PTP LINKPlanner

User Guide

Version 2.7.0

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About This User Guide

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

Motorola provides the PTP LINKPlanner application with the PTP 250, PTP 300, PTP 400, PTP 500, PTP 600 and PTP 800 equipment. Use PTP 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?

If any problems are experienced with PTP LINKPlanner, see *Contacting Motorola*

Getting started

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

How to use PTP LINKPlanner

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

- *Unlicensed Band Tutorial* - for PTP 250, PTP 300, PTP 400, PTP 500 and PTP 600 link planning.
- *Licensed Band Tutorial* - for PTP 800 link planning.

If the resulting data throughput and link availability predictions look promising, plan the link in greater detail as described in *Using PTP 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 PTP LINKPlanner*.
- For definitions of common terms, see *Glossary*.

General Information

Purpose

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

Motorola 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 Motorola

Feedback on PTP 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.ptp@motorolasolutions.com.

Motorola Point-to-Point

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URLs:

Main web site: http://www.motorola.com/ptp
Web support: http://www.motorola.com/ptp/support

Email addresses:

Sales enquiries: sales.ptp@motorolasolutions.com
Email support: support.ptp@motorolasolutions.com

Wireless Broadband Technical Support telephone numbers

Region and country	Support telephone number
North America:	
USA and Canada	866-961-9288
Europe, Middle East and Africa:	
Denmark	043682114
France	0157323434
Germany	06950070204
Italy	0291483230
Lithuania	800 030 828
Netherlands	0202061404
Norway	24159815
Portugal	0217616160
Spain	912754787
Russia	810 800 228 41044
Saudia Arabia	800 844 5345
South Africa	0800981900
United Kingdom	0203 0277499
All other countries	+44 203 0277499
Latin and Central America:	
Argentina	0800-666-2789
Brazil	0800-891-4360
Chile	800-225-288
Columbia	01-800-912-0557
Mexico	001-800-942-7721
Peru	0800-70-086
All other countries	+420 533 336 946
Asia, Pacific and China:	
Australia	800 457 439
Singapore	64 155 110
All other countries	+420 533 336 946

Reporting problems

If any problems are encountered when using PTP 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.motorola.com/ptp/software)
3. Search the release note for this version of the product (available at http://www.motorola.com/ptp/software)
4. Ask your Motorola products supplier to help.
5. Escalate the problem to Motorola Technical Support as follows:

- Either: send an email to linkplanner.ptp@motorolasolutions.com
- Or: Contact Motorola PTP Support at http://www.motorola.com/ptp/support/contact

Warnings, cautions and notes

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

Getting started

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

- *LINKPlanner Concepts*
- *Installing PTP LINKPlanner*

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

- *Quick Tutorial - Unlicensed Band* (for PTP 250, PTP 300, PTP 400, PTP 500 and PTP 600 links).
- *Quick Tutorial - Licensed Band* (for PTP 800 links).

LINKPlanner Concepts

NLoS and LoS

The Motorola PTP Series of point-to-point wireless Ethernet bridges 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. PTP 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 PTP 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. Motorola 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 PTP LINKPlanner are:

- **Project**: a set of data about the sites and links in a wireless network.
- **Site**: the location of a PTP outdoor unit and its antenna.
- **Link**: a wireless connection between two sites.
- **Path**: an alternative wireless link between two units at different sites, when each site has multiple units.

Inputs and Outputs

The main inputs to LINKPlanner are:

- Site name, position and maximum antenna height (input by the user).
- Details of the PTP equipment and license restrictions (selected by the user).
- Required performance targets for each link (input by the user).
- Profile of the terrain along the path of each link (obtained using a Motorola 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:

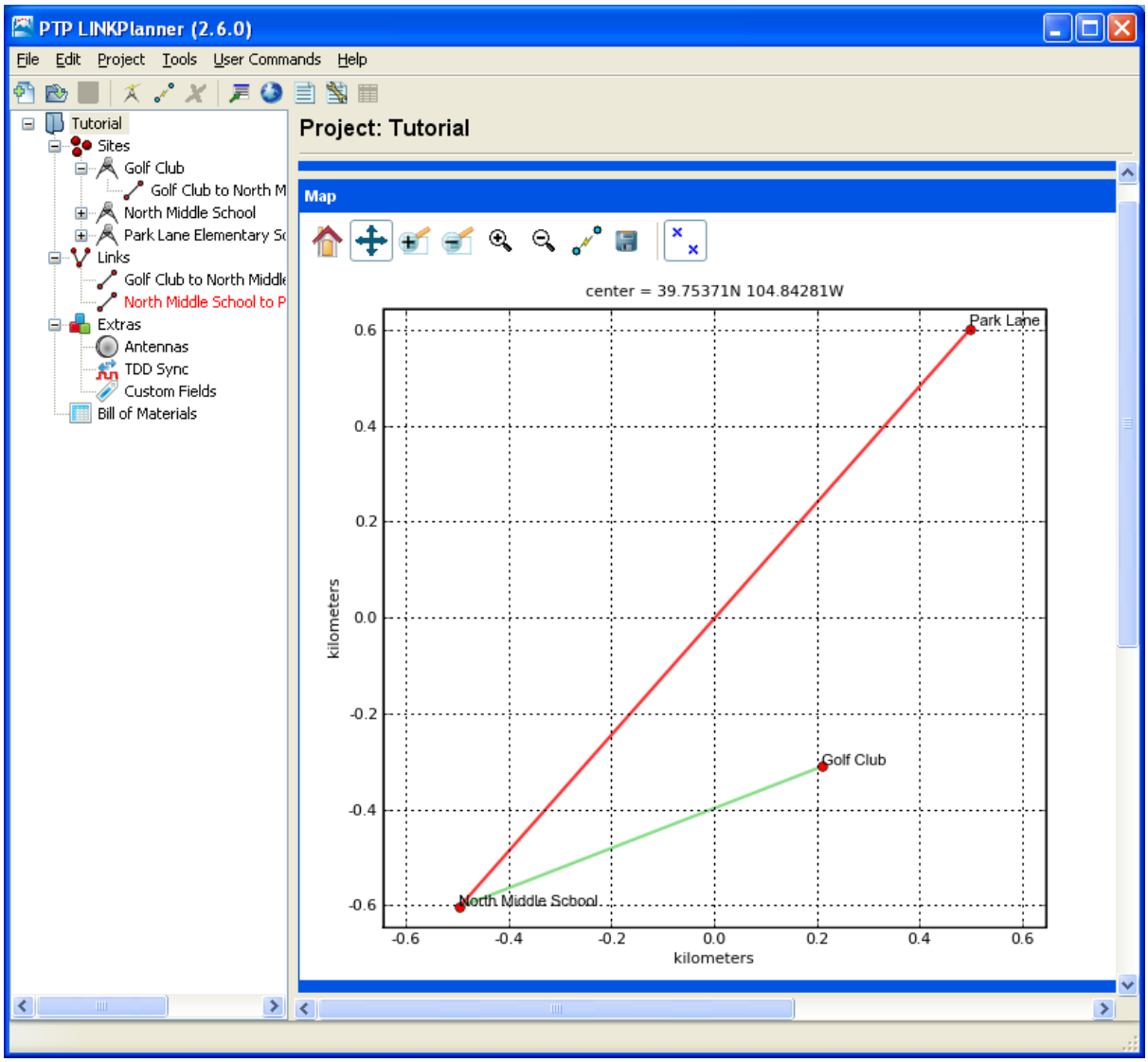


Figure 2.1: User Interface

Installing PTP LINKPlanner

Windows Installation

If PTP 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 PTP LINKPlanner in Windows:

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

Mac Installation

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

Quick Tutorial - Unlicensed Band

This section is a quick tutorial for experienced Windows or Mac users. It describes how to create a project to analyse the performance of a single 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 PTP 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)*.

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. Obtain the path profile for the link and update it 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. Select **New Project**  .

   The *Project Page* is displayed

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

   Select **Save Project** 

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

3. Select **New Site** 

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

   Name: North Middle School

   Maximum Height: 10 metres

   Latitude: 39.74828N

   Longitude: 104.84861W

   Description: Antenna mounted on school building

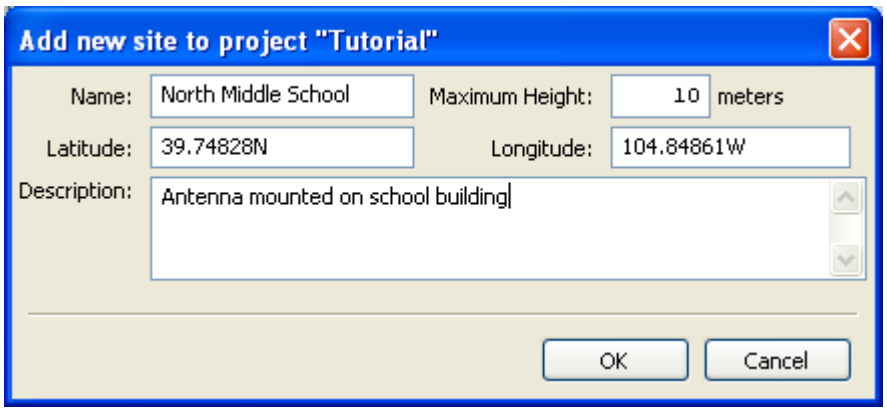


Figure 2.2: Inserting Site 1 (Unlicensed)

4. Select **New Site** 

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

   Name: Park Lane Elementary

   Maximum Height: 10 metres

   Latitude: 39.75914N

   Longitude: 104.83700W

   Description: Antenna mounted in school yard

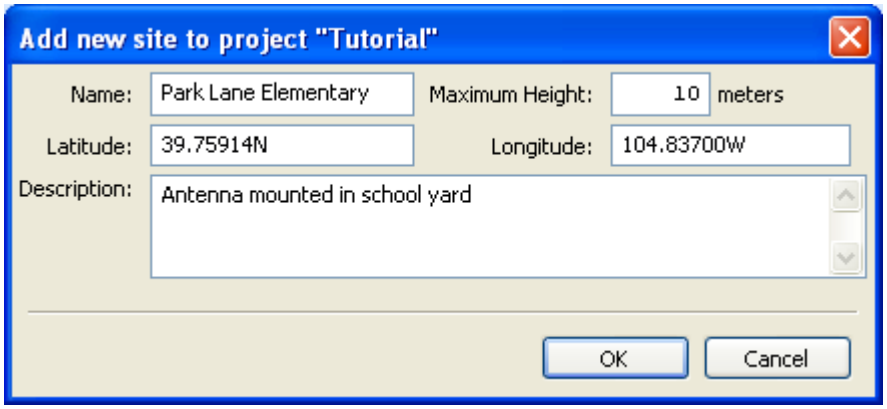


Figure 2.3: Inserting Site 2 (Unlicensed)

5. Select New Link 

   The *Add New Link* page is displayed.

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

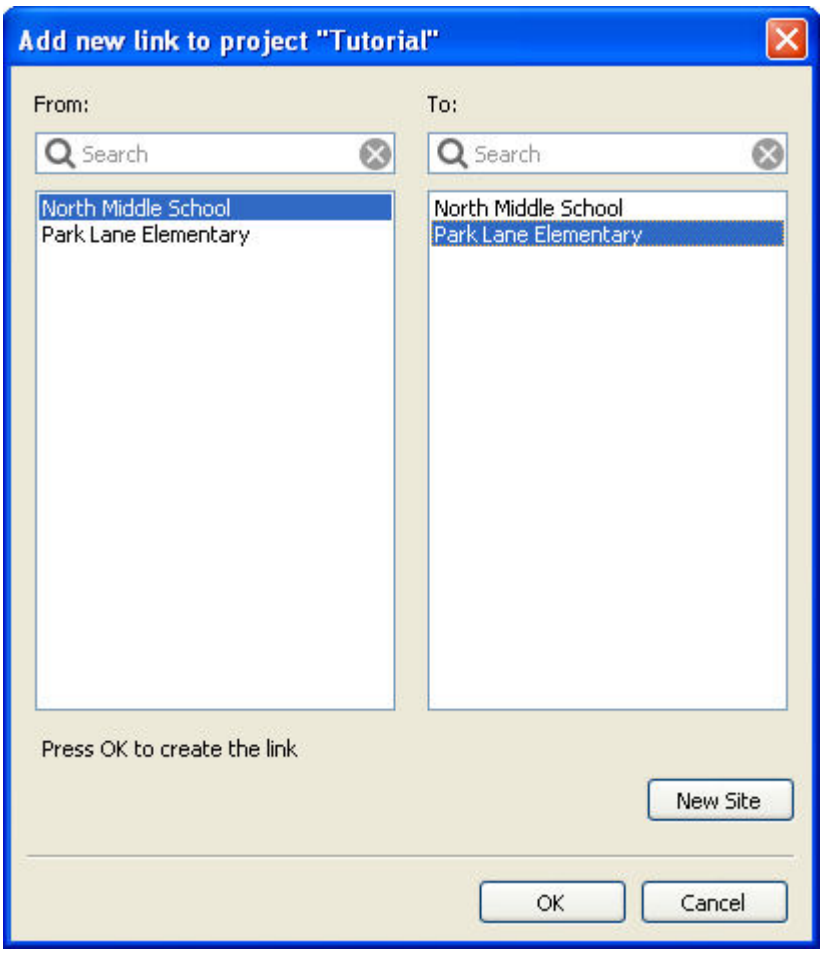


Figure 2.4: Inserting Link (Unlicensed)

6. Select **Project**, **Get Profiles**.

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

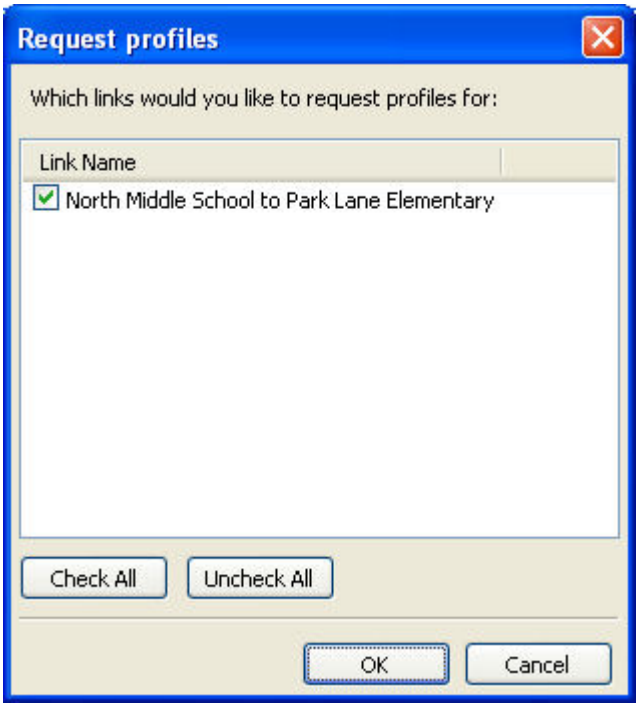


Figure 2.5: Requesting Profiles (Unlicensed)

The profile request is sent to the Motorola PTP Path Profiler. After about 5 minutes, PTP Path Profiler will send an email containing the profile to your inbox.

7. While waiting for the path profile email, configure the link equipment, see *Equipment (unlicensed bands)*:

   Band: 5.8 GHz

   Product: PTP 58500

   Regulation: FCC

   Bandwidth: 15 MHz

   E1/T1: None

   Optimisation: TDM

   Sync: Disabled

   Symmetry: Symmetric

   Dual Payload: Enabled

   Master: North Middle School

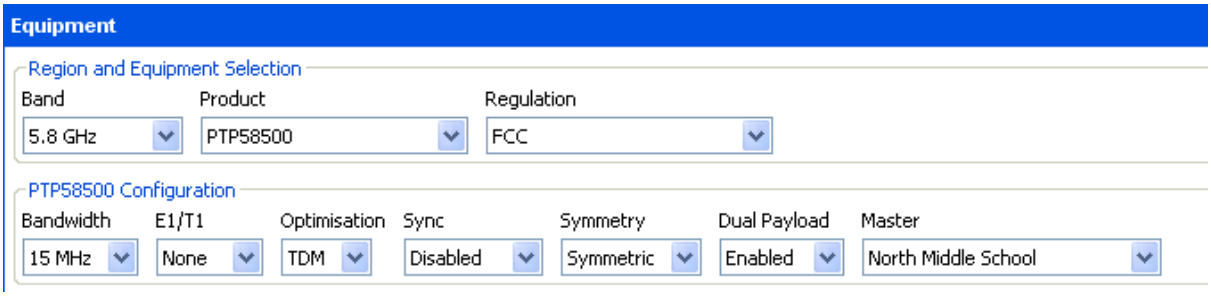


Figure 2.6: Link Equipment (Unlicensed)

8. Select **Save Project** 

Updating Profile with Obstructions (Unlicensed Band)

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

1. Review your email inbox after about 5 minutes. If an email entitled **Motorola PTP Path Profile Do Not Reply** has been received, open it.

   Double-click on the attached file **North_Middle_School_to_Park_Lane_Elementary.ptpdat** and select **Open**.

   The profile in PTP LINKPlanner is automatically updated with the information from the .ptpdat file.

2. Review the *Profile*.

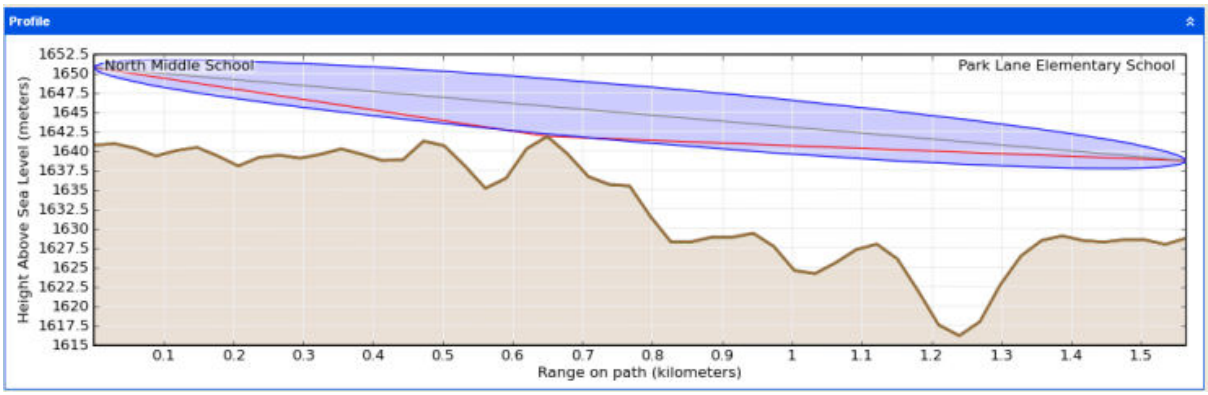


Figure 2.7: Path Profile (Unlicensed)

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

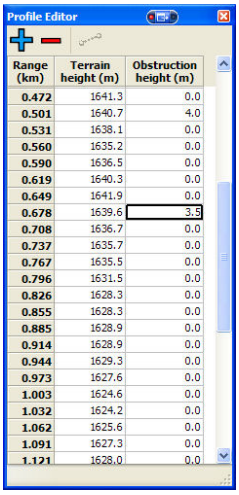
   The profile can be verified using Google Earth(TM), maps, GPS data and site visits. It is particularly important to verify the antenna heights, to measure interference and to identify obstructions near both ends of the Fresnel zone.

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

4. Double-click on the profile. The Profile Editor is displayed. Enter a 4 metre high Obstruction at Range 0.501 km and a 3.5 metre 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)
0.472	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
1.003	1624.6	0.0
1.032	1624.2	0.0
1.062	1625.6	0.0
1.091	1627.3	0.0
1.121	1628.0	0.0

Figure 2.8: Profile Editor (Unlicensed)

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

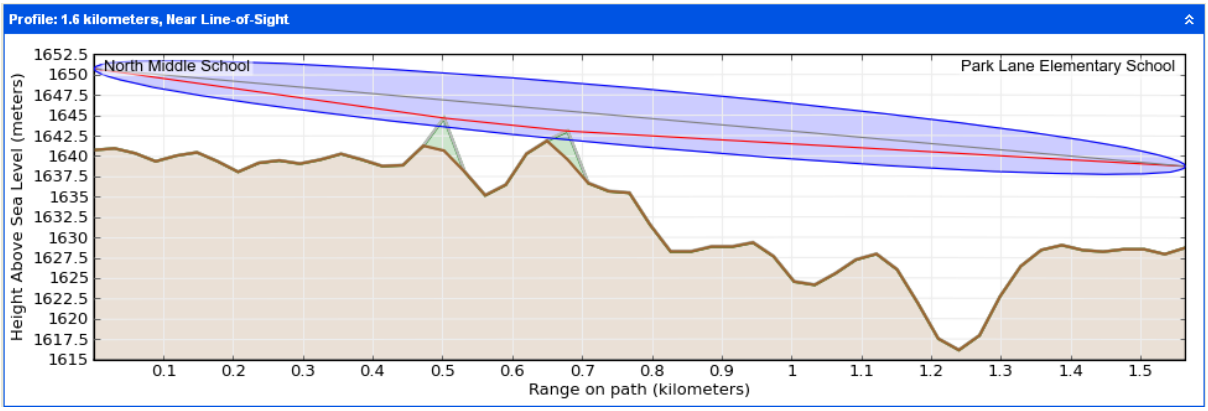


Figure 2.9: Path Profile with Obstructions (Unlicensed)

6. Select 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.

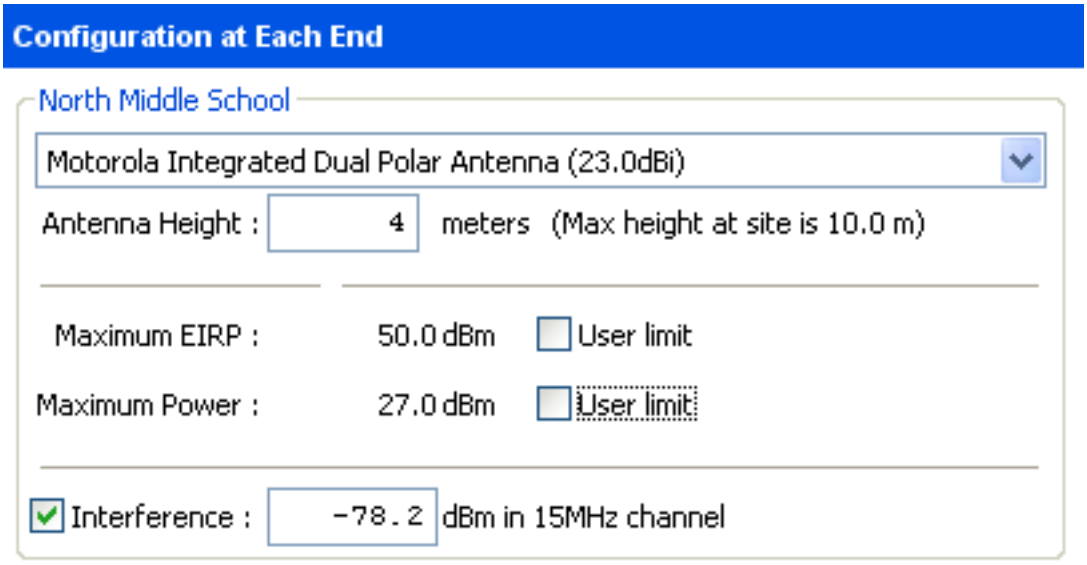


Figure 2.10: Adjust One End of Unlicensed Link

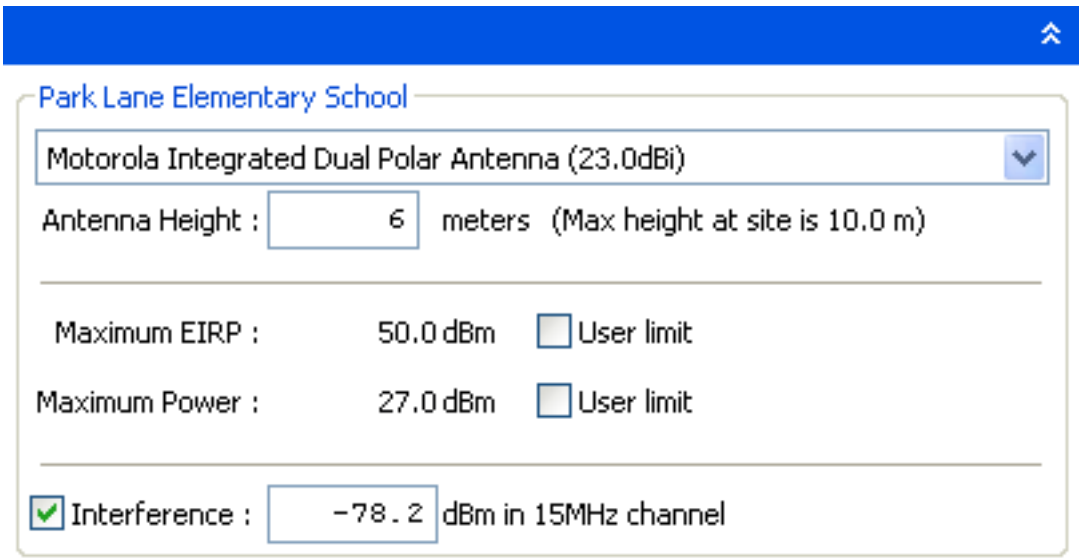


Figure 2.11: Adjust Other End of Unlicensed Link

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.

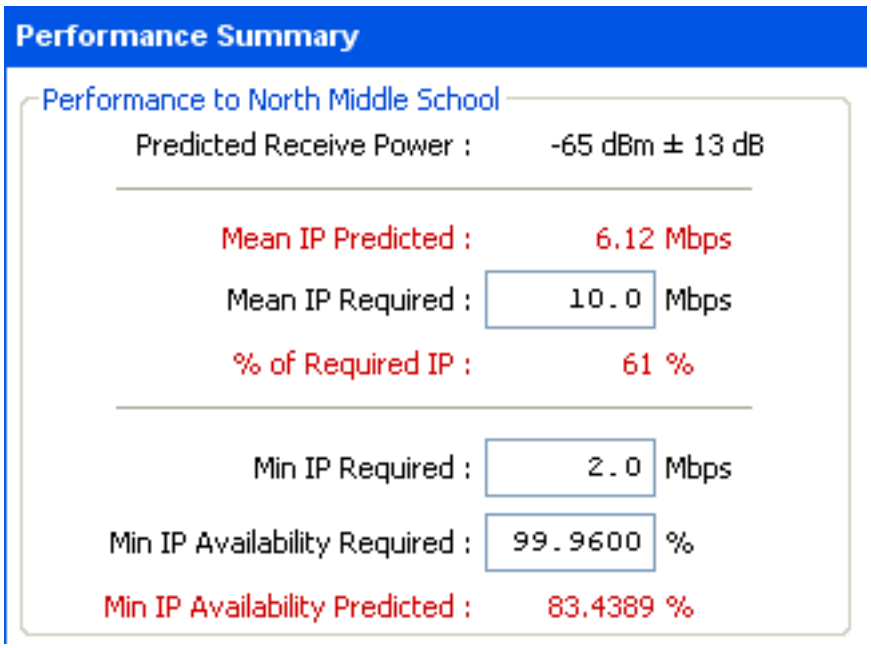


Figure 2.12: Performance Unacceptable at One End of Unlicensed Link

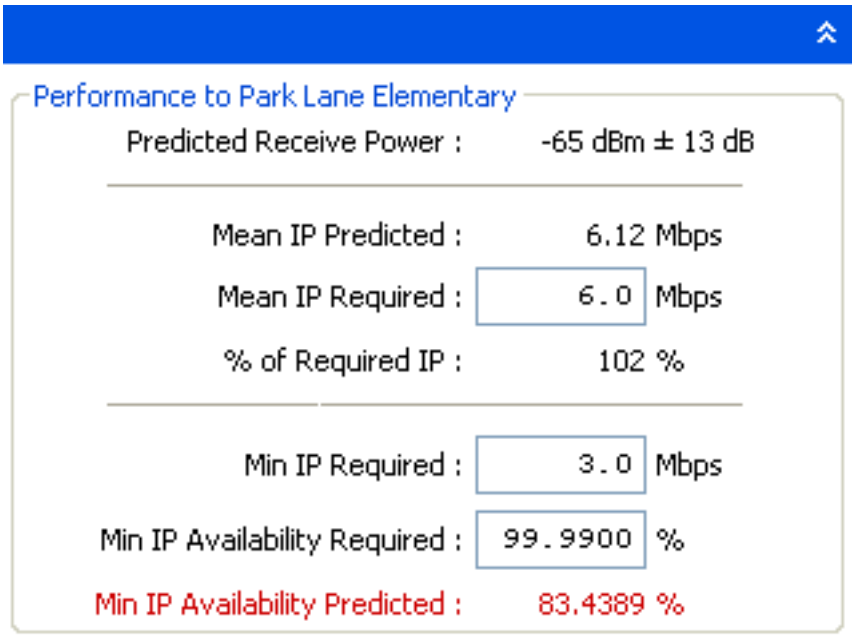


Figure 2.13: Performance Unacceptable at Other End of Unlicensed Link

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

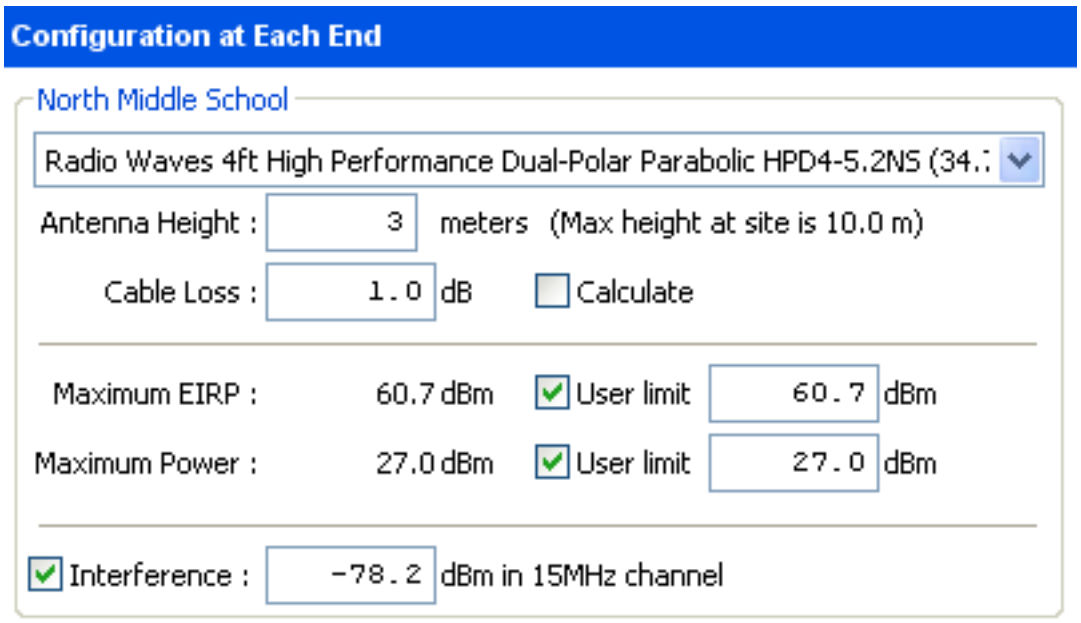


Figure 2.14: Adjust One End of Unlicensed Link Again

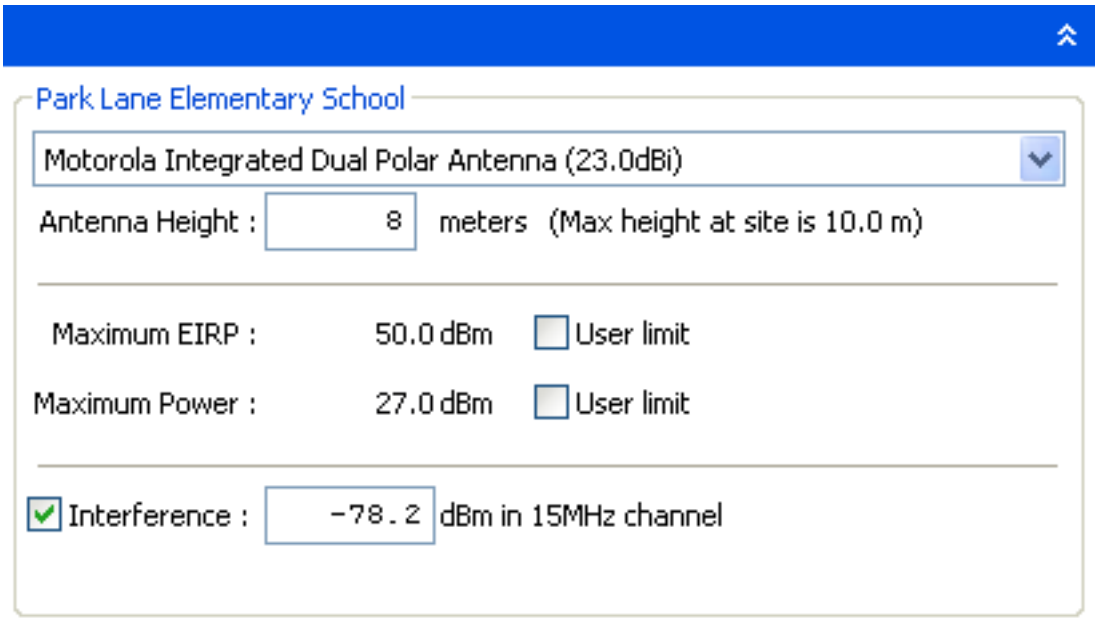


Figure 2.15: Adjust Other End of Unlicensed Link Again

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

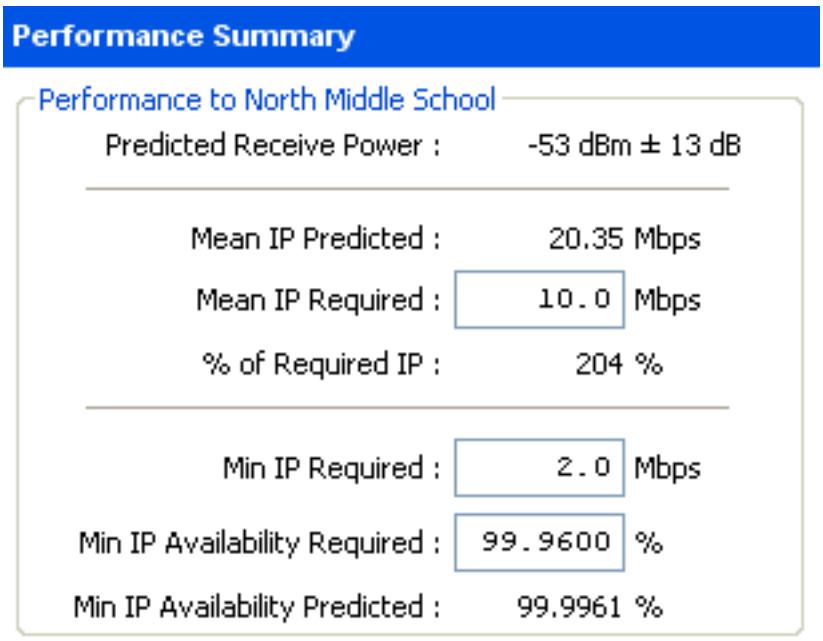


Figure 2.16: Performance Acceptable at One End of Unlicensed Link

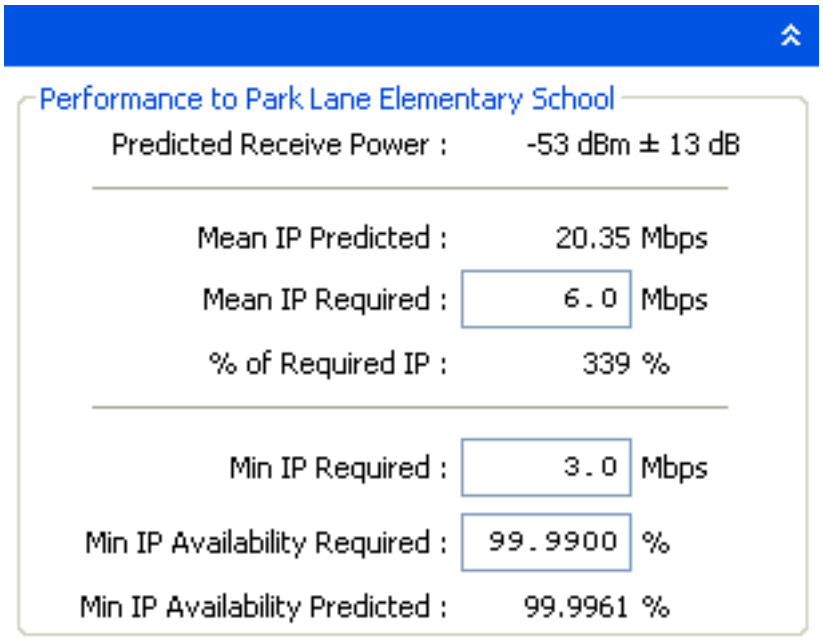


Figure 2.17: Performance Acceptable at Other End of Unlicensed Link

5. Select Save Project 

Quick Tutorial - Licensed Band

This section is a quick tutorial for experienced Windows or Mac users. It describes how to create a project to analyse the performance of a single 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 PTP 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)*.

