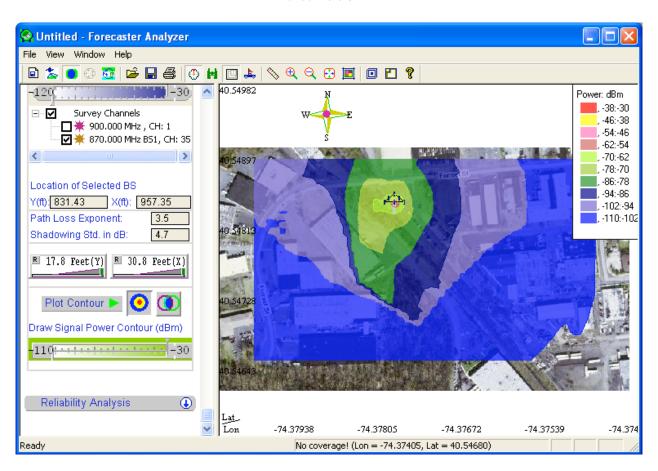
Forecaster

Manual version 2.1



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BVS Projector User Manual (PC software)

BVS Projector is used to create a geo-coded map for the analysis of the collected data with BVS survey software, such as Forecaster and Drone.

Getting started with BVS Projector

To use the BVS Projector, a GPS unit or GoogleEarth is needed to provide the latitude and longitude of the points in the map. There are two ways to do the projection:

- 1. Take a GPS unit to the survey area and record latitude and longitude for more than 8 points and also record the location of the measurement points; or
- 2. Open GoogleEarth. The latitude and longitude for any point can be seen.

Note that the accuracy requirement for latitude and longitude in the projector program is very high. The accuracy threshold is 0.00001° in decimal degree. The points should be spread out in the map to improve the accuracy of projection.

Open a Map

To begin using the BVS Projector, click on the hotkey to load a map, which can be a bmp, dib, emf, gif, ico, jpg, wmf, tif or tiff file. Then the map will be shown on the screen. To open a GEOTIFF file, just select the file and open it.



Converting a GEOTIFF File to a CPF or DPF File

Click on the hotkey to open the GEOTIFF file, select the file and open it. Select "Output Geo-Map" off the File Manu to save it as a coyote projection file (CDF) or a drone projection file (DPF).

Saving BVS Projector Workspace

At anytime after the project has been created it can be saved to a file. The current settings including state of controls and graph (map, bitmap and points) are saved in a project file and can be recalled later. To save a project select Save or Save as... from the File menu or the Hotkey from the Toolbar. If the project has previously been saved the Save option will overwrite the existing file while the Save as... will allow a new file name to be selected.



Opening an Existing Project

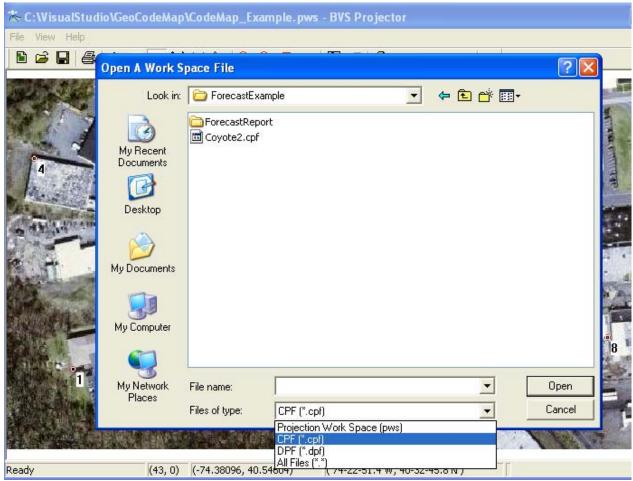
To open an existing Project select "Open" from the File menu or the Hotkey from the Toolbar. A dialog box will appear to allow the selection of the project workspace file (*.pws).

Opening a CPF Project

To open a CPF file, select "Open" from the File menu or the Hotkey from the Toolbar. A dialog box will appear, click on the down arrow and then select the "*cpf". All the CPF files in the current fold will be shown.

Opening a DPF Project

To open a DPF file, select "Open" from the File menu or the Hotkey from the Toolbar. A dialog box will appear, click on the down arrow and then select the "*dpf". All the DPF files in the current fold will be shown.



Select a Map to Show

If a TIF or TIFF file has multiple maps, the button will be enabled. Click on the button will pop up a dialog box to select the map to display.

Saving Current View as a Bitmap

The current view of the map (with the points) can be saved as a bitmap. Select Save as Bitmap... from the File menu.

