ellisys
Better Analysis

User Manual

Bluetooth® Analyzers

Vanguard™ ▪ Explorer™ ▪ Tracker™

Version 3.2 | March 23, 2021

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This manual is populated throughout with screenshots captured from a specific version of Ellisys Protocol Analyzer software. All information contained in these screenshots should be considered samples and are intended to serve for instructional purposes only.

Document Revision History

Date	Revision	Changes
May 11, 2011	1.0	Initial release.
January 9, 2012	1.1	Updated to version 3.0 of the software.
February 21, 2013	1.2	Updated to version 4.0 of the software.
June 1, 2014	1.3	Updated to version 5.0 of the software.
January 16, 2017	2.0	Added Bluetooth Tracker
May 25, 2018	3.0	Added Bluetooth Vanguard
January 13, 2020	3.1	Miscellaneous updates
March 23, 2021	3.2	Auto-detect and tZERO features, and other updates

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The warranty begins on the date of purchase and covers a period of two (2) years or three (3) years, depending on the product configuration.

Governing Law

These conditions and terms shall be governed by and construed in accordance with the law of Switzerland.

Jurisdiction; Venue

The parties consent to the exclusive personal jurisdiction of, and venue in, the District Court of Geneva, Switzerland.

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About this Manual

Typographic Conventions

Bold is used to indicate menu commands, buttons, and tabs.

Italics are used to indicate fields, pane names, window names and cross references.

A warning symbol describes a possible critical situation and how to avoid it.

An information symbol tells you how to respond to a situation that may arise.

A tip symbol tells you information that will help you carry out a procedure.

Where to Find More Help

- Go to the Ellisys website and the following pages for the latest information:
- Ellisys products page - Go to **www.ellisys.com/products/** for the latest product information and documentation.
- Application notes and white papers - Go to **www.ellisys.com/technology/** to find up-to-date information about the technology.
- Distributors - Go to **www.ellisys.com/sales/** to find a list of Ellisys distributors.
- Technical support - Go to **www.ellisys.com/support/** to send a question directly to the Ellisys support team.

1. Introduction

The Ellisys line of Bluetooth analyzers include the Bluetooth Explorer™, Bluetooth Tracker™, and Bluetooth Vanguard™. Each of these analyzers provide an array of features designed to enable various analyses and characterizations of protocol, performance, and RF behaviors for Bluetooth technology, with model- and edition-dependent support for capture and analysis of Wi-Fi, WPAN (IEEE 802.15.4), Host Controller Interface (HCI) standards, and several wired protocols.

In this manual, references are generally made to a singular analyzer, which may be the Bluetooth Tracker, Bluetooth Explorer, or Bluetooth Vanguard. All analyzers share a unified software application and have several common hardware and application software characteristics and capabilities. Where differences exist, distinctions are made to indicate the specific analyzer being referenced.

Figure 1 Vanguard, Explorer, and Tracker

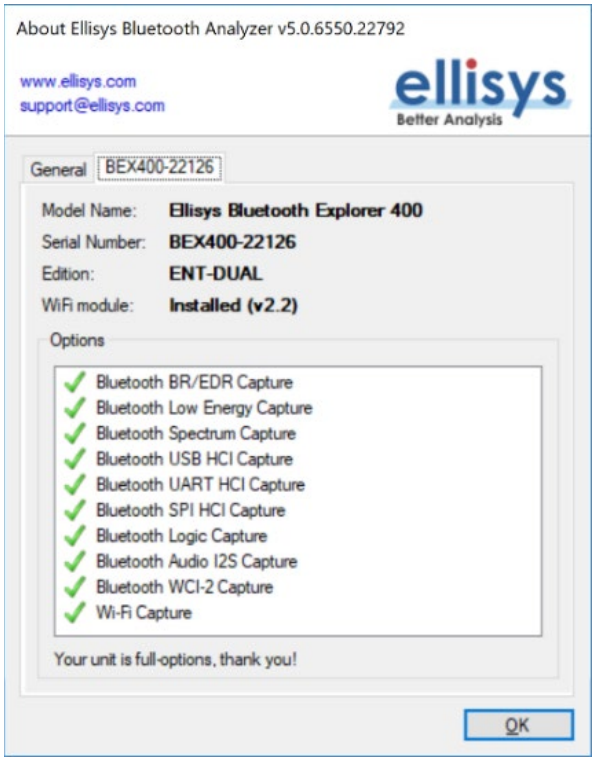
Major uses for the analyzer include verification of specification conformance and design goals, interoperability testing, debugging of software stacks and applications, system performance characterizations, and wireless coexistence analysis.

1.1 Models, Editions, and Configurations

All analyzer models are purchased and configured in feature-specific editions - Basic (BAS), Standard (STD), Professional (PRO), and Enterprise (ENT). Only the Bluetooth Tracker uses the BAS edition. The Explorer and Vanguard models may be configured to support a single Bluetooth radio (BR/EDR or BLE) or both Bluetooth radios (DUAL). The Tracker is BLE-only.

For more information on models, features, and editions, see www.ellisys.com/sales/prices.php.

When the analyzer is attached to the Control PC, the **Help** menu of the application describes the specific model, serial number, edition, and options installed, as shown below. See *Section 1.6, How to Check the Analyzer's Model, Edition, Features* for details.



1.2 Model Comparison

The chart below summarizes the differences between the models. Note that this information is subject to change. Consult the Ellisys website (www.ellisys.com) or contact Ellisys as needed for latest details.

Ellisys Bluetooth® Analyzers Comparison Chart

	 Bluetooth Vanguard™	 Bluetooth Explorer™	 Bluetooth Tracker™
Radio Capabilities			
Bluetooth Classic (BR/EDR)	✓	✓	
Bluetooth Low Energy	✓	✓	✓
Dual-Mode Capability	Full	Partial[1]	
Wi-Fi® 802.11	11ac 3x3	11n 2x2	11n 1x1
WPAN 802.15.4	2.4GHz 16 ch		
Spectrum Analysis	✓	✓	✓
Emerging Specifications	✓	✓	
Wired Capabilities			
USB 2.0 HCI	✓	✓	
UART HCI	✓	✓	✓
SPI HCI	✓	✓	✓
Logic Analysis	✓	✓	✓
UART, SPI, I2C, SWD	✓	✓	✓
Other Characteristics			
USB Upload	USB 3.1	USB 2.0	USB 2.0
USB Bus-Powered	PD		✓
USB Ethernet Upload	1GbE		
Power Over Ethernet	PoE+		
Backup Battery	✓		

1.3 Bluetooth Tracker

The Bluetooth Tracker is an ultra-portable, bus-powered analyzer supporting concurrent capture of Bluetooth Low Energy (BLE), Wi-Fi, and other features as shown below.

Editions	Basic	Standard	Pro	Enterprise
Wideband BLE capture	X	X	X	X
BLE 1 Mbps	X	X	X	X
BLE 2 Mbps			X	X
BLE Long Range			X	X
BLE Advertising Extension			X	X
WiFi 11n 1x1				X
Spectrum capture				X
HCI capture (UART, SPI)			X	X
Logic capture			X	X
WCI-2 capture				X
Audio I2S capture				X
Protocol decoding	X	X	X	X
Instant Timing		X	X	X
Instant Piconet		X	X	X
Instant Channels		X	X	X
Instant Throughput		X	X	X
Instant Audio		X	X	X
Warranty	1 year	1 year	2 years	2 years

1.4 Bluetooth Explorer

The Bluetooth Explorer is an all-in-one analyzer supporting concurrent capture of Bluetooth Basic Rate/Enhanced Data Rate (BR/EDR), Bluetooth Low Energy (BLE), Wi-Fi, and other features as shown below.

Radio Configuration	EDR	LE	DUAL
BR/EDR capture	X		X
Low Energy capture		X	X

Editions	Standard	Pro	Enterprise
Wideband Bluetooth capture	X	X	X
HCI capture		X	X
Logic capture		X	X
Spectrum capture		X	X
Audio I2S capture		X	X
WCI-2 capture		X	X
Wi-Fi 802.11 a/b/g/n capture			X
Warranty	2 years	2 years	3 years

1.5 Bluetooth Vanguard

The Bluetooth Vanguard is an all-in-one analyzer supporting concurrent capture of Bluetooth Basic Rate/Enhanced Data Rate (BR/EDR), Bluetooth Low Energy (BLE), Wi-Fi, WPAN (IEEE 802.15.4), and other features as shown below.

Radio Configuration	EDR	LE	DUAL
BR/EDR capture	X		X
Low Energy capture		X	X

Editions	Standard	Pro	Enterprise
Wideband Bluetooth capture	X	X	X
HCI capture		X	X
Logic capture		X	X
I2C, UART, SPI, SWD capture		X	X
Spectrum capture		X	X
Audio I2S capture		X	X
WCI-2 capture		X	X
Wi-Fi 802.11 a/b/g/n/ac capture			X
WPAN 15.4 capture			X
Warranty	**2 years**	**2 years**	**3 years**

Lithium Ion Battery

The Bluetooth Vanguard unit has an interior, multi-cell, lithium ion battery installed. It is not user accessible. The battery is charged by the supplied DC power supply when it is attached to the analyzer. A combination indicator/push-button is located on the back panel of the unit, which provide battery status and on/off control. Cells are less than 20 Wh and the battery itself is equal to 60 Wh. Run-time for the battery is between 1.5 hours and 2.5 hours.

Rechargeable lithium ion batteries are potentially hazardous. These can present a fire hazard and/or emit toxic fumes if they are damaged, used incorrectly, disassembled by the user, or defective in some way.

Avoid exposure to water, all other liquids, especially saltwater, and DO NOT charge the battery if this has occurred. If ambient temperature is below 40 degrees F (4 C), DO NOT charge the battery.

If the Bluetooth Vanguard unit has been damaged from being dropped or from shipping damage, contact Ellisys to arrange for return of the unit to Ellisys for inspection

DO NOT use a charger other than the charger (external DC power supply) supplied by Ellisys. Contact Ellisys for information on obtaining a replacement power supply as needed.

Battery Reference Documentation

US Department of Transportation (DOT) regulations for shipping lithium batteries, found in document 49CFR173.185

UN 3481 Lithium ion batteries contained in equipment.

IATA 2020 Lithium Battery Guidance Document or local government guidelines and regulations as applicable.

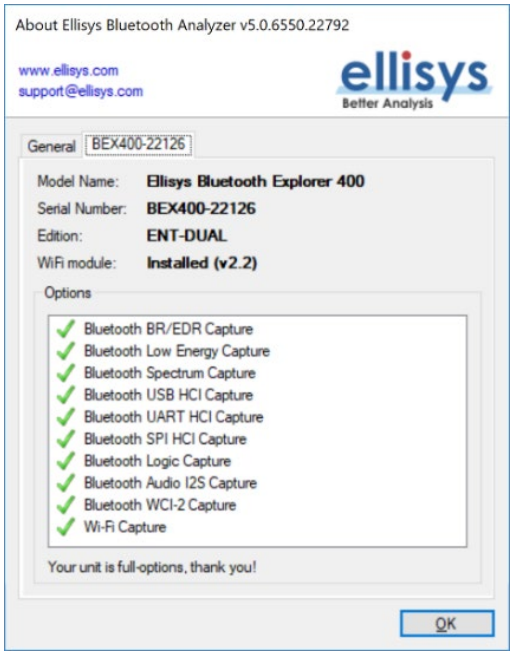
1.6 How to Check the Analyzer's Model, Edition, Features

To check your analyzer to learn the model (Tracker, Explorer, or Vanguard) and the edition (Basic, Standard, Professional, or Enterprise), whether it is configured to support single-radio (BLE or BR/EDR) or dual-radio (BLE and BR/EDR), and the complement of features licensed, follow the steps below.

1. Connect the analyzer's Control Port to the Control Computer where the Ellisys Bluetooth Analyzer software is installed. All models have USB control. Vanguard also has a Gigabit Ethernet (GbE) Control Port.

2. In the analyzer software application, open the **Serial Number** tab located in the **Help**/**About** menu. See figure below. Various information is shown, including model, edition, serial number, features enabled (or not enabled) and whether the hardware supports Wi-Fi (some earlier Explorer models do not have Wi-Fi hardware support).

To see the Wi-Fi module information, Bluetooth Explorer models will need the supplied DC Power Supply attached to the back-panel **Power** receptacle.



1.7 Upgrading from One Edition to Another

Customers may electronically upgrade an analyzer's configuration in the field, using a feature-enabler file provided by Ellisys. Contact Ellisys Sales for more information.

1.8 Software Application Download

The Analyzer is operated using a software application supplied by Ellisys. In addition, this same application can be used to view files created and saved during recording operations. Download information for this software application can be requested at www.ellisys.com/support/download.php.

The application software can be updated from the **Help** menu by selecting the **Check for Updates** option.

Fixes and feature updates to the software application happen with regularity. It is always a good idea to keep your Ellisys software up to date.

2. Minimum Application Prerequisites

Before installing the analyzer software application, please ensure the computer system on which it will reside, meets the following minimum requirements.

