Introduction to NetSurveyor 802.11 Network Discovery Tool

NetSurveyor is an 802.11 (Wi-Fi) network discovery tool and, as such, its goal in life is to gather information about nearby wireless access points in real time and display it in a useful way. The data is displayed using a variety of different diagnostic views and charts. Data can be recorded for extended periods and played-back at a later date/time. Also, reports can be generated in Adobe PDF format. Applications for NetSurveyor include the following:

- During the installation of a wireless network, as an aid in verifying the network is properly configured and antennas are positioned at locations to achieve efficient transmission / reception -- that is, for use in verifying Wi-Fi coverage and maximizing beacon signal strength
- Trouble-shooting an existing network or wireless environment that is performing poorly
- Reporting the presence of Wi-Fi networks and local access points and the signal strengths of their beacons
- Conducting wireless site surveys where the installer is interested in learning about the coverage of a new or existing access point, roaming capability, presence of RF interference or "dead spots", and optimum location of access points, their antennas and client stations
- In a secure business environment, for use in detecting the presence of rogue access points
- As a learning tool to help understand the relationship between access points (BSSIDs), wireless networks (SSIDs), and client stations (STAs)

NetSurveyor is distributed freely by Nuts About Nets LLC both as a convenience to network engineers, IT administrators, wireless technicians and WiFi users and, also, as a way of drawing attention to and generating interest in our other diagnostic products and RF analyzers. **NetSurveyor** can be downloaded from

<u>www.NutsAboutNets.com</u> and <u>www.PerformanceWifi.net</u>. You may also distribute *NetSurveyor* as long as that is done without charge and you agree to the terms of the <u>License Agreement</u>.

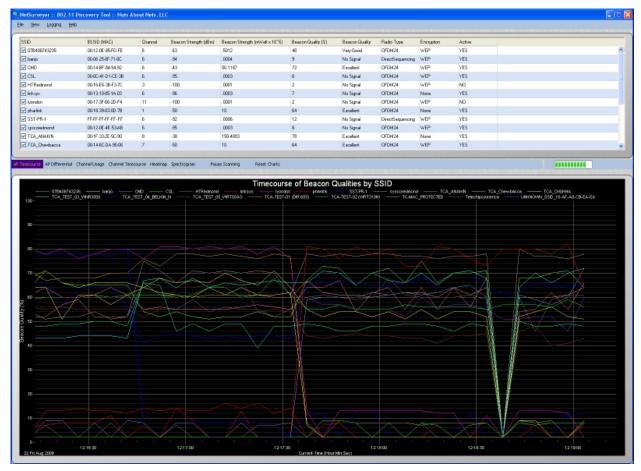
NetSurveyor is a diagnostic tool that falls under the category of WiFi Scanners or 802.11 Network Discovery Tools. The best known in this category is **NetStumbler** (www.NetStumbler.com). A discovery tool reports the Service Set Identifier (SSID) for each access point (AP) it detects, along with the channel used by the AP. The way this works is that roughly every 100 mSec an AP sends an "I'm here" beacon — and the discovery tool (running on your laptop and using its 802.11 wireless adapter, also known as a station or STA) picks-up that beacon and adds the SSID to its list of known access points. In addition, the discovery tool reports the RSSI (Received Signal Strength Indication) for each AP, which is roughly an indication of how close the AP is to your current location (i.e. how close it is to the client STA). Just to be clear, the RSSI reflects the strength of the beacon as received by the STA — it is not an indication of performance.

We know there are other choices and discovery tools available – so, we appreciate your interest in *NetSurveyor* and the time you've taken to check it out. And we're sure you won't be disappointed. *NetSurveyor* distinguishes itself from other tools in its category in the following ways:

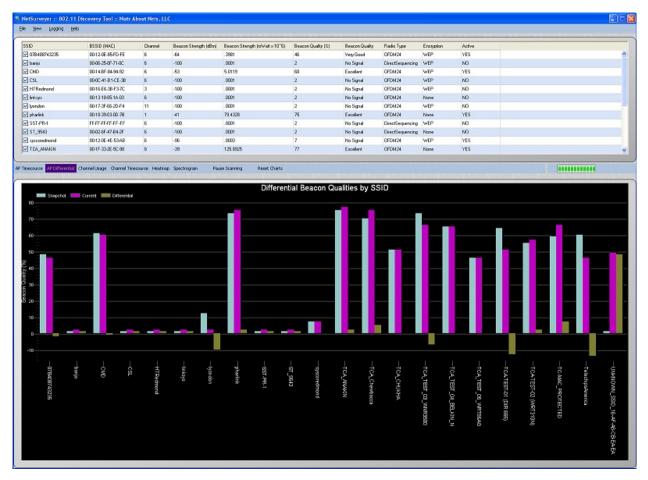
- It's free.
- In addition to the grid that repeatedly updates information about each access point, there are 6 graphical, diagnostic views (discussed elsewhere in this document): (1) Timecourse of Beacon Qualities For Each Access Point, (2) Differential Display of Beacon Qualities for Each Access Point, (3) Usage of Each of the 802.11 b/g Channels, (4) Timecourse of the Usage of Each of the 802.11 b/g Channels, (5) Heatmap / Waterfall Chart of the 802.11 b/g Channels and (6) Channel Spectrogram of the 802.11 b/g Channels. The more (and different) ways you have at looking at the data then the greater the chance will be that something will catch your eye that you might otherwise miss if only a single type of chart were used.
- Generates reports in Adobe PDF format that include the list of access points and their properties along with images of each of the