Printing

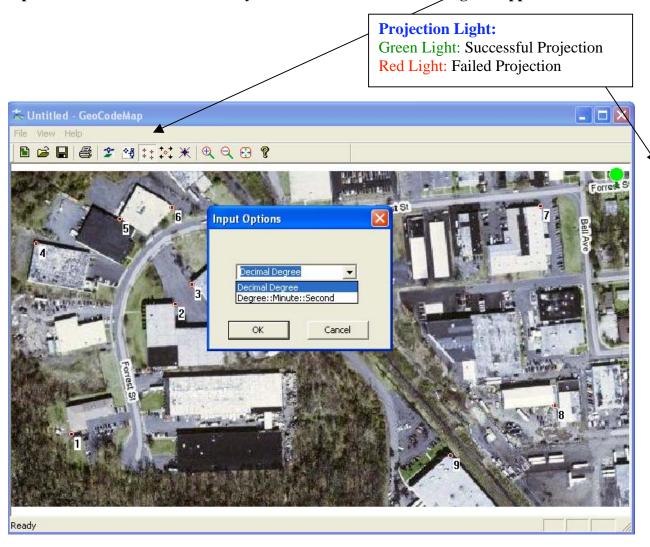
The standard Windows printing selections Print, Print Preview and Print Setup are available from the File menu.

Projection Light

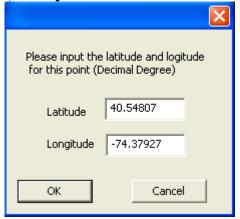
A projection light is used to show if the projection is successful. If it is successful, the light is green; if it is failed, the light is red.

Input Format Selection

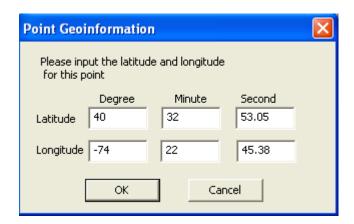
Input format can be selected in the format of decimal degree or Degree::Minute::Second. The default setting is decimal degree. To select the format use the Hotkey located on the top toolbar. Left click on the hotkey and the format selection dialog box appears.



If a decimal degree is selected, the input format will be

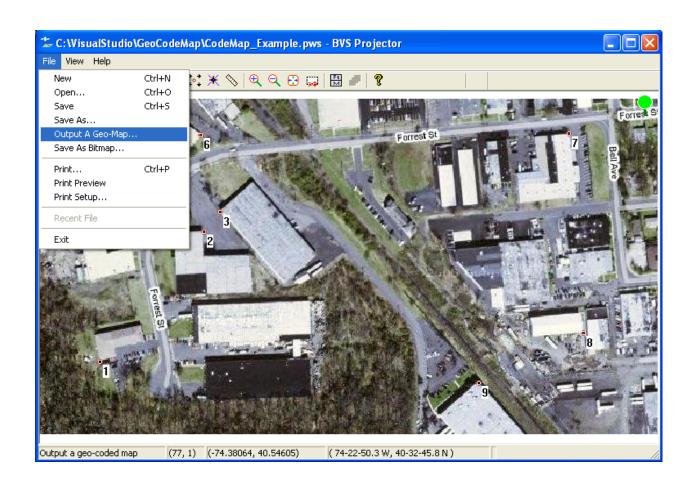


If "Degree::Minute::Second" is selected, the input format will be



Output a Geo-Coded Map

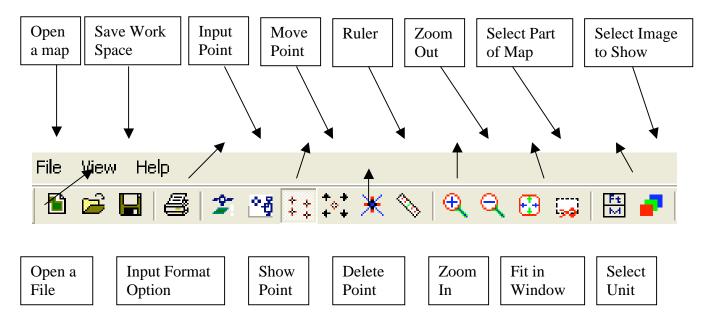
After projection light becomes green, a geo-coded map can be output. Select "Output A Gep-Map" from the File menu and then save it as a CPF file or a DPF file. If the projection light is red, the software is unable to output a geo-coded map.



Output Part of a Geo-Coded Map

If the whole map is too large, for example, one geotiff file can cover a state in the United States. If only part of the map is desired to use, please use the button to select the part from the map and then use the "Output A Geo-Map" key to output a CPF file or DPF file.

Control Buttons in the Toolbar



There are several hot keys available to change the zoom of the graph view.

Button	Name	Description
(Zoom In Tool	After clicking this hot button, the
a a	2001111111001	cursor changes to a magnifying glass.
Q	Zoom Out Tool	After clicking this hot button, the
4		cursor changes to a zoom-out glass.
•	Fit to Window	Pressing this hot key fits the image to the current size of the graph window.

Double Click on the point will show the latitude and longitude of the point.

