Overview

Surveyor is a path propagation calculator developed by 4RF Limited to assist path planners quickly and efficiently verify the viability of point-to-point transmissions deploying the 4RF Aprisa™ microwave radio systems.

Upon entering data or preferences into the data fields, the program will calculate the anticipated link performance for the transmission system elements selected.

The calculations are an estimate of performance and do not constitute a path survey. No guarantee of path performance is expressed or implied. The results of ITU-R availability are estimated and may differ from other availability standards. 4RF recommends that detailed path planning be performed for each link, including site investigations to confirm the viability of the linking path.

Your results should be regarded as indicative in that:

- Source data may be limited or not available
- The ITU-R availability calculations are based on formulae derived from statistically-processed data
- Unique RF propagation affects may not have been considered

Contents

Surveyor consists of 5 data/information groups:

Saving your *Surveyor* file

Surveyor exists as an Excel spreadsheet. To run *Surveyor* in Excel, click on file named 4RF Su**rveyor 1-6c**. Save the edited sheet with a unique filename and directory as needed.

1. Radio data

Radio platform
Frequency range
Channel size
Modulation

Select the Aprisa radio variant and the product parameters.

Transmitter power

The transmitter power is automatically set to the maximum level for the product variant selected. The actual transmitter power level will depend on the radio platform chosen, the operating frequency band and the modulation selected.

Gross capacity

The maximum amount of data transported over the radio link.

Equivalent DS0 or E1

The equivalent number of data timeslots in 64 kbps (DS0) blocks. If the data capacity is more than 2048 kbps, then the equivalent number of E1 circuits is displayed.

Wayside capacity

The data capacity left over when considering either the number of full 64 kbps time slots, or the number of full E1 circuits. The wayside capacity may be valuably used for remote monitoring or wayside Ethernet traffic.

Bit Error Rate

The figures show typical receiver sensitivities for bit error rate (BER) of 10^{-3} and 10^{-6}. The sensitivity is dependant on the frequency range, channel spacing, and modulation selected.

◄ 2. Site data

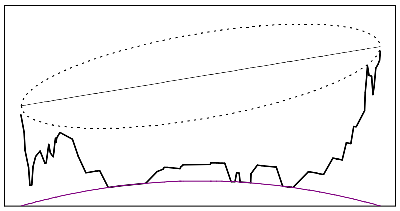
General

Typically the results are dependant on the accuracy of the site data.

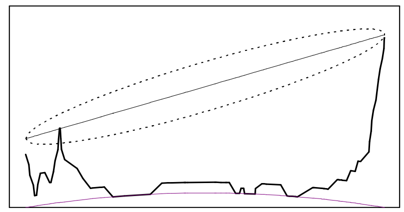
Surveyor assumes a LOS (line-of-sight) linking path. For a good LOS linking, there should be near full first-fresnel zone (F1) clearance, as shown by the dotted lines in the first profile plot below. However, it does have an option to include an *Estimated obstruction loss* figure. This may be used to account for any path obstructions or effects that introduce RF attenuation into the propagating signal. The calculator integrates the RF loss into the RSSI and fade margin results. Typically, terrain obstructions cause most RF losses to the propagating signal. Typical examples could be:

- Add no obstruction loss (0 dB) if the propagation is open LOS with clearance over the whole path
- Add 6 dB if the propagation is grazing over a knife-edge obstruction, like a mountain range
- Add 10 dB if it is a grazing over typical average terrain, like rolling hills.
- Add 15 dB if it is grazing over the bulge of the sea

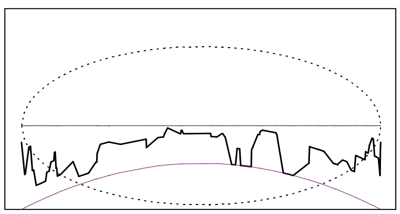
Grazing implies that only some of the propagating signal is obstructed.



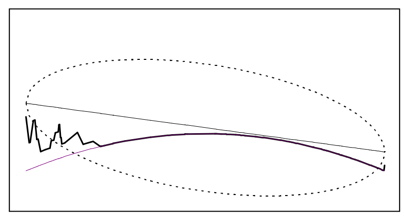
No obstruction loss (0 dB) if the propagation is open LOS with clearance over the whole path.



6 dB obstruction loss if the path is grazing over a knife-edge obstruction, like a mountain range.



10 dB obstruction loss if it is a grazing over typical average terrain, like rolling hills.



15 dB obstruction loss if it is grazing over the bulge of the sea.

Antenna type

Select a suitable parabolic or Yagi antenna.

Feeder type

Select the type of low loss foam-filled coaxial feeder cable from a cable diameter range of ½", ⅞", 1¼", or 1⅝".

Feeder length

Specify the cable length from the radio installed in the equipment rack, out to the tower, and up the tower to the antenna.

Site height

Specify the site height above sea level (asl), excluding the tower height.

Antenna height

Specify the antenna height above ground level (agl).

Frequency split

The frequency spacing between the transmit channel and the receive channel. The splits may be selected for the frequency range chosen or entered manually.

TX power reduction

The transmitted power may be reduced in 15 steps of 1 dB.

Distance type

The three distance entry options are:

- Manually entering a distance
- Using metric grid references to calculate the distance between sites
- Using latitude/longitude to calculate the distance between sites. (Modelled to the Haversine method and WGS84. The actual distance may vary slightly when compared to the various mapping models that are available.

Region of the world

The location will typically have a localized atmospheric behaviour that will influence the availability of the link. This factor does not influence the calculated RSSI and fade margin. It only affects the availability calculation.