- Microsoft Windows® 7 or later.
- Microsoft Windows Installer 3.0 or later. If the installation does not run smoothly, or if the system indicates a version error, update your Windows installer.
- Microsoft .NET Framework version 3.5 or later.
- Intel Core, 2 GHz or compatible processor, or better.
- 4 GB RAM or more.
- 1280 x 1024 screen display resolution with 65,536 colors, or better.
- USB 2.0 EHCI Host Controller (for Vanguard, USB-C receptable with USB Power Delivery and USB 3.1 is preferred for better operation, but not required).
- Vanguard Network Connection: Minimum 100Mbps (1Gbps ideal). DHCP required.

The analyzer requires several software components. Please be sure you have updated your Microsoft Windows installation using the appropriate menus available on your Windows computer (typically Windows Update, located in Settings).

Ellisys recommends that you visit the following web page as needed, to update your versions of Microsoft .NET Framework:

- www.microsoft.com/net to download the Microsoft .NET Framework version. When using the Windows update service, it will automatically download and install Microsoft .NET Framework.

2.1 Software Installation

To install the Ellisys application software, download and run the setup application from a link provided by Ellisys. Follow the onscreen prompts to install the software application.

To request the application software from Ellisys, please visit the Downloads section on the Ellisys website at www.ellisys.com or contact support@ellisys.com.

Once the software application is installed, users can check for recent updates and install these updates from the application's **Help** menu.

3. Analyzer Hardware Overviews

3.1 Front Panel Overview - Explorer

The front panel of the Bluetooth Explorer is shown below:

Earlier versions of the Explorer labelled the left antenna port as **Generate** and the right antenna port as **Capture**. The left port was later repurposed as a secondary RF capture port, used for Wi-Fi (on units enabled for Wi-Fi capture). A later version of the Explorer faceplate changed the left port labelling to **Secondary**, although the port's functionality did not change (see below). This later version also changed the right port from **Capture** to **Primary**.

Figure 2 Explorer Front Panel (Earlier Version)

Figure 3 Explorer Front Panel (Later Version)

Capture Connector (or Primary)

The (Standard SMA) **Capture** connector (or **Primary** connector on later faceplates) is used to connect the antenna (supplied) for capture of BR/EDR and BLE traffic, and Wi-Fi, on units configured for Wi-Fi capture. To determine whether your Explorer is hardware-enabled for Wi-Fi and/or licensed for Wi-Fi capture, see *Section 1.6, How to Check the Analyzer's Model, Edition.*

When attaching an antenna to the front panel, DO NOT over tighten. Screw on the antenna to a light finger-tight torque only.

Generate Connector (or Secondary)

The generation function is deprecated. The (Standard SMA) **Generate** connector (or **Secondary** connector on later faceplates) is used for Wi-Fi capture on units configured for Wi-Fi. To determine whether your Explorer is hardware-enabled for Wi-Fi and/or licensed for Wi-Fi capture, see *Section 1.6, How to Check the Analyzer's Model, Edition, Features.*

HCI Connectors

The **HCI** connectors (USB 2.0 Standard-A and Micro-B) are used for USB HCI traffic capture.

Power LED

The **Power** LED indicates if the unit is correctly powered from the supplied DC power adapter (or from the battery for Vanguard units equipped with an internal battery). It also indicates whether the unit is successfully connected to the control computer over the control connection.

Regarding Flashing LED indications on the Power LED, the indications described below may vary depending on whether the unit has previously initialized. With a flashing LED of any color on the Power LED, it is advised to simply remove both the USB and DC Power connections from the back of the unit such that neither is attached, then reconnect them to the unit (in any order).

Constant green: DC-powered and USB-connected (including USB driver properly loaded by the operating system), ready to operate.

Flashing green: DC-powered but not USB-connected/USB driver loaded.

Flashing red: USB-connected but not DC-powered (includes cases where the USB driver does not load – the USB driver is in the *Drivers* folder that installs with the Ellisys Bluetooth Analyzer application).

Off: Not DC-powered and not USB-connected. The Power LED may also be off if when the unit is in power-saving mode after the control computer has been turned off.

Operating LED

The **Operating** LED indicates if the unit is presently performing a task directed by the user, for example when the user has initiated a recording action.

Off: Unit is not in use and available.

Constant green: Unit is in use.

Orange: In use, waiting for event.

Red: Memory full, downloading.

Trigger LED

The **Trigger** LED indicates whether a trigger event has occurred. Currently not implemented.

Off: No trigger event detected.

Green flash: Trigger event detected.

Capture BR/EDR LED

The **Capture BR/EDR** LED indicates that the analyzer detects the presence of BR/EDR traffic, irrespective of whether a recording is underway.

Off: No BR/EDR traffic detected.

Flashing green: BR/EDR traffic detected.

Capture LE LED

The **Capture LE** LED indicates that the analyzer detects the presence of Bluetooth Low Energy traffic, irrespective of whether a recording is underway.

Off: No Bluetooth Low Energy traffic detected.

Flashing green: Bluetooth Low Energy traffic detected.

Generate BR/EDR LED (Some Models)

Reserved for future implementation.

Generate LE LED (Some Models)

Reserved for future implementation.

3.2 Front Panel Overview – Vanguard

The front panel of the Vanguard is shown below:

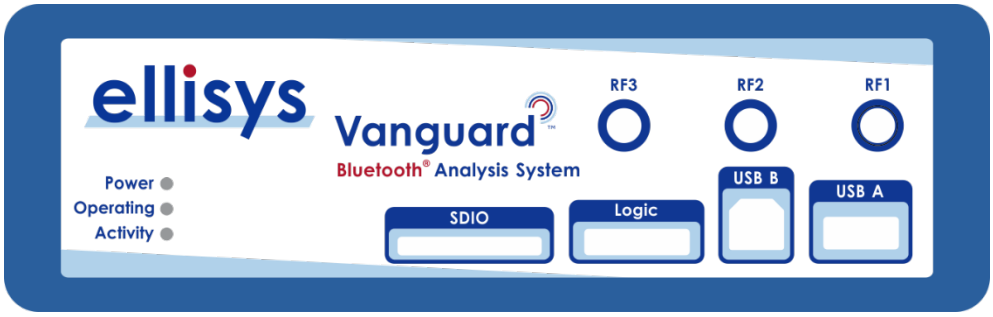


Figure 4 Vanguard Front Panel

RF1 Connector

The (Standard SMA) **RF1** connector is used to connect the antenna (supplied) for capture of BR/EDR, BLE, and Wi-Fi.

RF2 Connector

The (Standard SMA) **RF2** connector is used to connect the antenna (supplied) for capture of Wi-Fi and is also shared for BR/EDR and BLE (see *Section 7.3, Bluetooth Capture Diversity*).

RF3 Connector

The (Standard SMA) **RF3** connector is used to connect the antenna (supplied) for capture of Wi-Fi and WPAN.

USB B and USB A Connectors

The **USB B** and **USB A** connectors (USB 2.0 Standard-A and Standard-B) are used for USB HCI traffic capture.

Logic Connector

The **Logic** connector is used to attach to a flying-leads probe (supplied) for capture of logic signals, HCI (UART and SPI), I2S Audio, and generic communications (I2C, SWD, UART, and SPI). See *Section 25, Flying Leads Probe – Tracker and Vanguard* for details.

SDIO Slot

Not presently enabled for end-user access – factory programming access only.

Power LED

The **Power** LED indicates if the unit is correctly powered from the from any of the power sources (PoE, USB Power Delivery, or DC Power). It also indicates whether an IP address has been acquired or is being acquired.

Flashing white fast: First-stage bootloader loading.

Flashing white slow: Operating System loading.

Flashing red: Power issue.

Flashing magenta: USB control port-connected but not DC-powered (assumes USB control port is not providing enough power/not USB Power Delivery compatible).

Constant blue: Unit powered, and operating system booted.

Constant green: Backup battery enabled.

Flashing green: Operating on battery after a DC-power loss.

Off: Not powered or powered off.

Operating LED

The **Operating** LED indicates if the unit is ready to be operated or presently performing a task directed by the user, for example when the user has initiated a recording action.

Off: Unit is not in use.

Constant blue: Control-Port connected, IP address acquired, or USB driver loaded on Control Computer, and ready to operate.

Constant green: Unit is in use (recording or initializing).

Flashing magenta: Maintenance task in progress.

Activity LED

The **Activity** LED indicates the unit is operating and traffic (wired or wireless) is being captured.

Off: No event detected.

Green flashing: Activity detected.

3.3 Back Panel Overview – Explorer

The back panel of the Bluetooth Explorer is shown below:

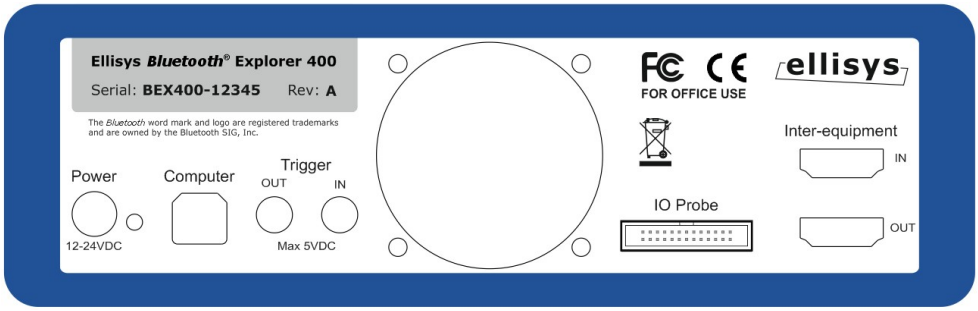


Figure 5 Explorer Back Panel

When connecting the USB cable DO NOT force the connector into the unit. The metal part of the connector should not be inserted completely into the connection port. Forcing the connector or inserting all the metal part of the connector will break the port connection and is not covered by the warranty.

Power

DC jack power input. The adjacent LED illuminates constant green if a correct voltage is applied and illuminates constant red if the voltage is applied reversed.

Accepted Voltage Range: 12VDC to 24VDC. Minimum Power: 18W

To prevent damage to your Bluetooth Explorer, use only the DC power supply provided by Ellisys. Contact Ellisys for replacement details.

Computer

Type B USB 2.0 receptacle. Attaches to the Control Computer.

Trigger OUT

Disabled.

Trigger IN

Disabled.

IO Probe

Integrated logic analyzer probe for capturing UART and SPI HCI traffic, generic UART, SWD, I2C, and SPI, Audio I2S signals, WCI-2 traffic, and logic signals. A flying-leads adapter cable is supplied when these options are included with purchase. See *Section 24, Flying Leads Probe – Explorer* for details.

Inter-equipment IN and OUT

Reserved for future extensions.

3.4 Back Panel Overview – Vanguard

The back panel of the Bluetooth Vanguard is shown below.

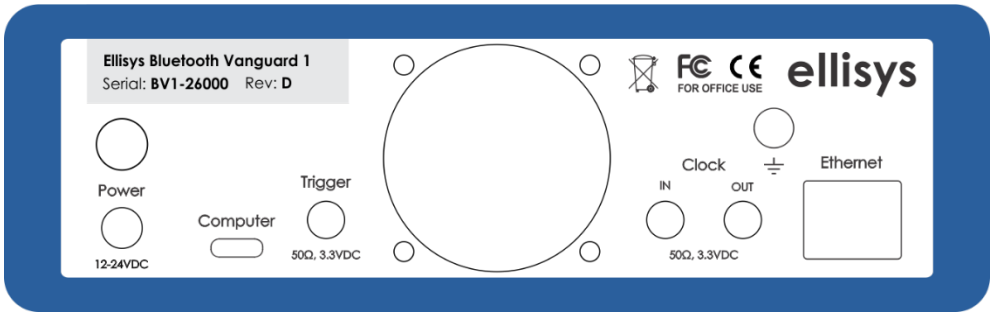


Figure 6 Vanguard Back Panel

Power

Push-button LED and associated DC jack **Power** input. The LED is constant blue if a correct voltage is applied and illuminates constant red if the voltage is applied reversed. Push-button controls on/off of the internal battery, on Vanguard units equipped with a battery (early versions may not have a battery installed).

Note that the (supplied) external DC **Power** input may not be required if the **Ethernet** connection is supported with Power Over Ethernet (PoE) or alternatively, if the USB (**Computer**) connection supports USB Power Delivery and is able to negotiate a sufficient power contract with the analyzer's USB Power Delivery port.

For all connections using the analyzer's Ethernet port, DHCP is required.

Computer

Control port receptacle. Type-C, USB Power Delivery-capable. Supports USB 2.0 (480Mbps) and USB 3.1 Gen 1 (5Gbps). Used for power and control (or control only if PD not supported on Control Computer).

Trigger

Reserved future use.

Clock IN

SMA connector used for sending TTL voltage level shift or pulse to external equipment. Reserved future use.

Clock OUT

SMA connector used for accepting TTL voltage level shift or pulse from external equipment. Reserved future use.

Ethernet

Control port receptacle. 100Mbps minimum (1 Gigabit Ethernet supported). Used for power (PoE, if available) and control of the Vanguard.

Ground Jack

Connected to Vanguard chassis.

3.5 Connections and LEDs Overview – Tracker

The LED indicators and various connections on the Bluetooth Tracker are described below. There are four multi-color LEDs on top of the unit, and on the sides, an antenna SMA receptacle, two Sync micro-USB receptacles (not used), a Logic/GPIO connector, and for power and control, a micro-USB with an adjacent DC jack (needed only when power supplied over the micro-USB connection is insufficient).