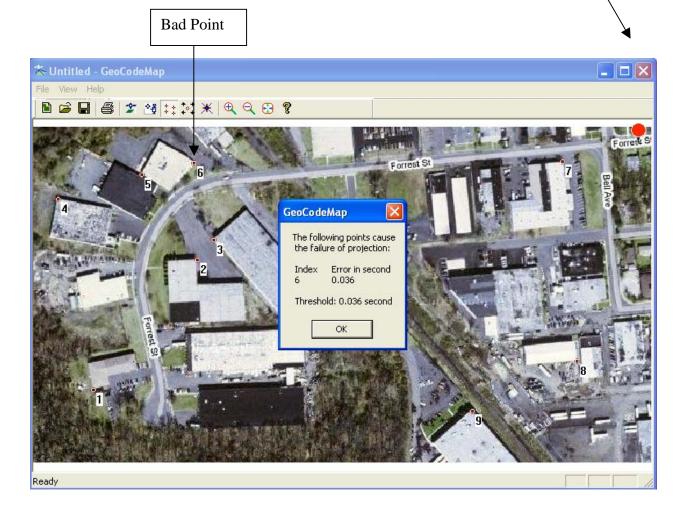
Measure Distance

After projection light becomes green, the ruler button is active. As mouse moves on the map, the latitude and longitude are shown. Left click and hold on the graph to start the measurement. As the mouse moves, distance is displayed in the lower right corner of the window.

Input Points

After a point with latitude and longitude is set, the software will compute the projection parameters. If the requirement for projection is not met, the projection light will be red. The points, which do not meet the projection requirement, will be shown on a Dialog. For the example shown below, the 6^{th} point does not meet the requirement, where the error threshold is 0.036 second (0.00001 degree). Double click on the 6^{th} point, check if the input latitude and longitude is right.

Note: Please spread out the points in the map to get an accurately geo-coded map. If the points are within a small area in the map, it will be difficult to do the projection successfully for the whole map.



Forecaster Analyzer User Manual

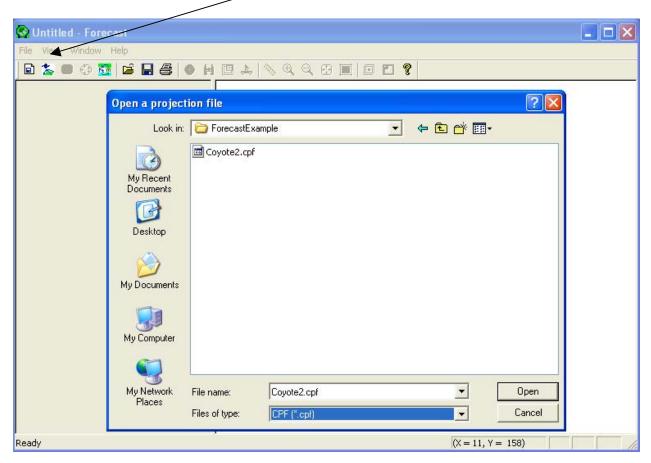
Forecaster Analyzer is the analysis component of Forecaster software package for Coyote or Panther Receivers. It provides analysis of coverage, reliability, channel reuse and more.

Getting started with Forecaster Analyzer

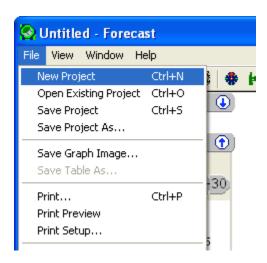
Forecaster Analyzer uses a geo-coded map from the Projector and data files recorded with Coyote or Panther Receiver.

Projector generates a Projection File (*cpf) that contains the map of the survey. Coyote or Panther Receiver produces a data log file (*.klf or *.plf) that contains the collected data.

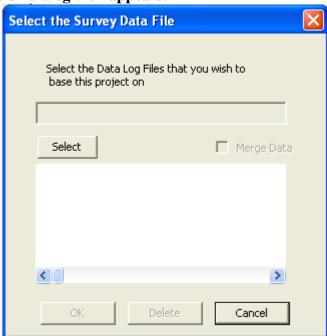
The Forecaster is project based. To begin using the Forecaster, a projection file is first generated (Please see the manual for Forecaster Projector). Click on the hotkey located in the toolbar near the top of the screen. When Panther is used to collect data in scan mode, please log data file in Fast mode first and then switch to Scan mode. The Projection File dialog box then appears. Open the projection file (map) you wish to use. BVS YellowJacket Drone Projection file (*.dpf) can also be used by Forecaster Analyzer.



Then the data log files must be loaded to create a project. The Forecaster Analyzer can process multiple log files. To create a new project select "New Project" from the File menu or the Hotkey from the Toolbar.



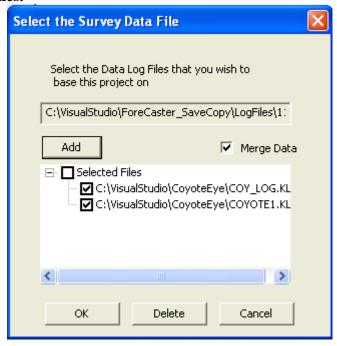
The data log file selection dialog then appears.



In the data log file selection dialog press the "Select" button and browse for the *.klf files you wish to work with.

More files can be selected by clicking on the "Add" button. If you wish to use two or more files that you have saved, the data in these files can be merged to process by checking the box before "Merge Data". If a file is added in by mistake, check the box before the file and

then press the "Delete" button. All selected files will be deleted. Click the "OK" button to load the data in the files.