- 6 diagnostic charts.
- Powerful and innovative logging and recording capability. Other products, if they even offer a recording/playback feature, usually follow the "tape recorder" paradigm. *NetSurveyor* is integrated with *NetPlayer* (an application we use for displaying recorded data files). *NetPlayer* is unique in that it shows you all the recorded data that is, you do not press a 'play' button and then forced to watch minutes or hours of data scroll by in the hope that some unusual event will catch your eye. *NetPlayer's* unique approach makes reviewing recorded data a snap.
- If your laptop or PC has multiple wireless adapters installed not a problem. When *NetSurveyor* launches it detects each of these and asks you to choose which one to use for that session.
- Supports most all wireless adapters that is, those that are installed with an NDIS 5.x driver (or later). This would include wireless adapters running on Windows 2000, XP and Vista.
- Can be run in 'Demo' mode so, even if you don't have a wireless adapter attached to your desktop or laptop machine you can still experiment with the application to see whether it suits your needs.

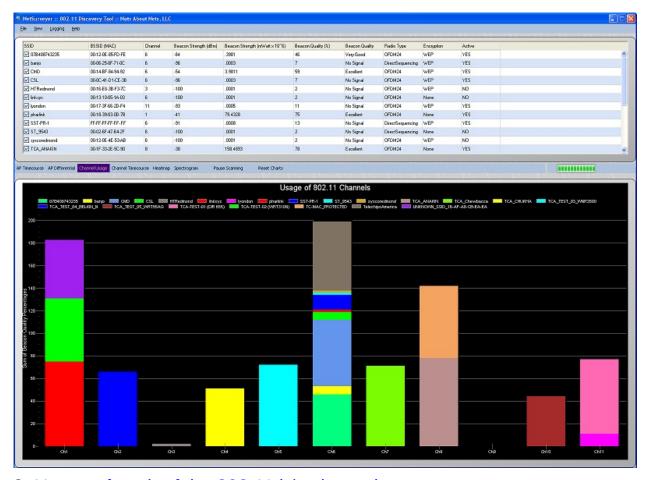
Below are sample screenshots taken of the various diagnostic views. Each of these are discussed in greater detail elsewhere in this document.



1. Timecourse of Beacon Qualities for each access point (AP).



2. Differential display of Beacon Qualities for each access point (AP).



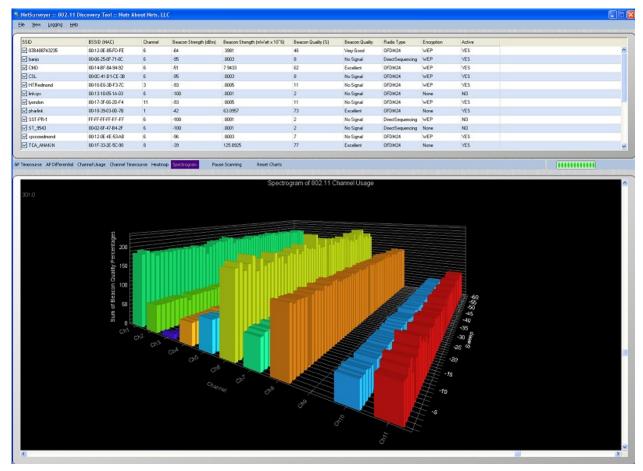
3. Usage of each of the 802.11 b/g channels.



4. <u>Timecourse of the usage of each of the 802.11 b/g channels</u>.



5. Heatmap / waterfall chart of the 802.11 b/g channels.



6. Channel Spectrogram chart of the 802.11 b/g channels.

System Requirements

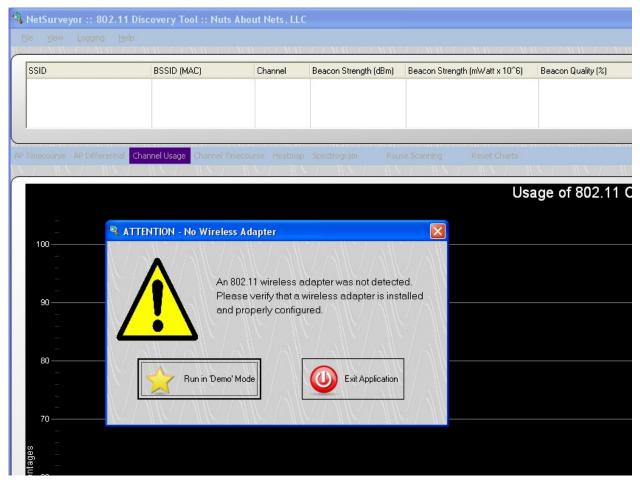
System Requirements:

- PC running 32-bit Windows 2000/XP/Vista
- 802.11 b/g wireless adapter installed with NDIS 5.x drivers (or later)
- Microsoft .NET Framework version 2.0 (or later)
- CD-ROM Drive (for installing software)
- a minimum of 300 MB available hard disk space