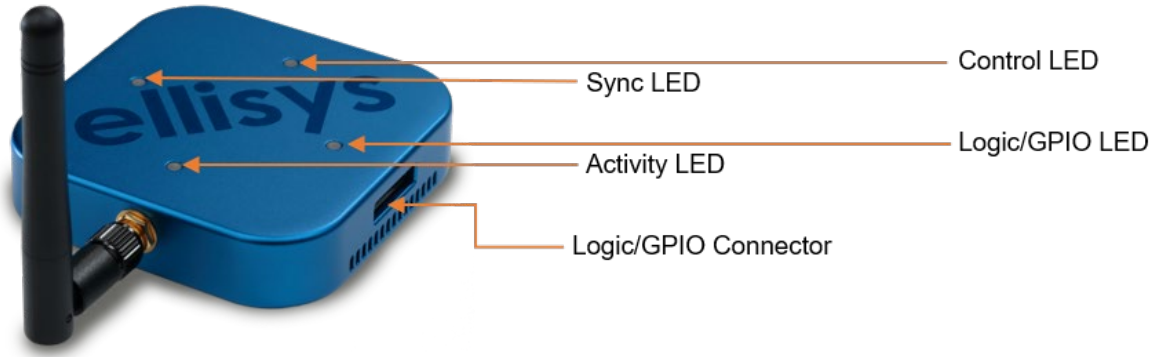


Figure 7 Tracker LEDs and Logic/GPIO Connector

Activity LED

The Activity LED, located next to the antenna, indicates whether wireless traffic is being detected. This LED will be off until a recording is started.

Off: No wireless traffic detected / unit has not been initialized with a recording.

Green blinking: BLE traffic detected.

Violet blinking: Wi-Fi traffic detected.

Green/Violet Blinking: BLE and Wi-Fi traffic detected.

Powering and Controlling the Unit

The Tracker is powered and controlled by the Control Computer over a micro-USB connection, located on the side opposite the antenna. The unit will generally require just this connection from the Control Computer, but in cases where the power provided over this connection is insufficient, the Ellisys application software will advise the user to attach an additional (supplied) cable from any Standard-A USB port on the Control Computer to the DC Jack in order to deliver the additional power required for the unit to operate.

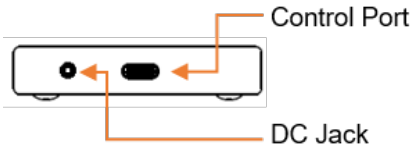


Figure 8 Tracker Control Port and DC Jack

To prevent damage to your Bluetooth Tracker, use only the cable(s) provided by Ellisys. Contact Ellisys for replacement details.

Control LED

The Control LED indicates if the unit is correctly powered at its control port from USB port on the Control Computer and whether the USB driver is loaded on the control computer.


Off: Not powered and not connected.


Blue blinking: USB control connected; driver not loaded.


Red/blue blinking: Power failure.


Blue steady: USB control connected; driver loaded.


White blinking: Driven by software applications to identify a unit.


Green steady: Analyzer active and capturing.


Red steady: Analyzer memory full.

Yellow steady: Analyzer active but not capturing.

Sync LED

Not used

Logic/GPIO LED


Red blinking: Signaling Detected

Logic Connector

The logic connector is used to attach to a flying-leads probe (supplied) for capture of logic signals, HCI (UART and SPI), I2S Audio, and generic communications (I2C, SWD, UART, and SPI). See *Section 25, Flying Leads Probe – Tracker and Vanguard* for details.

3.6 USB Driver Installation

All Ellisys Bluetooth analyzers use a USB connection, either required for operation or as an alternate method for control and connection, or power. The Bluetooth Vanguard also provides an Ethernet control connection. For the Bluetooth Tracker and Bluetooth Explorer, the USB connection is USB 2.0 (480Mbps signaling) and for Bluetooth Vanguard, it is USB 3.2 Gen 1 (5Gbps signaling), although the system will default as necessary to support USB 2.0 as well. To use the USB control connection, the USB driver must be installed.

Driver installation procedures may vary depending on the user's Operating System. Therefore, no specific driver installation procedures are described in this document. A given Operating System may present a series of dialogs to enable the driver installation, and another Operating System may make this process more automated. If assistance is needed to install the driver, please contact Ellisys at support@ellisys.com.

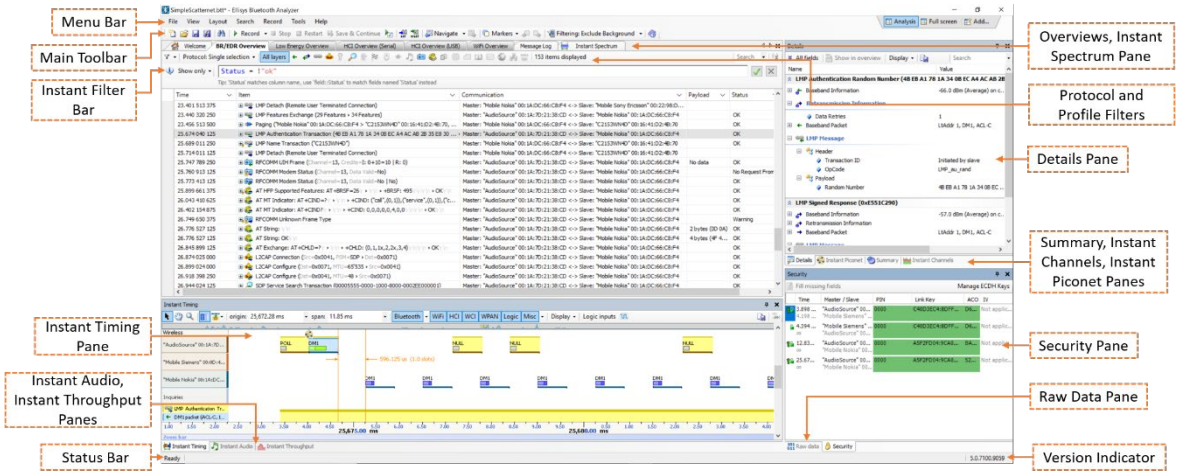
Note that the driver is included and installed with the application software installation and is located as described in the note below.

If the controlling PC does not detect the presence of the USB control port on the analyzer (or if the driver otherwise fails to install), the user can manually install the USB driver by going to the operating system's Device Manager, typically located in the Windows Control Panel, selecting the attached Ellisys analyzer, and manually pointing via "Update Driver" to the Ellisys "Drivers" folder which installs with the Bluetooth Analyzer application. This folder is typically located in your Program Files folder at [path]\Ellisys\Ellisys Bluetooth Analyzer\Drivers.

For Tracker and Explorer USB control connections, Ellisys recommends that you connect the unit to a high-speed (480Mbps) USB 2.0 port or a USB 3.2 port (which will default to USB 2.0 high-speed on attach to Tracker and Explorer). For Vanguard (Type-C) USB control connections, Ellisys recommends that you connect the unit to a port capable of operating using USB 3.2 Gen 1 (5Gbps).

4. User Interface Reference

The user interface of the Analyzer application provides various windows, panes, menus, toolbars, and other visual and control elements. All panes are dockable and can be hidden, resized, and re-positioned to suit the needs and preferences of the user. Most panes are inter-linked to provide synchronization with other panes and include various display options.



The Analyzer application displays several windows and panes in the default layout. Each pane displays specific information or allows the user to interact with the software for a given task:

Overviews – Displays chronological and highly configurable records of traffic and events recorded for all supported wired and wireless traffic, including BR/EDR, BLE, HCI (UART, SPI, USB), WCI-2, WPAN, Generic Communications (I2C, UART, SPI, SWD) and a Message Log.

Details Pane – Displays a detailed breakdown of the event selected in the active Overview.

Raw Data Pane – Displays the raw data of the event selected in the active Overview. Fields selected in the Details Pane are yellow highlighted here.

Instant Timing Pane – Displays a graphical representation of Bluetooth and Wi-Fi packets, HCI, generic communications, and logic signals captured, and allows for various timing analyses, throughput indications, and statistical information.

Instant Spectrum – Displays spectral RF energy characteristics from any sources in the 2.4GHz ISM spectrum used by Bluetooth (2400-2480 MHz), concurrent with precision overlay of Bluetooth, Wi-Fi, and WPAN packets, as well as statistical information on Bluetooth transmission characteristics.

Instant Audio Pane – Displays captured over-the-air and HCI audio streams and provides a variety of controls including real-time audio play, playback, looping, and other features.

Instant Piconet Pane – Displays a graphical representation of devices, piconets, and scatternets, along with connection and topology characteristics, throughput, and RSSI indications.

Instant Filter Bar – Text query approach that uses programmatic entries to precisely filter the contents of the active Overview.

Instant Channels Pane – Displays various per-channel transmission statistics.

Instant Throughput Pane – Displays various data throughput characteristics.

Security Pane – Displays security information and allows for user input of Link Keys, PIN, etc.

Mesh Security Pane – Displays keys relating to Mesh protocol and allows for various user inputs.

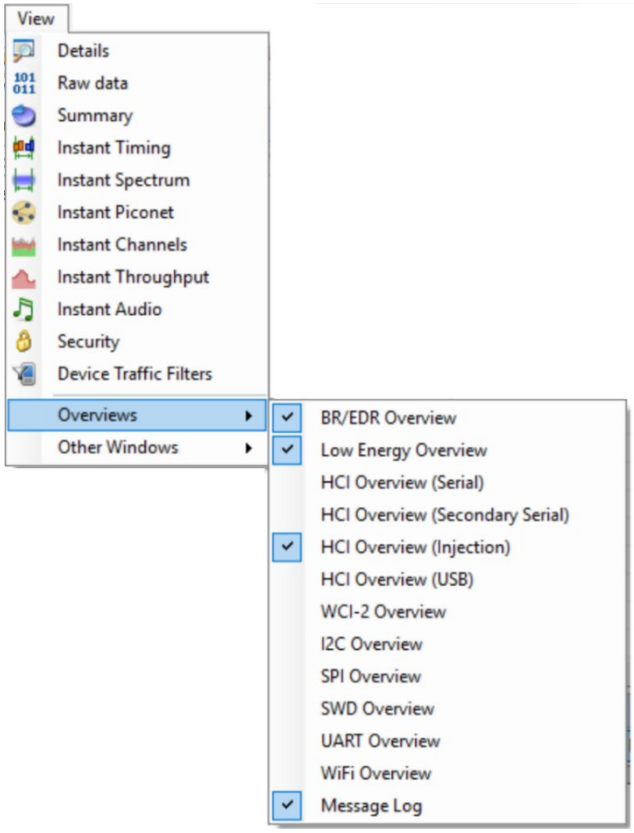
Message Log – Provides a way for users to enter text data to be displayed in time with traffic captured. Can also be used by the Injection API to programmatically inject information from other sources (see *Section 7.7, Ellisys Injection API*).

4.1 Organizing Panes

The various panes provided can be shown or hidden, moved, docked, and resized to suit the user's preferences. See *Section 6.2, Using Layouts* for more information on saving display preferences.

To open or display a pane or an Overview:

1. Select **View** in the menu and select the desired pane or Overview.



To close a pane:

1. Click on **Close** positioned at the top-right corner of the title bar of the pane.

To hide a pane:

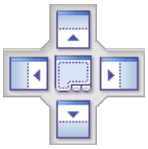
1. Click on **Auto-Hide** positioned at the top-right corner of the title bar. The pane is then hidden, and the pane's name will appear as a tab at the right side of the screen.

To move a pane or a window:

1. Click on the title bar of the desired pane or window.

2. Depress and hold the left mouse button and drag the pane or window.

A window placer appears:



3. Keep the mouse button depressed and point to one of the following:

Center to open a pane as a floating window in the screen.

Top to move the pane to the top of the screen or pane group.

Right to move the pane to the right of the screen or pane group.

Left to move the pane to the left of the screen or pane group.

Bottom to move the pane to the bottom of the screen or pane group.

4.2 Main Toolbar

The table below shows the Analyzer toolbar buttons and their actions:

	**New**	Creates a new empty capture file.
	**Open**	Opens a previously saved capture file.
	**Save**	Saves a capture file.
	**Save Filtered Copy**	Saves a filtered capture file (devices that are filtered-in).
	**Search**	Opens the Search dialog.
	**Record**	Starts a recording on the selected analyzer.
	**Stop**	Stops the current recording.
	**Restart**	Aborts current recording and restarts a new one.
	**Save and Continue**	Saves the current capture and starts the next.
	**Set**	Sets the line selected in an Overview at 0.000 000 000 or to a value selectable by the user.
	**Reset**	Resets the time reference to its original value.
	**Navigate**	Navigate to the previous selection history.
	**Markers**	Opens the Markers menu.
	**Go to Previous Marker**	Jumps to previous marker.
	**Go to Next Marker**	Jumps to next marker.
	**Filtering**	Opens the Device Traffic Filters menu.
	**User Guide**	Opens the User Guide.

