Quick Start Guide

Vision™ Software

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Part Number: 10580-00417
Revision: C
Published: April 2017

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Chapter 1 — Installation

1-1 Introduction

This Quick Start Guide provides the following information:

- Installation Instructions
- Exercises that illustrate the use of Vision™
  - Using a sample database and the Vision Simulator to acquire sweep traces and monitor channels.
  - Using the Morgan Hill test bed to acquire live data and directly access the monitors.
  - Setting up your own custom database and start acquiring real data of interest.

1-2 Application Overview

The Vision™ application consists of several main components: Vision Monitor, Vision Acquire (included in Vision Monitor), Vision Locate, and a High-Speed Port Scanner.

Vision Monitor (option 400) interrogates the database where measurements are collected to show date/time stamped trace information, spectrograms, and intuitive ways to monitor for interference signals.

Vision Acquire is the component the runs continuously in the background, talking with the remote monitors to collect, verify, and store sweep traces in a database located on the remote PC/server. Vision Acquire is also used to setup alarm notifications and to generate reports on spectrum health.

Vision Locate (option 401) performs Geo-location of signals of interest. Algorithms used include both Power of Arrival and Time Difference of Arrival.

The High-Speed Port Scanner (option407) is included with the Vision installation program. However, the Scanner can run as an independent stand-alone program for rapid scanning multiplexed RF IN ports (see User Guide for Anritsu's remote spectrum monitor products) as well as for individual frequency channels within each antenna port scanned.

1-3 Vision™ Application Installation

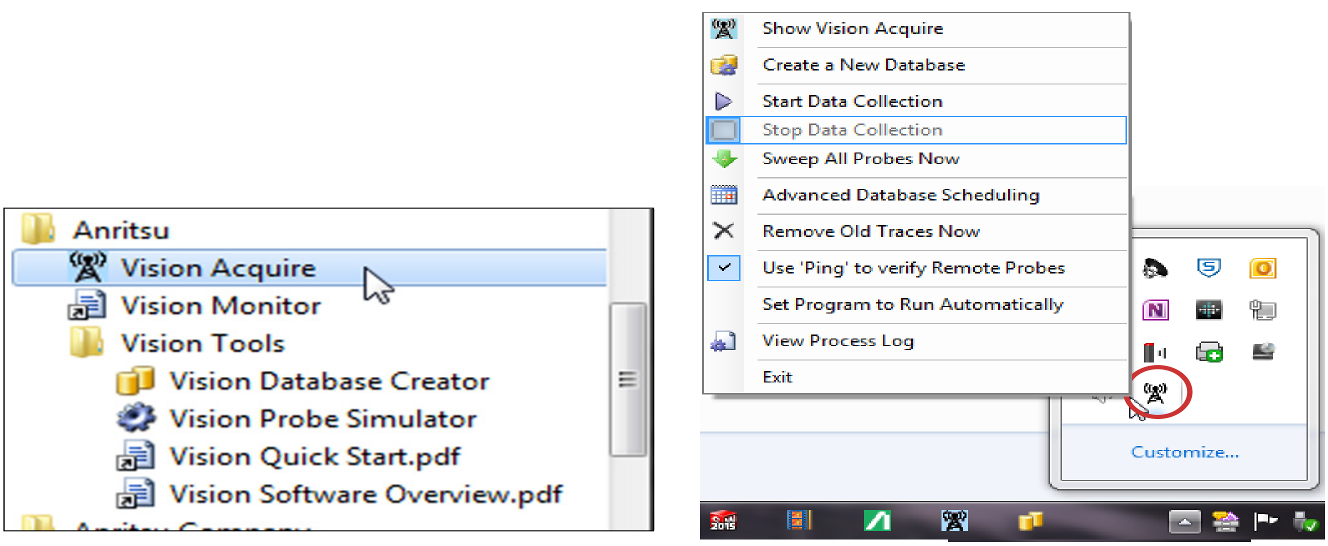
1. Download or copy VisionInstaller.msi to the PC.
2. Run VisionInstaller.msi by double-clicking the file. The installer asks a few questions and presents the standard Anritsu License agreement. The default responses will work best in most circumstances.
3. When the Vision program is installed, several short-cut icons will appear on your desktop. One icon is presented for Vision Monitor and Vision Locate and one for the High-Speed Port Scanner. Each program must be purchased separately to be operational.
4. On start-up of the Vision Monitor program, you may receive a pop-up window if a database has not been previously chosen. You will be given the choice of navigating to the location of your database or creating a new database. A third choice is to close the pop-up window and Vision program. See the section below for instructions on creating a new database.

Note	In order to install Vision, Microsoft .NET 4 (or above) must be installed on your PC. If .NET 4 is not present, the Vision installer will prompt you to install this program. The download of Microsoft .NET 4 is free of charge. Insure that you download the Web Installer version of .NET.

1-4 Application Access

Once the applications are installed, they can be accessed via desktop shortcuts or from the Windows Start menu. Vision applications will appear on the Start Menu under the Anritsu folder (Figure 1-1).

Note	During installation, Vision Acquire is also added to the Startup folder so it appears in the system tray whenever the application is started (see Figure 1-1). Right-clicking the icon within the system tray provides a menu with a number of selection choices: *Show Vision Acquire*, *Create a New Database*, *Start Data Collection*, *Stop Data Collection*, *Set Program to Run Automatically*, *View Process Log*, and *Exit*. Vision Acquire can be made to run automatically when the PC restarts by selecting *Set Program to Run Automatically*. If you try to close Vision Acquire using the ‘x’ close box in the upper right-hand corner of the application window title bar, Vision Acquire will not exit; it simply becomes hidden. To close the application, right-click the icon in the System Tray and select Exit. You will not be able to use Vision Acquire or Vision Monitor until you have created and attached a database. The database is used to configure each monitor for sweeping, and to store the resulting trace data.



Vision Acquire, Vision Monitor and Vision Tools in the Windows Start Menu

Vision Acquire Icon and Selections in Startup Folder (System Tray)

Figure 1-1. Vision Acquire and Vision Monitor Program Access Example for Windows 7

Chapter 2 — Setup and Monitor

2-1 Introduction

This chapter provides exercises for the following setup and monitoring activities:

- "Using a Sample Database"
- "Manually Creating a Vision Database"
- "Creating a Real Database for Your Probes"

2-2 Using a Sample Database

In this exercise, you will create a database based on a sample database definition file. Before you begin, you will need to run the Vision Probe Simulator. This will allow Vision Acquire to appear to capture and store trace data, even though no probes are deployed.

Launching the Vision Probe Simulator

1. On the Windows Start menu, find the folder for Anritsu, then open the sub-folder named Vision Tools.
2. Click the **Vision Probe Simulator** application icon.

   A window will open, ready to receive and respond to commands from Vision Acquire.

Creating Your First Database

1. On the Windows Start menu, find the folder for Anritsu, then open the sub-folder named Vision Tools and click on the **Vision Database Creator** icon. Use the next steps to create and deploy your first Vision database.
2. Click the Load button from the main application button bar (Figure 2-1). An Open File dialog will appear.
3. In the Open File dialog, browse to and open the file named `St Louis.def`. The sample file is stored under the application folder in an Example Files sub-folder. The path will be something like: `C:\Program Files (x86)\Anritsu Company\Vision Trace Acquisition\Samples.` The directory path is an example. The database location you set may differ.
4. Click the Path button in the button bar. Designate a location to create the database. A suggested location might be in an Anritsu Databases sub-folder created under your Documents folder.
5. Click the Create button. You will see process information appear in the process log portion of the screen. When this has run to completion, you have created the database.
6. Close Vision Database Creator application.

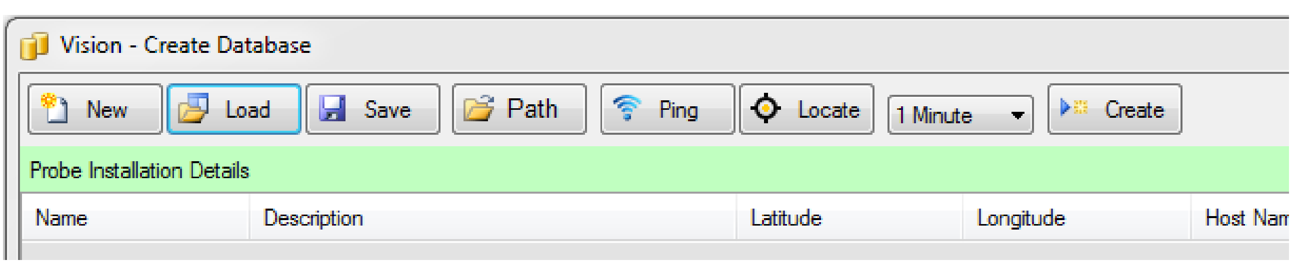


Figure 2-1. Vision – Create Database Application Toolbar

Acquiring Traces

The Vision Acquire application is activated to collect traces from the Vision Probe Simulator.

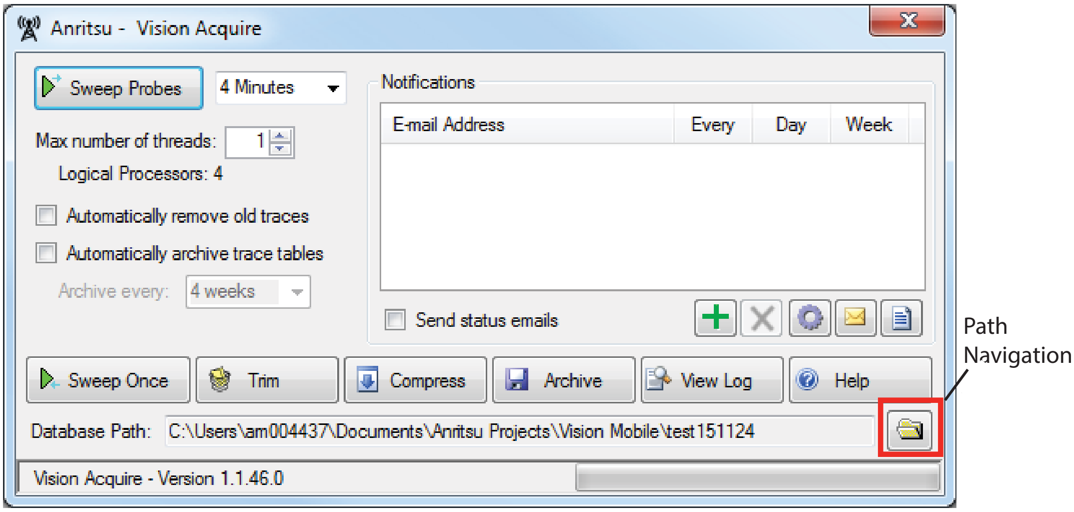


Figure 2-2. Vision Acquire Application Window

1. Run the Vision Acquire application which is located under the Anritsu folder in the Windows Start menu.
2. Provide the Database Path by navigating to the database location. Near the bottom right-hand corner of the application is a button with a folder icon (Figure 2-2). Click the button, browse to the folder where you created the database described in the previous section, then select the database.
3. Set Max number of threads: to 18.
4. Adjacent to the Sweep Probe button is the Set Time pull down list. Select 20 seconds.
5. Click **Sweep Probes**. The application will now start collecting sweep traces.