Suggested Hardware Requirements:

- CPU: Intel Pentium 4, 1.2 GHz or faster
- Memory: 512 MB
- Hard Drive: 1000 MB free space
- Video: 32 MB video RAM

Demo Mode



NetSurveyor supports a 'Demo' mode. This is most useful when you do not have an 802.11 wireless adapter installed yet still wish to run the application -- e.g. either for evaluation purposes or for accessing **NetPlayer** to playback a previously-recorded data file. All features are fully functional in Demo mode -- the one difference, of course, is the data being displayed is generated by a built-in, simulation module (rather than acquired from a wireless adapter). When **NetSurveyor** is launched and there are no available 802.11 wireless adapters present then a dialog box appears asking whether you wish to continue running the application in 'Demo' mode or exit the application (as seen above).

Grid ofAccess Points

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SSID —	BSSID (MAC)	Channel	Beacon Strength (dBm)	Beacon Strength (mWatt x 10 ⁶)	Beacon Quality (%)	Beacon Quality	Radio Type	Encryption	Active
☑ 07B408743235	00-12-0E-85-FD-FE	6	-64	.3981	46	Very Good	OFDM24	WEP	YES
☑ banjo —	00-06-25-0F-71-0C	6	-100	.0001	2	No Signal	DirectSequencing	WEP	NO
✓ CMD	00-14-BF-84-94-92	6	-54	3.9811	59	Excellent	OFDM24	WEP	YES
✓ CSL	00-0C-41-D1-CE-3B	6	-100	.0001	2	No Signal	OFDM24	WEP	NO
✓ HTRedmond	00-16-E6-3B-F3-7C	3	-100	.0001	2	No Signal	OFDM24	WEP	NO
✓ linksys	00-13-10-05-1A-03	6	-100	.0001	2	No Signal	OFDM24	None	NO
✓ Iyondon	00-17-3F-66-2D-F4	11	-93	.0005	11	No Signal	OFDM24	WEP	YES
✓ pharlink	00-18-39-03-0D-7B	1	-43	50.1187	72	Excellent	OFDM24	None	YES
SST-PR-1	FF-FF-FF-FF	6	-100	.0001	2	No Signal	DirectSequencing	WEP	NO
✓ ST_9543	00-02-6F-47-B4-2F	6	-100	.0001	2	No Signal	DirectSequencing	None	NO
☑ ST_9544	00-02-6F-47-B5-A4	6	-100	.0001	2	No Signal	DirectSequencing	None	NO
✓ ST_9546	00-02-6F-44-35-A2	6	-100	.0001	2	No Signal	DirectSequencing	None	NO
syscoredmond	00-12-0E-4E-53-AB	6	-100	.0001	2	No Signal	OFDM24	WEP	NO
▼ TCA_ANAKIN	00-1F-33-2E-5C-90	8	-38	158.4893	78	Excellent	OFDM24	None	YES
▼ TCA_Chewbacca	00-14-6C-DA-90-06	7	-46	25.1189	68	Excellent	OFDM24	WEP	YES
▼ TCA_CHUKHA	00-1F-33-2E-5E-3A	4	-58	1.5849	54	Very Good	OFDM24	WEP	YES
▼ TCA_TEST_03_WNR3500	00-1F-33-2A-10-AC	5	-48	15.8489	66	Excellent	OFDM24	None	YES
▼ TCA_TEST_04_BELKIN_N	00-1C-DF-A8-51-CF	2	-43	50.1187	72	Excellent	OFDM24	WEP	YES
▼ TCA_TEST_05_WRT55AG	00-0C-41-14-E1-D5	10	-65	.3162	45	Very Good	OFDM24	WEP	YES
✓ TCA-TEST-01 (DIR 655)	00-1C-F0-F7-84-D3	11	-50	10	64	Excellent	OFDM24	WEP	YES
▼ TCA-TEST-02 (WRT310N)	00-1D-7E-CE-01-A0	1	-57	1.9953	55	Very Good	OFDM24	WEP	YES
▼ TC-MAC_PROTECTED	00-14-6C-DA-8F-A8	8	-52	6.3096	61	Excellent	OFDM24	WEP	YES
✓ TelechipsAmerica	00-18-F8-E3-3A-A1	6	-52	6.3096	61	Excellent	OFDM24	WEP	YES
✓ UNKNOWN_SSID_16-AF	16-AF-A8-CB-EA-EA	1	-57	1.9953	55	Very Good	DirectSequencing	None	YES

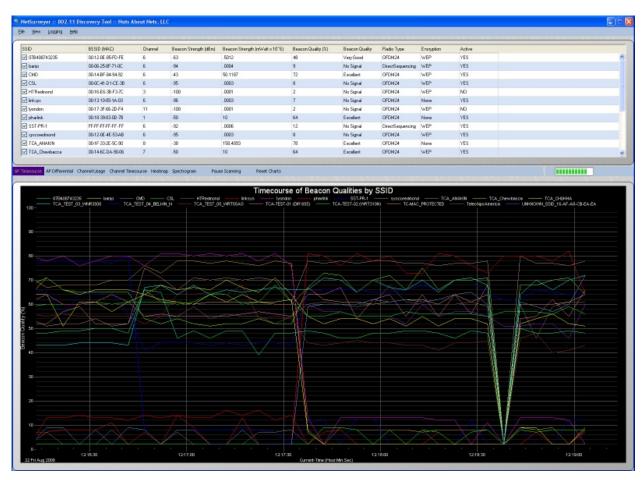
This grid of local access points is updated in (semi) realtime -- that is, scans are performed approximately once every 5 seconds. The data for each column is briefly described below:

SSID	Service Set Identifier a human-readable identifier corresponding to a wireless network. In general, there could be multiple BSSIDs (i.e. APs) operating on the same wireless network and using the same SSID. A client station (STA) can choose to associate with any of the BSSIDs on the same wireless network (though performance may differ for a variety of reasons).
BSSID (MAC)	Basic Service Set Identifiers corresponds to the access points (APs) from whom beacons were detected. For infrastructure 802.11 networks, the BSSID is equivalent to the MAC address of the AP.

Channel	An access point is configured to transmit/receive on a particular 802.11 channel (actually, a specific frequency range). Under 802.11 b/g there are 14 possible channels, but only 11 are used in North America (i.e. channels 1 - 11).
Beacon Strength (dBm)	Received signal strength indication (RSSI) in dBm. This measures the strength or power of the "I'm here" beacon transmitted from an AP approximately every 100 mSec. It is a reflection of the distance between the AP and the client STA and is *not* an indication of performance.
Beacon Strength (mWatt x 10^6)	Same as above, but measured in mWatt x 10^6.
Beacon Quality (%)	Converts the beacon's signal level into a signal quality (0-100%) where a maximum signal is assumed to be -20 dBm and the dissociation signal is -85 dBm (http://www.ces.clemson.edu/linux/dbm-rssi.shtml). More intuitive than reporting a RSSI in dBm or mWatt.
Beacon Quality	Qualitative measure of beacon strengths: where "Excellent" implies > -57 dBm, "Very Good" implies > -67 dBm, "Good" implies > -71 dBm, "Low" implies > -81 dBm, and "Very Low" implies > -90 dBm. Any RSSI below -90 dBm is reported as "No Signal".
Radio Type	The network type supported by the access point: where 'DirectSequencing' refers to 802.11 b, and 'OFDM24' refers to 802.11 g
Encryption	Whether encryption is supported and enabled on the access point 'WEP' implies that it is, 'None' implies that encryption is not being used.
Active	An indication of whether the access point is currently active - - that is, whether a beacon for this access point was

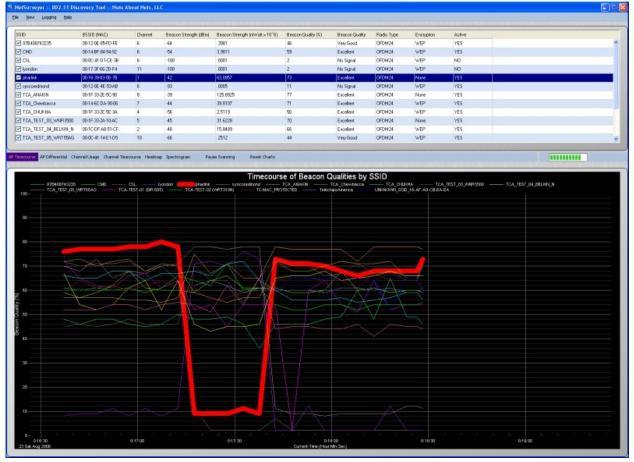
detected during the last scan.

Timecourse of Beacon Qualities For Each Access Point

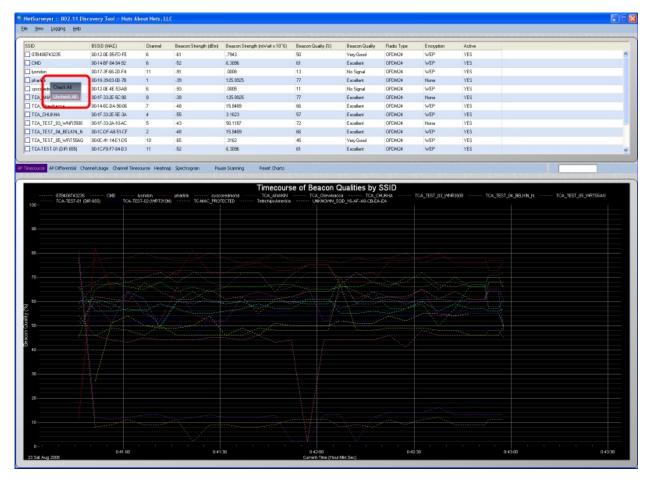


This chart displays the beacon strength of each access point *as a function of time*. The Y-axis reports the signal strength as a signal quality (0 - 100%) -- where a maximum signal is assumed to be -20 dBm and the dissociation signal is -85 dBm

