed diversity spacing to 18m.

Height Clearance

When planning a diversity link it is important to ensure that all paths have sufficient clearance. For licensed band links all paths must be Line of Sight and it is advisable even for unlicensed links. Any additional path loss on the diverse path will not be taken into account in the availability calculations, therefore if some paths are not LoS the predicted availability will be optimistic.

In addition to ensuring LoS, the path between the two main antennas should give clearance over the Worst Earth curvature (grey line), however other paths may allow some penetration of this area into the Fresnel zone.

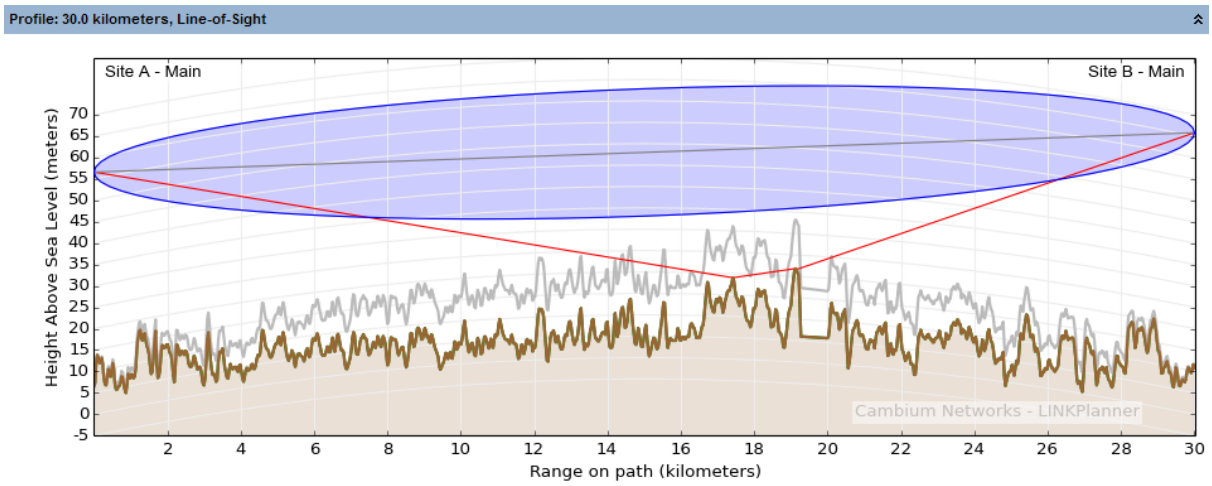


Figure 4.65: Height Clearance between main antennas

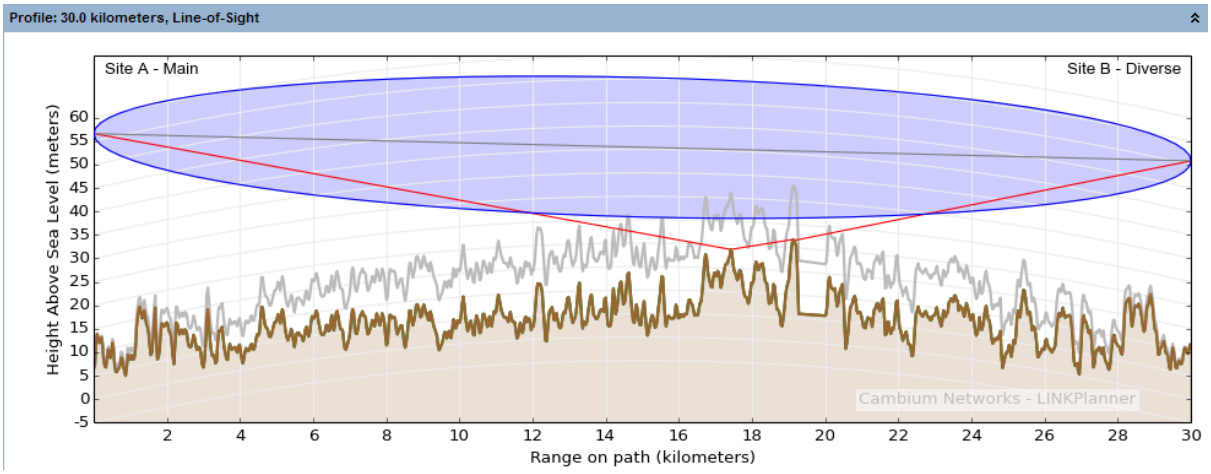


Figure 4.66: Height Clearance between main and diverse antennas

Frequency Diversity

Frequency diversity uses a single antenna at each end of the link, but uses two transmitters at each end to send the same digital information over the same physical path on two different frequencies. The amount of diversity gain achieved for a given link is dependent on the path length, center frequency, frequency separation and fade margin.

Frequency diversity can be used to overcome the same phenomena as space diversity, although it is more commonly used only to combat atmospheric multipath where space constraints prevent the use of spatial diversity. As two frequencies are required it is less spectrally efficient than spatial diversity and is not permitted by all regulators, check with the local regulatory agency.

Frequency diversity is only available when a PTP 810 product is selected at frequencies of 6 GHz and above. It is then available from the **Link Type** menu (**1+1 Frequency Diversity**), except in the FCC regulatory region where it is not permitted to be used.

Improvement Factor Equations

The diversity gain improvement equations are taken from ITU-R P530, using the method given in section 6.2.5 to calculate outage for space and frequency diversity. These algorithms are primarily aimed at long paths above 25 km (15 miles) and for frequencies up to 11 GHz. Care should be taken if applying diversity to shorter paths or those at higher frequencies. At higher frequencies rain becomes the dominant factor in the availability calculation and diversity does not provide any improvement against rain fading, therefore adding diversity will give very limited improvement at higher frequencies.

When using the space diversity algorithm the separation distance is valid between 3 and 23m (10 and 75ft). For frequency diversity, the frequency separation should not be more than 5% of the central frequency and is limited at 0.5 GHz, these constraints are met within the range of frequencies available in each band.

CHAPTER 5

Planning PMP networks

The goal of PMP network planning is to ensure that the Subscribers are connected to the appropriate Access Point and will perform to an acceptable level, measured by the Predicted Receive Power and Max Usable Mode values in the *Performance Summary* section of the *Subscriber Modules*. To allow LINKPlanner to predict the Receive Power and Max Usable Mode, the planner must enter the variables that affect link performance, such as: band, region, equipment, antenna, height, terrain and obstructions.

To achieve this goal, follow this process:

1. Start the application and set options. See *Starting the Application*.
2. Build a project to model a PMP network. See *Projects*.
3. Enter details of all sites in the project. See *Sites*.
4. Define the Hubs. See *Hubs*.
5. Create the Access Points on each hub. See *Access Points*.
6. Connect Subscriber Sites to an Access Point and create profiles of those links. See *Subscriber Modules*.
7. Adjust the link profile to allow for terrain height variance and obstructions. See *Adjusting Link Profiles*.
8. Confirm that the link will perform to an acceptable level, measured by the Receive Power and Max Usable Mode values in the *Performance Summary* section of the *Subscriber Modules*.
9. Export and report project, site and link data. See *Exporting and Reporting*

Hubs

The hub site is the location of one or more Access Points.

Creating Hub Sites

To create a new Hub, either click **Project, New Hub** or click **New Hub** . The New Hub page is displayed.

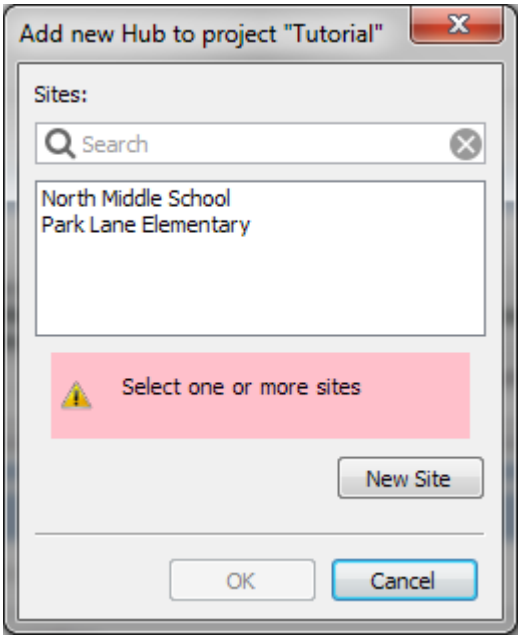


Figure 5.1: New Hub Page

The list of available network sites is displayed. The search field narrows the choice when there is a large number of sites in the list. Select one or more sites from the list and hit **OK**.

The sites are then listed in the project navigation tree below **PMP Links**

Deleting Hub Sites

To delete a hub site, select the hub site in the navigation pane, right click and choose delete from the pop-up menu, or select **Project, Delete** Hub Site name.

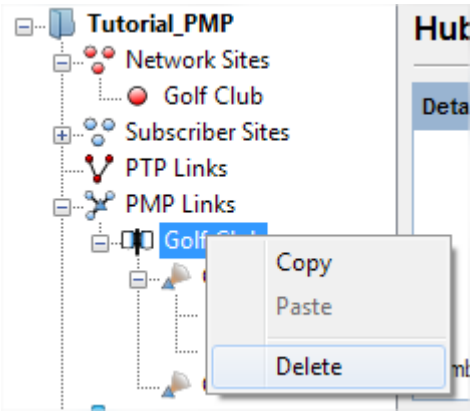


Figure 5.2: Delete Hub Site

NOTE

Deleting a Hub Site will delete all Access Points and links to Subscriber Modules connected to the Access Points on the Hub Site. The Subscriber Sites will not be deleted and will be available to connect to other Access Points.

Hub Page

The Hub page includes the following features:

- Each section begins with a blue title bar. Click on this bar to open or close the section.
- The numeric data entry fields can be incremented or decremented in steps by using the up and down arrow keys. Use this feature to evaluate the impact of step changes on performance.
- If a field is highlighted in pink, its value is out of the permitted range.

Hub Details

View the Name, Maximum Height, Latitude, Longitude, Description and Number of Access Points. To update this information, see *Sites*.

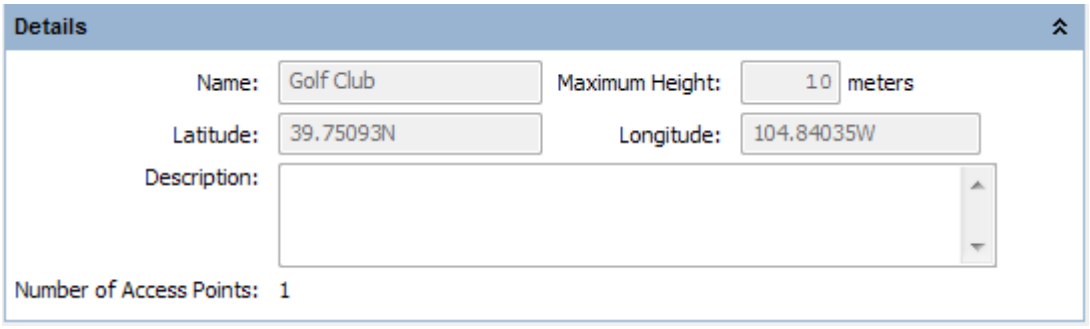


Figure 5.3: Hub Details

Access Points View

View, add, delete and modify Access Points on the Hub Site. To manage the information displayed in the list, see *Managing List Views*.

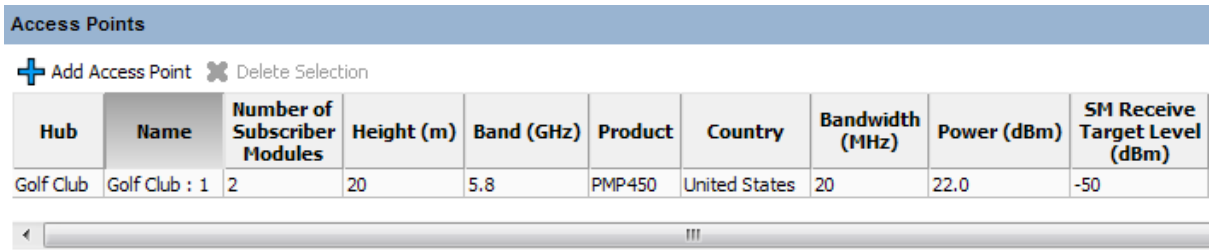


Figure 5.4: Access Point View on Hub Page

To add additional Access Points at the hub site, click . A new access point will be added, incrementing the Access Point number, the other parameters will be the same as the first Access Point. To add multiple Access Points with the same configuration, configure the first Access Point before adding the remaining Access Points.

NOTE

To update subscriber module parameters and performance calculations after editing Access Point parameters, select **Calculate Now** , unless **Automatic Calculations** are enabled, see *Project Toolbar* .

To delete an Access Point at the hub site, select the Access Point row and click .

NOTE

A Hub site must contain at least one Access Point

Bill of Materials for Hub

LINKPlanner automatically calculates the Bill of Materials for the Access Points on a Hub Site. The Bill of Materials for the Hub Site includes the aggregate equipment required for all the Access Points on the Hub Site. To add additional items to the BOM, click **New Extra** New Extra. A list of optional extras for the hub will be displayed. To add an item to the BOM highlight the option required and click **OK**. The item will appear in the main list, where the quantity can be adjusted by selecting the number in the **Qty** column and adjusting as required. To delete an optional item from the BOM list, highlight the item and click **Delete Extra** Delete Extra. A star denotes optional extras which have been added to the automatic BOM items.

NOTE

Only the quantities for the optional extras will be saved as changes with the project. To change quantities for the Access Points adjust the

quantities on the Access Point Bill of Materials, see *Bill of Materials for Access Point*.

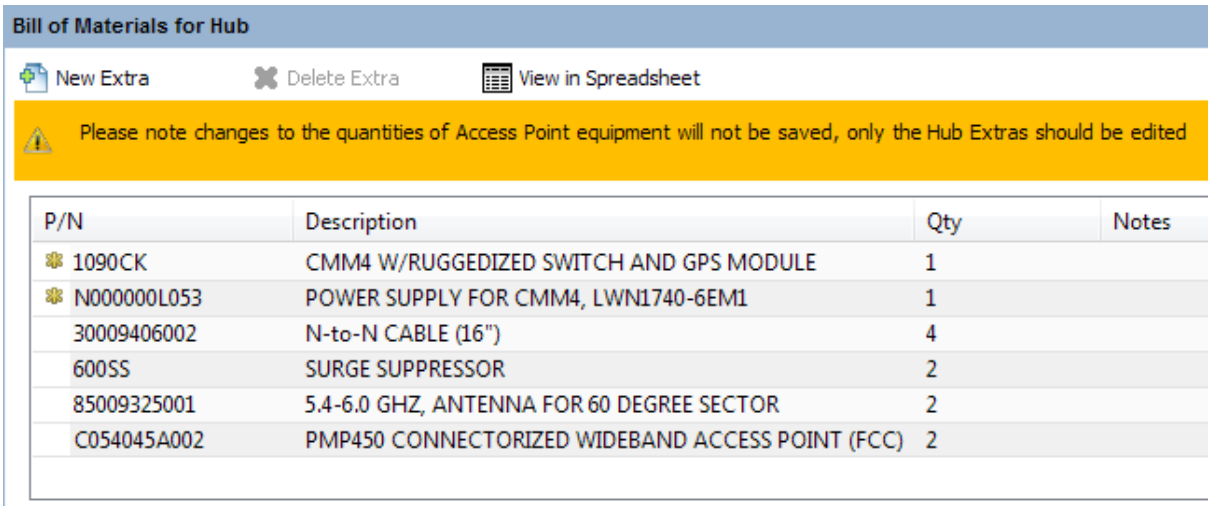


Figure 5.5: Bill of Materials for Hub

Viewing & saving the Hub BOM file in MS Excel

To view the Hub BOM in Excel, click **View in Spreadsheet** while viewing the Hub BOM. Once in the spreadsheet the file can be saved as normal.

NOTE

All numeric only part numbers consist of 11 digits, if the number displayed is only 10 digits the part number should start with a zero.

Access Points

The Access Point connects to one or more Subscriber Sites to create links to Subscriber Modules.

Creating Access Points

To create a new Access Point, either click **Project, New Access Point**, click **New Access Point** or add from the Access Points view on the Hub Page, see *Access Point View on Hub Page*. If creating through the **New Access Point** options, the New Access Point page is displayed.

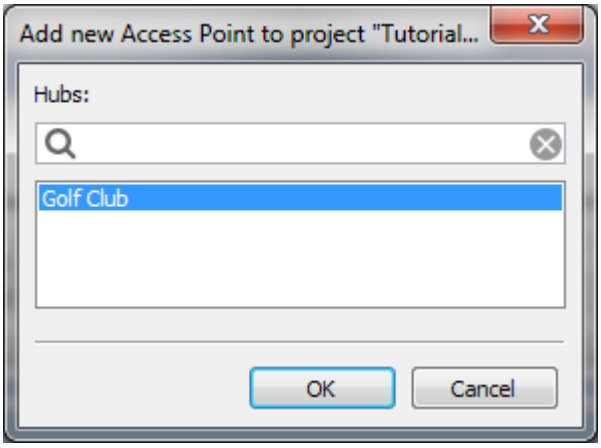


Figure 5.6: New Access Point Page

The list of available Hub sites is displayed. The search field narrows the choice when there is a large number of Hubs in the list. Select a Hub Site from the list and hit **OK**.

The Access Point is then listed in the project navigation tree below selected Hub Site.

Deleting an Access Point

To delete an Access Point, select the Access Point in the navigation pane, right click and choose delete from the pop-up menu, or select **Project, Delete** Access Point name, in the same manner as deleting Hub Sites, see *Delete Hub Site*.

NOTE Deleting an Access Point will delete all links to Subscriber Modules connected to the Access Point. The Subscriber Sites will not be deleted and will be available to connect to other Access Points.

Access Point Page

The Access Point page includes the following features:

- Each section begins with a blue title bar. Click on this bar to open or close the section.
- The numeric data entry fields can be incremented or decremented in steps by using the up and down arrow keys. Use this feature to evaluate the impact of step changes on link performance.
- If a field is highlighted in pink, its value is out of the permitted range.

Access Point Details

Enter the Name and Description of the Access Points. The MAC Address of the equipment may also be added. The MAC Address must be included for the PMP 450 configuration file to be created. When an Access Point has Subscribers connected the contact information for the Sales Contact for the location of the Access Point will be shown. To update this information click **Refresh**

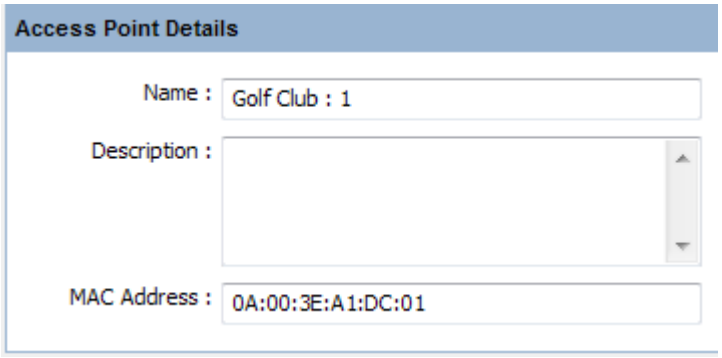


Figure 5.7: Access Point Details

Access Point Equipment

Select the equipment, regulation and parameters for the Access Point. The fields that are displayed in the “Access Point Equipment” box will change depending on the type of equipment selected. For example, when a PMP 450 is selected, the Color Code field is displayed.

NOTE

Some parameters are required when configuring the product but are currently not used in the LINKPlanner calculations, they will be used in future releases. These items are identified as “(information only)” in the descriptions below.

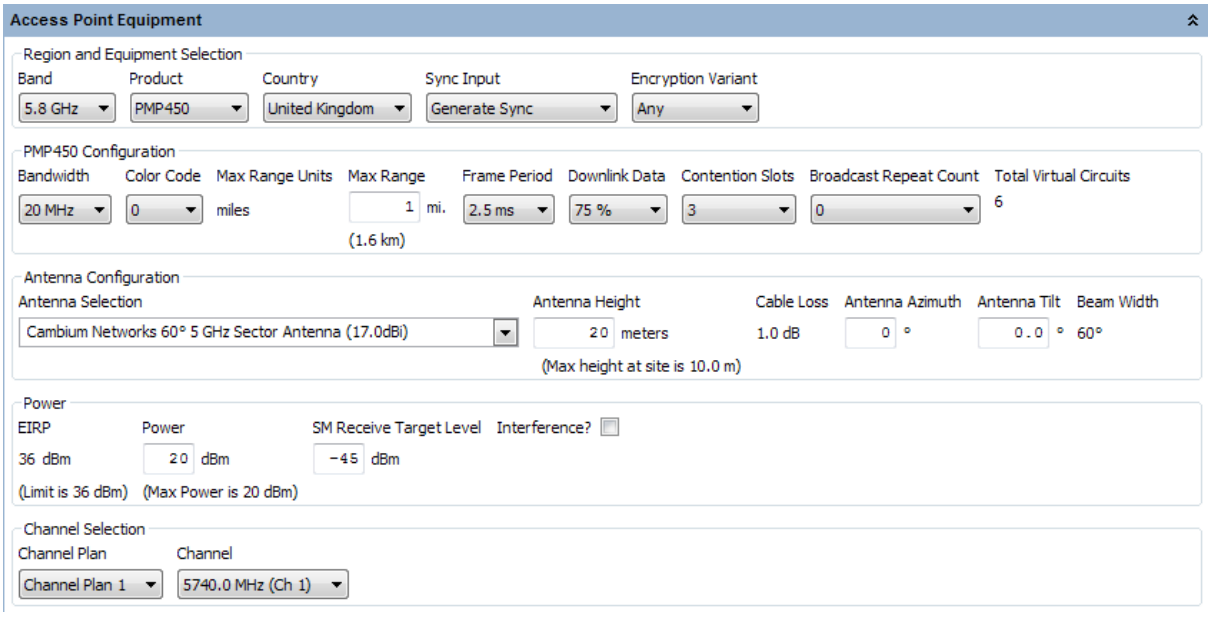


Figure 5.8: Access Point Equipment

Region and Equipment Selection

Band: Select the frequency band used by the Access Point.

Product: Select the PMP product.

Country: Select the country in which the Access Point is located.

Sync Input: (PMP 450 and 450i only). Select the synchronization option for the link (information only).

Encryption Variant: (PMP 450 and 450i only). Select the encryption option for the link, used for product selection only.

Configuration

Bandwidth: Select the channel bandwidth.

Color Code: Select the Color Code for the Access Point (information only).

Max Range Units: Select the units for the Max Range for ePMP, for PMP 450 Max Range must be entered in miles.

Max Range: Set the maximum range for the Access Points. Subscriber sites beyond this range will not be shown as valid subscriber module options and if the Max Range is reduced after adding Subscribers, any subscribers beyond this range will be shown as invalid (i.e. in red).

Frame Period: Select the Frame Period.

Downlink Data: (PMP 450 and 450i Only) Set the proportion of the link to be used for downlink data.

Maximum Mod Mode: (ePMP Only) Set the maximum modulation for the Access Point on the downlink to all Subscribers.

DL/UL Ratio: (ePMP Only) Select the required DL/UL Ratio.

Control Slots: (PMP 450 and 450i Only) Set the number of control slots required.

Broadcast Repeat Count: (PMP 450 and 450i Only) Select the value required (information only).

Total Virtual Circuits: (PMP 450 and 450i Only) Calculated value based on the number of Subscriber Modules, 1 per Subscriber Module plus 1 additional circuit for each Subscriber Module which has **High Priority Channel** set to Enabled.

SM Registration Limit: (ePMP Only) Set the maximum number of Subscribers allowed on the Access Point.

Synchonization Source: (ePMP Only) Set the required Synchonization Source, select None to use the Integrated or Unsynchronized Connectorized Access Point.

Antenna Configuration

Antenna Selection: Select the antenna for the Access Point.

Antenna Height: Select the height of the Access Point above ground level.

Cable Loss: Loss of the cable between the Access Point and the antenna, read only value for most antenna options.

Antenna Azimuth: Set the bearing of peak of beam of Access Point antenna.

Antenna Tilt: Set the angle of tilt of the access point antenna, enter downtilt as a negative value.

Beamwidth: Read only value showing the beamwidth of the antenna selected.

Power

EIRP: Read only value showing the EIRP of the antenna, if the country selected has a regulatory limit this value is shown in brackets underneath.

Power: Set the transmit power for the Access Point, if the country selected has a regulatory limit (or an implied limit to meet the EIRP limit) the value is shown as “Max Power” in brackets underneath.

SM Receive Target Level: Set the receive power required at the Access Point from each of the Subscribers.

Interference: This is the amount of site noise in the selected channel bandwidth, 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 radio. The bandwidth displayed depends on the bandwidth selected in the Equipment Settings box (in this example it is 20 MHz). To enter Interference, tick the box and update the default value. If the Access Point has been set up and background power measurements are available, then use these measurements.

Channel Selection

This section is only displayed if a Channel Plan exists for the given Band, Product, Country and Bandwidth.

Channel Plan: Select the Channel Plan required.

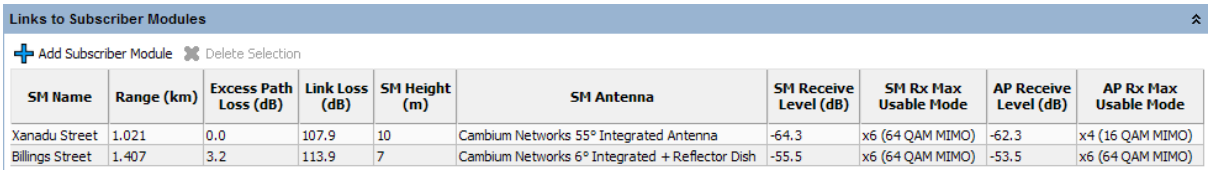
Channel: Select the Frequency required for the Access Point.

NOTE

To update subscriber module parameters and performance calculations after editing Access Point parameters, select **Calculate Now** , unless **Automatic Calculations** are enabled, see *Project Toolbar* .

Links to Subscriber Modules

View, add, delete and modify Subscriber Modules on the Access Point. To manage the information displayed in the list, see *Managing List Views*.


Links to Subscriber Modules

Add Subscriber Module Delete Selection

SM Name	Range (km)	Excess Path Loss (dB)	Link Loss (dB)	SM Height (m)	SM Antenna	SM Receive Level (dB)	SM Rx Max Usable Mode	AP Receive Level (dB)	AP Rx Max Usable Mode
Xanadu Street	1.021	0.0	107.9	10	Cambium Networks 55° Integrated Antenna	-64.3	x6 (64 QAM MIMO)	-62.3	x4 (16 QAM MIMO)
Billings Street	1.407	3.2	113.9	7	Cambium Networks 6° Integrated + Reflector Dish	-55.5	x6 (64 QAM MIMO)	-53.5	x6 (64 QAM MIMO)

Figure 5.9: Links to Subscriber Module View on Access Point page

To add additional Subscriber Modules at the Access Point, click . A list of available subscriber sites will be displayed. Any subscriber sites which are not connected to the Access Point will be highlighted. To create an additional Subscriber Module at the same subscriber site select the required subscriber site and a duplicate Subscriber Module is created.

To delete a Subscriber Module at the Access Point, select the Subscriber row and click .

Performance Summary

This section provides a summary of the Maximum Usable Modulation Modes of all the PMP Links on the Access Point and the Mean Predicted Throughput per modulation mode and for the AP. These values assume that all subscribers are evenly loaded and using the modulation modes shown, it does not include the capacity limits of individual subscribers.

The performance summary can be saved as a CSV or Excel file by clicking **View in Spreadsheet** .

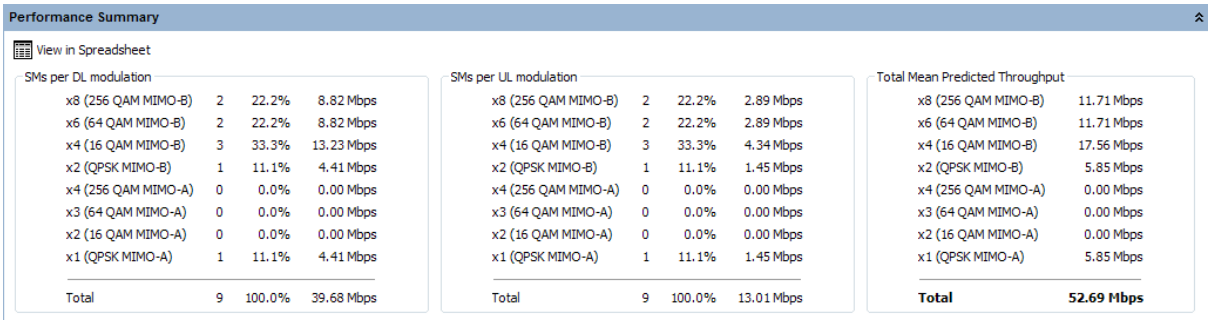


Figure 5.10: Performance Summary for the Access Point

NOTE

A PMP Link will only be included in the summary if it supports a modulation mode at the required performance level in both directions of the link. A warning will show the number of PMP Links which don't meet this criteria.

Bill of Materials for Access Point

LINKPlanner automatically calculates the Bill of Materials (BOM) for the required components of the Access Point. The Access Point BOM contains the list of part numbers and associated quantities. To add additional items to the BOM, click **New Extra** New Extra. A list of optional extras for the Access Point will be displayed. To add an item to the BOM highlight the option required and click **OK**. The item will appear in the main list, where the quantity can be adjusted by selecting the number in the **Qty** column and adjusting as required. To delete an optional item from the BOM list, highlight the item and click **Delete Extra** Delete Extra. A star denotes optional extras which have been added to the automatic BOM items.

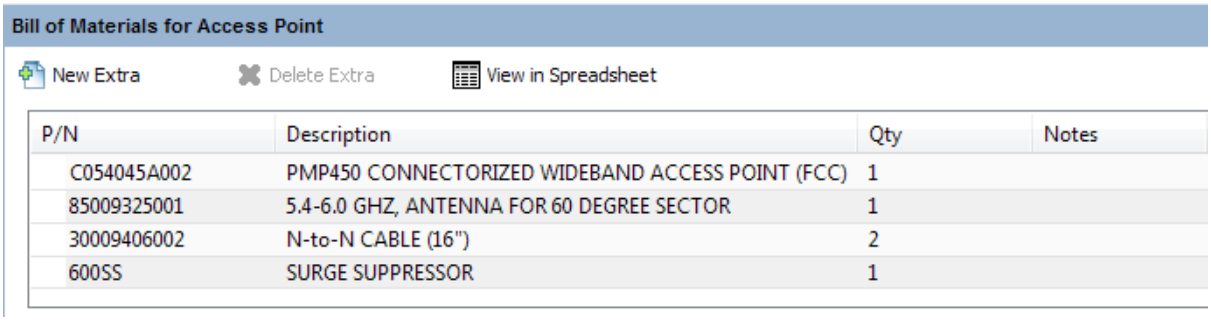


Figure 5.11: Bill of Materials for Access Point

P/N: The Cambium part number. If the component is not supplied by Cambium, this is set to '(no part number)'.

Description: Description of the components.