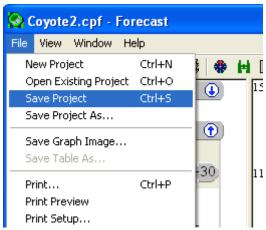
Note that the "Merge File" means merging the data in the files in the process. It does not mean that multiple files are merged into one file.

Log File Truncation

When a log file is stored in CF card, the size of the file is equal to that of CF card. Usually is it much larger than the real size. When the file saved in a CF card is loaded to process, a dialog box will be popped up to ask if the file needs to be truncated to its real size.

Saving a Forecaster Project File

At anytime after a project has been created it can be saved to a file. The current settings including state of controls and graph (map, bitmap and analysis) are saved in a project file and can be recalled later. To save a project select Save or Save as... from the File menu or the hotkey from the Toolbar.



If the project has previously been saved the Save option will overwrite the existing file while the Save as... will allow a new file name to be selected.

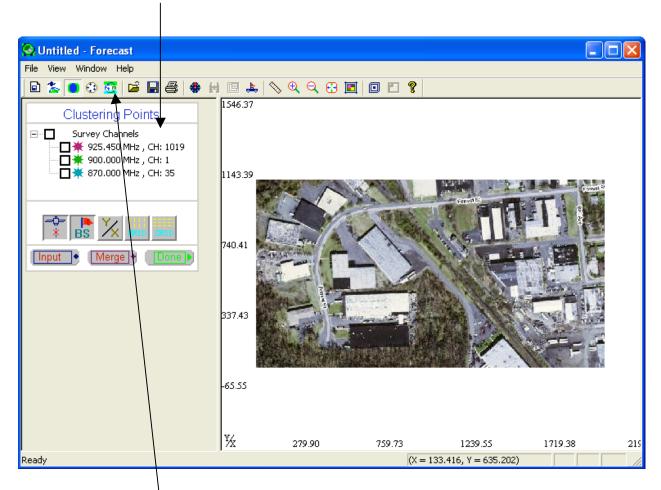
Opening an Existing Forecaster Project

To open an existing Forecaster Project select Open Existing Project from the File menu or the Hotkey from the Toolbar. A dialog box will appear to allow the selection of the project file (*.fws).

The Forecaster Analyzer screen is displayed in two sections.

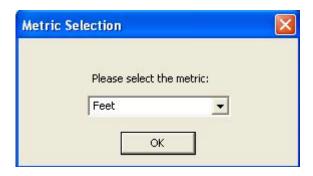
The left pane of the display contains the Control Window used for Clustering Points, View Options, Channel Selection, and Reliability Analysis.

The right pane contains the graph and the map from the Forecaster Projector.



Metric Selection

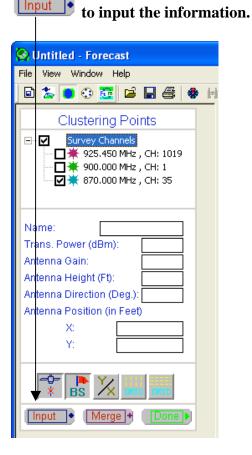
Metric information dan be displayed in feet or meter. The default setting is feet. To select the metric use the Hotkey located on the top toolbar. Left click on the hotkey and the metric selection dialog box appears.



Clustering Points

After loading the log files, the interface for clustering points is shown. This is used to separate the points with the signals, which have the same frequency, but they are transmitted from different towers/antennas. The automatic clustering has been done before this interface is shown. To separate the points, click the Hotkey, left click and hold on the graph to start the clustering. As the mouse is up, the points within the rectangular will be grouped as shown in the list of survey channels. To merge two groups (channels) with the same frequency, check the boxes before them and then click Button to survey the same frequency.

When a channel is selected (the box is checked), the parameters and information for the antenna is shown. Please type in the information or parameters if they are known. Press



After (base station) antenna's position is input, the BS will be shown on the graph. To move the BS, click, left click at the center of the BS icon, hold on the graph and move it to the correct location.

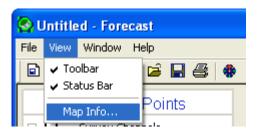
After the clustering is finished, click The software will proceed to the next step of post processing.

Buttons in Control Window for Clustering Points

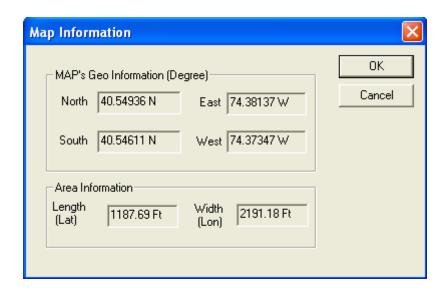
Button	Name	Description
~ \$	GPS Status	Show GPS status by black circles. 3D fix: No black circles;
*		2D fix: small black circles; No fix: big black circles.
	Show/Hide	Show or Hide base stations on the map
BS	Base Stations	
Y	Y/X or	Y/X: Use real distance (feet or meter) in the axis
/ ^	Lat/Lon	Lat/Lon: Use Lat/Lon (decimal degree) in the axis
	Vertical Grid	Show vertical grid lines
bicity	Lines	
	Horizontal	Show horizontal grid lines
BRID	Grid Lines	
Input •	Input	Input the parameters for base stations and antennas
	Parameters	
Merge +	Merge Groups	Merge multiple groups (in the channel list) into one group
Done ▶	Finish	Process the data after clustering
	Clustering	-

Map Information

Click on the "Map Info..." off the View menu and the information about the map will be shown. These values cannot be changed.