   Watch the Process Status bar at the bottom of the application window – you will see it progressing repeatedly through each probe in the database to collect sweep data. You can also watch the Vision Probe Simulator (Figure 2-3) and verify that it is receiving and responding to a variety of remote commands to setup, acquire and transfer sweep data.

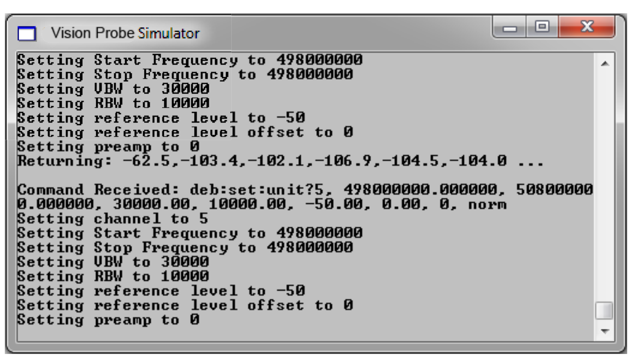


Figure 2-3. Vision Probe Simulator

6. End data collection. The application will continue to collect data from the Probe Simulator until you end the data collection See Figure 2-4, "Vision Acquire Command List".

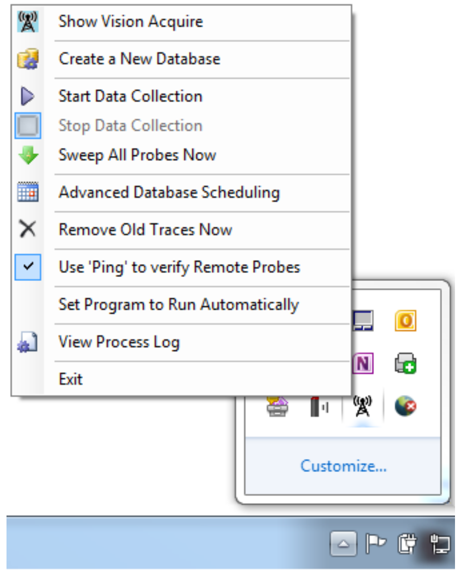


Figure 2-4. Vision Acquire Command List

a. Click the up arrow button on the Task Bar to open the System Tray.

b. Right click on the **Vision Acquire** icon. The Vision Acquire command list opens.

c. Click **Stop Data Collection**.

Viewing Trace History

The Vision Monitor application is launched to view the stored traces. This assumes that Vision Acquire has been running for a few minutes and there are now traces stored in the database.

1. Run **Vision Monitor** from the Windows Start menu or look for **Vision Monitor** under the Anritsu folder. A sample application screen is shown in Figure 2-5.

   The first time you run Vision Monitor, it has no database connection. There is nothing to do in Vision Monitor without a database connection, so you will be directed to locate a database of interest.

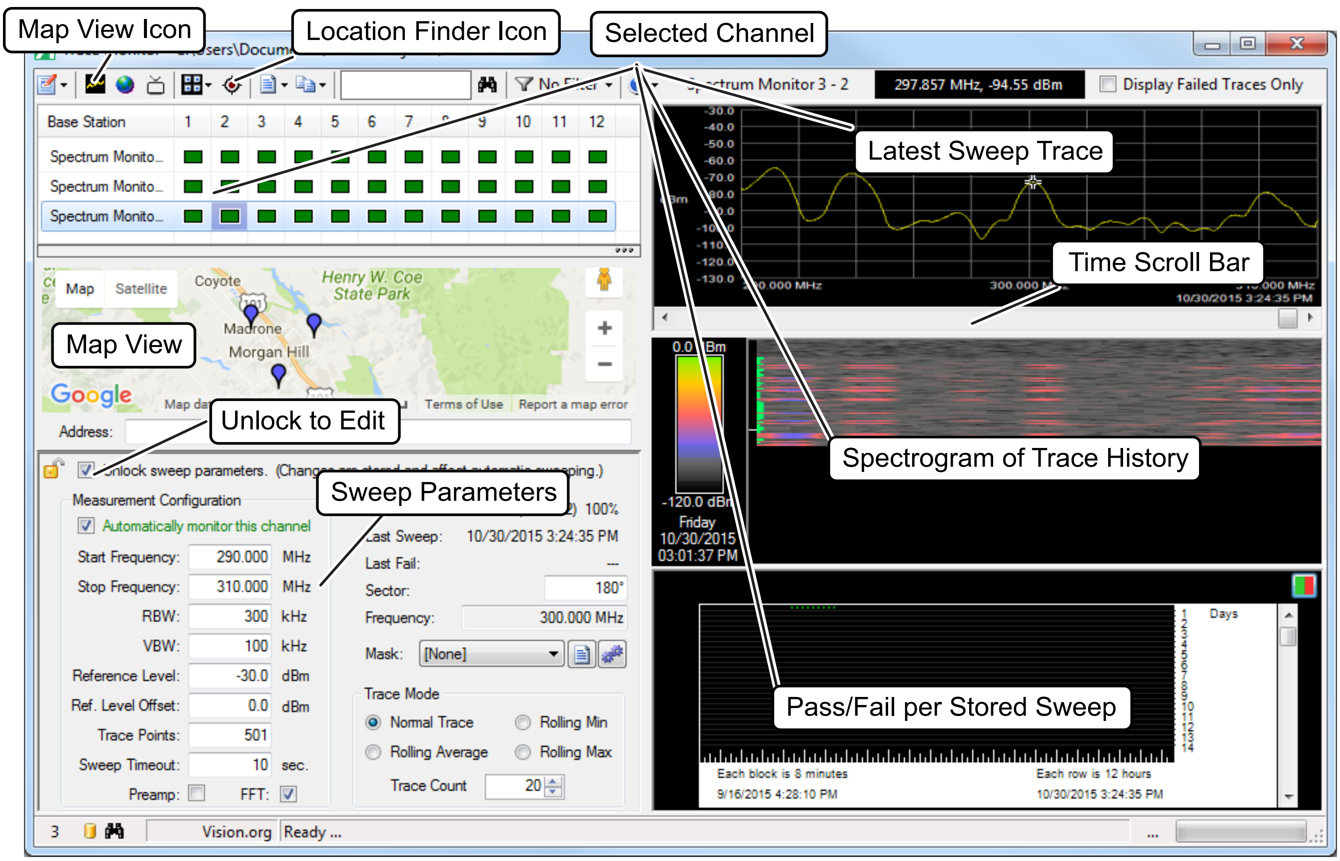


Figure 2-5. Sample Vision Monitor Application Screen

2. Browse to the database that you created earlier, and ensure that you have Vision Monitor pointed to collecting traces.The icon to set the database location is located in the upper left corner of the Vision Monitor screen. Click **Set Database Location**.

   Once you have selected the database, you will see a list of monitors. Each probe can have up to12 channels. The channels represent different sectors and carrier frequencies; different physical antennas at a base station, for instance. The number of probes and channels/probe were determined when we created the database – this example uses 36 probes with 12 channels per probe, but these are arbitrary numbers. Each channel has an indicator that shows the status of that channel.

3. Select one of the channels. You will see three graphs in the main portion of the screen as shown above in Figure 2-5. The top is the most recent sweep trace from the selected probe/channel. Below this is a spectrogram showing the trace history for this monitor/channel. At the bottom is a time chart, this indicates Pass/Fail for each sweep stored for the monitor/channel selected. At the moment, you have very little data, so there isn't much to look at, but the data will be growing, adding a trace for each channel about twice per minute. To include Map View in the left column, click on the three dots below the Base Station and Channel scroll bar. See Figure 2-6, "Three Dots to Open Trace History, Monitor Map, or Live Data Stream"

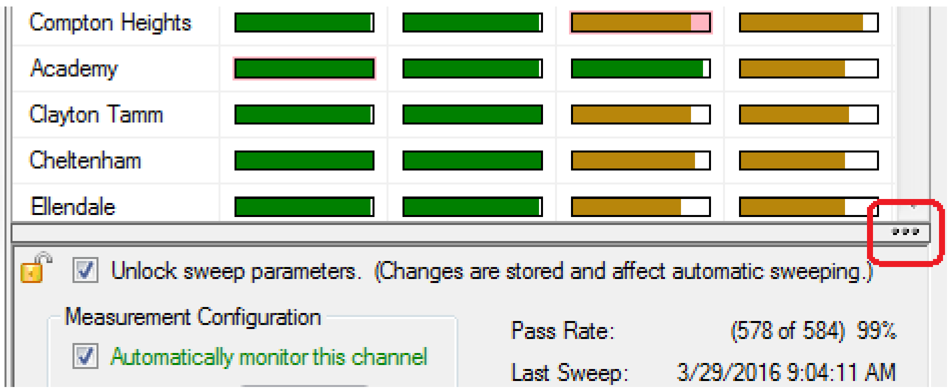


Figure 2-6. Three Dots to Open Trace History, Monitor Map, or Live Data Stream

4. Below the Probe list there is a section that shows sweep parameters for the selected channel. These are the values stored in the database. You will not normally edit these values, as that will change all subsequent automatic sweeps collected by Vision Acquire. When you do want to change sweep parameters for automated sweeps, this is where you do it. By default, the parameters are locked, so they will not be changed by accident. At the top of the parameter panel is a checkbox used to unlock the panel for editing.

5. In the main button bar, there is an icon of the earth which opens Map view. Click this icon to see the monitor locations on a map. By default, Google Maps is used for this view. If you prefer, you can change to OpenStreetMap export files. OpenStreetMap files are especially useful if you are using Vision Monitor without a live Internet connection, or if you are in a part of the world where Google is blocked. You can change the Map source under the Maps, Trace Files, and Program Settings menu (accessed from the first button to the left in the button bar (indicated in Figure 2-7). After opening the Open dialog, if the desired.shp file in not in the Anritsu Mapfiles folder, navigate to the folder where it was saved.

6. Right-click on any probe in the Probe list and hover the mouse pointer over the bottom menu item labeled Probe Groups. A side menu opens: Select the option Show Groups. This will cause the Probe list to be displayed differently. You can collapse and expand groups. Groups are logical sets of probes, arranged any way that is convenient, whether geographically, by modulation type, or by the person or organization in charge of maintenance.

