

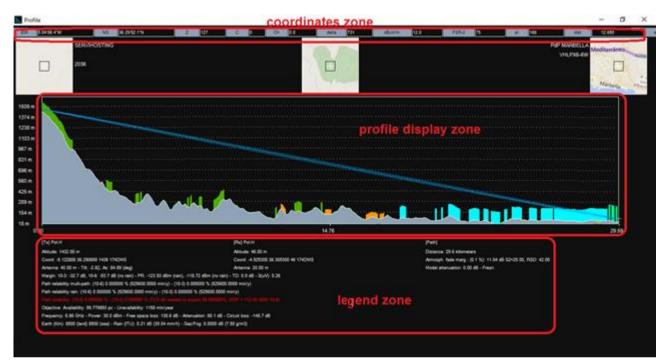
MW Link Profile window

Release number v1.0



1. Introduction

The Microwave Link Profile window is accessible from MK link list, by double left-clicking on a specific MW link. It is divided in three main zones:



MW link Profile window

By left clicking on the Profile window (anywhere outside the profile display zone), a pop up menu will appear, offering different options, that will be explained in this document.

2. Coordinates zone

In this zone, each cursor movement on the profile is presented in real time, and the three boxes below this area show the map position for Tx, Rx and mouse cursor, according the layer displayed in the project (DTM or Image).



The coordinate zone indicates (from left to right):

- EW longitude (long or X field).
- NS latitude (Lat or Y field).
- Altitude Z.
- Clutter code C (displays 0: if no ground occupancy is present).
- Clutter height Ch.



- *Delta*, in meters, corresponding to the height difference between the altitude of the current point plus the clutter height and the elevation of the direct ray.

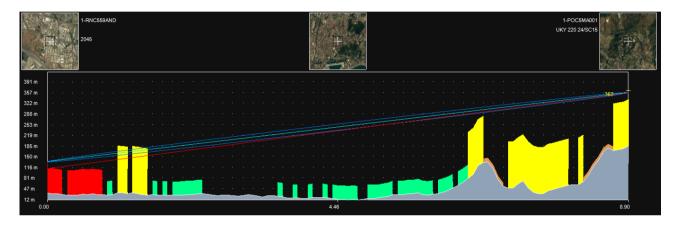
- Field strength value in $dB\mu V/m$, considering the current propagation model.

- *FSR*-2: field strength value in dBµV/m, considering free space, or previous model, in case "alternative propagation model..." option is used (see point 5. Pop up menu).

- Number of pixels (pt) from Transmitter location (0) to Receiver location (last point).
- Distance from the transmitter in the same unit as the one selected in the main window (top bar).
- Width of the first Fresnel zone (ellipsoid).
- Ellipsoid: Radius of the first Fresnel zone.

3. Profile display zone

The display zone shows the profile encountered between the transmission and the reception points.



The profile area shows the following information:

- Three image boxes with:
 - The transmission and reception sites at the extremities of the profile along with the location of the two sites on the map. If the path budget is drawn from an existing microwave link (M-W), administrative information set for the two sites (sites A and B).
 - A central image corresponding to the current point (mouse cursor).
- Profile altitude in grey (DTM).
- Clutter layer colored according to ground-occupancy codes.
- First Fresnel zone with line of sight between the Transmitter and the Receiver.
- Receiver antenna height + n * lambda (n= factor of spacing between antennas) in yellow. The display of this information can be modified with regards to clutter, field-strength, the ellipsoids and the factor of spacing between antennas via the Option command (by left click outside profile zone).
- The coordinates displayed correspond to:
 - o for Y1: altitude in meters.
 - \circ for Y2: the field-strength in dBµV/m.
 - for X: the distance between Transmitter/Receiver (unit can be change in the pop up menu of Profile window, by left click outside profile zone).



A popup menu offering various options is accessible by left clicking on any point of the profile:



- Move Tx option allows the user to move the transmitter to another location along the profile. The ellipsoid and the results are recomputed accordingly.
- Move Rx option allows the user to move the receiver to another location along the profile. The ellipsoid and the results are recomputed accordingly.
- Record option saves the new position of both transmitter and receiver and moves the stations on the terrain. The system prompts the user to confirm the new positions and if coverage was associated to the stations, the system will offer either to delete the coverage or to keep them. The profile window is then closed. The terrain is re-displayed and presents the new positions of objects.
- Restore option retrieves the original location of the transmitter and the receiver.