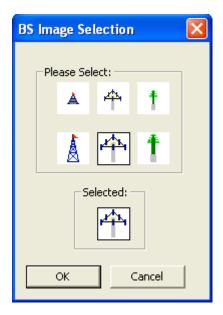


With a projection file it shows the ranges in feet or meter, without a map it shows the ranges in latitude and longitude.



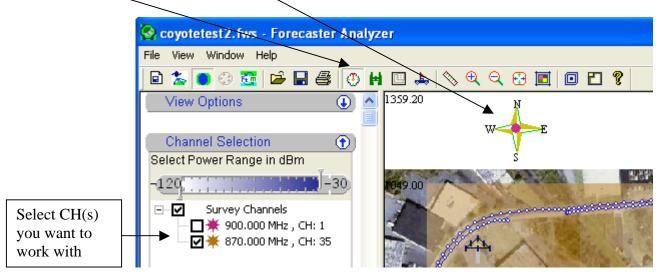
Change Base Station Icons

Right click on the base station, a dialog to select base station image is shown. Click on the desired image, press "OK" Button.



Show Map Directions

Press the button, the map directions are shown.

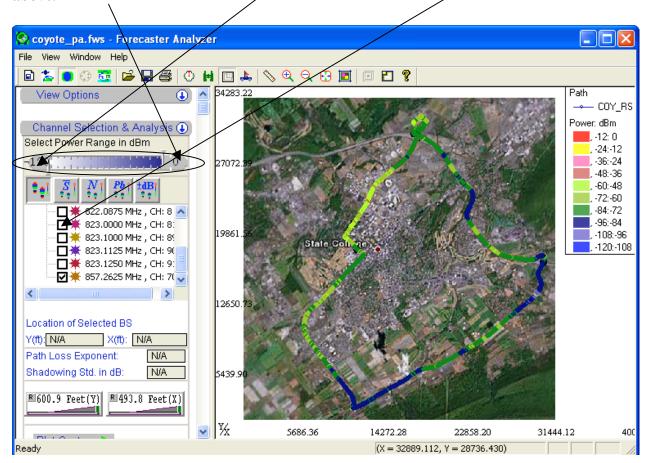


Buttons in the View Options

Buttons	Name	Description
••1	Walk/Drive	Show/Hide Walk/Drive Path
	Path	
1 =	Path Width	Change the Width of Walk/Drive Path
	Plot RSSI along	Plot the RSSI of Measurement Points along the Survey Path.
J * # 8	Path	
*	GPS Status	Show GPS status by black circles. 3D fix: No black circles;
		2D fix: small black circles; No fix: big black circles.
BS	Show/Hide	Show/Hide Base Stations on the Map
	Base Stations	
Y/ Lat	Coordinates	Y/X: Use the real distance in the axis
/X Ton	Selection	Lat/Lon: Use Lat/Lon (decimal degree) in the axis
GRID	Horizontal Grid	Show/Hide Grid Lines in X (Lon) Direction
	Lines	
BRID	Vertical Grid	Show/Hide Grid Lines in Y (Lat) Direction
	Lines	
5 Lines	Number of Grid	Change the Number of Lines in the Grid
	Lines	

Plot RSSI along Survey Path

To plot the RSSI along the survey path, click on the button and then select the channel. A colorful drive path is shown below. Since GPS data is updated every second, the software will first filter out the redundant data and then average the independent data in the second. Note this is different from the processing stages in Coyote Sieve. The range in the map is from 0 dBm to -120 dBm. To change the range of RSSI, please move the sliders above.



Plot The Averaged RSSI along Survey Path

If the distance traveled in one second is less than 40 lambda, the software will find the data within 40 lambda and then do the weighting average. The data are obtained by averaging the samples within one second. To plot the averaged RSSI along the survey path, click on

the button and then select the channel. A colorful drive path is shown. If none of the channels is selected, a dialog will be popped up to ask for selecting channels. The range of RSSI can also be changed by moving the sliders above.

Plot The Number of Averaged Points along Survey Path

The number of the points, which are used for averaging, can also be plotted along the walk/drive path. Click on the button under "Channel Selection and Analysis". A dialog will be popped up to take the range for the numbers.