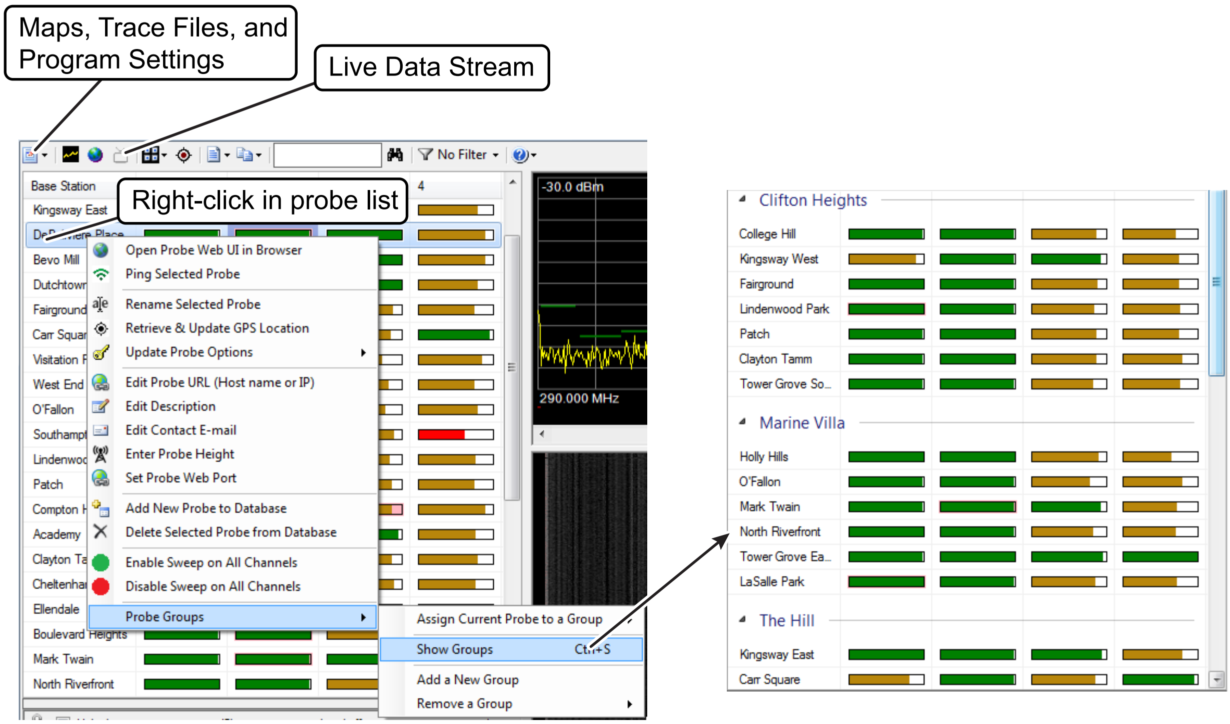


Figure 2-7. Probe Groups Configurations

7. Feel free to click buttons and interact with Vision Monitor. The Live Data Stream button (Figure 2-7) will not do anything useful at this point because in this exercise, we are not connected to real probes. The Locator button will be discussed in depth in the next section.

Vision Location Finder

Vision Monitor can be used to locate a source of interference. This is not a precise location, but will get you close enough where you can then drive to the general area and use Anritsu's Mobile InterferenceHunter™ to finish locating the source.

1. Select a channel of interest. This would generally be a channel that exhibits a problem such as a high failure rate, or there are a lot of dropped calls, or system performance issues at a particular cell site. In this example case we don't have a real interference source, so it doesn't matter which channel you select.
2. Right click the mouse which opens the context menu. Highlight Update Probe Options and select either Update Selected Probe or Update All Probes. This updates the data to the probes.
3. Click the Location Finder button in the main button bar (indicated in Figure 2-5). The button has an icon that looks like a target.

   This will open up the Vision Source Locator window (shown in Figure 2-8). Trace data is loaded for three nearby probes. The traces are shown along the right edge, while most of the screen contains as map of the area around the probe you selected in Step 1.
4. Click on one of the graphs to set a frequency for the interference source. In real conditions, the interferer will be visible in the trace data. If you cannot see the interference in the sweep data, you cannot locate it with Vision.

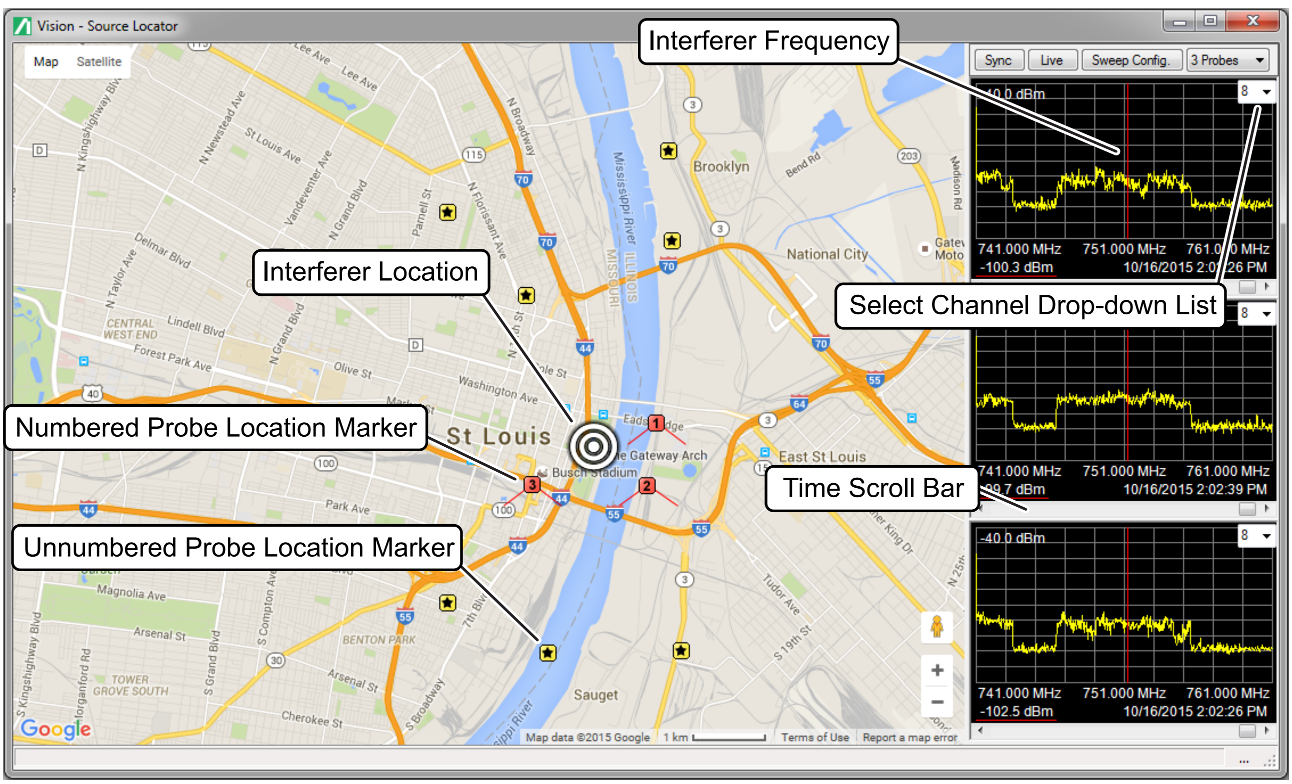


Figure 2-8. Vision Source Locator

5. The interferer frequency is marked in all three graphs by a bright red line. You can adjust the interferer frequency (and thus the position of the red line) by moving the mouse wheel with the mouse pointer over one of the graphs. As you position the interferer frequency, you will see a bulls-eye icon on the map that indicates the interferer location.

   Note that this is a fictitious interferer frequency at the moment since we don't have a true interference source. However, you can still see that as you move the frequency, the location moves in response to the relative power levels at the interferer frequency position.

6. You can scroll through the traces back and forth in time with the scroll bars under each trace.
7. In the Vision Source Locator window, click the Sync Button to toggle synchronization of the traces in time. When Sync is on, moving any of the scroll bars causes all three graphs to adjust to a trace that is as close as possible in time.
8. In the same window, click the Live button. This will simulate getting live data from the monitors. This data is coming from the Simulator (which should still be running).
9. You can change which channels are used for each of the three probes by selecting from the drop-down list in the upper right-hand corner of each graph (indicated in Figure 2-8).
10. You can change which of the monitors shown on the map are active by clicking one of the numbered markers, then clicking on one of the unnumbered markers.

    The numbered markers represent the three probes active and used for location estimation. The unnumbered markers (yellow markers) are inactive. Vision Monitor tries to pick three logical probes, but it doesn’t know where the interferer is yet, so you will typically have to adjust which probes are used to get the proper coverage.
11. You can change from 3 Probe mode to 1 Probe mode using the drop-down list. 3 Probe mode is the default. It uses the Power on Arrival for three nearby probes to locate an interference source. In 1 Probe mode, a single probe is used with data taken from each of three sectors on the same base station for instance. This is useful if the interference source is near the edge of the sectors and can be seen by two antennas on the same mast. In this case, the relative power is used to determine a beam line toward the interference source.This indicates a direction, with an uncertainty (beam width) based on relative power. This is only useful if the interference source is clearly visible in the sweep data of two adjacent sectors on the location.
12. When you close the Interferer Locator, you can choose to see the interferer location last found on the map in the main Vision Monitor window. Under the Maps, Trace Files, and Program Settings menu, select Show Location Estimate on Map.

This completes the first exercise. You have successfully created a Vision database, collected traces, and viewed them in Vision Monitor.

2-3 Manually Creating a Vision Database

In this exercise, you will create a database for three simulated probes located in St. Louis, MO. You need to run the Vision Probe Simulator for this exercise.

Creating the Database

For more description on an entry field, press the Help button in the bottom left corner of the dialog.

1. On the Start menu, find the folder for Anritsu, then open the sub-folder named Vision Tools and select the **Vision Probe Simulator**.
2. From the same Vision Tools sub-folder select the **Vision Database Creator**. Follow the subsequent steps to create and deploy a Vision database.
3. Click the **New** button from the main application button bar.
4. Click on the **Manual Entry** radio button.
5. Enter the settings as shown in Figure 2-9.

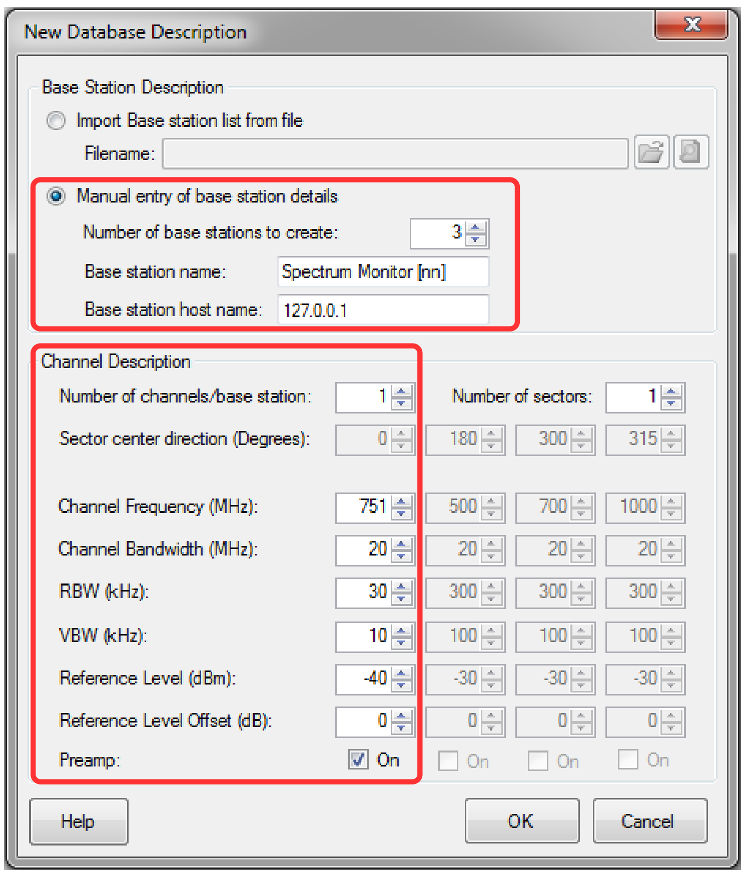


Figure 2-9. New Database Description Dialog – Manual Base Station Entry

6. Set the Number of base stations to create to 3.
7. Base station description should read: Spectrum Monitor [nn] The [nn] will be replaced sequentially with 1, 2, 3, …
8. Base station host name should read: 127.0.0.1
9. Set the Number of channels/base station to 1.
10. Set the Channel Frequency (MHz) to 751 and the Channel Bandwidth (MHz) to 20.