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. Obtain the path profile for the link and update it 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. Select **New Project**  .

   The *Project Page* is displayed

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

   Select **Save Project** 

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

3. Select **New Site** 

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

   Name: Wood Farm

   Maximum Height: 15 metres

   Latitude: 50.44138N

   Longitude: 003.77435W

   Description: Antenna mounted on roof

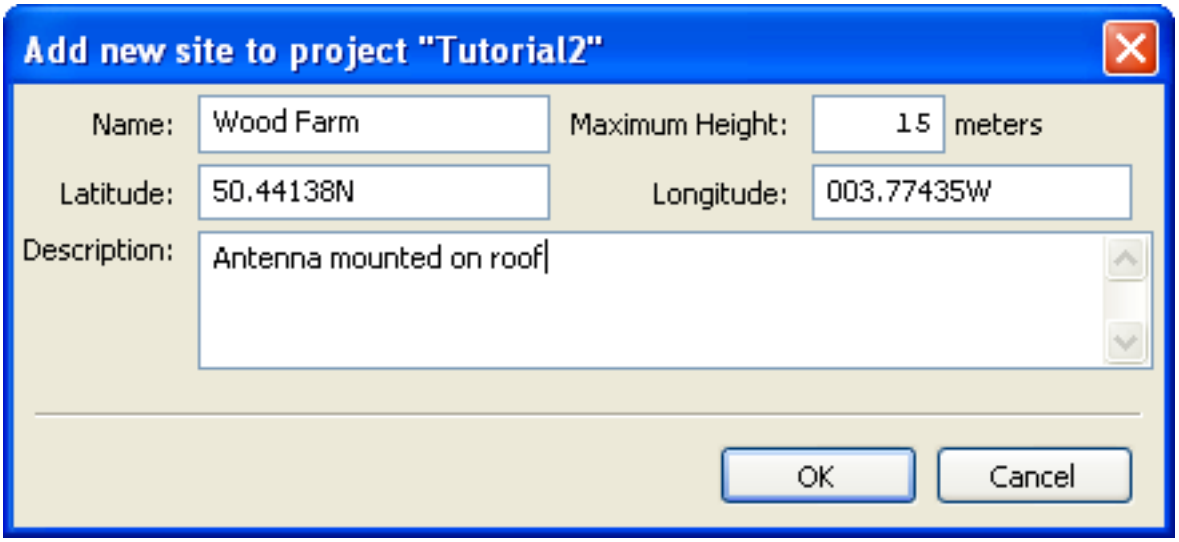


Figure 2.18: Inserting Site 1 (Licensed)

4. Select **New Site** 

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

   Name: West Tower

   Maximum Height: 15 metres

   Latitude: 50.44840N

   Longitude: 003.77415W

   Description: Antenna mounted on tower

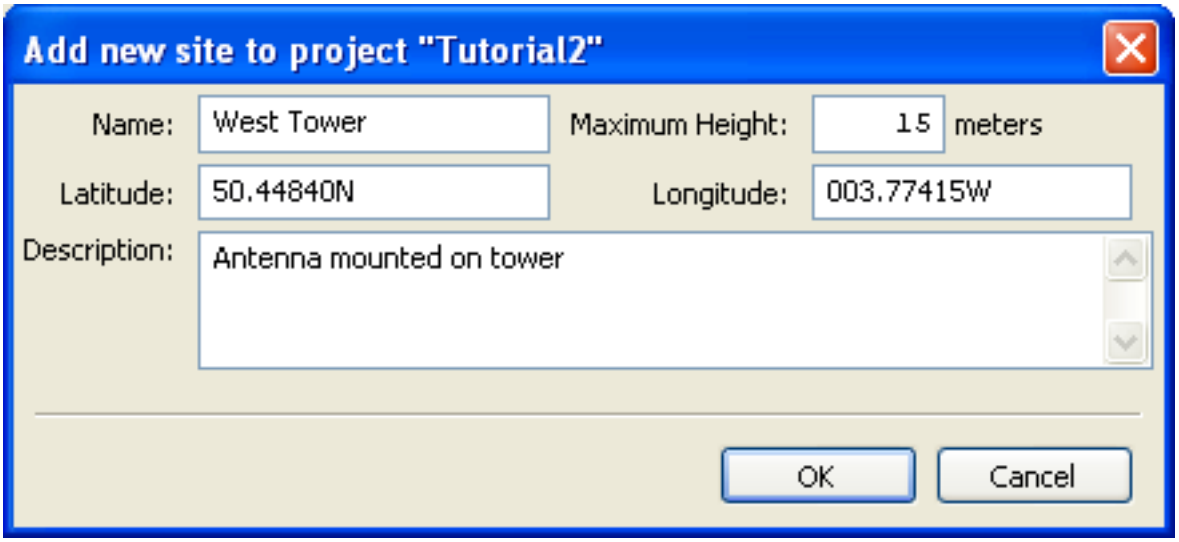


Figure 2.19: Inserting Site 2 (Licensed)

5. Select **New Link** 

   The *Add New Link* page is displayed.

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

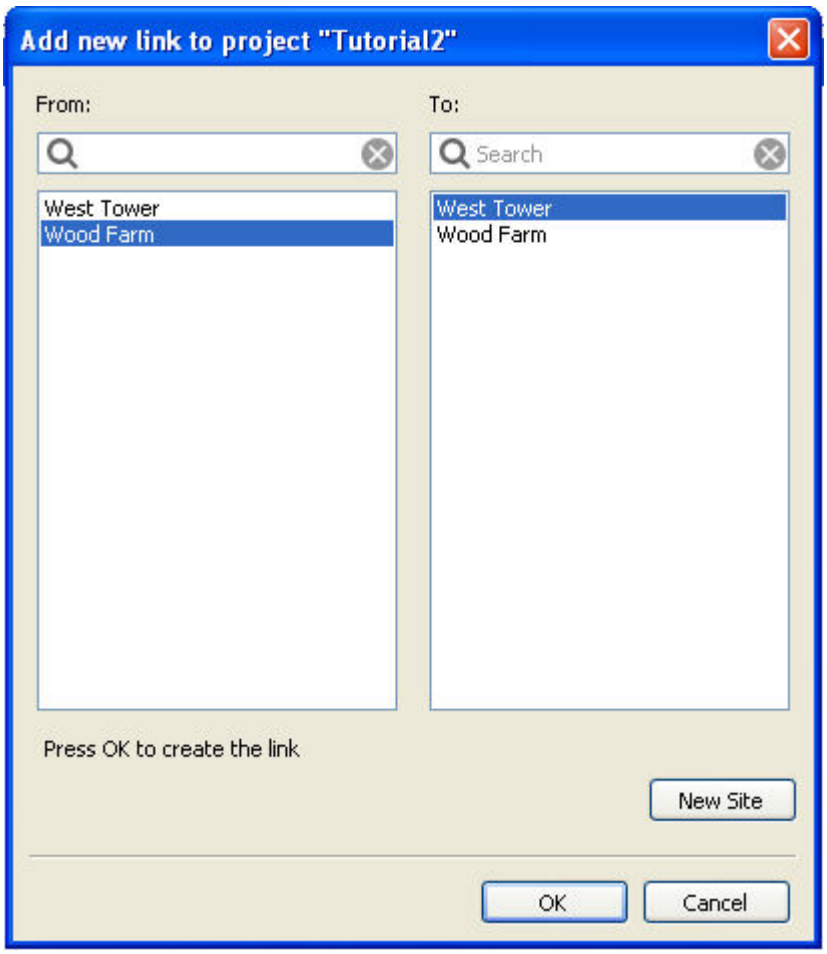


Figure 2.20: Inserting Link (Licensed)

6. Select **Project**, **Get Profiles**.

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

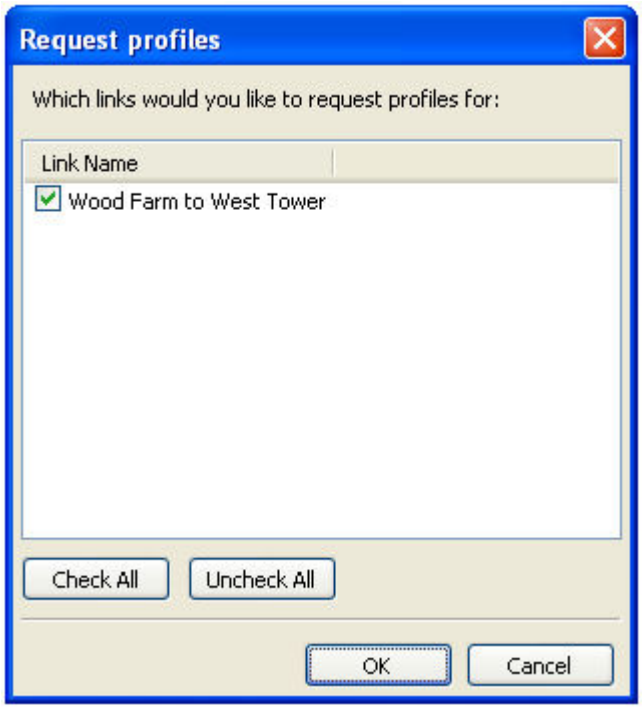


Figure 2.21: Requesting Profiles (Licensed)

The profile request is sent to the Motorola PTP Path Profiler. After about 5 minutes, PTP Path Profiler will send an email containing the profile to your inbox.

7. While waiting for the path profile email, 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)

   Polarisation: Vertical

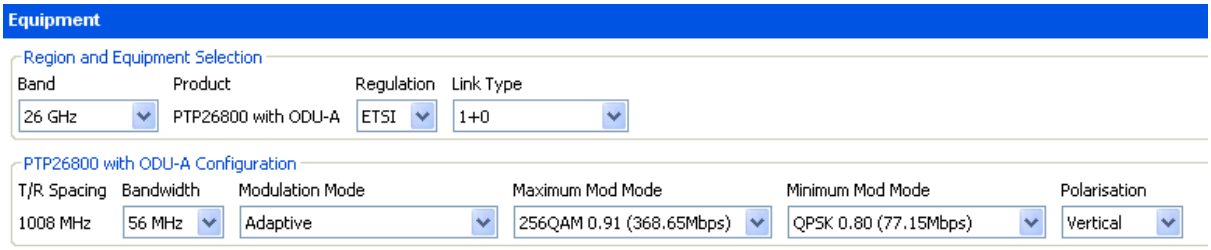


Figure 2.22: Link Equipment (Licensed)

8. Select **Save Project** 

Updating Profile with Obstructions (Licensed Band)

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

1. Review your email inbox after about 5 minutes. If an email entitled **Motorola PTP Path Profile Do Not Reply** has been received, open it.

   Double-click on the attached file **Wood_Farm_to_West_Tower.ptpdat** and select Open.

   The profile in PTP LINKPlanner is automatically updated with the information from the .ptpdat file.

2. Review the *Profile*.

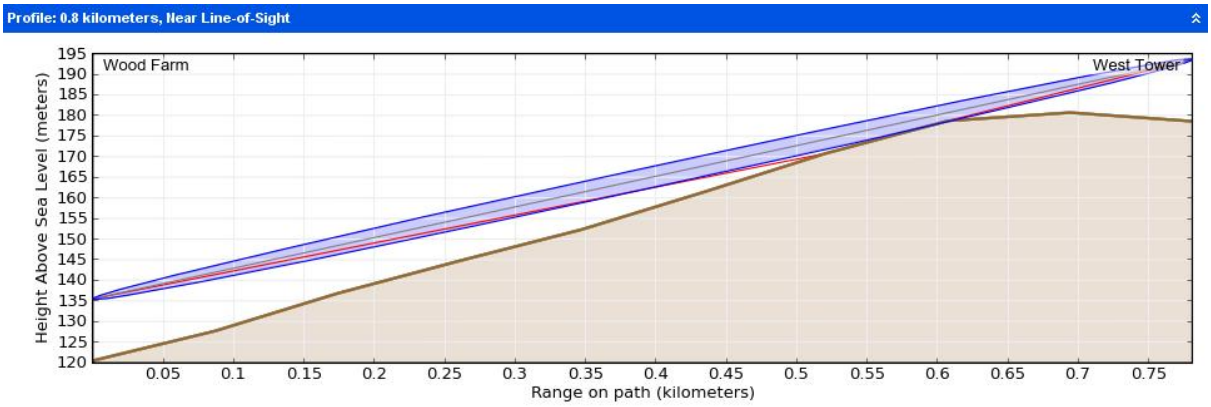


Figure 2.23: Path Profile (Licensed)

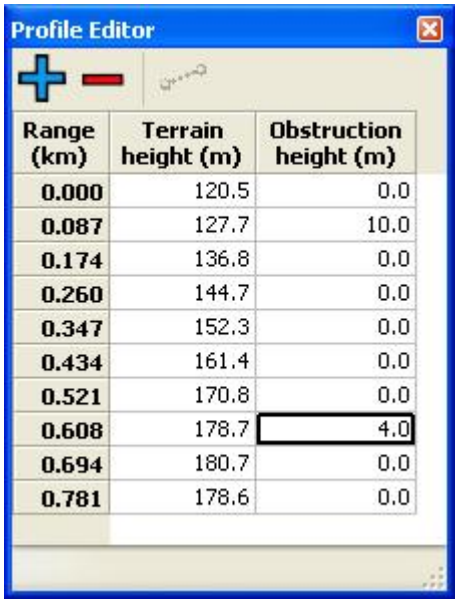
3. Check that the profile is accurate and identify any obstructions that may affect signal quality.

   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	120.5	0.0
0.087	127.7	10.0
0.174	136.8	0.0
0.260	144.7	0.0
0.347	152.3	0.0
0.434	161.4	0.0
0.521	170.8	0.0
0.608	178.7	4.0
0.694	180.7	0.0
0.781	178.6	0.0

Figure 2.24: Profile Editor (Licensed)

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

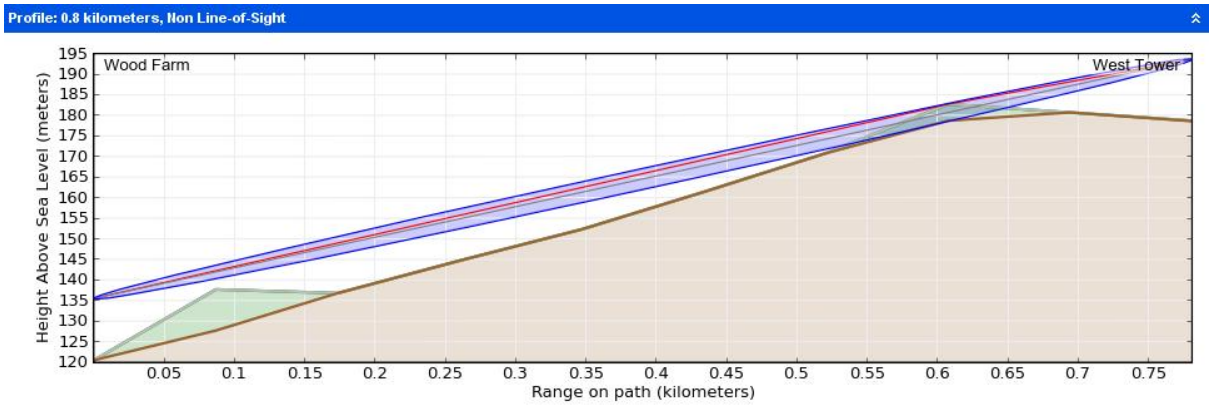


Figure 2.25: Path Profile with Obstructions (Licensed)

6. Select 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.

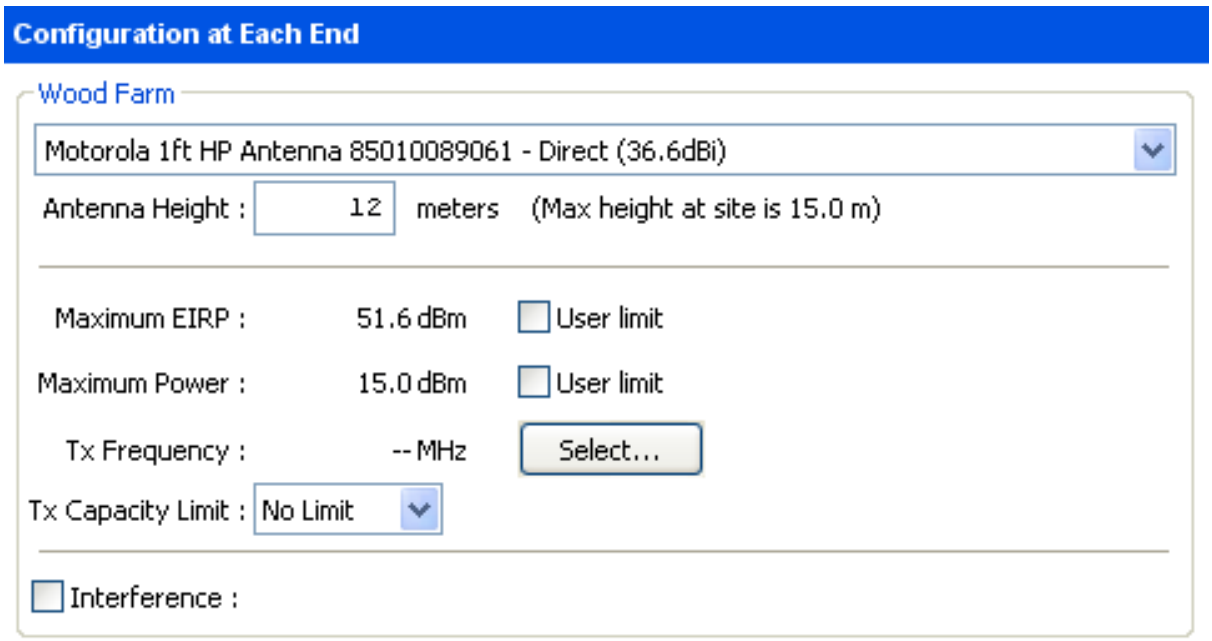


Figure 2.26: Adjust One End of Licensed Link

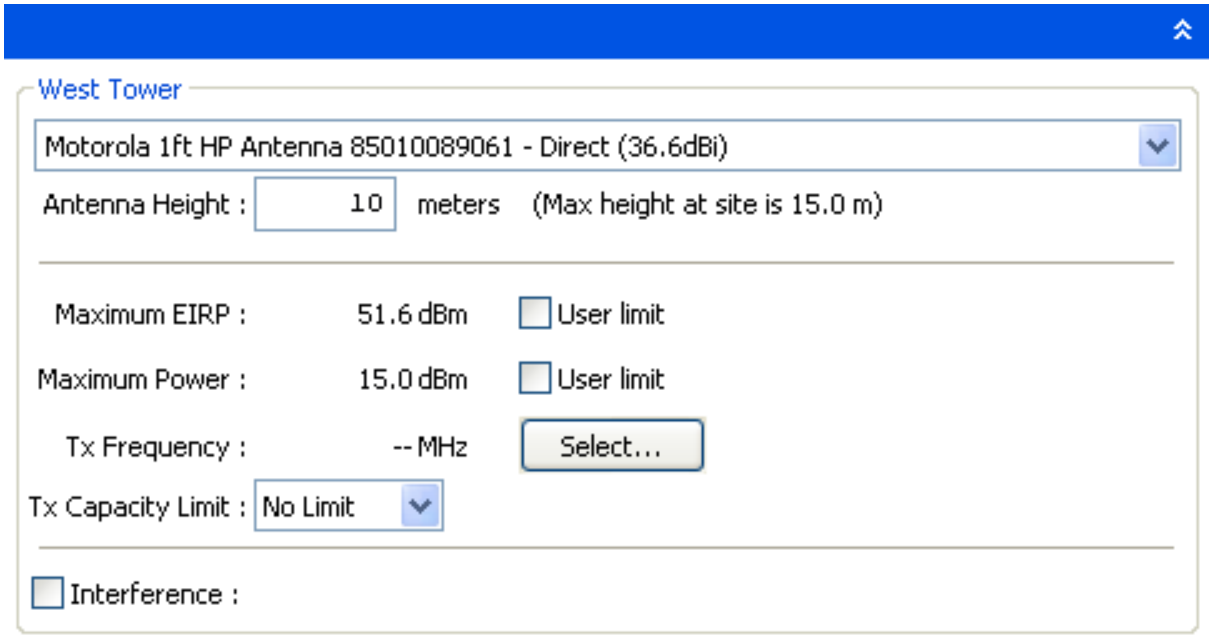


Figure 2.27: Adjust Other End of Licensed Link

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.

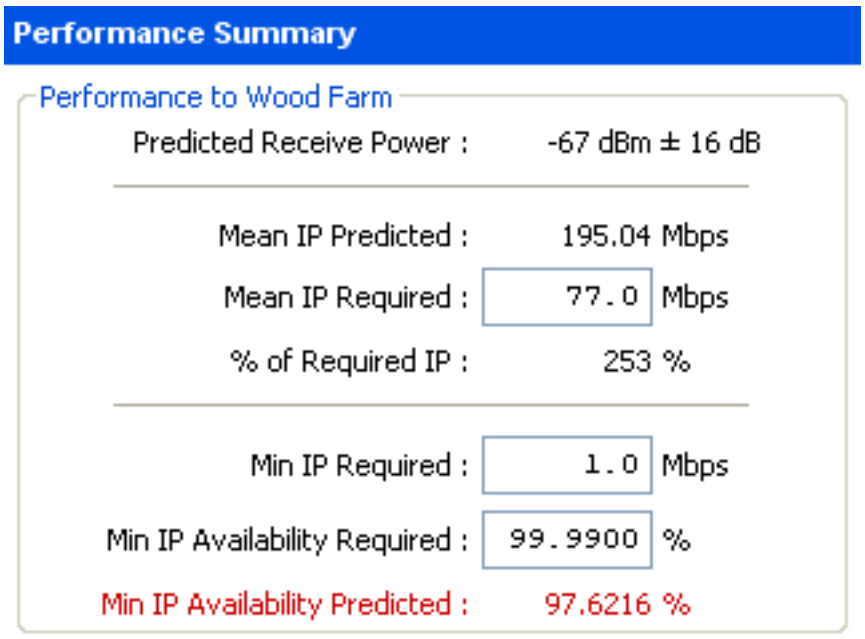


Figure 2.28: Performance Unacceptable at One End of Licensed Link

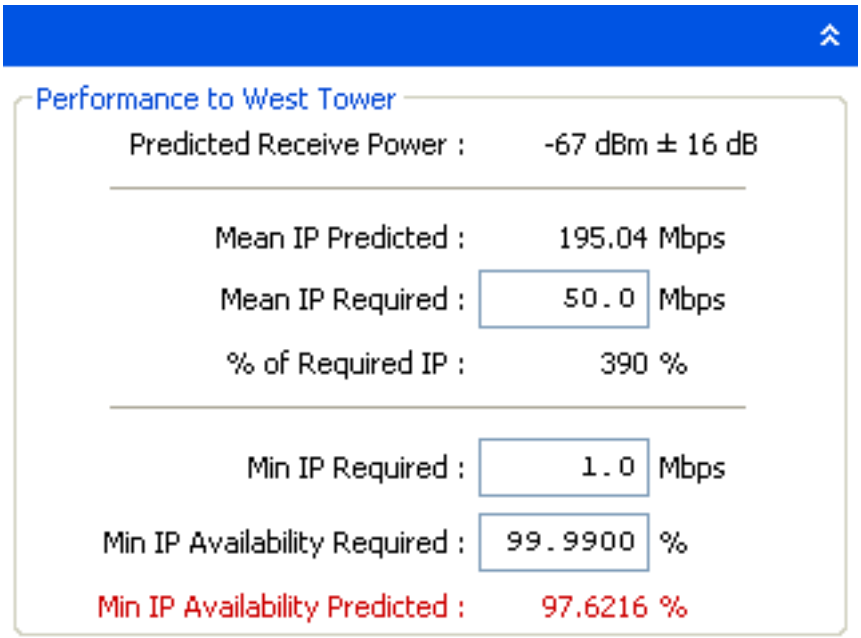


Figure 2.29: Performance Unacceptable at Other End of Licensed Link

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

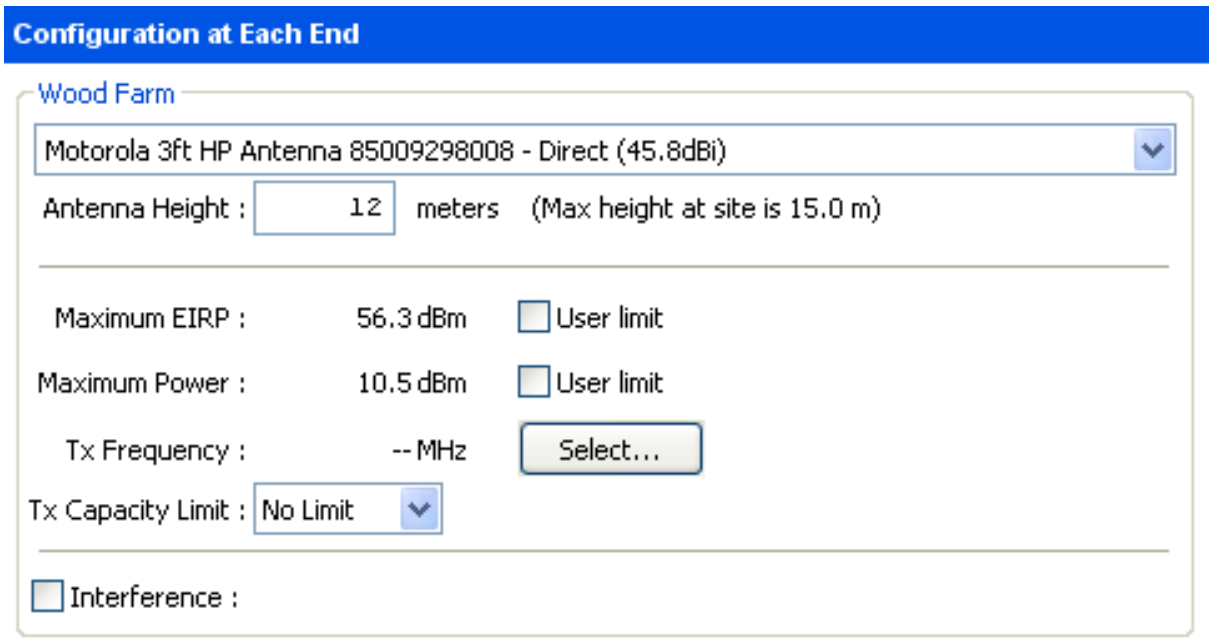


Figure 2.30: Adjust One End of Licensed Link Again

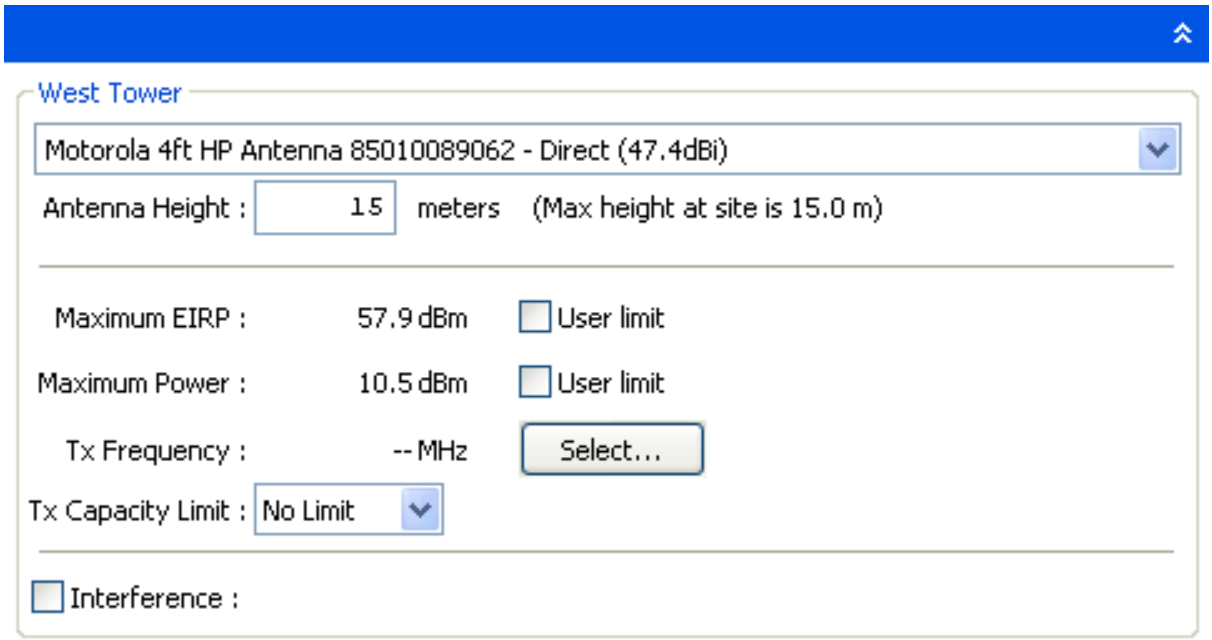


Figure 2.31: Adjust Other End of Licensed Link Again

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

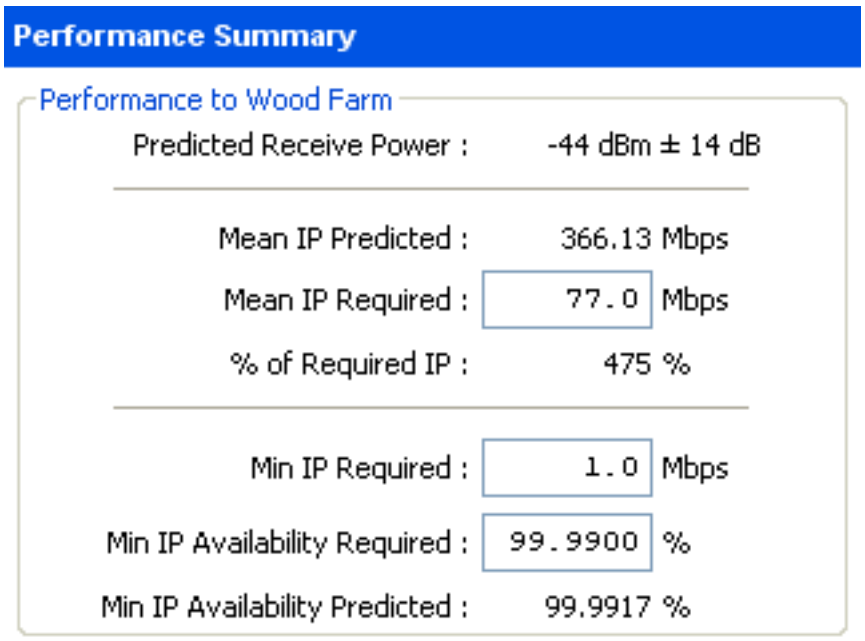


Figure 2.32: Performance Acceptable at One End of Licensed Link

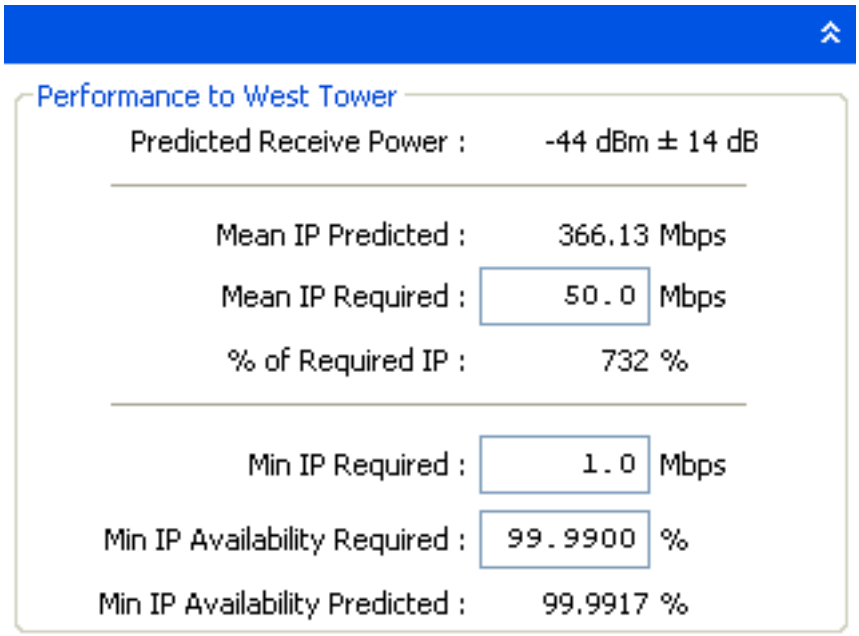


Figure 2.33: Performance Acceptable at Other End of Licensed Link

5. Select Save Project 

Using PTP LINKPlanner

The goal of 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 PTP 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*

User Interface Tips

Custom fields can be assigned to projects by selecting the **Custom Field** node in the Navigation Tree.

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**  .

Starting the Application

Start PTP LINKPlanner. The Main Screen is displayed.

NOTE

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

Main Screen

The *Main Screen* consist 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.