Plot The Reliability of Averaged RSSI along Survey Path

To plot the reliability of averaged RSSI along the walk/drive path, click on the button under "Channel Selection and Analysis". A dialog will be popped up to take the range for the reliability. The default value of RSSI variation to calculate the reliability is 1dB. For example, if the reliability is 90%, it means that the possibility that the averaged RSSI is within \pm 1dB of the real mean value is 90%. The accuracy of the averaged RSSI to the real mean value increases with the reliability. Assuming the number of points is N, the reliability is p, the variation is σ , the equation to calculate the reliability is n

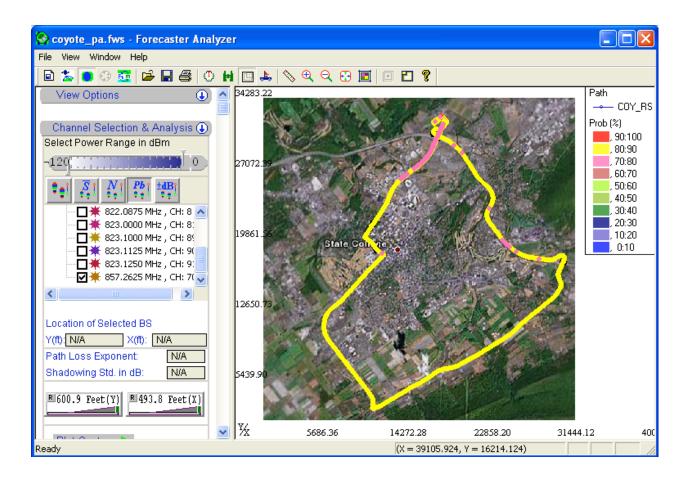
$$p(\sigma) = erf\left(\frac{\sigma\sqrt{N}}{7.8760}\right)$$
$$erf(x) = \frac{2}{\sqrt{\pi}} \int_{0}^{x} \exp(-t^{2}) dt$$

This figure showing the reliability of averaged data is show below.

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¹ Please refer to the book – "The Mobile Radio Propagation Channel", David Parsons, John Wiley & Sons, New York, 1992.



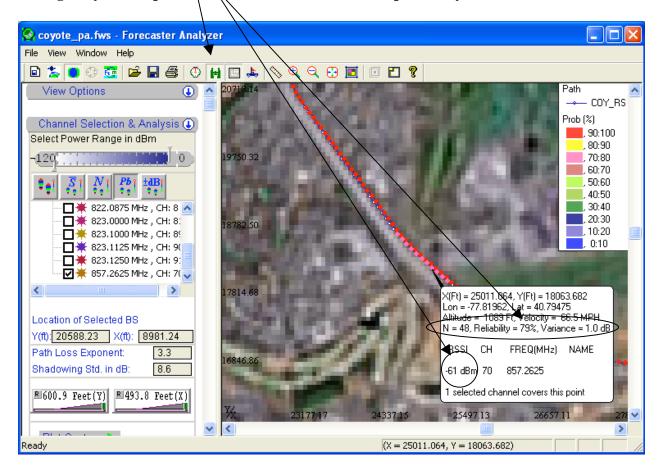
Plot The Variation of Averaged RSSI along Survey Path

To plot the averaged RSSI along the walk/drive path, click on the button "Channel Selection and Analysis". A dialog will be popped up to take the range for the variation. The default value of the reliability to calculate the reliability is 90%. The accuracy of the averaged RSSI to the real mean value decreases with an increasing variation. Assuming the number of points is N, the reliability is p, the variation is σ , the equation to calculate σ is

$$\sigma(p) = \frac{5.57 erf^{-1}(p)}{\sqrt{N/2}}$$

Analyze Measurement Data Using Information Window

The following figure shows the analysis of measurement data by using the information window. Click on the hotkey and then move the mouse to the point to be analyzed. Stay at the point for a second and the information window will be shown. The information window in this figure shows that the averaged value at this point is -61 dB, which is averaged by 48 samples. The real mean value has 79% possibility within -61±1 dB.



Channel Selection

Select the channels or group of channels you wish to work with in the control window under "Channel Selection". The Channel Selection tool contains a list of all channel(s) that are present in the log files. Checking the box next to the frequency includes the channel(s) in the analysis. As the channel is selected, its coverage graph will be shown in the graph window.

Color Selection

The color indicator between the frequency and the check box has two functions:

One is to select the color used to graph signal strength from that channel(s). To change the color for a selected channel(s) right click on the color indicator. A color selection dialog box will appear.

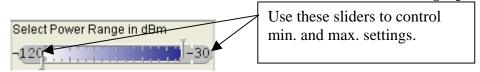
The other is to select how channels are grouped for analysis. After checking the channel, the RF coverage of that channel will be shown if it is not in the Reliability Analysis mode. If it is in the Reliability mode the area with certain reliability is shown. Reliability Analysis is explained in the following section. There are two conditions the user can choose from as shown in the following table:

Example Grouping Description

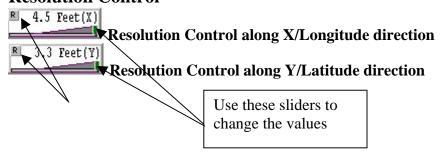
Example	Grouping	Description
□ ✓ Survey Channels	Individual	Each selected channel is graphed in its own color indicated by the color of the star.
□	Group Selection	The best coverage for all channels is shown using the group color.