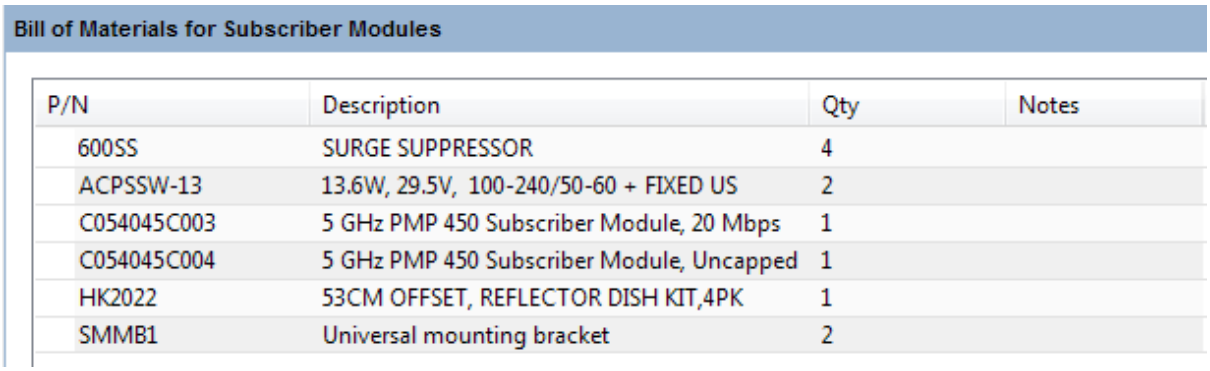
Qty: Quantity required.

Notes: By default this displays information about certain items, such as whether they are obsolete, or to prompt for additional required information. This field can

be edited to allow additional information to be added to the item. The default text is returned if the edited text is deleted. When information is displayed in the Notes field, items will only be aggregated at the higher level BOMs if the Notes field contains identical information as well as being the same part number.

Bill of Materials for Subscriber Modules

The Subscriber Modules BOM displayed in the Access Point page contains an aggregate view of all the equipment required for the Subscribers connected to the Access Point. This BOM cannot be edited at this level. To change the quantities or add Optional Extras, select the individual Subscriber Modules.



Bill of Materials for Subscriber Modules

P/N	Description	Qty	Notes
600SS	SURGE SUPPRESSOR	4	
ACPSSW-13	13.6W, 29.5V, 100-240/50-60 + FIXED US	2	
C054045C003	5 GHz PMP 450 Subscriber Module, 20 Mbps	1	
C054045C004	5 GHz PMP 450 Subscriber Module, Uncapped	1	
HK2022	53CM OFFSET, REFLECTOR DISH KIT,4PK	1	
SMMB1	Universal mounting bracket	2	

Figure 5.12: Aggregate Bill of Materials for Subscriber Modules on an Access Point

Viewing & saving the BOM file in MS Excel

To view the Access Point BOM or Subscriber Module Aggregate BOM in Excel, click **View in Spreadsheet** in the appropriate BOM section. Once in the spreadsheet the file can be saved as normal.

NOTE

All numeric only part numbers consist of 11 digits, if the number displayed is only 10 digits the part number should start with a zero.

Subscriber Modules

A Subscriber Module is created when a Subscriber Site location is connected to an Access Point.

The Subscriber Module automatically assumes a number of the Access Point equipment parameters and the choices available at the Subscriber Module are dependent on how the Access Point has been configured.

The Subscriber Module contains the link to the Access Point, including the path profile and performance information.

The Subscriber Module contains the following sections:

- *Creating and Deleting Subscriber Modules*
- *Subscriber Module Description and Equipment*
- *Profile*
- *Performance Summary*
- *Performance Details*
- *Bill of Materials for Subscriber Module*

Creating and Deleting Subscriber Modules

The Access Point connects to one or more Subscriber Sites to create links to Subscriber Modules.

Creating Subscriber Modules / PMP Links

To create a new Subscriber Module, either click **Project, New Subscriber Module**, click **New PMP Link** or add from the Links to Subscriber Modules view on the Access Point Page, see *Access Points*. If creating through the New Subscriber Module or New PMP Link options, the New PMP link page is displayed.

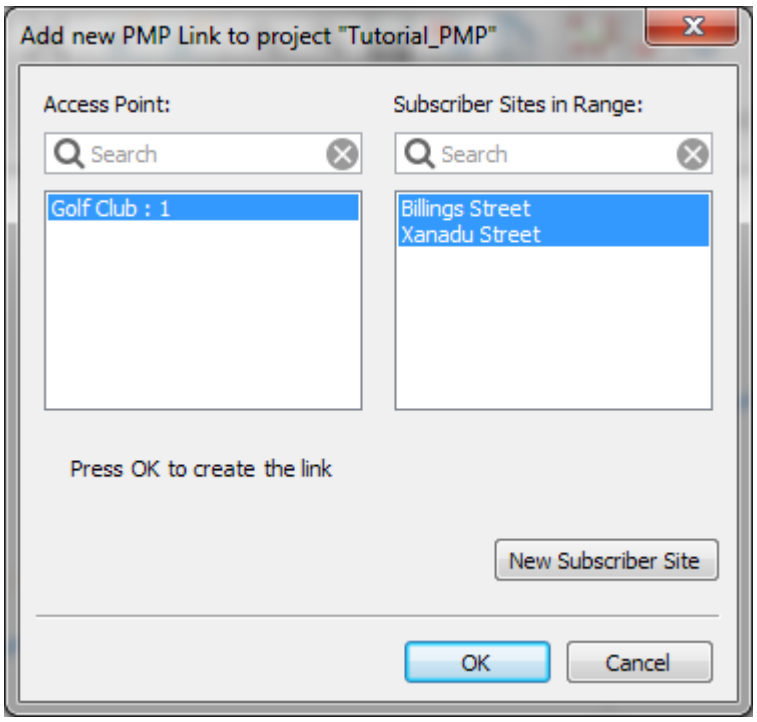


Figure 5.13: New PMP Link Page

The list of available Access Points is displayed on the left. Select an Access Point from the list and then a list of available Subscriber Sites for that Access Point are displayed on the right. Select one or more Subscriber Sites and hit **OK**. The search field narrows the choice when there is a large number of Access Points or Subscriber Sites in the list.

If creating Subscriber Modules from the Access Point Page, the New Subscriber Module (SM) page is displayed.

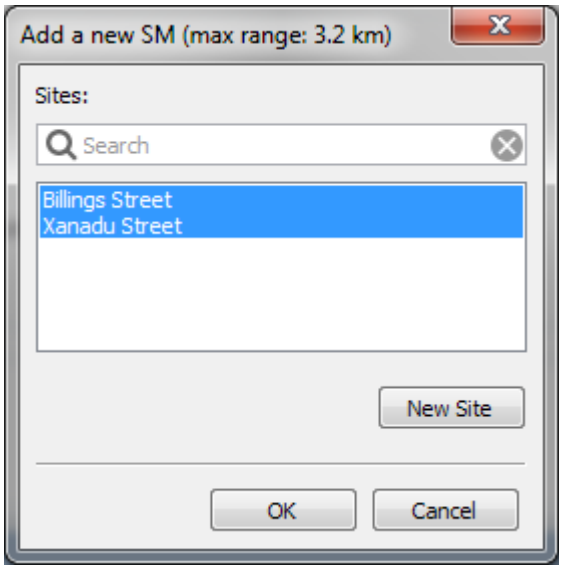


Figure 5.14: New Subscriber Module Page

This page only shows the Subscriber Sites as the Access Point is already known.

In both cases only Subscriber Sites which are within the Max Range defined for the Access Point are visible in the list. The list is further constrained by the sector coverage and Azimuth bearing of the Access Point antenna. To set the sector coverage of the Access Point antenna, see *Project Properties*, choose from the following two options:

Enhanced: only affects PMP 450 and 450i antennas and allows an additional 15 degrees on each side of the nominal beamwidth

Nominal Beamwdith: limits the subscribers to only connect within the stated beamwidth of the AP antenna selected.

The Subscriber Modules are then created and listed in the project navigation tree below selected Access Point.

Deleting Subscriber Modules

To delete a Subscriber Module, select the Subscriber Module in the navigation pane, right click and choose delete from the pop-up menu, or select **Project, Delete Subscriber Module name**, in the same manner as deleting Hub Sites, see *Delete Hub Site*.

Subscriber Module Description and Equipment

Subscriber Module Description

Enter the Name and Description of this link. The MAC Address of the equipment may also be added. The MAC Address must be included for the PMP 450 configuration file to be created. The default contact information for Cambium Networks will be shown. When the link profile has been received the information will change to show the Sales Contact information for the location of the link. To update this information click **Refresh**.

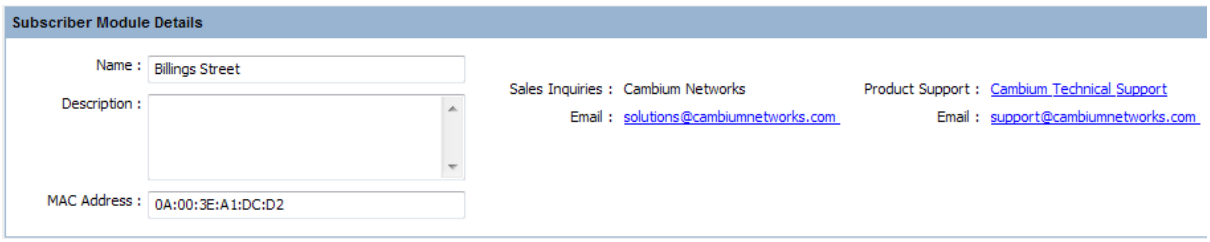


Figure 5.15: Subscriber Module Description

Subscriber Module Equipment

Select the available subscriber parameters for this link. The fields that are displayed in the “Equipment” box will change depending on the type of equipment selected. For example, when a PMP 450 is selected, the Color Code field is displayed.

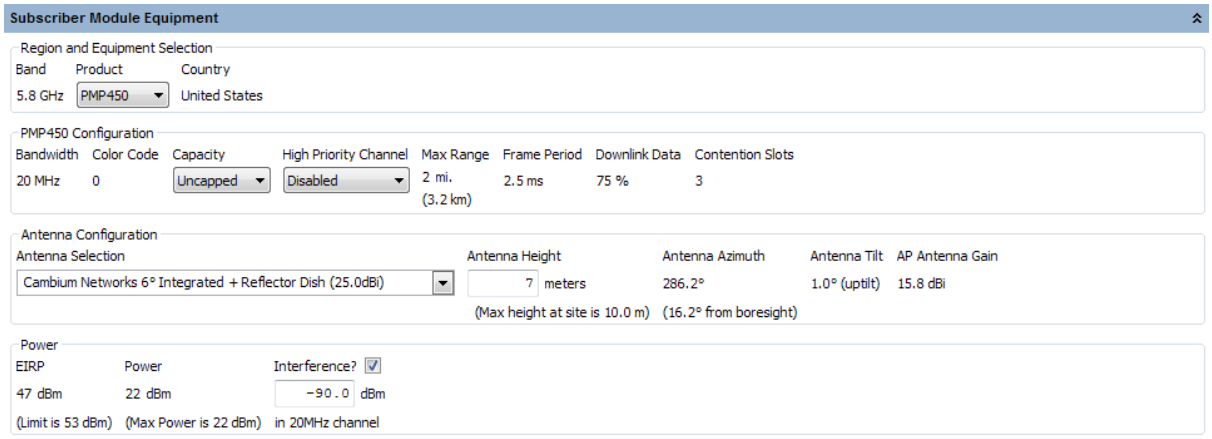


Figure 5.16: Subscriber Module Equipment

Region and equipment

Band: Read only value reflecting the band selected at the Access Point.

Product: Select from the available list, based on the product selected for the Access Point.

Country: Read only value reflecting the country selected at the Access Point.

Configuration

Bandwidth: Read only value reflecting the bandwidth selected at the Access Point.

Color Code: (PMP 450 and 450i only). Read only value reflecting the color code selected at the Access Point.

Capacity: (PMP 450 only) Select the capacity limit for the Subscriber Module.

High Priority Channel: (PMP 450 and 450i only). Defaults to Disabled. Enable additional High Priority Channel if required.

Max Range: Read only value reflecting the max range selected at the Access Point.

Frame Period: Read only value reflecting the frame period selected at the Access Point.

Downlink Data: (PMP 450 and 450i only) Read only value reflecting the downlink data ratio selected at the Access Point.

DL/UL Ratio: (ePMP only) Read only value reflecting the downlink data ratio selected at the Access Point.

Maximum Mod Mode: (ePMP Only) Set the maximum modulation for the Subscriber Module on the uplink to the Access Point.

Control Slots: (PMP 450 and 450i Only) Read only value reflecting the number of control slots selected at the Access Point.

Antenna Configuration

Antenna Selection: Select the antenna for the Subscriber Module

Antenna Height: Select the height of the Subscriber Module above ground level

Cable Loss: Only displayed for external antennas, read only value for PMP 450 antenna options.

Antenna Azimuth: Calculated angle from Subscriber Module to Access Point

Antenna Tilt: Calculated elevation angle from Subscriber Module to Access Point - a negative value indicates downtilt is required.

AP Antenna Gain: Calculated value of the Access Point sector antenna in the direction of the Subscriber Module.

Power

EIRP: Read only value showing the EIRP of the antenna, if the country selected has a regulatory limit this value is shown in brackets underneath.

Power: Calculated value to meet the **SM Receive Target Level** at the Access Point, if the country selected has a regulatory limit (or an implied limit to meet the EIRP limit) the value is shown as “Max Power” in brackets underneath.

SM Receive Target Level: Set the receive power required at the Access Point from each of the Subscribers.

Interference: This is the amount of site noise in the selected channel bandwidth, 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 radio. The bandwidth displayed depends on the bandwidth selected in the Equipment Settings box (in this example it is 20 MHz). To enter Interference, tick the box and update the default value. If the Access Point has been set up and mean power measurements are available, then use these measurements.

Profile

This section contains a visualization of the path between the Access Point and the Subscriber Module (*PMP Profile with Trees*).

In this example, a 4m high tree at 0.808 km and and an 8.0 m high tree at 0.958 km enter the Fresnel zone and alter the slope.

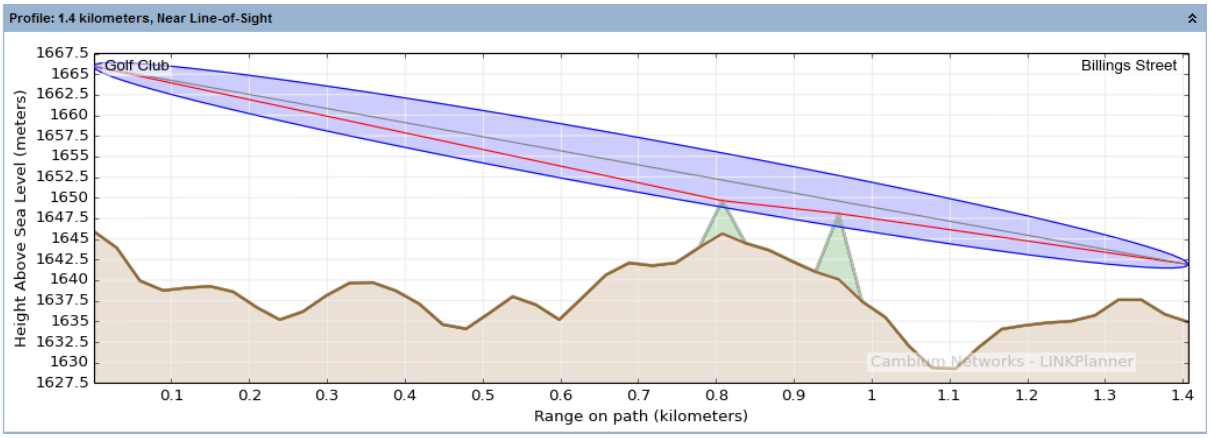


Figure 5.17: PMP Profile with Trees

Color code used in the profile:

- Brown: terrain.
- Green: obstructions (such as trees or buildings).
- Red: line of site from the antennas to the largest obstruction (called “slope”).
- Blue: the Fresnel zone.
- Grey: the profile worst case which occurs up to 0.01% of the time. Sometimes known as Worst Earth curvature (Ke). (This line will only be shown on longer links).

To update the profile to allow for terrain height and obstructions, see *Adjusting Link Profiles*.

The Fresnel zone shown is a visualization of $F_{0.6}$ or $0.78F_1$, which is shown for guidance when setting antenna heights for path clearance. It is not used directly in the diffraction loss calculations.

To view the profile in Google Earth(TM), click the **Google Earth** toolbar icon . For more information, see *Using Google Earth(TM)*.

An additional shortcut menu is available by right-clicking on the profile which will give access to the following items:

Copy: selecting this option copies the profile information. It can then be pasted into another link or into an Excel spreadsheet or text editor, see *Updating Link Profiles*.

Paste: this option is only available if a profile has previously been copied either from another profile or from a spreadsheet, see *Updating Link Profiles*.

Edit Profile: selecting this option displays the Profile Editor, see *Updating Link Profiles*.

Performance Summary

This section shows how well the link is predicted to perform in response to the selected combination of the variables, such as band, region, equipment, antenna

and height. It shows performance at each end of the link.

Figure 5.18: PMP Link Performance Summary

Performance to Access Point and Subscriber Module

This summary is a prediction of the Receive Power, Max Usable Mode and Availability at each end of the link, based on the equipment parameters entered.

Predicted Receive Power: The predicted receive power and associated tolerance level at this end of the link. The tolerance is the sum of two components, a fixed value which is dependent on the equipment performance over temperature and a variable value which is proportional to the amount of Excess Path Loss. When using adaptive modulation the receive power shown is the maximum for the link, which corresponds to the lowest selected modulation mode and Maximum Power.

Min Mod Mode Required: Select the minimum modulation mode which provides the required throughput performance. If the Max Usable Mode is below Min Mod Mode Required, at either end of the link, the link will turn red.

Min Availability Required: Set the minimum availability the **Min Mod Mode Required** must meet for acceptable performance.

Max Usable Mode: The maximum modulation mode which is above the sensitivity threshold and can meets the active required performance metric. This parameter will be shown in red if it is below the **Min Mod Mode Required**.

Predicted Availability: The predicted availability of the selected **Min Mod Mode Required**. This parameter will turn red if the value is less than **Min Availability Required**.

NOTE If any of the parameters fail to meet the configured requirements this will turn the link red and the SM will not be included in the Performance Summary of the Access Point.

Link Summary

This summary 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 0.6. The Total Path Loss and System Gain Margin are also given.

Lowest Mode Availability (%): This is the availability of basic link operation. This is equivalent to the availability of the most robust modulation in both directions.

System Gain Margin (dB): This is the margin in dB above which the ratio of (mean wanted receive level) to (mean interference plus thermal noise), or “C to (I+N)”, for the worst link direction is above the level required for basic link operation for the most robust modulation.

Free Space Path Loss (dB): The amount that the signal would be attenuated if travelling through a vaccuum.

Mean Atmospheric Loss (dB): The amount of attenuation due to oxygen and water in the atmosphere.

Excess Path Loss (dB): The amount of attenuation due to obstructions in the path. If the path is completely line-of-sight, this will be zero.

Total Path Loss (dB): The sum of Free Space, Mean Atmospheric and Excess Path Loss.

Performance Details

This section contains more detail about the predicted performance of the link.

Performance Details

Common details

Mode:	256QAM	64QAM	16QAM	QPSK	256QAM	64QAM	16QAM	QPSK
MIMO Type:	MIMO-B	MIMO-B	MIMO-B	MIMO-B	MIMO-A	MIMO-A	MIMO-A	MIMO-A
Multiplier:	x8	x6	x4	x2	x4	x3	x2	x1

Performance to Access Point

Fade Margin (dB):	-1.3	7.8	13.8	20.7	-1.3	7.8	13.8	22.8
Mode Availability (%):	14.2909	99.9841	99.9885	99.9885	0.0006	0.0115	0.0115	100.0000
Receive Time in Mode (%):	14.2909	85.6931	0.0044	0.0000	0.0006	0.0109	0.0000	0.0000

Performance to Subscriber Module

Fade Margin (dB):	-2.5	8.5	14.4	20.8	-2.5	8.5	14.4	21.5
Mode Availability (%):	1.8769	99.9867	99.9885	99.9885	0.0000	0.0115	0.0115	100.0000
Receive Time in Mode (%):	1.8769	98.1098	0.0018	0.0000	0.0000	0.0115	0.0000	0.0000

Figure 5.19: PMP 450 Link Performance Details

Common Details - PMP 450

Mode: The modulation technique used.

MIMO Type: Indicates whether the mode is operating in MIMO-B (dual payload) or MIMO-A (single payload) mode.

Multiplier: Indicates the relative capacity capability of the different modes.

Common Details - ePMP

MCS: The Modulation Coding Scheme Number

Mode: The modulation technique used.

Payloads: Indicates whether the modulation mode is using dual or single payload

Code Rate: The code rate for the specified mode.

Performance to each end (Access Point and Subscriber Module)

Fade Margin (dB): The margin available to each end in the specified Mode.

Mode Availability(%): The percentage of time that the modulation mode for each end is predicted to be available.

Receive Time in Mode(%): The percentage of time the specified mode is predicted to be used to receive data.

Bill of Materials for Subscriber Module

LINKPlanner automatically calculates the Bill of Materials (BOM) for the Subscriber Module. The BOM contains the list of part numbers and associated quantities for the Subscriber Module. Optional items can be added to the list. The BOM can be saved as a CSV or Excel file by clicking **View in Spreadsheet**  .

To view the Subscriber Module BOM, open the Subscriber Module page and scroll down to the ” *Bill of Materials for Subscriber Module*” section.

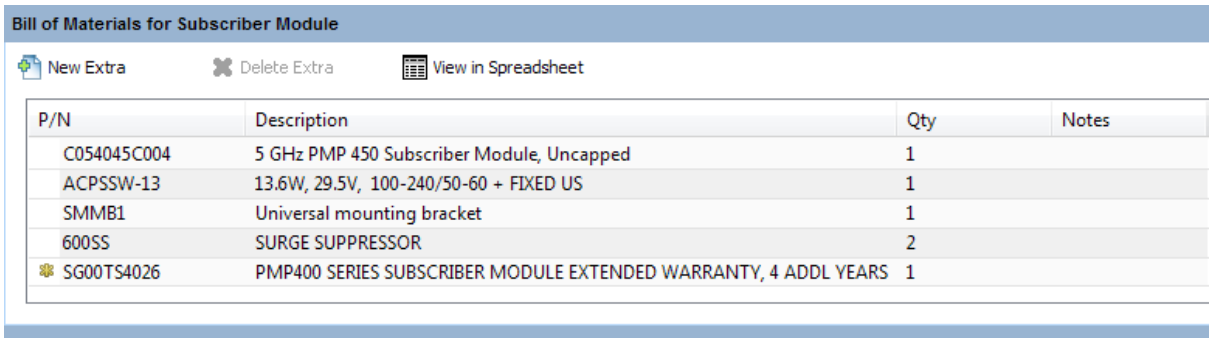


Figure 5.20: Bill of Materials for Subscriber Module

P/N: The Cambium part number. If the component is not supplied by Cambium, this is set to ‘(no part number)’.

Description: Description of the components.

Qty: Quantity required.

Notes: By default this displays information about certain items, such as whether they are obsolete, or to prompt for additional required information. This field can be edited to allow additional information to be added to the item. The default text is returned if the edited text is deleted. When information is displayed in the Notes field, at the aggregate level the notes will also be aggregated into a list.

A star denotes optional extras which have been added to the automatic BOM items.

To add additional items to the BOM, click **New Extra** New Extra. A list of optional extras for the given product will be displayed. The list of items will vary depending upon the product selected. To add an item to the BOM highlight the option required and click **OK**. The item will appear in the main list, where the quantity can be adjusted by selecting the number in the **Qty** column and adjusting as required. To delete an optional item from the BOM list, highlight the item and click **Delete Extra** Delete Extra.

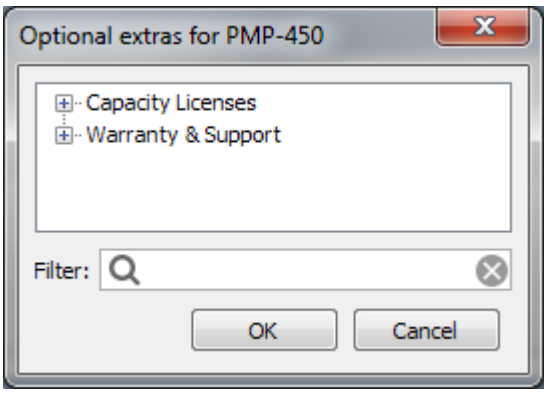


Figure 5.21: Bill of Materials Optional Extras for Subscriber Module

The groups and extras will vary depending on the chosen product.

Cable, Accessories & Spares: This allows items such as RF and Ethernet Cable to be added to the order.

Capacity Licenses: PMP 450 upgrade keys.

Installation & Mounting: This allows items such as mounting brackets to be added to the order.

Lightning Protection: This allows Lightning Protection Units, grounding kits or surge suppressors to be added to the order.

Power: This allows ePMP spare power supplies to be included with the order

Warranty & Support: Additional warranty options are available to extend the warranty by 1, 2 or 4 years.

To filter the list of optional extras, enter a part number or description in the Filter field.

NOTE

For instructions on how to view and save the BOM for the entire project, see *Bill of Materials for Project*.

Viewing & saving the Subscriber Module BOM file in MS Excel

To view the Subscriber Module BOM in Excel, click **View in Spreadsheet** while viewing the Subscriber Module BOM. Once in the spreadsheet the file can be

saved as normal.

NOTE

All numeric only part numbers consist of 11 digits, if the number displayed is only 10 digits the part number should start with a zero.

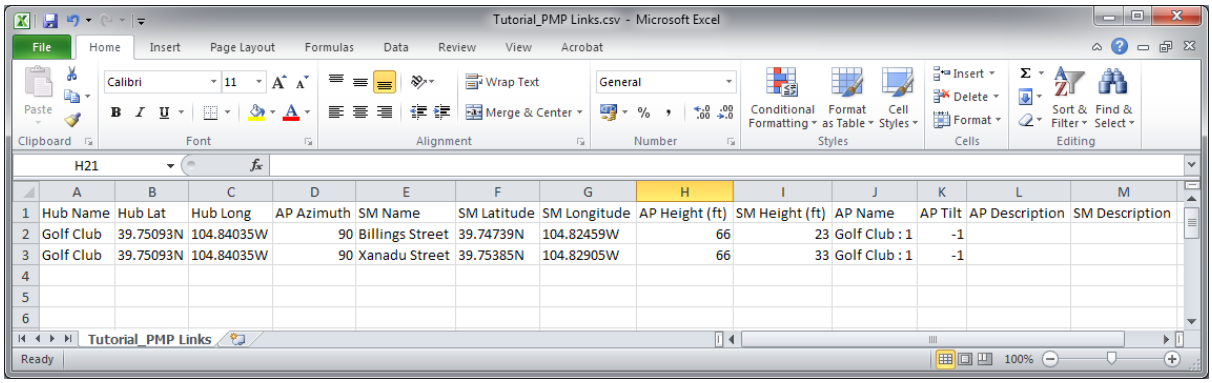
Importing PMP Links

Use this method when PMP link information is in a spreadsheet. The required fields for each PMP link are Hub Name, Hub Latitude, Hub Longitude, AP Azimuth, SM Name, SM Latitude and SM Longitude. The optional fields are AP Height, SM Height, AP Name, AP Tilt, AP Description, SM Description (*PMP Link Data in a Spreadsheet*).

NOTE

The PMP link import file combines a small subset of the information from the PMP Hub, Access Point and PMP Links files which are exported from LINKPlanner. An exported PMP link CSV file cannot be imported directly back into LINKPlanner.

The procedure is:



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Hub Name	Hub Lat	Hub Long	AP Azimuth	SM Name	SM Latitude	SM Longitude	AP Height (ft)	SM Height (ft)	AP Name	AP Tilt	AP Description	SM Description
2	Golf Club	39.75093N	104.84035W	90	Billings Street	39.74739N	104.82459W	66	23	Golf Club : 1	-1		
3	Golf Club	39.75093N	104.84035W	90	Xanadu Street	39.75385N	104.82905W	66	33	Golf Club : 1	-1		
4													
5													
6													

Figure 5.22: PMP Link Data in a Spreadsheet

1. Import the data from a CSV file.

   To import from CSV: save the spreadsheet as a CSV (comma separated) file; then in LINKPlanner, click **File**, **Import**, **PMP Links from CSV**.

2. The *PMP Table Import Wizard* is presented:

   LINKPlanner attempts to detect the correct delimiter and encoding for each CSV file, but it does not always succeed. If the data is not displayed in the correct columns, specify a different delimiter or encoding.

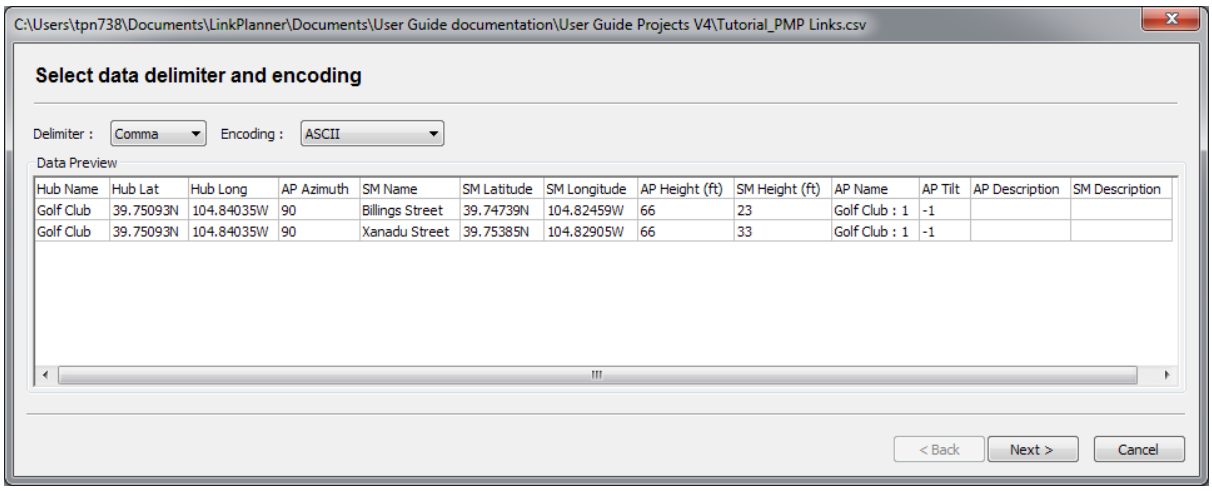


Figure 5.23: PMP Table Import Wizard

3. Select the columns to be imported:

   If the first row contains column headings, tick **Skip first row**.

   For each column, select the correct attribute for the data in the column. Ensure that unwanted columns are ignored (*Selecting PMP Columns to be Imported*). The antenna height values may be specified in feet or meters, select the correct column heading for the units required. Select multiple Description columns if required, but select the other columns once only.