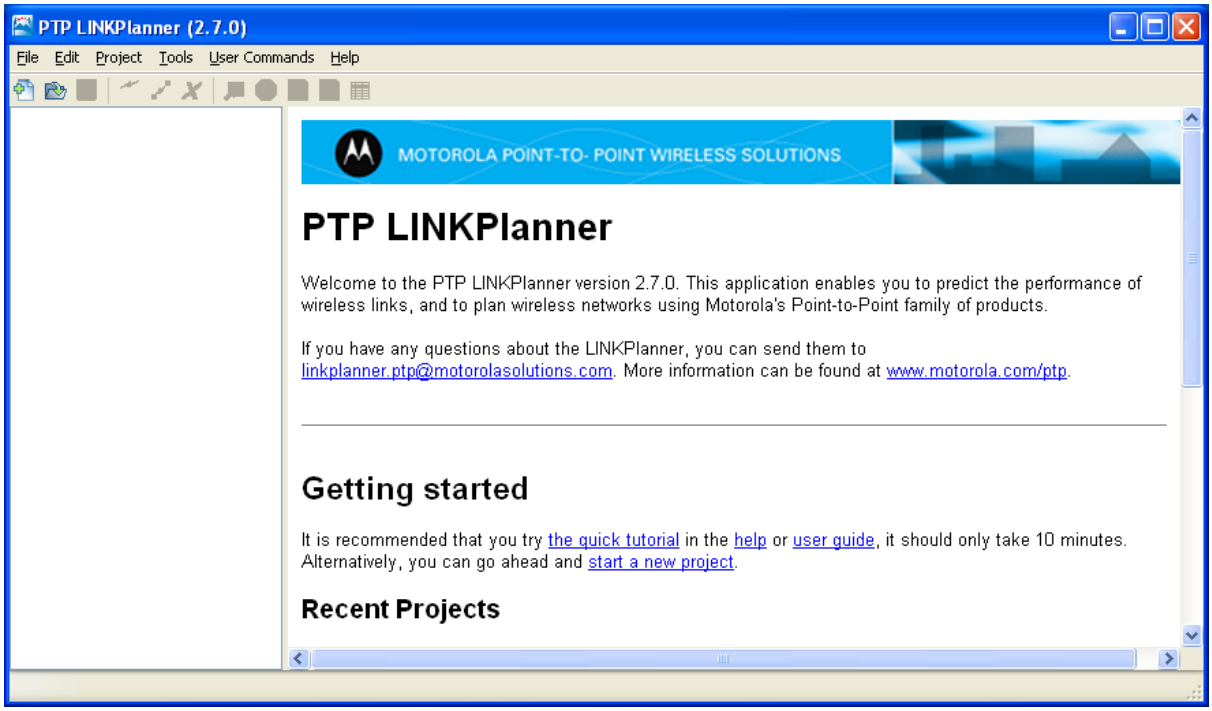


Figure 3.1: Main Screen

Options (Preferences)

Before using PTP 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, select **Tools**, **Options**.

- On a Mac, open **Preferences**.

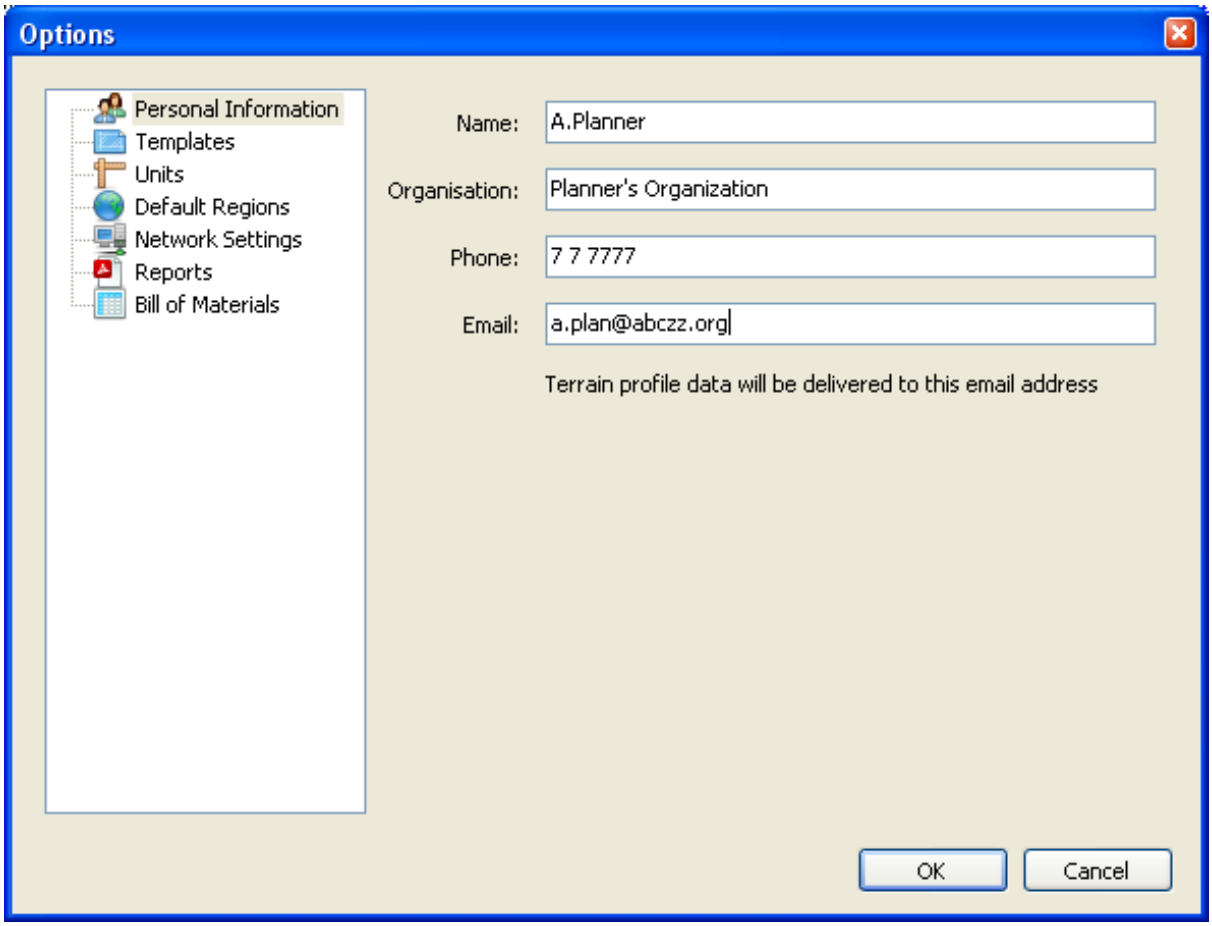


Figure 3.2: Options (Preferences) Page

Personal Information

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

NOTE

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

Templates

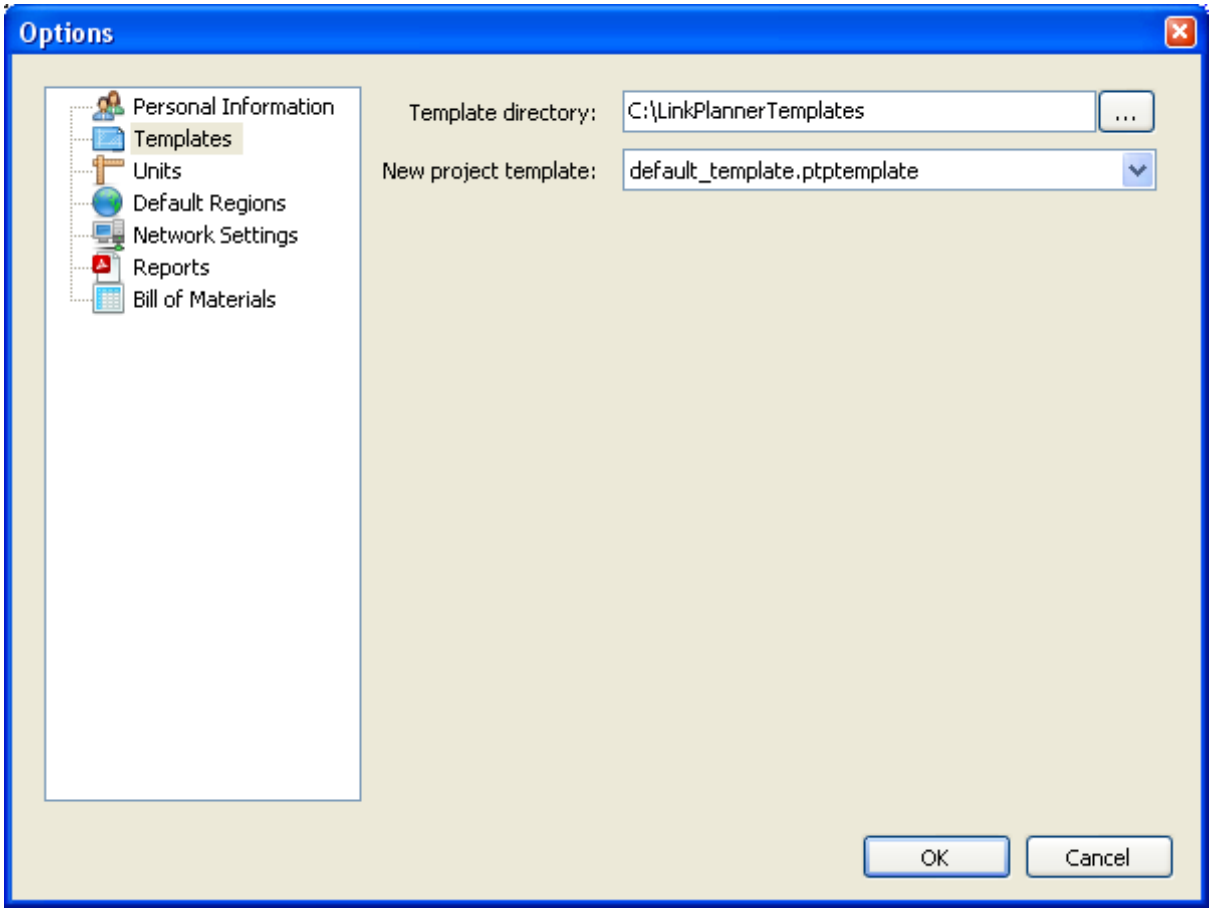


Figure 3.3: Templates Page

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.

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

Units

Select the required units for Height, Length, Latitude and Longitude.

Default Regions

Select the priority order for the default licenses for each region.

Network Settings

Select options for connecting to the network. The Get Profiles feature uses these settings, as described in *Obtaining Link Profiles*. PTP 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.

⚠ CAUTION

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

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.

Bill of Materials

Select the default region option for power leads

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*):

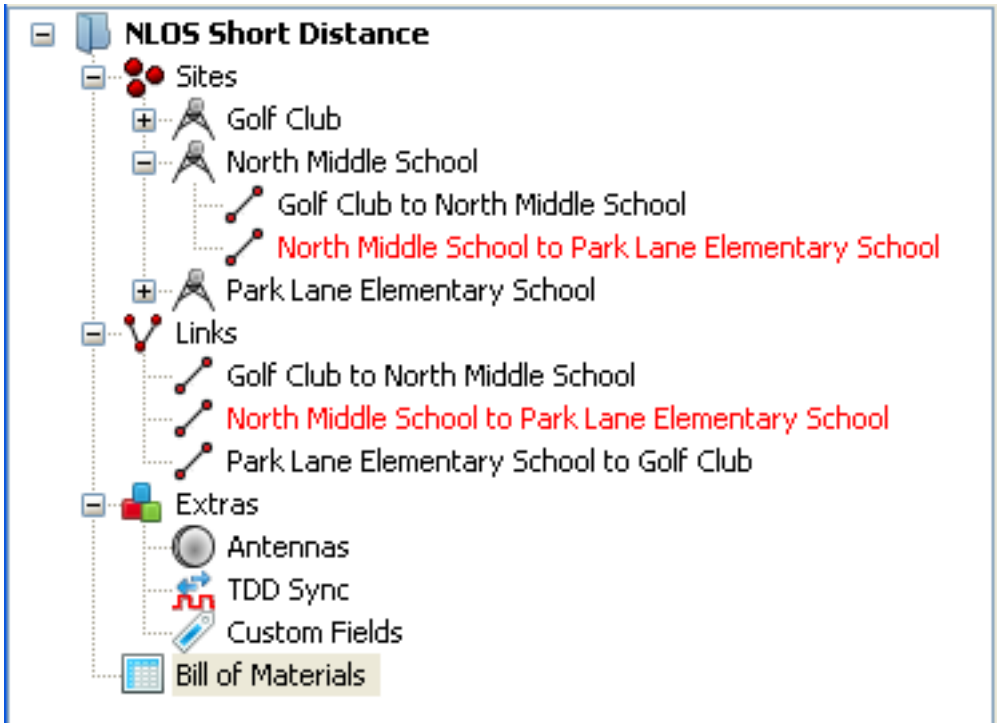


Figure 3.4: Navigation Tree

Use the + and - boxes to open and close each level: project, site and link. Click on a node to open it for viewing and updating.

The PTP 800 product has 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 = 2+0 Cross-Polar

 Link Type = 2+0 Co-Polar

Project Node

To display the Project page, click on a project node, for example “NLOS Short Distance”. 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, select **File**, **Save** (or **Save As**), or select **Save Project**  . All project, site and link data is saved. The project name reverts to normal typeface when saved.

Sites Node

To display the list of all sites within the project, click on the “Sites” node. See *Displaying the Sites List*.

Individual Site Node

To display the Site page, click on an individual site node, for example “North Middle School”. See *Site Page*.

Links Node

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

Individual Link Node

To display the Link page, 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.

Extras Node

To edit custom antennas, TDD synchronization parameters and custom fields, click on the “Extras” node. See *Extras*.

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*.

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 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*.

Creating, Saving and Viewing Projects

New Projects

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

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

Saving Projects

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

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

PTP LINKPlanner now uses the .ptpprj file name as the project name in the navigation tree.

Figure 3.5: Project Node NLOS Short Distance 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:

- Select **File**, **Open (Ctrl+O)**.
- Select **Open Project**  .

- Select **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, and the default settings for new links.

NOTE

You can vary these defaults settings in the Links Page for each link. See *Introduction to Link Evaluation*.

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.

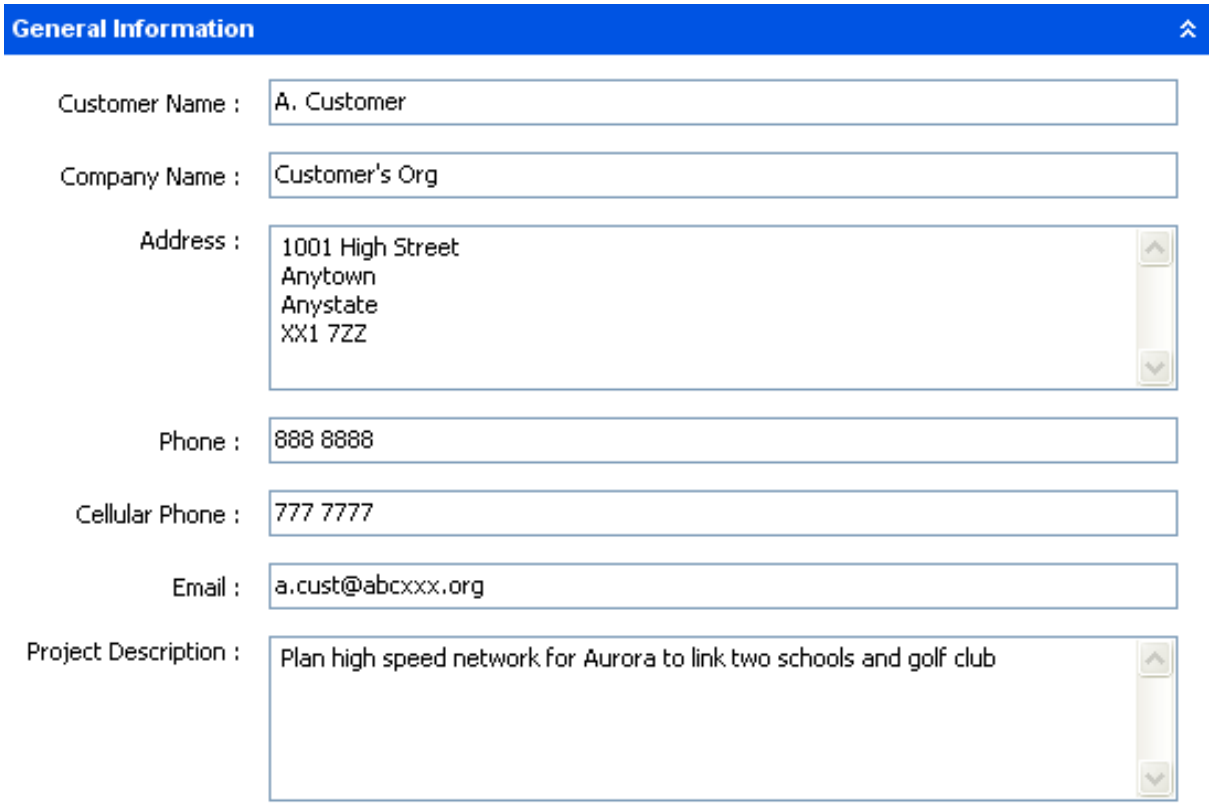


Figure 3.6: General Information

Map

The *Project Map* is a simple plan of the sites and links that have been entered in this 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.

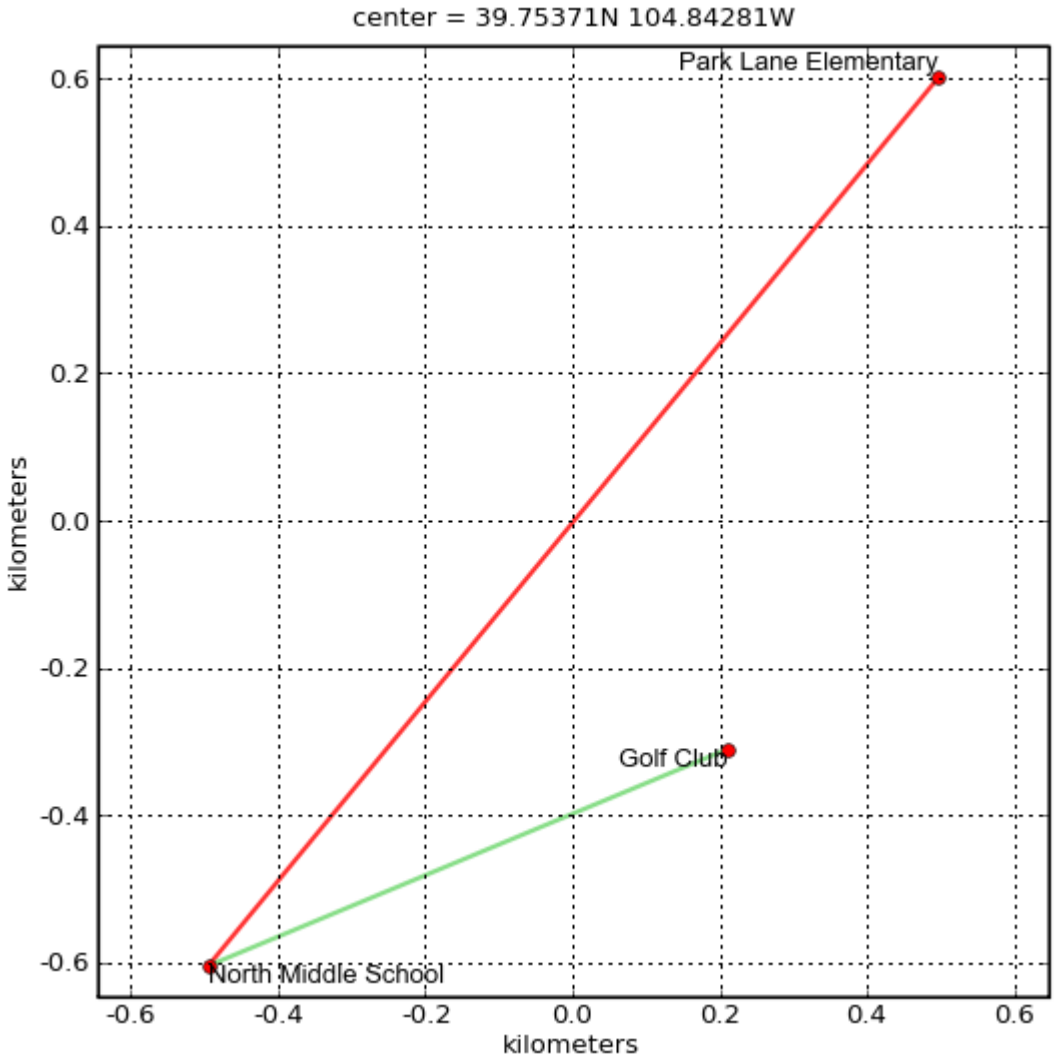


Figure 3.7: Project Map

Default Settings for New Links

Select the Equipment Defaults for the project. For definitions of the fields, see *Link Description and Equipment*.

Select the Default 1 and Default 2 site antenna defaults for the project. For definitions of the fields, see *Configuration at Each End*.

To use these defaults in all new projects, then save the project as a *project template*.

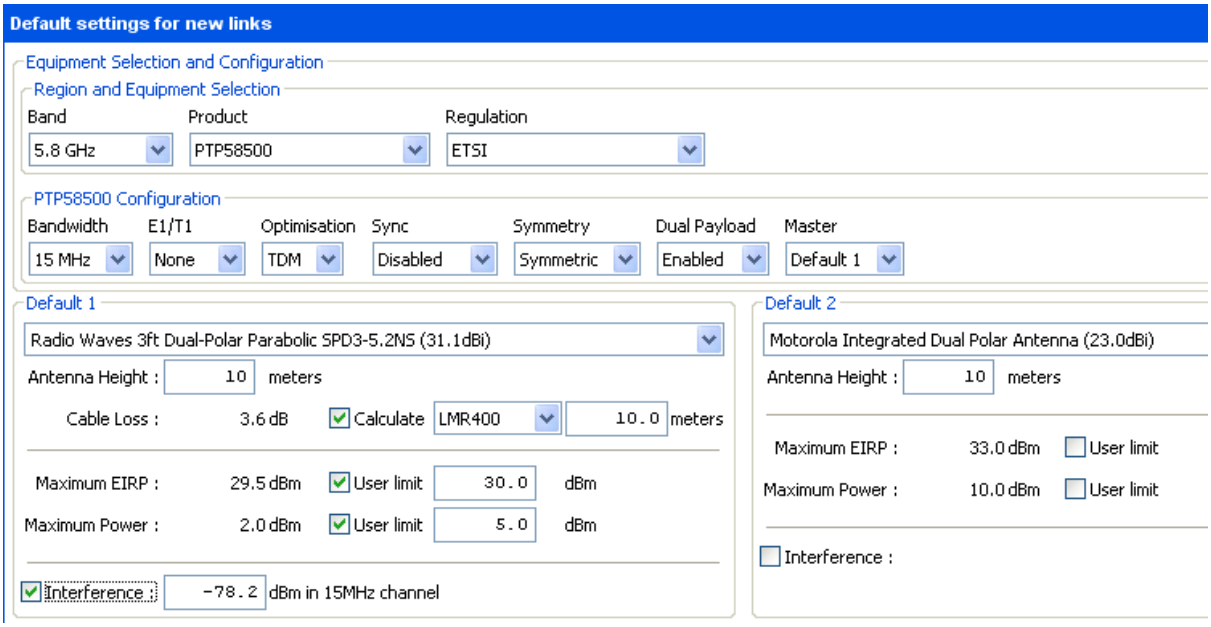


Figure 3.8: Default Settings for New Links

Importing Path Data

If path data is available in Hydra, PTP 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 or Pathloss.

Hydra files (.pth)

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

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

PTP files (.ptpdat)

PTP files contain data for sites, links and profiles. Select **File**, **Import**, **PTP Path (.ptpdat)**.

Pathloss files (.txt)

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

Sites

Sites are points that must be connected via PTP links. A Project would normally contain at least two sites.

Identify all sites in the project 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.
- Multimap: http://www.multimap.com/.

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)*.

New Sites

Import sites from external files as described in *Copying or Importing Sites*, or create them in PTP LINKPlanner as described in *Creating Sites*.

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 PTP 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 PTP 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.

NOTE

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 PTP LINKPlanner:

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

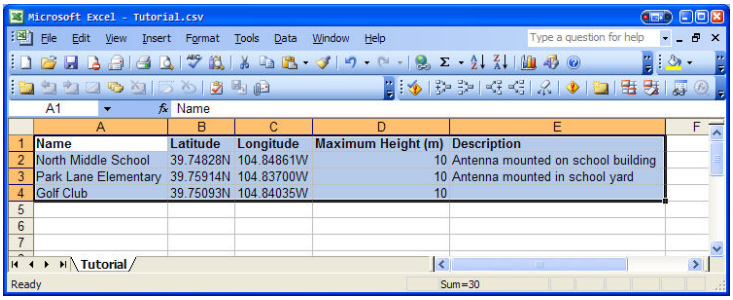


Figure 3.9: Importing From a Spreadsheet Using Copy and Paste

   - To import from CSV: save the spreadsheet as a CSV (comma separated) file; then in PTP LINKPlanner, select **File**, **Import**, **Sites from CSV**.
2. Whichever method is used, the *Table Import Wizard* is presented:

   PTP 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.

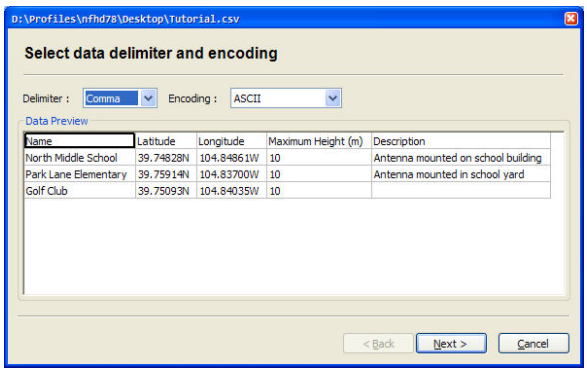


Figure 3.10: Table Import Wizard

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.

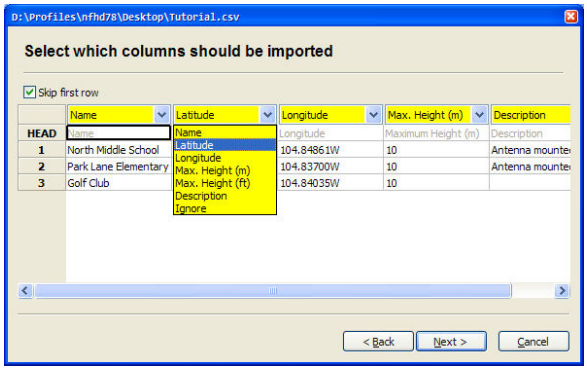


Figure 3.11: Selecting Columns to be Imported

4. Correct any values that cannot be imported:

   If PTP 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*).

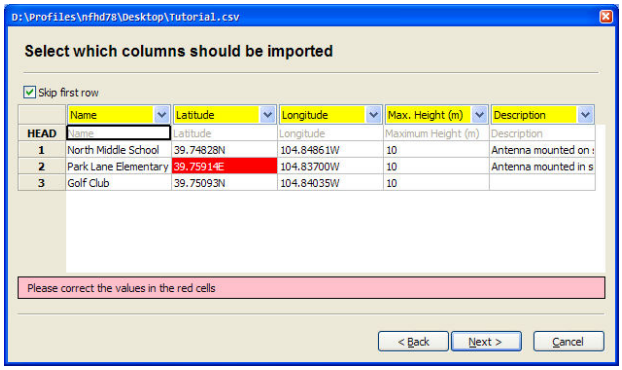


Figure 3.12: Value Cannot be Interpreted

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**.

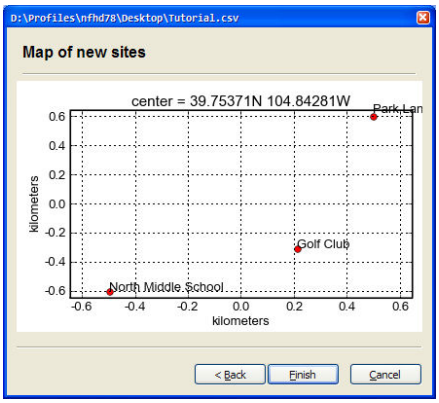


Figure 3.13: Map of Newly Imported Sites

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 Multimap. Copy the latitude and longitude of each site.

To insert the site in PTP LINKPlanner, either select **Project**, **New Site**, or select **New Site**  . The New Site page is displayed.

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

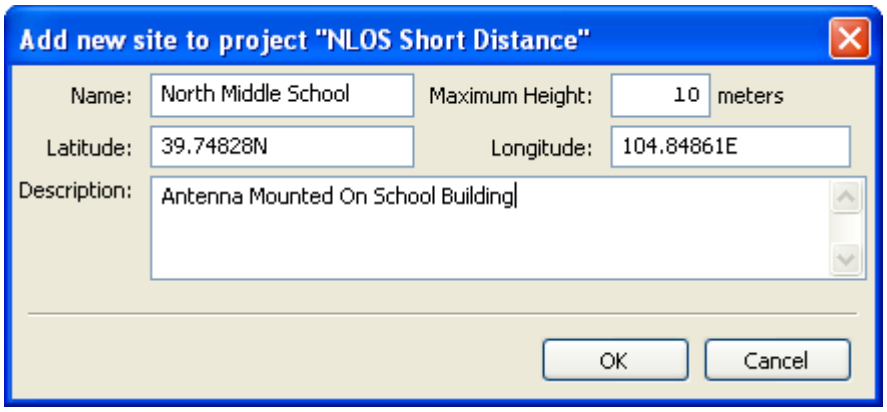


Figure 3.14: New Site Page

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:

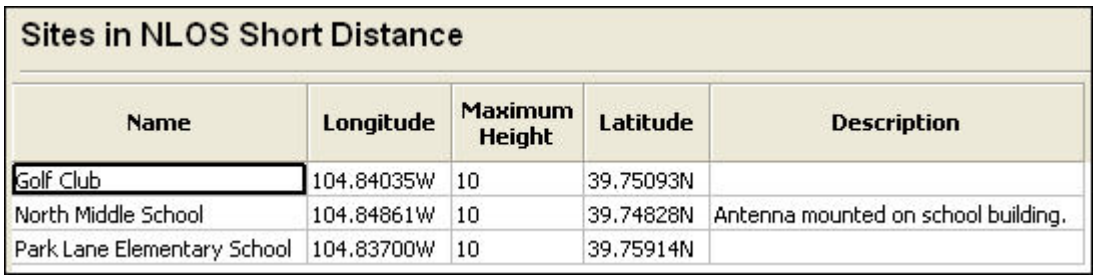
Format	Examples
Decimal degrees prefixed by sign to indicate point of Compass: + means North or East. - means South or West.	*+12.34567* *-12.34567*
Decimal degrees and point of Compass.	*12.34567N* *12.34567E*
Degrees, decimal minutes and point of compass.	*12:34.567S*
Degrees, minutes, decimal seconds 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 sites have been created, they appear in the *Sites List*. To display this list, select the **“Sites”** node in the navigation tree. The Sites list is displayed in the right hand panel.



Sites in NLOS Short Distance

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

Figure 3.15: 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.

Deleting Sites

The Sites list can be used to delete sites altogether. To delete a site, right-click over it and select **Delete Sites**.

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*.

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*.

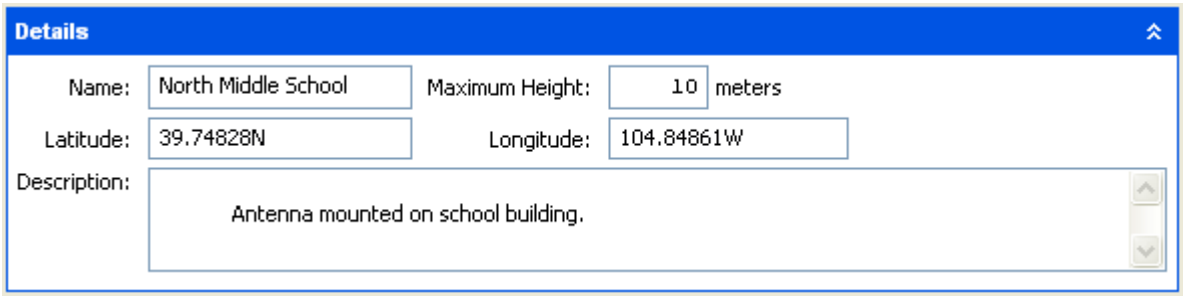


Figure 3.16: Details in Site Page

Links

This is a list of links that have been defined between this site and other sites in the project. 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*.

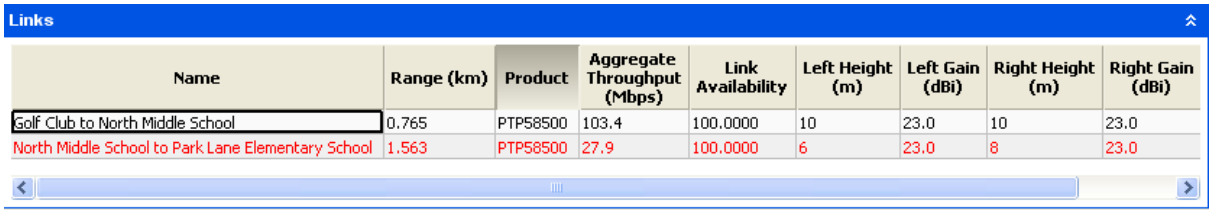


Figure 3.17: Links in Site Page

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.