4.3 Main Menu

The table below shows the Analyzer's main menu options and their actions, with shortcuts shown in parentheses:

File

	**New** (Ctrl+N)	Creates a new capture file.
	**Open** (Ctrl+O)	Opens a folder to open a previously saved capture.
	**Save** (Ctrl+S)	Saves the current capture.
	Save As...	Saves the current capture to a new name.
	**Save Filtered Copy**	Saves the current capture as defined by the Traffic Filter.
	Load Sample	Opens sample files provided with application.
	Trace Information	Provides details on the trace currently opened.
	Share to Cloud	Opens a dialog allowing the user to upload capture to the Ellisys secure cloud storage.
	Retrieve from Cloud	Opens a dialog allowing the user to retrieve a shared capture from the Ellisys secure cloud storage.
	Import (Ctrl+P)	Imports a file to view in the analyzer application.
	Export (Ctrl+E)	Exports a capture to various formats.
	Switch Workspace	Switch to a different Workspace or to create a new Workspace.
	Import and Export Settings	Opens the Import and Export Settings Wizard.
	**Page Setup**	Opens Page Setup dialog allowing user to set page margins and other printing parameters.

	**Print Preview**	Opens the Print Preview window.
	**Print**	Print the selected Overview window.
	Exit	Closes the application.

View

	**Details**	Opens the Details pane.
	**Raw Data**	Opens the Raw Data pane.
	**Instant Timing**	Opens the Instant Timing pane.
	**Instant Spectrum**	Opens the Instant Spectrum window
	**Instant Piconet**	Opens the Instant Piconet pane.
	**Instant Channels**	Opens the Instant Channels pane.
	**Instant Throughput**	Opens the Instant Throughput pane.
	**Instant Audio**	Opens the Instant Audio pane.
	**Security**	Opens the Security pane.
	**Mesh Security**	Opens the Mesh Security pane.
	**Device Traffic Filters**	Opens the Device Traffic Filters window.

View | Overviews

	BR/EDR Overview	Opens the BR/EDR Overview.
	Low Energy Overview	Opens the Low Energy Overview.

HCI Overview (Serial)	Opens the Serial HCI Overview.
HCI Overview (Secondary Serial)	Opens the Secondary Serial Overview.
HCI Overview (Injection)	Opens the Injection HCI Overview.
HCI Overview (USB)	Opens the USB HCI Overview.
HCI Overview (WCI-2)	Opens the WCI-2 Overview.
I2C	Opens the Generic I2C Overview.
SPI	Opens the Generic SPI Overview.
SWD	Opens the Generic SWD Overview.
UART	Opens the Generic UART Overview.
WiFi Overview	Opens the Wi-Fi Overview.
WPAN Overview	Opens the WPAN Overview.
Message Log	Opens the Message Log.

View | Other Windows

 **Welcome**	Opens the Welcome screen.
 **Tasks**	Opens the Tasks pane.

Layout

Full Screen	Changes the layout to the Full Screen layout.
Analysis	Changes the layout to the Analysis layout.
 **New Layout**	Creates a new layout based on the current layout.

Rename Layout	Renames the existing layout.
Reset Layout	Resets the existing layout to default.
Delete Layout	Deletes the user-defined layout.

Search

Search (Ctrl+F)	Opens the Find menu.
Search In	Designates the Overview in which to search
 **Instant Search** (Ctrl+I)	Places the cursor in the Instant Search window.
Go To (Ctrl+G)	Opens the Go To Item window.
Go To Next	Expands a menu to enable search for next various Bluetooth or HCI items.
Go To Previous	Expands a dialog to enable search for previous various Bluetooth or HCI items.
Find Next (F3)	Searches forward for the last event found in a search.
 **Navigate Backward** (Alt+Left)	Navigate to the previous selection history.
 **Navigate Forward** (Alt+Right)	Navigate to the next selection history.

Record

 **Start Recording** (Ctrl+R)	Starts a recording.
 **Stop Recording** (Ctrl+Shift+R)	Stops the current recording.

Save and Continue Recording	Forces save of current capture and restarts the recording
Restart Recording	Aborts the current recording and starts a new one.
Select an Analyzer	Opens the Available Analyzers dialog to allow for selection of attached analyzer to be used or opens Injection API.
Recording Options	Opens the Recording Options dialog.

Tools

Prepare support info	Opens a Save-As dialog to save technical support information in a compressed format.
Web control interface	Opens the *Web Capture Control* interface in default browser
Remote control interface	Opens the *Remote Control* tab in Options
Set Time Reference (Ctrl+T)	Sets the time of the line selected in the current Overview at 0.000 000 000 or to a value selectable by the user.
Reset Time Reference (Ctrl+Shift+T)	Resets the time reference to its original value.
Hopping Sequence Calculator	Opens a BLE hopping sequence calculator. See *Section 21, BLE Hopping Sequence* Calculator.
Options	Open the Options dialog.

Help

User Guide	Opens the User Guide.
Ellisys website	Opens the Ellisys website in the default browser.

	**Contact support**	Opens a form in the default browser to contact Ellisys technical support.
	Download Offline Installer	Downloads the analyzer application installation file.
	Check for updates	Checks online for the latest software version.
	**About**	Opens the About window. When unit is attached to the controlling computer, also provides information on enabled features.

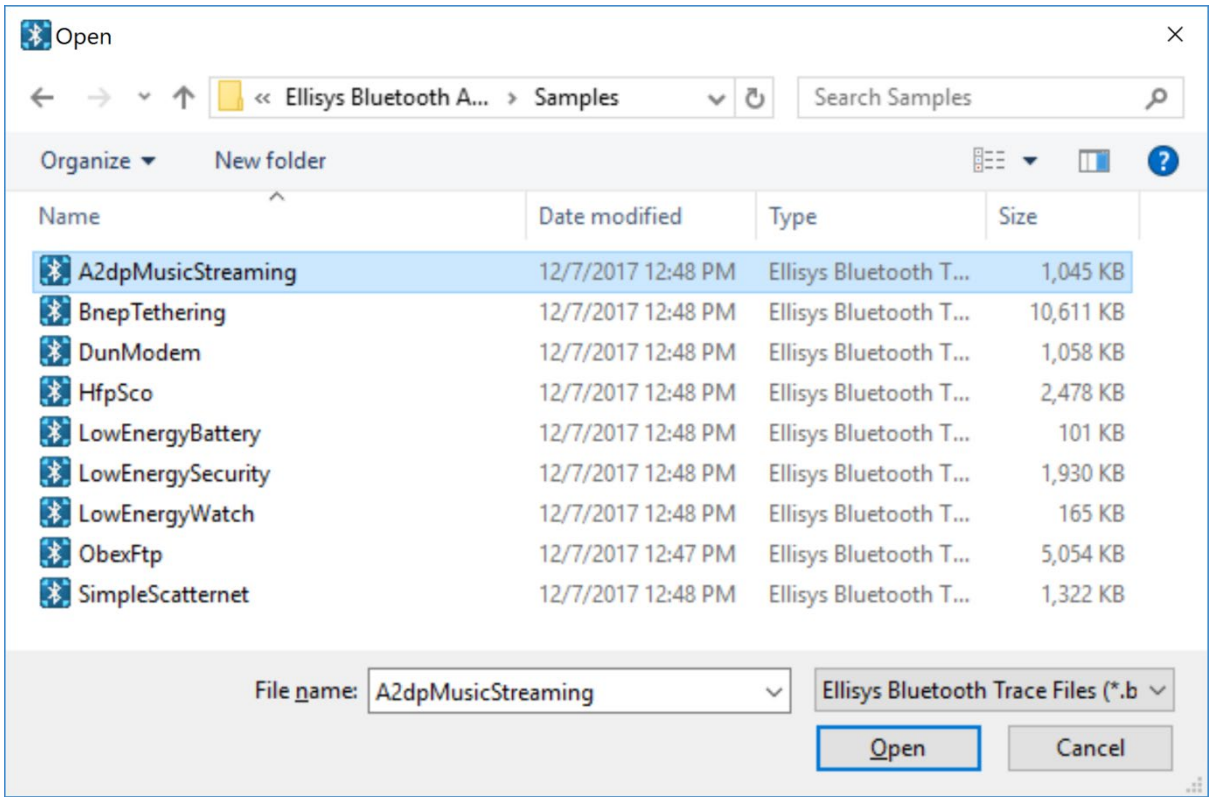
5. Managing Capture Files

5.1 Opening a Capture File

To open a capture file:

1. Select **File | Open** in the menu or click on **Open.**

The *Open* menu appears:



5.2 Saving a Capture File

To save a capture file:

1. Select **File | Save** in the menu or click on **Save.**

To save a capture file with a new name:

1. Select **File | Save As** in the menu**.**

2. Navigate to the directory where the file is to be saved, enter the desired name of the file in the **File name** field and click on **Save**.

5.3 Saving a Filtered Copy of a Capture File

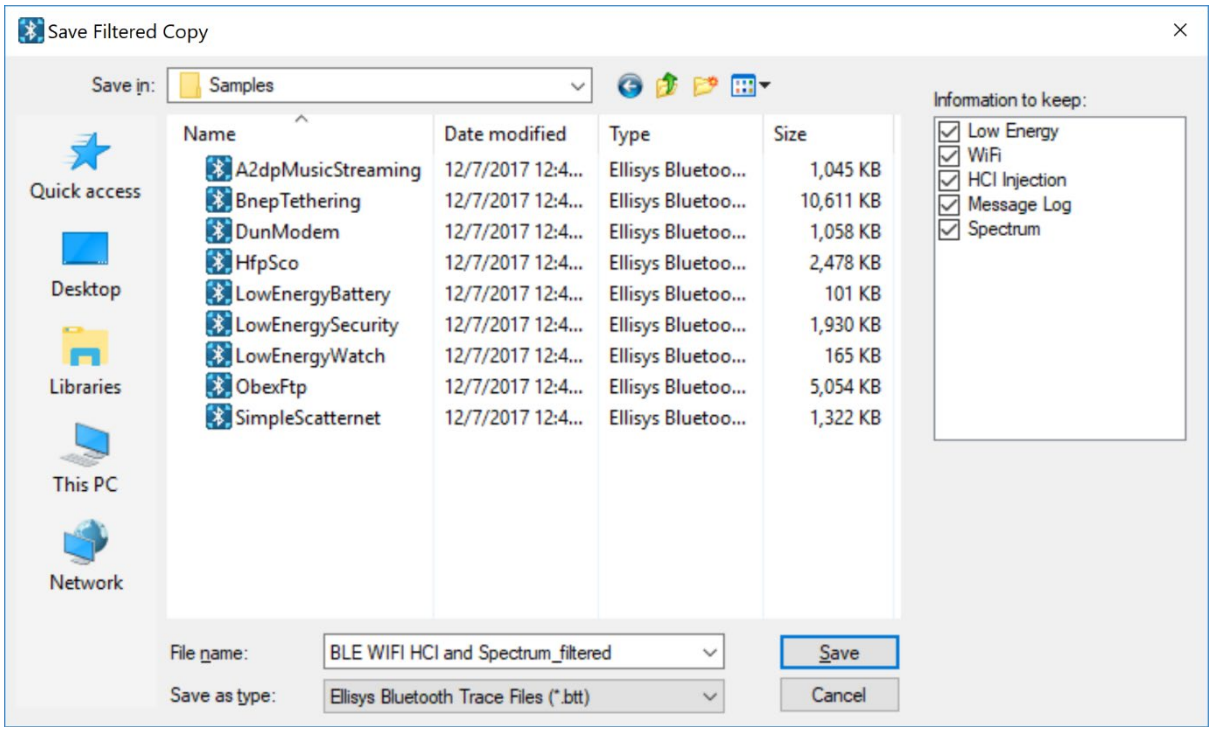
The analyzer captures traffic from all neighboring Bluetooth devices (for Wi-Fi, the capture is more specific, based on Wi-Fi channel selections in **Recording Options | Wireless**). The application provides a device filter to allow the user to display only the device(s) of interest (see *Section 9.6 Bluetooth Device Traffic Filter*). For Bluetooth devices, once this filter is configured, the user can save a filtered version of the capture containing just the traffic involving the selected devices. This approach can greatly reduce file size.

There is a convenient method to include/exclude components of a capture (such as BLE or BR/EDR traffic, Wi-Fi traffic, raw spectrum data, HCI, etc.). This is done in the *Save Filtered Copy* dialog (shown below) at the right side of the dialog in box labelled *Information to keep*. This can help reduce file size.

When using *Save Filtered Copy*, the *File Name* box appended with *_Filtered* to avoid potentially overwriting the original file.

To save a filtered version of a Bluetooth capture file:

Configure the *Device Traffic Filter* as desired then select **File | Save Filtered Copy**.



5.4 Opening a Sample Capture File

Several sample capture files are included with the application. These can be useful for studying typical operations of various profiles and protocols and for learning the Ellisys software application.