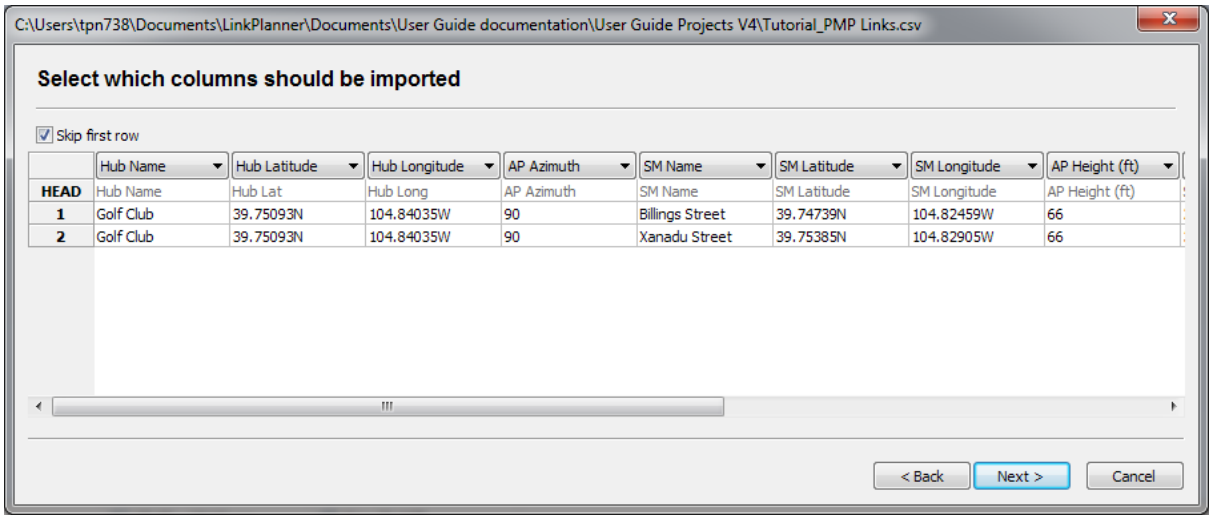


Figure 5.24: Selecting PMP Columns to be Imported

4. Correct any values that cannot be imported:

   If LINKPlanner cannot interpret any of the values (for example, if a latitude or longitude is not formatted correctly), the cell is highlighted in red. Double-click in a red cell to edit it (*PMP Link Value Cannot be Interpreted*).

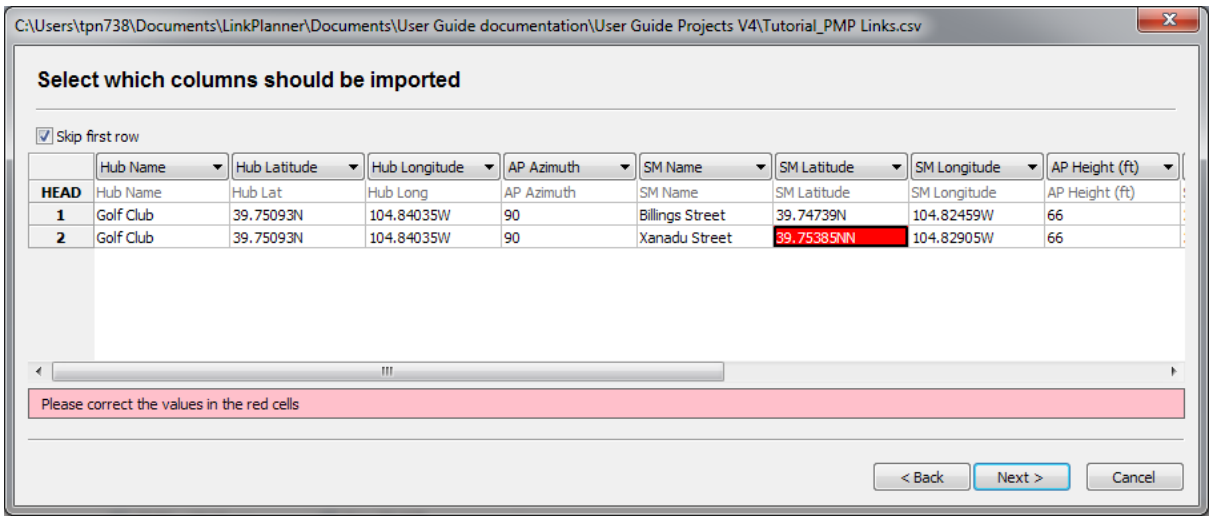


Figure 5.25: PMP Link Value Cannot be Interpreted

5. Verify the map of newly imported links:

   The wizard displays a map of the new links and sites to confirm that the positions are correct (*Map of Newly Imported PMP Sites and Links*). If they are correct, press **Finish**.

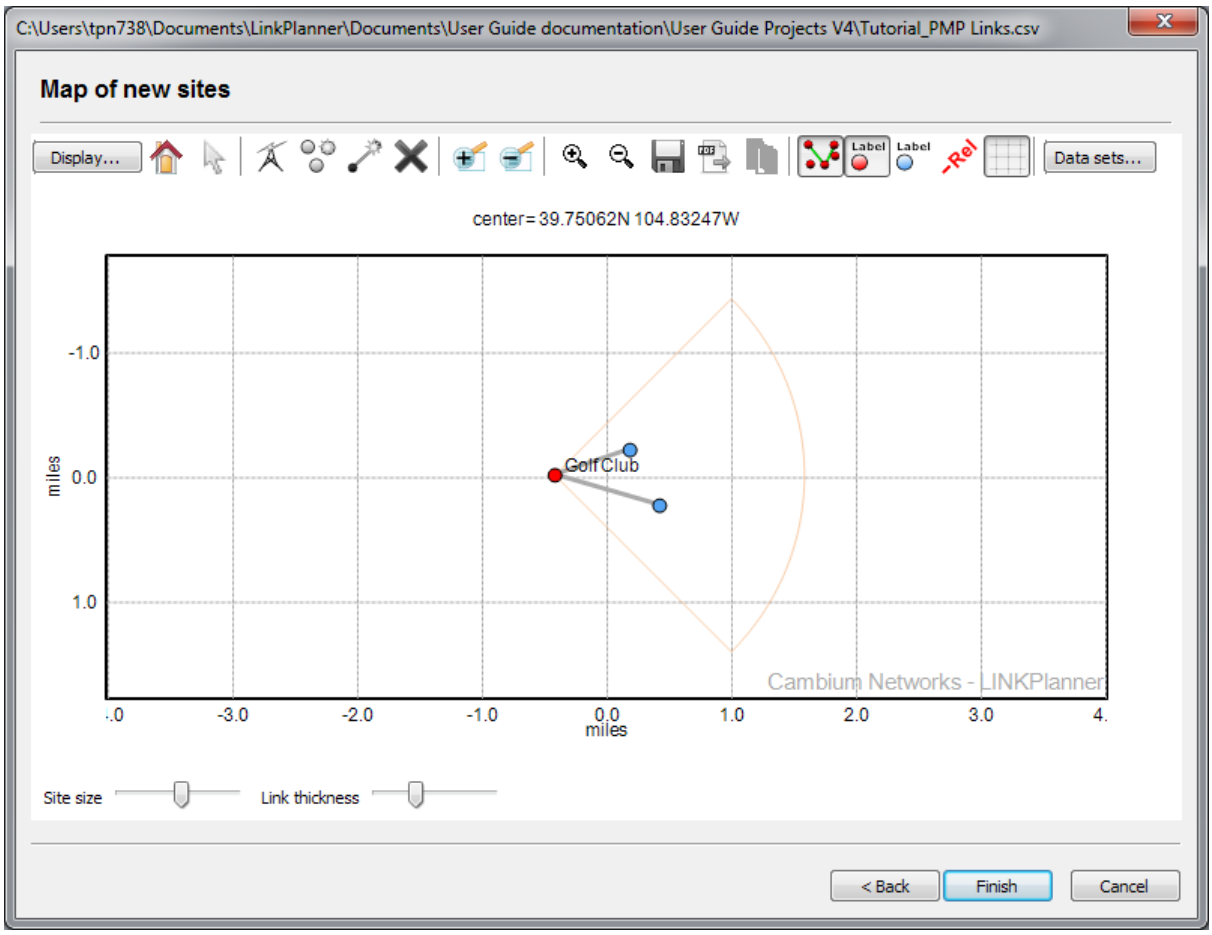


Figure 5.26: Map of Newly Imported PMP Sites and Links

6. Merge Duplicate Data:

   If any of the PMP links or sites are similar to those that already exist in the project then a dialog appears to assist in merging the data(see *Merging Duplicate PMP Data*). Items in the left-hand lists mean that the existing links or sites will be used. Items in the right-hand lists will result in new links and sites being created, even though they are similar to the existing links or sites.

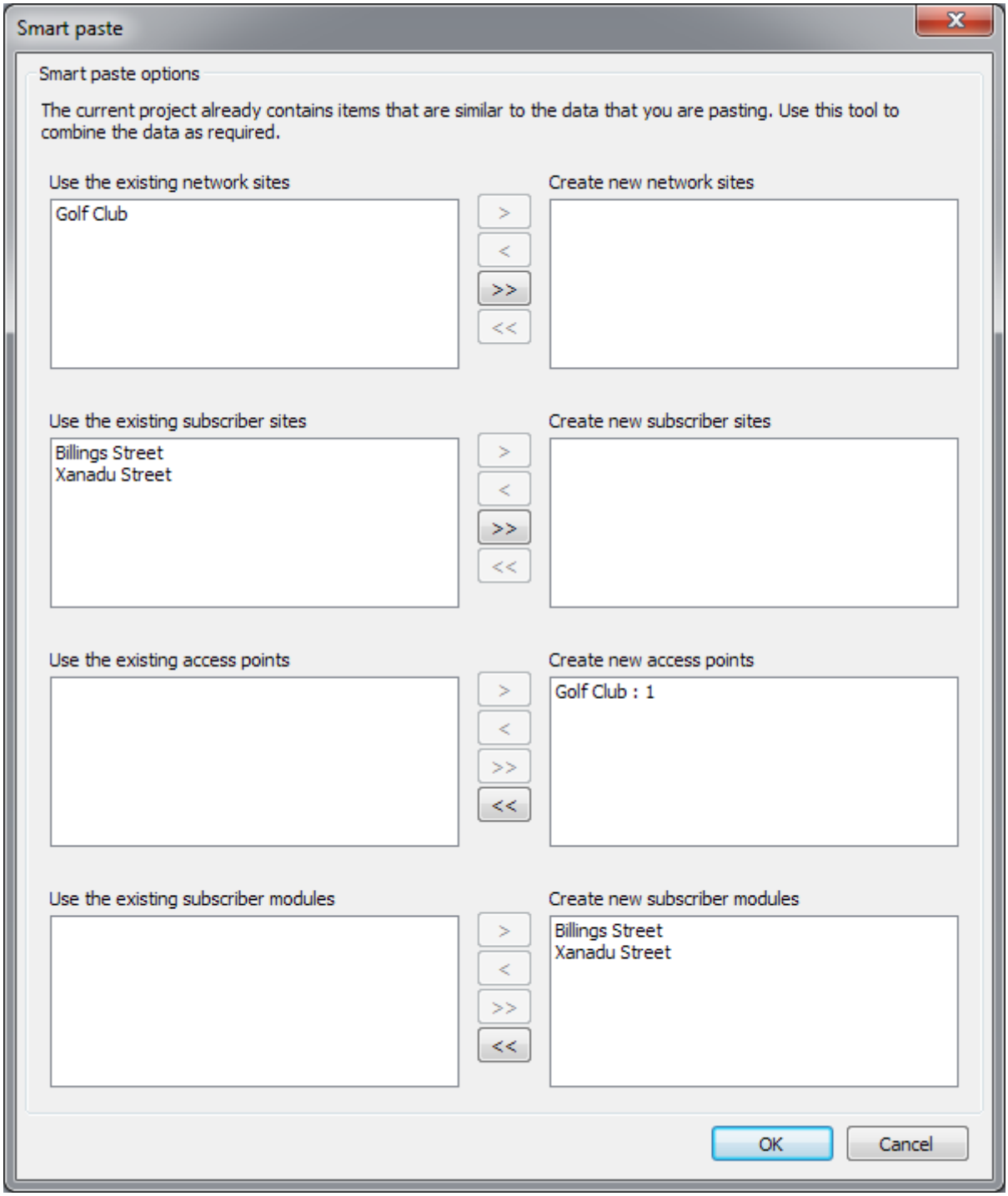


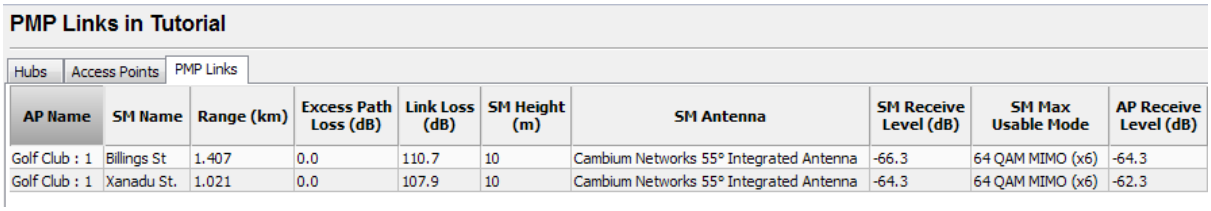
Figure 5.27: Merging Duplicate PMP Data

NOTE

- Sites are considered equal if they are within 1 meter of an existing site

Displaying PMP Networks

When Hubs, Access Points and Subscriber Modules have been created, they appear in the PMP Links list. To display these lists, click the **“PMP Links”** node in the navigation tree. Select the required tab to display the list of Hubs, Access Points or PMP Links.



PMP Links in Tutorial

Hubs | Access Points | PMP Links

AP Name	SM Name	Range (km)	Excess Path Loss (dB)	Link Loss (dB)	SM Height (m)	SM Antenna	SM Receive Level (dB)	SM Max Usable Mode	AP Receive Level (dB)
Golf Club : 1	Billings St	1.407	0.0	110.7	10	Cambium Networks 55° Integrated Antenna	-66.3	64 QAM MIMO (x6)	-64.3
Golf Club : 1	Xanadu St.	1.021	0.0	107.9	10	Cambium Networks 55° Integrated Antenna	-64.3	64 QAM MIMO (x6)	-62.3

Figure 5.28: PMP Network Lists

By default, if a PMP link is displayed in **red**, it means that the predicted performance of the link is below requirements. It is possible to alter the default colors in the *Graphics Page*.

To manage the information displayed in each of the lists, see *Managing List Views*.

CHAPTER 6

Background Information

The following background information is provided to help users of LINKPlanner:

- A description of availability models. See *Availability*.
- A description of path loss. See *Path Loss*.
- A description of the Cambium Path Profiler. See *Path Profiles*.
- Specifications of import file formats. See *Import File Formats*.

Availability

Availability is the amount of time that a link is predicted to be above a given threshold (the fade margin) and is usually expressed as a percentage of a year. LINKPlanner offers two different prediction models for calculating the availability.

- ITU-R P530-12 is the international standard from the ITU
- Vigants - Barnett, commonly used in the United States of America

The ITU prediction model is the default within LINKPlanner. To change to the Vigants - Barnett model select the main project page and then **Project Properties**. See *Project Page*.

ITU-R P530-12

P530 is an international standard from the ITU and is continuously being reviewed and updated. Version 12 was last updated in 2007 and is the method currently used in LINKPlanner. The ITU model is fully defined and has no ambiguity in its implementation, hence all implementations should return the same results for a given configuration of a link.

Vigants - Barnett

The Vigants - Barnett model is widely used in the United States of America. This model was defined in the 1970's and the algorithms used are described in the following two references:

- Multipath Propagation at 4, 6 and 11 GHz, by W.T. Barnett, Bell System Technical Journal, Vol 51 Feb 1972 Number 2
- Space-Diversity Engineering, by A. Vigants, Bell System Technical Journal, Vol 54 Jan 1975 Number 1

These papers define the algorithms, but the implementation is open to interpretation. The following describes the implementation used within LINKPlanner:

- The Climatic Factor is automatically read from a database of the atmospheric conditions maps and is taken at the mid-point of the path.
- The terrain roughness is calculated for 50 evenly spaced points in the central 80% of the path, using terrain height above mean sea level plus obstruction height as the reference height.
- The temperature used to convert from worst month to annual availability is taken for the mid-point of the path using the standard ESATEMP data file available from the ITU.

Path Loss

Path loss is the amount of attenuation a radio signal undergoes between the two ends of a link. Path loss comprises the sum of the attenuation of the path if there were no obstacles in the way (Free Space Path Loss) and the attenuation caused by obstacles (Excess Path Loss). It is also necessary to consider 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.

LINKPlanner uses the following equation to judge whether a particular link can be installed:

Path Loss Equation:

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

Where	Is	See also
$L_{FreeSpace}$	Free Space Path Loss (dB)	*Free Space Path Loss*
L_{Excess}	Excess Path Loss (dB)	*Excess Path Loss*
L_{Fade}	Fade Margin Requirement (dB)	*Fade Margin*
L_{Season}	Seasonal Fading (dB)	
$L_{Capability}$	Equipment Capability (dB)	

When the link has been installed, web pages provide information about the link loss currently measured by the equipment, both instantaneously and averaged.

Adaptive modulation ensures that the highest possible throughput is achieved instantaneously, taking account of propagation and interference. See also:

- *Free Space Path Loss*
- *Excess Path Loss*
- *Fade Margin*
- *Fresnel Zone*
- *Maximum Path Loss*
- *Paths Over Sea or Very Flat Ground*

Free Space Path Loss

Free Space Path Loss is the loss incurred along a line-of-sight path between the two end points of the radio link. The following graph shows the value in dB by range, at the frequency used by PTP 500 bridges:

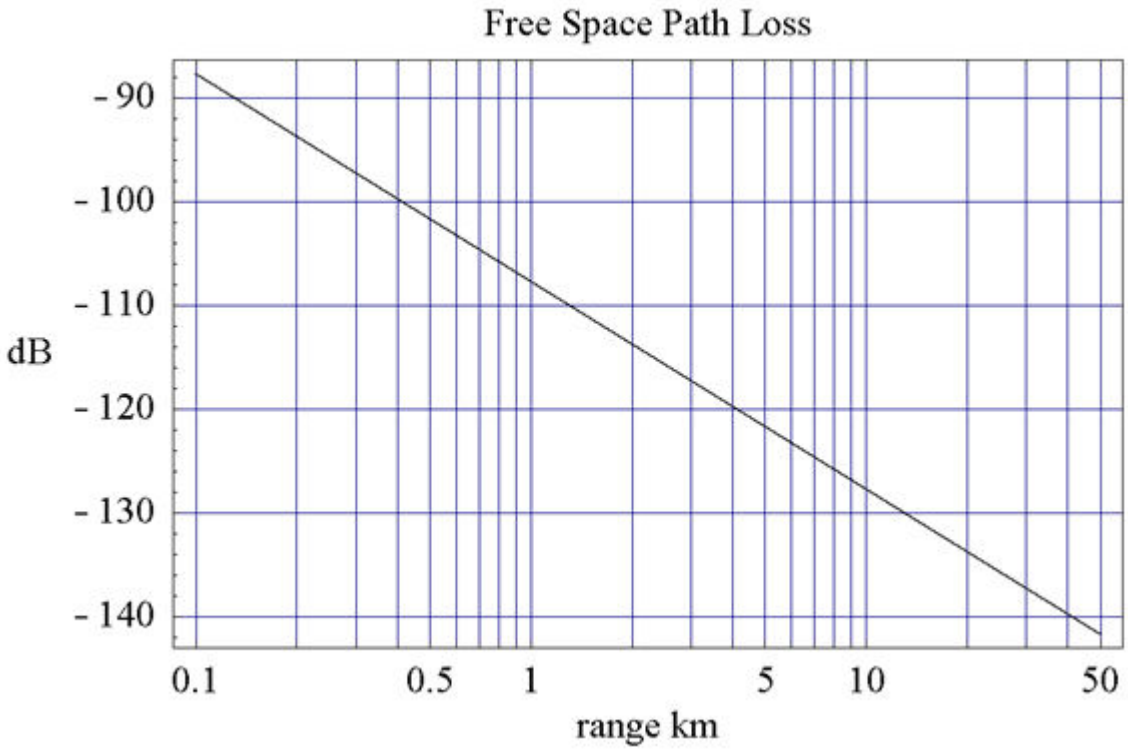


Figure 6.1: Free Space Path Loss at 5.8 GHz

Excess Path Loss

Excess Path Loss is the loss incurred due to obstacles between the two end points of the radio link. This loss is calculated by LINKPlanner. Trees and foliage create a number of problems:

- They are often not marked on the path profiles, leading to optimistic results.
- They are not completely solid, leading to pessimistic results.
- They are responsible for seasonal variation.

Identify trees and foliage as obstructions in LINKPlanner, thus giving worst case results. When the link is installed, make an allowance for seasonal variations in the estimated mean path loss.

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, for example 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 the following graph:

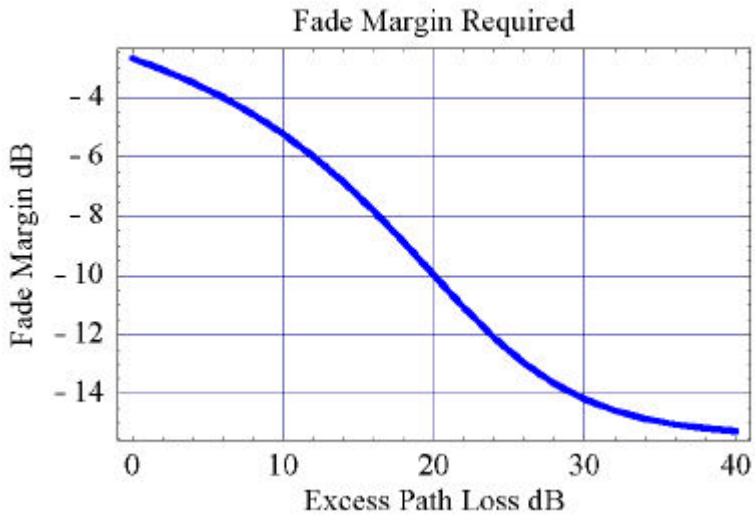


Figure 6.2: Fade Margin vs Excess Path Loss for 99.99% Link Availability

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.530-12. The estimation tool adds together the probabilities for the NLoS fading and the LoS fading.

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 in the following equation:

Fresnel Zone Radius Equation

$$\text{Fresnel Zone Radius (m)} = 17.32 \cdot \sqrt{\frac{d1 \cdot d2}{f \cdot (d1 + d2)}}$$

Where	Is
d1	distance from one end in meters
d2	distance from the other end in meters
f	frequency in MHz

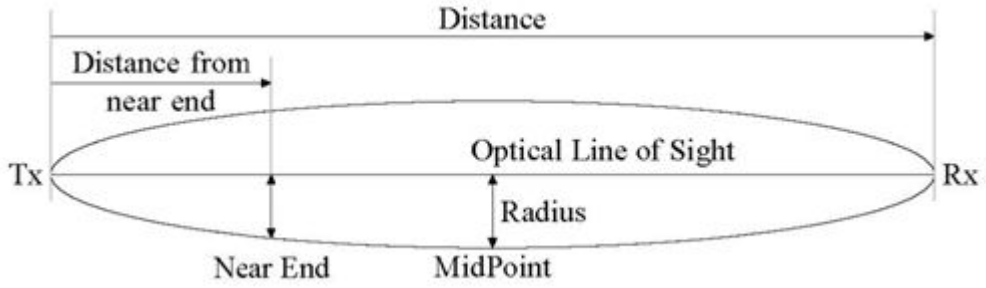


Figure 6.3: Fresnel Zone

For a thorough understanding of the Fresnel Zone refer to ITU-R P.526.9.

To view the Fresnel zone projected onto the ground, see *Using Google Earth(TM)*.

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. Deployment considerations may limit the maximum power which is used. Also, there may be local interference sources from other users of the 5.8 GHz band.

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. The following figure illustrates the problem and the solution, using a PTP 500 bridge:

Figure 6.4: Propagation Over The Sea

The background of the diagram is shaded to illustrate the changing density and therefore refractive index. The upper antennas are in a signal inversion.

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 polarization selected for the antennas are single V and H polarization on the left and a dual polarized antenna on the right. The two graphs on the right illustrate the signal received on each polarization while on the left the individual antennas will receive the same signal level independent of polarization 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 single antenna and to a lesser extent the height of the pair of antennas on the left. An allowance is made for the apparent height of the middle of the path due to the mean radio curvature of the earth (4/3).

The procedure for updating link profiles to allow for reflection is described in *Updating Link Profiles*.

⚠ CAUTION

LINKPlanner does not adjust the reliability of the link based upon the possible reflection, but a link that suffers reflection can have very bad performance if the mitigation has not been applied.

Path Profiles

The accuracy of the LINKPlanner results depends upon obtaining accurate path data. NASA has provided 1 arc second data (30m) covering land masses between latitudes 60 north and 60 south. The vertical accuracy is claimed by NASA to be 10 meters RMS. (See *SRTM Technical Guide*). LINKPlanner also imports from other data sources to cover the areas above latitude 60 north and below 60 south and other areas not covered by the 1 arc second data.

LINKPlanner uses the following data sources:

- SRTM V3 (See *SRTM Technical Guide*)
- ASTER Version 1 (For more information, visit http://www.nasa.gov/centers/jpl/missions/aster.html)
- GeoBase (For more information, visit http://www.geobase.ca/geobase/en/index.html)

Note that the SRTM and ASTER data collection methods generally map the top of the landscape including its land cover, which means that significant areas of land cover such as forest and urban areas may be incorporated into the terrain height. The SRTM data collection happened in February, a period of minimum leaf cover for northern latitude deciduous forests.

Even with accurate path data, the losses over certain objects depend 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, helps the user to understand the concept of non-line-of-sight.

To obtain an accurate link estimate where the path impinges on the Fresnel zone, an accurate height profile of the path is required. Cambium provides the PTP Path Profiler web based utility for this purpose, as described in *Path Profiler*. 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.

Path Profiler

Cambium has produced the web based utility Path Profiler to create path profiles, which can be directly imported into LINKPlanner:

The file output by Path Profiler is complete 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 LINKPlanner for translated files.

LINKPlanner automatically generates requests and sends them to Path Profiler (either as soon as the link is created or from the menu options **Project, Get Profiles**). Path Profiler imports the path profile data automatically into LINKPlanner. See *Obtaining Link Profiles*.

When path profiles are loaded into LINKPlanner, verify them as described in *Adjusting Link Profiles*. The following questions must be answered:

- Has Path Profiler given the correct ground height at each end of the link?
- Has Path Profiler given accurate data for any sections of the path that pass over water? The method of survey, which is radar on board a satellite, may cause inaccuracies over water. The ground return is dispersive in angle, 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, introducing potentially large errors.

SRTM Technical Guide

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).

Reverb Acknowledgement:

Earth Observing System Data and Information System (EOSDIS). 2009. Earth Observing System ClearingHouse (ECHO) / Reverb Version 10.X [online application]. Greenbelt, MD: EOSDIS, Goddard Space Flight Center (GSFC) National Aeronautics and Space Administration (NASA). URL: http://reverb.echo.nasa.gov/reverb/

USGS Acknowledgement:

These data are distributed by the Land Processes Distributed Active Archive Center (LP DAAC), located at USGS/EROS, Sioux Falls, SD. http://lpdaac.usgs.gov

For more information, visit:

- USGS LP DAAC SRTM Global 1 arc second (USGS)
- NASA Jet Propulsion Laboratory SRTM home page: http://www2.jpl.nasa.gov/srtm/
- Global Land Cover Facility (University of Maryland): http://www.landcover.org/data/srtm/

Import File Formats

Path from Hydra - no Site Names (*.pth)

Format of the path file exported by Motorola Hydra (without site names):

```
40.047845833333334 -75.175095277777771
40.042207222222224 -75.168060277777784
50 TxHt(Meters)
8 RxHt(Meters)
5734 Freq(Mhz)
0
0 95 0 0
0.76553904027639119 95 0 15
1.5310780805527824 95 0 15
2.2966171208291732 95 0 150.60,1712.7,,0.00
```

Path from Hydra - with Site Names (*.pth)

Format of the path file exported by Motorola Hydra (with site names):

```
SiteNames
Big House
Garage
40.047845833333334 -75.175095277777771
40.042207222222224 -75.168060277777784
50 TxHt(Meters)
8 RxHt(Meters)
5734 Freq(Mhz)
0
0 95 0 0
0.76553904027639119 95 0 15
1.5310780805527824 95 0 15
2.2966171208291732 95 0 15
```

Sites from CSV File

Network Sites or Subscriber Sites can be defined in a CSV (comma separated variable) file, created using Excel or a text editor. The first row contains titles. For example:

```
Name, Latitude, Longitude, Maximum Height, Descripion
Place1, 50.371N, 3.523W, 200, Desc of place 1
Place2, 50.384N, 3.525W, 100, Desc of place 2
```

PTP Links from CSV File

PTP Links can be defined in a CSV (comma separated variable) file, created using Excel or a text editor. The first row contains titles. For example:

```
Name,   Desc.,  Local      Local       Remote     Remote      Local   Remote
                Latitude,  Longitude,  Latitude,  Longitude,  Height, Height
A to B, Description, 39.75093N, 104.84035W, 39.74828N, 104.84861W, 10, 20
```

NOTE

The PTP link import file only imports the coordinates and heights, which is different from the format in which PTP links are exported from LINKPlanner as the export contains all the detailed link parameters. An exported PTP link CSV file cannot be imported directly back into LINKPlanner. To import a PTP Link exported CSV, first remove all the detailed parameter columns until only the above columns are left in the CSV.

PMP Links from CSV File

PMP Links can be defined in a CSV (comma separated variable) file, created using Excel or a text editor. The first row contains titles. For example:

```
Hub Name,  Hub         Hub          AP       SM Name,  SM          SM
           Latitude,  Longitude,  Azimuth,           Latitude,  Longitude,
Golf Club, 39.75093N, 104.84035W, 90,      Billings, 39.74739N, 104.82459W,

AP           SM          AP Name,    AP Tilt, Description
Height(ft),  Height(ft),
66,          23,         Golf Club:1, -1,     Description
```

NOTE

The PMP link import file combines a small subset of the information from the PMP Hub, Access Point and PMP Link files which are exported from LINKPlanner. An exported PMP link CSV file cannot be imported directly back into LINKPlanner.

Path from CSV File

Paths can be defined in a CSV (comma separated variable) file, created using Excel or a text editor. The first row contains the headings. To ensure that the path is imported correctly the units should be defined in the header. Range can take the units (km) or (mi.) and the height values can be in (m) or (ft). If the units are missing or not recognized then the preferred units will be used. The range value increments from zero at the local (left hand) end of the path to the maximum path length. For an example, see *Path Profile Units*.

Path from Pathloss (*.txt)

Path profiles can be imported from Pathloss text reports, using the **Terrain profile listing** which will give the name and co-ordinates of each site and the path profile including obstructions between the sites.

In Pathloss 5 the text report is built by clicking **Operations, PL5 reports**. In the Composite reports window click **Terrain profile listing**, then click **Print selected links**. Save the resulting output as Text Format (*.TXT). Multiple sites can be included in the same file.

LINKPlanner can only support path profiles from Pathloss with a Datum of World Geodetic System 1984 (WGS 1984) or North American 1983.