11. Set RBW to 30 kHz and VBW to 10 kHz.
12. Set Reference Level to –40 dBm and the Reference Level Offset to 0 dB.
13. Set Preamp to On.
14. Click **OK**. This will close the New Database Description dialog and populate the input tables as shown in Figure 2-10.
15. Click the **Ping** button in the main tool bar.

    You will see process information in the black status pane as communication with each probe is verified. If there are any errors, correct them and Ping again. If it is successful, you see a line stating each probe is being 'pinged', and then a number at the end of the line that indicates the time elapsed for a response in milliseconds. Since we are using the Vision Probe Simulator for this exercise, the elapsed time for a response may be zero.
16. Click the Locate button in the main toolbar. This will capture the GPS coordinates of each probe and add that information to the Probe Definition input table. GPS coordinates are assigned randomly, your dBase may not exactly match the coordinates shown here.
17. You need to add a limit line mask. Click the Import Masks button located in the header of the Mask Definition table. Browse to the `Example Masks.msk` file located in Example Files sub-folder of the Vision Monitor Application Folder (`C:\Program Files (x86)\Anritsu Company\Example Files`). You will now see several masks in the Mask Definition table.
18. In the Channel Definitions table, click twice slowly, on the field under the Mask heading. This enters Edit mode for the table. Enter 751 MHz in the Mask field for that channel and click Enter.
19. You need to set the destination folder for the database. The current output destination folder is listed in the status bar. If you want to use the same location as in the last exercise, it should be remembered and listed here. Nothing is required to reuse the same location. If you want to enter a different location, click the Path button in the main tool bar and select a destination folder for this database.
20. Click the Create button and the database should be created with progress showing in the status pane.
21. You can now close the Database Creator program.

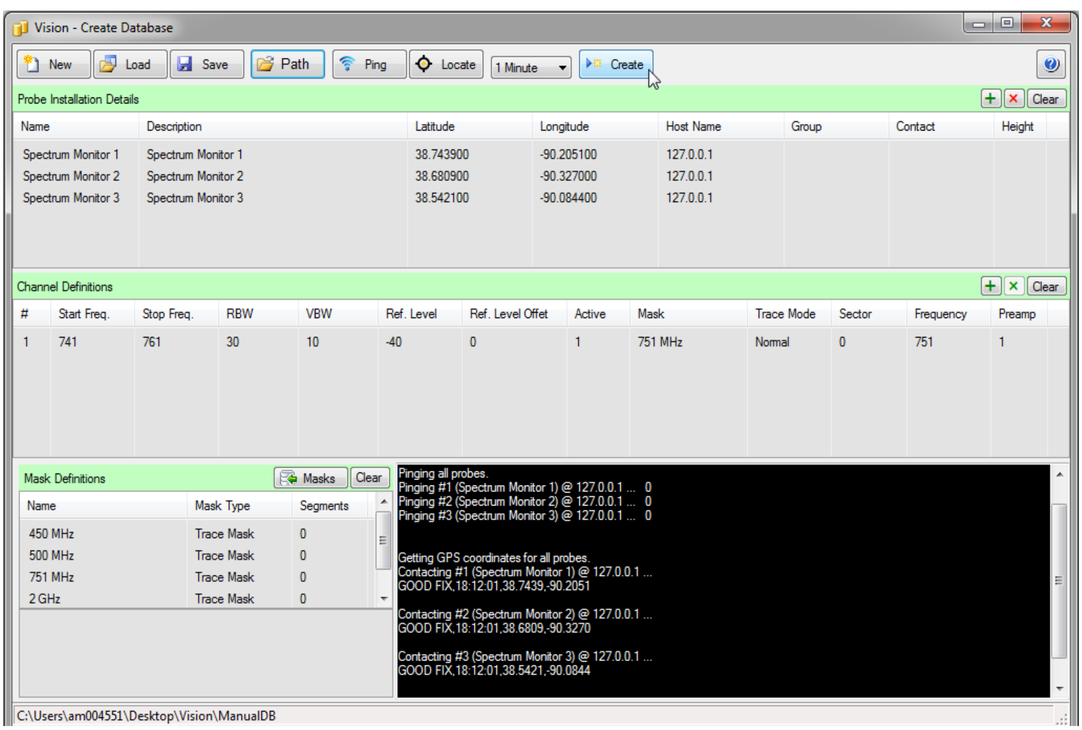


Figure 2-10. Create Database Dialog – Manual Base Station Entry

Acquiring Traces

1. Open Vision Acquire and set the database location to the location used in the previous section.
2. Adjacent to the Sweep Probe button is the Set Time pull down list. Select 20 seconds.
3. Set Max number of threads to 3 (since there were only 3 probes created in the database for this exercise).
4. Click Sweep Probes to start data collection.

Viewing Trace History

1. Run Vision Monitor from the Windows Start menu or look for Vision Monitor under Anritsu.
2. Set the database location to the same path used to create the database, and the path Vision Acquire is using to save traces.
3. You will see three probes listed. The format of the list is different because you do not have multiple channels for each probe.
4. Let it run for a few minutes and you will see the icons for each probe update a couple of times per minute to reflect the traces that have accumulated in the database.
5. Click on one of the probes to see the traces and spectrogram displayed.

You are free to interact with the web server interface: You can change frequency range, bandwidth, reference level, trace mode, etc. These changes will not affect the value of the sweep parameters stored in the database, and if Vision Acquire is still collecting traces, changes you make will be overwritten each time Vision Acquire sweeps the probe you are accessing.

2-4 Creating a Real Database for Your Probes

Creating your Custom Database

Creating a custom database requires more work than what has been done in the earlier exercises. Previously we relied on a saved database definition in the first case, and a very small and simple database in the second case. When creating a database for a set of probes installed somewhere in the real world, each probe requires careful attention, and some fields will have to be individually edited for each probe.

Vision Database Creator (Figure 2-11) requires four fields in the Probe Definition table for each probe. These are: Name, Latitude, Longitude and Host Name (or IP Address.) Actually, if you just have a probe name and network host name, then you can use the Locate feature to capture the GPS coordinates of each probe. That is enough information in the Probe Definition table to create the database.

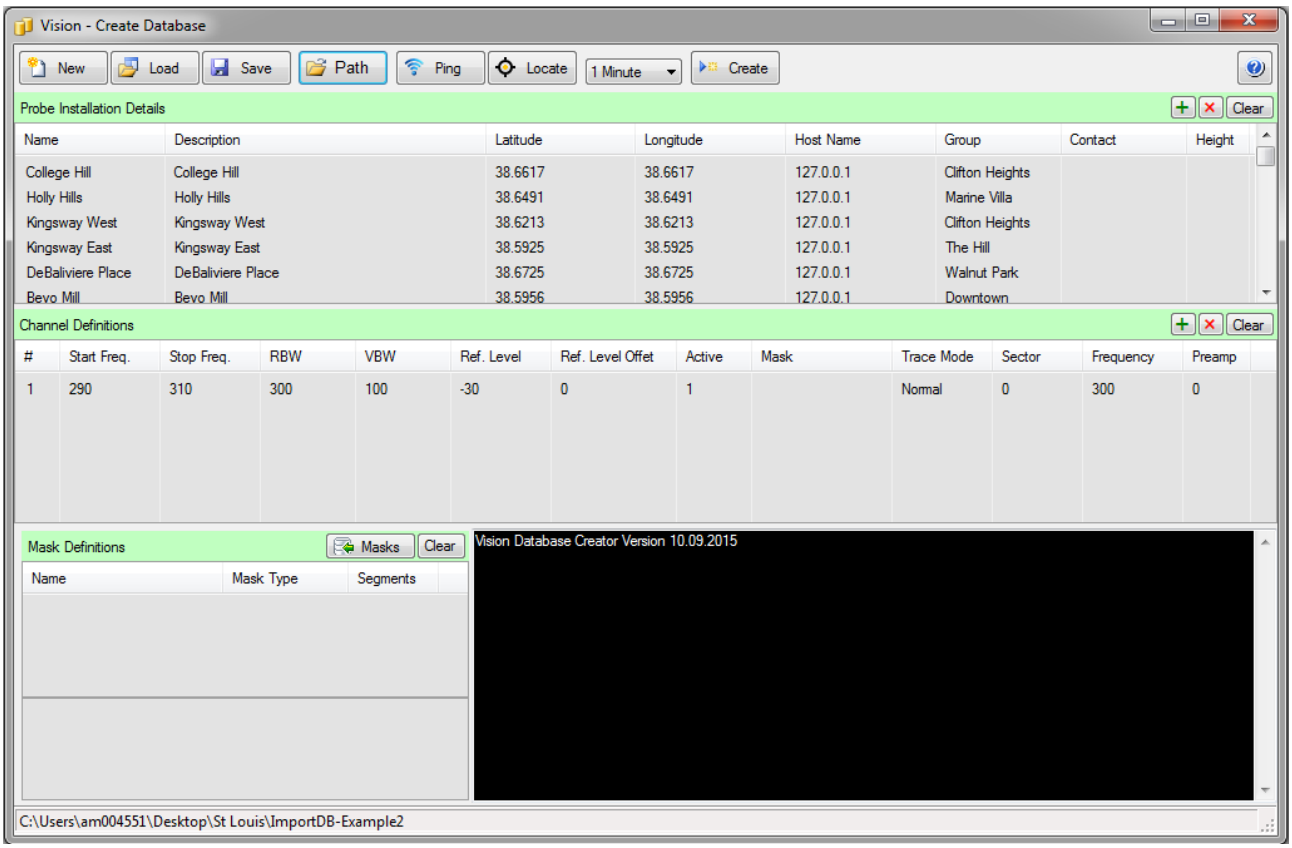


Figure 2-11. Vision Database Creator

The Group, Contact, and Height fields are often left blank. If an email address is entered in the Contact field for a particular probe, then an email is sent to the contact email address each time that probe has a failure.

Note	Before email notifications can be sent, email settings must be configured in Vision Acquire. See Figure 2-12 on page 2-13. Clicking on the Email Configuration button opens a dialog where the user enters their email server and user credentials. Also the Send Status Emails check-box in Vision Acquire must be checked before any notifications will be sent.

The Height field is reserved for future use. Leaving this blank will generate Warning messages when creating a database, but it will not stop the database creation. Since the value is not used you are not forced to enter anything.

The only field you can leave blank in the Channel Definitions table is the Mask field. If no mask is specified, every trace passes. Also, if a mask is applied that does not match the frequency range of the sweep data, then the sweep will pass. If the range of the mask overlaps the sweep data, even if only slightly, the mask will be applied where possible and the trace marked as failed if it exceeds the mask where it can be tested.

The only way to enter Mask definitions into a database when it is created is to export masks from another database using the Mask Editor in Vision Monitor, then importing that mask definition into the Database Creator. If you do not have masks that can be imported, or you have no useful masks in another database, then you will need to create the database without masks defined. Once the database is created, collect some traces, then open the Mask editor and use the traces present as reference traces to generate and apply masks to the database.

You will use the New button in the Vision Database Creator to begin the process of creating a custom database. Enter as much information as you can, then click OK. This will generate entries for the input tables. The tables will almost certainly need to be edited.

Following are two examples where we import probe details prepared outside of Vision.