To open a sample file:

1. Select **File | Load** Sample in the menu.
2. Click on the desired sample.

5.5 Sharing a Capture File to the Cloud

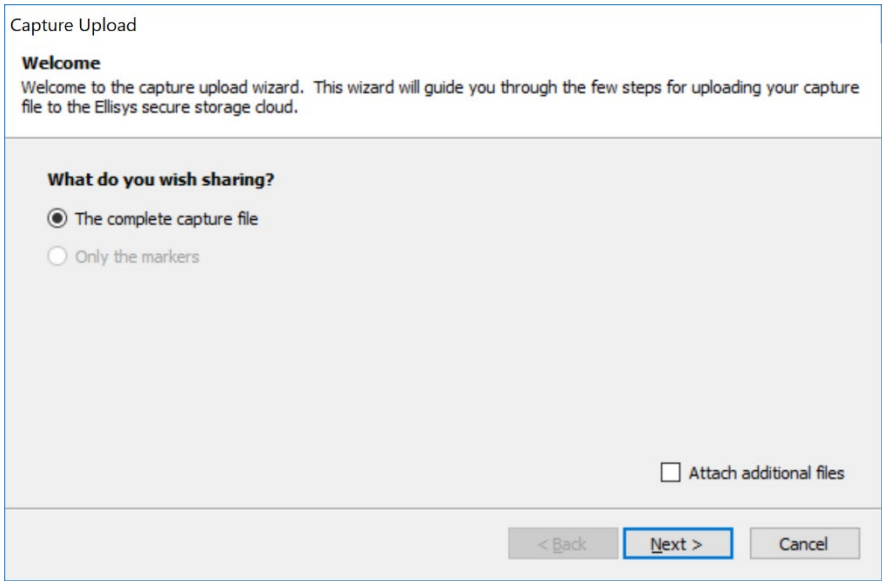
The application provides a convenient feature allowing users to share a capture file, markers, and optionally other files, to the Ellisys secure storage cloud for retrieval by other persons who also have an installation of the Ellisys software application. Note that Ellisys does not have access to files stored via this method, and the Sharing ID, created on upload, is the only way to access files uploaded.

Capture files can be quite large and can exceed the limits of most E-mail systems. Sharing saved capture files (or Bookmark files) to other users through the Ellisys secure storage cloud is a convenient method to collaborate with other users.

To share a file to the Cloud:

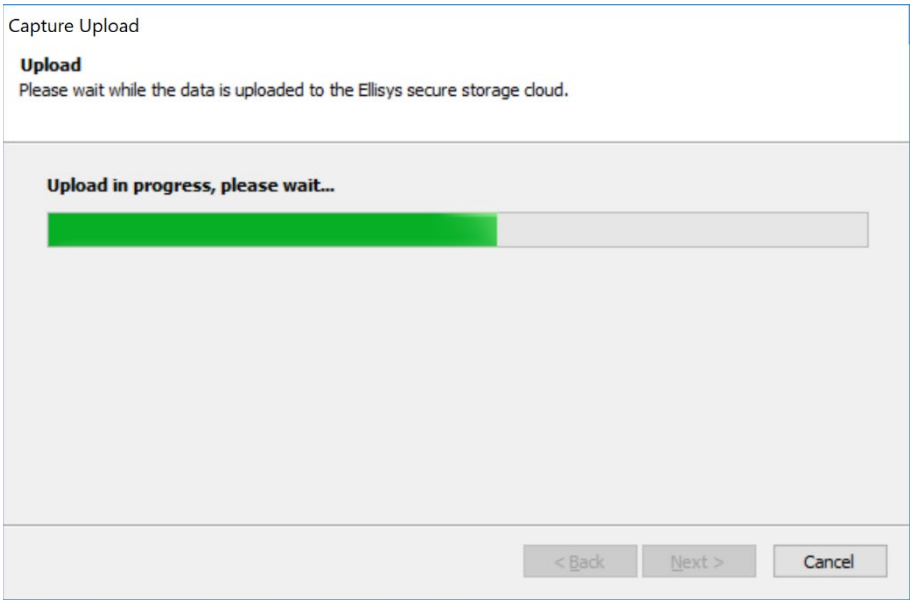
1. Open the capture file to be uploaded to the cloud.
2. Select **File | Share** to cloud in the menu.

The *Capture Upload* dialog appears:

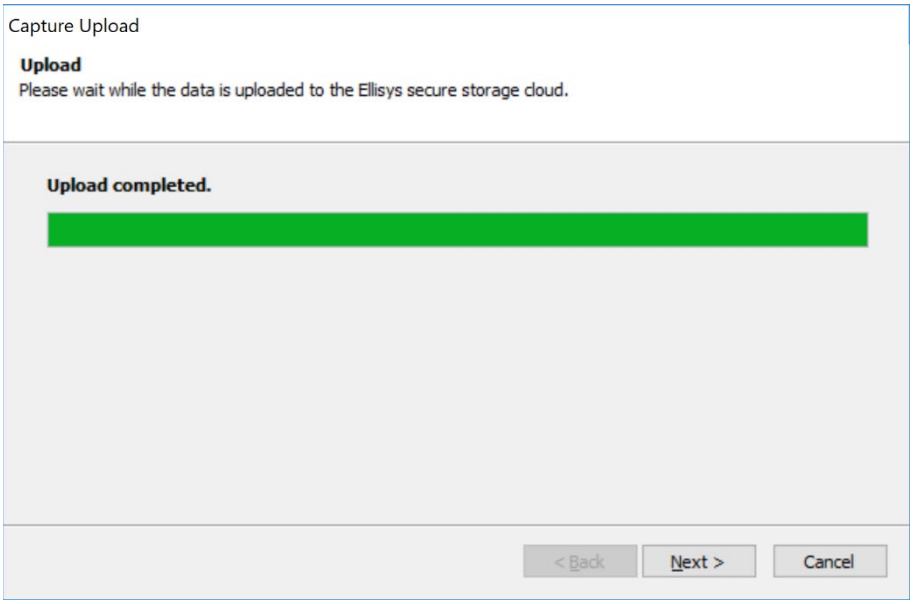


3. Select the **Attach additional files** checkbox if files in addition to the capture files are to be uploaded to the Cloud, then click **Next**.

The *Capture Upload* dialog shows **Upload in progress**:

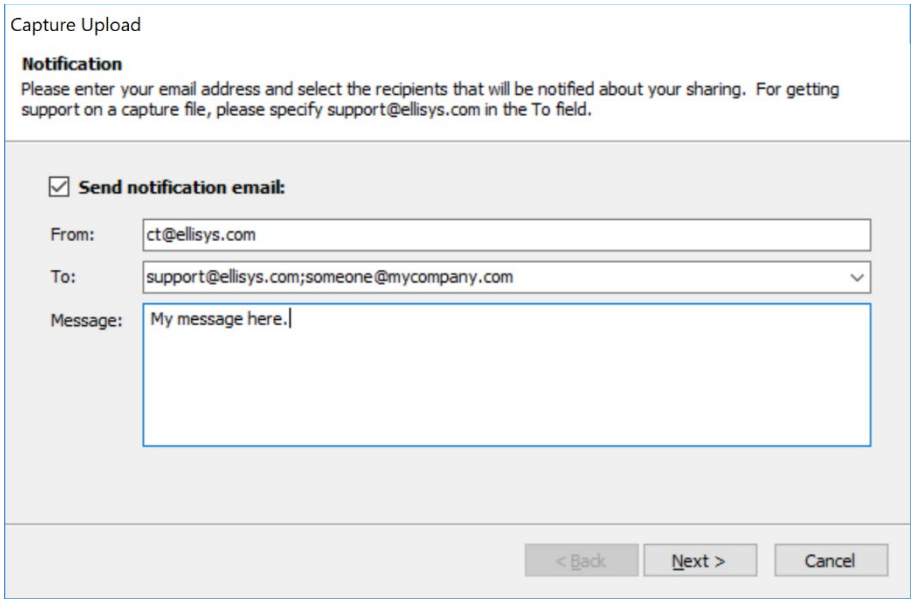


When the upload is complete, the *Capture Upload* dialog shows **Upload Completed**:



4. Click **Next**

The *Capture Upload Notification* appears:



5. If desired, check the **Send notification email** checkbox to have an email sent to notify one or more recipients of your shared file(s).

Separate individual email addresses with a comma or semi-colon.

To send your capture file to Ellisys Technical Support, please include support@ellisys.com in the **To:** field.

6. If **Send notification email** was checked, the specified recipient(s) will receive an email with retrieval instructions, as shown below:

Hello,

The following files have been shared for you on the Ellisys storage cloud by me@mycompany.com:

- DunModem.btt (1.03 MB)
- ellisys.bmp (365 kB)

Shared files can be retrieved from the Ellisys software, in the File > Retrieve menu, by using this identifier:

{cc19d6e4-c962-46aa-bdd6-d1dfff6d25c9}

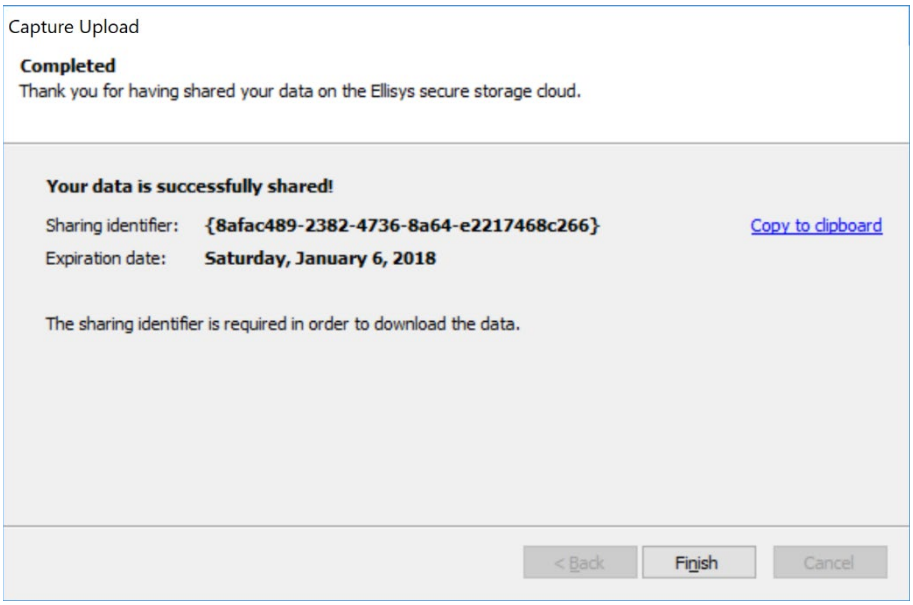
Message from the sender:

test

Thank you for using Ellisys products!

7. Click **Next**.

The *Capture Upload Completed* dialog appears:



8. If desired, click on **Copy to clipboard** to copy the *Sharing Identifier* to your system's clipboard. This identifier is needed to retrieve the shared file(s).

The sending of the E-Mail generated by the Ellisys software application may be blocked by your E-Mail server rules. In these cases, simply copy the Sharing ID using the step described above and use your E-Mail application to send this this to the recipient.

9. Click **Finish**.

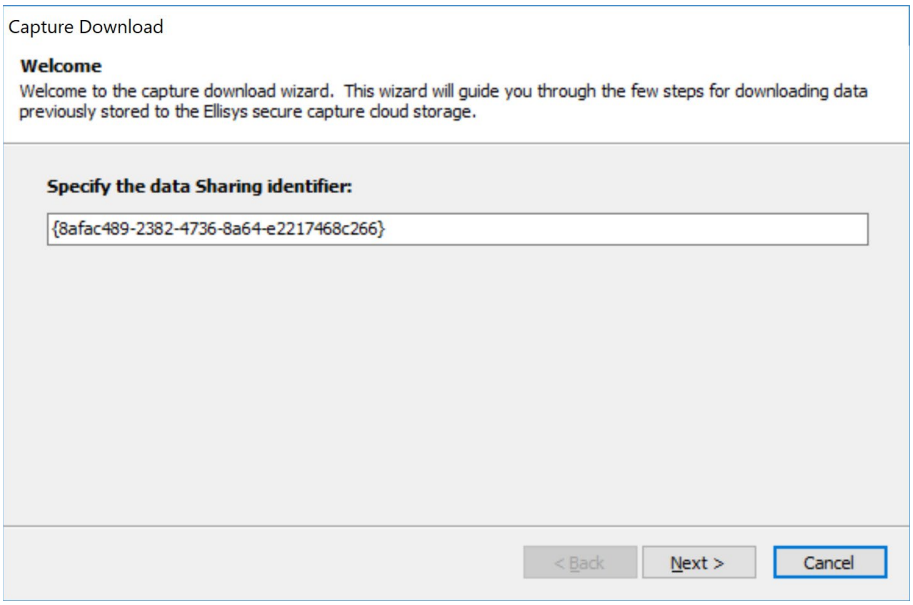
5.6 Retrieving a Shared Capture File from the Cloud

Once a capture file is uploaded to the cloud, it is accessible only to persons having the sharing identifier (produced during the upload) and the Ellisys software application. Ellisys does not have access to this identifier or to any files uploaded via this method.