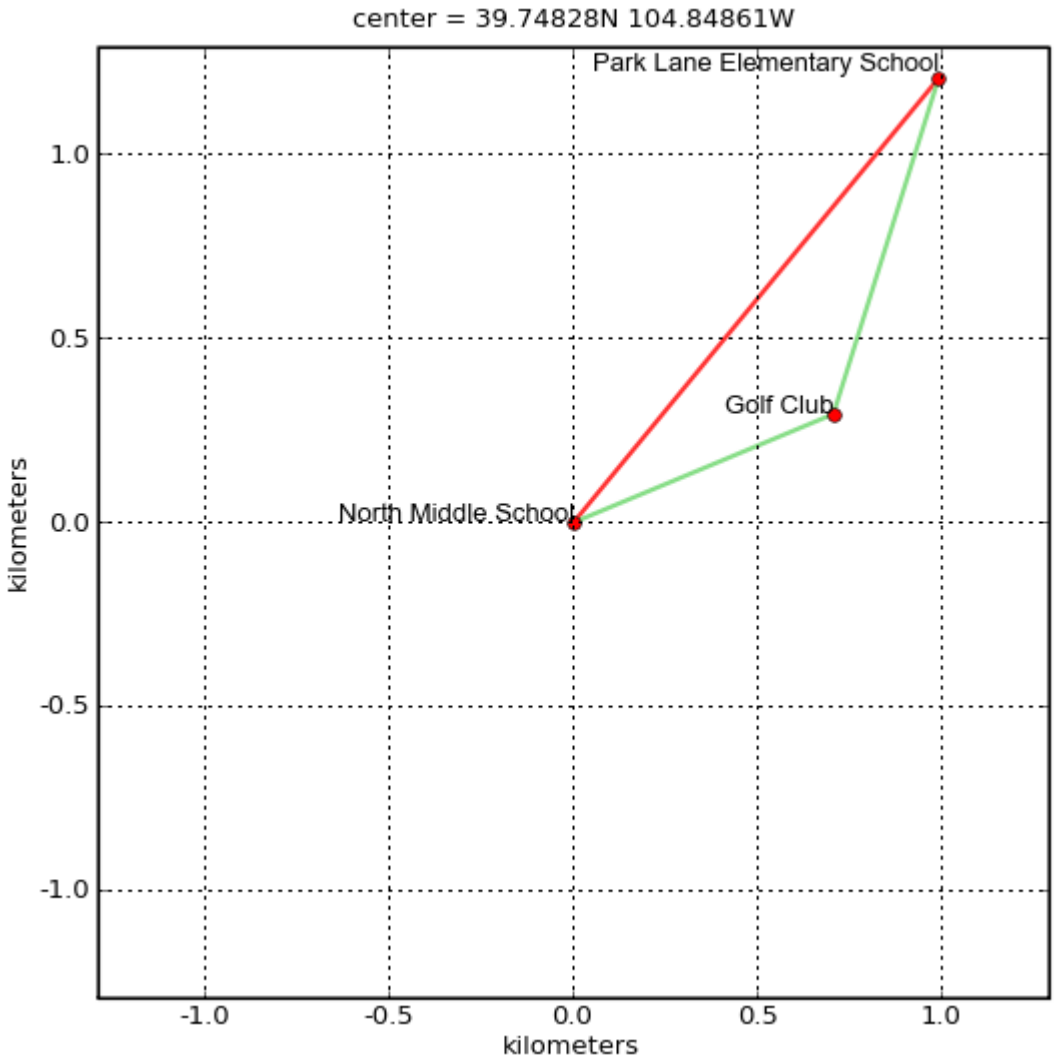


Figure 3.18: Links Graph in Site Page

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 as described in *Creating Links*.
2. Display the list of links in the project and open the new link, as described in *Displaying Links*.
3. Obtain profiles of the link terrain as described in *Obtaining Link Profiles*.
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* and *Setting Hot Standby Protection (1+1)*

Creating Links

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

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

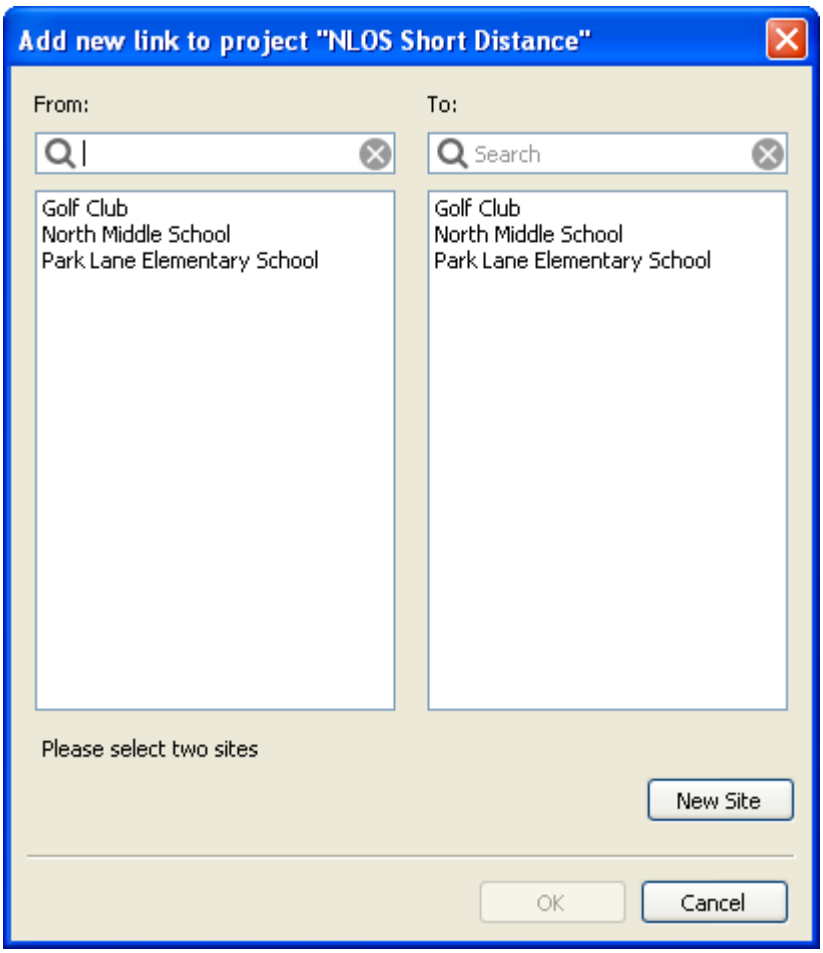


Figure 3.19: New Link Page

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 site from each list and hit **OK**. The link is made between those two locations and the Link page is displayed.

Displaying Links

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

Links in NLOS Short Distance

Name	Link Loss (dB)	License	Range (km)	% req. Throughput	Aggregate Throughput (Mbps)
Golf Club to North Middle School	105.4	FCC USA, Canada, Taiwan, Brazil	0.765	984.8	98.6
North Middle School to Park Lane Elementary School	115.9	FCC USA, Canada, Taiwan, Brazil	1.563	43.1	65.6
Park Lane Elementary School to Golf Club	107.3	FCC USA, Canada, Taiwan, Brazil	0.957	983.9	98.5

Figure 3.20: Links List

If the link is displayed in **red**, it means that the predicted performance of the link

is below requirements.

Customizing the Links list

The 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.

Deleting Links

The Links list can be used to delete links altogether. To delete a link, right-click over it and select **Delete Links**.

Editing Link details

Link Name and Description can be edited directly in the Links list.

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. See *Link Page*.

Obtaining Link Profiles

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

To obtain profiles of the terrain between the two end points of each link, follow these steps:

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

   If PTP 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.

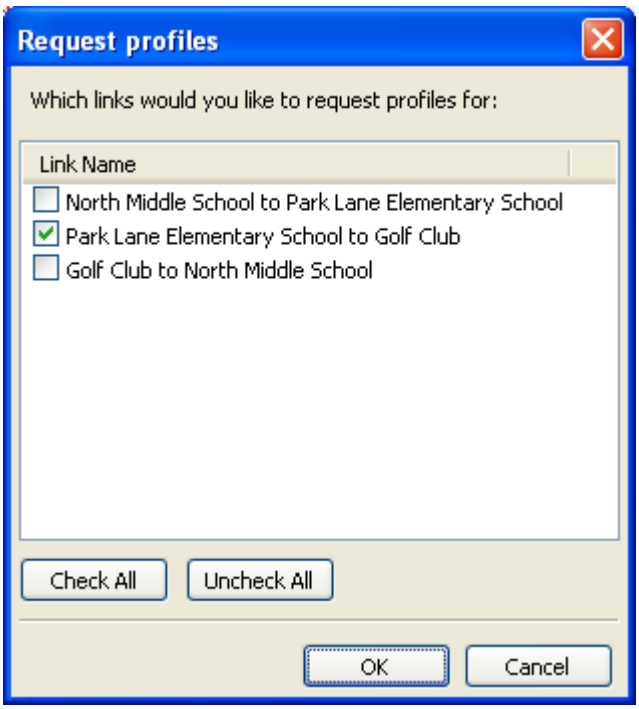


Figure 3.21: Request Profiles Page

3. Select OK to obtain profiles:

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

   After about 5 minutes, check email inbox to see if there is a new message entitled **“Motorola PTP Path Profile Do Not Reply”**.

   NOTE

   Business servers may presume Path Profile emails to be spam and reject them. If the email is not received within an hour, contact the IT helpdesk.

4. Open the email:

   Double-click on the attached file, for example **“North_Middle_School_to_Park_Lane_Elementary.ptpdat”** and select **Open**.

5. Complete the import:

   If there is an existing profile for this link, the Import .ptpdat File page is displayed and the overwrite warning box must be checked before the existing profile may be overwritten.

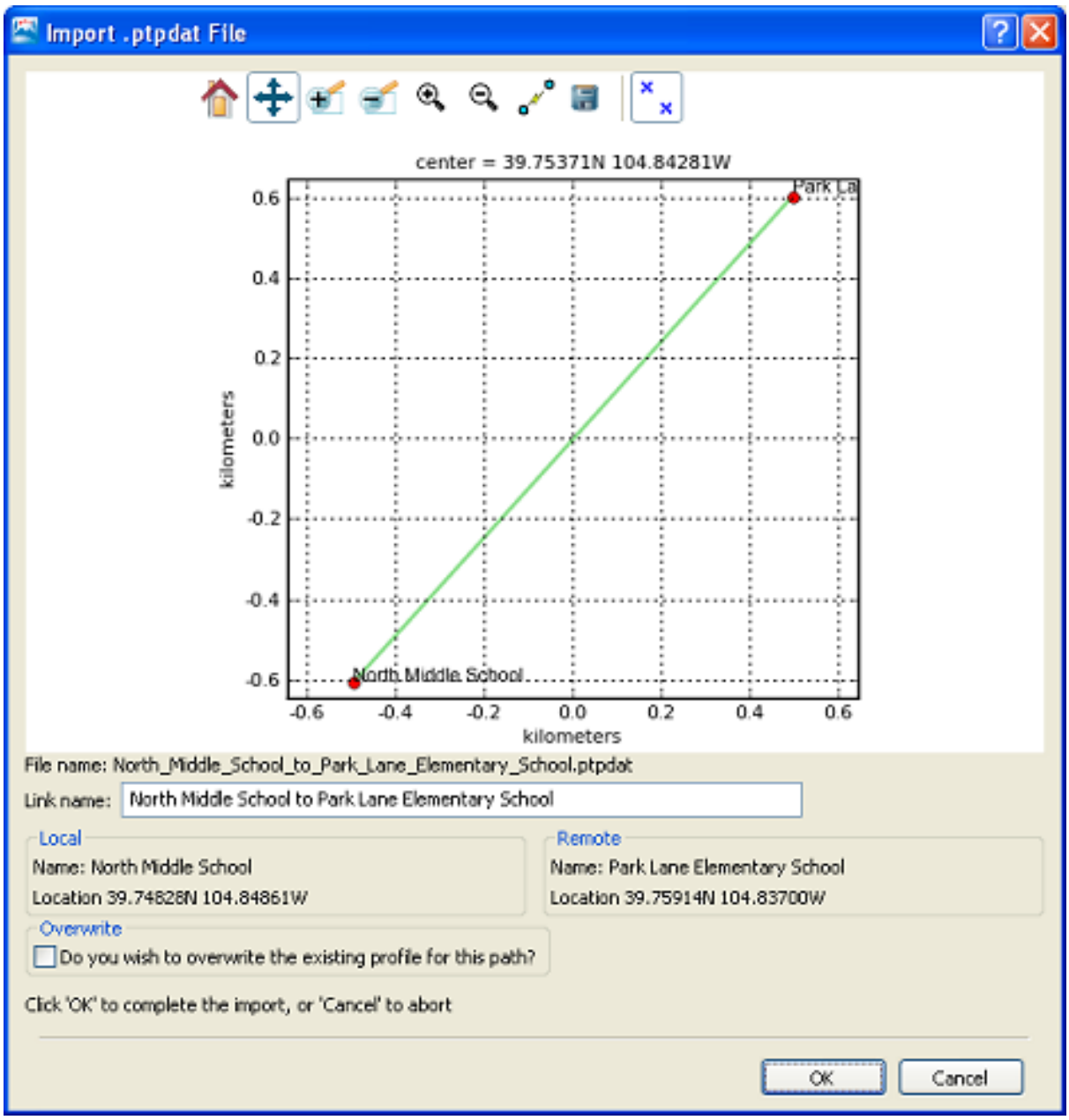


Figure 3.22: Import.ptpdat Page

Click **OK** to import the profile.

The profile in PTP LINKPlanner is automatically updated with the information from the .ptpdat file.

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*
- *Flags*

Link Description and Equipment

Link Description

Enter the Name and Description of this link.

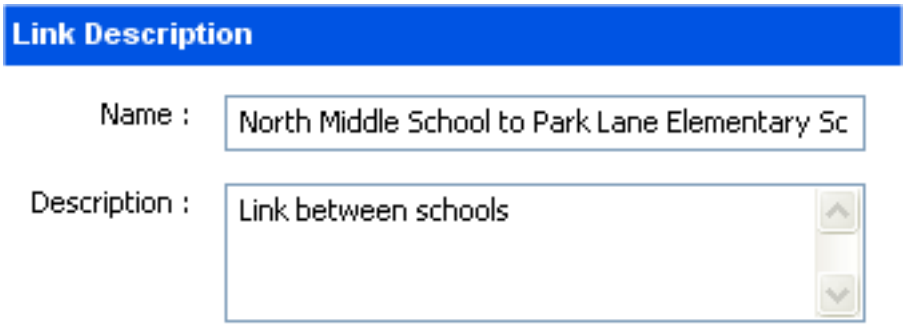


Figure 3.23: Link Description

Equipment (unlicensed bands)

Select the equipment, regulation and optimisation 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.

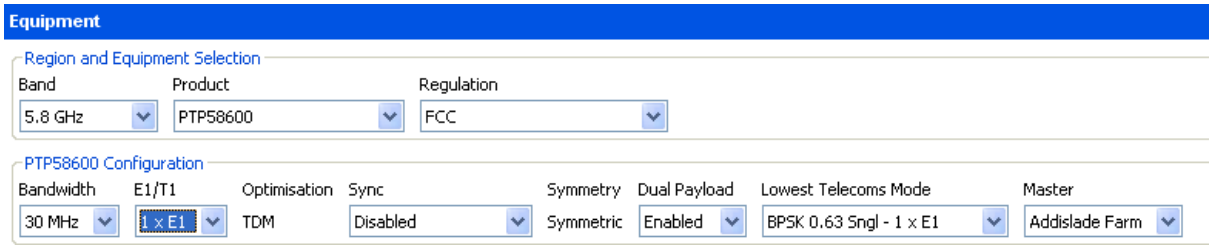


Figure 3.24: Equipment (unlicensed bands)

Region and equipment

Band: Select the frequency band used by the link.

Product: Select the PTP bridge product.

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

Configuration

Bandwidth: Select the channel bandwidth.

E1/T1: (PTP 300, 500 and 600 only). 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*.

Optimisation: Select the optimisation for the link, either for IP Traffic or TDM Traffic. If TDM is enabled, the link is optimised automatically for TDM traffic/latency.

Sync: 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: Select the link operation (Symmetric, 1:1 or 3:1).

Dual Payload: Allow dual-payload modulation modes for better throughput.

Lowest Telecoms Mode: 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: When using the PTP 250 product, select the modulation mode to be used by the equipment.

Master: Select which site is the master.

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*

Equipment (licensed bands)

Select the equipment, regulation and configuration for this link.

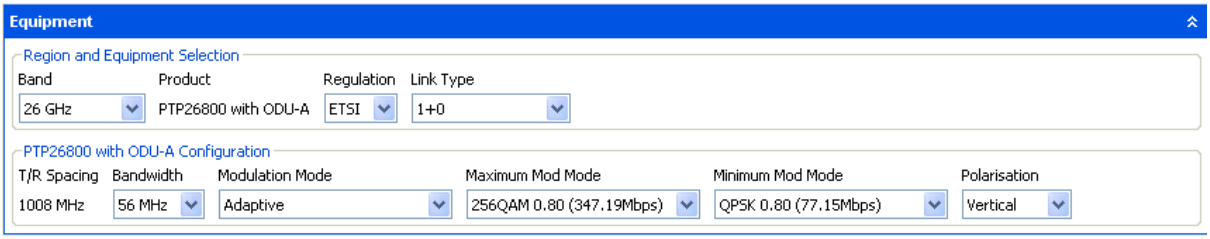


Figure 3.25: Equipment (licensed bands)

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 further information on the two ODU types see *PTP 800 Licensed Ethernet Microwave 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 equipment select **1+1 Hot Standby**, for more information, see *Setting Hot Standby Protection (1+1)*.
- If using 2+0 Antenna Sharing select either **2+0 Cross Polar** or **2+0 Co-Polar** (only the Co-Polar variant is available for the IRFU), for more information, see *Setting 2+0 Antenna Sharing*.

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

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.

Polarisation: Select the antenna polarisation to be used (Horizontal or Vertical).

Profile

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

In this example, a 4m high tree at 0.5 km and and a 3.5 m high tree at 0.68 km enter the Fresnel zone and alter the slope.

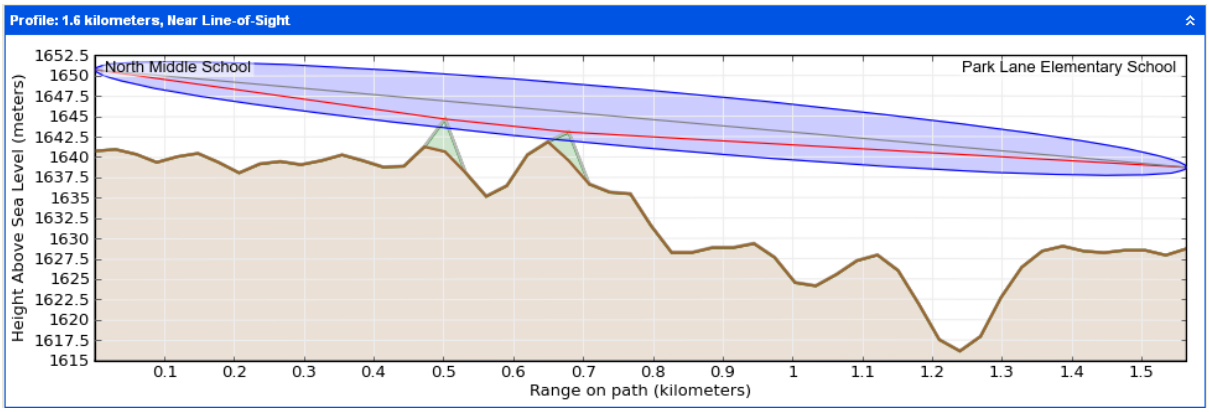


Figure 3.26: Profile with Trees

Colour 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*.

To view the profile in Google Earth(TM), select 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:

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.

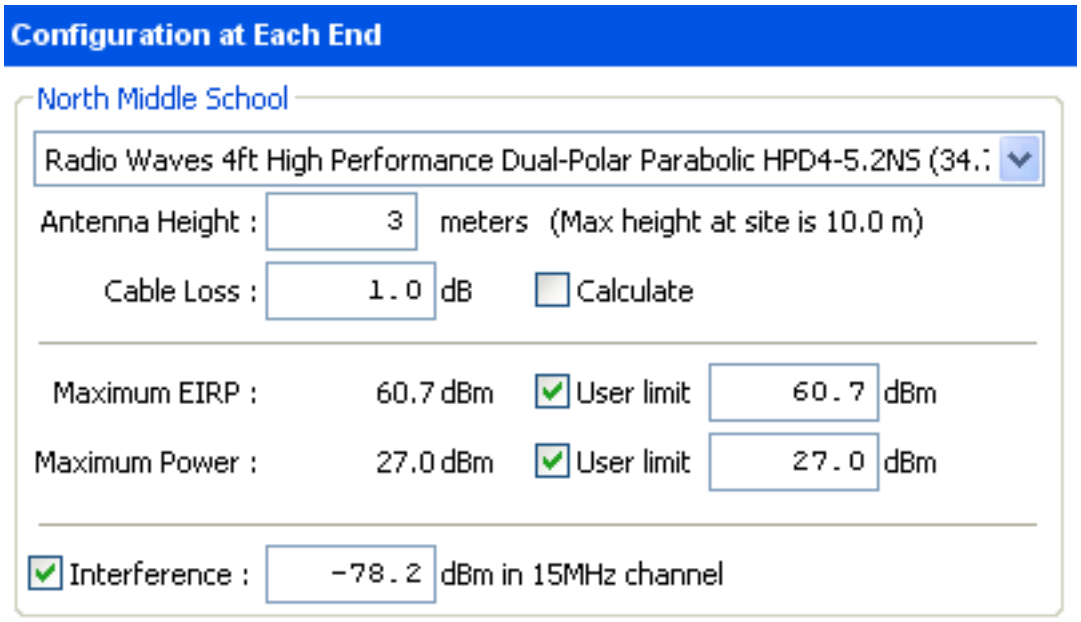


Figure 3.27: Configuration at Each End (one end shown)

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, select 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 Motorola 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): This field is only displayed if a single polar external antenna is selected with an unlicensed band product.

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 that connects the radio to the antenna (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.

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 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 select **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 3’ 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.

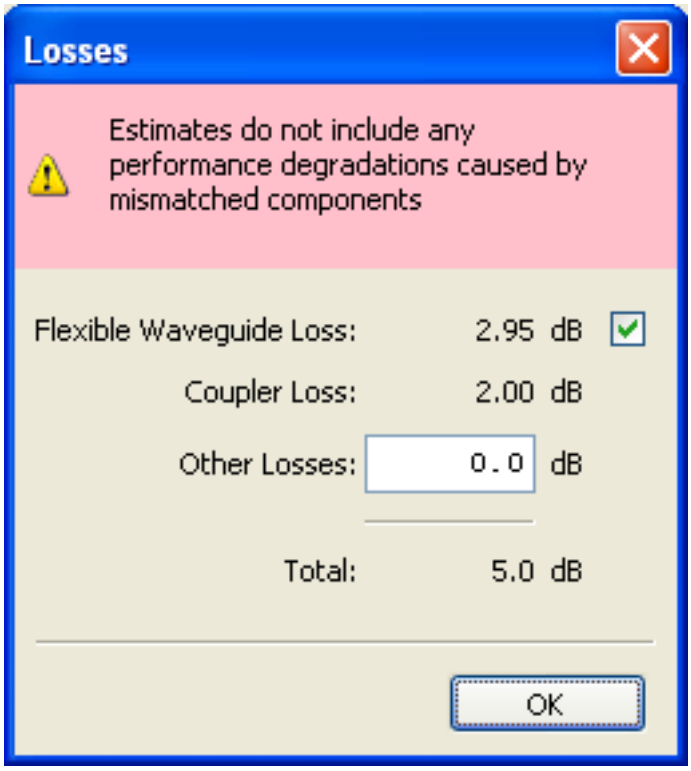


Figure 3.28: Additional Feeder Losses in Licensed Band

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.

Transmit 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 with the highest frequency will automatically be designated **Hi** and the other end **Lo**.

It may be necessary to unset the Transmit Frequency in order to change the BOM to a non-specific ODU for the band. If this is required then press Clear Selection.

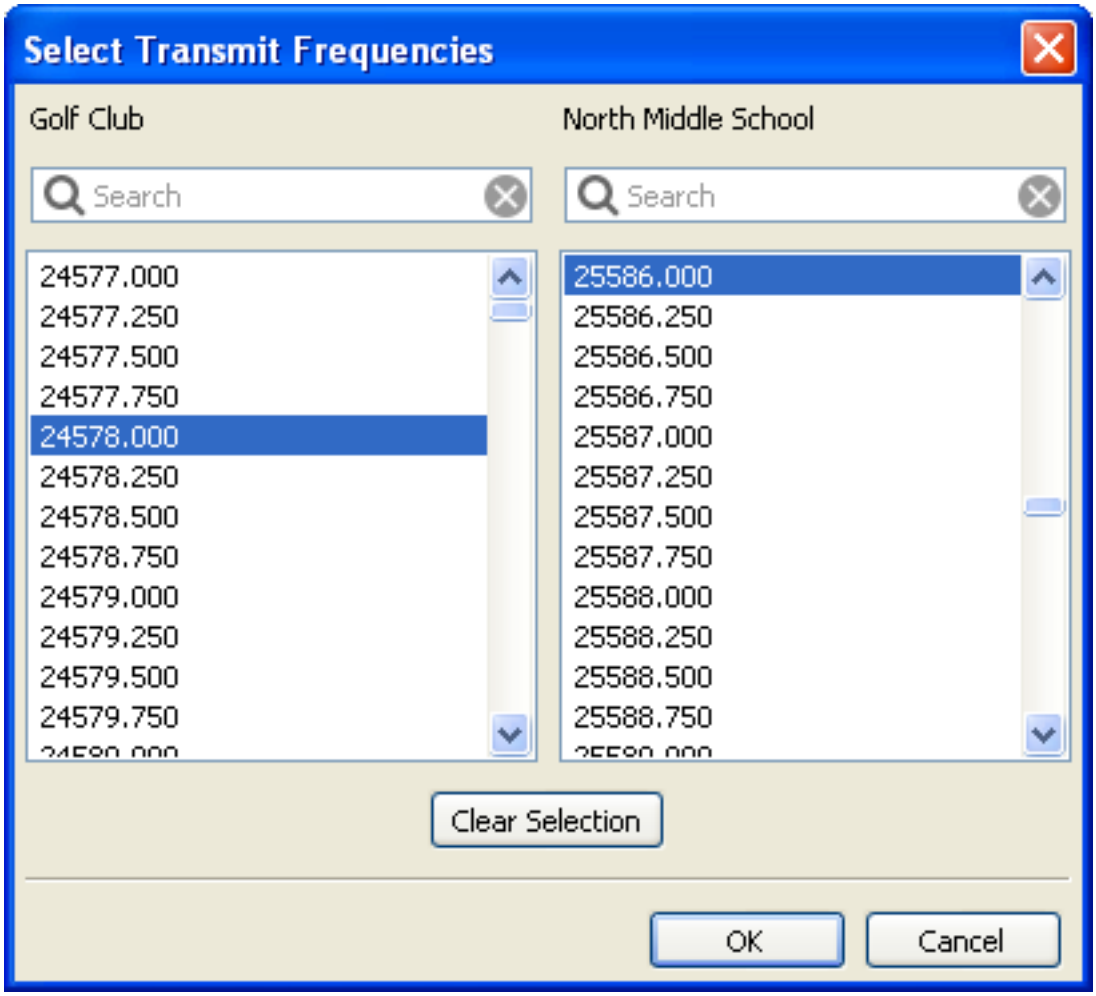


Figure 3.29: Select Transmit Frequencies

Tx Capacity Limit: 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.

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:

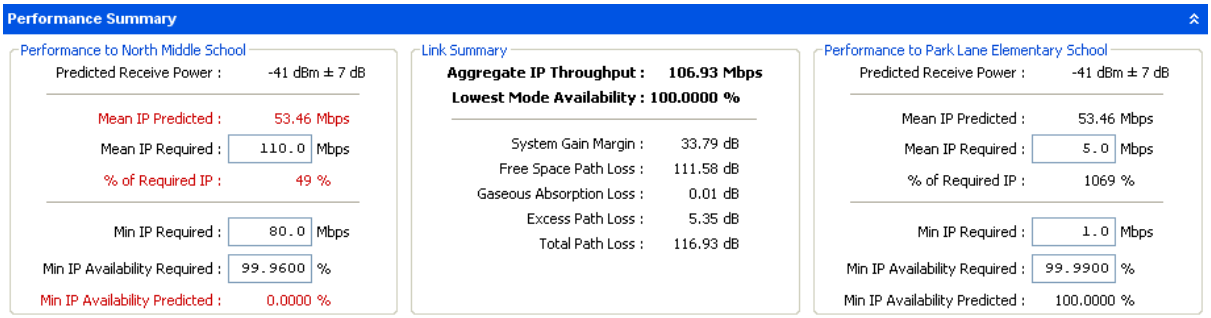


Figure 3.30: Performance Summary

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.

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.

Operating Conditions

This option is only available when the PTP 250 product is selected. The throughput of the PTP 250 product 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.

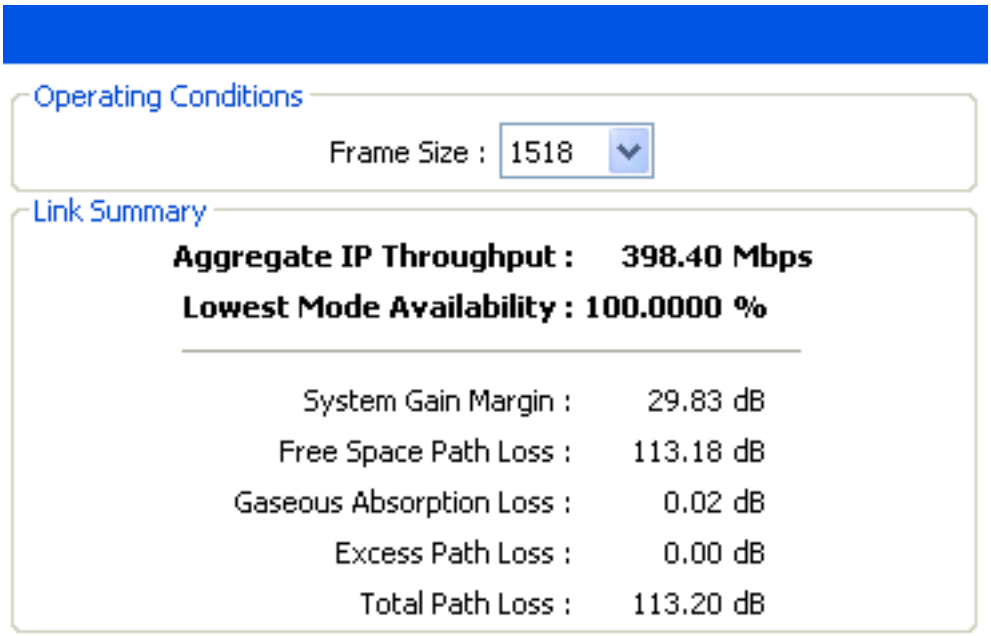


Figure 3.31: Operating Conditions for PTP 250

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 0.5. 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 (dB): 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 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.

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

Performance Summary when E1/T1 is selected

If the equipment is PTP 300, 500 or 600 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*.

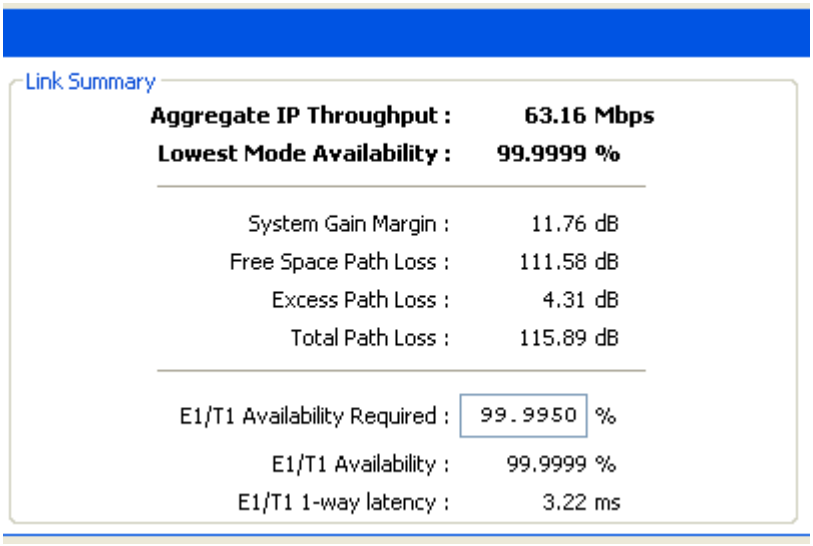


Figure 3.32: Performance Summary with E1/T1

Link Summary additional information for PTP 800

If the equipment is PTP 800, 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*. This allows the information to be viewed during planning without having to produce a proposal report.

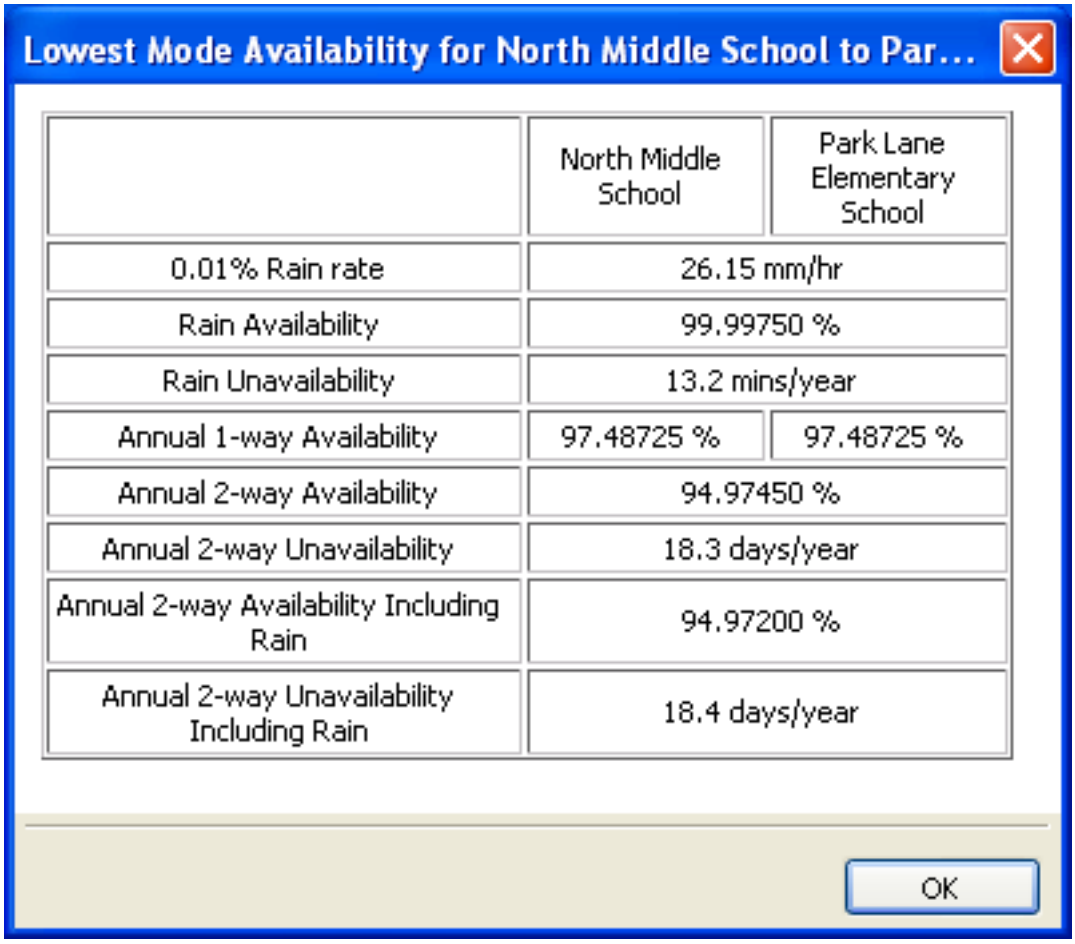


Figure 3.33: Detailed Availability Information

This window shows the following information for Link Availability, when in fixed modulation mode or for Lowest Mode Availability when Adaptive Modulation has been selected:

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 centre 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.

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.