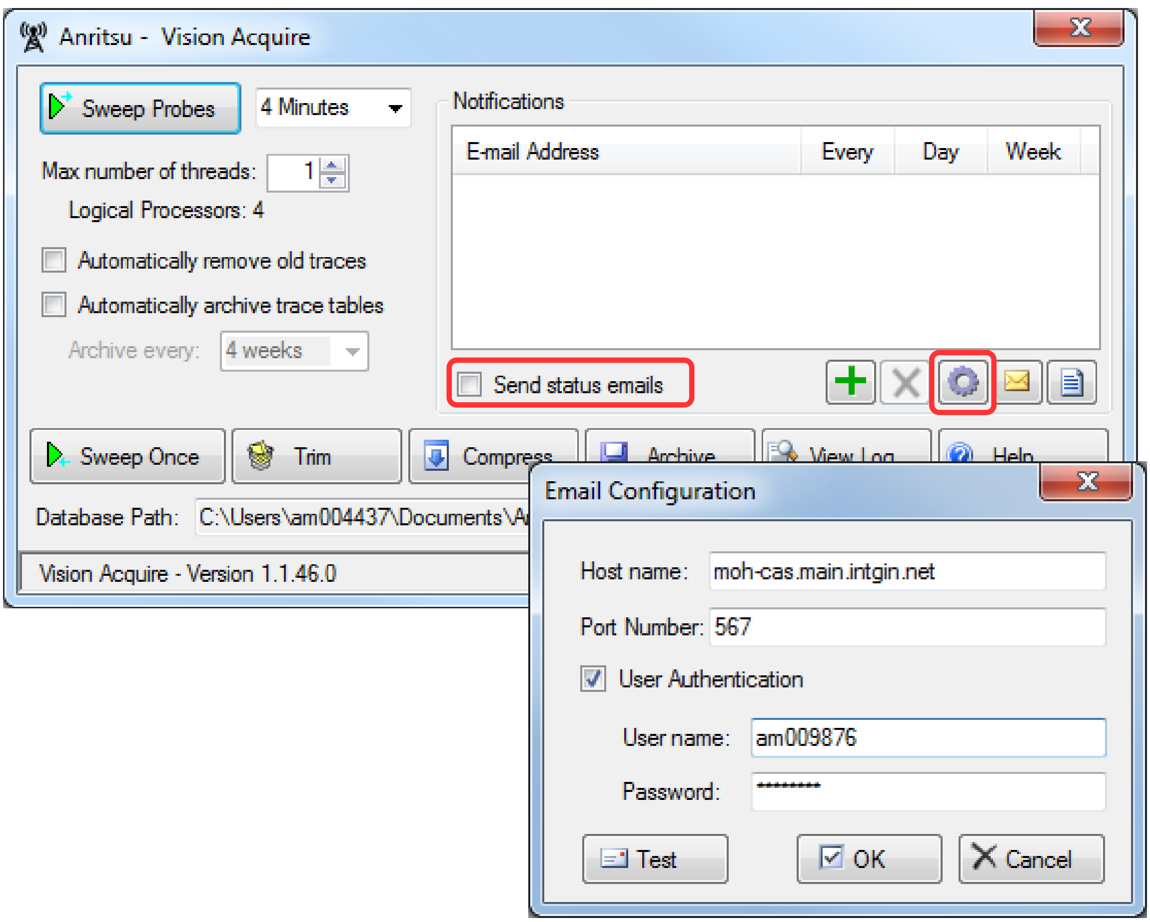


Figure 2-12. Email Notification Configuration in Vision Acquire

Importing a Probe List – Example 1

1. Run the Vision Database Creator, starting with all of the input tables being clear.
2. Click **New** on the main button bar.
3. In the New Database Description dialog, click the **Help** button at the lower left. This slides out a description of the information that goes into each field.
4. Click the **Import Base station list from file** radio button
5. Click the button with the folder icon to browse for file containing a probe list.
6. Locate the file `St Louis Name_IP.lst` in the Example Files sub-folder of the Vision application folder under Program Files (x86).
7. Click the button next to the folder button to toggle a preview of the contents of the probe import file as shown in Figure 2-13.
8. Set number of Channels/base station to 1.
9. Click **OK**.

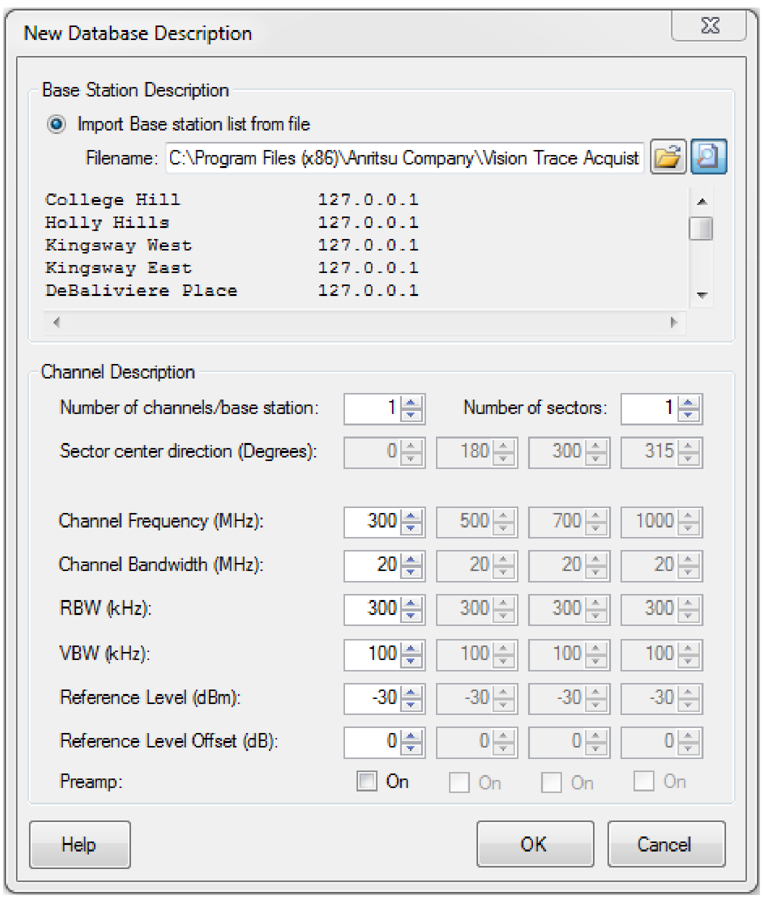


Figure 2-13. New Database Description Dialog – Example 1

10. You will now see the Import Base Stations dialog (Figure 2-14 on page 2-15). This dialog lets you specify what each field in the import file corresponds to in the Probe list. The file we have selected has just two columns, Name and IP address. This is enough to create a database. The import dialog will try to determine the field separator (comma, semicolon or tab) and make a best guess at the fields the file contains. It will not always be right, so you can use the drop-down lists above each column to specify the role that column of data is to have in the database.

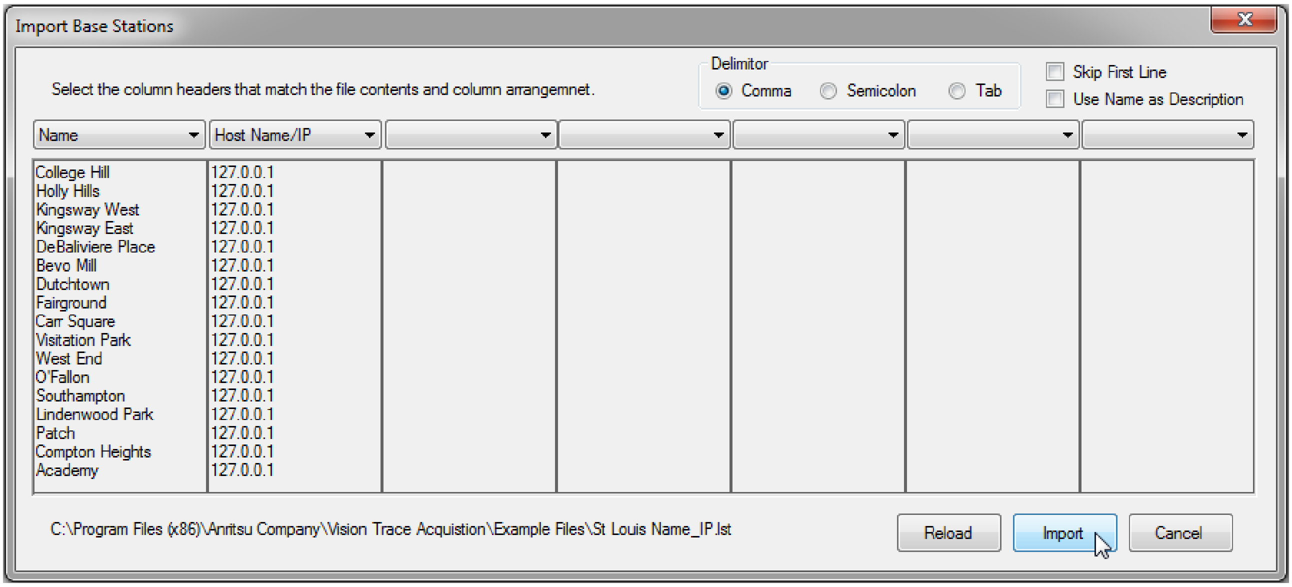


Figure 2-14. Import Base Stations Dialog – Example 1

11. Click the **Import** button and the input tables in Database Creator are filled in. This import file did not contain GPS coordinates for the probes, so you will need to click the Locate button (Figure 2-15) to get that from the probes. If Vision Probe Simulator is running, you can do that now to complete the Probe Definition table.

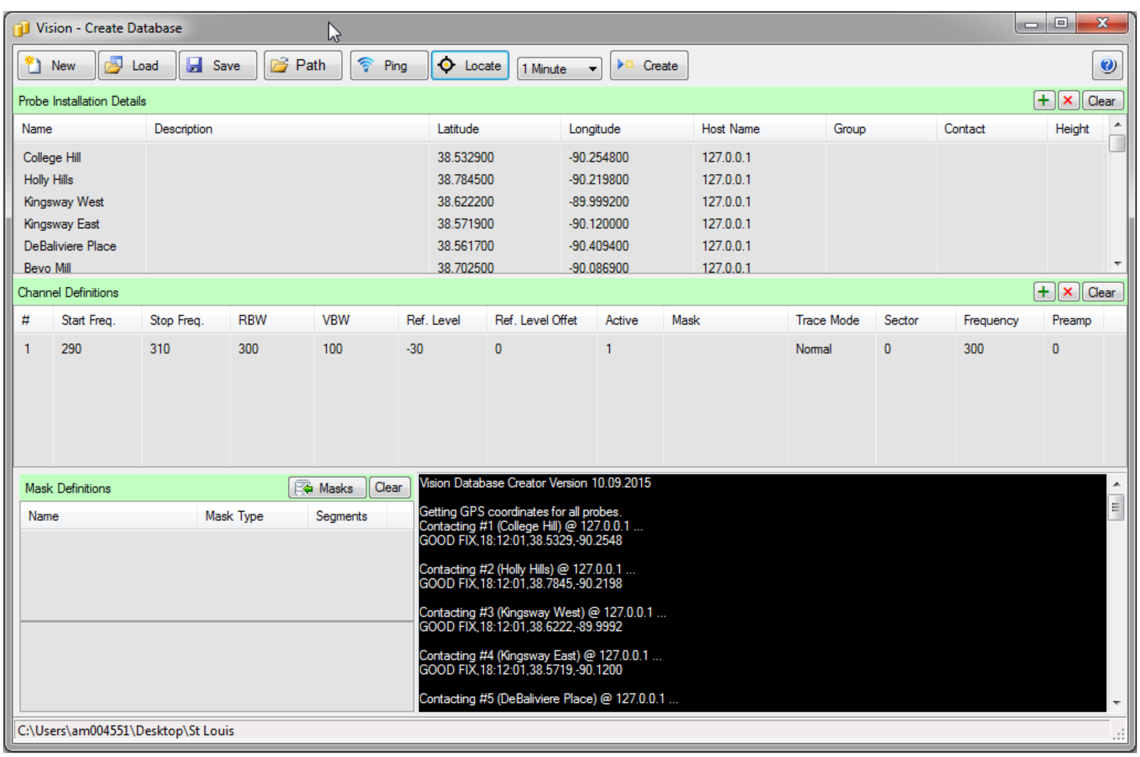


Figure 2-15. Create Database Dialog – Imported Probe List – Example 1

Importing a Probe List – Example 2

1. Clear all of the input tables in Vision Database Creator and click New on the main button bar.
2. With the Import Base station list from file radio button checked, click the button with a folder icon to browse for a file containing a probe list.
3. Locate the file `St Louis GPS_Group.lst` in the Example Files sub-folder of the Vision application folder under Program Files (x86).
4. As in the previous section, click the preview button to see that this file has more content than the last.
5. Set Number of channels/base station to 1, as shown in Figure 2-16.