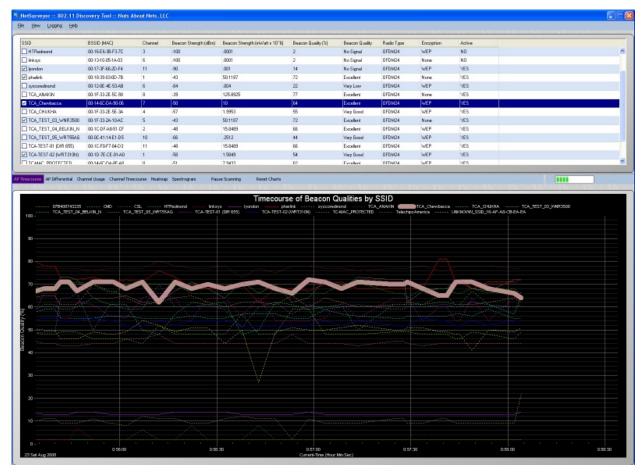
(http://www.ces.clemson.edu/linux/dbm-rssi.shtml). We find this more intuitive than reporting a RSSI in dBm or mWatt. If you would also like to know the signal strength in dBm then this is reported in the grid above the chart.



This chart can become difficult to read when there are many access points -- because there are so many lines. Even though each timecourse is color-coded to correspond to a particular AP, it becomes hard to pick out a single AP and follow its timecourse. To this end, *NetSurveyor* provides a couple of ways to aid you in viewing the behavior of a specific AP in a crowded chart. In the grid above the chart, by simply selecting (i.e. highlighting) the row that corresponds to a particular AP then the corresponding timecourse is highlighted in the chart. In the example above we selected the BSSID corresponding to 'pharlink' and now we can clearly monitor that particular timecourse.

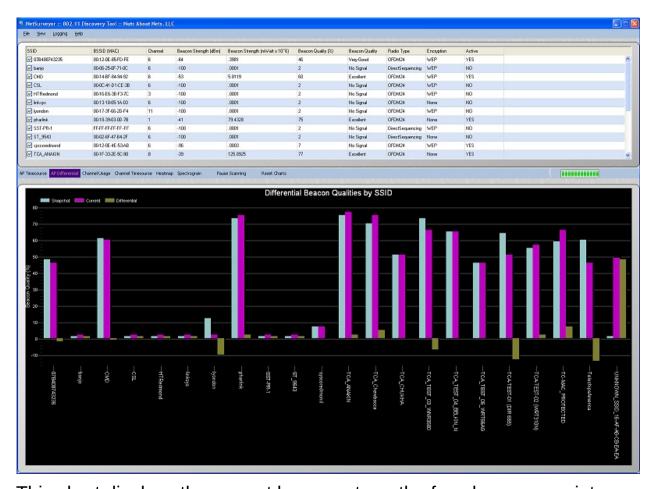


When you right-click the mouse button in the area of the grid then a popup menu appears with two choices: Check All' and 'Uncheck All'. By choosing 'Uncheck All' then all the timecourse lines are redrawn as dotted lines -- as shown above. The lines are drawn as thin, solid lines when the checkbox under the SSID column (in the grid) is checked.



Using some combination of 'Checking' and 'Selecting' you can tailor the view to focus on the access points you are most interested in monitoring.

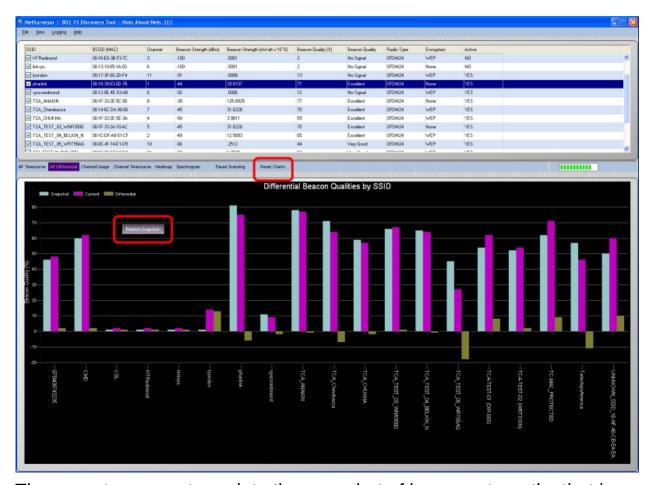
Differential Display of Beacon Qualities for Each Access Point



This chart displays the current beacon strength of each access point compared with an earlier snapshot. The current beacon strength is displayed in purple, the snapshot in light-blue, and the difference in olive green. The Y-axis reports the signal strength as a signal quality (0 - 100%) -- where a maximum signal is assumed to be -20 dBm and the dissociation signal is -85 dBm (http://www.ces.clemson.edu/linux/dbm-rssi.shtml). We find this more intuitive than reporting a RSSI in dBm or mWatt. If you would also like to know the signal strength in dBm then this is reported in the grid above the chart.