Terrain type

This selection also influences the availability of the link. It also does not influence the calculated RSSI and fade margin.

◀ 3. Protection and diversity

1+1 MHSB protection

This configuration uses two Aprisa radios and a protection switch. The RF fade margin and availability of this option is reduced as the two receive paths are split via an RF passive splitter, introducing typically 4 dB of loss in the receive paths. The transmit path also introduces 0.5 dB of loss as a co-axial relay switch is used to switch between the active and standby radios. Surveyor includes this loss in the calculations.

Space diversity

This option improves the RF path availability. Space diversity relies on the improvement factor that is obtained where there are two separate antennas at each end of the link receiving the signal. They must be spaced far enough apart so they receive entirely separate signals. As there are now effectively two RF linking paths to the same site, there is more chance that a strong received signal is available from one of them giving an overall improvement in availability. Space diversity is particularly beneficial if the linking path is:

- Exposed to a large body of water where there are strong path reflections
- Both linking sites are elevated and very far apart
- Any location with a history of poor atmospheric activity

Space diversity may be used in any frequency band, but is less effective in the UHF bands and is typically used in the 1400 MHz band, or higher. Space diversity also requires two separate radios and a "hitless" data switch. This allows for seamless errorless switching between the two receive antenna systems. The transmit circuitry is commonly fed into only one of the antennas at each end of the link and still uses a coaxial relay switch.

The ITU recommend an optimal spacing for space diversity. As the antenna spacing is dependent on the wavelength of the carrier frequency, the lower frequencies will typically have greater antenna spacing then the higher frequency variants.

Diversity spacing

The diversity spacing field enables the entry of the diversity antenna spacing. This indicates the range of antenna spacing in which the optimum diversity improvement factor is achieved. However, usually, there are tower aperture limitations that control the overall improvement factor achievable. Therefore, the list below allows the user to enter the antenna spacing, within the optimum range shown. The optimum spacing of the antennas are:

- 2500 MHz — 8 m and 29 m
- 2000 MHz — 9 m and 36 m
- 1400 MHz — 13 m and 50 m
- 900 MHz — 21 m and 82 m
- 700 MHz — 25 m and 96 m
- 400 MHz — 43 m and 166 m
- 300 MHz — 52 m and 197 m

UHF antenna stacking (UHF antennas only)

Stacking the antennas improves the overall gain of the antenna system. The stacked antennas are co-axially combined and fed to the radio terminal via a single co-axial feeder. This field only becomes selectable if UHF frequencies and Yagi antennas are selected. The antennas options are:

- Single antenna — (standard gain of a UHF antenna)
- 2 x antennas — (2.8 dB gain improvement)
- 4 x antennas — (5.6 dB gain improvement)
- 8 x antennas — (8.4 dB gain improvement)

Yagis may be stacked vertically or side-by-side, or in a combinatioin of both.

◄ 4. System results

Frequencies and distance	The frequencies shown are typical mid-band figures derived from the equipment data entered and used for the availability calculation. The distance reflects either the hand entered distance or that calculated from the grid reference or latitude/longitude data.
Antenna system gain	The gain of the antenna selected including any Yagi stacking gain. Only UHF Yagi antennas have been given the option to be stacked as parabolic antennas cannot be reliably stacked.
Loss per 100 m	The loss characteristics of co-axial feeder selected.
Feeder system loss	The calculated feeder loss for the length of cable entered. It includes between 0.2 dB to 0.5 dB of fixed loss to account for the essential connectors and lightning arrestor in the feeder system.
TX power	The maximum transmitted power at the Aprisa terminal measurable at the duplexer output connector.
EIRP	Effective peak radiated power out of the antenna.
Path loss	The theoretical loss of the RF signal as it propagates through space. It is sometimes referred to as 'spreading loss'.
RSSI	The received signal level at the antenna port on the duplexer. A higher RSSI is always more desirable as it allows the receiver to process a signal with a good S/N (Signal–to-Noise) ratio.
Fade margin	The difference between the received signal (RSSI) and the receive signal threshold, relative to the BER selected in the radio data section. As with all RF transmission, the radio path will fade by some depth for some of the time. The larger the fade margin the more the link will be available for data transmission. Typically, a fade margin of 20 dB or more is considered acceptable for most installations in the sub 3 GHz frequency band.

◄ 5. Path availability

Notes	The received signal is continuously fading to some extent. Occasionally it may fade below the receiver threshold and be momentarily lost. This is referred to as an outage. Therefore, the higher the availability figure, the less chance there is for an outage. The availability indicates the percentage of time the received signal is above the threshold. It can never be 100% as this implies a perfect link. The availability calculation is derived from ITU-R standards based upon statistically processed measurements. As there are so many variables affecting RF propagation, it is impossible to provide predictions for all linking environments. The *Surveyor* program incorporates: • The Aprisa frequency ranges • Averaged atmospheric gradients • Typical terrain factoring • ITU-530-10 outage predictions based on time rather than errored seconds (ES) or seriously errored seconds (SES) It does not consider rain fading, as the affects of this are negligible at sub-3 GHz frequency bands.
Worst month of the year availability	The availability prediction considers the month of the year when atmospheric behaviour is at its worst. This is referred to as 'the worst month of the year'. The percentage of time has been converted to unavailable seconds per month.
The availability per year	The availability per year considers the availability over a year-long period, rather than a single month. The result is always slightly better than the worst month of the year figure. The yearly percentage of time has been converted to unavailable seconds per year.