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Participants in the discussion that led to this decision include the folk from Abisource, Robert Roebling, Julian Smart, Markus Fleck, Karsten Ballueder, and

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Universal Encoding Detector

(https://pypi.python.org/pypi/chardet)

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CHAPTER 8

Changes to LINKPlanner

This is a list of the main changes that have been made to the LINKPlanner application since version 3.0.0

Changes since version 4.0.0

Changes in version 4.3.7

New or changed features

- Added support for PTP 820 Rel 8.2
  - PTP 820C and PTP 820S - Added 10 and 20 MHz bandwidths
  - PTP 820G - Added adaptive transmit power for ACM
  - Removed support for 2048 QAM as a fixed mode and updated other allowed modulations
  - Updated XPIF and DFM parameters
- PTP 820
  - Added remote mount option and additional antennas
  - Added new FCC regulations at 7 and 13 GHz
  - Added new Canadian regulation at 8 GHz
  - PTP 820S - Added 7 and 8 GHz frequency bands
  - PTP 820G - Added 10 and 20 MHz bandwidths to 7 GHz NTIA regulation
- ePMP
  - Added Force 200 at 5 GHz as SM and PTP options
- PTP 650 - Release 01-41
  - Added Japan Low Power at 4.9 GHz
  - Added Australia at 4.9 GHz
  - Increased maximum range to 250 km
- PTP 700
  - Added Australia at 4.9 GHz

Bug Fixes

- Re-instated regional based optional extras on PTP 650
- Fixed bug that was duplicating BOM estimates when copying links

Changes in version 4.3.6

New or changed features

- ePMP
  - Added AP Lite parts to Optional Extras
  - Added additional South African Development Community countries
- PMP/PTP 450/450i Rel 14.1.1

  - Added interoperability for PMP between PMP 450 Access Points and PMP 450i SMs and between PMP 450i Access Points and PMP 450/450d SMs
  - Added 5.1 and 5.2 GHz bands for Mexico and 'Other'
  - Added 4.9, 5.1, 5.4 and 5.8 GHz bands for 'Other - ETSI'
  - Updated sensitivity levels for PMP/PTP 450i - note that this will change predicted performance levels from earlier versions
  - Extended the 3.6 GHz 'Other' regulatory band to 3500 - 3800 MHz
  - Added High Gain Integrated Antenna option for 3.x GHz bands
  - PMP 450i 900 MHz - Added 20 MHz bandwidth
- Updated Installation Reports to give separate sections for Installation and Commissioning
- Added a Full BOM sheet to the main BOM Export to Workbook
- Added LINKPlanner version number to both the BOM Export from the main project and the Estimator.
- Limit the precision of the range, height and obstruction values when exporting the profile to a CSV file so that it reflects the precision used inside LINKPlanner

Bug Fixes

- Fixed default cable losses on AP and SM antennas
- Fixed an error with Channel Plans for ePMP Force 180 and 200
- PTP 820 - changed the band edge channel selection to use the occupied bandwidth
- PTP 820G - correct the capacity license key for 60 MHz at 128 QAM from 300 to 500 Mbps
- PMP 450/450i - corrected error in throughput calculations for 10 MHz when the Maximum Range was either 25 or 34 miles.
- PTP 700 - updated the throughput calculation in line with product changes, resulting in slightly reduced throughput rates.
- Corrected upper frequency limits for ePMP 2.4 GHz and 5.9 GHz, changes centre frequency for PTP links, which impacts fade margin calculations and hence availability and throughput, especially for Force 180 and Force 200.
- Fix error when creating a PTP600 link with E1/T1
- Add the 250 kilometer ranging mode for PTP700
- Prevent errors creating a new PMP BOM Estimate after previously removing all of the estimates
- Prevent the mouse-wheel scroll event from propagating out of the offline map
- Corrected the AP Performance Summary table, which did not show the correct number of SMs on the DL end when the SMs used a different product
- Fix bug which prevents the license from being edited through the links table

Changes in version 4.3.5

New or changed features

- New Feature - Added PMP support to BOM Estimator Tool
- ePMP
  - Added Force 180 at 5 GHz and Force 200 at 2.4 GHz as SM and PTP options
  - Added ePTP option in DFS regions
- PMP 450i
  - Added 900 MHz Frequency Band at 5, 7 and 10 MHz bandwidths
- PTP 700
  - Added Lite capacity option
  - Increased maximum range to 250 km
- Remove the Google Earth view on 12 December 2015 when Google stop the service

Bug Fixes

- Fixed bug which was creating additional APs when opening a project with the Prediction Model set to Vigants-Barnett
- Fixed PMP 450i AP line cord options in the BOM optional extras.
- PMP 450 SM ACPSSW-xx power supplies are now obsolete, replaced by N000900L001
- Added 11 GHz Taper Transition back into the default BOM for PTP 800 ODU-A Long Waveguide
- Fixed error to restrict single payload modes to Highest Mod Mode on PTP 650 and PTP 700.
- Fixed subscriber BOM aggregation issue for items with no part number.
- Note - some PTP 650 ancillary part descriptions have changed to become more generic, where the products are now being used across multiple products.

Changes in version 4.3.4

Bug Fixes

- Fixed error with rule formatting for 1+1 and 2+0 links

Changes in version 4.3.3

New or changed features

- New Feature - Availability calculations for PMP Link Performance and ability to define Required Availability

- New Feature - PMP Link Formatting Rules
- PMP/PTP 450i
  - Updated BOM with additional parts and added more to Optional Extras
  - Added Industry Canada part numbers
  - Removed Preliminary from Brazil and Mexico for PTP 450i
- PTP 650
  - Removed Mid Capacity option (all Mid Capacity users can now upgrade for free to Full)
- PTP 700
  - Updated transmit powers and sensitivity values, this will show a degradation on predicted performance for most links from the previous version.
  - Added Industry Canada part numbers
  - Removed Preliminary from FCC countries for 4.5 and 4.9 GHz
- PTP 820
  - Updated 1+1 BOM for PTP 820C and PTP 820S to remove PoE and add Optical Fibre support
  - Added additional 3ft antennas to APAC and EMEA region
  - Added 60 MHz bandwidth to Lower 6 GHz FCC for 2+0 ACAP and ACCP
  - Added Warranty part numbers to Optional Extras
- Obsoleted PTP 250, 500 and PTP 600 products (except at 4.5 and 4.8 GHz)

Bug Fixes

- Fixed error when calculating cable lengths in the BOM, which was over-predicting the amount of cable required in some cases
- Differentiate between PMP azimuth and tilt angle error indication when bearing is out of range
- Add additional explanatory notes to BOM items for PTP-SYNC for PTP 650 and PTP 700 and PoE Injector for PTP 820C and updated other notes on the BOM
- Prevent the “Test profile service” from returning successful when username or password are incorrect

Changes in version 4.3.2

New or changed features

- New Feature - PMP Equipment Templates to define AP Equipment types
- New Feature - BOM Estimator Tool for PTP
- ePMP 1000
  - Added support for 4.9 GHz in PTP mode

  - Added 2.5 ms Frame Period
  - Added PMP 450 60 and 90 degree antennas as options to the AP
  - Modified sync options from CMM to CMM3 and CMM4
- PTP 820
  - Added PTP 820C 2+0 SD
  - Added 15 GHz Canadian Regulation
- PMP/PTP 450i
  - Added PMP 450 60 degree antenna to AP option list
  - Added Mexico in 4.9, 5.4 and 5.8 GHz
  - Updated regulations for 5.8 GHz for all PMP countries and 4.9 GHz and 5.8 GHz PTP in Brazil
- PMP 450
  - Extended Downlink Data range to 15 - 75% for North America region at 5.4 GHz
- Unlicensed Band
  - Added antenna patterns for all Cambium unlicensed external antennas to the Save Antenna Pattern feature
  - Added PTP 450i to FCC/IC Antenna Approval warning list and updated list for PTP 650 and 700
- Updated Installation Reports for PMP/PTP 450, PMP/PTP 450i and ePMP, including adding Frequency Carrier information

Bug Fixes

- Fixed bug that prevented Channel Plans from being edited
- Corrected part numbers for PMP/PTP 450i radios in Bill of Materials and updated brackets and optional extras
- Removed capability to define an AP antenna from Hub Level
- Corrected throughput for Lowest Ethernet mode when used in conjunction with TDM for PTP 600, 650 and 700
- Fixed issue with corruption of config file when there is no access to internet

Changes in version 4.3.1

New or changed features

- Change the power supply for PTP 820S. It now uses the same power supply and surge suppressor as PTP 650
- Add PMP/PTP 450i to the configuration file export

Bug Fixes

- Correct issues with the PTP 820 coupler losses

- Fix quantities and parts for PTP 820 mediation devices in the BOM
- Fix issues when editing the product or license across multiple links in different bands

Changes in version 4.3.0

New or changed features

- Added support for PMP/PTP 450i at 4.9, 5.4 and 5.8 GHz
- Added support for PTP 700 including 4.5 GHz band
- Added the Worst Earth Curvature, Ke and Excess Path Loss at Ke to the Climatic Factors section of the Proposal Report
- Added Malaysia to PMP 450 at 5.8 GHz

Bug Fixes

- Removed FCC antenna warning from PTP 250, 300, 500 and 600 products
- Limited PTP 820 14 MHz bandwidth to Profile 9 (removed 2048 QAM mode)
- Moved PTP 820 Outdoor Fiber Distribution Closure Splitter to Optional Extras from 1+1
- Prevent the “Access is Denied” error when saving a project file on Windows

Changes in version 4.2.8

New or changed features

- Added support for PTP 820 Release 8.0:
  - PTP 820G 1+1 Spatial Diversity (select 1+1 Hot Standby and then Spatial Diversity in Antenna Configuration)
  - PTP 820G - added 10 and 20 MHz bandwidths
  - PTP 820G - added 2048 QAM support for bandwidths above 14 MHz
  - PTP 820G - added XPIC support for 50 and 60 MHz
  - PTP 820C and PTP 820S ACM now supports adaptive transmit power
  - PTP 820C - added support for 7 and 14 MHz on 2+0, including XPIC and MC-ABC
  - PTP 820C and PTP 820S transmit power at 13 GHz, 256 QAM reduced from 22 to 20 dBm
- PTP 820C New Frequency bands:
  - Removed Preliminary from 26 and 38 GHz
  - Added 28 GHz ETSI
  - Added 11 GHz ETSI T/R 530 MHz
- PTP 820G New Frequency bands:

  - Added 26 GHz (ETSI and FCC), 28 GHz (ETSI), 32 GHz (ETSI) and 38 GHz (Canada, FCC and ETSI)
- PTP 820S New Frequency Bands:
  - Removed Preliminary from Upper 6 GHz and 15 GHz
  - Added 13 and 28 GHz ETSI
  - Added 11 GHz ETSI T/R 530 MHz
- Added 200 and 300 Mbps capacity keys for PTP 820G and PTP 820S and 300 Mbps for PTP 820C
- Added PTP 820 NMS parts under Optional Extras in the BOM
- Consolidated 11 GHz to use the T/R 490/500 parts, may result in a change of part number for PTP 820G when using T/R 530 MHz
- PTP 820 - 11 GHz, added Canadian compliance to Andrew 4ft antennas
- Added the *Worst Earth Curvature*, Ke and Excess Path Loss at Ke to Licensed Band Pop-up information window and PTP Links view
- Added new Project Property to define Sector Coverage, allows PMP 450 to be restricted to nominal beamwidth

Bug Fixes

- Fixed issue with PTP 650 Lowest Telecoms Mode not working
- Reinstated Force 110 antenna option for ePMP Subscriber Modules
- Corrected the coordinates displayed in the PMP reports
- Added capability to include user defined parabolic antennas which can be selected for the United States (Parabolic) regulations at 5 GHz
- Updated BOM parts list for PTP 820C and PTP 820S 1+1 configurations
- Convert obstruction heights to 0 if the user tries to import negative obstruction values using copy/paste

Changes in version 4.2.7

Bug Fixes

- Prevent error when deleting an Access Point in the project tree
- Fix save errors when the user name contains Unicode characters

Changes in version 4.2.6

New or changed features

- Added support for PMP 450d Subscriber Module at 5 GHz
- Added ability to define PMP channel plans, allocate channels to APs and color code the sectors in the Offline Map
- Improved the reflection editor for licensed band

- Added Proposal reports at PMP Network, Hub and AP levels
- Added additional notification to PTP 650 5.1 GHz FCC for Parabolic antennas
- Added capability to automatically create required custom fields for FCC 3.65 GHz Device Registration
- Added the capability to save antenna pattern files stored in LINKPlanner
  - currently only supports licensed band antennas.
- Added confirmation setting when converting linked sites
- Added 3, 4 and 6ft Radiowaves antennas at 6 GHz for PTP 820 in NA and CALA.
- Added bearing from boresight and indication of direction of tilt for Subscriber Modules

Bug Fixes

- Add 5 and 10 MHz to Ecuador for ePMP at 5.1 GHz
- Corrected missing MC-ABC option for PTP 820C Narrow at 80 MHz
- Corrected error on PTP 820C 38 GHz links when adding external interference
- Fixed error in embedded Google Maps when using the select pointer
- Added handling of read errors when requesting path profiles
- Disabled write caching when saving project files (e.g. to prevent errors when saving to USB drives).

Changes in version 4.2.5

New or changed features

- Added the ability to plan 80 MHz bandwidth links using PTP 820 narrow radios, this results in lower capacity than using the PTP 820 wide radios.
- Added PTP 820 sub-band prioritization to reduce the number of sub-bands for single frequency links.
  - This may change the sub-band for some links in existing projects, existing sub-bands are still valid
- Added the AP Lite parts to the Optional Extras for PMP 450
- Added a Summary table to the Access Point Installation Reports
- Added the capability to export the project level BOM to a single Excel Workbook with each PTP link on a separate sheet
- Added an export file with the FCC device registration information for PMP/PTP 450 3.65 GHz devices
- Added bearing to magnetic north and magnetic declination information to installation reports
- Offline Map enhancements

  - Pop-out overlapping sites in the offline-map to make them easier to select
  - Edit a hub from the AP pop-up menu
  - Hide/Show items in the map
  - New selection window to hide, show, copy, delete multiple items
- Added ability to control whether profile previews appear in the Google Earth Export
- Added a search bar to the main toolbar to make it easier to locate items in the tree
- Added “Show in map” menu item to the navigation tree pop-up
- Performance improvements when opening large PMP projects
  - Note: Projects will need to be saved in the new version first.
- Obsolete Gabriel antennas

Bug Fixes

- Added support for adjacent 30 MHz bandwidth channels in FCC Lower 6 GHz for PTP 820 (actual separation is 29.65 MHz)
- Made AP name unique when copying and pasting APs into the same project and allow reports to be created with duplicate AP names
- Updated frequency stability and wide bandwidth TtoI curves for PTP 800 and PTP 810 PathLoss equipment files
- Added support for Brazil power supply cords in the PTP 450 options

Changes in version 4.2.4

New or changed features

- Added additional map features to the context-sensitive map:
  - Create Hubs and APs from a Network Site
  - Attach subscribers to an Access Point
  - Edit items without leaving the map
- Automatically set the azimuth when creating a new Access Point

Bug Fixes

- Remove SM equipment choices from PMP 450 AP view
- Add 5.4 GHz US TDWR Radar warning in PMP mode
- Change ePMP Enhanced PTP mode to ePTP mode
- Fixes for KML/KMZ export
  - Remove hyperlinks
  - Update the Subscriber Site profile preview to only show links to unattached Access Points

Changes in version 4.2.3

New or changed features

- Support ePMP System Release 2.4
  - Add Enhanced PTP Mode
  - Add Maximum Mod Mode configuration for AP and SM
- Additional PTP 820 functionality
  - PTP 820C
    - Support for greater than 1 Gbps throughput on 2+0 link types
    - Preliminary support for 26 and 38 GHz ETSI and 38 GHz FCC & Canada
    - Increased 7 MHz bandwidth to 1024 QAM (Profile 9)
    - Increased 14 MHz bandwidth to 2048 QAM (Profile 10)
  - PTP 820G
    - 11 GHz ETSI
  - PTP 820S
    - 2+0 Co-Polar and 2+0 Cross-Polar capability
    - 7 (to 1024 QAM (Profile 9) and 14 MHz (to 2048 QAM Profile 10) bandwidth options
    - Preliminary support for 15 GHz ETSI
  - PTP 820C and PTP 820S
    - 80 MHz bandwidth at 11 GHz ETSI
    - 1m Protection Cable added to BOM for 1+1 link types
  - PTP 820C and PTP 820G
    - 56 MHz bandwidth at 13 GHz ETSI
  - PTP 820C, PTP 820G and PTP 820S
    - Removed antenna availability warning for 6 ft Global antennas
- Improved PMP Reports with new Installation reports at AP and Hub level
- Added sample external SM antenna options for PMP 450 to each frequency band

Bug Fixes

- Corrected display of PTP Link Custom Field in the PTP Links view
- Corrected issue when starting LINKPlanner without contact to the path profile server
- Corrected problem with applying Equipment templates which contain configured frequencies
- Updated country lists to correctly include 4.9 GHz for non-US FCC countries

- Corrected refresh issue in the BOM when changing PTP 800 capacity keys
- Apply the display style correctly when the project contains multiple formatting rules

Changes in version 4.2.2

New or changed features

- Support PMP/PTP 450 System Release 13.2 and 13.3
  - Add MIMO-A modulation modes to PMP 450
    - This updates sensitivity levels for all modulation modes
  - Add 7 MHz Bandwidths for PTP/PMP 450
  - Add ability to select Frame Period for PTP/PMP 450
  - Removed Canada Lower from 3.6 GHz (supported on 3.5 GHz units), renamed Canada Upper to Canada
  - Added an export capability to provide configuration files
- Support ePMP System Release 2.2 to 2.3.4
  - Add MIMO-A modulation modes
    - This updates sensitivity levels for all modulation modes
  - Added 5 and 10 MHz bandwidth options in PMP mode
  - Add SM Tx Power Manual Limits to reports as required
  - Updated regulatory information for multiple countries
- Support System Release PTP 650 01-40
  - Added 3:1 and 5:1 symmetry options
  - Updated regulations for Indonesia (5.8 GHz), India (5.8 GHz) and Brazil (4.9 GHz)
  - Added 45 MHz bandwidth option to 5.4 GHz ETSI countries
  - Added new regulatory options for FCC countries for links using Parabolic antennas
- Updates to Map Features
  - Clicking hyperlinks now takes users to the links part of the Navigation Tree
  - Allow users to display SM names on PMP map in the installation report
  - Updated graphics preferences to include PMP links
  - Map display at site level zooms to centre on selected site
- Added ability to remotely update data files
- Add a field to record the MAC Address for the ends of a link, AP or SM
- Display a warning when the number of SMs exceeds the SM Registration Limit

Bug Fixes

- Updated PathLoss import formats with respect to changes in PathLoss file formats
- Fixed MAC CHM link
- Fixed issue with preserving User Limits when switching between 2+0 Link Types
- Fixed error when reversing a link on 1+1 licensed band links
- Updated PTP 650 reports to exclude reduced installation receive level on short links
- Fixed error when trying to switch to TDD Sync enhanced mode
- Cancel profile requests when closing a project or deleting links
- Prevent duplicate profile requests when pasting links into a project

Changes in version 4.2.1

New or changed features

- Added support for ePMP 1000 in PTP mode
- Added high level Mean Predicted Throughput for ePMP 1000 AP
- Updated PTP 820 Part Descriptions
- Updated Optional Extras for PTP 450 and PTP 820
- Removed EIRP limit from PTP 450 Canada, FCC and Other-FCC at 5.8 GHz
  - For existing projects please check that the correct country option is selected.

Bug Fixes

- Fixed issue when creating SM custom antenna
- Fixed PTP 800 and PTP 810 Installation Report issues
- Prevent site coordinates from being changed on sites that have PMP links

Changes in version 4.2.0

New or changed features

- Added support for PTP 450
- Added high level Mean Predicted Throughput for PMP 450 AP
- Added Global SM Height value to the Project Properties
- Enabled option to select paper size when exporting a map as a PDF

Bug Fixes

- Changed PTP 820S Upper 6 GHz to Preliminary

- Modified PTP 820 80 MHz capacity key requirements and removed 1024 QAM option for 2+0 links with 80 MHz bandwidth
- Removed modulation modes above 512 QAM for 7 and 14 MHz for PTP 820C
- Removed 7 and 14 MHz options from 2+0 link types for PTP 820C
- Added warning about availability of Commscope 6ft antennas for PTP 820
- Added LPU to PTP 820G automatic Bill of Materials and additional Optional Extras
- Changed Edge-CET-Node licenses to a quantity of 2 rather than 4, for 820G 2+0 configurations
- Removed Canadian 310.5 compliance from Andrew 3ft 11 GHz for PTP 820
- Fixed Capacity and Throughput values in Aggregate Proposal Reports for 810 and 820
- Fixed rounding errors in 820G XPIC capacity calculations, minor change to reported values
- Removed “Other” option from Antenna selection list for PTP 820
- Increased 5.8 GHz upper frequency limit, this may make a minor change to fade margin and availability for some regulations.

Changes in version 4.1.2

New or changed features

- Added support for PTP 820G for 1+0, 1+1, 2+0 Cross-Polar, 2+0 Co-Polar and 2+0 XPIC in the following bands:
  - Lower 6, Upper 6, 7, 8, 11, 13, 15, 18 and 23 GHz
- Added support for 7 and 14 MHz for 820C for all Link Types except 2+0 XPIC

Bug Fixes

- Fixed issue with re-ordering, sorting and deleting columns in table views
- Fixed issue with renaming of 2+0 XPIC links
- Fix bug when double-clicking on a 2+0 XPIC link in the map
- Fixed display of E1/T1 in PTP 810 2+0 Aggregate Performance Details
- Fixed issue when creating equipment templates from an existing 1+1 link
- Fixed issue applying equipment template optional extras
- Fixed error when changing the sites on a 2+0 PTP link

Changes in version 4.1.1

New or changed features

- Added support for PTP 820C 2+0 configurations
- PTP 820 “Global” antenna now default option

Bug Fixes

- Corrected refresh issues on PTP 810 2+0 Aggregate page
- Prevented error when changing from licensed to unlicensed frequency bands when on a child link on PTP 820
- Removed 28 MHz BW from PTP 810 8 GHz 126 T/R spacing as no valid frequency pairs
- Reinstated ODU-B as default option for PTP 800/810
- Round TDD Frame Offset to nearest integer to match product data entry

Changes in version 4.1.0

New or changed features

- Support for PTP 820 1+0 and 1+1 link types in the following bands
  - PTP 820C at Lower 6, Upper 6, 7, 8, 11, 13, 15, 18 and 23 GHz
  - PTP 820S at Lower 6, Upper 6, 11, 18 and 23 GHz

Changes in version 4.0.3

New or changed features

- Added support for FCC, Other-FCC and Canada Lower and Upper in 3.6 GHz band for PMP 450
- Added support for Japan at 4.9 GHz and Slovenia at 5.8 GHz for PTP 650
- Added option to specify Required Modulation Mode on PMP links - links which don’t meet this will go red
- Added ability to import PMP Links from a csv file - see User Guide for format details
- Added additional information into Available Antenna lists to specify product and part numbers for SM additions.
- Added regulatory frequency ranges to PMP Links in the Installation Reports
- Added PMP Product Software Release version information to Installation Reports
- Updated displayed antenna description for Force 100 antennas for ePMP

Bug Fixes

- Fixed issue preventing Google Earth Export when project only contains PMP Links
- Fixed issue with “red line” on path profile not updating when AP Height changed
- Fixed issue with contents listing in HTMLHelp file
- Fixed issue on downlink with transmit power not backing off correctly in 256QAM and QPSK - SISO for PMP 450 at 3 GHz

- Fixed issue importing multiple Pathloss profiles.

Changes in version 4.0.2

New or changed features

- Added a Performance Summary for each Access Point, which collates the Maximum Modulation mode for all PMP Links
- Removed “Preliminary” from PTP 650 5.1 GHz for United States and other FCC countries
- Updated ePMP Force 100 part descriptions
- Improved PMP Links view to ensure header line stays visible
- Added improved functionality to PMP Links when exported to Google Earth

Bug Fixes

- Fixed an issue to ensure link formatting rules hide links in map view when requested
- Corrected ePMP SM Maximum Transmit Powers for 5.4 and 5.8 GHz
- Removed ePMP Mounting Bracket from integrated antennas or where provided
- Fixed an issue when creating installation reports with PTP 810i 1+1 and 2+0 links
- Prevented copy function creating duplicate Access Points
- Fixed issues when creating and saving custom SM antennas
- Removed extra dish antenna from BOM when selecting Force 100
- Added distance markers back in to PTP 1+1 and 2+0 link export to Google Earth

Changes in version 4.0.1

New or changed features

- Add the ability to save a project in the v3.x.x format
  - Any new features will be lost from the file
- Include the number of PMP links in the project summary information
- Add the option to create a new custom antenna from the Subscriber Module antenna selection list

Bug Fixes

- Fixed errors when double-clicking an item in the Offline Map
- Fixed errors when copying equipment templates and rules
- Fixed errors with the new PMP link dialog

- Fix a bug which prevented the creation of a custom antenna from the unlicensed band antenna list
- Fixed non-ASCII character problems
- Stop the Subscriber Modules from requiring recalculation when the Access Point changes do not impact the link (such as name, description)
- Refresh the PMP link performance summary when the Subscriber Module changes
- Fix errors when deleting PMP Objects

Changes in version 4.0.0

New or changed features

- Support for the PMP 450 product in 2.4 GHz, 3.5 GHz, 3.6 GHz, 5.4 GHz and 5.8 GHz bands
- Support for the ePMP product in 2.4 GHz, 5.1 GHz, 5.2 GHz, 5.3 GHz, 5.4 GHz and 5.8 GHz bands
- The Flags functionality in PTP has been removed and combined into the Custom Fields functionality. All existing Flag settings will now be available through Custom Fields.

Changes since version 3.0.0

Changes in version 3.6.6

New or changed features

- Support system release PTP 650 01-20
  - Add TDM Support including Network Indoor Unit (NIDU) provision in the BOM
  - Add PTP 650 MAB License and PTP 650 Group Access License to Optional Extras
  - Add Hungary (Rural) at 5.8 GHz
  - Add Guam, Puerto Rico, United States, US Virgin Islands at 5.1 GHz as Preliminary

Bug Fixes

- Correct the capacity and Precise Network Timing license entries in the BOM when using external antennas on PTP 650.

Changes in version 3.6.5

New or changed features

- Support system release PTP 650 01-10
  - Add PTP 650S through selection of Small Form Factor antenna (only available with Full capacity key)
  - Introduce TDD Sync for PTP 650 - introduced new TDD Sync Offset calculation option for all products
  - Add new RoW kit part numbers with US line cord option
  - Split 5.2 GHz into separate 5.1 and 5.2 GHz Frequency Bands
    - Note: this moves ETSI BBDR from 5.2 GHz band to 5.1 GHz band
  - Remove preliminary from 5, 15 and 30 MHz bandwidths
    - Note: slight adjustments to sensitivity figures across all bands and bandwidths may change availability
  - Change to Minimum Platform Transmit Power (from -11 dBm to -15 dBm)
  - Added Precise Network Timing option for license key for 1588 and Sync-E
    - Note: this license is added as default to PTP 650S
- Regulatory changes for PTP 650
  - Removed “Preliminary” from Argentina, Brazil, Chile, Oman, South Africa and Vietnam
  - Added Saudi Arabia (5.8 GHz), Brazil (4.9 GHz)
  - Removed “Preliminary” from Other at 5.1, 5.2 and 5.9 GHz and Other + Radar at 5.2 GHz

  - Added new countries to 5.1 and 5.2 GHz as “Preliminary”
  - Provided two regulatory options for Argentina (Private and Telecoms)
- Added new unlicensed Cambium antennas RDG4472, RDG4452, RDG4454
- Added new PTP 810 Series NMS AES License Key to Optional Extras - Security
- Removed the obsolete Summit X250, X350 and X440-L2-24t-AC switches
- Removed GPS Receiver as independent part - now only available as part of kit WB4141
- Replaced 6406066M02 with N000000L019 for use with the “All Indoor” ODU mounting

Bug Fixes

- Correct the data rate calculations for PTP 650 at 40 and 45 MHz bandwidths. This may increase or decrease the data rate seen in previous versions depending on the range of the link. Very short links are unaffected

Changes in version 3.6.4

New or changed features

- Regulatory changes for PTP 650
  - Removed “Preliminary” from Canada (4.9, 5.4 and 5.8 GHz) and United States (5.4 GHz)
  - Added United Arab Emirates (5.4 and 5.8 GHz)
  - Added 4.9 and 5.2 GHz for Other and 5.2 GHz for Other + Radar as “Preliminary”
  - Changed 5.9 GHz Other to “Preliminary”
- Added intermediate cable grounding kits for IRFU and long waveguide to the BOM for PTP 800 and PTP 810, for antenna heights greater than 23m

Bug Fixes

- Correct the PTP 810 1+1 Frequency Diversity BOM
  - Fix item quantities and some IRFU and antenna part numbers for IRFU configurations
- Corrected vertical scale issues in offline map
- Fixed copy/paste links issue which resulted in duplicate sites if using sub-band B4 or B5 ODUs in Lower 6 GHz band
- Fixed issue with saving flag parameters and interaction with link formatting
- Fixed issue when sizing the warning panel which resulted in an error message

Changes in version 3.6.3

New or changed features

- Added note to BOM to identify some Extreme Summit Switches which are obsolescent
- Changed “password” to “access token” in Web Profile registration to avoid confusion with Cambium Support web portal password
- Added intermediate cable grounding kits to the BOM for PTP 650, 800 and 810 for antenna heights greater than 23m.
- Removed “Preliminary” status for PTP 650 in Australia and New Zealand, added 5.4 GHz for New Zealand

Bug Fixes

- Changed default SKU for Canada from FCC/IC to RoW
- Restricted EIRP to 24 dBm at 45 MHz for 5.2 GHz in Regulatory Band 38 (FCC countries)
- Removed 2-port distribution manifold from default BOM when using the Dryline Dehydrator

Changes in version 3.6.2 (limited release)

New or changed features

- Update the warning when the selected antenna is not approved for FCC/IC to include 4.9 GHz and 5.2 GHz
- Round the data rate calculation for PTP650 Lite/Mid to the nearest Mbps
- Update the max EIRP values for Canada, United States and Hong Kong at 4.9 GHz
- Update the license availability for PTP650

Bug Fixes

- Maintain the Highest Modulation Mode when switching between Single/Dual Payload
- Display the correct project name after saving with a new filename
- Remove ODU RMK, Flex Waveguide Hangers and LPU End Kit from Long Waveguide default BOM
- Refresh the map after clicking the “Show the sites without links” button

Changes in version 3.5.5

New or changed features

- Support system release PTP 800-06-00
  - Remove Preliminary status for 60 MHz bandwidth at Lower 6 GHz and 80 MHz at 11 GHz for FCC regulation
  - Introduce sub-band B4 and B5 ODUs for Lower 6 GHz
    - Note: These overlap existing B1, B2 and B3 sub-bands, when opening old projects the BOM may update the selected ODUs

- Remove capability to request path profiles via email
- Apply Frequency Separation limits to common port T/R spacing on 2+0 and Frequency Diversity configurations using ODUs for both PTP 800 and PTP 810
  - Note: This change means that 2+0 and Frequency Diversity cannot be supported for all combinations of T/R spacing and frequency band
- Retire remaining PTP 400 product line
- Add additional Cambium part numbers for unlicensed antennas
- Obsolete Commscope Flat Panel Unlicensed antennas
- Add EWP52 and EWP63 waveguide types to unlicensed cable selection
- Updated IRFU extras for PTP 810

Bug Fixes

- Prevent automatic request of profile when pasting profile from another project, to maintain any previous edits
- Maintain map zoom level in Offline map when switching windows
- Prevent user-defined antenna reverting to integrated on bandwidth changes
- Allow multiple editing on Sites page
- Remove default ODU part numbers as standard, feature can be enabled from Options - Bill of Materials - Add default ODUs
- Update the font cache to prevent errors when the font name contains Unicode characters
- Disable path profile requests for very short links (< 10m)
- Fix the bug “Observable tries to pop from the EventCollection when the collection” raised by a number of users

Changes in version 3.6.1 (limited release)