To retrieve a shared file:

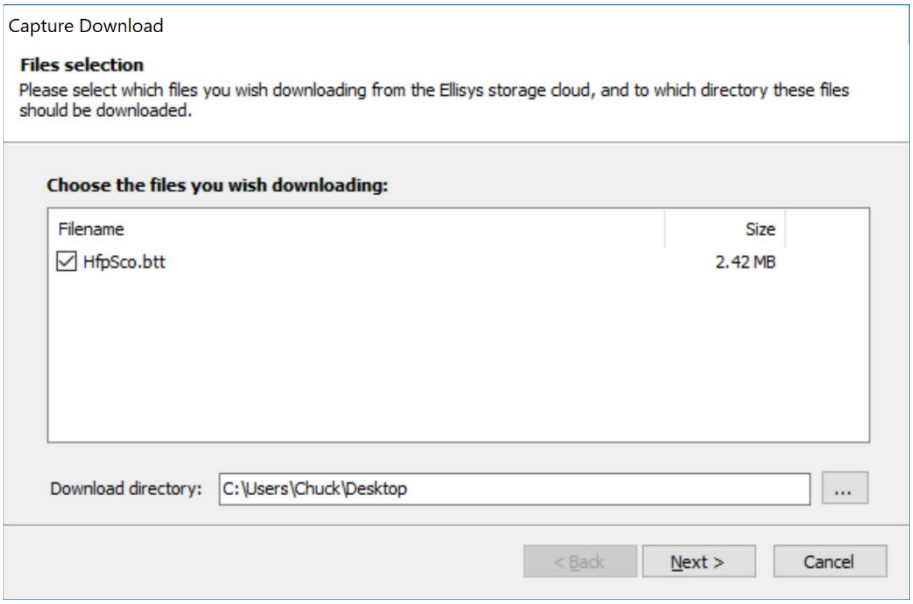
1. Select **File | Retrieve** from cloud from the menu.

The *Capture Download* dialog appears:



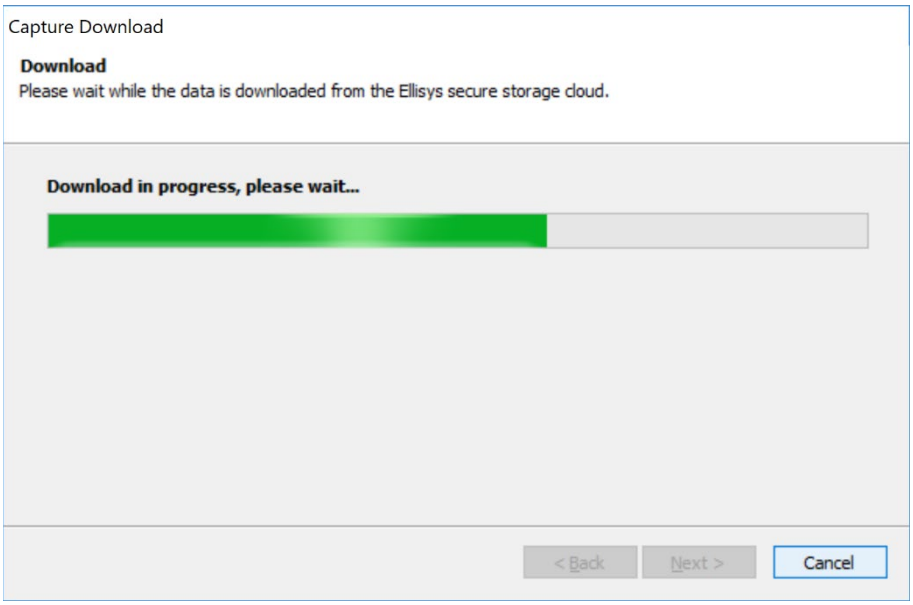
2. The Sharing ID will auto-paste if it is copied to the Windows clipboard, but otherwise simply enter the *Sharing Identifier* in the box (include the brackets) and click **Next**.

The *Capture Download, Files Selection* dialog appears, listing the available shared files.

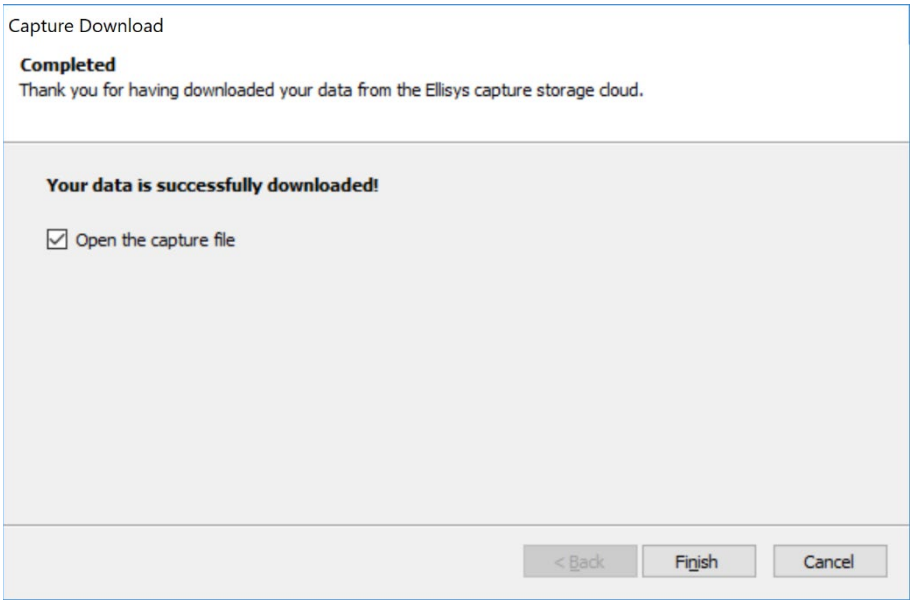


3. Uncheck any files not desired for download.
4. Specify a destination in the Download directory box.
5. Click **Next** to begin the download.

The *Capture Download Progress* dialog appears



When the download completes, the *Capture Download Completed* dialog appears:



6. If desired, check **Open the Capture File** checkbox to open the shared capture file.

7. Click **Finish**.

5.7 Printing a Capture File

Use the *Page Setup* option, **File | Page Setup**, to setup how the capture should be printed. This option will depend on the printer; please see your printer's documentation for more information.

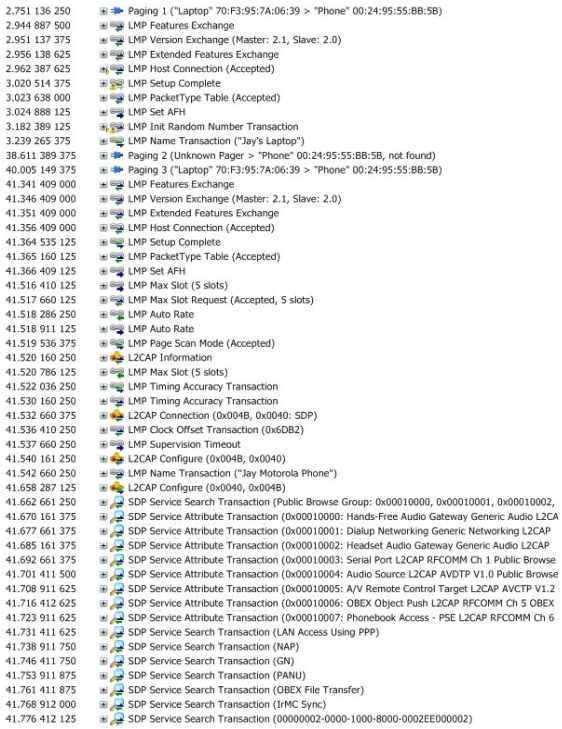
To preview a print job:

1. Select **File | Print Preview** from the menu.

2. Select the *Overview* desired.

A file can be very large therefore it is advisable to check the size of the file before trying to print the file.

The *Print Preview* window appears:



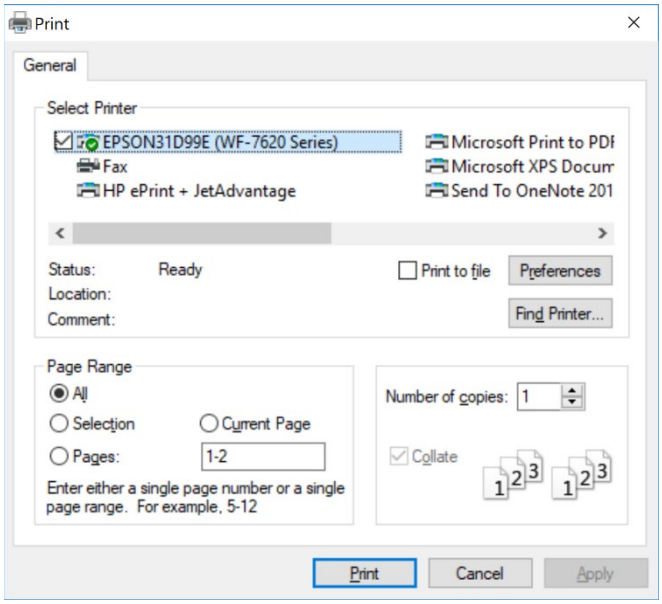
3. Print directly from the *Print preview* window using the print icon or select **Close** to return to the capture file.

To print a file:

1. Select **File | Print** in the menu then select the desired Overview.

2. Select the *Overview* desired.

The *Print* window appears:



3. Select the printer and printer setup if required.

4. Select **Print**.

The file is printed.

5.8 Importing Data to View in a Capture File

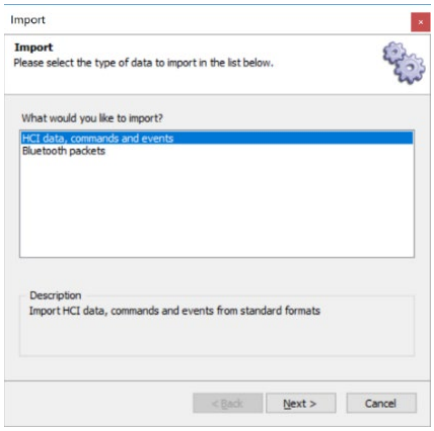
The application permits the user to import data from certain files types for display in the Ellisys viewer format. The analyzer hardware is not required for these operations. HCI commands and events may be imported from the Wireshark BT Snoop format (www.wireshark.org), from the Ellisys VisualUSB USB 2.0 software application (www.ellisys.com/products/usbex200/download.php) or from Ellisys Bluetooth captures. Additionally, Bluetooth raw packets may be imported from an ASCII format.

In addition to the standard import features, a command line switch is available to open Wireshark BT Snoop files, using /import"c:\log.btsnoop"

To import HCI commands and events or Bluetooth packets:

1. Select **File | Import** in the menu.

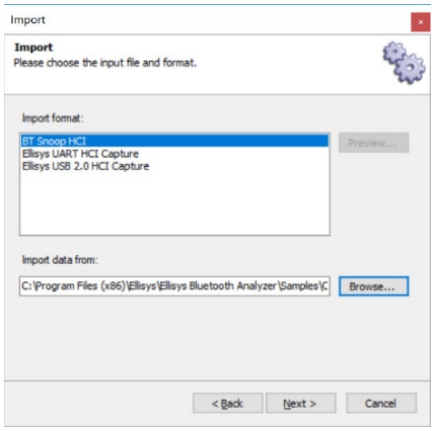
The *Import* menu appears:



2. Select **HCI commands and events** or **Bluetooth packets**.

3. Click on **Next**.

An *Import File and Format* Menu appears.



4. Browse to the desired files and follow the prompts to import the data.

The data will be displayed in the *HCI Overview (Injection)*, accessible from **View | Overviews**.

5.9 Export Options

A capture file can be exported for various purposes and in several formats.

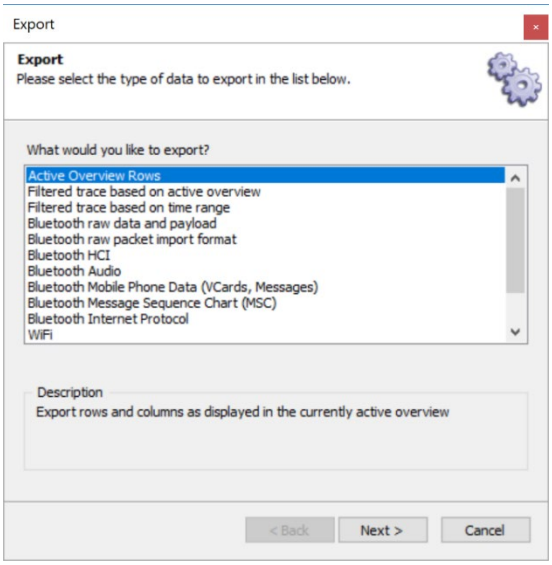
Export Type	*Export Options*	*Export Format*	*Comments/Usages*
Active Overview Rows	Export Displayed or Export All Hierarchy selections	CSV, XML, XLXS	Export rows and columns as displayed in the currently active overview.
Filtered trace based on Active Overview	None	Ellisys trace (*.btt)	Export a filtered trace based on the active overview filters.
Filtered trace based on time range	Start Time Trace Length (Bytes, seconds, items)	Ellisys trace (*.btt)	Export a portion of the trace based on a time range.
Bluetooth raw data and payload	Fields (Name, Time, Data) Hierarchy (Root items, All items, Up to specific level) Export Displayed or Export All	Text, CSV, XML, Binary	Export Bluetooth raw data or payload of items as in the overview to text, CSV or XML format file. Export whitened, encrypted, raw data, or payload only.
Bluetooth raw packet import format	None	ASCII	Export Bluetooth raw packet import format.
Bluetooth HCI	Start Time Trace Length (Bytes, seconds, items)	Libpcap HCI (Wireshark) BT Snoop	Export HCI traffic displayed in the active overview.