The Differential display can be used to view small (or large) perturbations in beacon strength over time. Here's how it works -- when the application is launched then a 'snapsot' of the beacon strengths is taken -- these are the light-blue bars. These bars are static and do not change. The purple

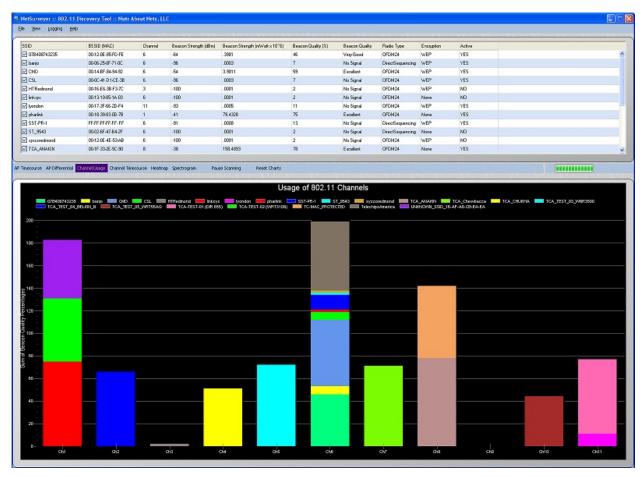
bars show the current beacon strengths, and the olive green is the difference between the snapshot and the current beacon strength.



There are two ways to update the snapshot of beacon strengths that is compared against the current beacon strengths: by right-clicking the mouse button on top of the chart then a popup menu appears with a single choice -- 'Refresh Snapshot'. By selecting 'Refresh Snapshot' then the snapshot is updated. Alternatively, by pressing the 'Reset Charts' button located on the toolstrip in the middle of the display then all the charts are reset, including the snapshot used for this view.

Finally, by checking/unchecking BSSIDs in the grid (above) you can tailor this view to better focus on the access points you are most interested in monitoring.

Usage of Each of the 802.11 b/g Channels



This chart combines the access points by channel and displays a summary of channel usage. As in most of the other charts, the Y-axis reports the signal strength of beacons as a signal quality (0 - 100%). In this view the data for each channel represents a collection of access points -- hence the signal quality as displayed along the Y-axis is often greater than 100%. This is because we are summing the signal qualities for each of the access points that use a particular channel. One thing important to keep in mind is that beacon signal strength is *not* a reflection of performance.

By checking/unchecking BSSIDs in the grid (above) you can tailor this view to better focus on the access points you are most interested in monitoring. 'Checked' access points are included in the summed beacon quality that is reported for a particular channel, whereas 'unchecked' access points are not.

Timecourse of the Usage of Each of the 802.11 b/g Channels



This chart combines the access points by channel and displays a summary of channel usage *as a function of time*. As in most of the other charts, the Y-axis reports the signal strength of beacons as a signal quality (0 - 100%). In this view the data for each channel represents a collection of access points -- hence the signal quality as displayed along the Y-axis is often greater than 100%. This is because we are summing the signal qualities for each of the access points that use a particular channel. One thing important to keep in mind is that signal strength is *not* a reflection of performance.

By checking/unchecking BSSIDs in the grid (above) you can tailor this view to better focus on the access points you are most interested in monitoring. 'Checked' access points are included in the summed beacon quality that is reported for a particular channel, whereas 'unchecked'

access points are not.

Heatmap / Waterfall Chart of the 802.11 b/g Channels



This chart combines the access points by channel and displays a summary of channel usage as a Heatmap. The Heatmap chart is also known as a "waterfall" graph. It is a 3-dimensional representation of the data, where the X-axis is the channel, the Y-axis is a time scale, and the "Z-axis" is the beacon signal quality that uses color scale. Each horizontal line in the Heatmap chart displays beacon signal strength (as a color) as a function of channel as measured over the time period of one scan. That is, with each scan (or sweep) a new row is added at the bottom of the Heatmap chart. The color legend to the right shows that stronger signals will appear red and weaker signals will appear blue.

By checking/unchecking BSSIDs in the grid (above) you can tailor this view to better focus on the access points you are most interested in monitoring. 'Checked' access points are included in the summed beacon

quality that is reported for a particular channel, whereas 'unchecked' access points are not.

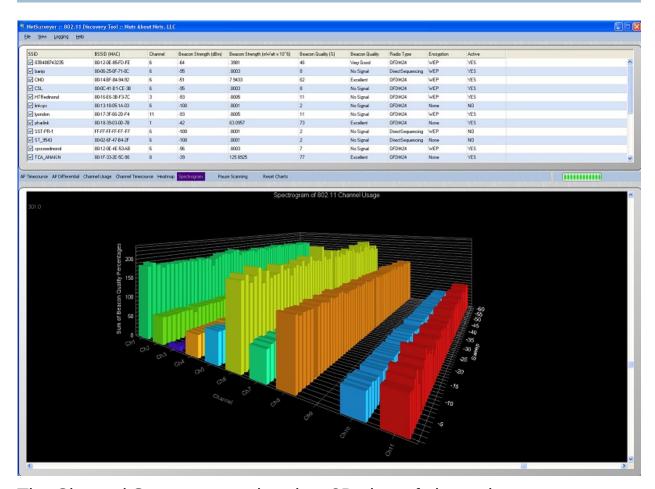


When right-clicking the mouse button on top of the chart then a popup menu appears with a single choice -- 'Rescale Heatmap...'. By selecting 'Rescale Heatmap...' then a small dialog box appears with a slider control. This control can be used to rescale beacon signal strengths to better spread them across the range of colors that are used. This is useful when beacon signal strengths are large and the Heatmap appears mostly red or when beacon signal strengths are low and the Heatmap appears mostly blue. Typically one would remap the color legend to better make use of the colors and how they are spread across the highs and lows of beacon signal strength values.