New or changed features

- Reduce QPSK to 64QAM power levels by 1 dB for PTP 650
- Update the “Other” and “Other + Radar” license definitions
- Remove mounting bracket from the PTP650 BOM

Changes in version 3.6.0 (limited release)

New or changed features

- Support for the PTP 650 unlicensed product in 4.9 GHz, 5.2 GHz, 5.4 GHz, 5.8 GHz and 5.9 GHz bands

Bug Fixes

- Include path profile obstructions when duplicating a link

- Fix a problem with the font cache which can occur when the font name contains Unicode characters

Changes in version 3.5.4

New or changed features

- Introduced Preliminary support for 60 MHz bandwidth at Lower 6 GHz and 80 MHz at 11 GHz for FCC regulation.
- New 5.4 and 5.8 GHz licenses for Vietnam for PTP 600
- New 5.8 GHz license for Indonesia for PTP 600
- Add Uncoupled IRFU Transceivers to optional extras
- Add end warranties and new UC-APL parts to optional extras for PTP 600
- Automatically add coaxial cable hoisting grips to BOM
- Changed link order in reports to reflect displayed link order in LINKPlanner
- Added capability to allow link formatting rules to identify LOS, nLOS and NLOS links

Bug Fixes

- Apply Equipment Templates when using “Create links from this hub”
- Prevent splash screen from staying on top during start-up
- Fixed PTP 810 refresh errors when changing product or link types
- Fixed issue with link formatting rules on PTP 810 2+0 links
- Updated HP/SP nomination of 6 and 11 GHz antennas
- Limited TDD Sync burst duration options for PTP 500 to those available in product
- Correctly handle Unicode characters when displaying the pop-up availability report
- Prevent errors when calculating the terrain roughness and all of the terrain heights are set to the same value

Changes in version 3.5.3

New or changed features

- Updates to the embedded Google views:
  - Option to display the site labels
  - Option to preview the path profiles for existing links and between nearby sites
- Add support for Indonesia at 5.8 GHz for PTP 500

Bug Fixes

- Fix a bug with the automatic path profile requests when the user name or company name contain non-ASCII characters
- Fix error when editing BOM quantities
- Minor updates to part descriptions and optional extras

Changes in version 3.5.2

New or changed features

- Add support for STM-1 in PTP 810 by including a new TDM configuration panel for STM-1 and E1/T1
  - Existing PTP 810 links, TDM and MMU Model settings may no longer be valid and will be reset to default values with a user warning
- Add support for Enhanced Standard Master I/O module and additional modules to support STM-1 for PTP 810
- Introduced 3 variants of the GigE model to show different capabilities of the 3 FPGA options
  - Existing projects will default to GigE “J” where available, with a user warning
- Add support for 15 GHz NTIA band for PTP 800 including new ODUs
- Add end warranties to PTP 250 and PTP 500
- Reduce the restrictions on IRFU antenna selections
- Add Upper 6 GHz 4ft Cat B2 dual polar antenna option
- Add default lengths (10m or 30ft) to elliptical waveguide lengths for:
  - Distance to shack
  - Distance inside shack
- New 5.4 and 5.8 GHz licenses for Vietnam for PTP 250 and PTP 500
- New 5.4 GHz licenses for PTP 250
  - Serbia and Mexico
- New Summit Extreme switches available for all products as Optional Extras in the Bill of Materials

Bug Fixes

- Reduced maximum receiver power for PTP 300 and PTP 500 from -45 dBm to -51 dBm. This increases the minimum range at which links which don?t have Radar enabled can be supported
- PTP810 optional extras moved from “Accessories” to either “Power” or “Cable, Accessories & Spares” sections, as for other products
- Stopped screen scrolling when adding extras to the BOM
- Fix a bug with the link formatting rules which appears if the user deletes a link whilst the rules are being processed

- Fix bug with the Google Map view which prevented the information balloon from appearing when selecting a link or site

Changes in version 3.5.1

New or changed features

- Include default project templates for the Vigants-Barnett/ITU-R prediction model settings

Bug Fixes

- Correctly display links that cross 180 degrees longitude in the maps
- Fix encoding error when displaying the sales contacts
- Fix bug with the installation report when a table wraps over 3 pages
- Correct error with the prediction model settings for protected links
- Fix bugs that occur when applying equipment templates to protected links, particularly when the template is for a different link type
- Prevent error when copying an antenna without a part number
- Fix bug with 1+1 Hot Standby links where the interference value would be set incorrectly when loading an existing file

Changes in version 3.5.0

New or changed features

- Introduction of web path profile service
  - Profiles entered straight into LINKPlanner project - no more emails
  - Option to automatically request profiles when a new link is created
- Display the appropriate Cambium contact information for links and projects
- Introduction of PTP 810 1+1 Frequency Diversity
  - Not allowed in FCC regions
- Support for different MMU Modems for PTP 810 at each end of link
- Support for Brazil regulation at 18 GHz for PTP 810
- Support for APC for 2+0 XPIC (allows 2+0 XPIC to be used at 18 GHz in ETSI region)
- Introduction of licensed band Hi/Lo site nomination - with default ODU part numbers put into BOM
  - This feature restricts frequency selection at an end to be compliant with site designation
- Enhanced Equipment Templates to include Performance Summary parameters
- Modified setting of Prediction Model to make it project based and not user based

  - Check model setting when first opening existing projects after upgrading
  - Prediction Model setting is stored in project templates
- Removed preliminary status from PTP 250 countries
  - Add Switzerland and Liechtenstein to 5.4 GHz band
- Add ability to create a ring of links on the offline map view

Bug Fixes

- Fixed screen refresh problem on Windows Vista and Windows 7 when using the Classic Theme
- Rounding down of PTP 810 GigE capacity figures for values below 100 Mbps
- Limited Diversity Improvement Factor to 200 in calculations as well as reports
- Removed 7 GHz FCC 25 MHz IRFU 2+0 XPIC option

Changes in version 3.4.0

New or changed features

- Introduce support for IRFU to PTP 810, including 2+0 Cross-Polar and 2+0 XPIC
- Add support for alternate T/R spacings on ODU's for PTP 810
- Add support for Super PDH Master I/O Module for PTP 810
- Add 21 x E1/T1 Expansion Module to optional extras for PTP 810 BOM
- Add support for NTIA with PTP 810 at 7 and 8 GHz
- Introduce capability to adjust frequency step size for IRFU to allow smaller rasters
- Expanded antenna selection for FCC at 6 and 18 GHz to include Cat B2 in line with FCC-12-87 rule change
- Add Cambium part numbers for unlicensed antennas

Bug Fixes

- Update of unlicensed antennas, resulting in:
  - A change of frequency specification for some antennas, which may no longer be available at 5.4 or 5.9 GHz
  - A slight change in antenna gain, the majority increasing by ~0.25 dB, which may result in a slight change in predicted availability and data rate
  - Links which included antennas that are no longer valid will be reset to the default antenna with a user warning
- Fix error which prevented feeder losses being applied from equipment templates to new links
- Ensure that changes to availability requirements for 1+0 are preserved if Link Type is changed

- Update “Missing Information” message when entering Personal Information, so that it is clear what must be included before the Options/Preferences can be saved

Changes in version 3.3.3

Bug Fixes

- Fix error which prevents the warning from being displayed when importing an incorrect file type
- Correct export links to spreadsheet so that it includes the primary link and both paths for PTP810 2+0 links
- Fix bug with the “paste sites” functionality which caused an error when pasting CSV data

Changes in version 3.3.2

New or changed features

- Add the lowest ethernet mode to PTP600 products
- New functionality to import links from CSV file
- Include the 30 MHz bandwidth for 4.5 GHz NTIA
- It is now possible to edit multiple antenna height values in the Links page
- Rename FCC (Extended) to FCC (Rural) and update the warning message to reflect the new FCC regulations
- Change 6 GHz “Cat B” licenses to “Cat B1” to reflect the new FCC regulations
- PTP250 has preliminary support for additional licenses in the 5.8 GHz band
  - Finland, Greece, Iceland, Liechtenstein, Portugal, Serbia, Switzerland
- PTP600 ATEX/HAZLOC supports additional licenses in the 5.8 GHz band
  - Finland, Greece, and Portugal

Bug Fixes

- Correct the reported installation receive power during alignment for protected links
- Update the max EIRP values:
  - 5.8 GHz - Bahrain, Bahrain, China, Denmark, Denmark, ETSI, Finland, Germany, Greece, Iceland, Ireland, Liechtenstein, Portugal, Serbia, Singapore, Spain, Switzerland, UK
  - 5.4 GHz - South Korea
- Fix bug to ensure that the correct flexible waveguide options are available for IRFU links
- Display the availability tooltip over the E1/T1 controls in the link loss summary panel

- Fix bug where transmit frequency does not reset correctly when switching band (1+1 links)
- Fix bug which caused an error when removing a user-defined antenna

Changes in version 3.3.1

Bug Fixes

- APC option must be disabled when the Link Type is 2+0 XPIC
- 2+0 XPIC is not available at 18 GHz/ETSI

Changes in version 3.3.0

New or changed features

- Add E1/T1 support to PTP810
- Incorporated ETSI Minimum Rated Transmit Power
  - Increases minimum transmit power level by 5 dB for ETSI regions, for short links enable ATPC
- Introduce ATPC/APC selection, which increases maximum transmit power setting on short links to optimize fade margin
  - Receive power levels at installation increased to a maximum of -20 dBm, operational receive levels keep the same upper limits
- New 5.8 GHz licenses for PTP500/PTP600
  - Finland, Greece, Iceland, Liechtenstein, Portugal, Serbia, Switzerland
- Added support for equipment templates
  - Multiple equipment templates can be defined to control the configuration of new links
  - Equipment templates can now include BOM optional extras
  - Replaces the default settings for new links
- Create links by pasting data from a spreadsheet
- MOL export no longer supported
- Removed Summit switches from optional extras

Bug Fixes

- Fix the links to help file on OSX
- Fixed a problem which limited the available PTP810 modulation modes
- Project templates now load correctly
- If an error occurs when exporting a map to a PDF, LINKPlanner no longer tries to open the file
- Select the correct flex twist hanger in the BOM for 11 GHz

- Updated 11 GHz Dual Pol with OMK antennas to include FCC Cat B (2ft) and Canada 310.7B (4ft)

Changes in version 3.2.2

New or changed features

- Introduce PTP 810 2+0 with link aggregation, including 2+0 XPIC
- Introduce PTP 810 Capacity Keys
- Add automatic MMU selection to BOM for PTP 810
- Additional optional extras
- New unlicensed antennas
- New Encryption option in the equipment settings for PTP 250
- PTP 250 now uses the Cambium part numbers
- Rename PTP 800 Maximum Tx Capacity Limit to “400 Mbps”

Bug Fixes

- Fix bug which prevented the project from being exported to Google Earth if a formatting rule excluded any of the links from the export
- Correct PTP 300/500 Capacity License Key descriptions

Changes in version 3.2.1

New or changed features

- Change the antenna manufacturer to Cambium Networks
- Update 1ft and OMK antennas part numbers
- Remove preliminary status from PTP11800i with IRFU-HP
- Updated parts list for PTP 810

Bug Fixes

- Update the BNC Voltage algorithm in line with the PTP 800 User Guide

Changes in version 3.2.0

New or changed features

- Introduce Preliminary PTP 810 planning capability for 1+0 and 1+1
- Support System Release PTP 500-05-00 including consolidation of PTP 300 with PTP 500
- Remove Preliminary Status from PTP 800 Spatial Diversity
- Remove Preliminary Status from 6 GHz IRFU
- Update 11 GHz 4ft antennas to support Canadian regulatory compliance

- Introduce the capability to display sales and support contact information in LINKPlanner
- Introduce the capability to display news information in the welcome page
- Updated Licensed Band Switch part numbers

Bug Fixes

- Corrected FCC 7 GHz 25MHz bandwidth emission designator
- Fix bug in VB availability calculations for links with negative fade margins
- Fix project tree refresh bug in OSX
- Correct PTP28800 minimum power output at 16QAM and 32QAM.
- Correct PTP28800 noise figure
- Trap the exception that can occur if an empty project is opened
- Trap the exceptions that can occur when starting the Google Earth icon server

Changes in version 3.1.2

New or changed features

- Updated PTP 250 FCC/IC Products to Cambium part numbers, added reference to Cambium part numbers for ETSI/RoW products
- Updated PTP 800 Long Waveguide parts to Cambium part numbers
- Updated PTP 800 installation reports
- Added antenna polarity to site installation section of licensed band reports
- Added 11 GHz 2 ft antennas to FCC regulation with Cat B compliance

Bug Fixes

- Fixed a bug in IRFU Spatial Diversity to ensure that Secondary uses the same Maximum Power and EIRP as the Primary as they share the same antenna system, only affected Non-LOS paths to diverse antenna.
- Fixed a bug in 1+0 licensed band installation reports which prevented all the antenna information being provided
- Fixed a bug in link formatting rules when testing against negative reference levels
- Fixed error that occurred when the cursor moved over a hyperlink whilst creating a link in the interactive map
- Removed Motorola from Part Number header in BOM spreadsheets

Changes in version 3.1.1

Bug Fixes

- Fix bug which prevents a project from being saved if the username contains non-ASCII characters

- Correct switch descriptions

Changes in version 3.1.0

New or changed features

- Introduce Preliminary Spatial Diversity capability for licensed
- Removed Preliminary Status from PTP 250 5.4 GHz licenses:
  - Canada
  - Guam
  - Puerto Rico
  - United States
  - US Virgin Islands
- Added optional capability for users to define a watermark for path profile images
- Included FCC 99.95% minimum payload requirement to link error status
- FCC License Coordination report now reports Cambium Antenna part number, receive end signal level and fade margin
- Added Switch selection option as an Extras tab for licensed products in the BOM

Bug Fixes

- Paste sites wasn't importing tower heights correctly in all cases
- Ensure link error status updates automatically when prediction model is switched between ITU and Vigants - Barnett
- Ensure default equipment settings are used for new links when generated through the link icon on the map
- Fixed a bug in the 1+1 Redundant Antenna BOM creation which wasn't generating correct feeder components for remote mount antennas.
- Fixed unpredictable behaviour when displaying a site or panning the view.

Changes in version 3.0.0.rc2

Bug Fixes

- Paste sites from Google Earth has been fixed
- The map "PDF Export" functionality works when the project has not been saved
- Fixed the export error that occurred if the link name contained a '.'
- Select the correct file extension when saving in OSX
- Remove the embedded web browser that displays the Google Map on OSX

  - This is a temporary measure until there is a suitable fix for a critical bug that causes LINKPlanner to crash on OSX
- Flexible waveguide selections for long waveguide links are now stored correctly in the project file

Changes in version 3.0.0

New or changed features

- Cambium rebranding
  - All reports now carry the Cambium Networks branding
  - New default installation location
  - Previous LINKPlanner preferences are duplicated
  - It is possible to run v3.0.0 and v2.7.0 at the same time
- Introduction of Vigants - Barnett Prediction Model
- Removed Preliminary Status from 2+0 Cross-Polar Common Dual Polar Direct Mount Antenna
- New interactive map and embedded Google Maps/Google Earth
  - Interactive map features:
    - Movable labels
    - Create links from hub (right-click on site)
    - Customisable colours and styles for links and sites
    - Export to full-page PDF
  - Embedded Google Map/Google Earth features:
    - Google Maps work on Microsoft Windows and OSX
    - Google Earth is only available on Microsoft Windows
    - Create and edit sites and links in Google Maps
- Copy and paste link path profiles
  - View and edit path profiles in a spreadsheet
- Multiple editing of links in the Links panel
  - Edit attributes for one or more links at once
- Link formatting rules
  - Create custom rules to control the visualisation properties of links
  - Use rules to control which links are included in the map, reports or in project export data
- Copy and paste links, sites and link formatting rules
  - Smart merge for when existing sites or links are similar to the data that is being pasted

  - Quickly duplicate links in the Links panel
- Project summary when you hover your mouse over the project name in the tree
  - Displays the number of sites and links in the project
- Display the reason for failure of a link in the map and on mouse-over the link in the tree
- Added detailed Feeder Loss fields to Links View

Bug Fixes

- Corrected 11 GHz Flex Waveguide Loss value for IRFU

  250 licenses:

  - Canada at 5.4 GHz (preliminary)
  - Guam at 5.4 GHz (preliminary)
  - Puerto Rico at 5.4 GHz (preliminary)
  - United States at 5.4 GHz (preliminary)
  - U.S. Virgin Islands at 5.4 GHz (preliminary)
  - Uganda at 5.8 GHz
- Minor changes to the PTP250 installation report
- Add ability for users to save a project as a .ptptemplate file
  - Templates can contain custom antenna information
- Add FCC Availability at Minimum Payload Capacity
- Update the available modulation modes for the FCC/adaptive in line with FCC regulation changes
- Changes to the BOM
  - Icons used to signify additional user input is required or that an item is an optional extra
  - Notes field can be edited
- New PTP 800 4ft antenna part numbers available for all regions. Previous part numbers are now obsolete.
- New antennas available at 6 and 11 GHz for Canada

Bug Fixes

- Distance ticks did not appear when displaying for 1+1 links in Google Earth
- Use the tropospheric fade margin when calculating the Annual 1-way Availability in the detailed Availability window
- Fixed a bug in the fade margin calculation for ODU-B products which was double counting the power offset in higher modulation modes, resulting in a degraded fade margin for modulation modes above lowest mode.

Changes in version 2.6.2

New or changed features

- The path profile service has been updated to use the following data sources:
  - SRTM v2.1
  - ASTER
  - GeoBase
- Add warning to link BOM panel reminding users not to order ODUs until the license has been granted
- New optional extras for PTP 600 UC-APL

Bug Fixes

- Add BNC Target Voltage to PTP 300/500 installation reports
- Correct emission designator for FCC 80 MHz bandwidth

Changes in version 2.6.1

Bug Fixes

- Update the part numbers for the 28 GHz ODU Coupler Mounting Kits
- Fix a bug that caused an error when generating a project level report if any of the links had a long waveguide

Changes in version 2.6.0

New or changed features

- Support system release PTP800-04-00:
  - 2+0 support
  - Added NTIA regulation to 7 and 8 GHz
  - ETSI 32 GHz is no longer preliminary
  - Added ETSI 28 GHz
  - Added support for ODU-B at 11, 18 and 23 GHz
  - Introduce new part numbers for 1ft and 4ft antennas for PTP 800 in EMEA region only (available through the grayed out selection area)
- Introduce User Defined Loss field for remote antennas for PTP 800
- Introduce Long Waveguide planning option for PTP 800 at 6 and 11 GHz
- Introduce FCC (Extended) regulation to support all modulation modes for PTP 800
- Introduce additional detailed availability information for PTP 800
- PTP 800 Link Summary Performance parameter Link Availability / Lowest Mode Availability now reports 2-way Availability plus Rain

- Added additional capacity information to Performance Charts when using Adaptive Symmetry (including PTP 250)
- Added Predicted Link Loss field to PTP 800 installation reports
- Updated regulatory information for Argentina, Ecuador, Lichtenstein, Norway, Peru and Venezuela for PTP 250
- Added Export function for Performance Chart data
- Changed project navigation tree for 1+1 to support a link node and four separate paths
- Improved icons in project navigation tree to distinguish different types of links

Bug Fixes

- Updated Installation report to provide maximum value for Max EIRP rather than left end value
- Fix a bug that prevented certain KML files from being imported
- Restrict existing FCC regulation to meet FCC modulation mode capacity limits for PTP 800

Changes in version 2.5.2

New or changed features

- Added spreadsheet export function to TDD Sync window
- Added antenna beamwidth to PTP 800 installation reports
- Added clarification to receive power for unlicensed band in the installation report to show it equates to transmit power during alignment
- Use neutral colours for the performance charts

Bug Fixes

- Added coupler losses for Hot Standby into Common Loss field in FCC License Coordination report
- Removed obsolete tag from 2 ft antennas at 32 GHz
- Include 3 ft antennas for 15 GHz Mexico regulation
- Remove 3 ft antennas for 11 GHz Canada regulation
- TDD Sync warning no longer appears when the settings are valid

Changes in version 2.5.1

New or changed features

- Updated regulatory information for China, India, Indonesia, Mauritius and South Korea for PTP 250
- Remove Preliminary status from PTP 800 Upper 6 GHz FCC regulation
- Incorporate Canada regulation into PTP 800 38 GHz

- Automatically include radome for 6 GHz 10 and 12 foot antennas in BOM and incorporate radome loss into performance calculations
- Add information note when first activating TDD-Sync to link to settings page
- Include additional installation items in BOM extras

Changes in version 2.5.0

New or changed features

- Support for the PTP 250 unlicensed product in 5.4 GHz and 5.8 GHz bands
- Display Predicted Receive Power in Performance Summary section
- Change order of Product and Regulation selection in Equipment panel
- Change Path Length calculations from spheroid to ellipsoid

  Note: This results in slight changes to the path length (<0.5%) and may result in small changes to the Predicted Availability

- Added capability to export BOM to a spreadsheet at link level
- Added capability to order the default licenses for each band in Options/Preferences
- PTP 800 Installation Reports updated to include Hi/Lo ends

Bug Fixes

- Change Maximum Receive Power limit to -35 dBm for PTP 800
- Updated “Max User IP Throughput in either Direction” on Installation Reports to show maximum rather than one end.

Changes in version 2.4.1

New or changed features

- Support 322MHz T/R spacing at 15GHz for ETSI regulations
- Display data rates and availabilities in tooltips on performance charts
- Include performance charts in reports
- Add Full Power regions for OOBM variants of PTP600

Bug Fixes

- Fix part numbers for Upper 6GHz ODUs for FCC regulations
- Fix 2 bugs that prevented certain KML files from being imported
- Ensure that the main window doesn’t appear off-screen on startup
- Fix a bug that could cause the power limit warning to be displayed at the wrong time.

Changes in version 2.4.0

New or changed features

- 1+1 Hot Standby support for PTP800
- ATEX/HAZLOC support for PTP600
- Import profiles from Pathloss
- Facility for modifying quantities and adding accessories to the Bill of Materials for a link
- Clearer warnings when a link is planned at 5.4GHz near a TDWR radar location. The warnings are also included in reports.
- Include PTP800 power supply (for converting 110/230V to 48V) by default in the Bill of Materials

  ---

  Note: You must select a region on the Options/Bill of Materials page in order to get the correct part number for the power cable.

- Support for FCC at Upper 6GHz, and increase the number of modulation modes available for FCC and Industry Canada at Lower 6GHz and 11GHz
- “Notes” column in the Bill of Materials that displays information about certain items (such as whether they are obsolete)

Bug Fixes

- Fix bug during report generation when using 60MHz channel separation in ETSI Upper 6GHz
- Don’t allow 2ft antennas at 11GHz in FCC regulations
- Warn when trying to open a profile as a project, and vice-versa
- Fix a bug in the profile chart when reversing a link

Please note that the contact address for link planner questions is now linkplanner.ptp@cambiumnetworks.com

Changes in version 2.3.10

Bug Fixes

Version 2.3.10 fixes 2 issues that were introduced in version 2.3.9

- Fix 3 antenna part numbers
- Fix an issue with using PTP 59600 in the 5.8GHz India regulation (region 19)

Changes in version 2.3.9

New or changed features

- Introduce new 2 ft and 3 ft antennas for PTP 800, and retire older 2 ft and 2.5f t antennas.
- Introduce new part numbers for PTP 300/500/600 in USA and Canada

- ETSI Upper 6 GHz is no longer preliminary

Bug Fixes

- Prevent the link panel from getting unnecessarily wide on Mac OS X

Changes in version 2.3.8

New or changed features

- Add Mexico as a supported region at 5.8 GHz and 5.4 GHz, using the Out Of Band Management variant of PTP 600

Changes in version 2.3.7

New or changed features

- Support system release PTP 500-04-00:
  - TDD Sync using PTP-SYNC
  - New region code for Spain at 5.8 GHz
- Support system release PTP 800-02-04:
  - 60 MHz channel separation in ETSI Upper 6 GHz
  - FCC 26 GHz is no longer preliminary
  - New 8 GHz channel pair at 311.32 MHz T/R spacing
- Include PTP 800 links using adaptive modulation in FCC Coordination output
- Include the FCC database of TDWR (weather radar) stations. A warning will be displayed for links operating at 5.4 GHz within 35 km of a TDWR station; steps must be taken by operators to ensure that they do not interfere with these radars.
- Include charts of throughput against availability in the Performance Details

Bug Fixes

- PTP 800:
  - 32QAM for 32 GHz at 7, 14 and 56 MHz bandwidths
  - 7 and 14 MHz bandwidths for Upper 6 GHz
  - Reduce power for 32QAM in Upper 6 GHz and 32 GHz
  - Restore bandwidths which were removed in version 2.3.5

Changes in version 2.3.6

Bug Fixes

- Fix a bug which caused antenna gain on some links using PTP 300/400/500/600 with integrated antennas to be calculated incorrectly (possibly as much as 5 dB low at each end)

Changes in version 2.3.5

New or changed features

- Support system release PTP 800-02-02
  - Add regulation definition for Mexico at 15 GHz with 315 MHz and 644 MHz T/R spacings
  - 8 GHz FCC and 8 GHz ETSI are now officially supported regulations (they are no longer preliminary)

Bug Fixes

- 38 GHz ETSI QPSK max power increased by 1 dB
- 38 GHz/700 MHz (FCC) max power and sensitivity each reduced by 1 dB
- PTP 800 Bandwidths are now restricted based on T/R spacing, some previously available combinations were actually not supported and have now been removed
- All PTP 800 T/R spacings other than 252.04 MHz and 311.32 MHz must use frequencies that are multiples of 250 kHz. This was not always enforced in previous releases
- Removed the ability to select PTP 800 transmit frequencies that are not separated by the selected T/R spacing.

Changes in version 2.3.4

New or changed features

- Add regulation definition for Spain at 5.8 GHz, which will be supported by PTP 58600 in the upcoming 09-01 system release
- Enable 256QAM and 64QAM0.92 in 5MHz channels on PTP 48600 and PTP 49600

Changes in version 2.3.3

Bug Fixes

- Fix a bug that prevented creation of custom antennas introduced in version 2.3.2

Changes in version 2.3.2

New or changed features

- Support for PTP 800 system release 02-01
- ETSI region for 15 GHz and 13 GHz is no longer considered preliminary
- Added Single/Dual payload control for PTP 600

Bug Fixes

- Do not display Spatial Diversity in reports for PTP 800

- Display a consistent antenna gain in reports even when no transmit frequency has been selected.

Changes in version 2.3.1

Bug Fixes

- Fix a bug that could cause PTP-600 not to display any dual-payload modulation modes

Changes in version 2.3.0

New or changed features

- Add support for Adaptive Modulation for PTP 800
- Allow multiple links between the same pair of sites

Bug Fixes

- Include Link BOM rather than Project BOM in installation report
- Adjust tolerance of timing errors for PTP-SYNC
- Updated part number for 7/8 GHz waveguides
- Fix coordinates in FCC Coordination output file

Changes in version 2.2.0

New or changed features

- Add support for PTP 800 in the following bands and licenses:
  - 38 GHz: FCC, ETSI
  - 32 GHz: ETSI
  - 26 GHz: FCC
  - 18 GHz: Brazil
  - 15 GHz: ETSI
  - 13 GHz: ETSI
  - 8 GHz: ETSI
  - 7 GHz: ETSI
  - Upper 6 GHz: ETSI
  - Lower 6 GHz: FCC, Canada, ETSI

  Some of these are marked as preliminary and will not be supported by PTP 800 until a later date.
- Add PTP-SYNC as an alternative TDD Synchronization mechanism for PTP 600
- Add submenus in column chooser
- Fix problems with non-ASCII characters in report filenames

- Fix issue with rain calculation in very dry parts of the world (e.g. Egypt or Antarctica)

Changes in version 2.1.0

New or changed features

- Support for the PTP 800 product range in ETSI at 11 GHz
- Fixed an error with the BoM for PTP 600 with E1/T1 selected
- Changed from Chmox to iChm as the recommended help reader for Macintosh
- Added the ability to reverse a link
- Removed the distance markers from links except for the selected link

Changes in version 2.0.0

New or changed features

- Support for the PTP 800 product range in licensed bands.
- Calculate the effects of rain and atmospheric absorption (ITU-R P.530 and supporting standards).
- Display a Bill of Materials for a link and also for a project as a whole.

Glossary

ACAP Adjacent Channel Alternate Polarization

ACCP Adjacent Channel Co-Polarization

AGL Above Ground Level

AMSL Above Mean Sea Level

AP Access Point

ASTER Advanced Spaceborne Thermal Emission and Reflection Radiometer

ATDI Advanced Topographic Development & Images Ltd.

BOM Bill of Materials

BPSK Binary Phase Shift Keying

CCDP Co-Channel Dual Polarized

CD Compact Disc

CSV Comma Separated Variables

DFS Dynamic Frequency Selection

DL Downlink

EIRP Equivalent Isotropic Radiated Power

ETSI European Telecommunications Standards Institute

FCC Federal Communications Commission

FEC Forward Error Correction

IRFU Indoor Radio Frequency Unit

ITU International Telecommunications Union

KML Keyhole Markup Language

LoS Line-of-Sight

MCS Modulation Coding Scheme

MHSB Monitored Hot Standby

MIMO Multiple-Input Multiple-Output

MMU Modular Modem Unit

NLoS non-Line-of-Sight

ODU Outdoor Unit

OMT Orthogonal Mount Transducer

PMP Point-To-Multi-Point

PTP Point-To-Point

QAM Quadrature Amplitude Modulation

QPSK Quadrature Phase Shift Keying

RFU Radio Frequency Unit

SD Spatial Diversity

SM Subscriber Module

SRTM Shuttle Radar Topography Mission

TDD Time Division Duplex

TDM Time Division Multiplexing

UL Uplink

VSWR Voltage Standing Wave Ratio

XPIC Cross-Polar Interference Cancellation

Credits

Additional icons provided by Yusuke Kamiyamane
[http://p.yusukekamiyamane.com/].

