

A Free Online VHF/UHF Propagation Tool for Technical and Non-Technical Users

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Abstract - Broadcasters are often confronted with questions about FM, TV and STL propagation, such as “is it more effective to raise my antenna 100ft, or increase the power of my transmitter?”, or “what would be the effect on my coverage if I move my transmitter site?”. While any really accurate answers require the assistance of a consulting engineer, there are simple tools now available to give some approximate indication quickly and for no cost at all.

NAUTEL RF TOOLKIT

Nautel has partnered with RF engineer Roger Coudé, the author of “Radio Mobile”^[1] to provide simple, fast online VHF/UHF coverage mapping and point to point analysis worldwide. These tools are part of the new Nautel RF Toolkit, available free online at the website www.nautel.com.

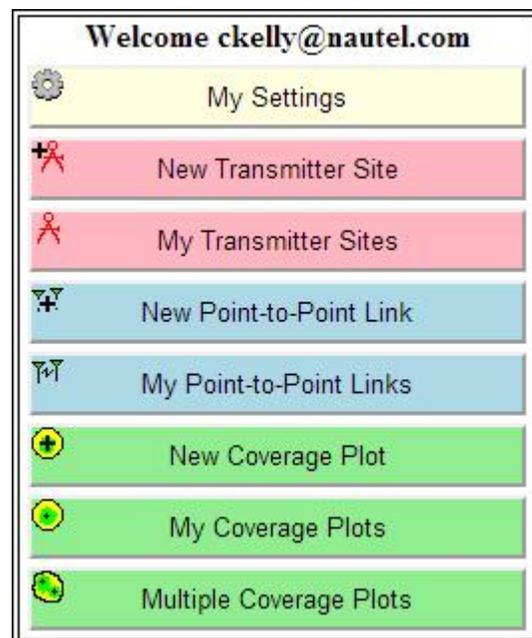
The Radio Coverage Tool is based on the Longley-Rice VHF/UHF “ITS” model^[2], and includes a nearly 1 terabyte digitized worldwide terrain database, based on NASA Shuttle Radar Terrain Mapping data as well as other sources. The accuracy of the data in the 48 contiguous US states is approximately 10 meters, while in Canada the accuracy is about 30 meters, and it’s about 100 meters in most other places. In addition, other databases hold land cover information and population information. The land cover data indicates whether a spot is tree covered or urban for instance, and this information improves the accuracy of the propagation model. The population data is obtained from publically available United Nations information, and allows the program to estimate the population within the desired contours.

LONGLEY-RICE MODEL

The Longley-Rice Irregular Terrain Model was originally developed in the late 1960’s by A.G. Longley and P. L. Rice, and is widely used to estimate RF coverage in the range 10MHz to 10GHz. Nautel’s implementation of the Longley-Rice model is limited to FM and TV broadcast frequencies as well as conventional STL frequencies used worldwide. When used with accurate terrain data, it has proven to be a reasonably accurate indicator of actual coverage.

ACCESSING THE NAUTEL RF TOOLKIT

There is no cost to use the RF Toolkit, simply login to www.nautel.com/rf-toolkit. If you already are a Nautel Users Group member and know your login, simply enter it, otherwise click the Register tab, and enter the required information and your password will be emailed to you in a few moments. Once you are logged in, click Radio Coverage Tool. You will be presented with the following menu.



If your desired language is not English, click My Settings, and change the language there. Currently, only French and English are supported. The My Settings tab also displays the Home location coordinates and Zoom level, but these are set elsewhere.

GETTING STARTED WITH COVERAGE PLOTS

To begin, let’s select your first transmitter location. Click New Transmitter Site, and you will see a map with a reddish cursor which can be dragged and dropped to your desired location. If your location is off the map, you can move the map and zoom in and out to select the correct site. If you know the geographic coordinates of the site, you can verify them with the numbers below the map. They are shown in both DMS and decimal degrees format. You can also switch to Satellite view, and actually locate the tower or other structures to get the position correct. Once the cursor is

precisely on the site where the antenna will be located, click Submit and this should be what you see:

Now, edit the Name field, changing “New Transmitter Site 1” to something more descriptive, and click Add to My Transmitter Sites, and the program will indicate that your location has been added to My Transmitter Sites.

Next click New Coverage Plot, and enter the description of this new plot. It is recommended that you use a name which includes the site name, transmitter power, antenna type and elevation of the antenna above ground in meters, such as “HQ 1kW 2 bay 30M”. Enter the elevation of the center of the antenna in meters above ground, and use the pull-down menu to indicate the approximate value of transmitter power and antenna type in the Tx System field. If the exact value in transmitter power isn’t shown, use the closest value. Enter the frequency in megahertz in the Frequency field.

The Rx System field also has a pull-down menu and is used to set the contours we want to see. Here are the choices:

- FM Car Receiver
- North America Standard 54/60 dBµV/m
- USA 60/70 dBµV/m
- Euro Standard 54/66 dBµV/m
- Euro Standard 54/74 dBµV/m
- ATSC TV 41/48 dBµV/m

Here are the parameters which correspond to the above choices – these parameters are being updated and added to.