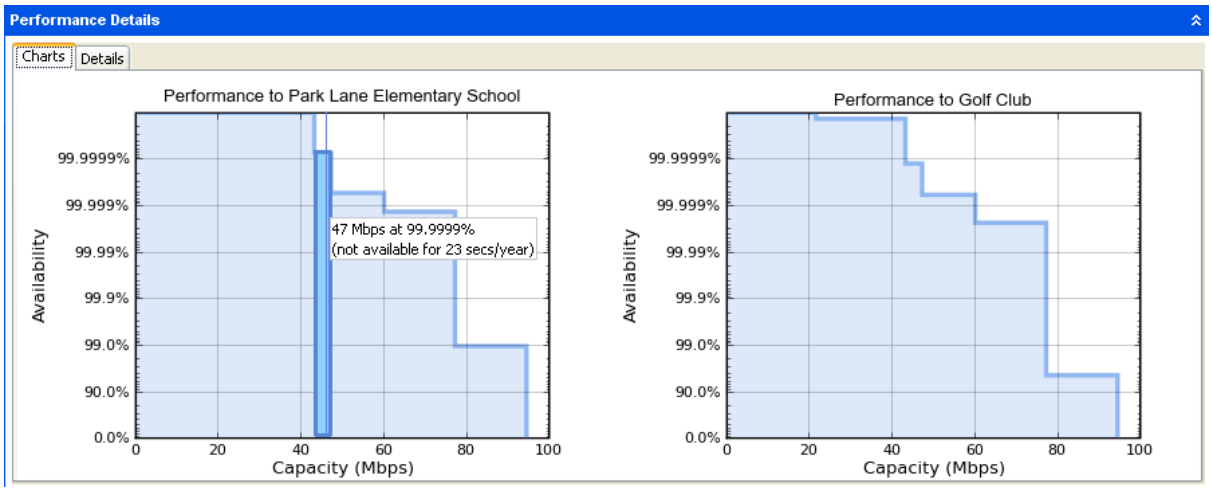


Figure 3.34: Performance Charts

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 **PTP 250** is selected the capacity shown in both the charts and the table is for the given frame size selected.

If **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 chart correlate with the values shown in the Performance Summary section.

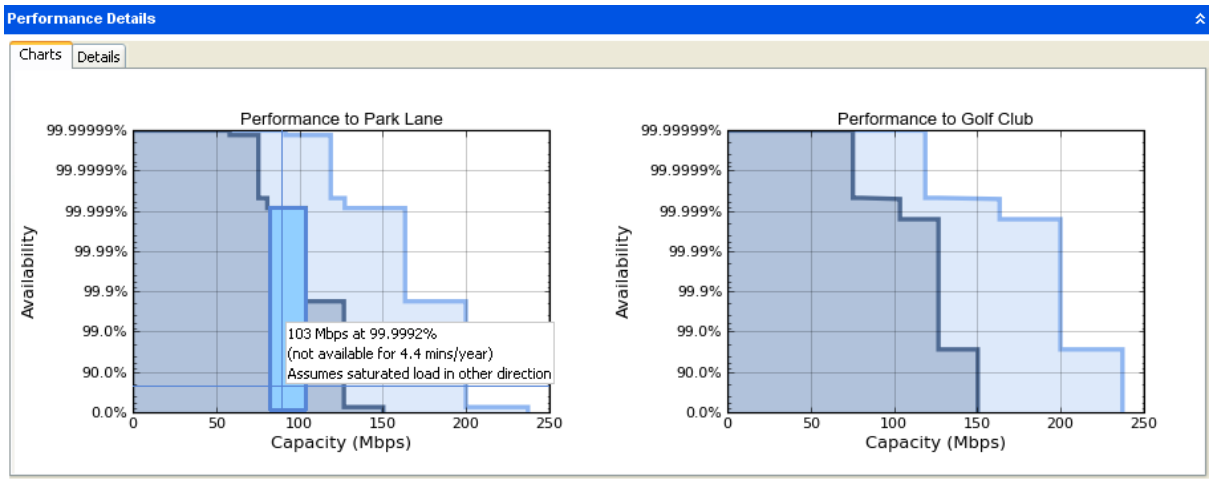


Figure 3.35: Performance Charts for Adaptive Symmetry

- 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

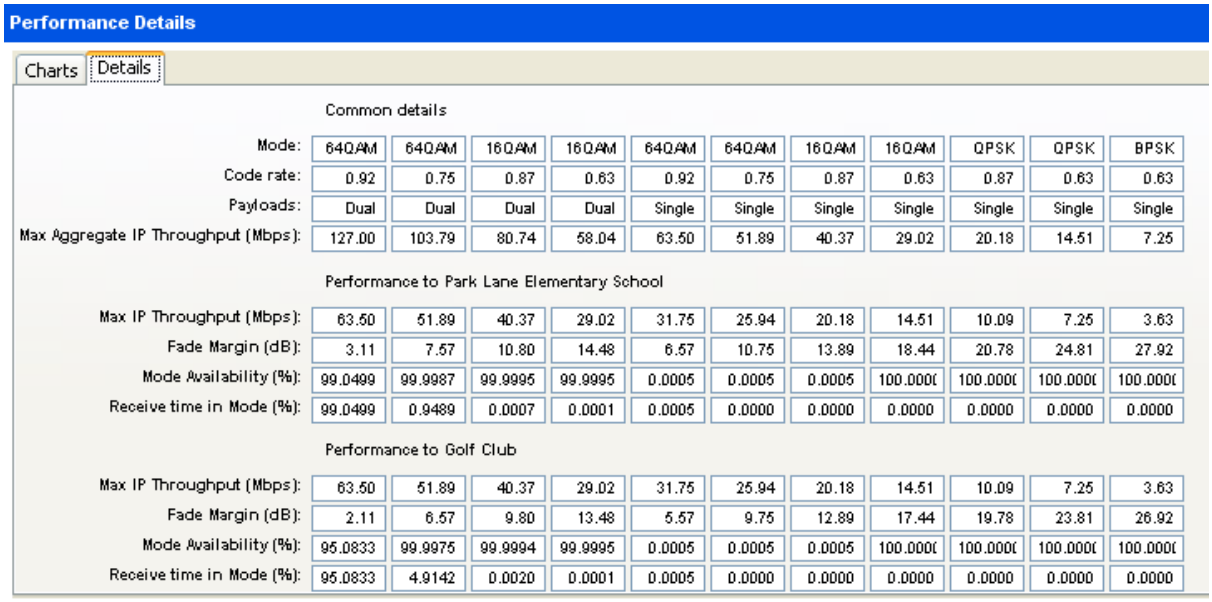


Figure 3.36: Performance Details

Common Details

Mode: The modulation technique used.

Code Rate: The code rate for the specified Mode.

Payloads: Indicates whether the payload mode is Single or Dual.

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.

E1/T1 Carried: This row is only displayed if the equipment is PTP 600 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. 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.

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 text file and imported into the Motorola ordering system or saved as a CSV or Excel file by selecting View in Spreadsheet  . The text file for the Motorola ordering system will only contain items with a Motorola part number, all items will be displayed in the spreadsheet.

To view the link BOM, open the Link page and scroll down to the ” *Bill of Materials for Link*” section.

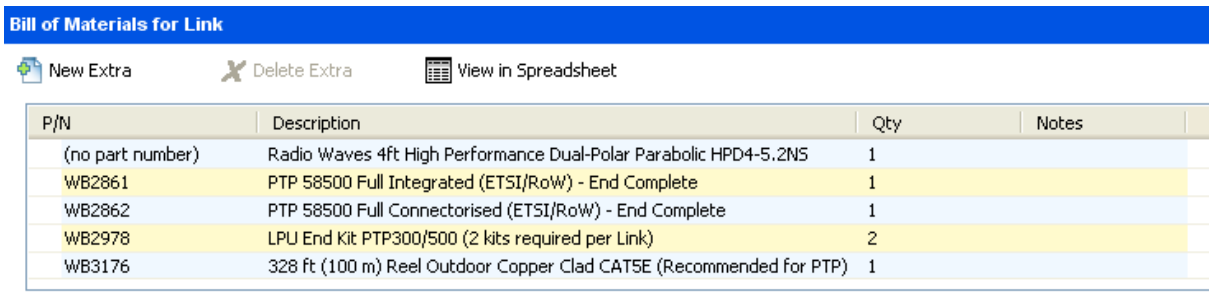


Figure 3.37: Bill of Materials for Link

P/N: The Motorola part number. If the component is not supplied by Motorola, 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.

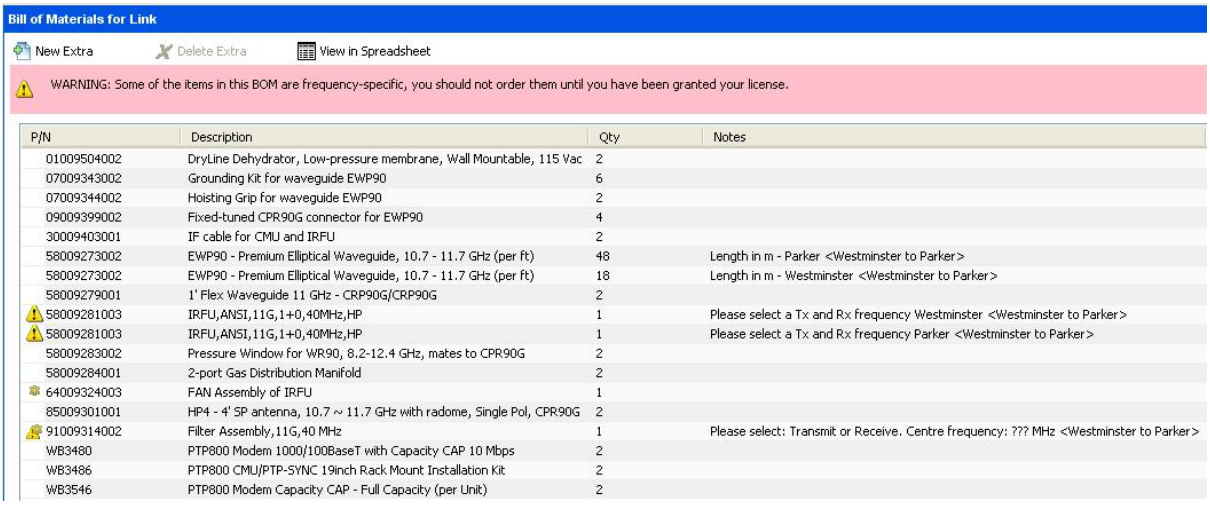


Figure 3.38: Bill of Materials Icons

To add additional items to the BOM, select **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 select **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 select **Delete Extra** Delete Extra .

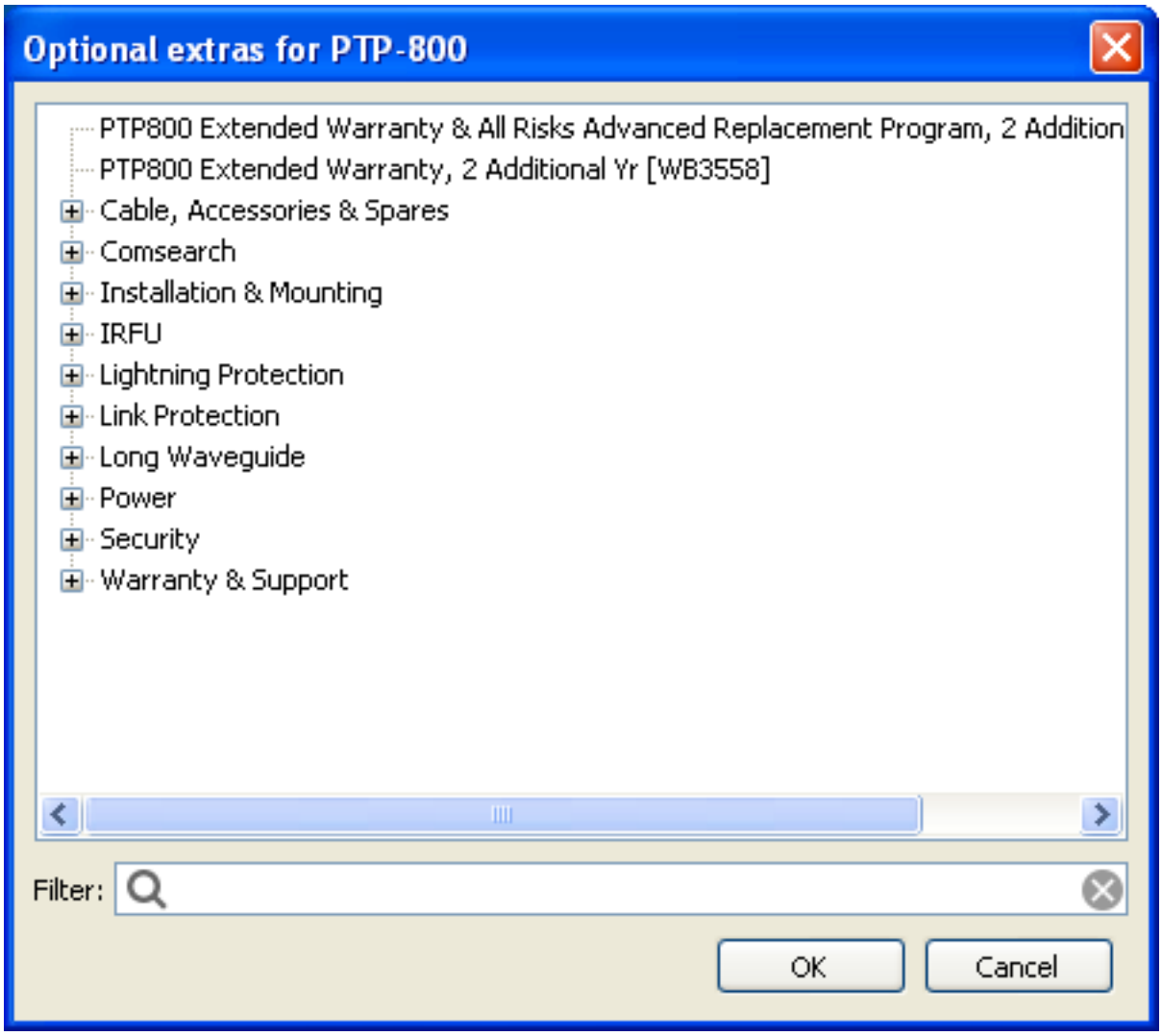


Figure 3.39: Bill of Materials Optional Extras

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.

Cable, Accessories & Spares: This allows items such as additional cable, optical splitters, PTP Sync, E1/T1 splitters etc. to be added to the order.

Comsearch: Allows FCC Frequency Coordination or Protection Services to be added to 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.

Link Protection: This option is only available for the PTP 800 series and allows the Optical-Y or Out-of-Band 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

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.

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, select View in Spreadsheet  while viewing the link BOM. Once in the spreadsheet the file can be saved as normal. Use this option to save links which contain IRFU products.

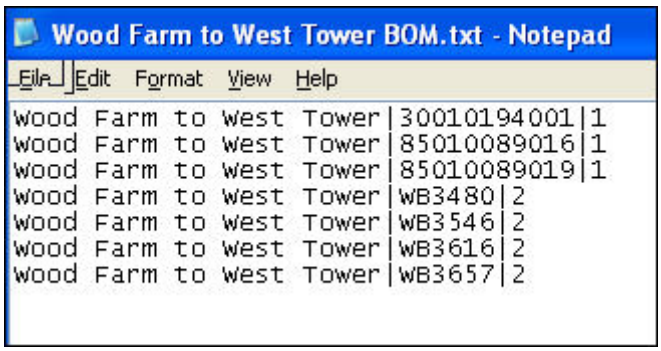
Creating an equipment order

Save the link BOM

To view the link BOM in Excel, select View in Spreadsheet  while viewing the link BOM. Once in the spreadsheet the file can be saved as normal. Use this option to save links which contain IRFU products.

To save the link BOM as a .txt file, in order to create a Motorola equipment order, display the link in the Link page and select the menu options File, Bill Of Materials, Link BOM.

The saved file consists of one or more records, each record appearing on a different line. Each record contains three parameters, “Link Name”, “Part Number” and “Quantity”, each parameter being separated by a pipe character. An example is:



NOTE

Items which do not have a Motorola Part Number will not be included in the saved file. IRFU links cannot be saved as a Motorola equipment order, as the frequency information in the notes field is essential to the order and this field is not one of the parameters included.

Create an Equipment Order

The saved link BOM .txt file can be imported into the Motorola Onine (MOL) system. MOL is a secure web based ordering tool for customers. Before attempting this, ensure that MOL is configured to import a simple pipe delimited file.

Speak to your local customer services contact for information on accessing and using MOL.

Flags

Use this section to add one or more flags to indicate the status of the link. For example, enter “Backbone”, “Spur” or “Unused”. Each Flag value is displayed as a column in the Links report.

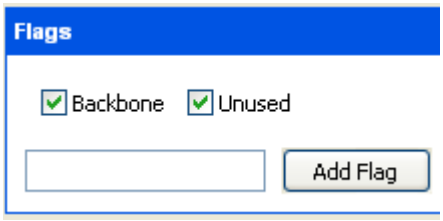


Figure 3.40: Flags

Extras

The Extras node of the navigation tree contains the following:

- **Antennas**: Create, edit and delete custom antennas. See *Available Antennas*.
- **TDD Sync**: Manage the global parameters for TDD synchronisation.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.

Available Antennas

This page enables the user to view, create, edit and delete custom antennas. To display this page, select the “Antennas” node in the navigation tree. The *Available Antennas* page is displayed in the right hand panel.

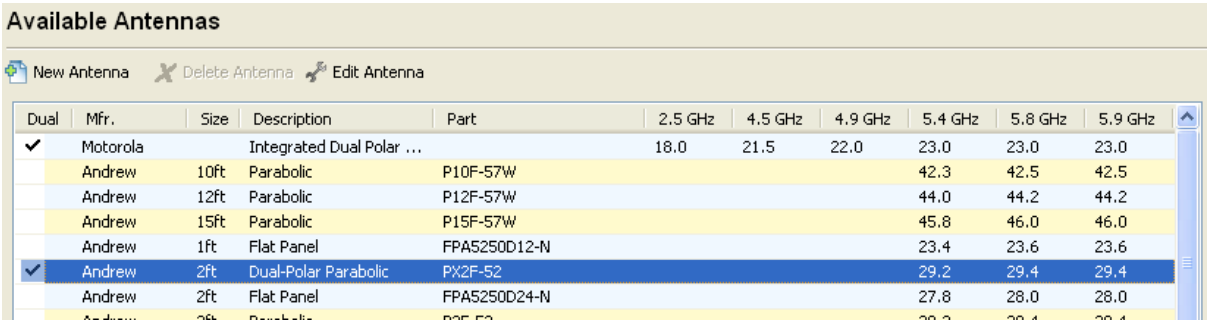


Figure 3.41: Available Antennas

If the required antenna is not in the list, select 

and enter the details in the User Defined Antenna page. New antennas can only be added in the unlicensed band, at present the licensed band only supports Motorola antennas.

To delete a new antenna, select 

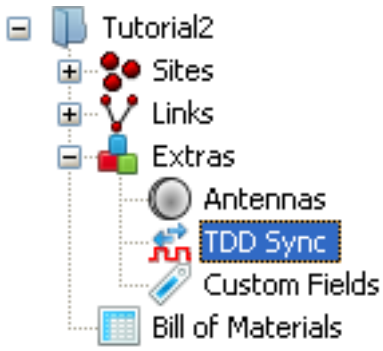
, this feature is only available for new antennas created by the user.

To edit antenna details, select 

and change the details in the Edit Antenna page. This feature only applies to unlicensed band antennas.

TDD Synchronization List

When TDD Syncnronization is enabled for one or more links in the project (as described in *Link Description and Equipment*), they appear in the *TDD Synchronization List*. To display this list, select 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.

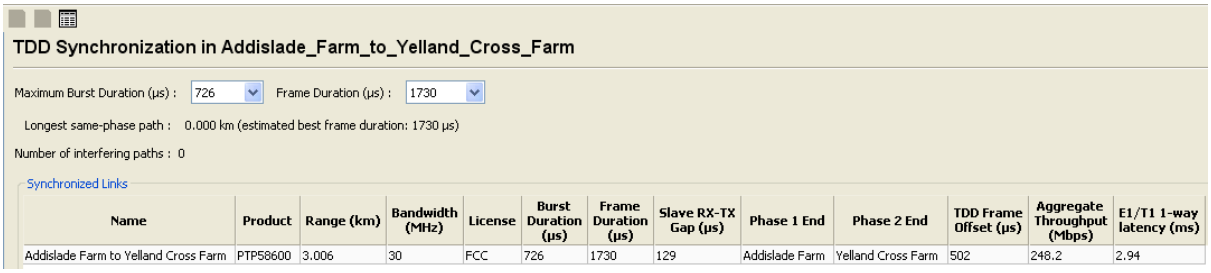


Figure 3.42: TDD Synchronization List

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*.

Bill of Materials for Project

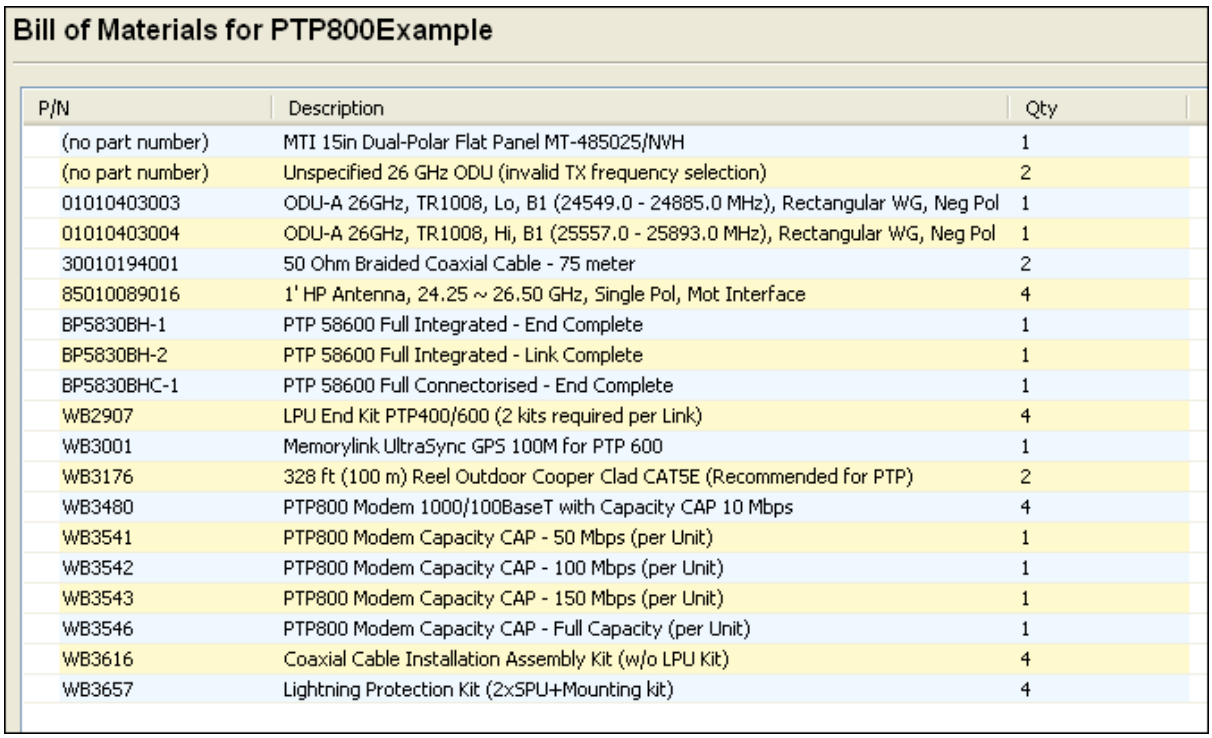
LINKPlanner automatically calculates the Bill of Materials (BOM) from the project configuration data. Optional items, for example the power supply unit and rack mount kit for PTP 800, can be added to the BOM at the individual link level, see *Bill of Materials Optional Extras*. The project BOM contains 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 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.

The project BOM can be saved as a text file and imported into the Motorola ordering system.

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



Bill of Materials for PTP800Example

P/N	Description	Qty
(no part number)	MTI 15in Dual-Polar Flat Panel MT-485025/NVH	1
(no part number)	Unspecified 26 GHz ODU (invalid TX frequency selection)	2
01010403003	ODU-A 26GHz, TR1008, Lo, B1 (24549.0 - 24885.0 MHz), Rectangular WG, Neg Pol	1
01010403004	ODU-A 26GHz, TR1008, Hi, B1 (25557.0 - 25893.0 MHz), Rectangular WG, Neg Pol	1
30010194001	50 Ohm Braided Coaxial Cable - 75 meter	2
85010089016	1' HP Antenna, 24.25 ~ 26.50 GHz, Single Pol, Mot Interface	4
BP5830BH-1	PTP 58600 Full Integrated - End Complete	1
BP5830BH-2	PTP 58600 Full Integrated - Link Complete	1
BP5830BHC-1	PTP 58600 Full Connectorised - End Complete	1
WB2907	LPU End Kit PTP400/600 (2 kits required per Link)	4
WB3001	Memorylink UltraSync GPS 100M for PTP 600	1
WB3176	328 ft (100 m) Reel Outdoor Cooper Clad CAT5E (Recommended for PTP)	2
WB3480	PTP800 Modem 1000/100BaseT with Capacity CAP 10 Mbps	4
WB3541	PTP800 Modem Capacity CAP - 50 Mbps (per Unit)	1
WB3542	PTP800 Modem Capacity CAP - 100 Mbps (per Unit)	1
WB3543	PTP800 Modem Capacity CAP - 150 Mbps (per Unit)	1
WB3546	PTP800 Modem Capacity CAP - Full Capacity (per Unit)	1
WB3616	Coaxial Cable Installation Assembly Kit (w/o LPU Kit)	4
WB3657	Lightning Protection Kit (2xSPU+Mounting kit)	4

Figure 3.43: Bill of Materials for Project

P/N: The Motorola part number. If the component is not supplied by Motorola, 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

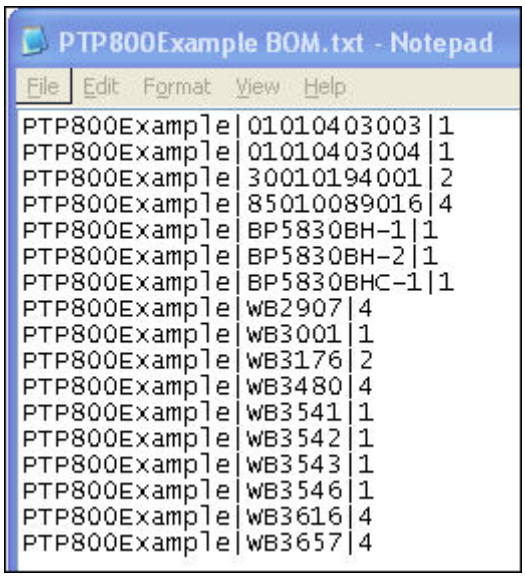
For instructions on how to view and save the BOM for an individual link, see *Bill of Materials for Link*.

Creating an equipment order

Save the project BOM

To save the project BOM as a .txt file, select the menu options **File**, **Bill Of Materials**, **Project BOM**.

The saved file consists of one or more records, each record appearing on a different line. Each record contains three parameters, "Project Name", "Part Number" and "Quantity", each parameter being separated by a pipe character. An example is:



NOTE

Items which do not have a Motorola Part Number will not be included in this saved file. Links which contain IRFU products will not be included in this file. To save the complete BOM see **Viewing & saving the project BOM file in MS Excel**

Create an Equipment Order

The saved project BOM .txt file can be imported into the Motorola Onine (MOL) system. MOL is a secure web based ordering tool for customers. Before attempting this, ensure that MOL is configured to import a simple pipe delimited file.

Speak to your local customer services contact for information on accessing and using MOL.

Viewing & saving the project BOM file in MS Excel

To view the project BOM in Excel, select View in Spreadsheet  while viewing the project BOM. Once in the spreadsheet the file can be saved as normal.

Advanced Features

To improve the performance of links additional features are available in certain PTP products.

For PTP 300, 500 or 600

- Optimize E1 or T1 latency, see *Optimizing E1 or T1 Latency*
- Use TDD Synchronization, see *Setting TDD Synchronization*

For PTP 800

- Enable Hot Standby Protection, see *Setting Hot Standby Protection (1+1)*
- Use 2+0 Antenna Sharing, see *Setting 2+0 Antenna Sharing*
- Installing ODUs indoor or at the base of the tower, see *Long Waveguide*

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.

On the PTP 600, the Lowest Telecoms Mode selection determines which modulation modes will be allowed to carry telecoms data. Lower modulation modes will only carry timing information. The PTP 600 will then optimize the latency for that modulation mode. For more information, see the section titled "Telecoms Circuits" in the PTP 600 Series User Guide, which can be downloaded from http://www.motorola.com/ptp/software.

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.

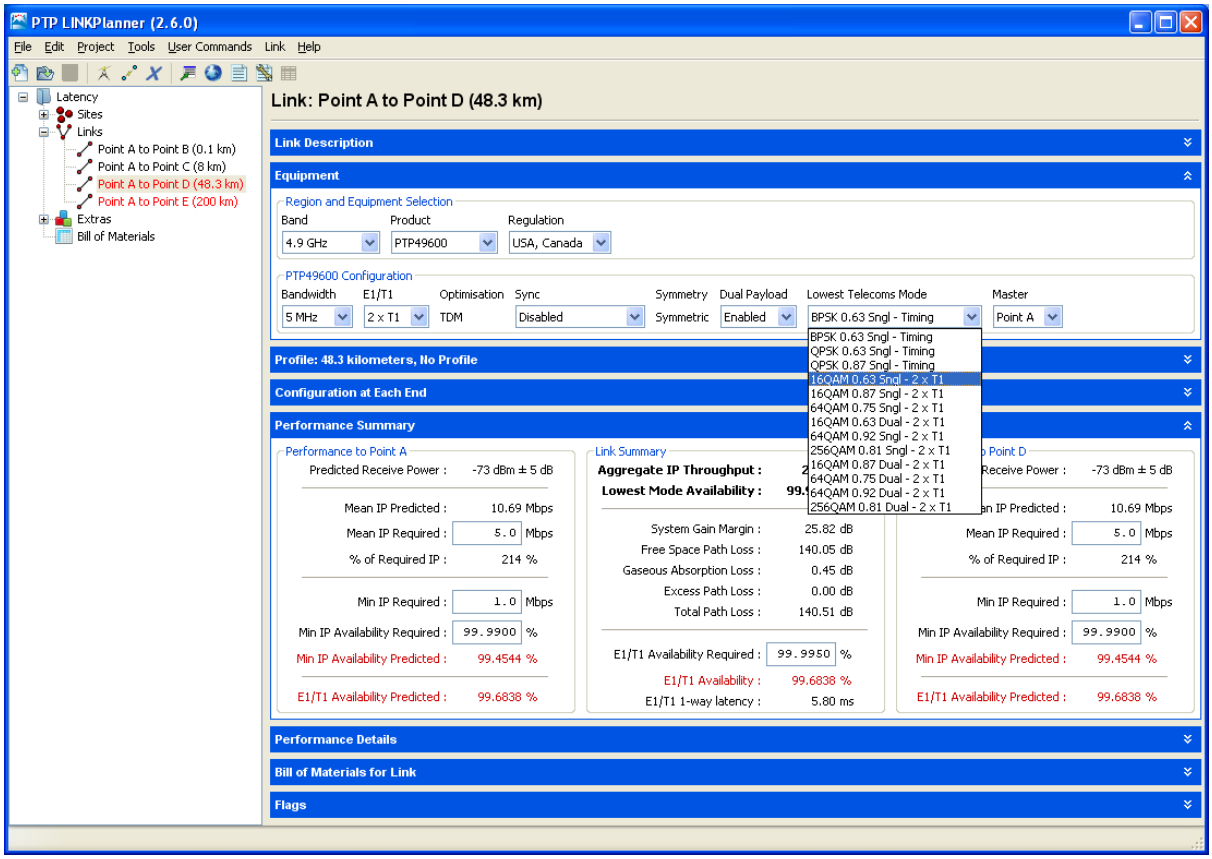


Figure 3.44: Lowest Telecoms Mode

In this example, **16QAM 0.63 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

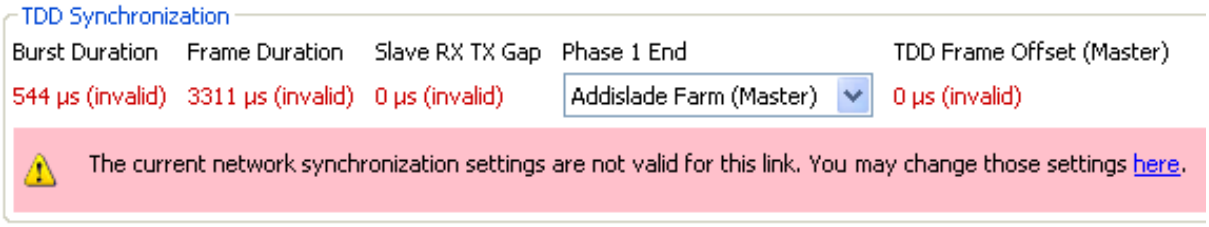


Figure 3.45: TDD Synchronization Error Message

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.

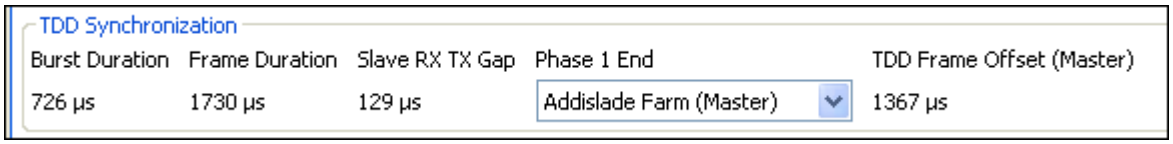


Figure 3.46: TDD Synchronization

   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*.

Setting Hot Standby Protection (1+1)

Hot Standby is available on PTP 800 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 *PTP 800 Licensed Ethernet Microwave 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*.

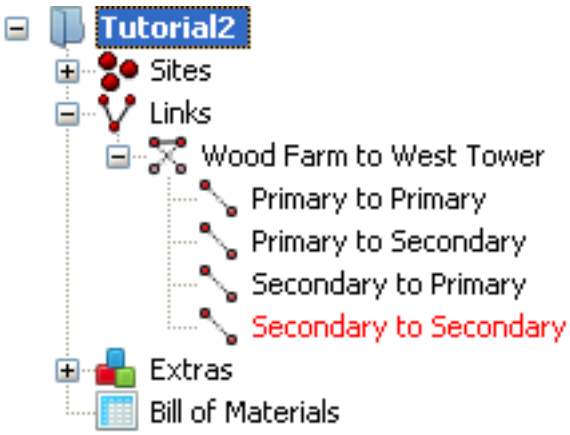


Figure 3.47: Navigation Tree for Protected (1+1) link

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**.