Symbols

A

B

C

D

E

F

G

H

I

K

L

M

S

T

U

V

W

X

Project MACHACHI RADIO ENLACES

PTP LINKPlanner Proposal Report

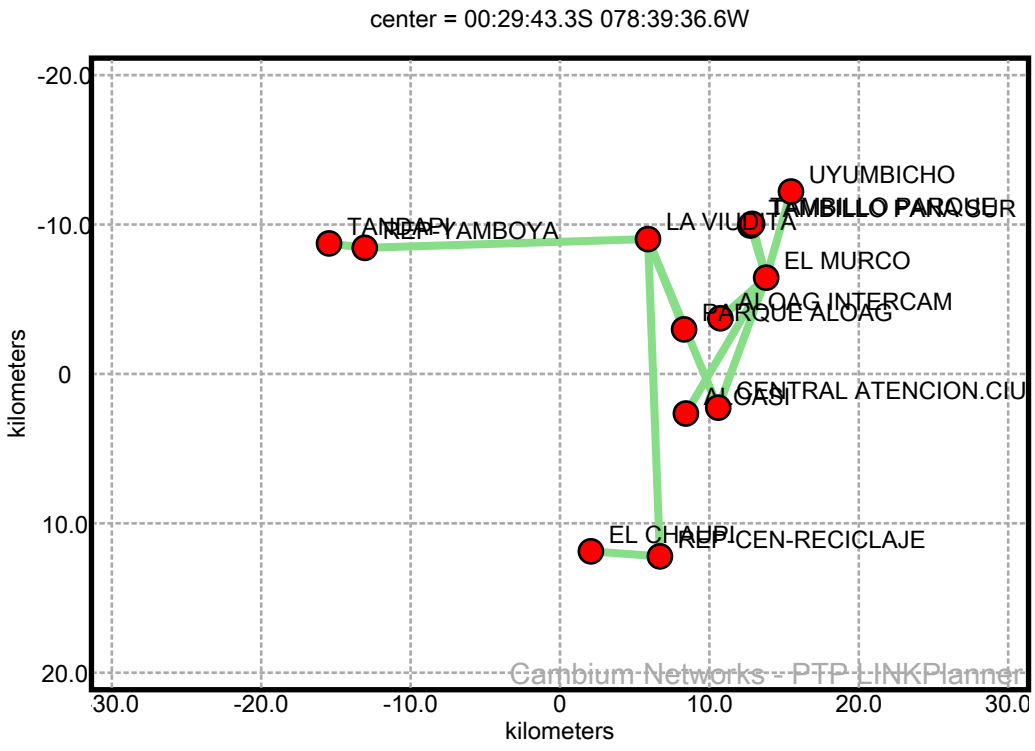
26 Nov 2014

FRANCISCO JURADO

Organisation: COMUNICACIONES GP

Phone: 0986038450

Email: fjurado@comunicaciones-gp.com



Cambium Networks

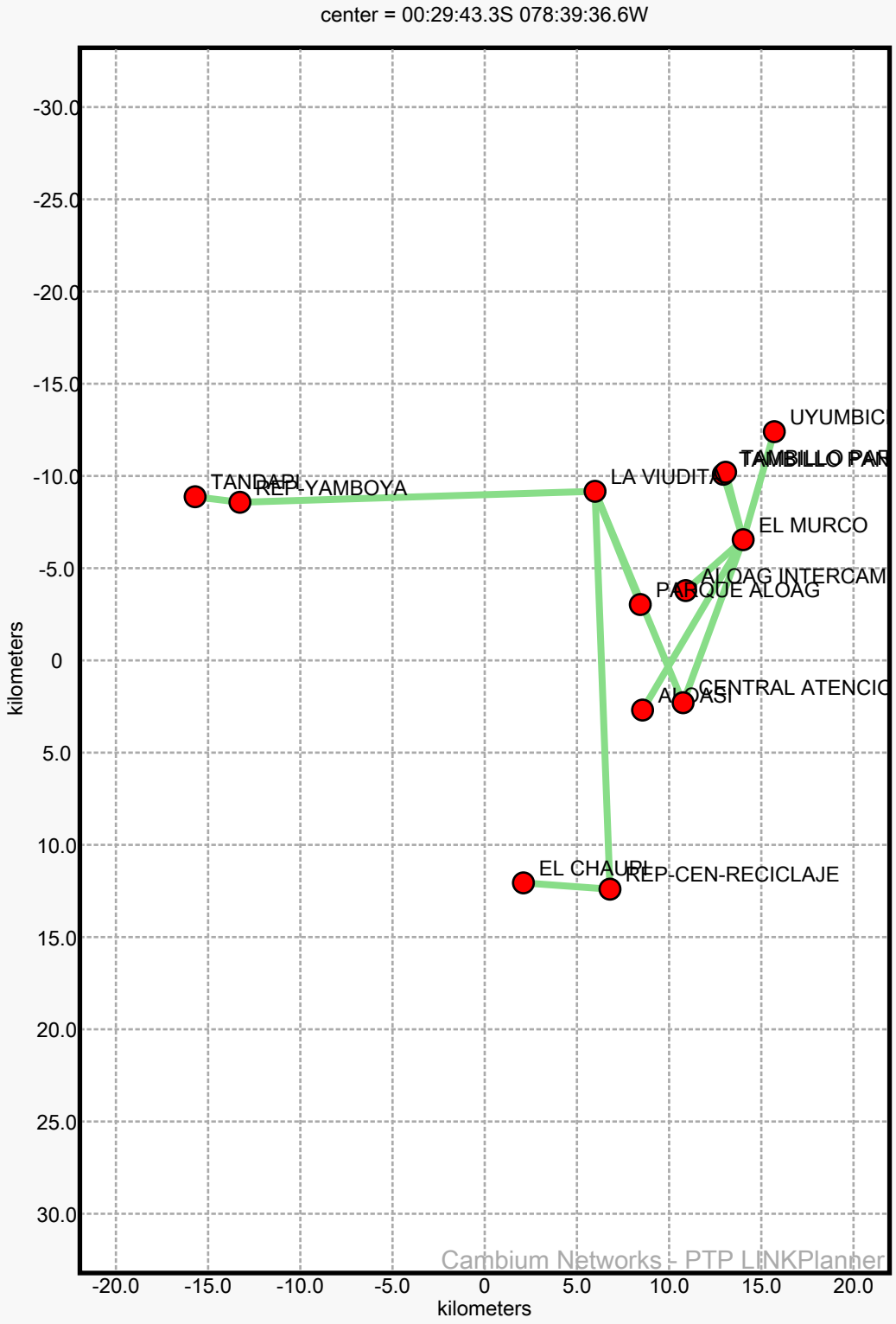
Table of Contents

1. Project Summary

Project: MACHACHI RADIO ENLACES

General Information	
Customer Name	
Company Name	
Address	
Phone	
Cell Phone	
Email	

Network Map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UYUMBIC
TAMBILLO PAR
LA VIUDITA
TANDAPI
REP-YAMBOYA
EL MURCO
ALOAG INTERCAM
PARQUE ALOAG
CENTRAL ATENCIO
ALOASI
EL CHAUPI
REP-CEN-RECICLAJE
-30.0
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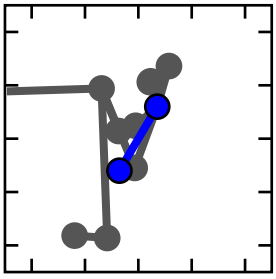
-15.0
-10.0
-5.0
0
5.0
10.0
15.0
20.0
kilometers
Cambium Networks - PTP LINKPlanner

Link name	Product	Local antenna	Remote antenna	Max aggregate IP throughput (Mbps)
ALOASI to EL MURCO	PTP58600	Motorola Integrated Dual Polar Antenna	Motorola Integrated Dual Polar Antenna	160.19
CENTRAL ATENCION.CIU to EL MURCO	PTP58600	Motorola Integrated Dual Polar Antenna	Motorola Integrated Dual Polar Antenna	177.59
EL CHAUPI to REP-CEN-RECICLAJE	PTP58600	Motorola Integrated Dual Polar Antenna	Motorola Integrated Dual Polar Antenna	244.89
EL MURCO to ALOAG INTERCAM	PTP58600	Motorola Integrated Dual Polar Antenna	Motorola Integrated Dual Polar Antenna	250.10
EL MURCO to TAMBILLO PANA SUR	PTP58600	Motorola Integrated Dual Polar Antenna	Motorola Integrated Dual Polar Antenna	257.64
EL MURCO to TAMBILLO PARQUE	PTP58600	Motorola Integrated Dual Polar Antenna	Motorola Integrated Dual Polar Antenna	256.27
EL MURCO to UYUMBICHO	PTP58600	Motorola Integrated Dual Polar Antenna	Motorola Integrated Dual Polar Antenna	214.84
LA VIUDITA to CENTRAL ATENCION.CIU	PTP58600	Motorola Integrated Dual Polar Antenna	Motorola Integrated Dual Polar Antenna	144.49
LA VIUDITA to REP-YAMBOYA	PTP58600	Motorola Integrated Dual Polar Antenna	Motorola Integrated Dual Polar Antenna	35.81
PARQUE ALOAG to LA VIUDITA	PTP58600	Motorola Integrated Dual Polar Antenna	Motorola Integrated Dual Polar Antenna	207.30
REP-CEN-RECICLAJE to LA VIUDITA	PTP58600	Motorola Integrated Dual Polar Antenna	Motorola Integrated Dual Polar Antenna	74.18
REP-YAMBOYA to TANDAPI	PTP58600	Motorola Integrated Dual Polar Antenna	Motorola Integrated Dual Polar Antenna	297.06

Part Number	Qty	Description
BP5830BH-2	12	PTP 58600 Full Integrated (ETSI/RoW) - Link Complete
WB2907	24	LPU End Kit PTP 600 (2 kits required per Link)
WB3176	12	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP)

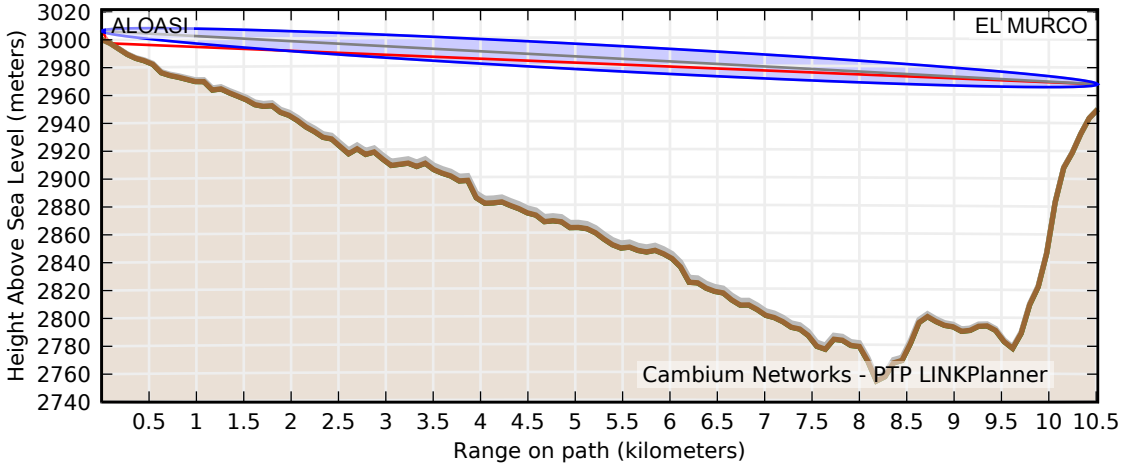
ALOASI to EL MURCO



Equipment: Motorola PTP58600 Integrated

Motorola Integrated Dual Polar Antenna @ 6 m

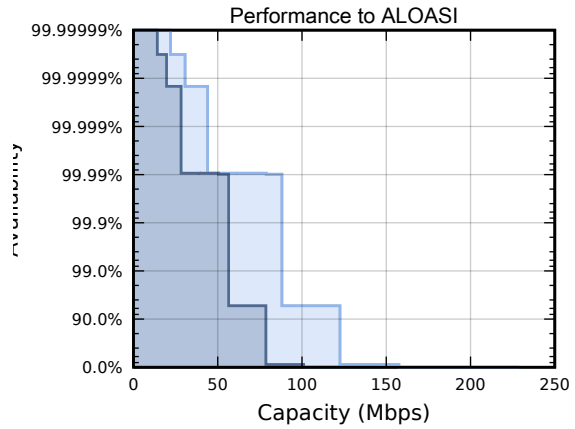
Motorola Integrated Dual Polar Antenna @ 18 m

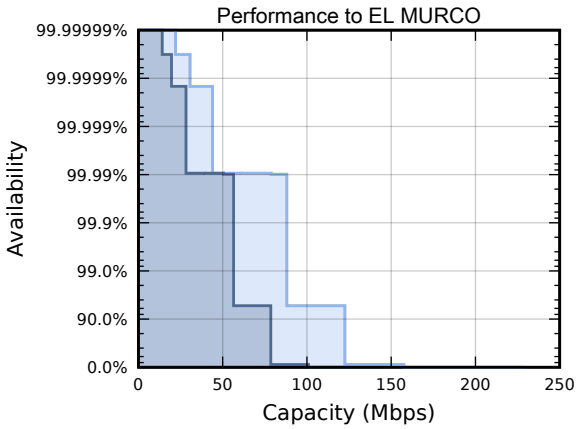


	Performance to ALOASI	Performance to EL MURCO
Mean IP	80.1 Mbps	80.1 Mbps
IP Availability	100.00000 % for 1.0 Mbps	100.00000 % for 1.0 Mbps

Link Summary			
Link Length	10.517 km	System Gain	147.33 dB
Band	5.8 GHz	System Gain Margin	19.15 dB
Regulation	Australia, Hong Kong	Mean Aggregate Data Rate	160.2 Mbps
Modulation	Adaptive	Annual Link Availability	100.00000 %
Bandwidth	30 MHz	Annual Link Unavailability	0 secs/year
Total Path Loss	128.19 dB	Prediction Model	ITU-R

Performance Charts





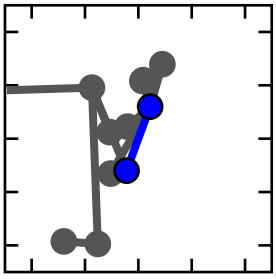
High Capacity, assumes there is no load in the other direction

Symmetrical Capacity, assumes a saturated load in the other direction

Climatic Factors, Losses and Standards			
dN/dH not exceeded for 1% of time	-142.61 N units/km	Link Type	Line-of-Sight
Area roughness 110x110km	958.02 metre	Excess Path Loss	0.00 dB
Geoclimatic factor	1.89e-005	Atmospheric Gasses	ITU-R P.676-7, ITU-R P.835-4
Fade Occurrence Factor (P0)	3.65e-007	Diffraction Loss	ITU-R P.526-10
Path inclination	3.63 mr	Propagation	ITU-R P.530-12
0.01% Rain rate	61.13 mm/hr	Rain Rate	ITU-R P.837-5
Free Space Path Loss	128.14 dB	Refractivity Index	ITU-R P.453-9
Gaseous Absorption Loss	0.05 dB		

Part Number	Qty	Description
BP5830BH-2	1	PTP 58600 Full Integrated (ETSI/RoW) - Link Complete
WB2907	2	LPU End Kit PTP 600 (2 kits required per Link)
WB3176	1	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP)

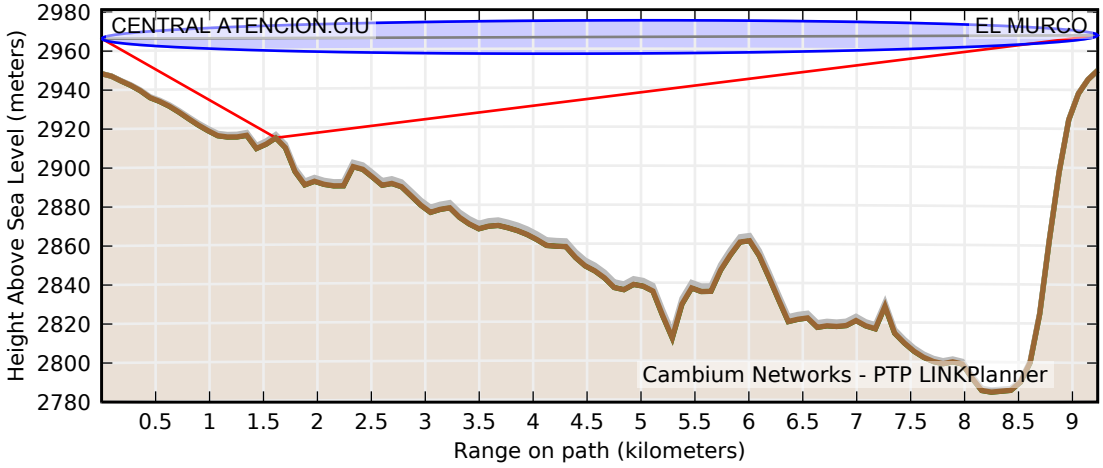
CENTRAL ATENCION.CIU to EL MURCO



Equipment: Motorola PTP58600 Integrated

Motorola Integrated Dual Polar Antenna @ 18 m

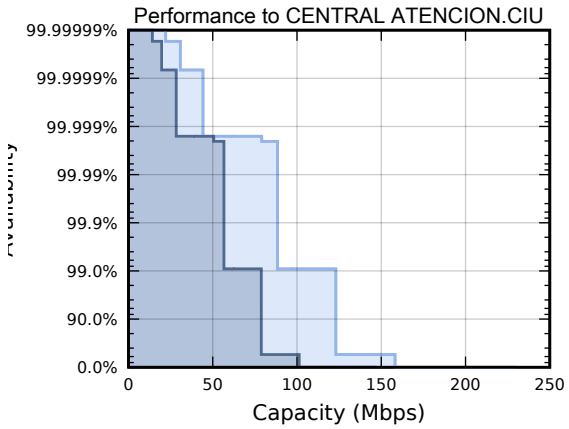
Motorola Integrated Dual Polar Antenna @ 18 m

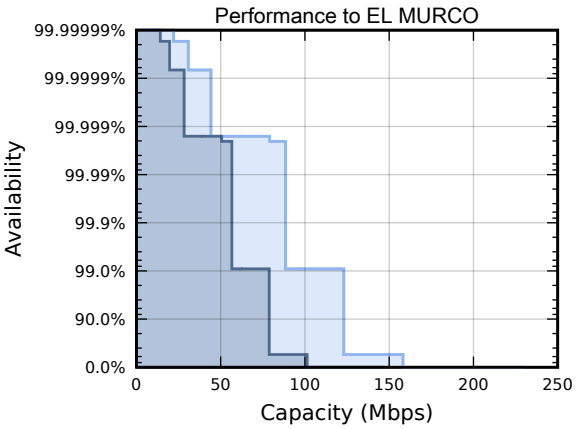


	Performance to CENTRAL ATENCION.CIU	Performance to EL MURCO
Mean IP	88.8 Mbps	88.8 Mbps
IP Availability	100.00000 % for 1.0 Mbps	100.00000 % for 1.0 Mbps

Link Summary			
Link Length	9.235 km	System Gain	147.33 dB
Band	5.8 GHz	System Gain Margin	20.28 dB
Regulation	Australia, Hong Kong	Mean Aggregate Data Rate	177.6 Mbps
Modulation	Adaptive	Annual Link Availability	100.00000 %
Bandwidth	30 MHz	Annual Link Unavailability	0 secs/year
Total Path Loss	127.05 dB	Prediction Model	ITU-R

Performance Charts





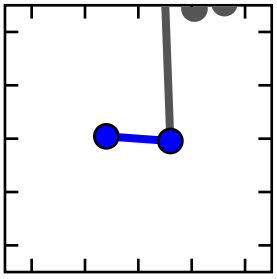
High Capacity, assumes there is no load in the other direction

Symmetrical Capacity, assumes a saturated load in the other direction

Climatic Factors, Losses and Standards			
dN/dH not exceeded for 1% of time	-142.81 N units/km	Link Type	Line-of-Sight
Area roughness 110x110km	946.22 metre	Excess Path Loss	0.00 dB
Geoclimatic factor	1.90e-005	Atmospheric Gasses	ITU-R P.676-7, ITU-R P.835-4
Fade Occurrence Factor (P0)	9.13e-007	Diffraction Loss	ITU-R P.526-10
Path inclination	0.18 mr	Propagation	ITU-R P.530-12
0.01% Rain rate	61.34 mm/hr	Rain Rate	ITU-R P.837-5
Free Space Path Loss	127.01 dB	Refractivity Index	ITU-R P.453-9
Gaseous Absorption Loss	0.05 dB		

Part Number	Qty	Description
BP5830BH-2	1	PTP 58600 Full Integrated (ETSI/RoW) - Link Complete
WB2907	2	LPU End Kit PTP 600 (2 kits required per Link)
WB3176	1	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP)

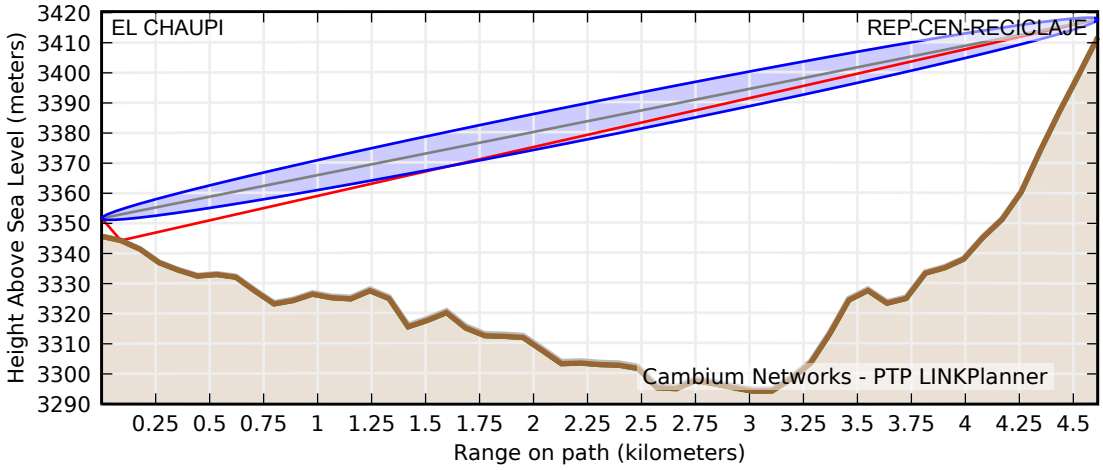
EL CHAUPI to REP-CEN-RECICLAJE



Equipment: Motorola PTP58600 Integrated

Motorola Integrated Dual Polar Antenna @ 6 m

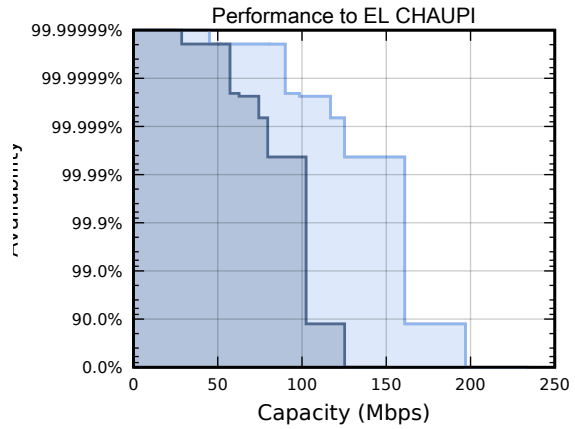
Motorola Integrated Dual Polar Antenna @ 6 m

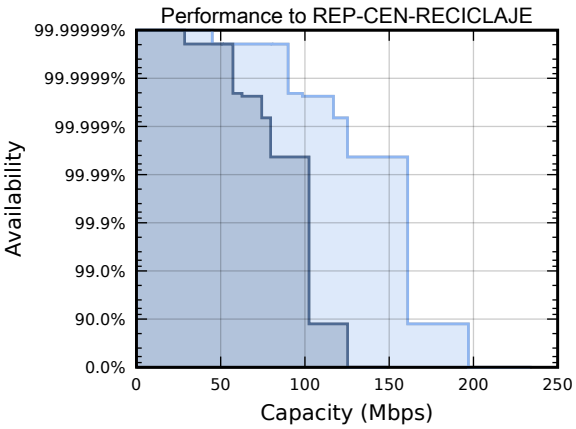


	Performance to EL CHAUPI	Performance to REP-CEN-RECICLAJE
Mean IP	122.4 Mbps	122.4 Mbps
IP Availability	100.00000 % for 1.0 Mbps	100.00000 % for 1.0 Mbps

Link Summary			
Link Length	4.613 km	System Gain	147.33 dB
Band	5.8 GHz	System Gain Margin	26.34 dB
Regulation	Australia, Hong Kong	Mean Aggregate Data Rate	244.9 Mbps
Modulation	Adaptive	Annual Link Availability	100.00000 %
Bandwidth	30 MHz	Annual Link Unavailability	0 secs/year
Total Path Loss	121.00 dB	Prediction Model	ITU-R

Performance Charts





High Capacity, assumes there is no load in the other direction

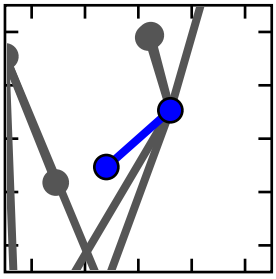
Symmetrical Capacity, assumes a saturated load in the other direction

Climatic Factors, Losses and Standards

dN/dH not exceeded for 1% of time	-140.45 N units/km	Link Type	Line-of-Sight
Area roughness 110x110km	1003.07 metre	Excess Path Loss	0.00 dB
Geoclimatic factor	1.82e-005	Atmospheric Gasses	ITU-R P.676-7, ITU-R P.835-4
Fade Occurrence Factor (P0)	3.73e-009	Diffraction Loss	ITU-R P.526-10
Path inclination	14.33 mr	Propagation	ITU-R P.530-12
0.01% Rain rate	59.61 mm/hr	Rain Rate	ITU-R P.837-5
Free Space Path Loss	120.98 dB	Refractivity Index	ITU-R P.453-9
Gaseous Absorption Loss	0.02 dB		

Part Number	Qty	Description
BP5830BH-2	1	PTP 58600 Full Integrated (ETSI/RoW) - Link Complete
WB2907	2	LPU End Kit PTP 600 (2 kits required per Link)
WB3176	1	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP)

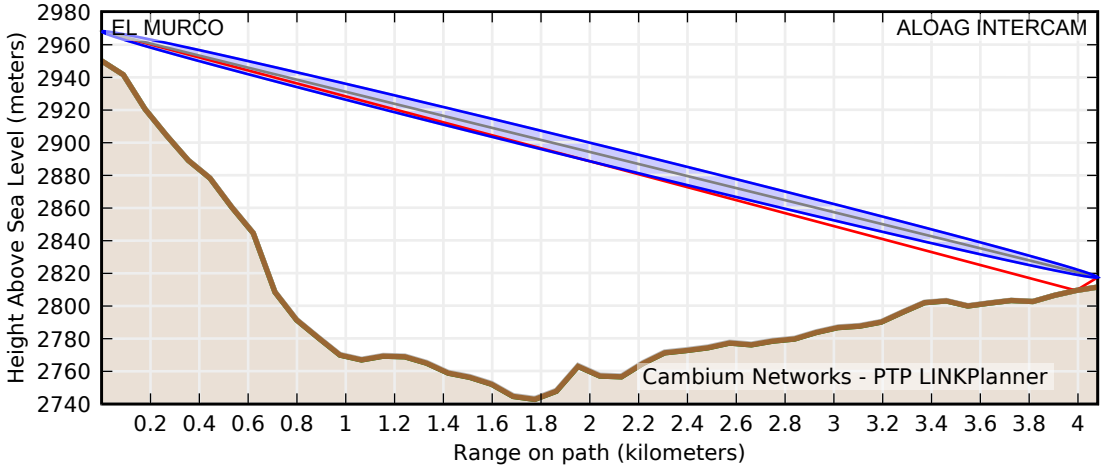
EL MURCO to ALOAG INTERCAM



Equipment: Motorola PTP58600 Integrated

Motorola Integrated Dual Polar Antenna @ 18 m

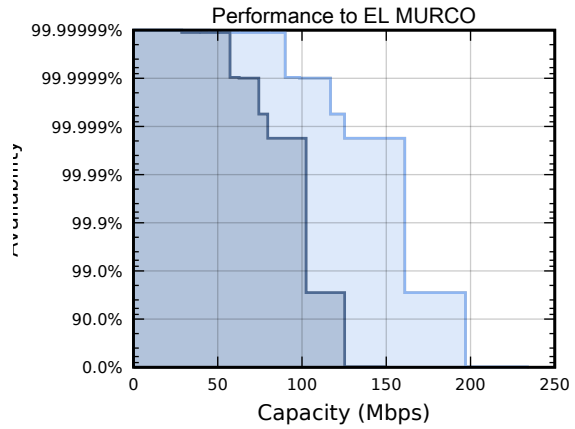
Motorola Integrated Dual Polar Antenna @ 6 m

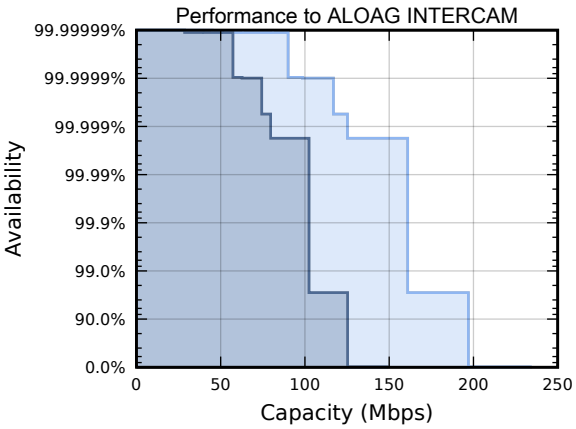


	Performance to EL MURCO	Performance to ALOAG INTERCAM
Mean IP	125.0 Mbps	125.0 Mbps
IP Availability	100.00000 % for 1.0 Mbps	100.00000 % for 1.0 Mbps

Link Summary			
Link Length	4.081 km	System Gain	147.33 dB
Band	5.8 GHz	System Gain Margin	27.40 dB
Regulation	Australia, Hong Kong	Mean Aggregate Data Rate	250.1 Mbps
Modulation	Adaptive	Annual Link Availability	100.00000 %
Bandwidth	30 MHz	Annual Link Unavailability	0 secs/year
Total Path Loss	119.93 dB	Prediction Model	ITU-R

Performance Charts





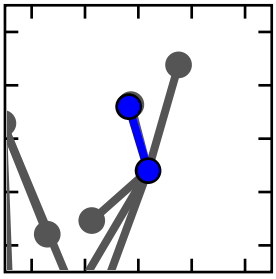
High Capacity, assumes there is no load in the other direction

Symmetrical Capacity, assumes a saturated load in the other direction

Climatic Factors, Losses and Standards			
dN/dH not exceeded for 1% of time	-143.05 N units/km	Link Type	Line-of-Sight
Area roughness 110x110km	956.19 metre	Excess Path Loss	0.00 dB
Geoclimatic factor	1.89e-005	Atmospheric Gasses	ITU-R P.676-7, ITU-R P.835-4
Fade Occurrence Factor (P0)	3.10e-009	Diffraction Loss	ITU-R P.526-10
Path inclination	36.88 mr	Propagation	ITU-R P.530-12
0.01% Rain rate	61.38 mm/hr	Rain Rate	ITU-R P.837-5
Free Space Path Loss	119.91 dB	Refractivity Index	ITU-R P.453-9
Gaseous Absorption Loss	0.02 dB		

Part Number	Qty	Description
BP5830BH-2	1	PTP 58600 Full Integrated (ETSI/RoW) - Link Complete
WB2907	2	LPU End Kit PTP 600 (2 kits required per Link)
WB3176	1	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP)