4. Legend zone

Below the profile area, a comprehensive legend provides the following information:

- Transmitter (Tx):
 - Polarization.
 - Altitude of the terrain at the Transmitter (Tx) location in meters.
 - Coordinates of the Tx point (X, Y, Z, grid code).
 - Antenna height in meters; tilt and azimuth in degrees.
 - Margin corresponding to the difference in dB between power received at the receiver location and threshold defined for 10-3 and 10-6 BER - Power received (PR) in dBm with and without rain, Threshold degradation (TD) in dB, Electric field received (S) in μV without rain.
 - Path reliability multi-path: Availability rate for 10-3 and 10-6 BER for multipath reliability.
 - \circ $\;$ Path reliability rain: Availability rate for 10-3 and 10-6 BER for rain reliability.
 - Path reliability: Total availability rate for 10-3 and 10-6 BER. By default, the rate must be greater than 99.99%. This rate can be changed in the pop up menu, *Display options...* A color code indicates the availability of a signal: red display (or color n°7 of the palette): target rate not achieved, green display (or color n°4 of the palette): target rate achieved.

The gain in dB needed to achieve the target availability for 10-6 BER is positive if not reached and negative if reached. The corresponding radiated power in dBW is also given.

Objectives: objectives results found according to the parameters entered in the Objectives tab of the Microwave link parameters box with ESR: Errored second ratio, SESR: Severely errored second ratio, BBER: background block error ratio - according to ITU-R F.1703 and ITU-T G.827 recommendations.

- Transmitting frequency in GHz- Radiated power in dBm Free space loss in dB– Attenuation in dB (difference between standard free space losses and free space losses using the current propagation model)– Circuit loss in dB (difference between the radiated power in dBm and the received power in dBm without rain).
- Earth radius in km (for land and sea), Rain attenuation and Gas/fog attenuation, as specified in the propagation model parameters.

ATD

- Receiver (Rx):
 - Polarization.
 - \circ Altitude of the terrain at the Receiver (Rx) location in meters.
 - Coordinates of the Rx point (X, Y, Z, grid code).
 - Antenna height in meters.
- Path:
 - Distance from Transmitter to Receiver (unit can be changed in the pop up menu of Profile window, by left click outside profile zone).
 - Atmospheric fade margin; S2 (path roughness used for Atmospheric fade margin calculations); RSD (Relative Standard Deviation).
 - Model attenuation in dB (difference between standard free space losses and free space losses using the current propagation model) and model name.

Notes:

- 1. Atmospheric attenuation as well as attenuation due to rain are not taken into account in field strength received or margin calculations.
- 2. If the profile has been drawn between two elements of Tx/Rx type, then a point to point calculation is performed taking into account the receiver antenna pattern.
- 3. With a clutter file present, the receiver height may vary depending on what was selected, according to either a Rx over ground or Rx over clutter. Modifications may be made in the Clutter box, which is accessible from the profile pop up menu, via the Clutter option. After any modification, the profile is redrawn and the attenuation values are recomputed. The receiver height remains the same however.



5. Pop up menu

A popup menu is accessible by left clicking anywhere outside the Profile display area:

	Report
	Profile sheet
	Export .TXT
	Export .PL3
	New profile
	Interpolate altitudes
	Change parameters
	Radar detection
	Change height of antenna
	Ellipsoid clearance
	Propagation model
	Clutter
	Reliability
	Alternative propagation model
	Model log
	Display constraints
	Display options
	Reflections
	Elevation zoom -
	Multi K factor display
	Display smooth profile
	High resolution profile
	Black/White switch
	Print
	Pan print
/	Kilometers
	Feet
	Miles (int. nautical)
	Miles (US statute)
	Meters
	Close profile
	Continue

Pop up menu



- Report...: generates a Path Budget report.
- Profile sheet...: generates a profile sheet including information about Tx, Rx and Path.
- Export .TXT...: Exports the profile characteristics in a (.txt) ASCII text file. The profile export file contains:
 - LONG or EW, of the profile point
 - LAT or NS, of the profile point
 - \circ ALTitude (m), of the profile point
 - o DTM STEP
 - DISTance (m) from the Tx to the profile point
 - o DIST RAY/GROUND (m): distance from the profile point to the ground
 - DIST RAY/CLUTTER (m): distance from the profile point to the clutter layer
 - ELLIPSOID (m): width of the Fresnel ellipsoid, in the profile point
 - DIST ELLIPSOID/GROUND (m): distance from below part of the Fresnel ellipsoid, in the vertical of the profile point, to the ground
 - DIST ELLIPSOID/CLUTTER (m): distance from below part of the Fresnel ellipsoid, in the vertical of the profile point, to the clutter layer
 - EARTH DELTA (m): vertical distance from the ground to the line defined by Tx and Rx, in the profile point
 - FS: field strength received from the Tx, in the profile point
 - CLUTTER CODE: clutter layer in the profile point
 - o CLUTTER H (m): clutter layer height in the profile point
 - BUILDING H (m): building layer height in the profile point
 - ATTENUATION (dB): signal attenuation from the Tx, in the profile point
 - Tx ELEVATION (m)
 - Rx ELEVATION (m)
- Export .PL3...: Exports the profile characteristics in a (.pl3) PATH LOSS file.
- New profile...: Creation of a user defined profile: the user may use the New profile control to set values of the profile model to be interpolated to -1, and then proceeds to enter known values of a terrain that is to be created.
- Interpolate altitudes: continuing with the New profile feature, the system proceeds to calculate the unknown altitude values (set at -1) according to the known data entered.
- Change parameters...: goes directly to MW link parameters window.
- Radar detection: Radar detection curve display mode. This control is not available in the MW link profile mode.
- Change height of antenna...
- Ellipsoid clearance...: this function gives the minimum altitude for Tx and Rx, among a given range, to clear the given percentage of the first Fresnel zone.
- Propagation model...: access to Propagation Models parameters window. The user can change propagation options, and the new profile will be displayed when closing Propagation models window.
- Clutter...: access to Clutter parameters box. The changes in clutter parameters will be applied automatically to the profile when closing clutter parameters box.
- Reliability...: Opens the Path reliability box that offers the several methods for the calculation of the reliability rate for 10-3 and 10-6 BER. Results will be given in the Legend zone of the profile: (see document "Path Reliability").
- Alternative propagation model...: As a first step, the curve corresponding to the field strength received with the previous model is copied on the curve previously used for the free space model. Then, the new current model is applied to the curve corresponding to the field strength received along the profile.