	Rx Sensitivity	Antenna gain	Antenna Height	Contour 1	Contour 2
FM Car Receiver	10.0 dBµV	- 0.5 dB	1M	34.0 dBµV/m	44.0 dBµV/m
North America Standard	10.0 dBµV	- 0.5 dB	10M	54.0 dBµV/m	60.0 dBµV/m
USA 60/70 dBµV/m	10.0 dBµV	- 0.5 dB	9M	60.0 dBµV/m	70.0 dBµV/m
Euro Std 56/66 dBµV/m	10.0 dBµV	- 0.5 dB	10M	54.0 dBµV/m	66.0 dBµV/m
Euro Std 54/74 dBµV/m	10.0 dBµV	- 0.5 dB	10M	54.0 dBµV/m	74.0 dBµV/m
ATSC TV 41/48 dBµV/m	10.0 dBµV	- 0.5 dB	10M	41.0 dBµV/m	48.0 dBµV/m

Normally, you can leave the default value for Maximum Range alone, but if you are using a very high power transmitter, or have a very tall site or tower, you may wish to increase this value. Note however that larger values take longer to calculate.

When you click submit, the program will begin computing, and may take a few minutes. The transmitter site you chose will be shown, as well as the resolution per pixel. Note this is the resolution of the display, not of the computations.

After the system is finished computing, you will see the estimated coverage shown over the top of a Google map. All the normal tools you have to zoom and pan are supported. You can turn on or off the plot, as well as the cursor showing the transmitter site using the check boxes below the picture. As useful as this drawing is, there’s more to see!

Click the button Add to My Coverage Plots. Then click My Coverage Plots, and select the plot you just created from the pull down menu. Now you will see the same plot, but now you have some additional features:

First, just above the map, you can see the color coding for the two selected contours, including the number of square kilometers and population covered by each contour. Also just underneath the map, there is a pull-up display of all the parameters that went into the creation of the map. Normally, I drag the map slightly to the right, then pull up the menu, and then do a screen capture (PrtSc) and paste the screen into my favorite image editing software, where I crop it and save it to my hard drive, or paste it into a document or email.

Just beneath the pull-up display under the map, there is a link that is used to download a Zip file containing the documents related to this map. Extract these files to a temporary directory. If you have Google Earth installed on your computer, you can click the .kml file, and Google Earth should open showing your coverage map on top of a dynamic 3D Google Earth presentation, allowing you to add other features or manipulate the graphic before saving it.

There are also .jpg and .png graphic files which are the images showing the estimated contour, the ground cover for the displayed area, the terrain height, and the population

density in the area. If you click the HTML file, it will overlay the estimated contour over a live Google Map.

MULTIPLE COVERAGE PLOTS

In some cases, you may wish to compare several site, tower height, antenna gain, and transmitter power level combinations to determine the best cost versus coverage. If you create several coverage plots as outlined above, and save them to My Coverage Plots, you can choose Multiple Coverage Plots from the Main menu, and then select the ones you would like to compare, holding down the Ctrl key as you select the, and click the Submit button.

On the resulting map, you can turn on and off the various layers and see the changes in coverage.

POINT TO POINT LINK ANALYSIS

In addition to coverage plots, the Nautel RF toolkit can also be used to determine the usability of proposed point to point STL links. To begin, define the location of the link sites in the same fashion as you defined the New Transmitter Sites above. Once you have the link sites defined, click on the New Point to Point Link button. Here's what you should see:

New Link	
From	Baldy
Antenna center height (m)	20
To	Smelter
Antenna center height (m)	20
Description	Baldy to Smelter
Frequency (MHz)	956.75
Tx power (Watts)	10
Tx line loss (dB)	2
Tx antenna gain (dBi)	18.9
Rx antenna gain (dBi)	18.9
Rx line loss (dB)	2
Rx threshold (µV)	40
Required reliability (%)	70
Use land cover	<input checked="" type="checkbox"/>
Use two rays	<input type="checkbox"/>

In the From pull down menu, select the link transmitter site (in many cases this is the studio), and the height of the center of the antenna above the ground in meters. Then do the same for the To site.

Enter a description for the link, and then the center frequency of the link in MHz. From the manufacturer's documentation, enter the antenna, transmitter and receiver details. If you don't have the details, you may need to contact the manufacturer. Leave the required reliability number at 70%. That allows the fade margin calculations to define the reliability rather than considering the fade margin twice.

Click Submit, and you will be presented with a huge page of information. At the top, you should see a profile of the path, which shows the terrain, and if long enough, even the curvature of the earth. The white ellipses are the calculated Fresnel zones which help understand the effect of ground reflection on the path. The color on the top of the ground denotes the ground cover information corresponding to the path.

Note that a limitation of this sort of program is that it can't predict the presence of buildings in the path. A visual evaluation is suggested.

Beneath the path profile are geographic results of the analysis, including coordinates, elevation data, and calculated antenna azimuths and tilts. Below that are the RF calculations, or as it is sometimes known, the link budget. Next is the actual calculation of the fade margin. Note that interpreting this number is best done by a qualified engineering consultant. Also note that this sort of analysis cannot predict the effects of interference, should it be encountered.

Lastly, a map is provided showing the overhead view of the path. You may choose to use screen captures to save the images and data for inclusion in a document or report.

CAVEAT EMPTOR

The Nautel RF Toolkit is intended to aid broadcasters in analyzing the approximate coverage with various transmitter sites, power levels, antenna heights and antenna gain. While the coverage tool is based on the well proven Longley Rice modeling techniques, and publicly available SRTM terrain data, it cannot be guaranteed and Nautel cannot assume any liability for the results. Further, the coverage tool is not meant to be a replacement for coverage studies and other work done by professional consulting engineers. Please consult with a qualified engineer before applying for your license or ordering your equipment

REFERENCES

[1] **Radio Mobile Website:**

<http://www.cplus.org/rmw/english1.html>

Radio Mobile Users Group:

http://groups.yahoo.com/group/Radio_Mobile_Deluxe/

[2] Longley-Rice ITS Information from NTIA:

<http://www.its.bldrdoc.gov/resources/radio-propagation-software/itm/itm.aspx>

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