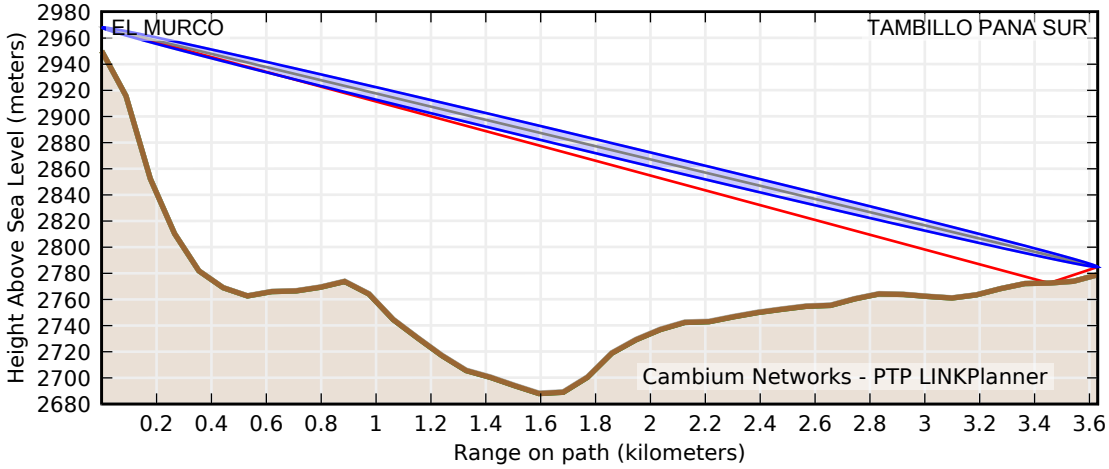
EL MURCO to TAMBILLO PANA SUR



Equipment: Motorola PTP58600 Integrated

Motorola Integrated Dual Polar Antenna @ 18 m

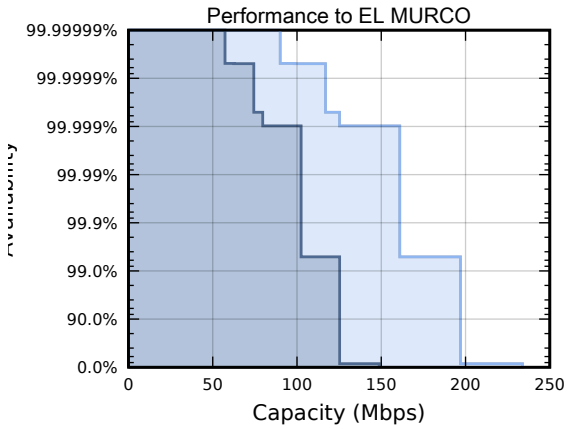
Motorola Integrated Dual Polar Antenna @ 6 m

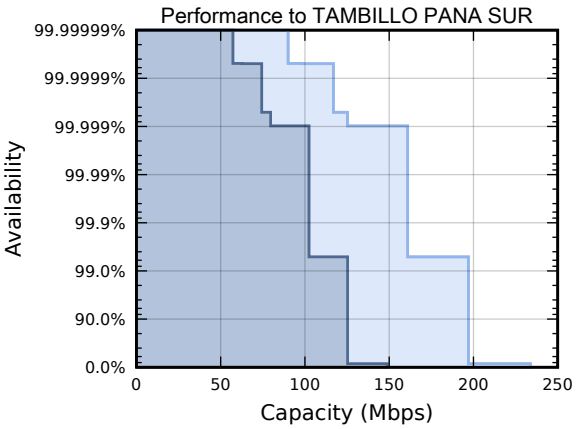


	Performance to EL MURCO	Performance to TAMBILLO PANA SUR
Mean IP	128.8 Mbps	128.8 Mbps
IP Availability	100.00000 % for 1.0 Mbps	100.00000 % for 1.0 Mbps

Link Summary			
Link Length	3.630 km	System Gain	147.33 dB
Band	5.8 GHz	System Gain Margin	28.42 dB
Regulation	Australia, Hong Kong	Mean Aggregate Data Rate	257.6 Mbps
Modulation	Adaptive	Annual Link Availability	100.00000 %
Bandwidth	30 MHz	Annual Link Unavailability	0 secs/year
Total Path Loss	118.91 dB	Prediction Model	ITU-R

Performance Charts





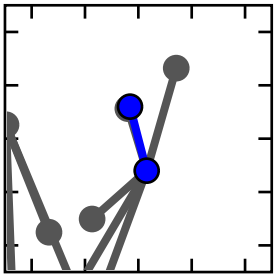
High Capacity, assumes there is no load in the other direction

Symmetrical Capacity, assumes a saturated load in the other direction

Climatic Factors, Losses and Standards			
dN/dH not exceeded for 1% of time	-143.47 N units/km	Link Type	Line-of-Sight
Area roughness 110x110km	957.09 metre	Excess Path Loss	0.00 dB
Geoclimatic factor	1.90e-005	Atmospheric Gasses	ITU-R P.676-7, ITU-R P.835-4
Fade Occurrence Factor (P0)	1.69e-009	Diffraction Loss	ITU-R P.526-10
Path inclination	50.46 mr	Propagation	ITU-R P.530-12
0.01% Rain rate	61.60 mm/hr	Rain Rate	ITU-R P.837-5
Free Space Path Loss	118.90 dB	Refractivity Index	ITU-R P.453-9
Gaseous Absorption Loss	0.02 dB		

Part Number	Qty	Description
BP5830BH-2	1	PTP 58600 Full Integrated (ETSI/RoW) - Link Complete
WB2907	2	LPU End Kit PTP 600 (2 kits required per Link)
WB3176	1	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP)

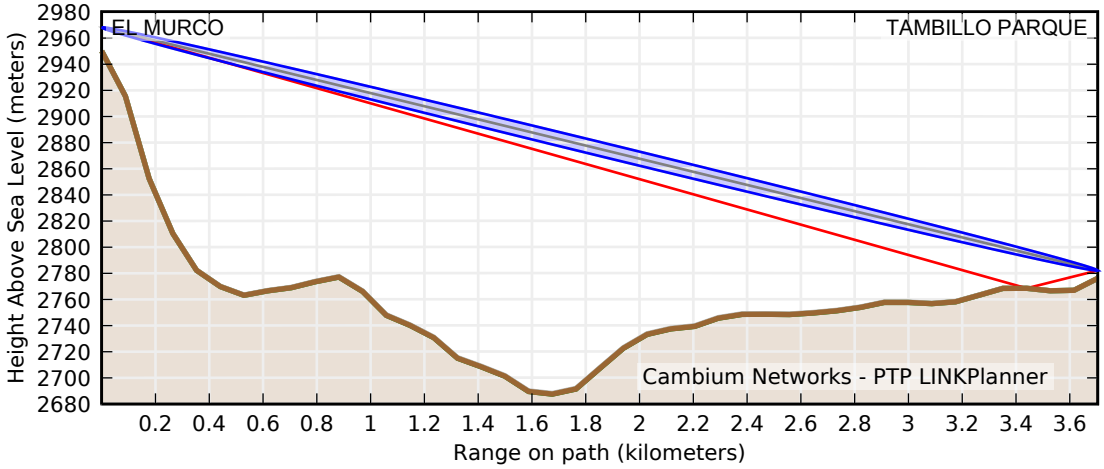
EL MURCO to TAMBILLO PARQUE



Equipment: Motorola PTP58600 Integrated

Motorola Integrated Dual Polar Antenna @ 18 m

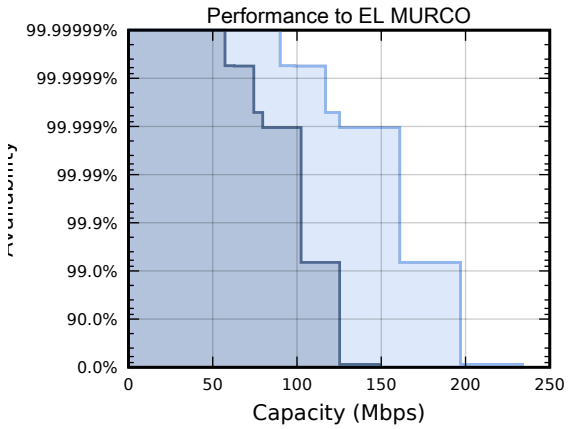
Motorola Integrated Dual Polar Antenna @ 6 m

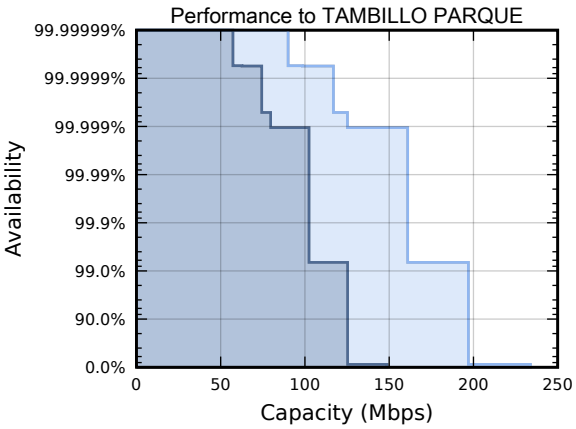


	Performance to EL MURCO	Performance to TAMBILLO PARQUE
Mean IP	128.1 Mbps	128.1 Mbps
IP Availability	100.00000 % for 1.0 Mbps	100.00000 % for 1.0 Mbps

Link Summary			
Link Length	3.704 km	System Gain	147.33 dB
Band	5.8 GHz	System Gain Margin	28.24 dB
Regulation	Australia, Hong Kong	Mean Aggregate Data Rate	256.3 Mbps
Modulation	Adaptive	Annual Link Availability	100.00000 %
Bandwidth	30 MHz	Annual Link Unavailability	0 secs/year
Total Path Loss	119.09 dB	Prediction Model	ITU-R

Performance Charts





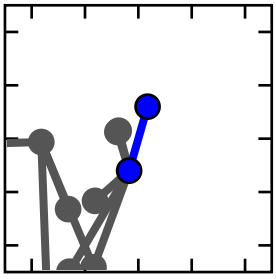
High Capacity, assumes there is no load in the other direction

Symmetrical Capacity, assumes a saturated load in the other direction

Climatic Factors, Losses and Standards			
dN/dH not exceeded for 1% of time	-143.48 N units/km	Link Type	Line-of-Sight
Area roughness 110x110km	956.68 metre	Excess Path Loss	0.00 dB
Geoclimatic factor	1.90e-005	Atmospheric Gasses	ITU-R P.676-7, ITU-R P.835-4
Fade Occurrence Factor (P0)	1.82e-009	Diffraction Loss	ITU-R P.526-10
Path inclination	50.19 mr	Propagation	ITU-R P.530-12
0.01% Rain rate	61.61 mm/hr	Rain Rate	ITU-R P.837-5
Free Space Path Loss	119.07 dB	Refractivity Index	ITU-R P.453-9
Gaseous Absorption Loss	0.02 dB		

Part Number	Qty	Description
BP5830BH-2	1	PTP 58600 Full Integrated (ETSI/RoW) - Link Complete
WB2907	2	LPU End Kit PTP 600 (2 kits required per Link)
WB3176	1	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP)

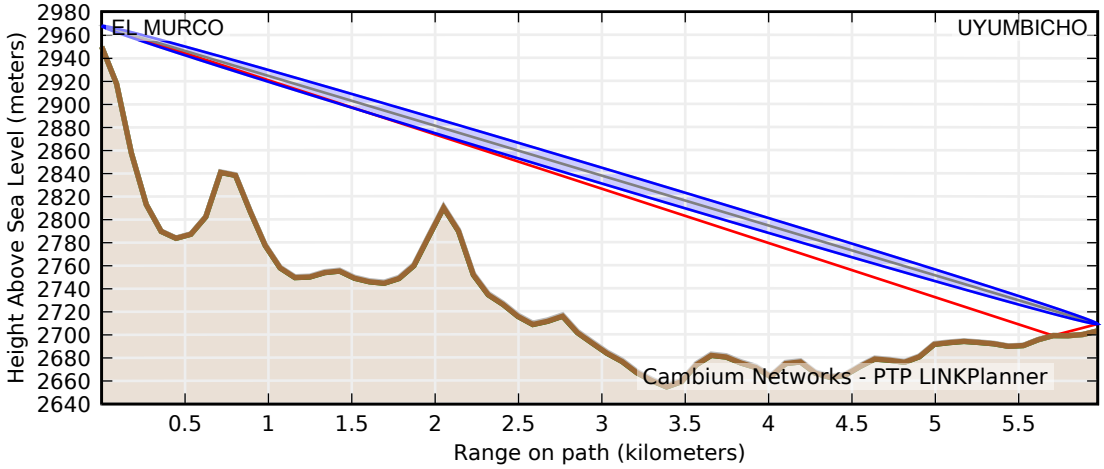
EL MURCO to UYUMBICHO



Equipment: Motorola PTP58600 Integrated

Motorola Integrated Dual Polar Antenna @ 18 m

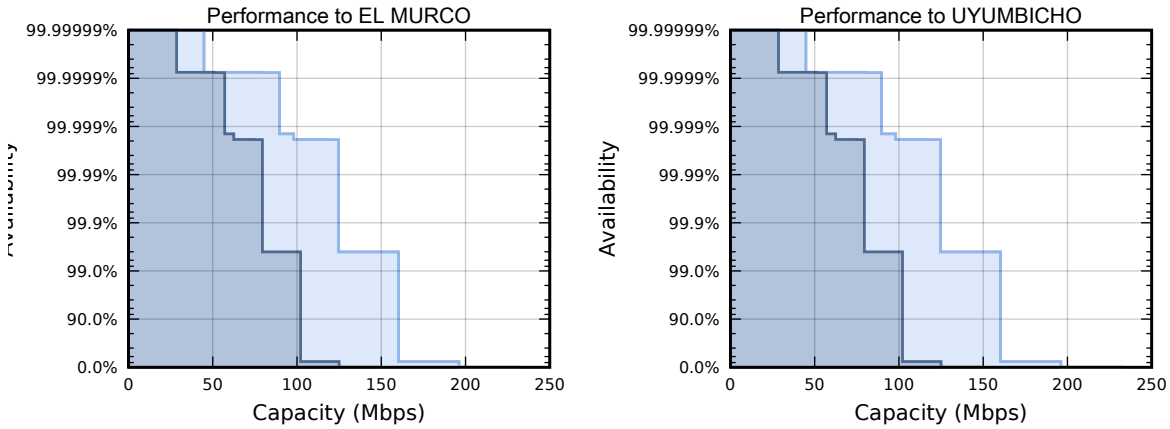
Motorola Integrated Dual Polar Antenna @ 6 m



	Performance to EL MURCO	Performance to UYUMBICHO
Mean IP	107.4 Mbps	107.4 Mbps
IP Availability	100.00000 % for 1.0 Mbps	100.00000 % for 1.0 Mbps

Link Summary			
Link Length	5.974 km	System Gain	147.33 dB
Band	5.8 GHz	System Gain Margin	24.08 dB
Regulation	Australia, Hong Kong	Mean Aggregate Data Rate	214.8 Mbps
Modulation	Adaptive	Annual Link Availability	100.00000 %
Bandwidth	30 MHz	Annual Link Unavailability	0 secs/year
Total Path Loss	123.25 dB	Prediction Model	ITU-R

Performance Charts



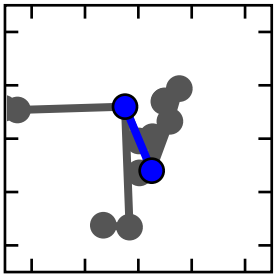
High Capacity, assumes there is no load in the other direction

Symmetrical Capacity, assumes a saturated load in the other direction

Climatic Factors, Losses and Standards			
dN/dH not exceeded for 1% of time	-143.80 N units/km	Link Type	Line-of-Sight
Area roughness 110x110km	947.85 metre	Excess Path Loss	0.00 dB
Geoclimatic factor	1.91e-005	Atmospheric Gasses	ITU-R P.676-7, ITU-R P.835-4
Fade Occurrence Factor (P0)	1.12e-008	Diffraction Loss	ITU-R P.526-10
Path inclination	43.29 mr	Propagation	ITU-R P.530-12
0.01% Rain rate	61.87 mm/hr	Rain Rate	ITU-R P.837-5
Free Space Path Loss	123.22 dB	Refractivity Index	ITU-R P.453-9
Gaseous Absorption Loss	0.03 dB		

Part Number	Qty	Description
BP5830BH-2	1	PTP 58600 Full Integrated (ETSI/RoW) - Link Complete
WB2907	2	LPU End Kit PTP 600 (2 kits required per Link)
WB3176	1	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP)

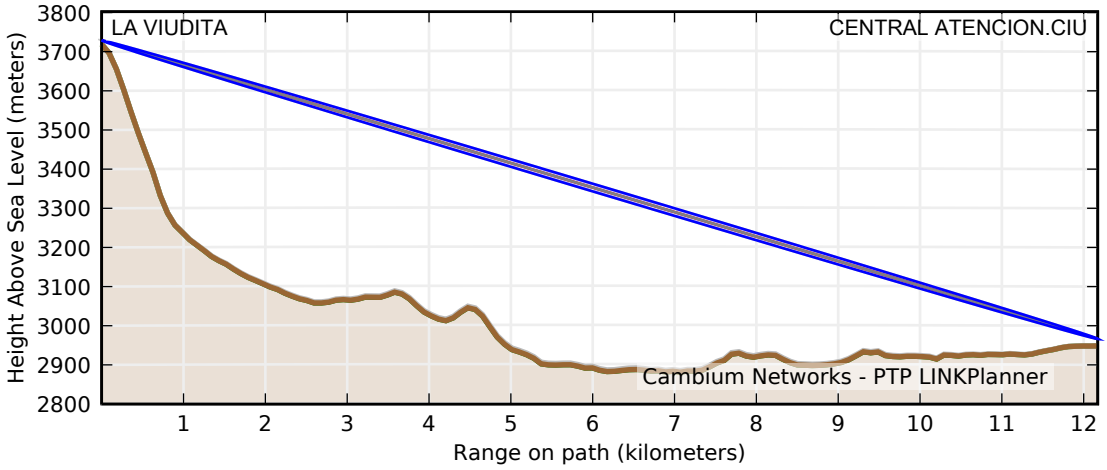
LA VIUDITA to CENTRAL ATENCION.CIU



Equipment: Motorola PTP58600 Integrated

Motorola Integrated Dual Polar Antenna @ 10 m

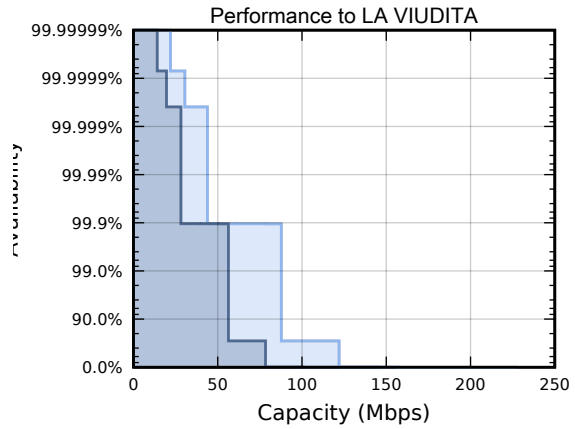
Motorola Integrated Dual Polar Antenna @ 18 m

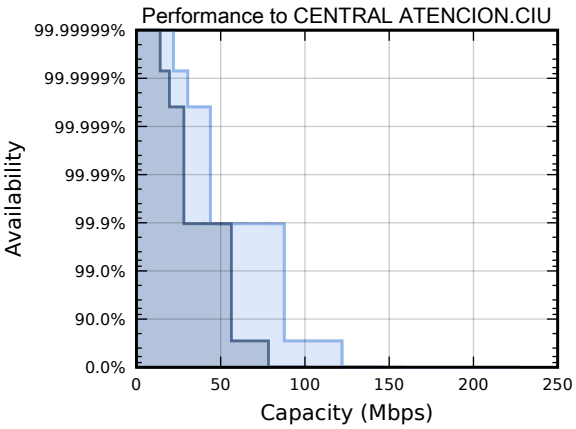


	Performance to LA VIUDITA	Performance to CENTRAL ATENCION.CIU
Mean IP	72.2 Mbps	72.2 Mbps
IP Availability	100.00000 % for 1.0 Mbps	100.00000 % for 1.0 Mbps

Link Summary			
Link Length	12.172 km	System Gain	147.33 dB
Band	5.8 GHz	System Gain Margin	17.87 dB
Regulation	Australia, Hong Kong	Mean Aggregate Data Rate	144.5 Mbps
Modulation	Adaptive	Annual Link Availability	100.00000 %
Bandwidth	30 MHz	Annual Link Unavailability	1 secs/year
Total Path Loss	129.46 dB	Prediction Model	ITU-R

Performance Charts





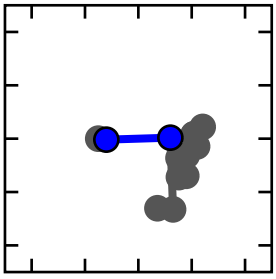
High Capacity, assumes there is no load in the other direction

Symmetrical Capacity, assumes a saturated load in the other direction

Climatic Factors, Losses and Standards			
dN/dH not exceeded for 1% of time	-142.23 N units/km	Link Type	Line-of-Sight
Area roughness 110x110km	995.28 metre	Excess Path Loss	0.00 dB
Geoclimatic factor	1.85e-005	Atmospheric Gasses	ITU-R P.676-7, ITU-R P.835-4
Fade Occurrence Factor (P0)	4.52e-008	Diffraction Loss	ITU-R P.526-10
Path inclination	62.64 mr	Propagation	ITU-R P.530-12
0.01% Rain rate	60.57 mm/hr	Rain Rate	ITU-R P.837-5
Free Space Path Loss	129.40 dB	Refractivity Index	ITU-R P.453-9
Gaseous Absorption Loss	0.05 dB		

Part Number	Qty	Description
BP5830BH-2	1	PTP 58600 Full Integrated (ETSI/RoW) - Link Complete
WB2907	2	LPU End Kit PTP 600 (2 kits required per Link)
WB3176	1	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP)

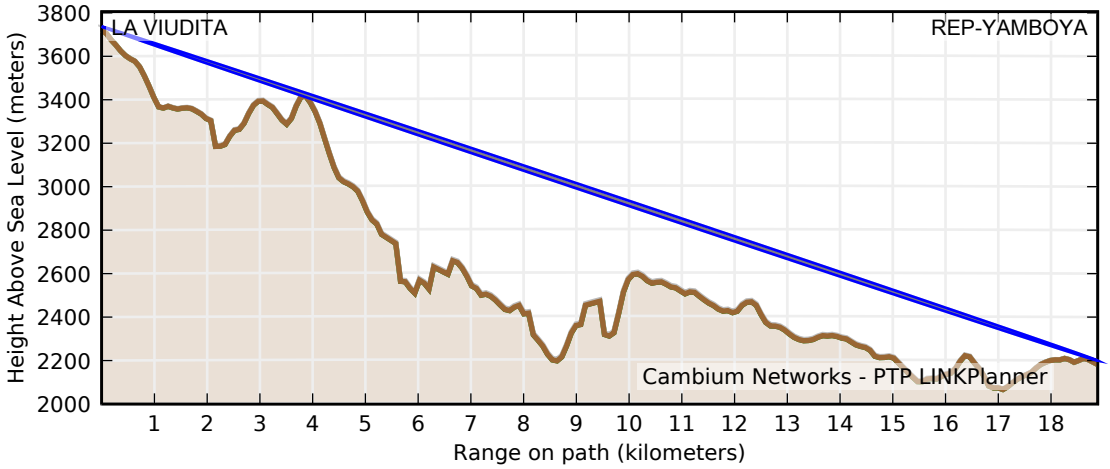
LA VIUDITA to REP-YAMBOYA



Equipment: Motorola PTP58600 Integrated

Motorola Integrated Dual Polar Antenna @ 18 m

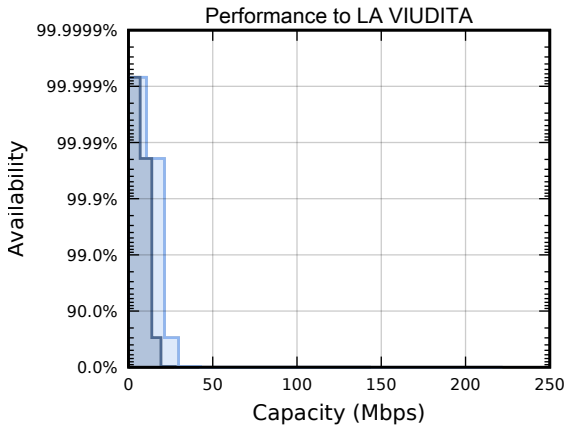
Motorola Integrated Dual Polar Antenna @ 18 m

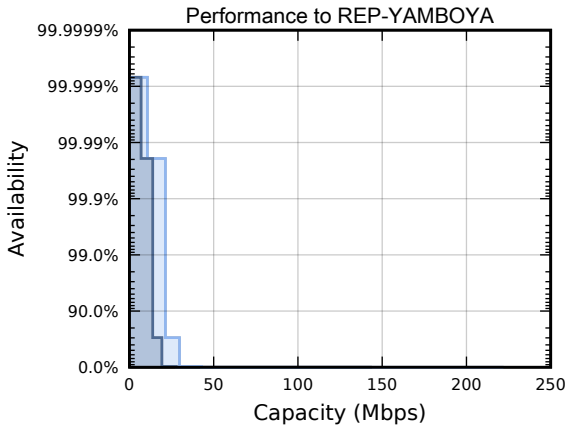


	Performance to LA VIUDITA	Performance to REP-YAMBOYA
Mean IP	17.9 Mbps	17.9 Mbps
IP Availability	99.99931 % for 1.0 Mbps	99.99931 % for 1.0 Mbps

Link Summary			
Link Length	18.886 km	System Gain	147.33 dB
Band	5.8 GHz	System Gain Margin	7.74 dB
Regulation	Australia, Hong Kong	Mean Aggregate Data Rate	35.8 Mbps
Modulation	Adaptive	Annual Link Availability	99.99931 %
Bandwidth	30 MHz	Annual Link Unavailability	3.6 mins/year
Total Path Loss	139.59 dB	Prediction Model	ITU-R

Performance Charts





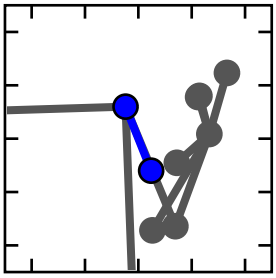
High Capacity, assumes there is no load in the other direction

Symmetrical Capacity, assumes a saturated load in the other direction

Climatic Factors, Losses and Standards			
dN/dH not exceeded for 1% of time	-140.55 N units/km	Link Type	Near Line-of-Sight
Area roughness 110x110km	1129.49 metre	Excess Path Loss	6.28 dB
Geoclimatic factor	1.74e-005	Atmospheric Gasses	ITU-R P.676-7, ITU-R P.835-4
Fade Occurrence Factor (P0)	6.03e-007	Diffraction Loss	ITU-R P.526-10
Path inclination	81.39 mr	Propagation	ITU-R P.530-12
0.01% Rain rate	58.26 mm/hr	Rain Rate	ITU-R P.837-5
Free Space Path Loss	133.22 dB	Refractivity Index	ITU-R P.453-9
Gaseous Absorption Loss	0.09 dB		

Part Number	Qty	Description
BP5830BH-2	1	PTP 58600 Full Integrated (ETSI/RoW) - Link Complete
WB2907	2	LPU End Kit PTP 600 (2 kits required per Link)
WB3176	1	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP)

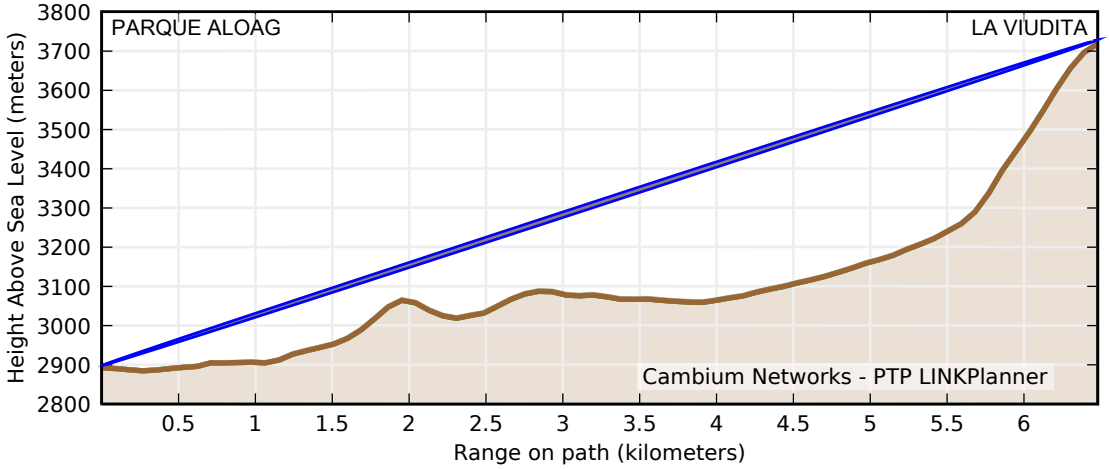
PARQUE ALOAG to LA VIUDITA



Equipment: Motorola PTP58600 Integrated

Motorola Integrated Dual Polar Antenna @ 6 m

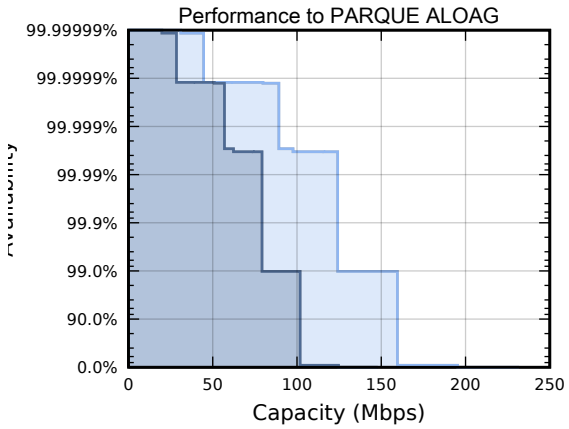
Motorola Integrated Dual Polar Antenna @ 10 m

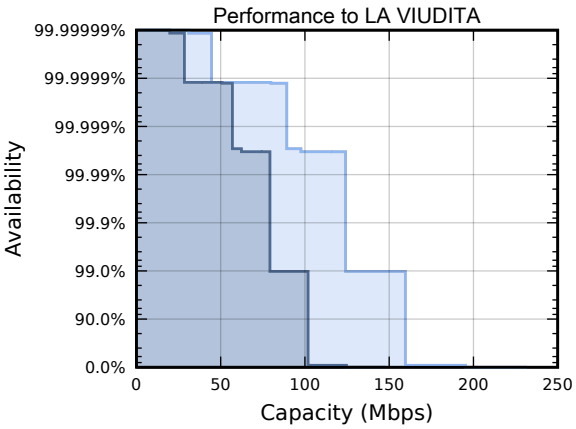


	Performance to PARQUE ALOAG	Performance to LA VIUDITA
Mean IP	103.7 Mbps	103.7 Mbps
IP Availability	100.00000 % for 1.0 Mbps	100.00000 % for 1.0 Mbps

Link Summary			
Link Length	6.480 km	System Gain	147.33 dB
Band	5.8 GHz	System Gain Margin	23.38 dB
Regulation	Australia, Hong Kong	Mean Aggregate Data Rate	207.3 Mbps
Modulation	Adaptive	Annual Link Availability	100.00000 %
Bandwidth	30 MHz	Annual Link Unavailability	0 secs/year
Total Path Loss	123.96 dB	Prediction Model	ITU-R

Performance Charts





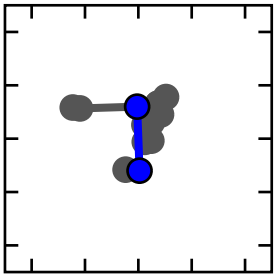
High Capacity, assumes there is no load in the other direction

Symmetrical Capacity, assumes a saturated load in the other direction

Climatic Factors, Losses and Standards			
dN/dH not exceeded for 1% of time	-142.22 N units/km	Link Type	Line-of-Sight
Area roughness 110x110km	1014.68 metre	Excess Path Loss	0.00 dB
Geoclimatic factor	1.84e-005	Atmospheric Gasses	ITU-R P.676-7, ITU-R P.835-4
Fade Occurrence Factor (P0)	3.43e-009	Diffraction Loss	ITU-R P.526-10
Path inclination	128.19 mr	Propagation	ITU-R P.530-12
0.01% Rain rate	60.37 mm/hr	Rain Rate	ITU-R P.837-5
Free Space Path Loss	123.93 dB	Refractivity Index	ITU-R P.453-9
Gaseous Absorption Loss	0.03 dB		

