
7 CALCULATIONS: LINK PERFORMANCE

7.1 INTRODUCTION

The Link Performance tool calculates the link performance for both analogue and digital radio links in the VHF, UHF, SHF and EHF frequency bands. WRAP includes several functions to assist in the planning of point-to-point and point-to-multipoint radio links, e.g. clearance calculations in the Coverage tool and interference calculations.

The Link Performance tool first calculates the received power level. The calculation is performed with any of the propagation models. A model accounting for terrain and climatic effects should normally be used.

Radio links are mostly very carefully planned to provide the desired grade of service, often defined as time availability (or non-availability) according to standardised criteria. Availability of analogue links is normally defined at a certain minimum received signal level and/or signal-to-interference ratio. Availability of digital links is defined at certain bit error rates in the delivered data. The Link Performance tool comprises the following:

- For analogue links the fading margin is calculated as the difference between received power and the threshold of the receiver. For digital links the net fading margin is also calculated. The calculation is performed according to [A14].
- The influence of multipath propagation is calculated according to [A14]. Both method 1 for initial planning purposes and method 2 for detailed link design are available to the WRAP user. For paths with strong surface reflections the geo-climatic factor is adjusted.
- The result is presented as the probability that the fading margin or the net fading margin for digital link is exceeded due to multipath (Rayleigh) fading. The formulas are valid for fading margins >15 dB.
- Rain fading is calculated as outlined in [A14] and [A15]. Input to this calculation is the rain rate that is exceeded for 0.01 % of the time. (Approximations of this rate can be found in [A16].)
- The result is presented as the probability that the rain attenuation exceeds the flat fading margin. The result is presented as the worst month probability. Any conversion from average annual percentage is performed according to [A17] using the global planning parameters.
- The digital link performance may be defined according to [A18] which defines degraded minutes, DM, and severely errored seconds, SES. If the threshold values are defined for bit error rare, $BER = 10^{-3}$ and $BER = 10^{-6}$, WRAP calculates the percentage of time with DM and SES, respectively. If only a threshold value for $BER = 10^{-3}$ is given, only SES is calculated.

The power budget and the resulting unavailability due to fading and rain at the required thresholds and fading margins are presented directly in the main window, refer to **Figure 7.1**. The user interface also provides an easy way to alter key parameters and update all subsequent calculations to take the alterations into account.

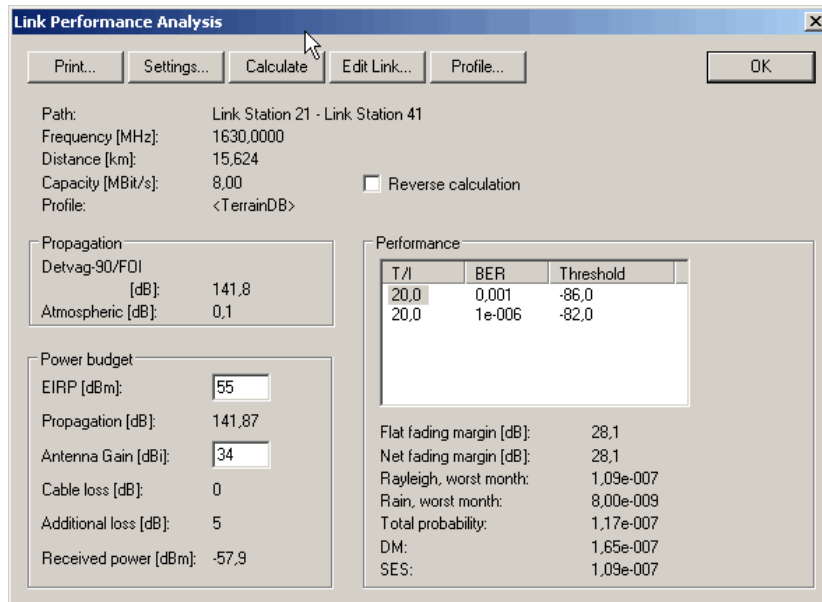


Figure 7.1: The Link Performance tool.

A number of settings are provided at the user level to supply the different models with the needed input, refer to **Figure 7.2**.

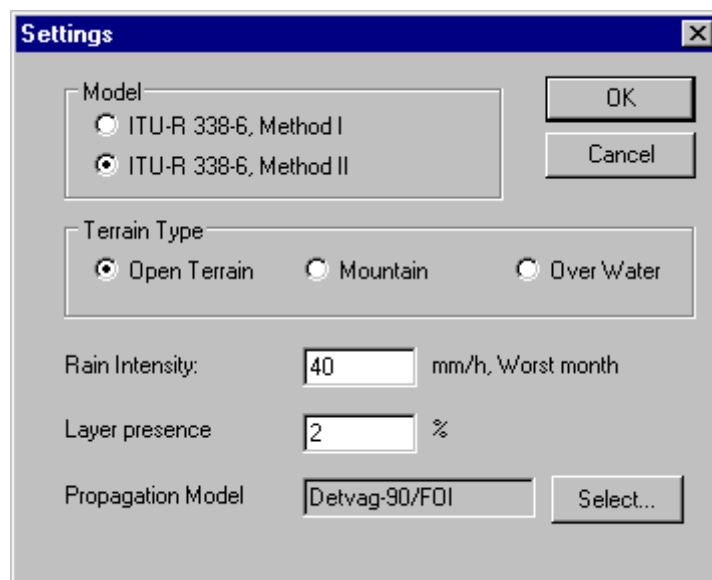



Figure 7.2: Settings for the Link Performance tool.

The Link Performance tool can also be used to calculate the transmission loss and link budget between any pair of stations. This is done by marking the two stations in the

station list and selecting the Link Performance calculation. The values for fading margins and outage probabilities should in this case be interpreted with great care, since they may not at all be applicable due to the models being applied out of their range of validity. However, the link budget values are relevant and useful.

7.1.1 Examples

Perform the following to learn about most of the commands described above:

- Open the project file **Link Performance.WPR**.
- Look at the stations in the project. Note that Link Station 30 has a much lower EIRP than the others.
- Select Link Station 21 and <**Tools**>-<Radio Link Performance...> or press the  button.

You are now looking at a complete link performance analysis, the calculation was performed immediately when you entered the tool. All link hops in the project are duplex links. Therefore, they are listed twice in the main window, once in each direction. We are now looking at a case where Link Station 21 is the transmitter and Link Station 41 is the receiver. At the top, to the left some basic characteristics for the hop are listed (**Detvag-90/FOI** is used as the default propagation model). Below, to the left there is a power budget which is the basis for calculating the fade margins to the right. By altering the **EIRP** or the **Antenna Gain** and pressing **Calculate** everything is updated. In the **Analyse Link Settings** dialogue you will find a number of settings, e.g. **Rain Intensity** and **Temperature**. By marking any T/I-BER-Threshold (equipment characteristics) combination listed in the box, the subsequent presentation is updated.

- Set EIRP to 20 dBm and press the [**Calculate**] button.

Note that the fade margins and the outage probabilities change.

- Try both T/I-BER-Thres combinations.

Note: Terrain profiles that have been created with the manual method according to section 2.12.6 for the currently selected link hop will be selectable using the Profile... button in the main window. This function is not available in the Demo version.



WRAP WIN 4.5 USER'S MANUAL
PART 1 – INTRODUCTION AND TUTORIAL