Range Control

This feature allows the user to control how the signal strength is represented using a graph. The two sliders set the minimum and maximum values for the graphing range.



Resolution Control



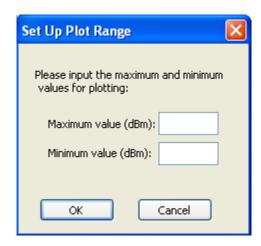
Use the "R" button to set the default resolution

hows the size of the points calculated. Setting the control for low e calculation time and decrease the resolution. The button **E** resets

the control to a reasonable default setting.

Plot the Contour

The detailed analysis with contours can be obtained by pressing the Plot Contour button. A dialog will be shown for the minimum and maximum values for contours.



Either the signal strength or the number of channels (N) in the coverage area can be shown

by clicking the (signal strength) or the (number of channels) button.

Draw Contours

The range of the power (or number of channels) is shown in the following range control diagram. Move the sliders on the range control by clicking and holding the sliders to the desired value and the contours for the two values will be displayed in the graph window.

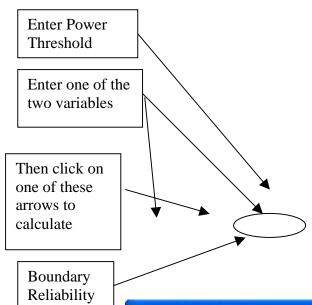
Draw Signal Power Contour (dBm)

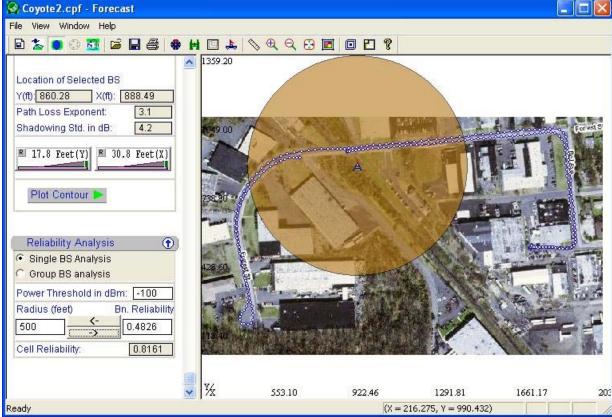
Reliability Analysis

Reliability Analysis shows the radius, boundary reliability, cell reliability and power threshold of the channel(s). The user can input numbers via the keyboard and calculate the coverage on both the map and in the control panel.

Channel(s) selected for Reliability Analysis is done with the channel Selection List. After selecting the channel(s) use the buttons in the control pane to calculate reliability analysis. To do single channel analysis select "Single Analysis" and the last selected channel is analyzed. Click on the "Reliability Analysis" button and input Power Threshold and Radius. Click and the boundary reliability for this channel is shown under "Bn. Reliability" and the cell reliability is also calculated and shown. The coverage of the last selected channel with the radius is shown as a circle on the graph window. The reliability represents the probability that the received signal's strength is larger than the threshold value. The boundary reliability stands for the probability of the signal received at the boundary (larger than the threshold); the cell reliability stands for the probability of the signal received at the circular area. On the other hand if power threshold and probability (boundary reliability) are known click and the radius and cell reliability will be shown. If "Group Analysis" is selected then all the selected channels will be analyzed with the same input data. An example is shown below.

Note: If the "Reliability Analysis" is open then the software is set to this mode. To see the coverage of the selected channel(s) click the "Reliability Analysis" again to pull up the interface and close this mode.





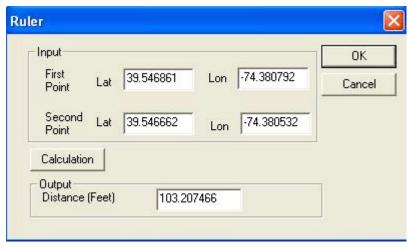
Buttons Controlling the View

There are several hot buttons available to control the graph view.

Button	Name	Description
Φ.	Zoom In Tool	After clicking this hot button, the
4		cursor changes to a magnifying glass.
Q	Zoom Out Tool	After clicking this hot button, the
		cursor changes to a zoom-out glass.
•	Fit to Window	Pressing this hot key fits the image to
	THE CO VIII GOV	the current size of the graph window.
t==t	Fit to Map	Show the graph image with the whole
	•	map.
①	Show Directions	Show the directions of the view.
	Show Map	Show/Hide the map
H	Information Window	Show information as mouse hovers
Œ	Legend Window	Show legend for the graph
.	Move Base Station	Move base stations on the map
	Ruler	Measure distance
	KML report	Create a KML report
	HTML report	Create a HTML report

Measuring Distances

Distance measurements can be made on a graph by using the ruler tool. To measure distances use the hotkey. Left click and hold on the graph to start the measurement. By releasing the button the distance is displayed by a distance dialog box.



Saving Coverage Graph

The current coverage graph can be saved as a bitmap. Select Save Graph Image... from the File menu.