Note concerning the top bar: the "FS2" field strength contains the value of the previous model or the free space model if the previous option has not been enabled.

- Model log...: when a profile is created with the 452-15 model, it is possible to generate a CSV file containing the variables used for the calculation.
- Display constraints: Displays the constraints areas and town encountered along the path profile according to the area files loaded (Function *Reports / Area covered / Area files setup*).



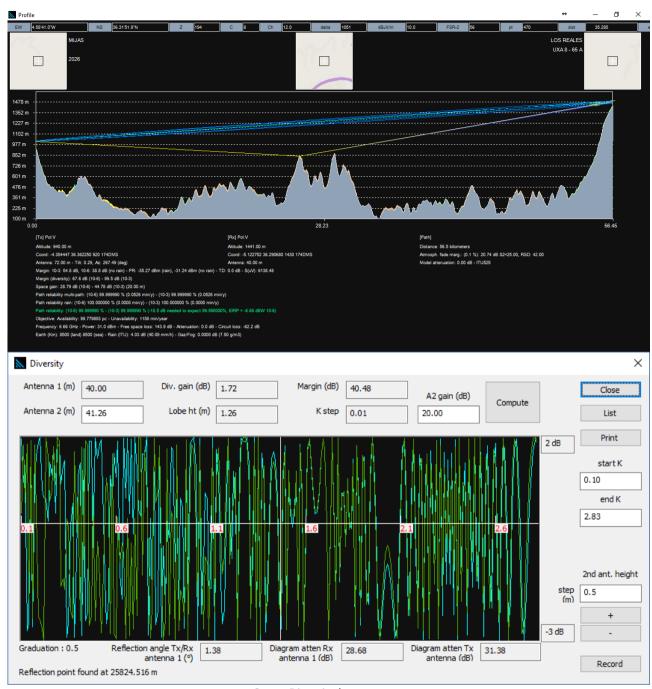
The profile screen will then be divided in all the constraints according the file loaded in *Reports / Area covered / Area files setup*

A report is generated containing the minimum distance separation for an obstacle located in each administrative area crossed along the profile.

Displays the constraints areas and towns encountered along the path profile according to the constraints files loaded

- Display options...: see section 5.1
- Reflections: Displays the reflection ray on the profile.





Space Diversity box

To define the reflection point, the following calculation is made: for each point of the profile, the system computes the incidental angle and the reflected angle and verifies that the two rays are cleared. The system keeps the point which absolute difference between the two angles is the weakest. If this difference is lower than «Angle error for reflection point» then the reflection point is found. Two cases:

1. A reflection point has been found. Direct ray and reflected ray must be cleared to found the reflection point. The Space diversity box that appears on screen, will help to calculate the height of the second antenna. Reflected ray is displayed in yellow.

2. A reflection point has not been found. If there is one ray for which there is line-of-sight between the reflection point and the transmitter and between the reflection point and the receiver, this ray is displayed in red.

• Elevation zoom (-/+): Switches between minimum terrain altitude displayed to zero / minimum terrain altitude found in the profile.