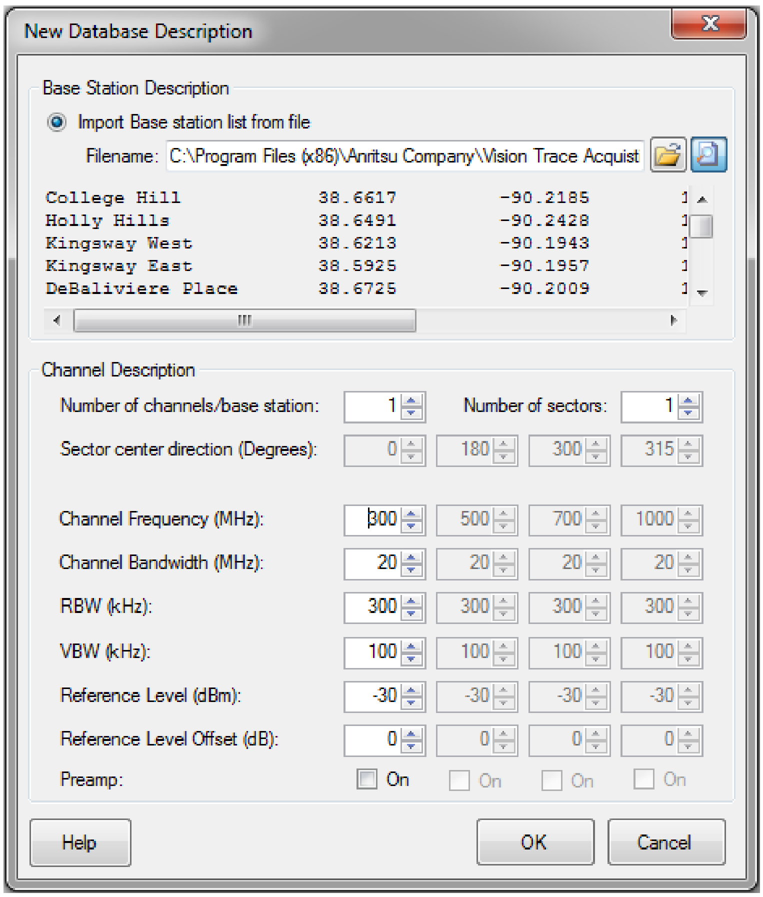


Figure 2-16. New Database Description Dialog - Example 2

6. Click **OK** to close the import dialog.

7. You will now see the Import Base Stations dialog (Figure 2-17). This dialog lets you specify what each field in the import file corresponds to in the Probe list. The file we have selected this time has five columns, Name, Latitude, Longitude, IP address, and Group name (under Description). The import dialog will try to determine the field separator (comma, semicolon or tab) and make a best guess at the fields the file contains. In this case it has identified the last column as Description, but that is not what is intended.
8. Click on the down-arrow in the header to the fifth column and change Description to Group.
9. We do not want to leave the Description field blank, so click the checkbox labeled: Use Name as Description. This will copy the Name field into the Description field in the next step.

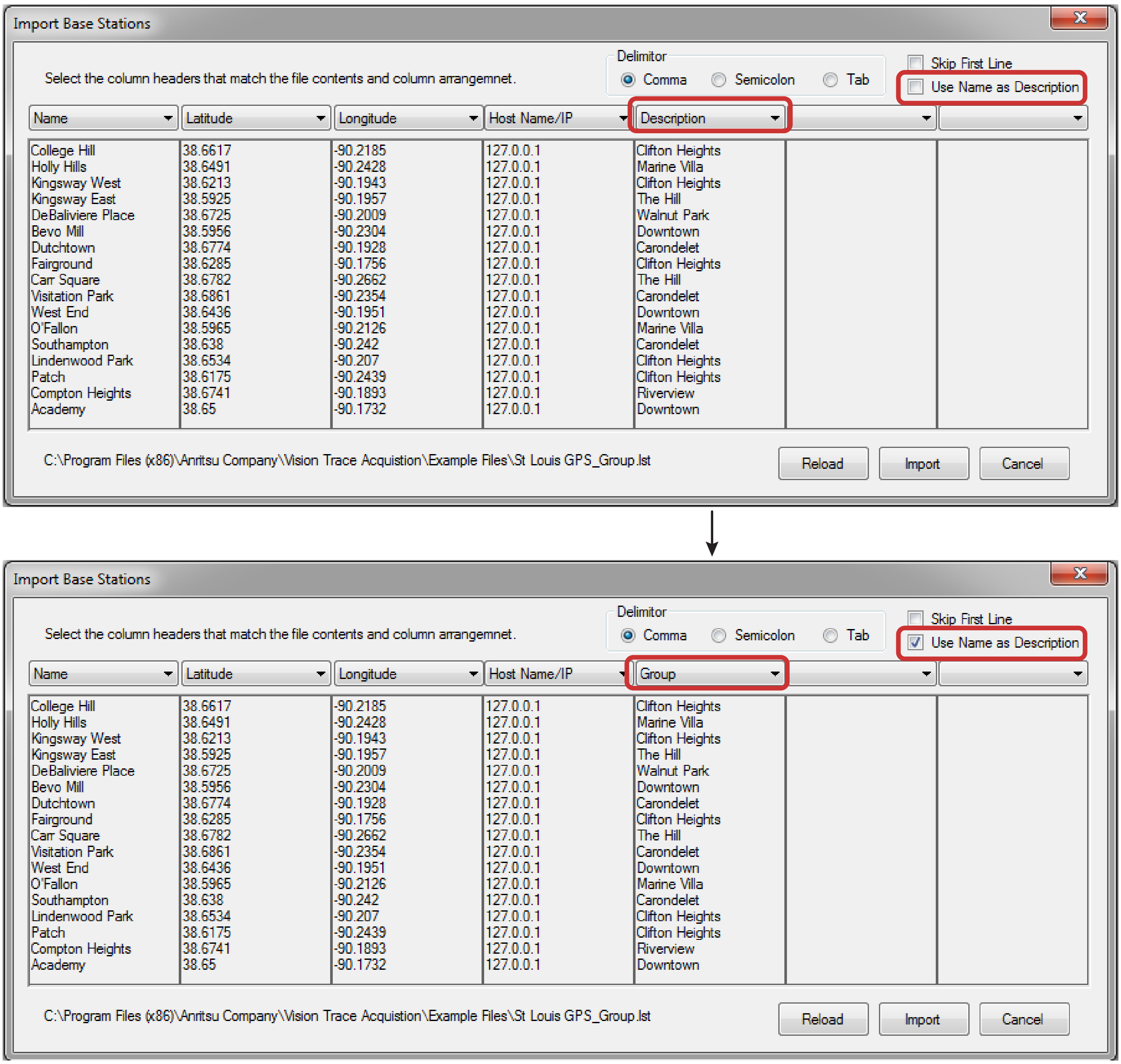


Figure 2-17. Import Base Stations Dialog - Example 2

10. Click the **Import** button and the input tables in Database Creator are filled in (Figure 2-18).

11. Set the output destination (click Path button) so that you do not overwrite a database you want to keep, and then click the Create button. This should successfully create the database.

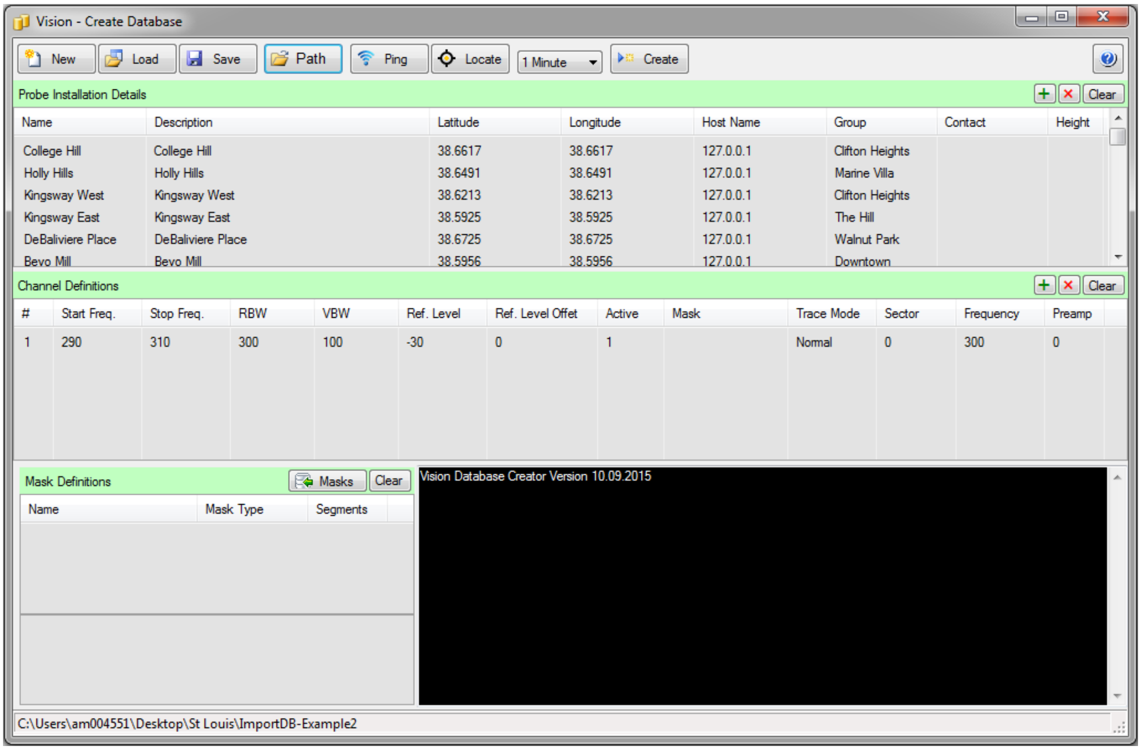


Figure 2-18. Create Database Dialog – Imported Probe List – Example 2

12. You will now need to run Vision Monitor to edit any further sweep parameters or Probe specific parameters.

13. In Vision Monitor, right-click any of the probes names to open the probe context menu (see Figure 2-19 on page 2-19). Here you can edit the name, description, location, height, group, contact, etc.