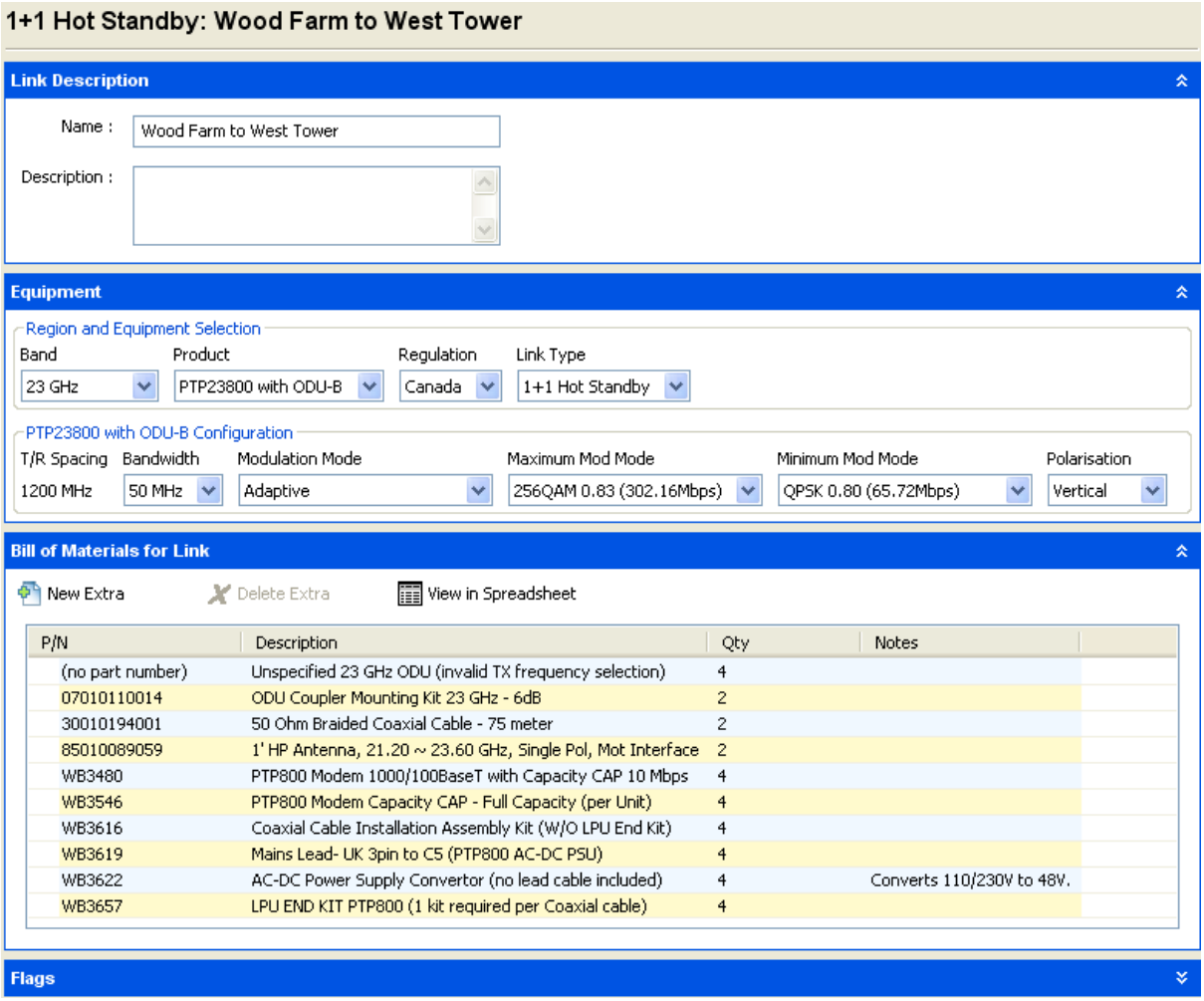


Figure 3.48: Link Node Information for Protected (1+1) link

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 Protection: There are 3 options which can be selected to match the possible configurations for Hot Standby when using and ODU Product

- **Common Antenna - 1+1 Symmetric Coupling**
- **Common Antenna - 1+1 Asymmetric Coupling** - default setting
- **Redundant Antennas**

There are 4 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**

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 option has been selected then a different antenna can be chosen for primary and secondary.

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 option has been selected then a different antenna height can be chosen for primary and secondary.

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 the ODU the symmetric coupler will have the same loss

for both primary and secondary (maximum 4 dB), whereas the asymmetric coupler has a lower loss for the primary (maximum 2 dB) and higher loss for the secondary (maximum 7.4 dB). 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.

Maximum Power: This field can be set independently for primary and secondary.

Tx Frequency: This value will always be the same for primary and secondary.

Tx Capacity Limit: This field can be set independently 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. 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%

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.

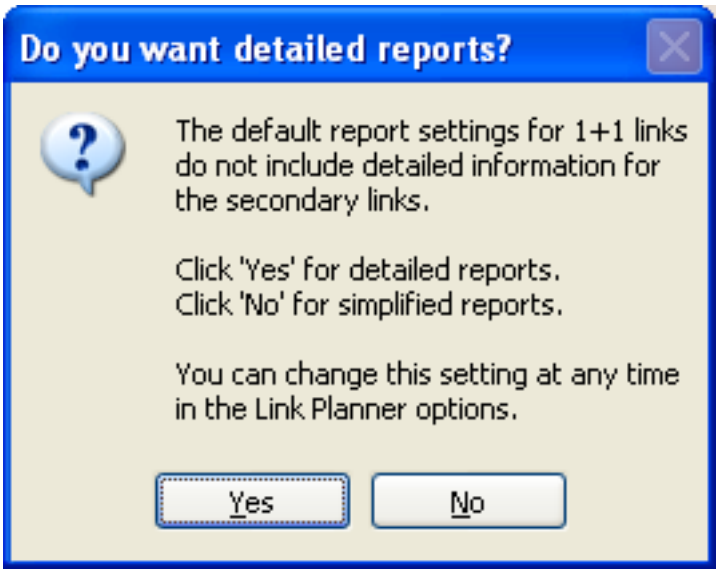


Figure 3.49: Detailed Reports Information Message

The type of reports can be changed at any time by selecting **Tools, Options, Reports** and then selecting or deselecting the **Generate detailed reports** option.

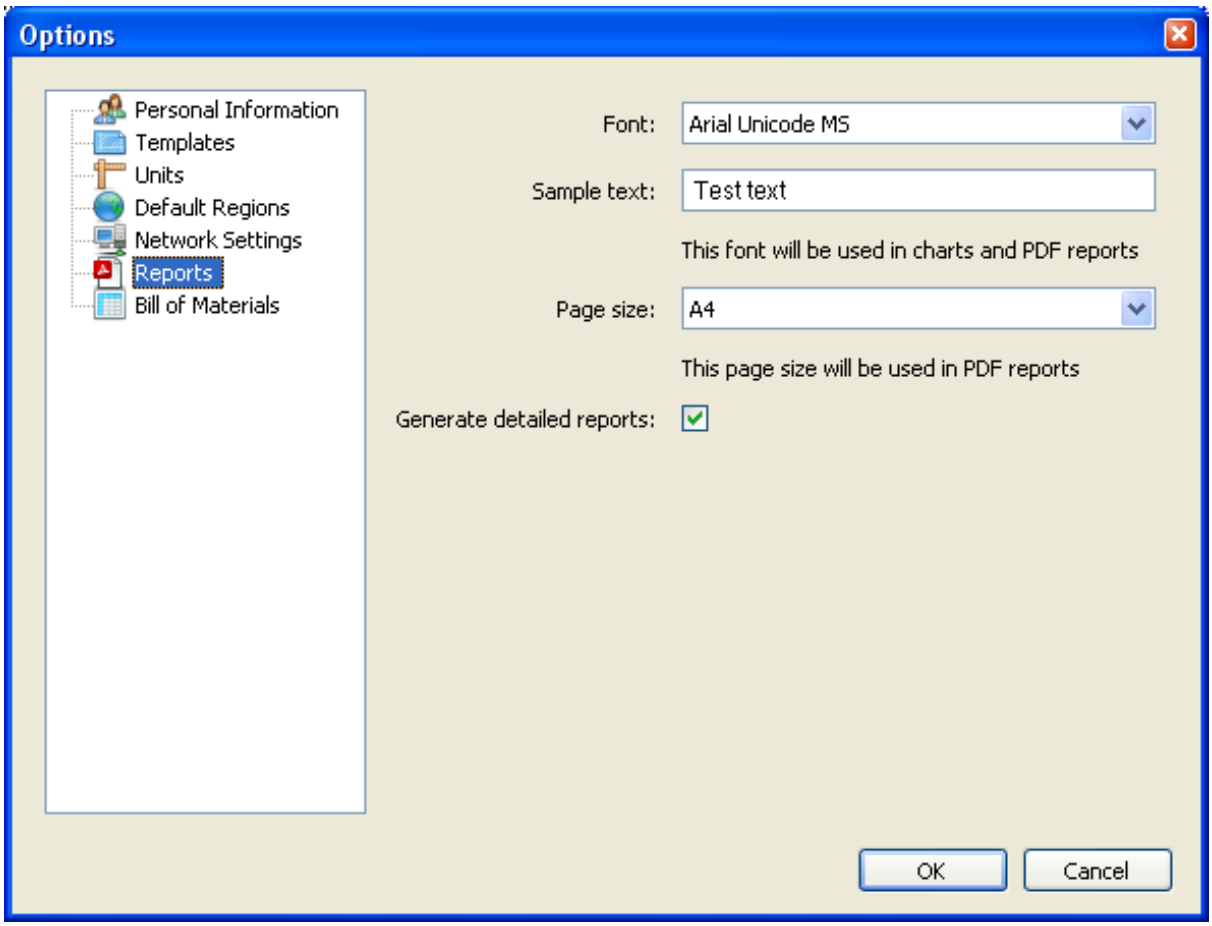


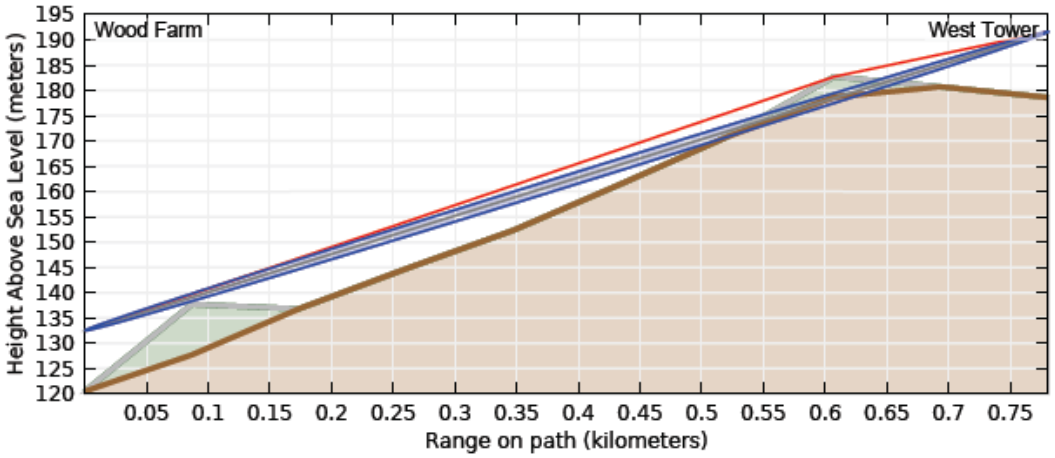
Figure 3.50: Detailed Reports Selection

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. The standard reports only show performance information for the primary to primary path. If a common antenna has been selected 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 have been selected separate installation notes will be produced for the primary and secondary units, as several parameters are likely to 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 3.51: 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. The site installation notes are given for both the primary and secondary units at each end of the link. 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 Licensed Ethernet Microwave 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.

Setting 2+0 Antenna Sharing

2+0 antenna sharing is available on PTP 800 links and involves configuring two units 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. The IRFU combines the two paths through an additional circulator to a single antenna, removing the additional loss of the coupler. For a more detailed understanding of 2+0 Antenna Sharing, see *PTP 800 Licensed Ethernet Microwave User Guide*.

2+0 Antenna Sharing can be enabled as described in *Link Description and Equipment*, for either 2+0 Co-Polar or 2+0 Cross-Polar. For the IRFU product the only option is 2+0 Co-Polar. 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*.

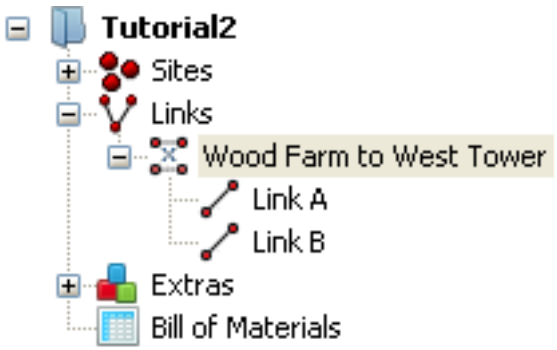


Figure 3.52: Navigation Tree for 2+0 Cross-Polar link

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.

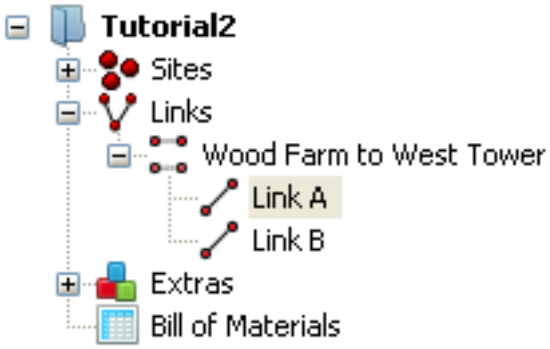


Figure 3.53: Navigation Tree for 2+0 Co-Polar link

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 2+0*. To access all other sections of the Link Page select either **Link A** or **Link B**.

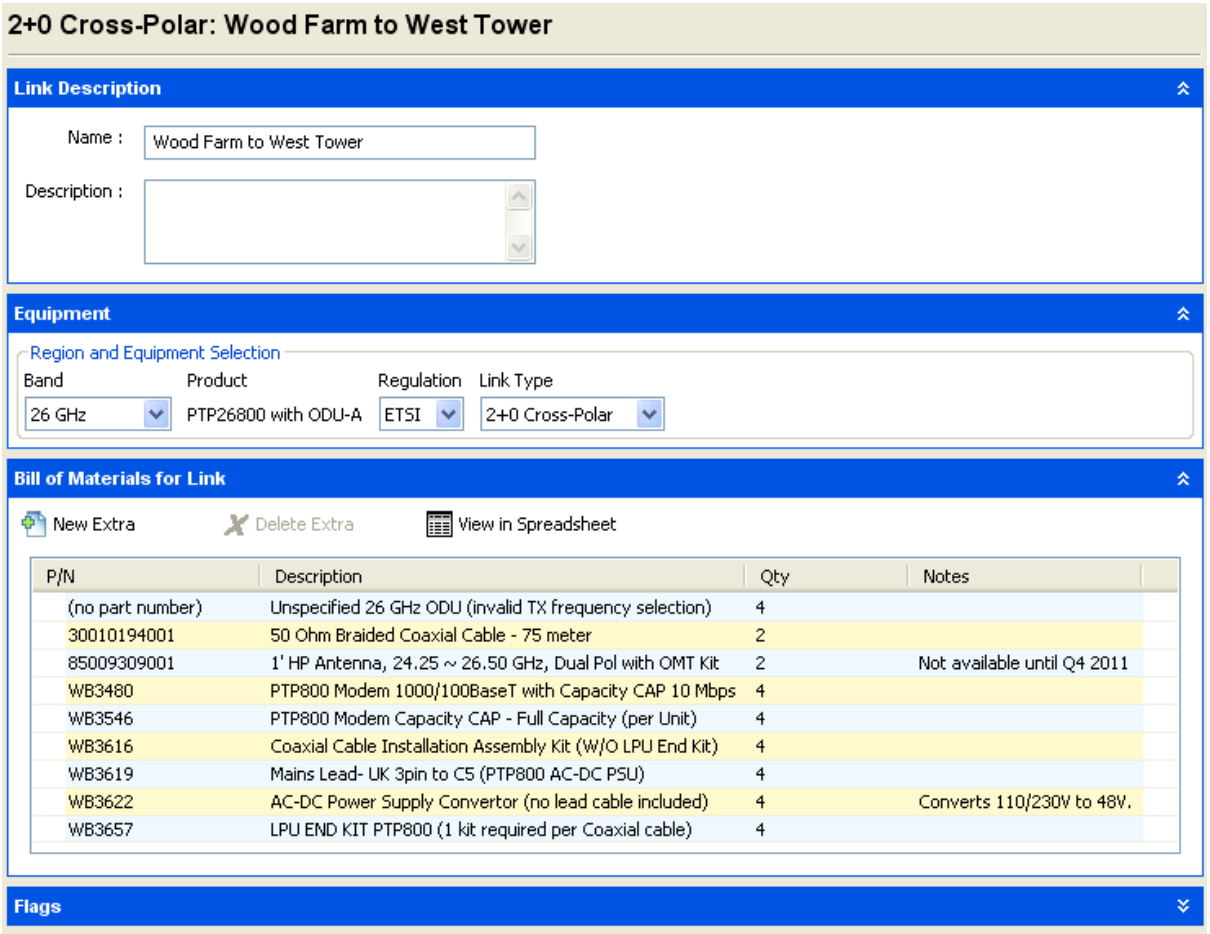


Figure 3.54: Link Node Information for 2+0

2+0 Equipment Configuration

Select either **Link A** or **Link B** to set up the product section of the equipment configuration. The Region and Equipment Selection information is repeated from the link node configuration. The **Link Type** cannot be changed at this level, however the other parameters can be changed and any changes will be reflected in the other link. The product configuration settings can all be changed independently for Link A and Link B with the exception of the Polarisation, 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.

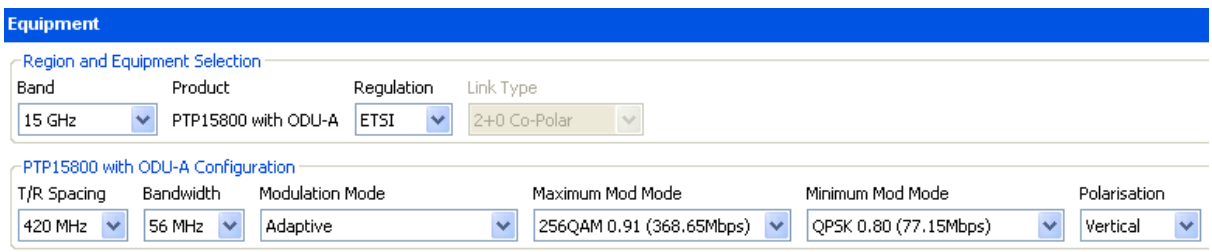


Figure 3.55: Equipment (2+0)

2+0 Configuration at Each End

The Configuration at Each End panel includes the following additional attribute for the ODU products:

Antenna Configuration: There are 2 options which can be selected to match the possible configurations for 2+0 Cross-Polar

- **Common Dual Polar Antenna (Direct Mount) - Preliminary** - default setting
- **Common Dual Polar Antenna (Remote Mount)**

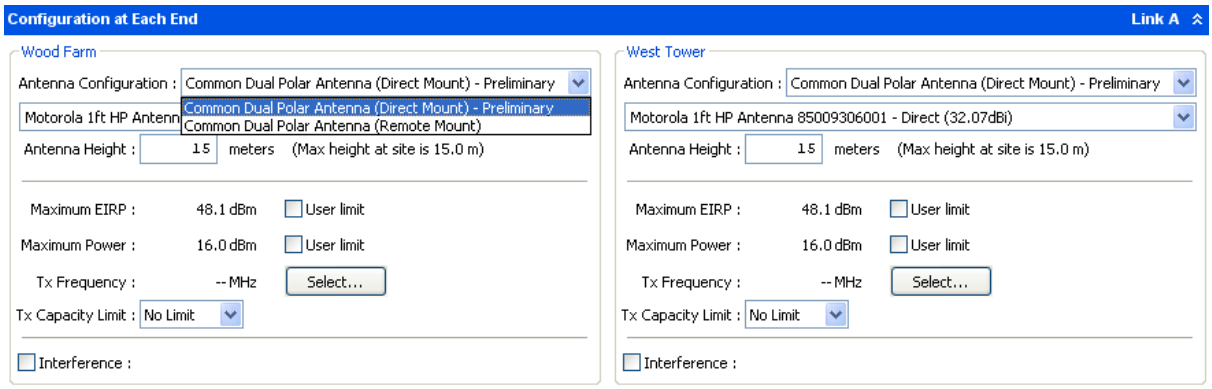


Figure 3.56: Configuration at Each End for 2+0 Cross-Polar

There are also 2 options available for 2+0 Co-Polar

- **Common Antenna - 1+1 Symmetric Coupling** - default setting
- **Common Antenna - 1+1 Asymmetric Coupling**

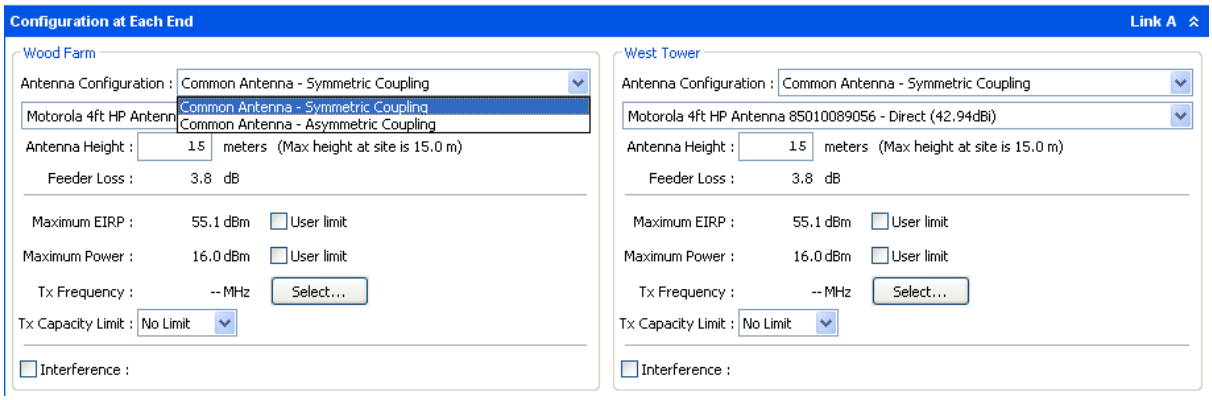


Figure 3.57: Configuration at Each End for 2+0 Co-Polar

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 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.

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. When using 2+0 Cross-Polar adjacent channels may be used. When using 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*.

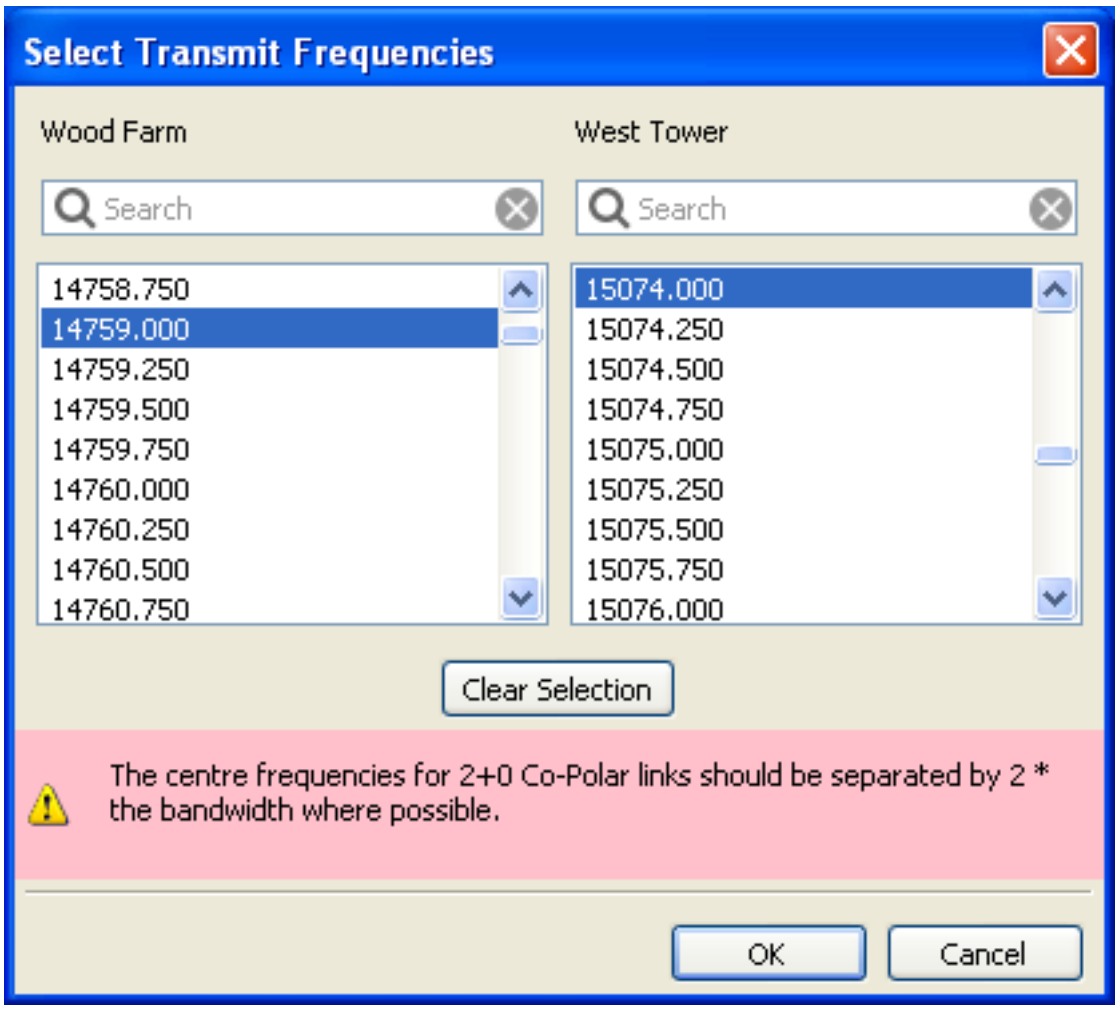


Figure 3.58: Select Transmit Frequency 2+0 Co-Polar Adjacent Channel Error

Tx Capacity Limit: This field can be set independently for the two links.

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. The required performance parameters can be set independently for each link and are defined in the usual way, see *Performance Summary*. If the predicted performance of either link is below requirements, then the main link will be displayed in **red**.

2+0 Reports

The reports for 2+0 configurations are created at the link node level in the usual way, see *Creating Reports* and 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.

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 Motorola 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 only restricts the antenna selection and provides the detailed losses form.

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.

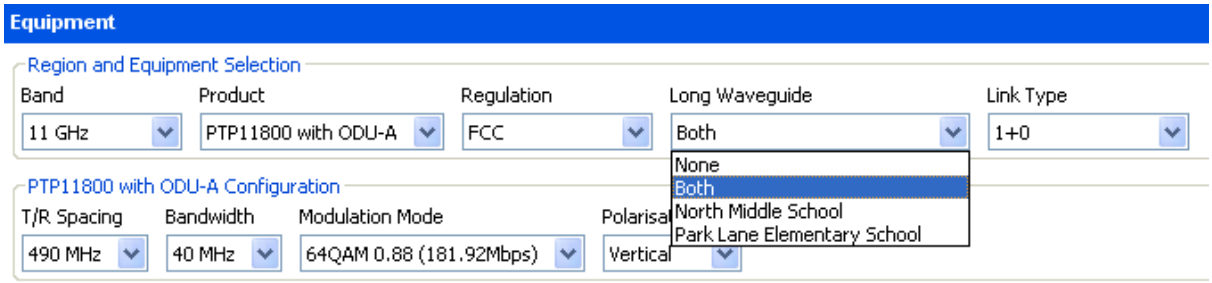


Figure 3.59: Link Equipment for Long Waveguide

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 can only be used with remote high performance antennas which have a VSWR of 1.06 or lower. The list of available antennas is therefore reduced from that used in a normal installation.

To adjust the amount of Feeder Loss click on **Edit**, see *End Equipment for Long Waveguide*.

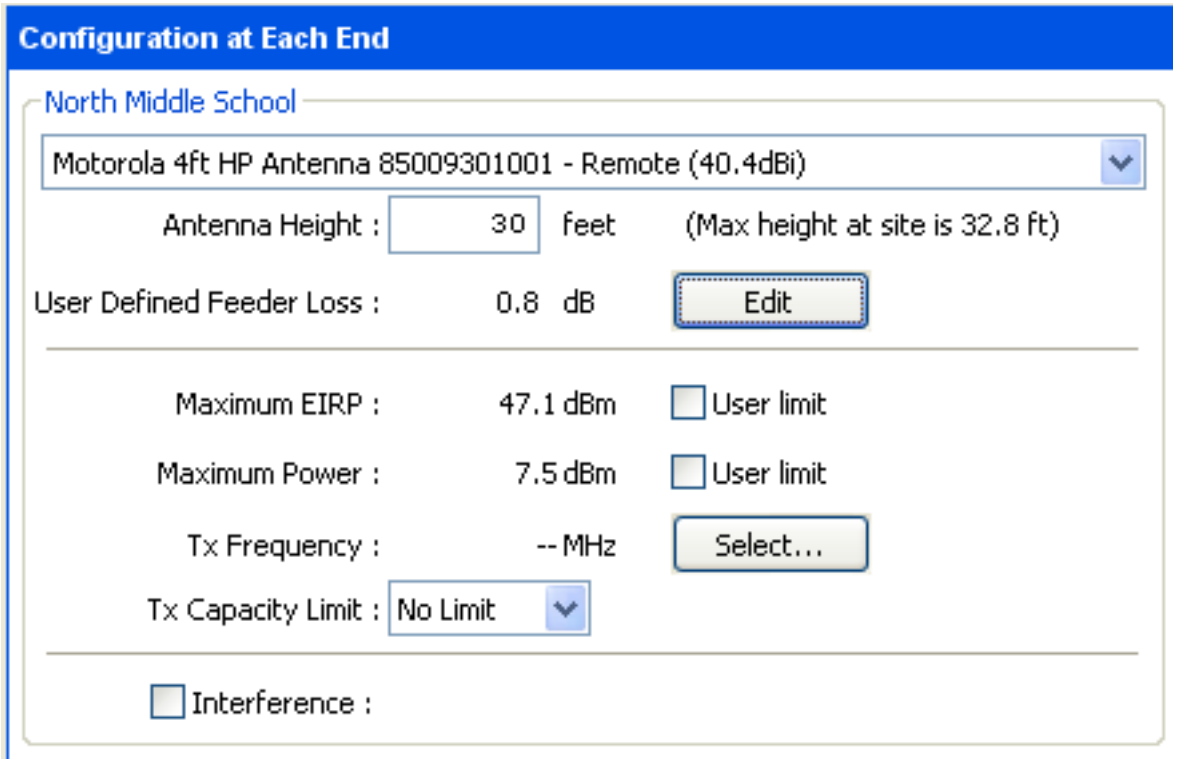


Figure 3.60: End Equipment for Long Waveguide

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.

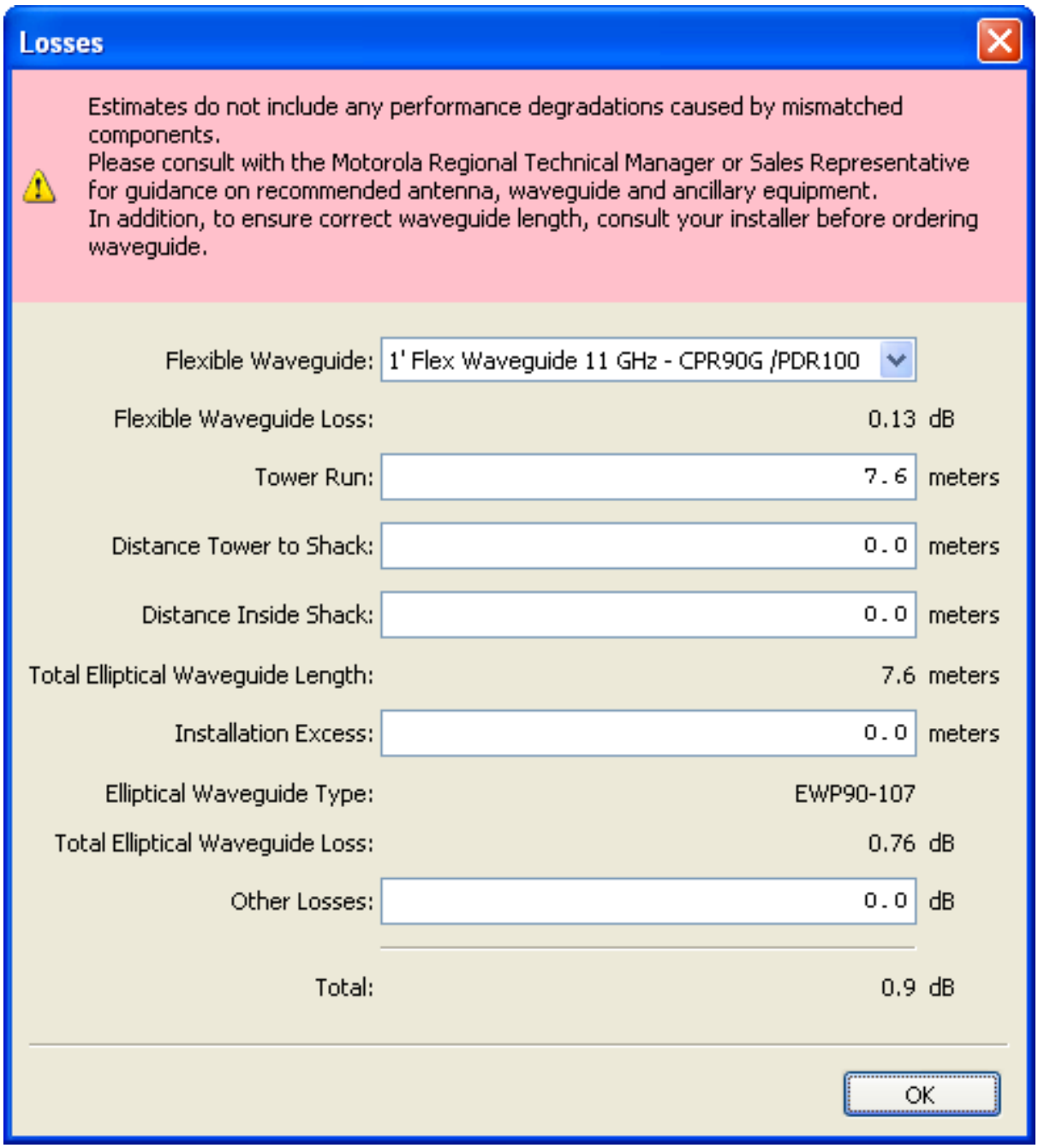


Figure 3.61: Losses (Long Waveguide)

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.