Export Type	*Export Options*	*Export Format*	*Comments/Usages*
Bluetooth Audio	PCM Synchronization buffer length	WAV	Export LC3, SCO, eSCO, A2DP, and other codecs (from active overview) and I2S audio.
Bluetooth Mobile Phone Data (VCards, Messages)	Single File One file per transfer/item	Mobile Phone Data, *.vcf	Export Mobile Phone related information such as VCards or Short Messages from active overview.
Message Sequence Chart (MSC)	Procedures, scale, orientation, various display options	*.PDF, *.PNG	Export the active Bluetooth Overview items as Message Sequence Chart (MSC).
Bluetooth Internet Protocol	None	Wireshark PCAPNG	Export (filtered) Bluetooth IP carrier protocols like DUN, BNEP from active Overview.
WiFi	None	Wireshark PCAPNG	Export WiFi packets to Wireshark 802.11 PcapNg file.
WPAN	None	Wireshark PCAPNG	Export WPAN packets to Wireshark PCAPNG file.
Spectrum	Export All Export Time Range	CSV	Export spectrum RSSI samples for each channel. Requires enabling the Spectrum capture in the Recording Options.
Logic Signals	None	CSV	Export logic signals transitions.
I2S PCM	None	WAV	Export decoded I2S PCM trace data.

To use the export feature:

1. Open the desired capture file.
2. Select **File | Export** from the menu.

The *Export* menu appears:



3. Select the desired export method.
4. Click on **Next**.
5. Select desired export options as applicable and click on **Next**.
6. Follow the prompts as applicable to complete the selected export.

Export of Active Overview Rows

With this selection, the user can export from the Overview that is selected (active). The user may specify the columns to be exported or may specify that all displayed columns be exported. See *Section 8.1, Configuring the Overview Columns,* for information on adding columns to an Overview. CSV and XML export formats are provided.

To customize the columns displayed in the Overview, right click on the column headers in the Overview and add columns from a default list or drag desired fields from the Details view and drop in the Overview to create a new column.

Export Filtered Trace Based on Overview

With this selection, the user can export the current trace based on the filtering applied.

Export Filtered Trace Based on a Time-Range

The user can export a portion of a trace to a new trace, based on a time range, number of bytes, or number of items.

Export of Bluetooth Raw Data and Payload

With this selection, the user can export into raw data (including headers, etc.) and/or payload into CSV, text, or XML formats. The item's name and timestamp can be exported or excluded. The user may include root items only or may select a hierarchy of items to export.

Export of Bluetooth Raw Packet Input Format

With this selection, the user can export the packets in a capture to an ASCII format.

Export of Bluetooth HCI

Export the active Bluetooth HCI Overview to BTSnoop or Wireshark formats.

Export of Bluetooth Audio

With this selection, the user can quickly export captured audio streams in the active Overview to WAV format. A PCM (Pulse-Code Modulation) selection allows the user to specify buffering, no buffering, or to select a specific synchronization buffer length. Audio streams are exported by direction, and individual audio streams are exported into separate WAVfiles.

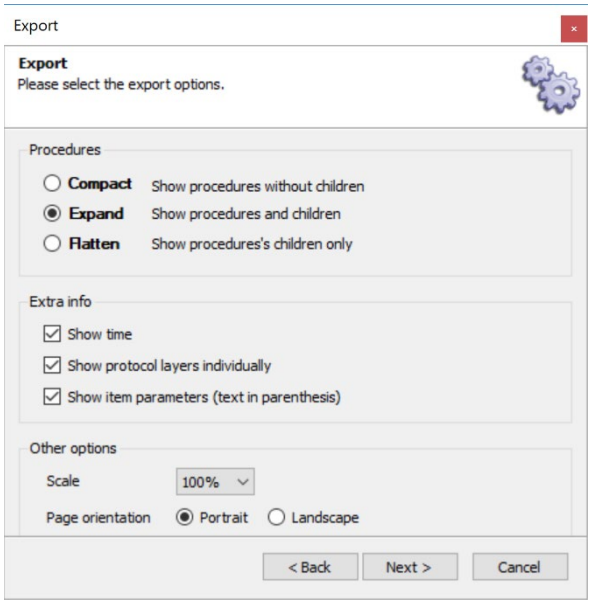
Export of Bluetooth Mobile Phone Data

With this selection, the user can export mobile phone information, including VCard and short messaging. The user can elect to export a single file, one file per transfer, or one file per item. If a photo is attached to the export, the user may elect to include or exclude the photo.

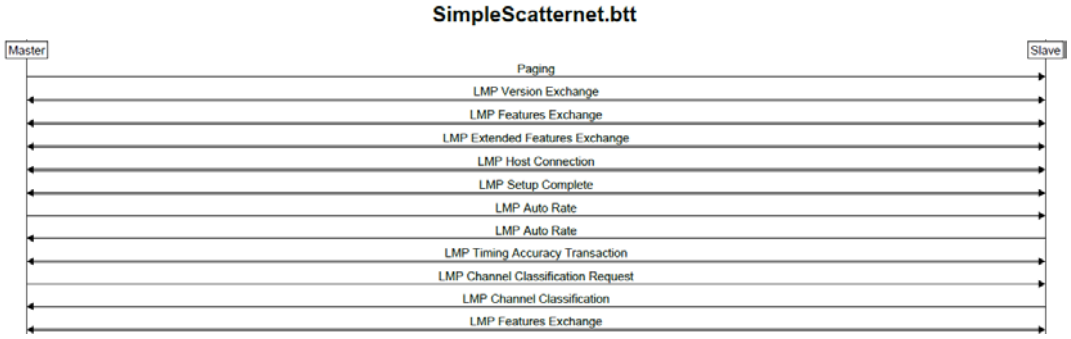
Export of a Message Sequence Chart

This selection exports a graphical depiction of message procedures from the active Overview. The display of procedures is controlled by selections available in the export menu, including **Compact**, **Expand**, and **Flatten**, as shown below.

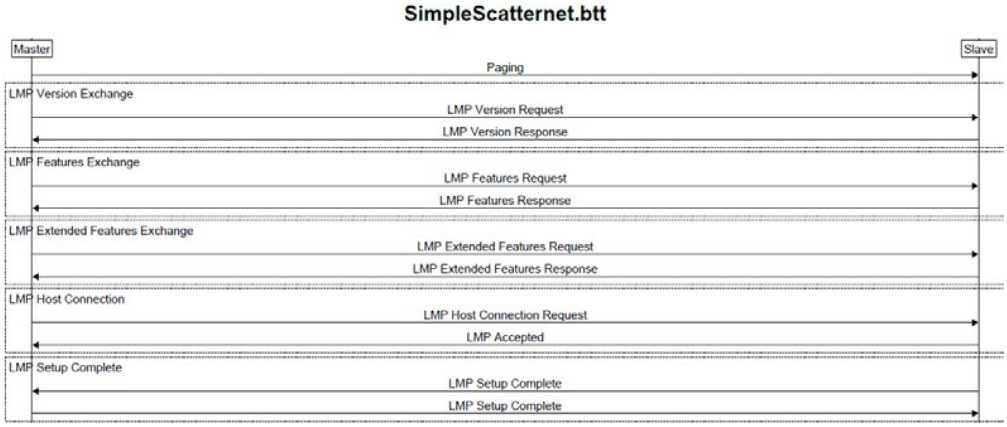
Various export options are available, including display of timestamps, protocol layers, item parameters, scale, and page orientation, as shown below:



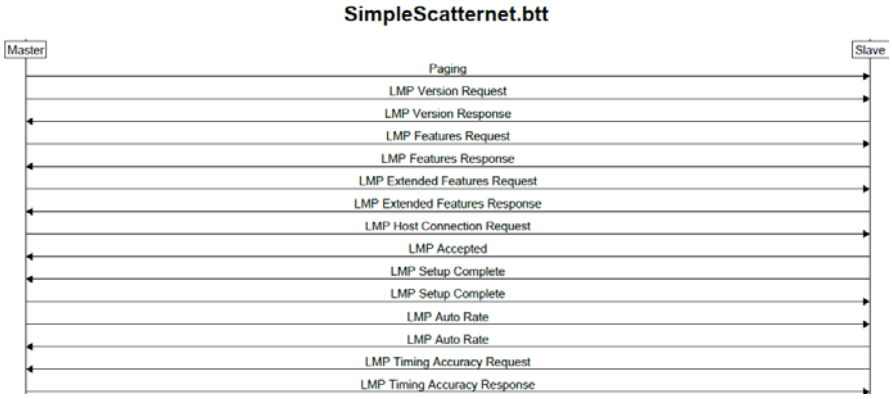
Compact (Shows Procedures without Children). LMP only is displayed for simplicity.



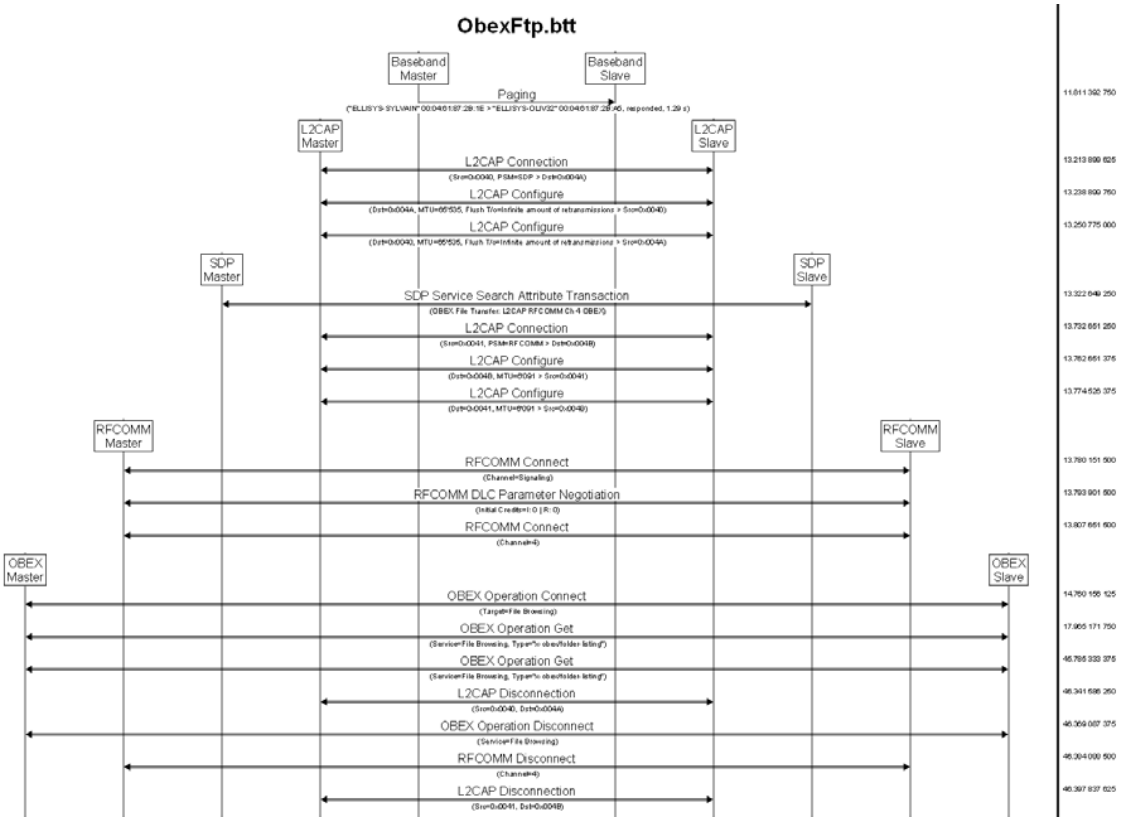
Expand (Shows Procedures and Children). LMP only is displayed for simplicity.



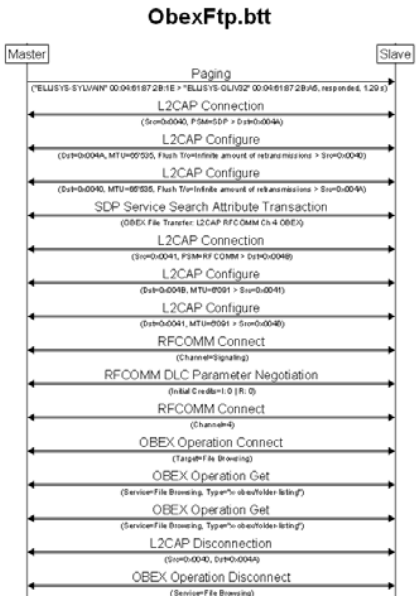
Flatten (Shows Procedures' Children Only). LMP only is displayed for simplicity.