14. On the Probe context menu you also have options to Add and Remove probes from the list as well as Enable/Disable Sweep on all channels of a selected probe.

    When a new probe is added, click **Enable Sweep on All Channels** to activate all channels on the new probe.

    Removing a probe is permanent. Traces are not deleted but you have no way to access them in Vision Monitor.

15. The first item on the context menu will open a web browser with a live connection. This is the same as Live View in Vision Monitor, but uses an external browser window, so Vision Monitor is not tied-up with Live View.

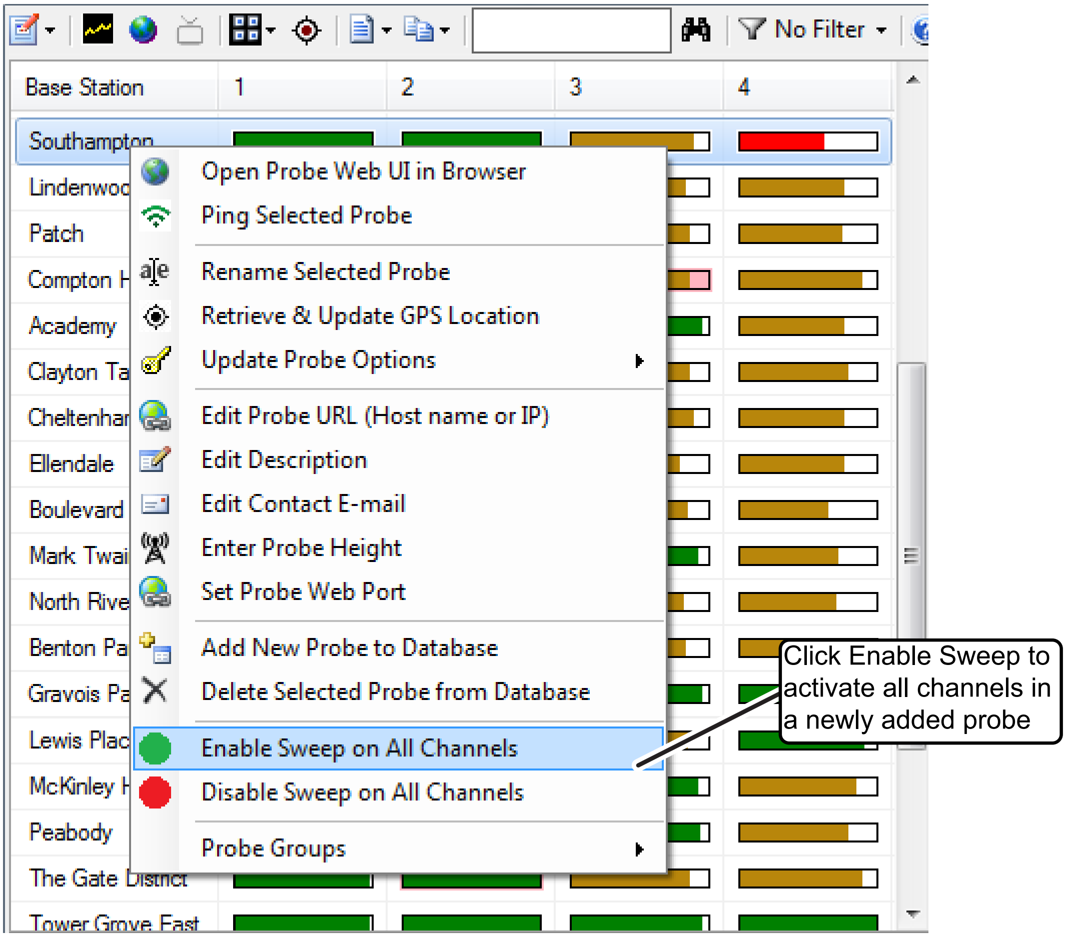


Figure 2-19. Probe Context Menu Selections

Chapter 3 — Vision Geo-Location Techniques

3-1 Introduction

Vision Monitor includes two algorithm methods for locating RF emitter signals - Power of Arrival (POA) and Time Difference of Arrival (TDOA). Power of Arrival (POA) is the default location algorithm for locating interference signals and it places a bullseye icon on the map to indicate a location estimation. TDOA is a method for locating an RF emitter based on the differential time of arrival of the transmitted signal to 3 or more remote probes. TDOA may not always produce a single unique estimation, so the POA estimate can help in choosing the most likely location for the RF source.

Power Of Arrival

Power of Arrival (POA) is a Geo-location algorithm that uses spectrum monitor receivers to capture and compare instantaneous power levels detected at 3 physically separated locations. By detecting relative power levels, an approximate location of a signal of interest can be found. POA works with both modulated and non-modulated (CW) signals types. POA techniques can also be used with bursted or pulsed signals. Measurement signals for each receiver are time synchronized in order to maximize accuracy.

Time Difference of Arrival

Time Difference of Arrival (TDOA) is a very powerful technique to locate interference sources and other modulated broadcasters. However, it is not universally useful, and it does take considerable care and experience to use it effectively. Many sources of interference are CW or just noisy electronics. There is nothing about these type of signals that can be time-aligned and those emitters will not be locatable with TDOA.

To use TDOA to locate interference sources, the following considerations need to be made:

- The source must be modulated. TDOA looks for features in the RF spectrum as measured at 3 locations. Those features are time-aligned, and the difference in the time for the signals to reach each receiver is used to calculate the location. If the signal of interest does not have features that can be aligned in time, then TDOA will produce meaningless results. Typically that means the signal must be modulated.
- A clean IQ diagram produces much more accurate results. The better you can setup the spectrum monitor to capture IQ data, the more accurate the position estimate will be. This means more time may be needed to set up each remote monitor, adjusting the frequency, span, reference level and preamp settings to get the best possible IQ capture. Strong signals that are close by will be relatively better, but weaker signals, and especially distant signals take some care to get meaningful results.
- Distance matters. 3 remote monitors are used to do the TDOA triangulation of the RF source. Best results will be achieved if the source is contained inside a triangle made by connecting the remote monitor locations. TDOA works for sources outside this triangle, and may be used to locate a source that is many kilometers outside the triangle, but it is more accurate for sources that are close by.

The reason distance matters is due to the uncertainty in any measurement made. We are looking for the intersection of three lines. Where those lines intersect at nearly right angles, then any uncertainty in the line positions produces a similar uncertainty in the intersection. However, if the lines approach each other at very shallow angles, then the lines may be within the distance of uncertainty for several kilometers. Distant sources outside the triangle of the remote monitors will almost always produce lines that have very small incident angles, and that can greatly multiply the uncertainty in position.

TDOA requires additional set ups and IQ Capture. This chapter provides exercises for the following setup and monitoring activities:

- TDOA Settings & Control Setup
- IQ Capture Settings
- View IQ Capture Results
- Generating a TDOA Report

3-2 Settings & Control Setup

To use TDOA, confirm the remote probes are installed with the TDOA option and need to be a part of the Vision database.

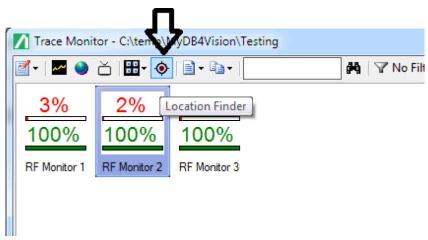


Figure 3-1. Spectrum Monitor List and Location Finder Button

1. Select a channel of a spectrum monitor of interest from the **Probe List**.
2. Press the **Location Finder** button in the main Vision Monitor toolbar.
3. The Vision Source Locater window opens, the trace data loads and accompanying geo-location map opens
4. Click on any of the trace graphs to set the frequency of the interference source.
5. Select **TDOA** from the Location Method drop down list..

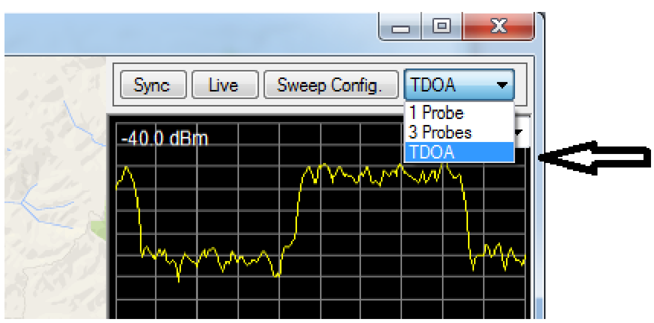


Figure 3-2. Trace Graph and Location Method Drop Down List

IQ Capture Settings

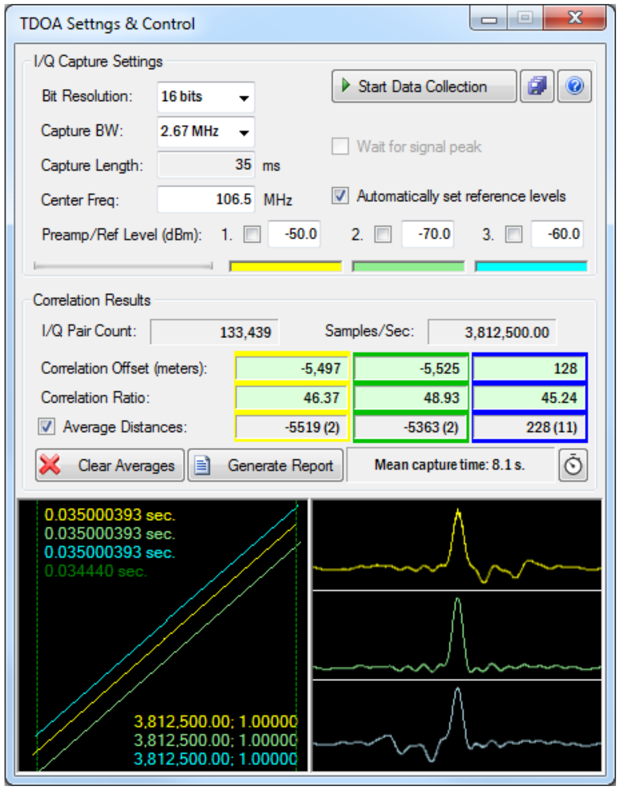


Figure 3-3. TDOA Settings & Control Window

Bit resolution - Allowed values are 8-bit, 10-bit, 16-bit and 24-bit. 16-bit is the recommended setting. Lower bit-resolution is faster to transmit, but provides less precise results. Higher bit resolution is slower to transmit but provides more precise results.

Spectrum Monitor Input Parameters (These parameters are used to set up the remote spectrum monitors. Set the parameters as desired.)

- Capture Bandwidth (BW)
- Capture Length
- Center Frequency

Start Data Collection: When pressed, Vision will repeatedly execute the TDOA measurement. New TDOA results are only averaged when the Correlation Ratio is higher than 30. After being pressed, the button will change to Stop Data Collection. Press it to end data collection.

The bottom line in the Correlation Results box shows the averaged distance in meters, and the number of averages used. The number of averages can be different for each set of probes because the correlation ratio may sometimes be too low for a particular probe pair.