Part Number	Qty	Description
BP5830BH-2	1	PTP 58600 Full Integrated (ETSI/RoW) - Link Complete
WB2907	2	LPU End Kit PTP 600 (2 kits required per Link)
WB3176	1	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP)

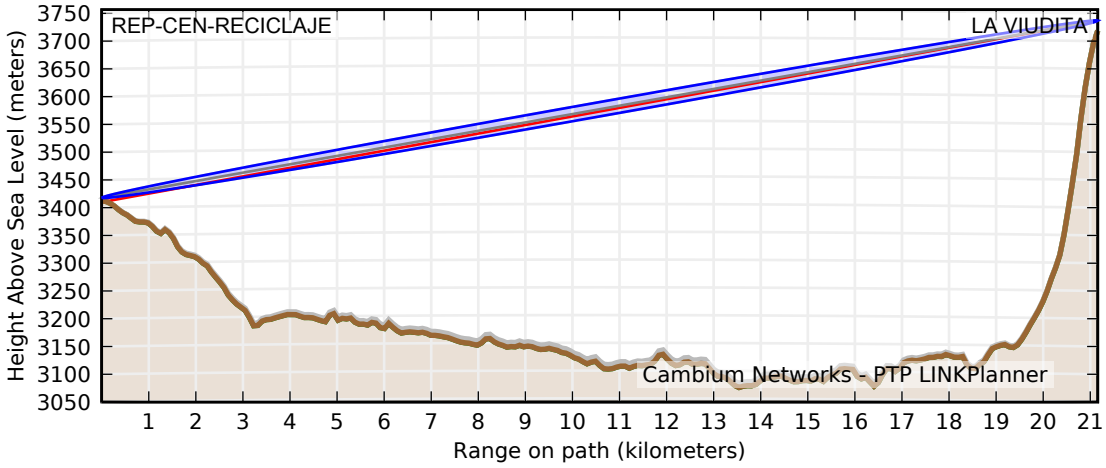
REP-CEN-RECICLAJE to LA VIUDITA



Equipment: Motorola PTP58600 Integrated

Motorola Integrated Dual Polar Antenna @ 6 m

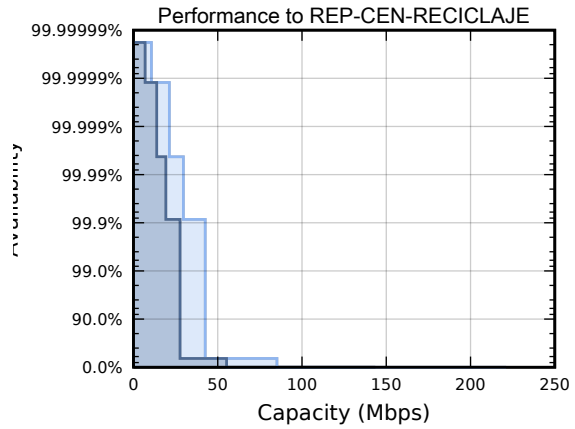
Motorola Integrated Dual Polar Antenna @ 18 m

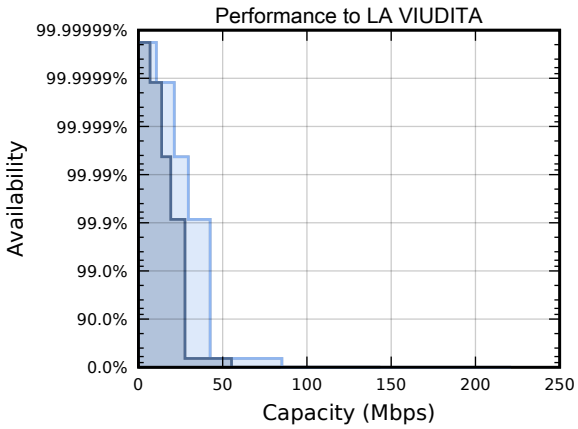


	Performance to REP-CEN-RECICLAJE	Performance to LA VIUDITA
Mean IP	37.1 Mbps	37.1 Mbps
IP Availability	99.99998 % for 1.0 Mbps	99.99998 % for 1.0 Mbps

Link Summary			
Link Length	21.159 km	System Gain	147.33 dB
Band	5.8 GHz	System Gain Margin	13.04 dB
Regulation	Australia, Hong Kong	Mean Aggregate Data Rate	74.2 Mbps
Modulation	Adaptive	Annual Link Availability	99.99998 %
Bandwidth	30 MHz	Annual Link Unavailability	6 secs/year
Total Path Loss	134.30 dB	Prediction Model	ITU-R

Performance Charts





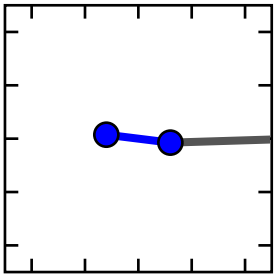
High Capacity, assumes there is no load in the other direction

Symmetrical Capacity, assumes a saturated load in the other direction

Climatic Factors, Losses and Standards			
dN/dH not exceeded for 1% of time	-141.53 N units/km	Link Type	Line-of-Sight
Area roughness 110x110km	1005.29 metre	Excess Path Loss	0.00 dB
Geoclimatic factor	1.83e-005	Atmospheric Gasses	ITU-R P.676-7, ITU-R P.835-4
Fade Occurrence Factor (P0)	4.12e-007	Diffraction Loss	ITU-R P.526-10
Path inclination	15.08 mr	Propagation	ITU-R P.530-12
0.01% Rain rate	60.12 mm/hr	Rain Rate	ITU-R P.837-5
Free Space Path Loss	134.21 dB	Refractivity Index	ITU-R P.453-9
Gaseous Absorption Loss	0.09 dB		

Part Number	Qty	Description
BP5830BH-2	1	PTP 58600 Full Integrated (ETSI/RoW) - Link Complete
WB2907	2	LPU End Kit PTP 600 (2 kits required per Link)
WB3176	1	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP)

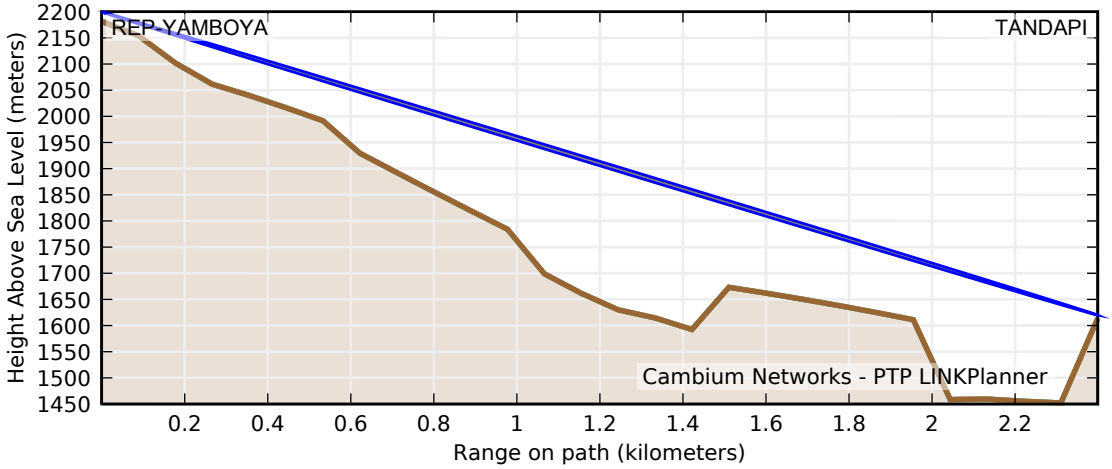
REP-YAMBOYA to TANDAPI



Equipment: Motorola PTP58600 Integrated

Motorola Integrated Dual Polar Antenna @ 18 m

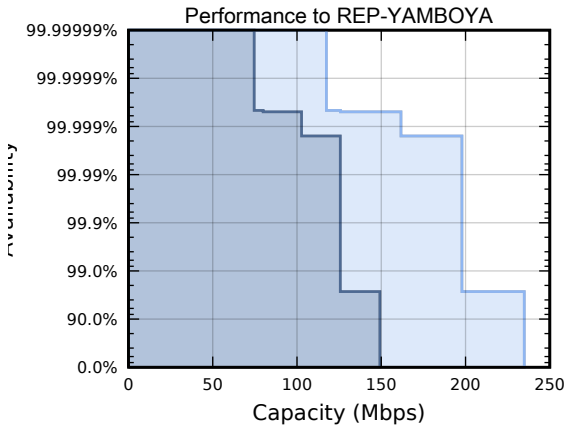
Motorola Integrated Dual Polar Antenna @ 6 m

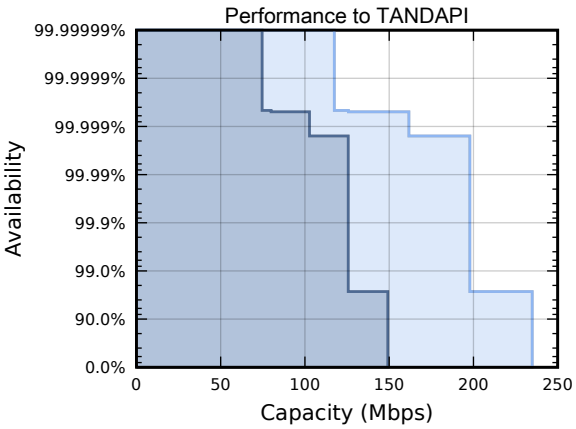


	Performance to REP-YAMBOYA	Performance to TANDAPI
Mean IP	148.5 Mbps	148.5 Mbps
IP Availability	100.00000 % for 1.0 Mbps	100.00000 % for 1.0 Mbps

Link Summary			
Link Length	2.399 km	System Gain	147.33 dB
Band	5.8 GHz	System Gain Margin	32.02 dB
Regulation	Australia, Hong Kong	Mean Aggregate Data Rate	297.1 Mbps
Modulation	Adaptive	Annual Link Availability	100.00000 %
Bandwidth	30 MHz	Annual Link Unavailability	0 secs/year
Total Path Loss	115.32 dB	Prediction Model	ITU-R

Performance Charts





High Capacity, assumes there is no load in the other direction

Symmetrical Capacity, assumes a saturated load in the other direction

Climatic Factors, Losses and Standards			
dN/dH not exceeded for 1% of time	-138.66 N units/km	Link Type	Line-of-Sight
Area roughness 110x110km	1203.10 metre	Excess Path Loss	0.00 dB
Geoclimatic factor	1.67e-005	Atmospheric Gasses	ITU-R P.676-7, ITU-R P.835-4
Fade Occurrence Factor (P0)	8.58e-010	Diffraction Loss	ITU-R P.526-10
Path inclination	241.63 mr	Propagation	ITU-R P.530-12
0.01% Rain rate	56.55 mm/hr	Rain Rate	ITU-R P.837-5
Free Space Path Loss	115.30 dB	Refractivity Index	ITU-R P.453-9
Gaseous Absorption Loss	0.02 dB		

Part Number	Qty	Description
BP5830BH-2	1	PTP 58600 Full Integrated (ETSI/RoW) - Link Complete
WB2907	2	LPU End Kit PTP 600 (2 kits required per Link)
WB3176	1	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP)

Cambium Networks

Disclaimer

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Cambium Networks

SPEC SHEET

PMP 450 Access Point

The Cambium Networks Point-to-Multipoint (PMP) 450 Access Point (AP) can provide more than 90 Mbps throughput and is interoperable with PMP 430 and PMP 100 Series Subscriber Modules (SM). Service providers with an installed base of PMP 100 subscribers can now migrate to new high-throughput PMP 450 modules to enhance overall capacity; allowing more users and/or higher rate plans.

Utilizing 2x2 MIMO-OFDM technology, new deployments can take advantage of Cambium Networks proprietary feature set, while achieving data rates higher than 90 Mbps. From the available synchronization options to its diverse feature set, the PMP 450 provides flexible deployment options that make it a good fit for high capacity, high reliability networks.

Cambium Networks provides exceptional wireless broadband connectivity solutions. With more than 3 million modules deployed in thousands of networks around the world, Cambium solutions are proven to provide cost effective, reliable data, voice and video connectivity.

SPECIFICATIONS

PRODUCT	
MODEL NUMBER	C054045A001A, C054045A002A
SPECTRUM	
CHANNEL SPACING	Configurable on 5 MHz increments
FREQUENCY RANGE	5470 - 5875 MHz
CHANNEL WIDTH	10 MHz (OFDM-only mode) or 20 MHz
INTERFACE	
MAC (MEDIA ACCESS CONTROL) LAYER	Cambium Proprietary
PHYSICAL LAYER	2x2 MIMO OFDM, FSK
ETHERNET INTERFACE	10/100BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
PROTOCOLS USED	IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
NETWORK MANAGEMENT	HTTP, Telnet, FTP, SNMP v2c
VLAN	802.1ad (DVLAN Q-inQ), 802.1Q with 802.1p priority, dynamic port VID
PERFORMANCE	
SUBSCRIBERS PER SECTOR	Up to 200
ARQ	Yes
NOMINAL RECEIVE SENSITIVITY (W/ FEC) @ 10MHZ CHANNEL	OFDM: 2X=-85, 4X=-78, 6X=-70
NOMINAL RECEIVE SENSITIVITY (W/ FEC) @ 20MHZ CHANNEL	OFDM: 2X=-82, 4X=-75, 6X=-67 FSK: 1X=-85, 2X=-80
MAXIMUM DEPLOYMENT RANGE	Up to 20 miles
MODULATION LEVELS (ADAPTIVE)	OFDM: QPSK, 16-QAM, 64-QAM (MIMO-B) FSK: 1X=2-Level FSK, 2X=4-Level FSK
LATENCY	3 - 5 ms
GPS SYNCHRONIZATION	Yes, via CMM3, CMM4 or UGPS
QUALITY OF SERVICE	Diffserve QoS

SPECIFICATIONS

LINK BUDGET	
ANTENNA BEAM WIDTH	60° (H+V+FSK patch) or 90° sectors are available
TRANSMIT POWER	OFDM: -30 to +22 dBm (combined, to EIRP limit by region) (1 dB interval) FSK: -30 to +23 dBm (1 dB interval)
ANTENNA GAIN	17 dBi H+V, 9 dBi FSK patch (with 60° sector antenna) 17 dBi H+V (with 90° sector antenna)
MAXIMUM TRANSMIT POWER	22 dBm combined OFDM, 23 dBm FSK
PHYSICAL	
WIND LOADING	190 km/hour (118 mi/hour)
ANTENNA CONNECTION	50 ohm, N-type (Dual Polarization OFDM), FSK V-Pol
MEAN TIME BETWEEN FAILURE	> 40 Years
ENVIRONMENTAL	IP67
TEMPERATURE	-40°C to +55°C (-40°F to +131°F)
WEIGHT	5.9 kg (13 lbs) with antenna 2.5 kg (5.5 lbs) without antenna
WIND SURVIVAL	90 lb (173 N)
DIMENSIONS (HxWxD)	Radio: 27x21x7 cm (10.6”x8.3”x2.8”) Antenna: 51x13x7.3 cm (20.2”x 5.1” x 2.9”)
MAXIMUM POWER CONSUMPTION	18 W
INPUT VOLTAGE	24 to 30 V
SECURITY	
ENCRYPTION	56-bit DES, 128-bit AES
CERTIFICATIONS	
FCC ID	Z8H89FT0002 (5.4 GHz Grant in future release)
INDUSTRY CANADA CERT	TBD
CE	TBD

MOTOROLA WIRELESS BROADBAND

PTP 100 Series

Motorola PTP 100 Wireless Ethernet Bridges

The Motorola PTP 100 Series of Point-to-Point wireless Ethernet bridges provide a low-cost-of-entry solution for deployment, expansion and extension of broadband communications networks. The PTP 100 Series also offers the scalability of simple, affordable software key-based license upgrades for additional performance and capacity as networks grow.

An organization can begin with a system that delivers 2 Mbps of aggregate throughput at one of the lowest initial costs in the industry. When upgrades are needed, the user simply purchases software license keys that allow incremental over-the-air upgrades to 4 Mbps and to 7.5 Mbps aggregate data rates. Licenses that deliver up to 14 Mbps are also available. Upgrades are fast, easy and cost-efficient.

The PTP 100 provides access in the 2.4, 5.2, 5.4 and 5.8 GHz frequencies. Using reflectors, ranges can be extended up to 35 miles (56 kilometers) in Line-of-Sight (LOS) environments. The system also provides powerful multi-level modulation schemes to mitigate against interference. Security solutions include built-in over-the-air DES encryption with AES encryption available as an option.

Motorola Wireless Broadband Leadership

The PTP 100 Series leverages Motorola's more than 80 years of wireless industry leadership, innovation and worldwide customer service and support. The PTP 100 is part of Motorola's comprehensive Point-to-Point solutions that offer high-speed connectivity – up to 300 Mbps – in challenging LOS, near-LOS and Non-LOS environments for data, voice and video communications.

Motorola Innovation

Motorola's comprehensive portfolio of reliable and cost-effective wireless broadband solutions together with our WLAN solutions provide and extend coverage both indoors and outdoors. The Motorola Wireless Broadband portfolio offers high-speed Point-to-Point, Point-to-Multipoint, Mesh, WiFi and WiMAX networks that support data, voice and video communications, enabling a broad range of fixed and mobile applications for public and private systems. With Motorola's innovative software solutions, customers can design, deploy and manage a broadband network, maximizing uptime and reliability while lowering installation costs.

SPECIFICATION SHEET

PTP 100 Series
Motorola PTP 100 Wireless Ethernet Bridges

	PTP 100 2 & 4 Mbps	PTP 100 7.5 Mbps	PTP 100 14 Mbps
Part Number	5700BH02, 5700BH04 5400BH02, 5400BH04	5700BH, 5400BH 5200BH, 2400BH	5700BH20, 5400BH20 5211BH20, 2400BH20
Market Availability	Asia Pacific	Worldwide	Worldwide
Radio Technology			
Frequency Band	5425-5725 MHz 5725-5850 MHz	2400-2483 MHz, 5250-5350 MHz 5470-5725 MHz, 5725-5850 MHz	
Non Overlapping Channels	6		
Channel Size	20 MHz		
Channel Spacing	Every 5 MHz		
EIRP	Adjustable from 10 mW to 1.0 W		
Antenna Gain	7 dB		
Reflector Gain	18 dB		
Antenna Beamwidth	3 dB Antenna Beam with 6 degrees Azimuth & Elevation		
Modulation	High Index 2- Level FSK Optimized for Interference Rejection		High Index 4- Level FSK Optimized for Interference Rejection
Access Method	Time Division Duplex (TDD)		
Performance			
Typical Aggregate Useful Throughput	2 & 4 Mbps	7.5 Mbps	14 Mbps
Typical LOS Range	2 Miles (3.2 km)	2.4 GHz: 5 Miles (8 km) 5.2, 5.4 & 5.7 GHz: 2 Miles (3.2 km)	2.4 GHz: 2 Miles (3.2 km) 5.4 & 5.7 GHz: 1 Mile (1.6 km)
Typical LOS Range (With Reflector)	5.4 GHz & 5.7 GHz: 35 Miles (56 km)	2.4 GHz: 35 Miles (56 km) 5.2 & 5.4 GHz: 10 Miles (16 km) 5.7 GHz: 35 Miles (56 km)	
Latency	2.5 msec		
Encryption	DES & AES		
Receive Sensitivity	-86 dBm		-79 dB
Carrier to Interference Ratio (C/I)	~3 dB at -65 dBm		~10 dB at -65 dBm
DFS		5.4 GHz: Implements DFS and TPC	
Data			
Interface	10/100 Base T, half/full Duplex, Rate Auto Negotiated (802.3 compliant)		
Protocols Used	IPV4, UDP, TCP, ICMP, Telnet, HTTP, FTP, SNMP		
Network Management	HTTP, TELNET, FTP, SNMP V2c		
Physical			
DC Power (Typical)	0.34A@24 VDC = 8.2W		
Dimensions (Module)	11.75" H x 3.4" W x 3.4"D (29.9 cm H x 8.6 cm W x 8.6 cm D)		
Dimensions (Passive Reflector)	18" H x 24" W (45 cm H x 60 cm W)		
Weight	1 lb (.45 kg)		
Operating Temperature	-40° C to +55° C (-40° F to +131° F)		
Wind Speed Survival	190 km/hr (118 miles/hr)		
Mean Time Between Failure (MTBF)	> 40 Years		
Humidity	100%		

STANDARDS

CE
5.4 GHz: Europe EN 301 893
5.7 GHz: Europe EN 302 502

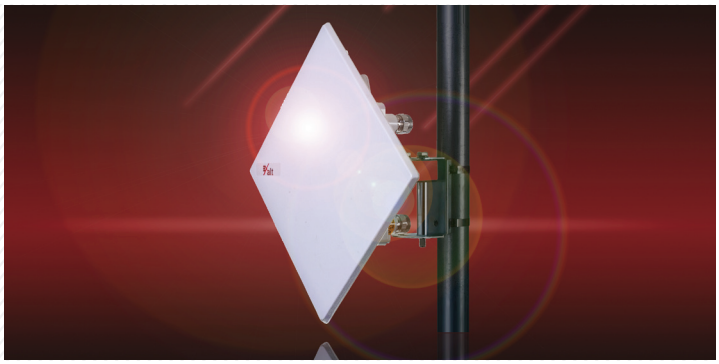
FCC Identification
2.4 GHz: ABZ89FC5808
5.2 GHz: ABZ89FC3789
5.4 GHz: ABZ89FT7623
5.7 GHz: ABZ89FT7630

Industry Canada (IC)
2.4 GHz: 109W-2400
5.2 GHz: 109W-5200
5.4 GHz: 109W-5400
5.7 GHz: 109W-5700G

MOTOROLA

Motorola, Inc. 1301 E. Algonquin Road, Schaumburg, Illinois 60196 U.S.A. **www.motorola.com/wirelessbroadband**

ExtendAir r5000 Series



High Performance Microwave Systems for Business Critical All-Outdoor Applications

ExtendAir is a first-of-its-kind line of entry-level high performance radio systems designed to deliver guaranteed Ethernet throughput and toll-quality voice over long ranges. The ExtendAir r5000 series radios are rugged, all-outdoor, tri-band systems operating in the 5.3, 5.4, and 5.8 GHz license-exempt bands delivering a best-in-class 162 Mbps of aggregate throughput and optional native 4xT1/E1. The ExtendAir r5000 series is designed to meet the business-critical performance and flexibility requirements of enterprises, government organizations and service providers.

Uncompromised performance. Exalt's unique high performance point-to-point technology allows the ExtendAir r5000 series to offer licensed-like performance, with the ability to deliver sustained throughput over long distances in high interference environments. As compared to competing systems that reduce throughput in the presence of interference just to maintain a connection, with ExtendAir, you always know what capacity you're going to get.

Lowest cost per Mbps-mile. ExtendAir delivers the highest throughput in the category for any given range and the longest range for any given throughput. That means ExtendAir offers the best value and the lowest cost per Mbps-mile in the industry.

Toll-quality voice. ExtendAir r5000 series radios support native Ethernet and, optionally, native TDM traffic, with 1 ms typical latency for both. So whether it's TDM voice or VoIP, ExtendAir won't get in the way of a good user experience.

Pay as you grow. The future is hard to predict. With ExtendAir systems, you don't have to. All capacity enhancements and optional features are remotely upgradeable using a software license key.

Best-in-class data networking. ExtendAir was designed to support complex IT environments, with support for Ethernet rate limiting, VLAN tagging (802.1Q) and QoS (802.1p) with four traffic classes and multiple filters. And ExtendAir offers the ultimate security with optional FIPS 197-compliant 128-bit and 256-bit AES.

Spectral flexibility. The tri-band ExtendAir offers a full 505 MHz of 5 GHz spectrum in which to find the best channel, providing selectable channel bandwidth and the ability to tune channels with 1 MHz resolution. ExtendAir puts the power to optimally manage spectrum utilization in the hands of the user.

Throughput symmetry control. Network managers know from experience that not all IP traffic is symmetric. ExtendAir can allocate Ethernet throughput evenly or asymmetrically up to 80:20 between the two link directions, maximizing channel utilization for applications such as video surveillance, data backup and Internet services.

Primary Specifications		ExtendAir r5000 / r5005 rc5000 / rc5005	ExtendAir r5010 / r5015 rc5010 / rc5015
Maximum Capacity	Ethernet (Aggregate)	162 Mbps	
	TDM	–	4xT1/E1
Frequency (GHz)		Tri-band 5 GHz: 5.250–5.350, 5.470–5.725, 5.725–5.875 GHz	

Specifications — ExtendAir r5000 Series

System			
Outdoor Unit (ODU) Models	1x10/100BaseT PoE		
	1x10/100BaseT PoE + 2x 10/100BaseT		
	1x10/100BaseT PoE + 4x T1/E1		
Frequency Bands[1](GHz)	5.250–5.350, 5.470–5.725, 5.725–5.875		
Tuning Resolution	1 MHz		
Output Power (full power)[2]	5.725–5.875 GHz	5.250–5.350 GHz[3]	5.470–5.725 GHz[3]
QPSK	+22 dBm	+20 dBm	+20 dBm
16QAM	+18 dBm	+18 dBm	+18 dBm
64QAM	+16 dBm	+16 dBm	+16 dBm
Output Power (min. power)	0 dBm		
Power Control Step Size	0.5 dB		
Aggregate User Throughput (Ethernet Mbps) [4]			
Channel Bandwidth[5]	8/10 MHz Channel	16/20 MHz Channel	32/40 MHz Channel
QPSK	13	27	55
16QAM	26	55	109
64QAM	38	81	162
Receiver Threshold (BER=10^{-6}) over temperature (dBm)			
QPSK	-86	-83	-80
16QAM	-79	-76	-73
64QAM	-73	-70	-67
System Gain (dB)			
QPSK	108	105	102
16QAM	97	94	91
64QAM	89	86	83
Non-overlapping Channels			
5.250–5.350 GHz	10	5	2
5.470–5.725 GHz	29	14	7
5.725–5.875 GHz	18	9	4
Range[6] (99.99% availability)	Up to 15 miles / 24 km at 162 Mbps sustained user throughput		
Maximum RSL	0 dBm no damage		
QPSK	-25 dBm error-free		
64QAM	-30 dBm error-free		
Throughput Symmetry Control	5 modes: 20/80, 80/20, 35/65, 65/35, 50/50		
Error Floor	10^{-12}		
FEC	T=8		
Latency (T1/E1)	1ms, typical		
Data Security	NIST FIPS 197-compliant 128-bit AES and 256-bit AES[7] or 96-bit proprietary encryption		
Spectrum Analyzer	Embedded		
Management	In-band and out-of-band management (5005 models only)		
Security	SSL/SSH and secure, encrypted SNMPv3		
HTTP	Embedded web server GUI (Internet Explorer, Firefox)		
CLI/Telnet	via 10/100BaseT		
SNMP	v1, v2c, and secure v3		
MIB support	MIB I, MIB II, Exalt MIB		
Installation and Management Manual	Embedded in radio, accessible via HTTP GUI		
Compliance	SNMP v1, 2c, v3		
	FCC 15.247, FCC 15.407		
	EN 301-893, EN 302-502		
	EN 60-950, EN 301-489		
	IC RSS-210		

[1] Not all frequency bands are authorized or available for use in all countries. Consult Exalt for UNII band availability in the US.

[2] Output power is specified per modulation to accurately show the corresponding system gain and throughput, and not just the maximum power the radio can achieve.

[3] Output power is limited to +13 dBm per US and International EIRP regulations for UNII bands. Consult your Exalt representative for full output power terms and availability.

[4] Total aggregate user throughput, not over-the-air modulated data rate. Systems are 27 Mbps with upgrade options of 55 and 120 Mbps. r5015 and rc5015 models are 5 Mbps +2xT1/E1 upgradeable to 120 Mbps+4xT1/E1.

[5] FCC: 8, 16, 32 MHz; ETSI: 10, 20, 40 MHz

[6] FCC rules, 5.8 GHz ISM band, average climate & terrain, connectorized rc version with 6' dish antennas, 3 dB transmission losses and 99.99% availability. Longer or shorter distances can be achieved for alternate antennas, country regulations, transmission system losses path topologies, availability requirements and radio configurations. Refer to Exalt Link Budget Calculator and Path Profiler tools.

[7] Software license key option.

Exalt™

Specifications (Cont.)

ExtendAir r5000 Series

System Components		
Complete Link	Two terminals, each mounting kit, & accessory kit	
Single Terminal	One terminal with mounting kit, & accessory kit	
Accessory Kit	Grounding hardware, water-proofing tape	
Power Supply Kits	AC Power Kit or DC Power Kit (ordered separately)	
Mounting Kits	Available for r and r-c models (spare)	
ExaltSync GPS Sync Kit	GPS receiver and mounting bracket (optional)	
Physical	Integrated antenna	Connectorized
Physical Configuration	Outdoor Unit (ODU)	
Dimensions (H x W x D)	13.3" x 13.3" x 4.5"	9.4" x 9.4" x 5.25"
	33.8 cm x 33.8 cm x 11.4 cm	23.9 cm x 23.9 cm x 13.3 cm
Antenna	Integrated	Type N Connector
Integrated Antenna		
Gain/3 dB Beamwidth	23 dBi / 10 degrees	
Operating Temperature	-40 to +65°C; -40 to +149°F	
Full Spec Temperature	-40 to +60°C; -40 to +140°F	
Weight	Connectorized rc: 2.72 kg / 6 lbs.	
	Integrated antenna r: 3.18 kg / 7 lbs.	
Environmental	NEMA 4 / IP66	
Altitude	4600 m / 15,000 ft.	
Humidity	100% condensing	
Interfaces		
RF	Connectorized r: N-type Female	
Ethernet	RJ48C/RJ45 Female (x1 or x3)[8]	
Interface Speed	10/100BaseT (PoE or PoE +ETH1 +ETH2)	
Duplex	Half, Full, Auto-MDIX	
Compliance	802.3	
VLAN	802.1q, transparent, trunk, and management only; over 4,000 VLAN IDs	
QoS	4 QoS traffic classes; filters on: port, IEE802.1p, IPv4 TOS or DiffServ, IPv6 traffic class, 802.1Q VLAN ID, SA/DA MAC	
Ethernet Rate Limiting	Configurable per port via software, 1 Kbps resolution	
Maximum Packet Size	2048 bytes	
T1/E1[8]	T1 (x4)	E1 (x4)
	RJ48C/RJ45 Female (x2)	
Impedance	100 ohms, balanced	120 ohms, balanced
Line Code	AMI, B8ZS, selectable per channel	HDB3
Data Rate	1.544 Mbps	2.048 Mbps
Compliance	ANSI T1.102-1987; ITU-T; G.823; GR-499-CORE	CEPT-1; G.703; ITU-T-G.703
Loopback Modes	Remote Internal; Remote External; Local Line	
ExaltSync Synchronization	RJ45 Female (x1)	
Input	1pps (GPS)	
Output	Sync out	
DC Power	<25W	
AC/PoE Power Adapter		
Input	100-240VAC, 0.5A	
Output	40W, 56VDC	

Warranty	Two years[9]

[8] TDM models include a single PoE 10/100BaseT port. IP/Ethernet only models include one PoE 10/100BaseT port and two additional 10/100BaseT ports.

[9] Terms and conditions apply. Consult your Exalt sales representative for details.

www.exaltcom.com

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DS-ExtendAir-r5000-D-0110