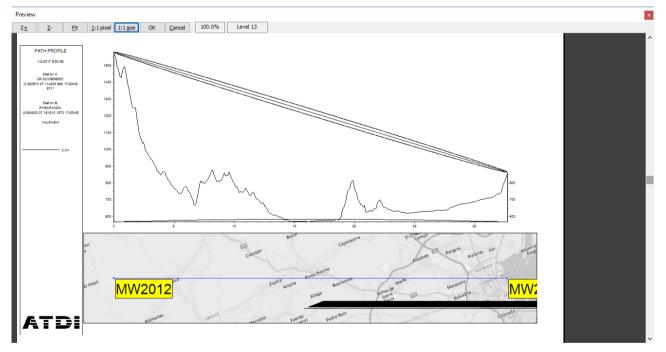
• Multi K factor display: The K factor, corresponding to the equivalent Earth radius, depends on the variation of the refractive index of the air. A tool to perform the conversion between these three values is provided in Tools/Earth radius converter. By default, the profile displayed uses a single standard K factor, corresponding to the average of the two earth radius (land and earth) specified in the propagation model. It is possible to display the profile following two different K factors by clicking

on Multi K factor display

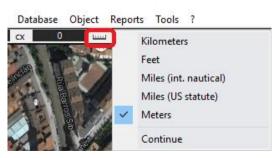
In that case, the two profiles displayed use Kmax (=4/3) and Kmin, Kmin being calculated as specified in the ITU-R 530-10 recommendation.

It is possible to get back to the default mode by clicking on Mono K factor display

- Display smooth profile: Not available in the MW link profile window.
- High resolution profile: In case the project has been loaded with a resampling factor equal to or greater than 2, this option will redraw the profile with a sampling factor or 1.
- Black/White switch: switch between black and white for profile background.
- Print...: Prints the profile. Printing the profile is done via the Print setup box. The profile is printed with a white background.
- Pan print...: Prints the profile in panoramic mode. In this printing mode, the terrain profile, the image of the path and a legend are printed.



• Change the units for the display of the distance. The user can do it from the pop up menu within the Profile window, or from the "Distance unit" button, in the tools bar:



• Close profile: Go back to the project.



5.1. Display options...

There are several options available to modify the components and the way they are displayed in the profile.

Different elements can complete the terrain profile display. Furthermore, ground-occupancy, field strength, and the Fresnel zone may (or not) be displayed as well.

A data input box enables to select the elements to be displayed and other parameters:

Parameters	×
Ellipsoid + ray display (0/1):	1
Clutter display (0/1):	1
Reflection display (0/1):	0
Elevation scale display (curve=1, flat=0):	0
Ellipsoid curve (FZ1):	1.00
Ellipsoid curve (FZ2):	1.00
Path roughness (S2-atmosph. fade margin calc.) (0=calculate):	25.00
Geographic factor (atmospheric fade margin calculation) (dB):	0.00
Spacing between antennas (space diversity) (n x lambda):	150
Angle error for reflection point (deg)	0.90
Use threshold degradation for margin $(0/1)$:	0
Reliability to achieve (%)	99.990000
0	K Cancel

- Ellipsoid + ray display (0/1): displays or not the direct ray between Tx and Rx, and the Fresnel ellipsoid
- Clutter display (0/1): displays or not the clutter layer
- Reflection display (0/1): displays or not the reflected ray
 - All the possible reflected rays are displayed in blue, depending on the values of the receiving antenna height (nominal antenna height plus or minus the Spacing between antennas), and using the standard K factor.

A traditional engineering rule is to set the Spacing between antennas value to 150 Lambda, where Lambda is the wavelength.

If there is one ray for which there is line-of-sight between the reflection point and the transmitter and between the reflection point and the receiver, this ray is displayed in red. This ray is displayed in yellow if, in addition, the angular difference between the incident ray and the reflected ray is lower than the "Angle error for reflection point in degrees".

It can be considered that there is a potential problem of reflection if such a yellow ray is displayed. The problems of reflection can be solved by adding space or frequency diversity.

- Elevation scale display (curve=1, flat=0): displays scale elevation lines flat or curve (according delta earth)
- Ellipsoid curve (FZ1): First percentage of the first Fresnel zone to be displayed, from 0.01 to 2
- Ellipsoid curve (FZ2): Second percentage of the first Fresnel zone to be displayed from 0.01 to 2.
- Path roughness (S2-atmospheric fade margin calc.) (0=calculate): set up the value for path roughness, or select "0" to be calculated automatically



- Geographic factor (atmospheric fade margin calculation) (dB): set up the Geographic factor value for atmospheric fade margin calculation ("0" by default)
- Spacing between antenna (space diversity) (n*lambda): factor n used to calculate the number displayed in yellow in the profile.
- Angle error for reflection point in degrees: maximum tolerance for the angle difference between the direct ray and the reflected ray. A reflection point can be defined as soon as the angle difference between the two rays is lower than this value.
- Use threshold degradation for margin: the margin calculation will take into account the threshold degradation found using the Microwave / Interference TD method options.
- Reliability to achieve: Target rate in percentage.