Wait for Signal Peak: When checked, two events occur:

- The program to waits until the power level on the first probe is within 10 dB of the reference level before the I/Q acquisition begins.
- After the I/Q data is acquired, it looks to see if there is dead time in the data set where the signal is missing. This dead-time is removed before th correlation is performed.

Automatically set reference levels: When this is checked, Vision will do a 20 sweep max-hold RF trace capture to determine the optimal reference level setting. It is important to use a reference level that is near the peak amplitude of the signal that is being sought. This maximizes the dynamic range and gives much better I/Q sample points. If the reference level is set too high, the I/Q plot will not fill in solid, but instead the points will appear in distinct rows and columns. This is equivalent to using a much lower bit resolution.

Average Distances: This check box is at the bottom row of the correlation results. Each time a TDOA I/Q capture is done, the distance result will be averaged with previous measurements. The resulting average values are shown along the line to the right of this check box. Checking the Average Distance (meters) check box causes the average values to be used when drawing the arcs on the map and locating the RF source. If the check box is clear, then the most recent measurement values will be used on the map, rather than the average values.

The values shown in the Averages look different. For example: -235 (12). The first number is the averaged value taken from the Correlation Offset (meters) field above. The number in parenthesis is the count of values used in the average. This can be a different number for each probe pair, depending on the Correlation Ratios from each measurement.

There is a **X Clear Averages** button below the Average Distances check box. This button will clear the averages. This should be done if you change which probes are being used, or if you change the frequency of the source you are looking for.

Mean capture time: This window displays the average time it takes to capture individual trace data.

Channel Delay Calibration: This button with the symbol of a clock is for experienced users only.

Once the above parameters have been set, IQ Capture may begin.

Press **Start Data Collection**. This process will take a few moments. Each remote probe is sent commands to configure the spectrum monitor as specified. Then IQ capture is initiated. It is essential for IQ captures to be synchronized in time, so each monitor will begin capturing data at the next GPS synchronization signal. The capture time is typically fairly short, several 10’s or 100’s of milliseconds. After IQ data has been captured on the remote monitors, it must be transferred over the network to the PC running Vision. This transfer can be slow, depending on the bandwidth available for communication with the remote monitors. The IQ data sets are very large, typically 10’s of megabytes. Press **Stop Data Collection** when you decide sufficient data has been collected.

There are four progress bars below the IQ Capture Settings section of the dialog window. The first will show activity as the monitors are configured and the IQ data is actually captured. The other three progress bars indicate the progress, for each of the monitors, at transferring the data. The color bars will be completely filled once the capture is complete. The transfer is typically the longest part of this process. The progress bars are color coded to match the IQ charts.

Figure 3-4. TDOA Settings & Control Window, Location Window, and Correlation Result

At the completion and calculation of the IQ data, you can see the results in the Correlation Results section of the TDOA dialog window. In the diagram above, a yellow, green and blue line are also drawn on the map of the Locater Window. Each line represents a path that has the same distance differential from two of the monitors. The TDOA algorithm indicates that the source is located somewhere along that path. By using a set of three monitors, we get three distant paths. The intersection of all three paths marks the location of the RF source. A green square marker with a star is placed on the map at the intersection of the lines.

View IQ Capture Results

.

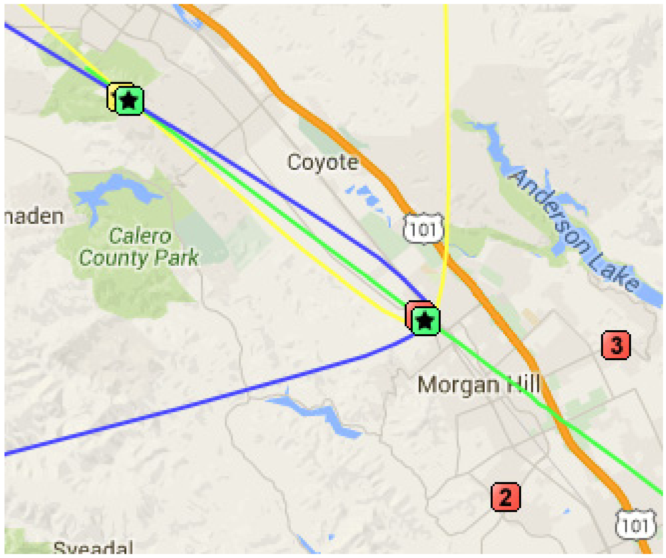


Figure 3-5. Remote Monitor Lines

In the figure shown, there are two intersection points designated by the green squares with a star. One is inside the triangle, near monitor 1. Here the lines approach each other at large angles and an uncertainty of say 50 meters in each line position produces a similar uncertainty in the intersection point. However, in this case the true source was the one located in the upper left-hand of the image. In this case the lines actually are within 50 meters of each other for a distance of almost 500 meters.

- The TDOA Settings & Control window will show some results that help in judging how much confidence to have in a given set of data, and in the results produced. The last two lines of the results section contain the Correlation Ratio and IQ Similarity.

Correlation Ratio

The Correlation Ratio is a number that relates to how strongly the algorithm was able to find the correct time alignment offsets. The correlation peaks at the position where the two sets of IQ data are aligned in time. If this peak is very pronounced, then you can have confidence in the time alignment. If it is not so pronounced, then the data is suspect. Basically, the Correlation Ratio is the peak amplitude divided by the average value of the correlation function. A value less than 20 means you should not trust the results at all, while a value above 100 is usually a strong indication that the correlation is good.

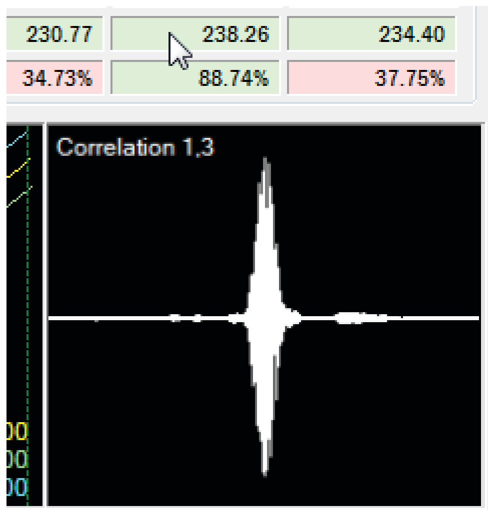
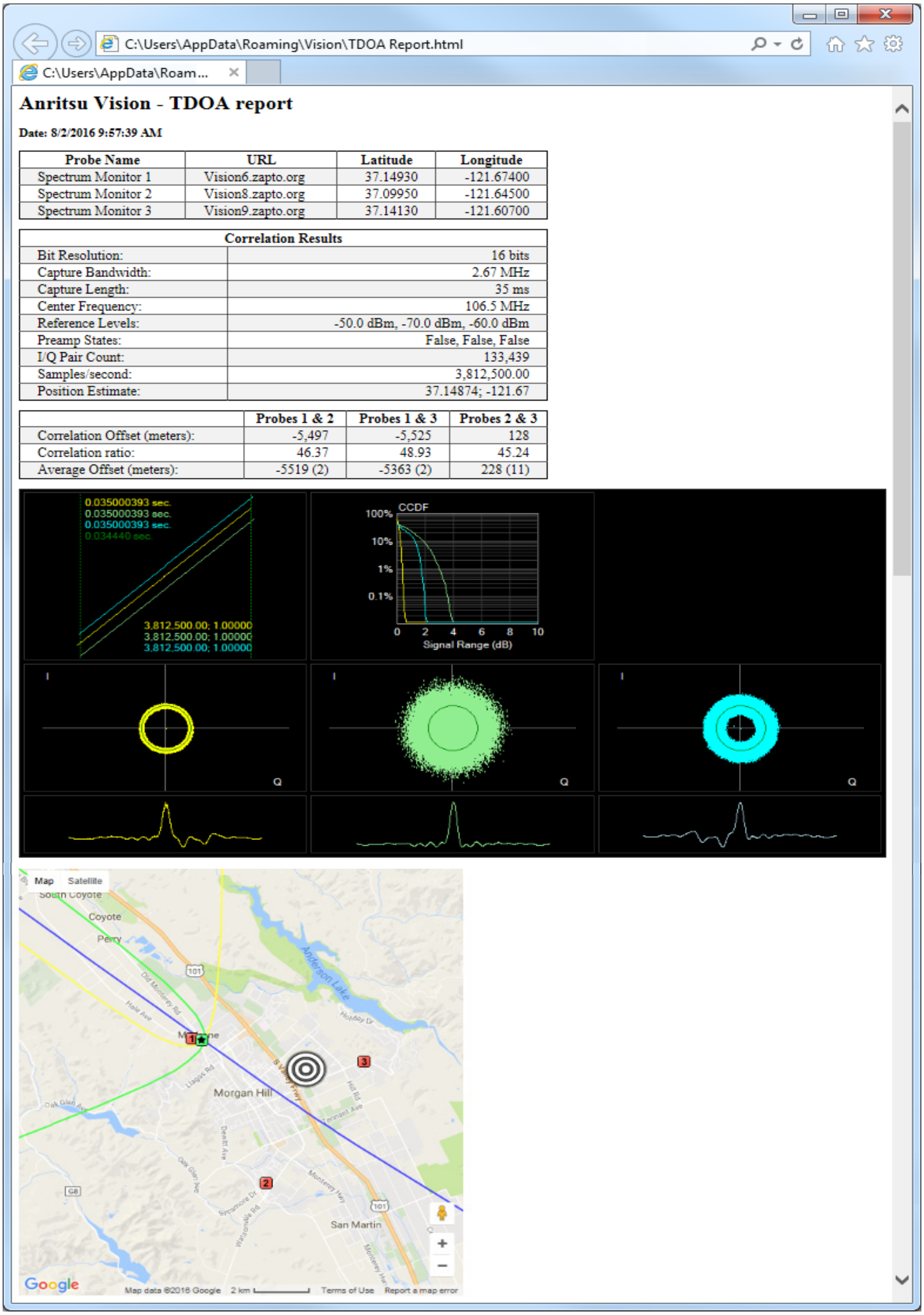


Figure 3-6. Correlation Ratio

Generate TDOA Report

After collecting TDOA data, press the **Generate Report** button to create a TDOA report within your browser.



C:\Users\AppData\Roaming\Vision\TDOA Report.html

Anritsu Vision - TDOA report

Date: 8/2/2016 9:57:39 AM

Probe Name	URL	Latitude	Longitude
Spectrum Monitor 1	Vision6.zapto.org	37.14930	-121.67400
Spectrum Monitor 2	Vision8.zapto.org	37.09950	-121.64500
Spectrum Monitor 3	Vision9.zapto.org	37.14130	-121.60700

Correlation Results	
Bit Resolution:	16 bits
Capture Bandwidth:	2.67 MHz
Capture Length:	35 ms
Center Frequency:	106.5 MHz
Reference Levels:	-50.0 dBm, -70.0 dBm, -60.0 dBm
Preamp States:	False, False, False
I/Q Pair Count:	133,439
Samples/second:	3,812,500.00
Position Estimate:	37.14874; -121.67

	Probes 1 & 2	Probes 1 & 3	Probes 2 & 3
Correlation Offset (meters):	-5,497	-5,525	128
Correlation ratio:	46.37	48.93	45.24
Average Offset (meters):	-5519 (2)	-5363 (2)	228 (11)

Figure 3-7. TDOA Report

Anritsu

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Anritsu utilizes recycled paper and environmentally conscious inks and toner.

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