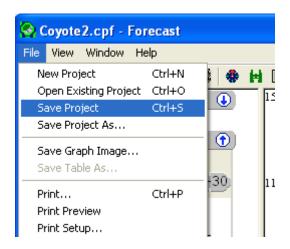
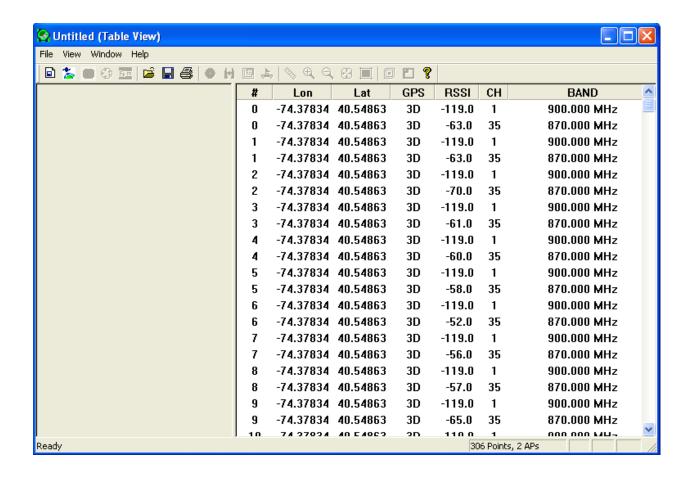


Table View

To view the data point in tabular form select Table Window from the Window menu.



An example of a table view follows on the next page.



where

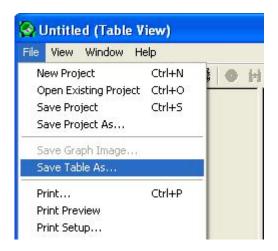
Lon: Longitude; Lat: Latitude;

GPS: 3D -> 3D fix, 2D -> 2D fix, 0 -> No fix; RSSI: received signal strength indicator;

CH: Channel number;

BAND: Channel carrier frequency;

To save the table in a form that can be used by spreadsheet applications and other programs select Save Table as... from the File menu.



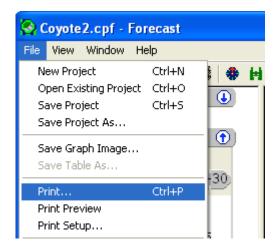
The save table options dialog then appears.



The output is an ASCII file that can be customized for easier conversion to a specific program.

Printing

The standard Windows printing selections Print, Print Preview and Print Setup are available from the File menu.



KML Report

Keyhole Markup Language (KML) files can be opened by <u>Google EarthTM</u> and the current view will be shown on top of GoogleEarth. If no projection files (*.cpf or *.dpf) exist the Forecaster software can generate a KML file automatically to plot the graph on top of the

map of GoogleEarth. To use this feature, press the Hotkey. If the map is shown in the graph, click on the Hotkey to enable the Hotkey. Select a file name to store the file when the dialog box appears. Then select a folder to store the image and write down some notes or descriptions for this image, which will be shown in GoogleEarth.



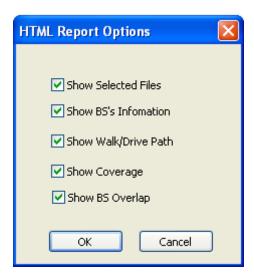
After creating a KML file right click on the file and select "GoogleEarth" to open it. Pull down the scroll button at "Places" to the bottom and check the box before the file name, the view will be shown on top of GoogleEarth and the transparency can also be adjusted by the underneath slider control. It can also be saved in "My Places".



HTML Report

HyperText Markup Language (HTML) files can be opened by Internet Explorer and can contain formatted text and graphics. Forecaster Analyzer can create a HTML report that has the information about the data survey files, the selected channels, the coverage of signal power and number of channels per location.

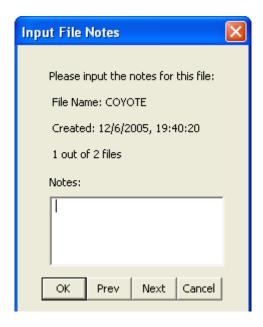
To use this feature select Hotkey. Select a file name to store the file when the dialog box appears. A dialog box for HTML report options will be shown. If no "Plot Contour" is carried the button "Show Coverage" and "Show BS Overlap" will be disabled.



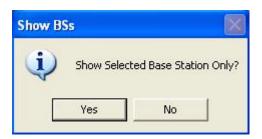
If "Show Selected Files" is checked a message box will appear asking if the selected files are to be displayed in the report. If "No" is clicked then all the files will be displayed in the report.



Then a dialog appears to take the notes for the selected file. Enter the notes for the different files by clicking the "Prev" or "Next" buttons. After entering the notes for all the files then click "OK". All notes will be stored and displayed in the report.



If "Show BS's Information" is checked a message box will appear asking if only selected base stations are shown in the report. If "No" is selected then all of the base stations will be displayed in the report.



Then a dialog box appears to take the parameters and notes for the selected base stations or channels. The parameters obtained at the interface for clustering points are shown here. Modify the parameters and notes for the different BSs by clicking the "Prev" or "Next" buttons. After entering the notes for all of the BSs click "OK". All notes will be stored and displayed in the report.