In the chart above we've rescaled the color legend so that channels 1, 6 and 8 clearly standout as being more heavily used than other channels.

Channel Spectrogram of the 802.11 b/g Channels



The Channel Spectrogram chart is a 3D view of channel usage as a function of time. Each channel is represented by its own set of bar graphs -- the X-axis is the channel, the Z-axis is a time scale, and the Y-axis reports the signal strength of beacons as a signal quality (0 - 100%). In this view the data for each channel represents a collection of access points -- hence the signal quality as displayed along the Y-axis is often greater than 100%. This is because we are summing the signal qualities for each of the access points that use a particular channel.

By checking/unchecking BSSIDs in the grid (above) you can tailor this view to better focus on the access points you are most interested in monitoring. 'Checked' access points are included in the summed beacon quality that is reported for a particular channel, whereas 'unchecked' access points are not.

Chart Selection and Scan Command

The toolstrip in the middle of the display contains buttons for selecting which chart to view, plus additional buttons for controlling scan behavior.

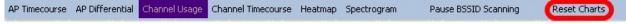
- AP Timecourse button selects the <u>Timecourse of Beacon Qualities</u>
 For Each Access Point chart
- AP Differential button selects the '<u>Differential Display of Beacon</u>
 Qualities for Each Access Point' chart
- Channel Usage button selects the 'Usage of Each of the 802.11 b/g Channels' chart
- Channel Timecourse button selects the '<u>Timecourse of the Usage of Each of the 802.11 b/g Channels</u>' chart
- Heatmap button selects the 'Heatmap / Waterfall Chart of the 802.11 b/g Channels' chart
- **Spectrogram** button selects the 'Channel Spectrogram of the 802.11 b/g Channels' chart



Pressing the 'Pause BSSID Scanning' button causes scanning to stop.



Pressing the 'Start BSSID Scanning' button causes scanning to continue (after having been paused).



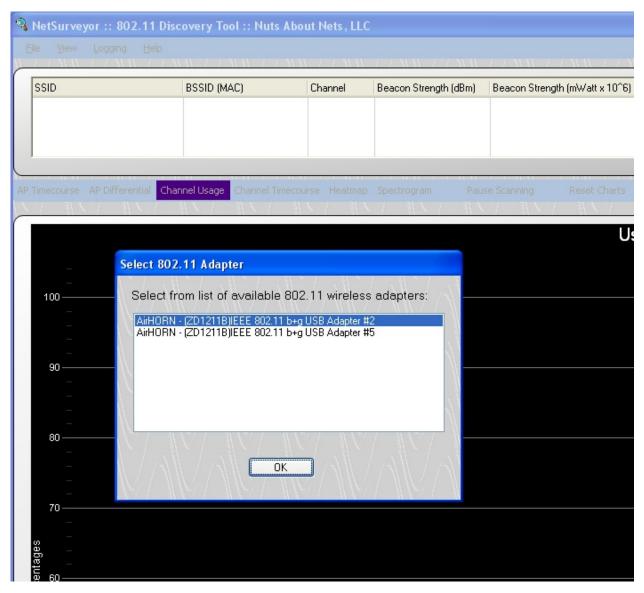
Pressing the '*Reset Charts*' button resets all the charts, including the snapshot used for the '<u>Differential Display of Beacon Qualities for Each</u>

Access Point' chart.

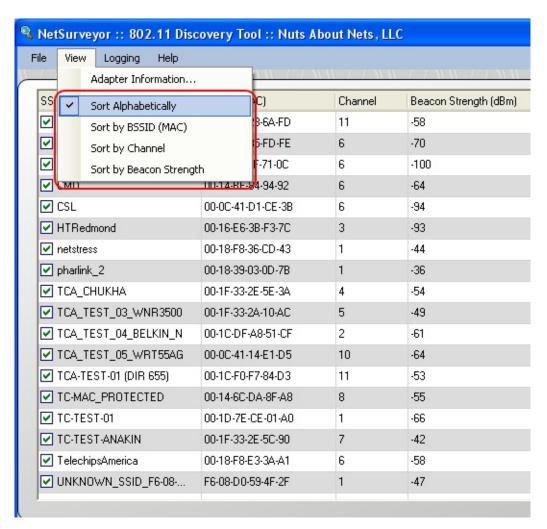
View Commands



When you select *View -> Adapter Information...* from the main menu then a dialog box appears that displays information about the 802.11 wireless adapter that is currently being used by *NetSurveyor*.



Typically there is only one wireless adapter installed per machine -- but there are occasions when multiple 802.11 wireless adapters may be present. In that case, when *NetSurveyor* is launched a dialog box appears that lists the available 802.11 wireless adapters -- and you would choose the one you wish to use for that particular session.