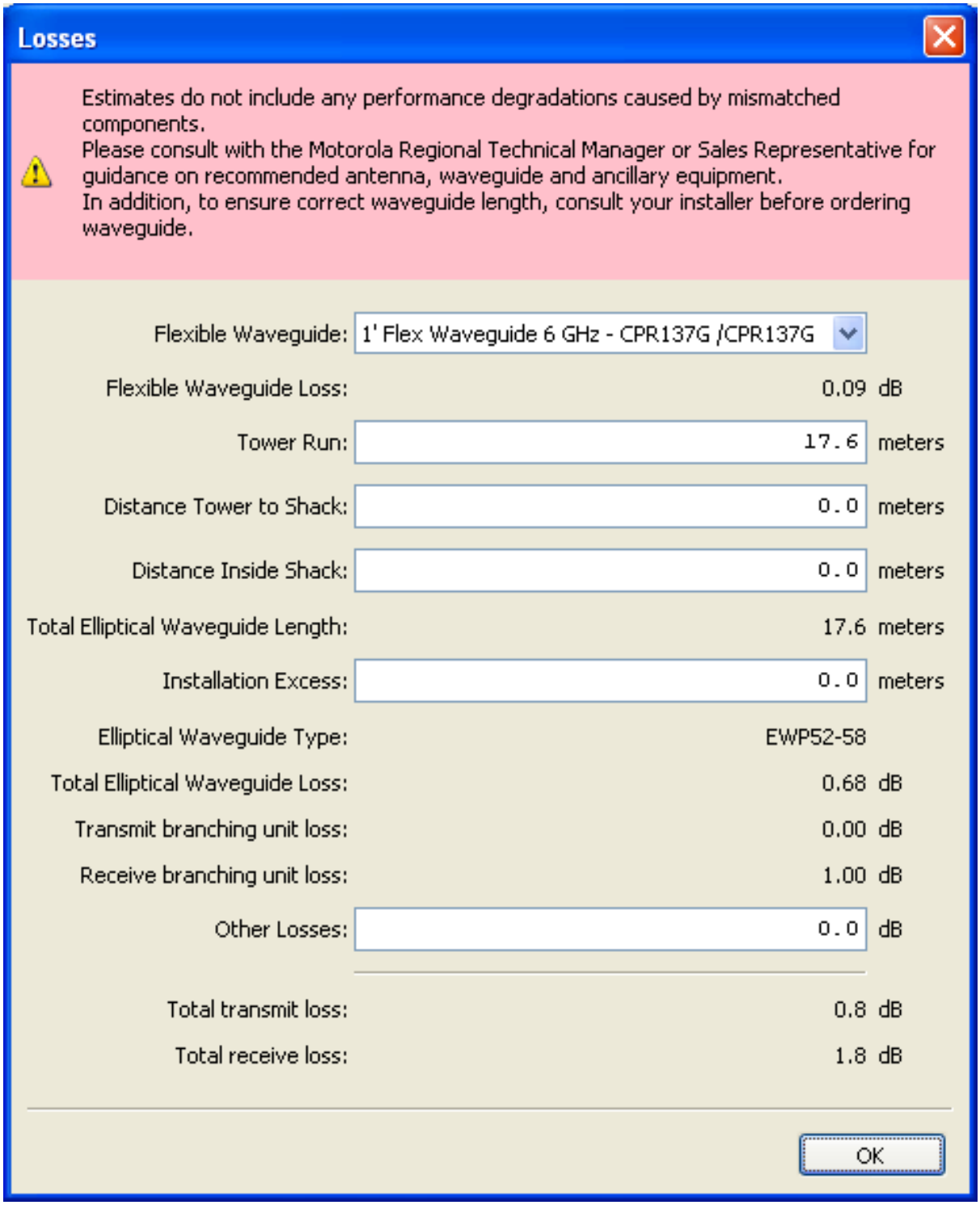


Figure 3.62: Losses (Long Waveguide for IRFU)

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, select **New Extras** 

and the **Long Waveguide** section, see *Bill of Materials Optional Extras*.

Project Templates

Overview

A project template can contain all of the items that exist in a regular LINKPlanner project file, such as default equipment settings, 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 'PTP LINKPlanner Project Template' (*Choosing the template file type*) (see and choose the destination and file name for the template.

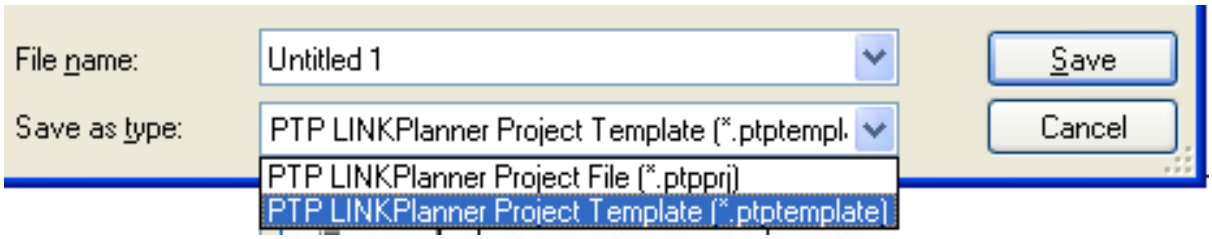


Figure 3.63: Choosing the template file type

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.

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 PTP 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 Motorola 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 PTP LINKPlanner navigation tree, then select 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*):

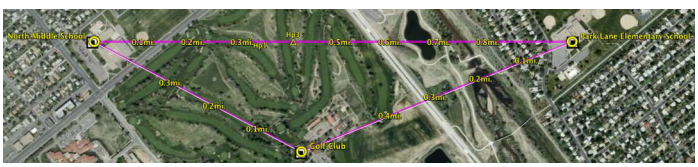


Figure 3.64: Google Earth(TM) Aerial Photograph with Distances Shown

To view a site, select the site in the PTP LINKPlanner navigation tree, then select 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 3.65: 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.

Colour 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 PTP 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.

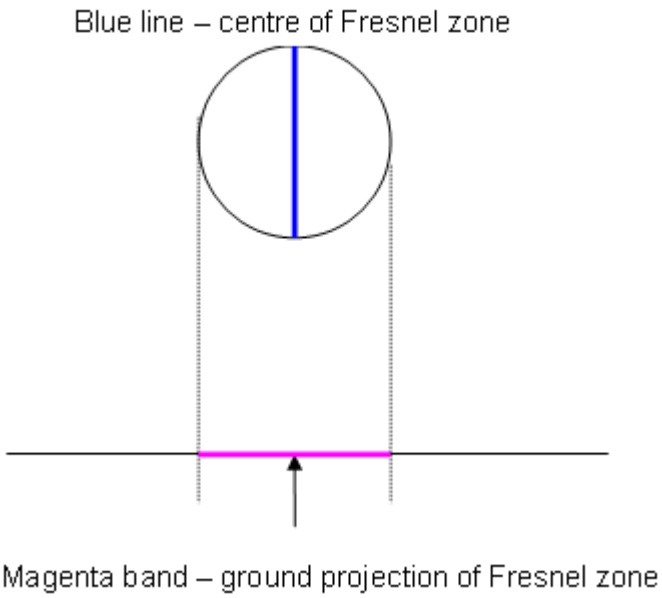


Figure 3.66: Fresnel zone representation in Google Earth

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 centre 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 PTP 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 PTP 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 Vizualization Chart* must be updated to include obstructions and, if the path is over water, to allow for reflection.

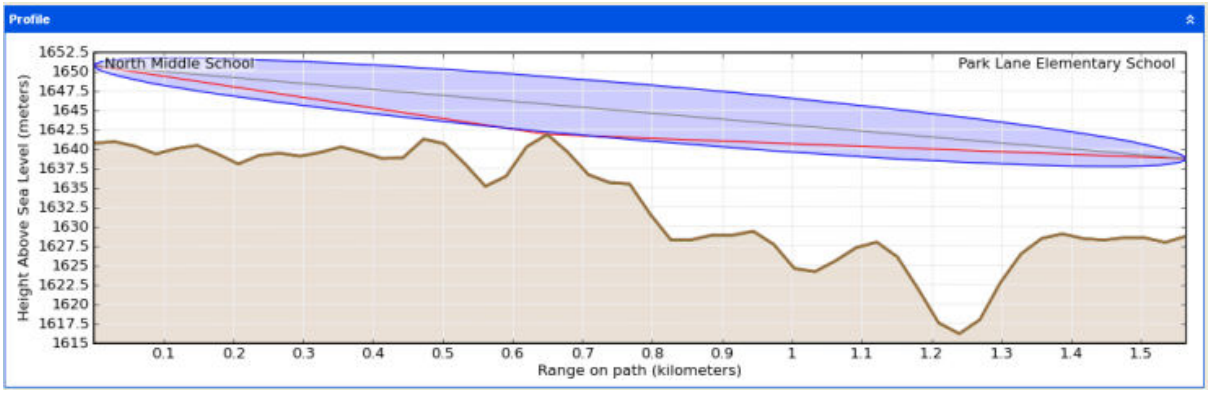


Figure 3.67: Profile Vizualization Chart

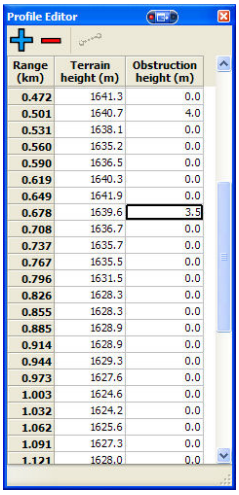
Obstructions

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 metre high Obstruction at Range 0.501 km and a 3.5 metre 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 metres into the right hand side of the zone, enter it as a 3 m high obstruction.



Range (km)	Terrain height (m)	Obstruction height (m)
0.472	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
1.003	1624.6	0.0
1.032	1624.2	0.0
1.062	1625.6	0.0
1.091	1627.3	0.0
1.121	1628.0	0.0

Figure 3.68: Profile Editor

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

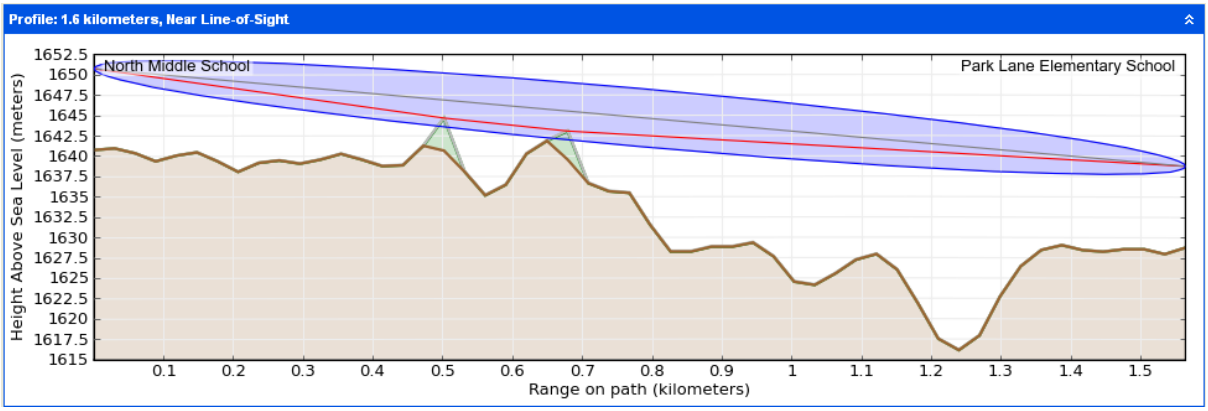


Figure 3.69: Profile Updated With Tree Obstructions (in green)

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.

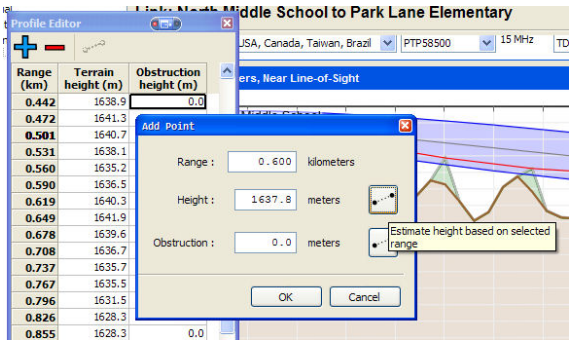


Figure 3.70: Adding a Profile Point

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 .

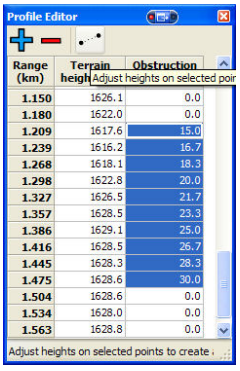


Figure 3.71: Setting a Constant Gradient

Reflections

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, select **Link, Edit Reflection Parameters**. Check the “Enable Reflection Mitigation” box (*Reflection Editor*) to enable the calculation and display a visualization of the reflection on the Profile chart. Adjust the Reflection Surface Height until the line (blue with gray ends) aligns with the height of the reflecting surface.

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.

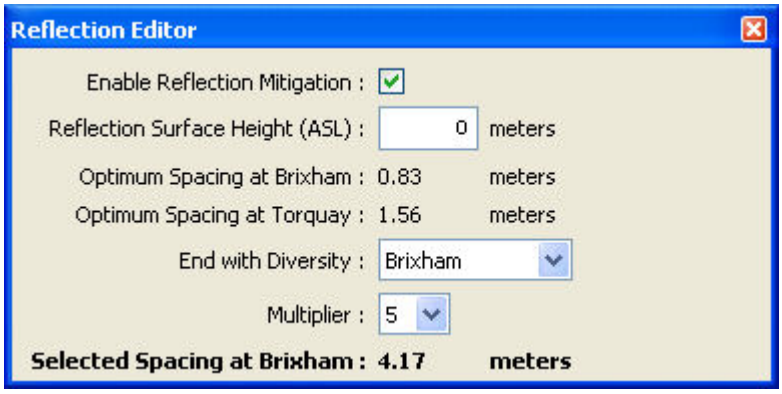


Figure 3.72: Reflection Editor

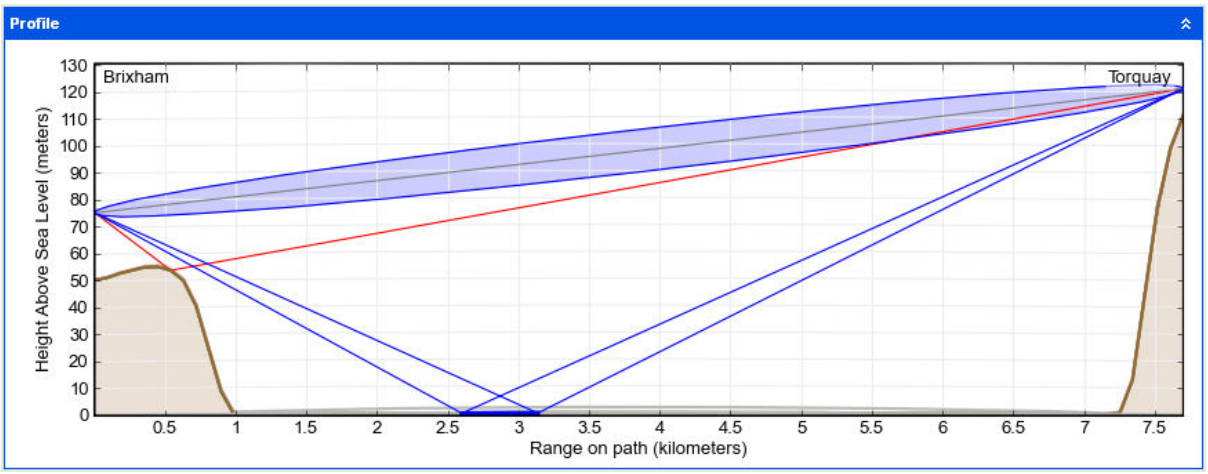


Figure 3.73: Profile with Reflection Visible

The optimum spacing may be different for each end of the link, and a Multiplier may be chosen from the pull down list to give a suitable spacing to use in the last line of the editor. In the example above, the Multiplier is set to 5 to give a spacing of 4.17 meters, which is easily achievable without much cable loss. Set the Multiplier, then transfer the resulting Spacing value to the Configuration Diversity Spacing, as described in *Configuration at Each End*.

In this example, an alternative solution is to lower the Brixham antenna. This makes diversity spacing unnecessary for reflection mitigation, because the

reflection path is obscured by the Brixham cliff edge (*Profile with Reflection Obscured*).

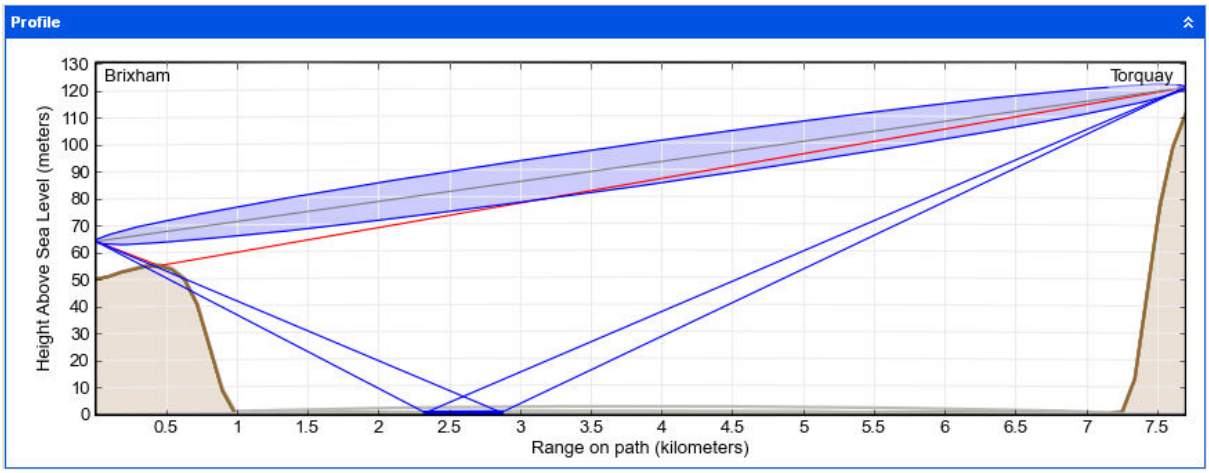


Figure 3.74: Profile with Reflection Obscured

For more information about reflections, see *Paths Over Sea or Very Flat Ground*.

Link Profile Adjustment Examples

These examples show how Motorola 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:

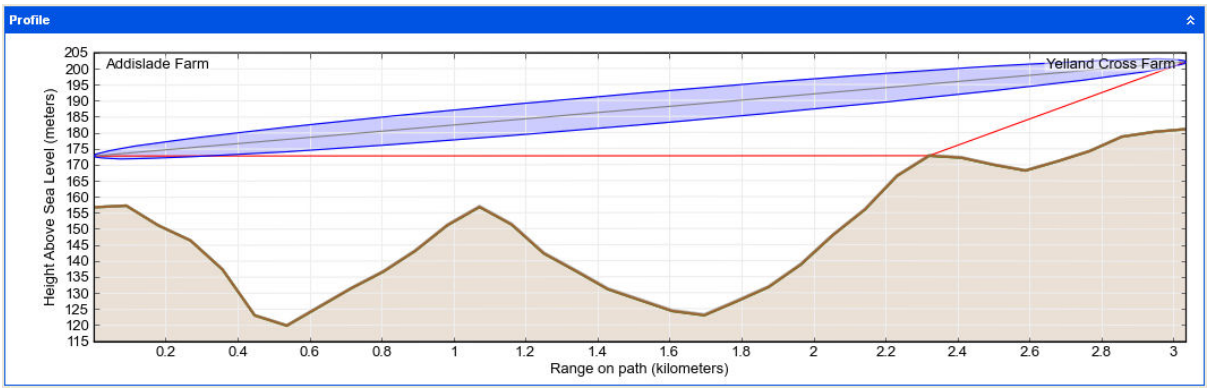


Figure 3.75: Original path profile

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:

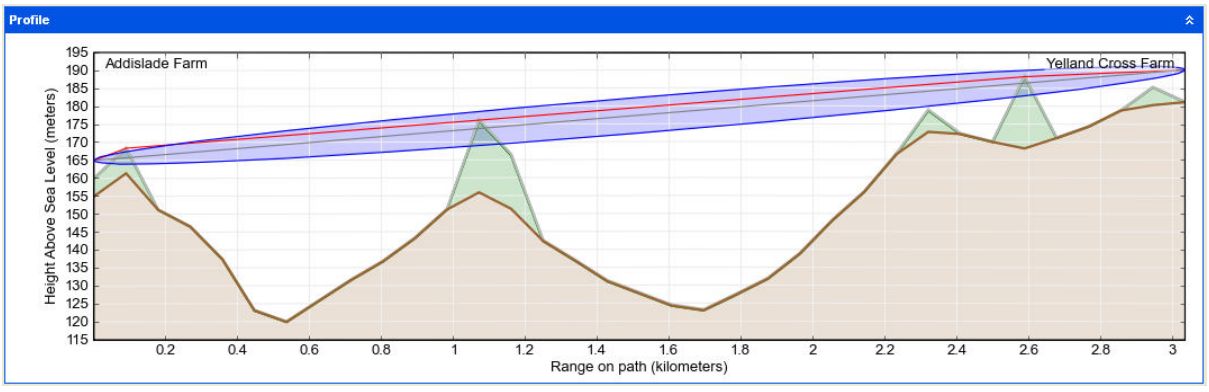


Figure 3.76: Adjusted path profile

Verifying a Link End Using a Map and Google Earth

This is an example to show how Motorola 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:

- PTP Path Profiler data imported into PTP LINKPlanner.
- PTP 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. PTP Path Profiler returned the following profile for the start of a link path:

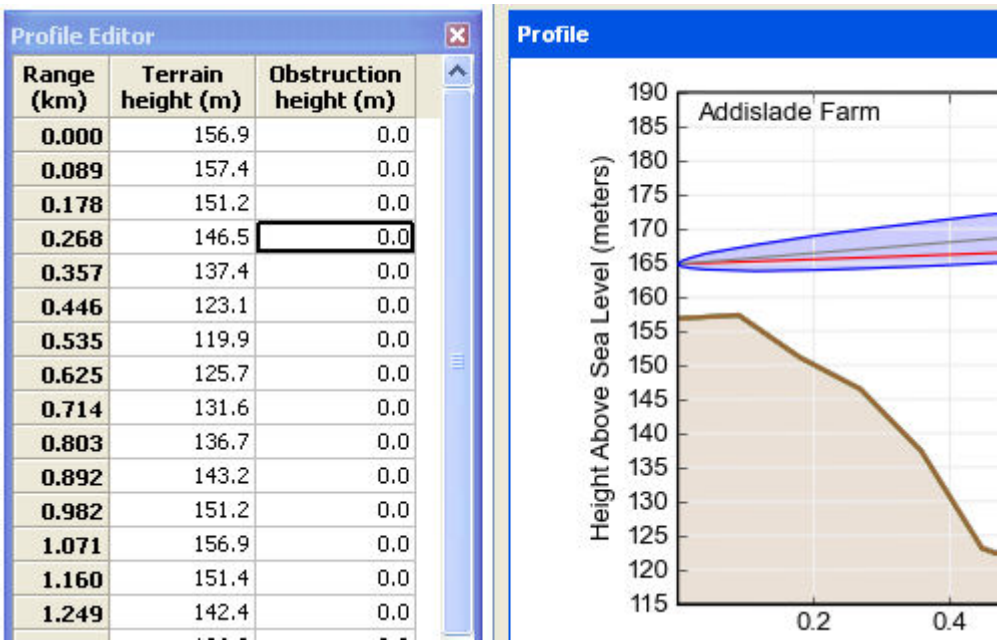


Figure 3.77: Unadjusted profile near antenna site

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

2. We examine the map of the site:

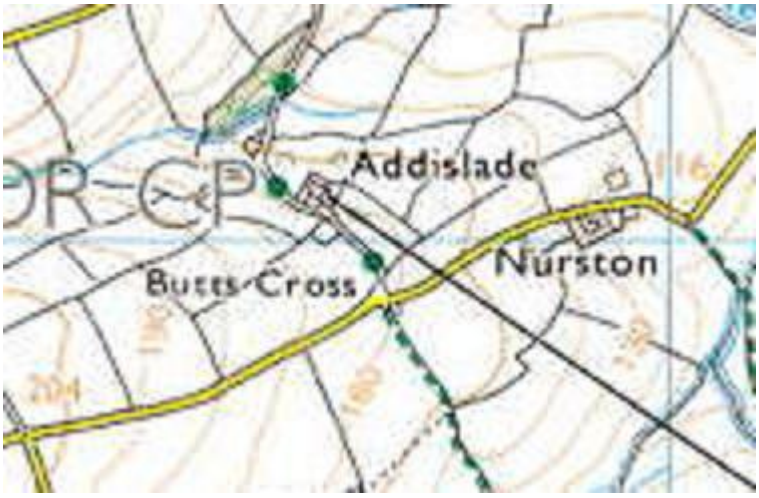


Figure 3.78: Map of Addislade

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 0.089 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:

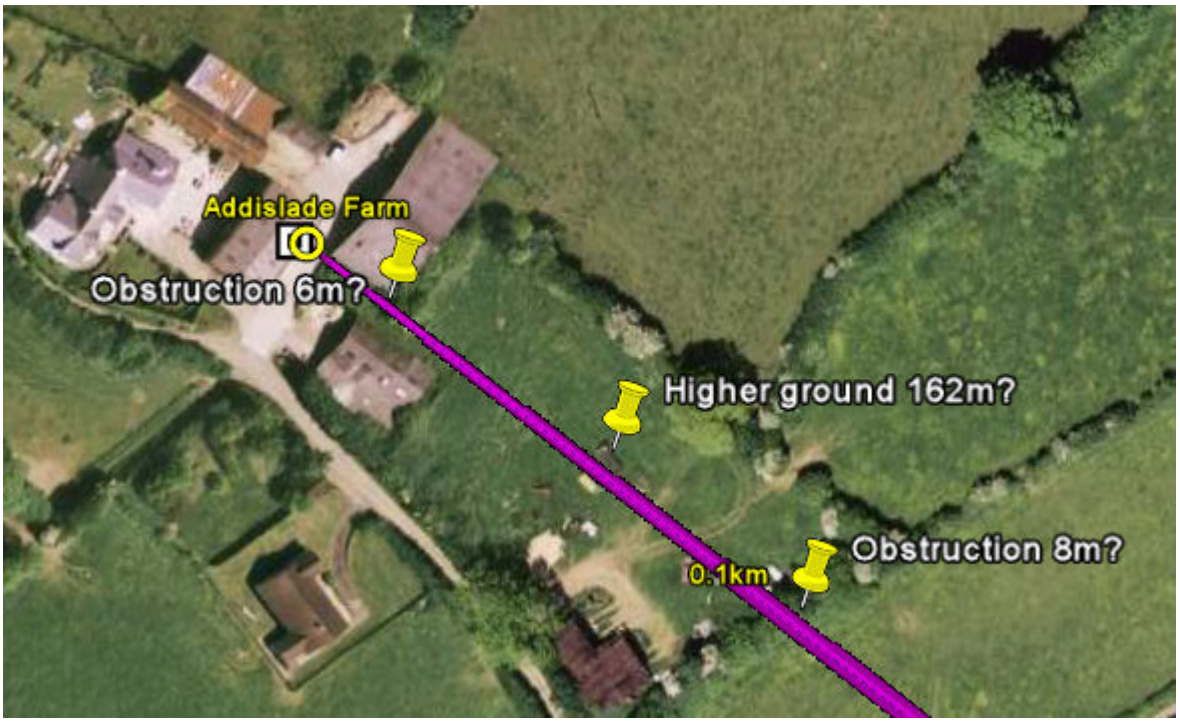


Figure 3.79: Obstructions and higher ground near Addislade

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

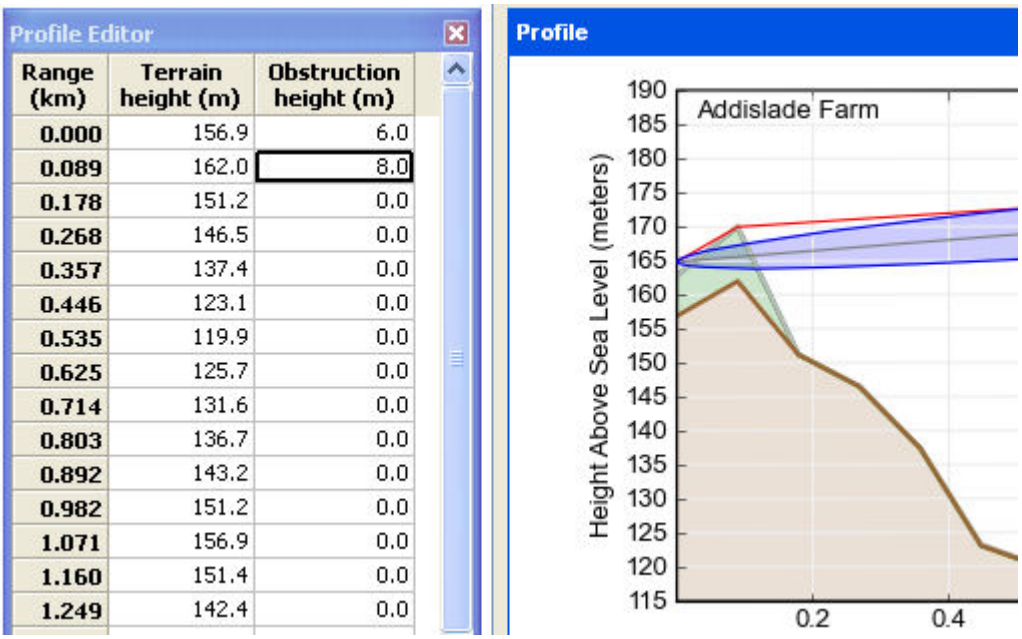


Figure 3.80: Profile Updated with Map and Google Earth Results

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 Motorola 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:

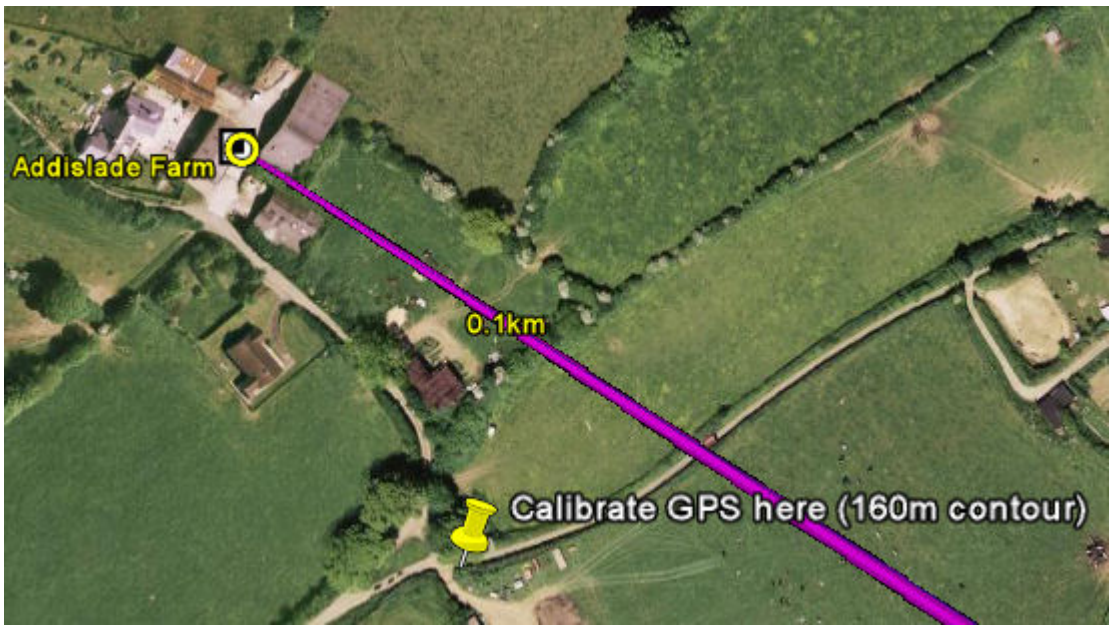


Figure 3.81: GPS Calibration Point

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)*

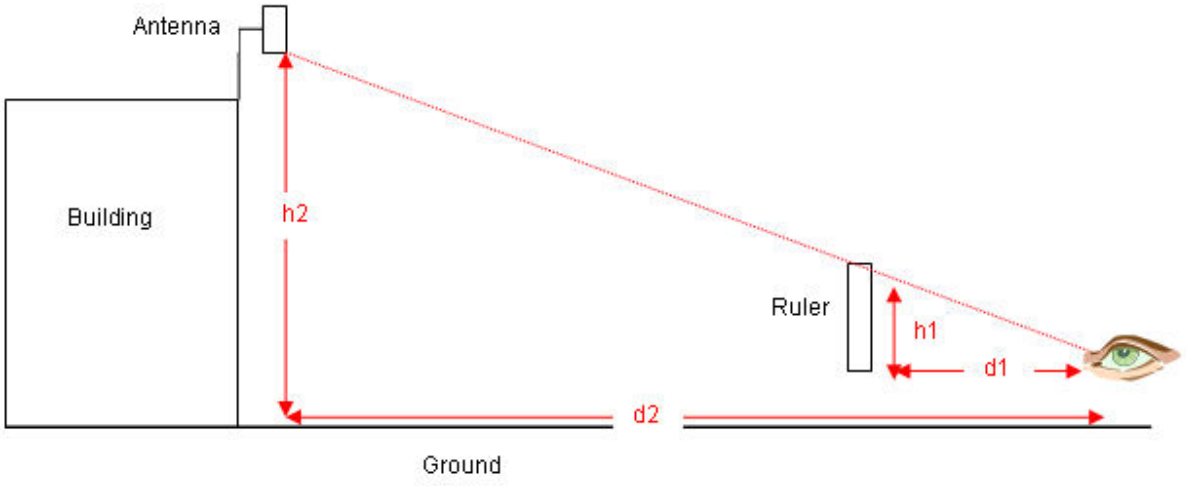


Figure 3.82: Using a ruler to estimate height

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 0.089 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:

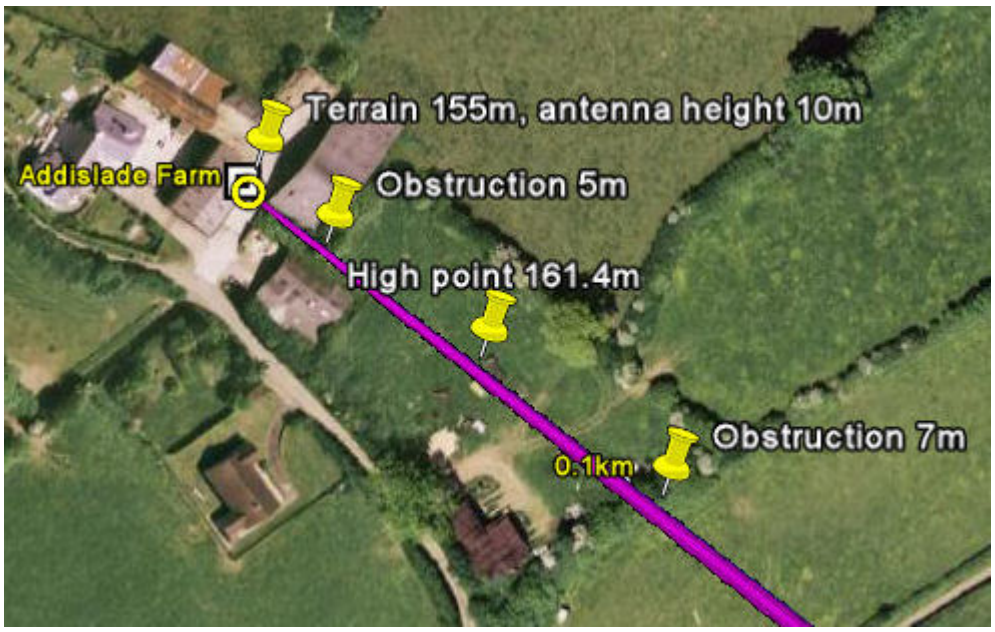


Figure 3.83: Results of site survey at Addislade

⚠ 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:

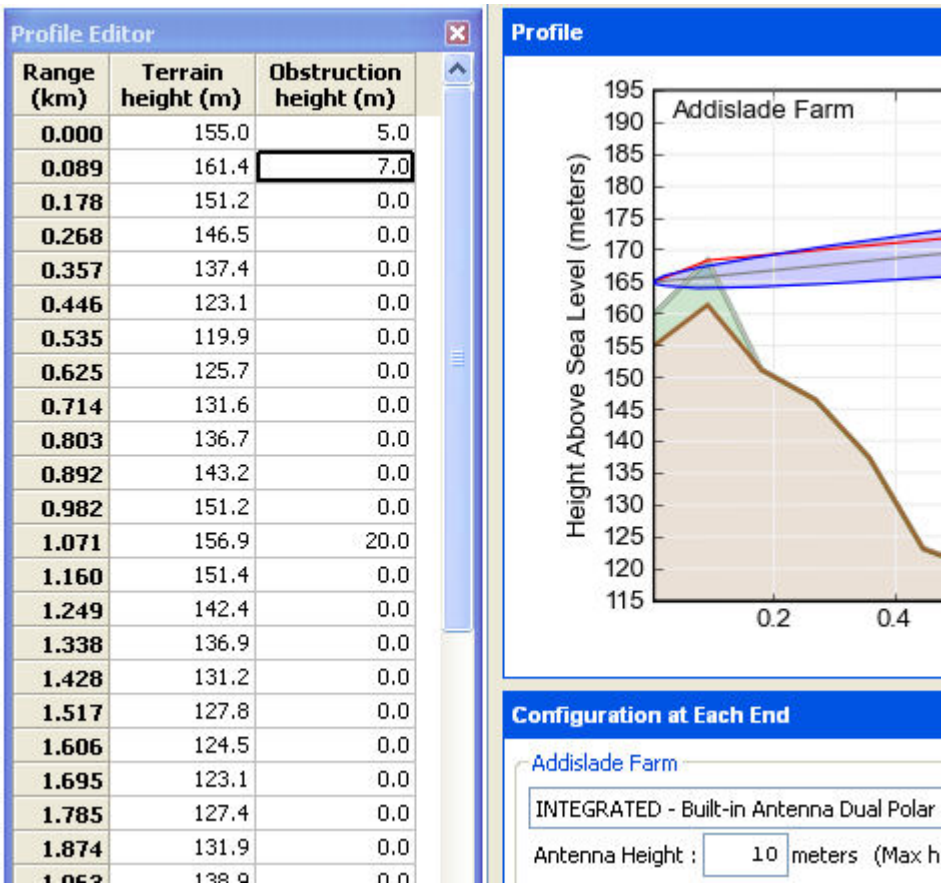


Figure 3.84: Profile updated with site survey results

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 Motorola 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:

- PTP Path Profiler data imported into PTP LINKPlanner.
- PTP 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. PTP Path Profiler returned the following profile for the high point at range 1.071 km:

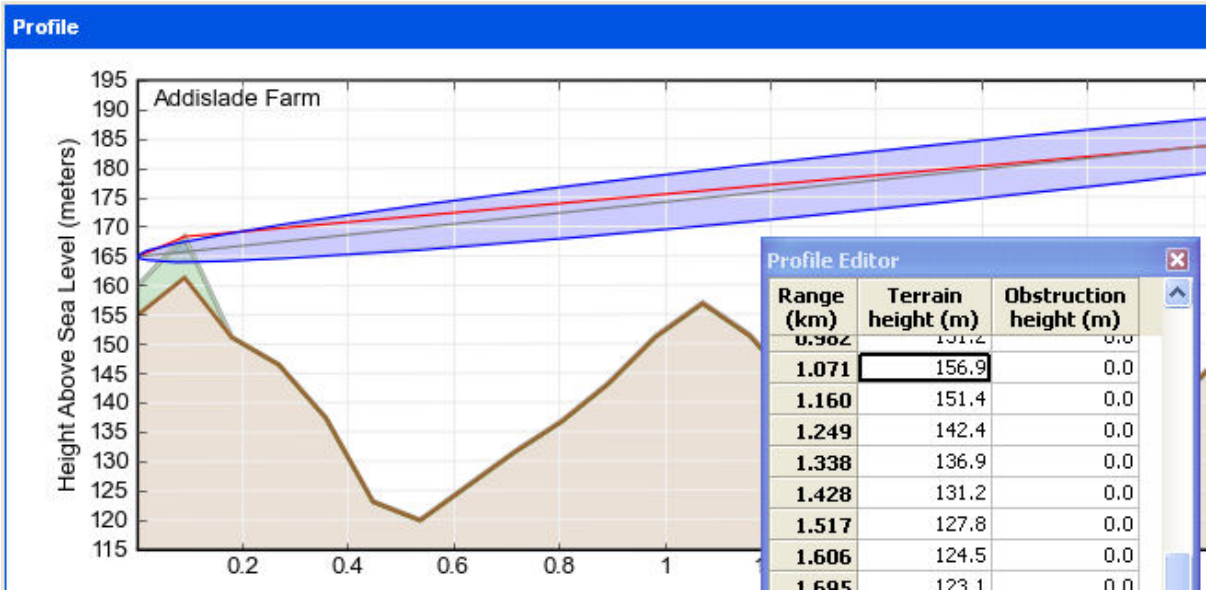


Figure 3.85: Unadjusted profile near high point

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 3.86: Map of Hp1

The path profile height 156.9 m at range 1.071 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:

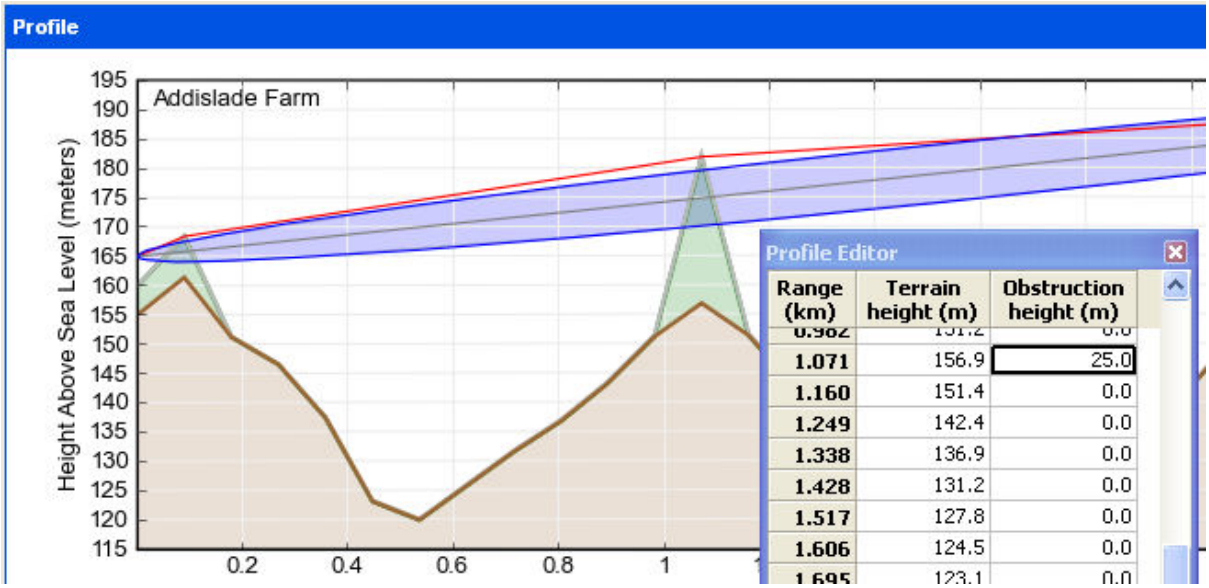


Figure 3.87: Estimated obstruction height near Hp1

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 Motorola 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:

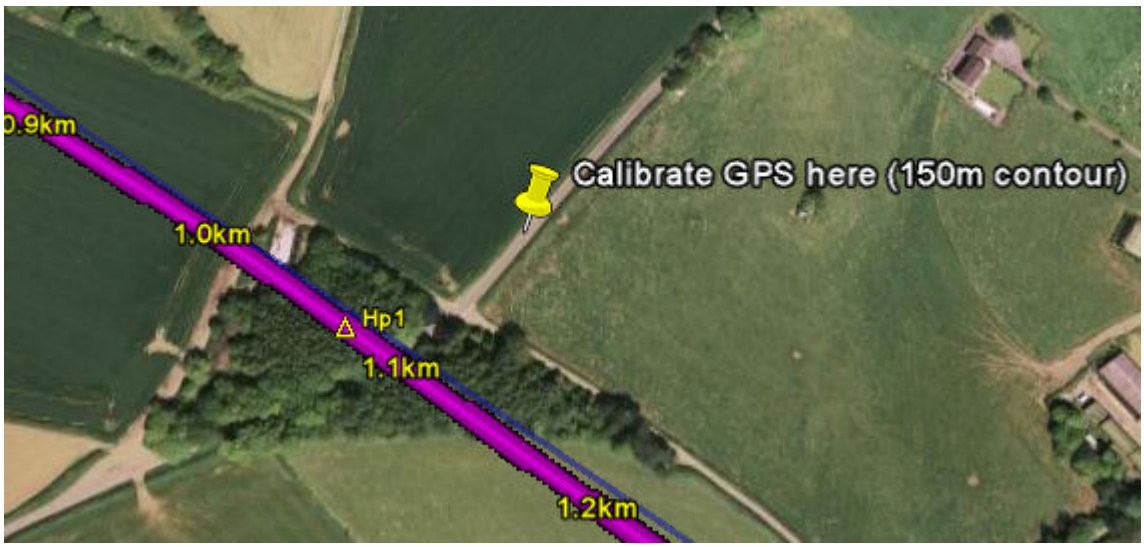


Figure 3.88: GPS Calibration Point near Hp1

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:

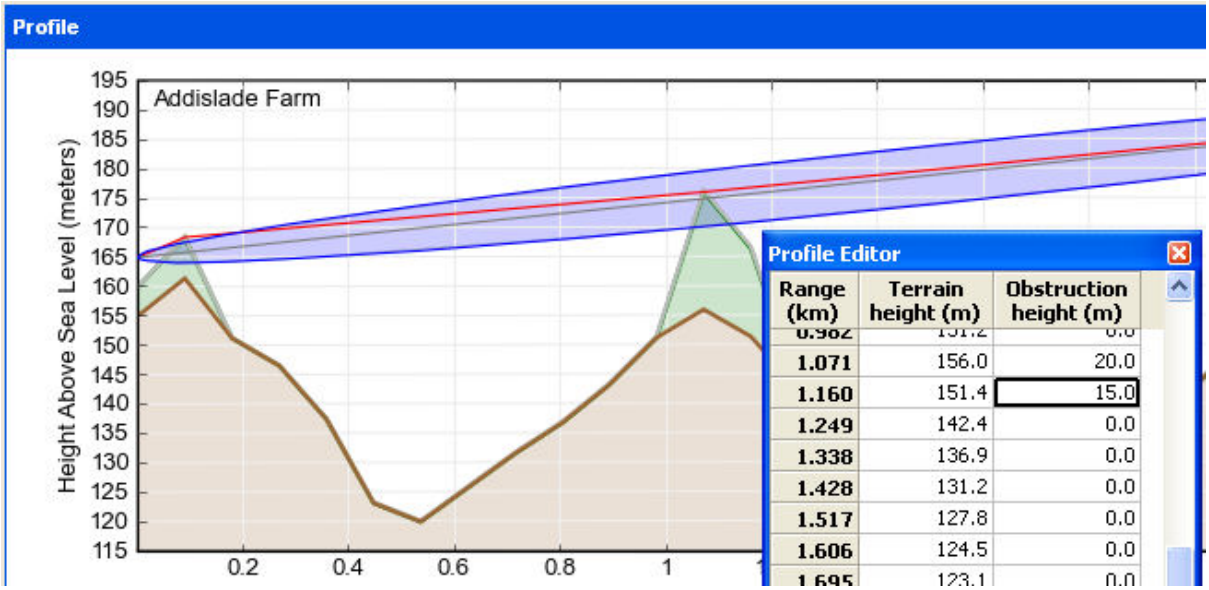


Figure 3.89: Profile updated with Hp1 survey results

We now have a more accurate profile of the high point. This will help us to

optimize the link and achieve acceptable data throughput.

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.

Links (CSV)

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

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

Sites (CSV)

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

Links from this site (CSV)

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

Google Earth(TM) (KML)

To export details of a single site to a KMZ/KML file, select **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 performance charts to a csv file, select **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, select **File**, **Export**, **FCC License Coordination**. The information will be exported to a CSV file, in the format required by Comsearch.

Creating Reports

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

- Proposal reports offer a general overview. Options are **Project** or **Link**.
- Installation reports contain detailed configuration and performance parameters. Options are **Project, Links Table, Link or Site**.

NOTE

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

Proposal Reports

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

- To preview, select **Proposal Report PDF** 
- To create as a PDF, select **File, Proposal Reports** and one of **Project** or **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 **Link** proposal report consists of a path profile, throughput, link summary, performance charts, climatic factors & losses and BOM.

Installation Reports

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

- To preview, select **Installation Report PDF** 
- To create as a PDF, select **File, Installation Reports** and one of **Project, Links Table, Link or Site**.

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

The **Links Table** installation report is a reproduction of the Links List.

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

The **Site** installation report consists of details of one site (site summary, network map and summary of links to the site).

Background Information

The following background information is provided to help users of PTP LINKPlanner:

- A description of path loss. See *Path Loss*.
- A description of the Motorola PTP Path Profiler. See *Path Profiles*.
- Specifications of import file formats. See *Import File Formats*.
- An overview of Time Division Duplex (TDD). See *TDD Overview*.
- An overview of TDD Synchronization. See *TDD Synchronization Overview*

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.

PTP 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:

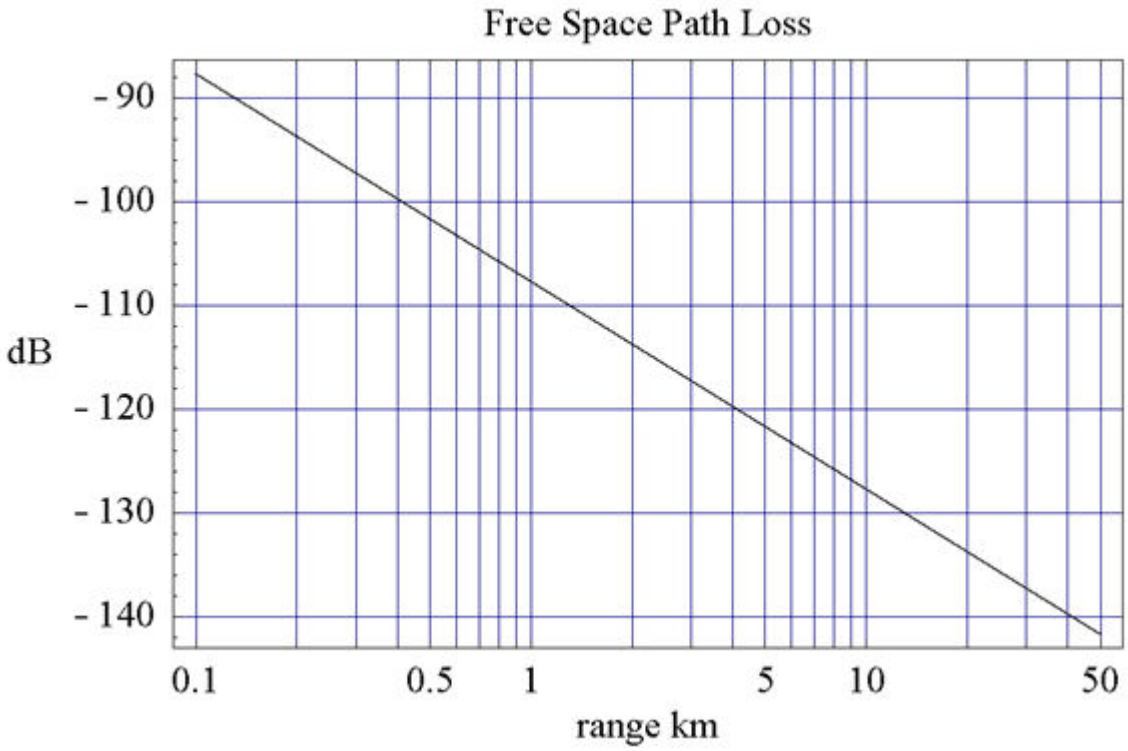


Figure 4.1: Free Space Path Loss at 5.8 GHz

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 PTP 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 PTP 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:

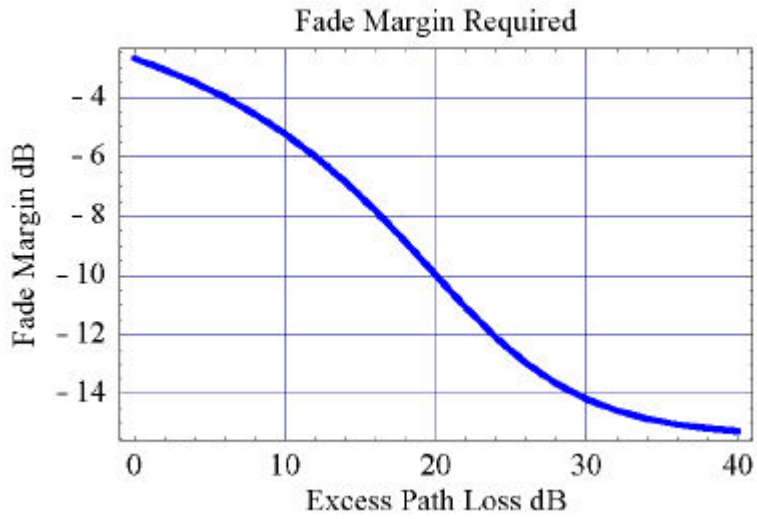


Figure 4.2: Fade Margin vs Excess Path Loss for 99.99% Link Availability

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

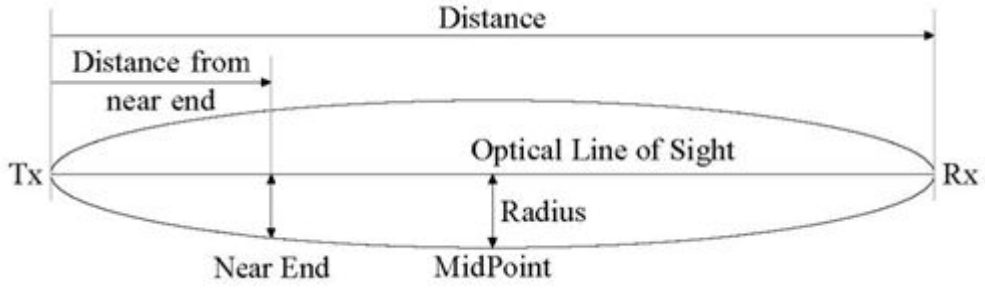


Figure 4.3: Fresnel Zone

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 4.4: 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*.

Path Profiles

The accuracy of the PTP LINKPlanner results depends upon obtaining accurate path data. In the US this data is readily available from recent 1 arc second data (20m) obtained by NASA. In the rest of the world 30 arc second data (500m) is freely available but NASA has provided 3 arc second data (50m) for the world between Latitudes 60 north and 60 south. (See *SRTM Technical Guide*). PTP LINKPlanner can also import from a number of other data sources. 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. Motorola provides the PTP Path Profiler web based utility for this purpose, as described in *PTP 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.

PTP Path Profiler

Motorola has produced the web based utility PTP Path Profiler to create path profiles, which can be directly imported into PTP LINKPlanner:

http://motorola2.motowi4solutions.com/support/ptp/pathprofile.php

The file output by PTP 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 PTP LINKPlanner for translated files.

Automatic Profile Requests

PTP LINKPlanner automatically generates requests and sends them to PTP Path Profiler (from the menu options Project, Get Profiles). PTP Path Profiler sends the path profiles to the email address specified in the Options/Preferences Page. See *Obtaining Link Profiles*.

Manual Profile Requests

If the automatic request generation does not work, the profile can be obtained manually by visiting the PTP Path Profiler site and entering the following information:

- The latitude and longitude of the both ends of the wireless link in decimal format to WGS 84.
- The heights above ground level of the antennas at both ends of the link.
- Selection of the required height and range units.

- A filename that is used to name the path profile files that are returned via email.
- Contact information including name, company and telephone number.
- An email address to which an email containing the path profile files can be delivered.

Location can be entered in a number of formats, for example:

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

The Antenna Heights are referenced to ground level, and they are adjustable in the PTP LINKPlanner. The number of points divided by the range of the link gives the resolution along the path of the link. The link name is displayed on the graphical display of the PTP LINKPlanner. The Filename has '.ptpdat' appended to it. The Contact Name enables Motorola to know who is requesting path profiles. The Company Name and Phone are for similar purposes. The Email address is the site where the path profile is delivered, usually in a few minutes after pressing **Send Form**.

When path profiles are loaded into PTP LINKPlanner, verify them as described in *Adjusting Link Profiles*. The following questions must be answered:

- Has PTP Path Profiler given the correct ground height at each end of the link?
- Has PTP 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.

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

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

See *SRTM Technical Guide* for links to SRTM sites.

Path Profile E-mail

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

- PTPDAT file: The PTPDAT file is a Motorola proprietary format file suitable for loading into the PTP LINKPlanner.

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).

For more information, visit:

- 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/

TDD Overview

Motorola 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.

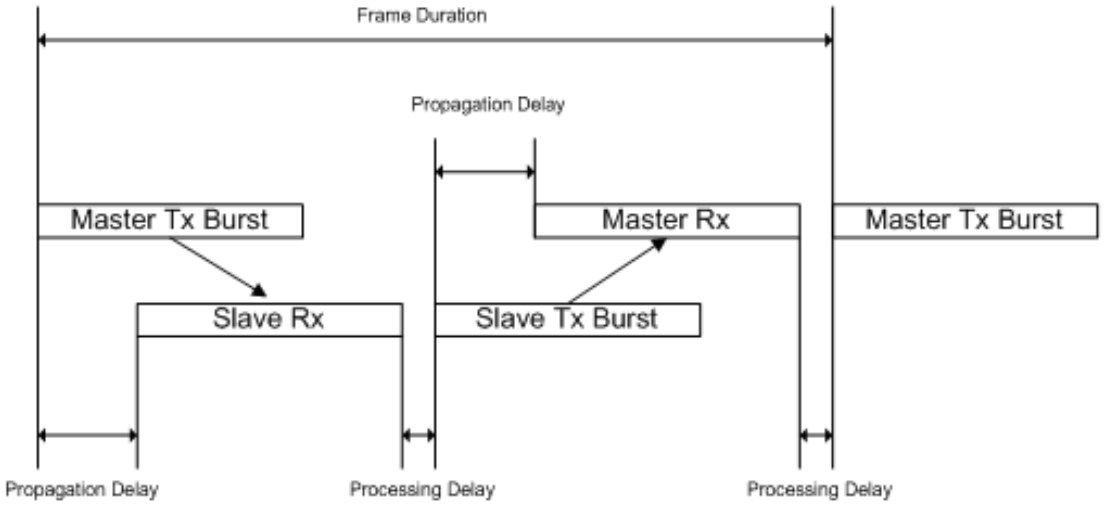


Figure 4.5: Basic TDD Frame

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 600 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 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 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 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 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.

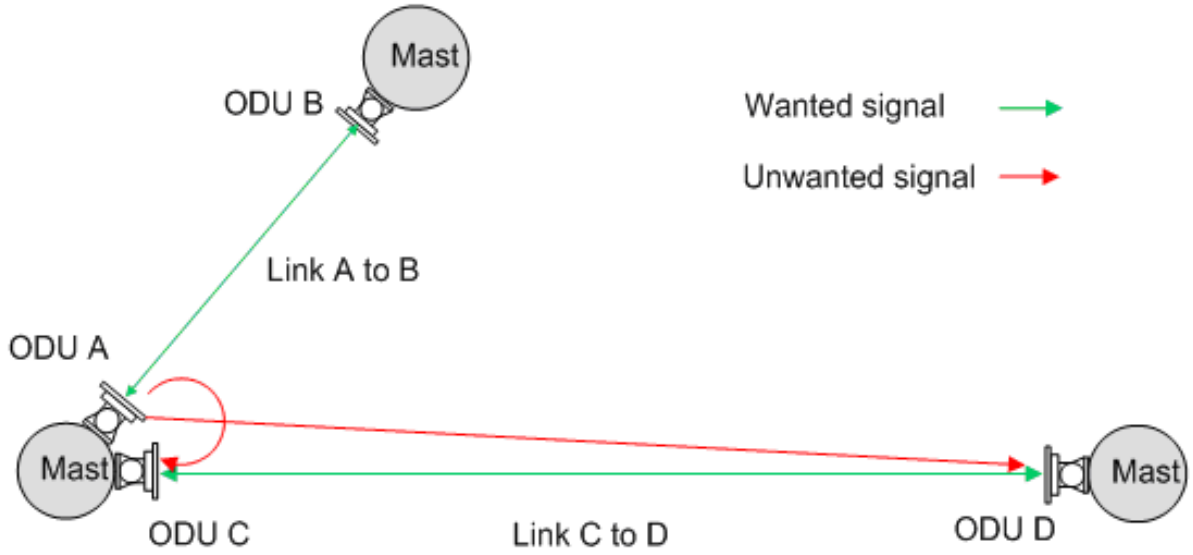


Figure 4.6: Interference Between ODUs

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.

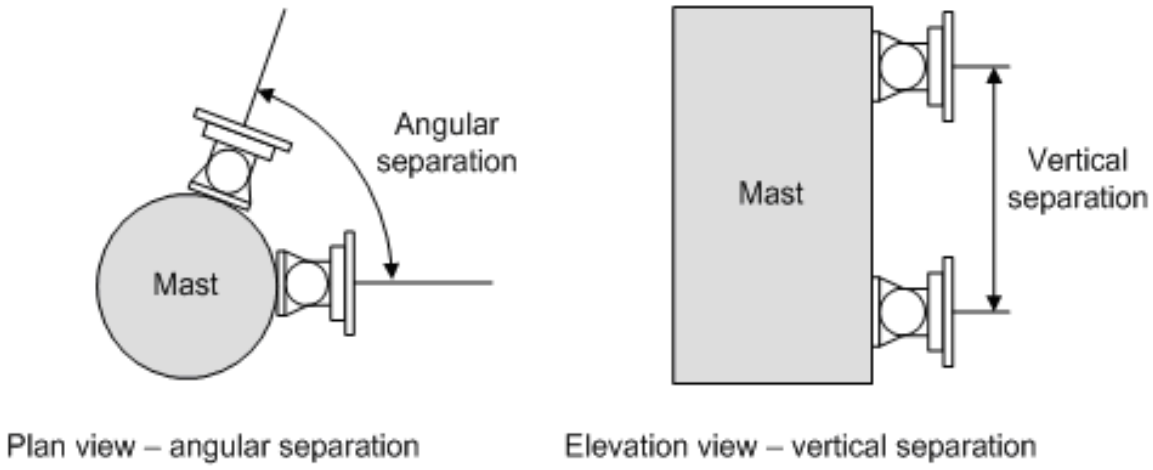


Figure 4.7: Separation of PTP 600 Units on a Mast

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. Note however that only PTP 600 links support TDD synchronization.

TDD synchronization works by aligning the frames of all PTP 600 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* 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.

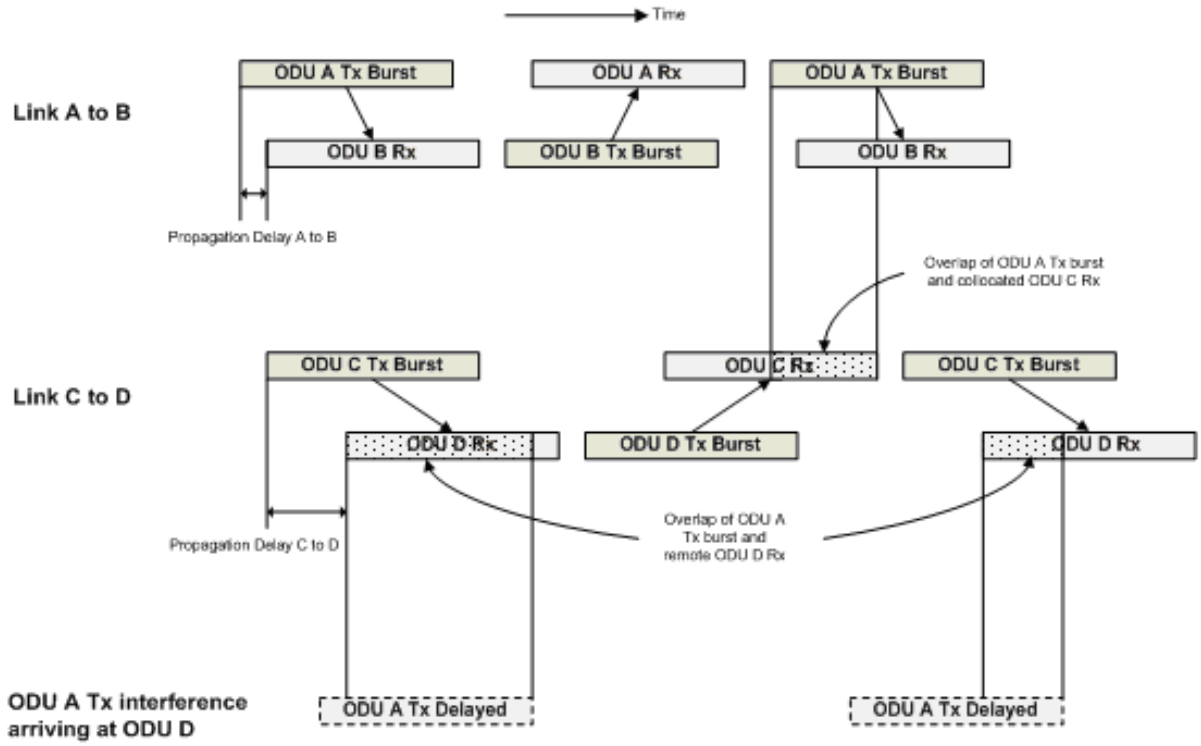


Figure 4.8: Unsynchronized Frames

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 centre 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 centre of the Master transmit burst) or Phase 2 (which is when the centre 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 centre 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*.

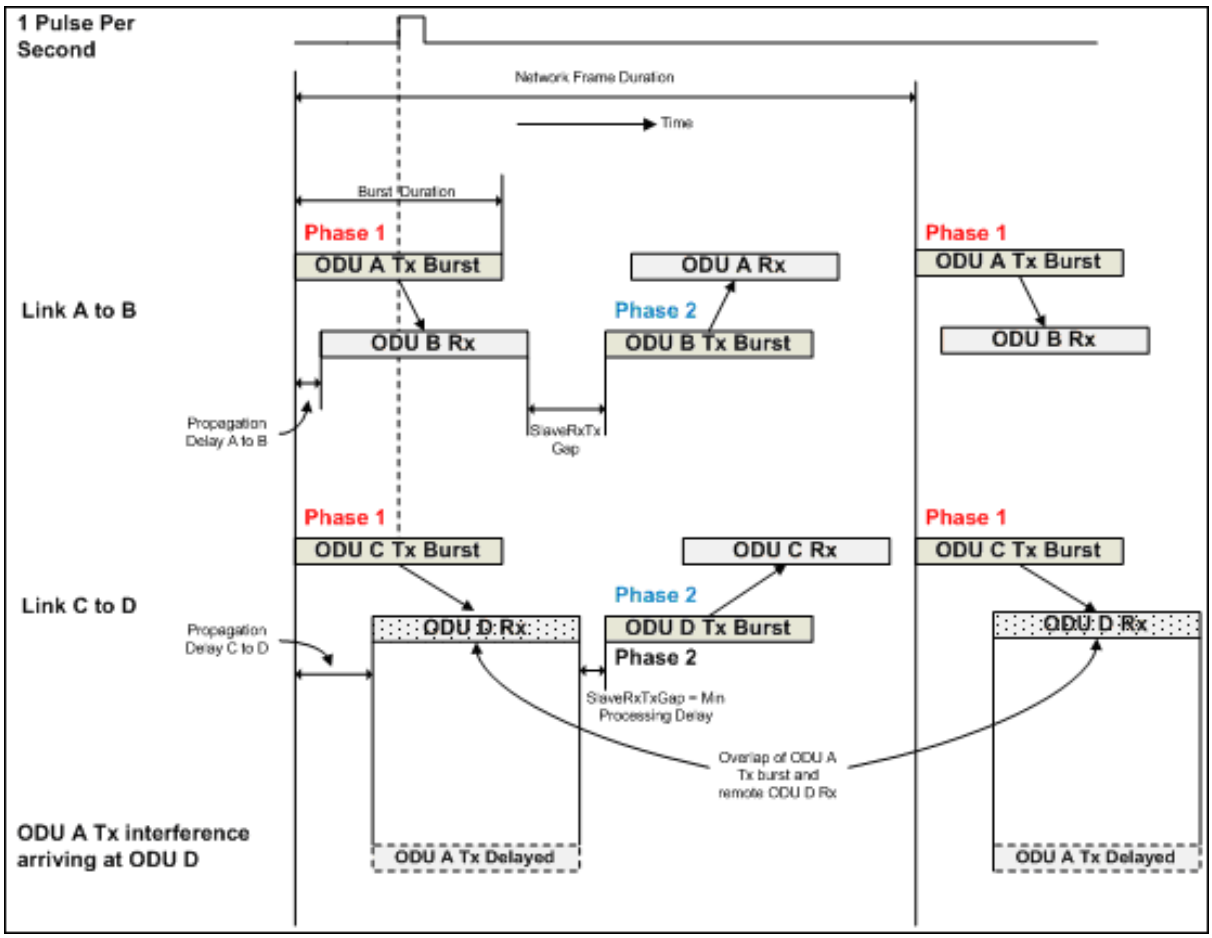


Figure 4.9: Synchronized Frames

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

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
```

Path from Pathloss (*.txt)

Paths can be imported from Pathloss text reports either just as the profile, 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. If tower heights and antenna heights at each site are also required then the **Transmission details** also need to be exported.

In Pathloss 5 the text report is built by selecting **Operations, PL5 reports**. In the Composite reports window either just select **Terrain profile listing** or select both

Terrain profile listing and **Transmission details**, then select **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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Changes to PTP LINKPlanner

This is a list of the main changes that have been made to the PTP LINKPlanner application since version 1.0.

Changes since version 2.0.0

Changes in version 2.7.0

New or changed features

- Introduce Preliminary IRFU PTP 800 planning capability
  - New FCC licenses at 7 GHz
- Updated capacity calculations for PTP-250-02-00
- New PTP 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@motorolasolutions.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

AGL Above Ground Level

AMSL Above Mean Sea Level

ATDI Advanced Topographic Development & Images Ltd.

BPSK Binary Phase Shift Keying

CD Compact Disc

CSV Comma Separated Variables

DFS Dynamic Frequency Selection

EIRP Equivalent Isotropic Radiated Power

ETSI European Telecommunications Standards Institute

FCC Federal Communications Commission

FEC Forward Error Correction

IRFU Indoor Radio Frequency Unit

ITU International Telecommunications Union

KML Keyhole Markup Language

LoS Line-of-Sight

MHSB Monitored Hot Standby

MIMO Multiple-Input Multiple-Output

NLoS non-Line-of-Sight

ODU Outdoor Unit

PTP Point-To-Point

SRTM Shuttle Radar Topography Mission

TDD Time Division Duplex

TDM Time Division Multiplexing

VSWR Voltage Standing Wave Ratio

Credits

Additional icons provided by Yusuke Kamiyamane
[http://p.yusukekamiyamane.com/].

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