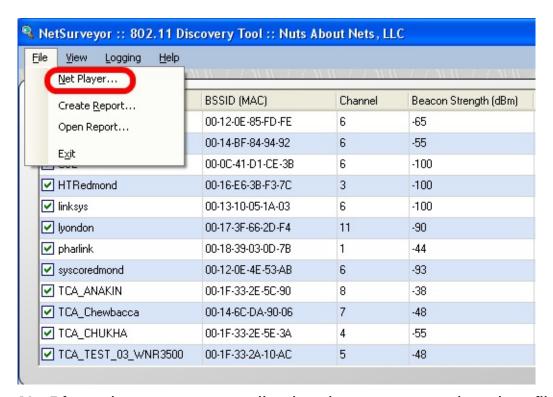
The *View* menu is also used for setting your sorting preferences. By default the grid of local access points is sorted alphabetically using the SSID property. Alternatively, you can sort by BSSID (MAC), channel or beacon strength. When you change the way the grid is sorted there may be a slight delay - the new sorting preferences will take effect following the next BSSID scan.

Data Recording and Playback

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1.7	11 11	<u>S</u> tarl	Recording	ı	$HH \rightarrow HH$	11// 1/11	1 1 11 1 1 11 1	
SSID)	Stop			ACI	Channel	Beacon Strength (dBm)	
☑ 0	7B4087	Sa <u>v</u> e		Start	Recording to Data	File	-65	
₩ 0	MD			00-14-BF-	84-94-92	6	-55	
✓ CSL				00-0C-41-	D1-CE-3B	6	-100	
✓ HTRedmond				00-16-E6-	3B-F3-7C	3	-100	
✓ linksys			00-13-10-0	05-1A-03	6	-100		
✓ Iyondon			00-17-3F-66-2D-F4		11	-90		
✓ pharlink				00-18-39-03-0D-7B		1	-44	
✓ syscoredmond ()			00-12-0E-4E-53-AB		6	-93		
▼ TCA_ANAKIN 00-1F-3			00-1F-33-2	2E-5C-90	8 -38			
✓ TCA_Chewbacca (00-14-6C-DA-90-06		7	-48		
▼ TCA_CHUKHA 00-1F			00-1F-33-2	2E-5E-3A	4	-55		
▼ TCA_TEST_03_WNR3500			R3500	00-1F-33-2	2A-10-AC	5	-48	

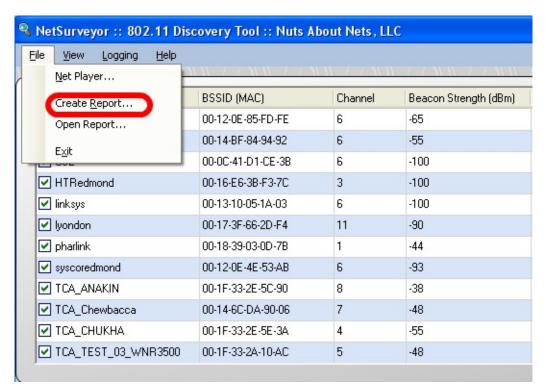
NetSurveyor features a simple, yet powerful, Data Recording capability. The data files that are created can later be viewed using the **NetPlayer** application (included as part of **NetSurveyor's** installation/setup). Please note that when recording over an extended period of time, data files can grow to be quite large and require significant disk space. So, the application does not automatically record the data -- it waits for you to select **Logging -> Start Recording** from the main menu. When you are done recording and do not wish to save the recorded data, then select **Logging -> Stop** from the main menu. If you are done recording and do wish to save the data then select **Logging -> Save** from the main menu and a SaveFile dialog box will appear allowing you to save the recorded data to a file and folder of your choosing.

NOTE: When *Logging -> Start Recording* is selected (and before recording actually begins) the application first checks for a minimum of 300 MB of free disk space on the drive on which the *NetSurveyor* application was installed. This would allow for over 24 hours of continuous recording. If sufficient disk space is not available then a warning message is displayed.

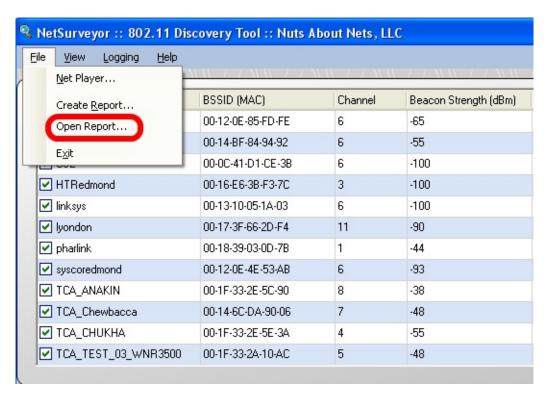


NetPlayer is a separate application that we use to view data files recorded by NetSurveyor -- it is included as part of **NetSurveyor's** installation/setup and was installed at the same time as **NetSurveyor**. The **NetPlayer** application can be launched from the main menu by selecting **File** -> **Net Player...**

Creating Reports



NetSurveyor has a powerful, yet simple-to-use, report generation capability. When you select **File -> Create Report...** from the main menu then you will be prompted for a folder and filename in which to the save the report file. An Adobe PDF formatted file will be created that includes the grid of access points along with images of the 6 charts. At the same time, Adobe Reader will be launched so you can verify the contents of the report you just created.



By selecting *File -> Open Report...* from the main menu you can open and view Adobe PDF formatted reports you've created (or any other PDF file).

License Agreement

Nuts About Nets, LLC

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Should you have any questions concerning this EULA please contact Nuts About Nets, LLC via email at NutsAboutNets@gmail.com or by phone at 425.881.6506.

Contact Us

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