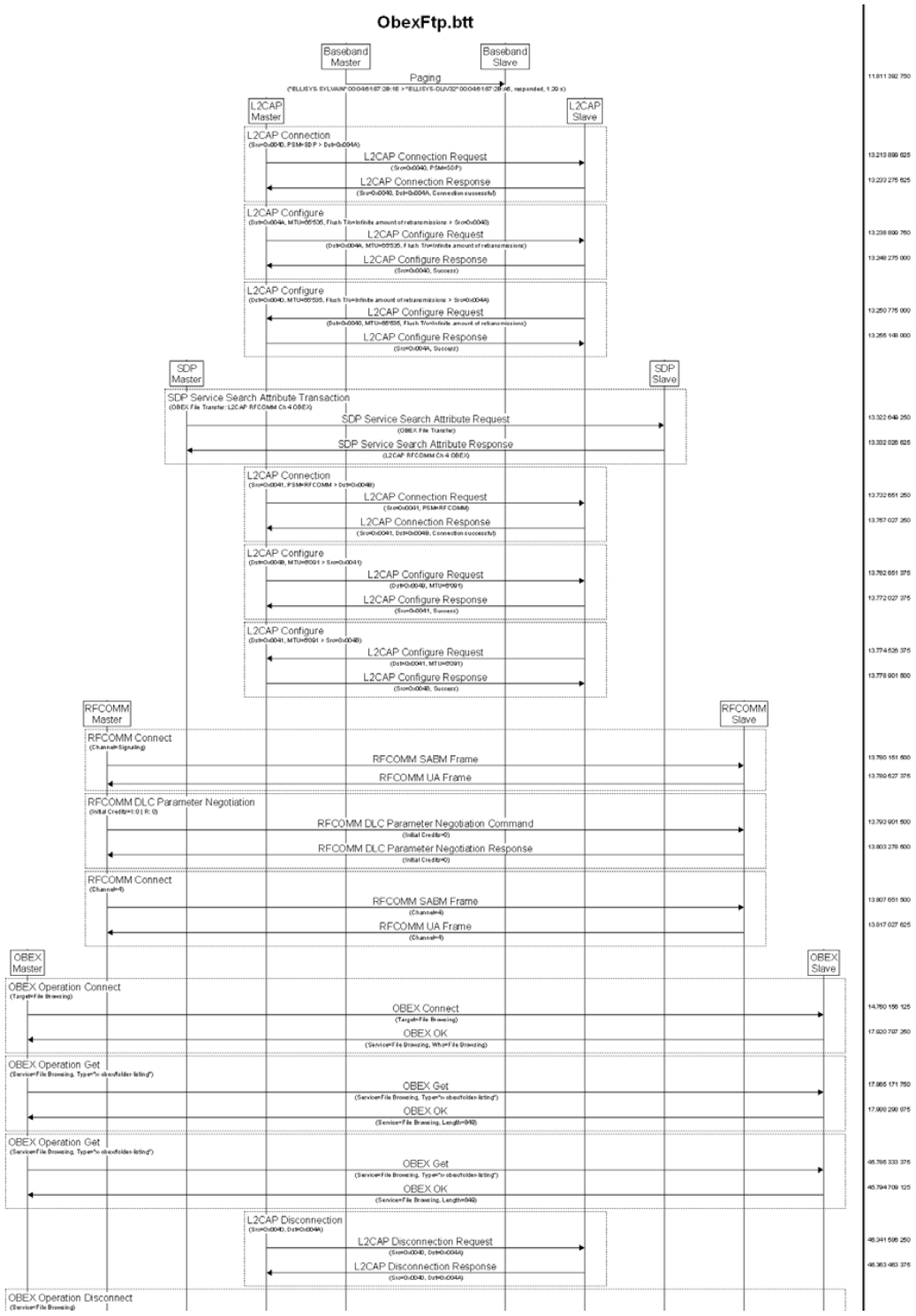
Below is an example of an MSC export, using the **Compact** selection, showing timestamps, item parameters, and procedures involving Baseband, L2CAP, SDP, RFCOMM, and OBEX. The option **Show Protocol Layers Individually** is selected.



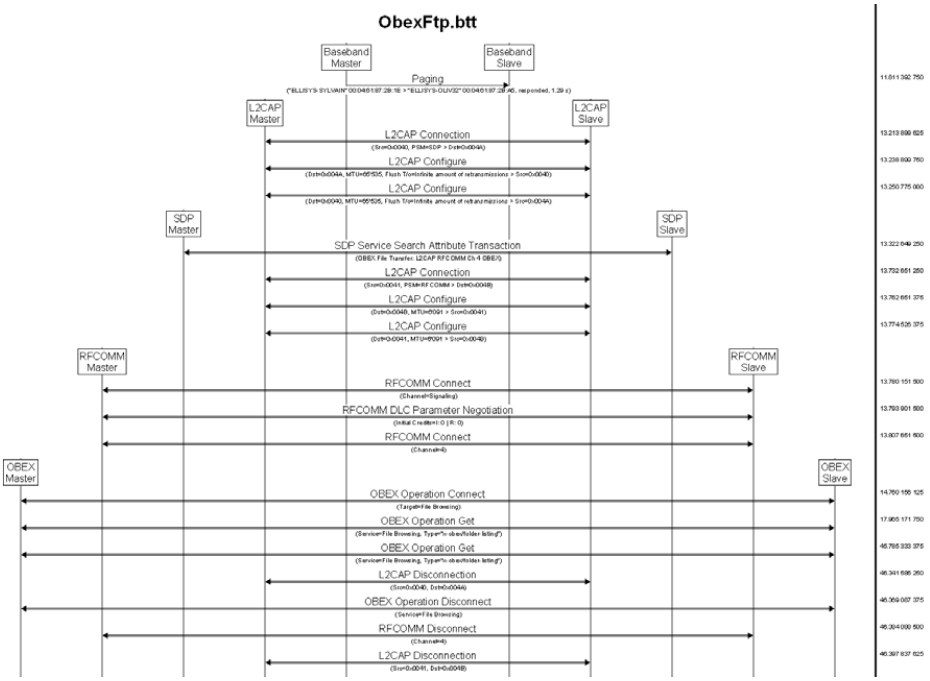
Below is an example of an MSC export, using the **Compact** selection with no layers. The option **Show Protocol Layers Individually** is unselected. Item parameters are displayed.



Below is an example of an MSC export, using the **Expand** selection, showing timestamps, item parameters, and procedures involving Baseband, L2CAP, SDP, RFCOMM, and OBEX.



Below is an example of an MSC export, using the **Flatten** selection, showing timestamps, item parameters, and procedures involving Baseband, L2CAP, SDP, RFCOMM, and OBEX.



Export of Bluetooth Internet Protocol

This selection allows for export of IP carrier protocols, such as BNEP and DUN. The export is carried out from the currently selected Overview (i.e., the active Overview). Wireshark format is supported.

Export of WiFi

This selection exports Wi-Fi traffic to Wireshark format (*. pcapng). RadioTap format is supported. See www.radiotap.org for details.

Export of WPAN

This selection allows for export of capture 802.15.4 packets (WPAN) to Wireshark format (*. pcapng).

Export of Raw Spectrum Information

This selection allows for export to CSV of RSSI for each channel. The raw spectrum capture option must be enabled on the analyzer unit and **Wireless Spectrum** must be selected in the Wireless tab located in the Record menu, under **Recording Options | Wireless**. With the unit attached to the PC via the USB control connection, see **Help | About** for a list of installed options.

Export of Logic Signals

This selection allows for export of captured logic signal transitions into CSV format. The logic signals capture option must be enabled on the analyzer unit and **Logic Signals** must be selected in the Wired tab located in the Record menu, under **Recording Options | Wired**. With the unit attached to the PC via the USB control connection, see **Help | About** for a list of installed options.

Export of I2S PCM

This selection exports decoded Audio I2S PCM data to a WAV file.

6. Workspaces and Layouts

6.1 Using Workspaces

The application allows the user to define a Workspace, which is a way of saving different sets of user settings preferences, such as display settings and other settings, like recording options, window/pane layouts and protocol verifications options (such as those available in the **Tools** menu, under **Protocol Verifications**).

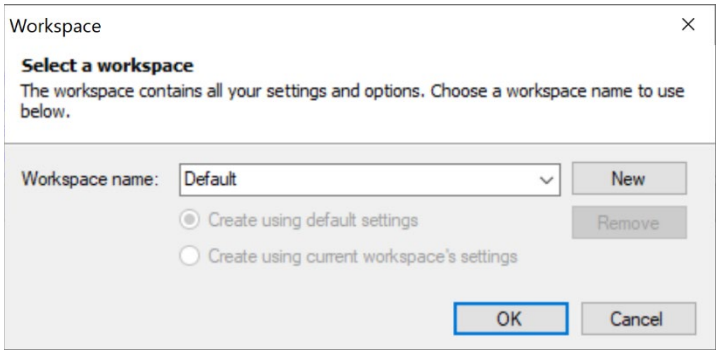
Workspaces can be edited and can also be exported for use on another PC.

A default Workspace is provided by the application, but users may create and save new Workspaces as desired.

To create a new Workspace:

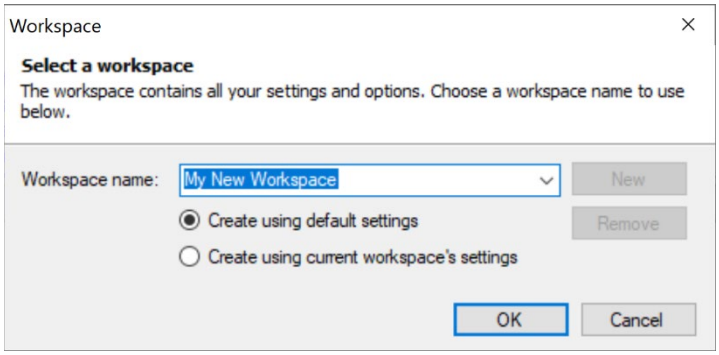
1. Select **File | Switch** Workspace from the menu.

The *Workspace* menu appears:



2. Click on **New**.

A new **Workspace name** appears:



3. Accept the name provided by the application, or type in a new name in the **Workspace name** box.

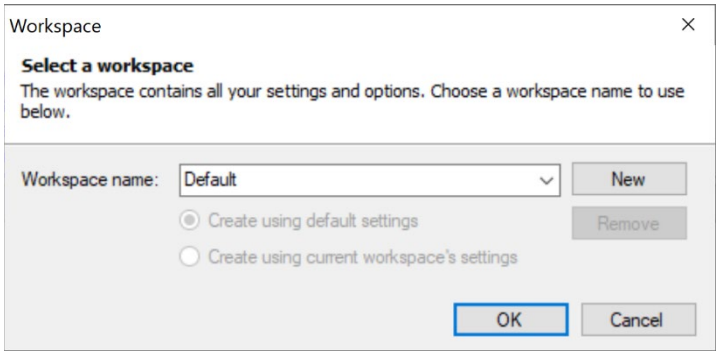
4. Select **Create using default settings** to establish a new Workspace based on the default settings. Alternatively, select **Create using current workspace's settings** to establish the new workspace based on the current settings.

5. Select **OK**.

To change from one Workspace to another:

1. Select **File | Switch Workspace** from the menu.

The *Workspace* menu appears:



2. Select the **Workspace name** drop-down arrow.

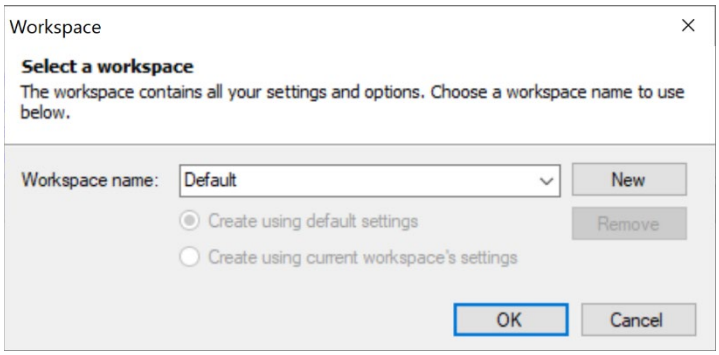
3. Select the desired Workspace name.

4. Click on **OK**.

To remove a Workspace:

1. Select **File | Switch** Workspace from the menu.

The *Workspace* menu appears:



2. Select the **Workspace name** drop-down arrow.

3. Select the desired Workspace name.

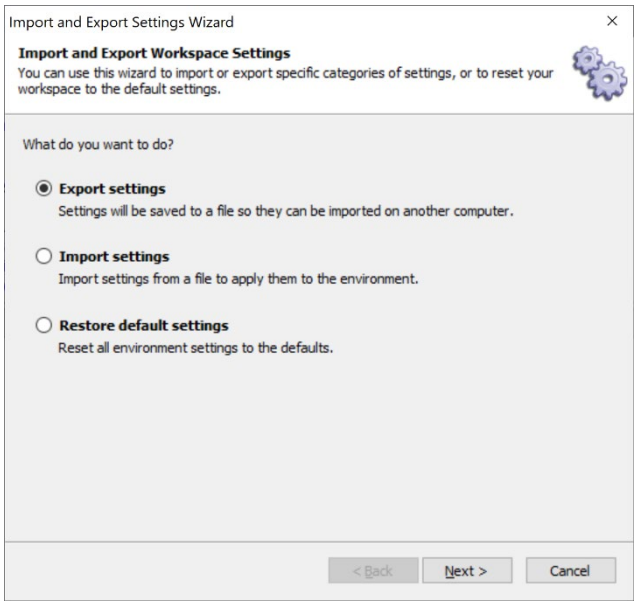
4. Click on **Remove**.

5. Click on **OK**.

To export Workspace settings to a file:

1. Select **File | Import**, then **Export Settings** from the menu.

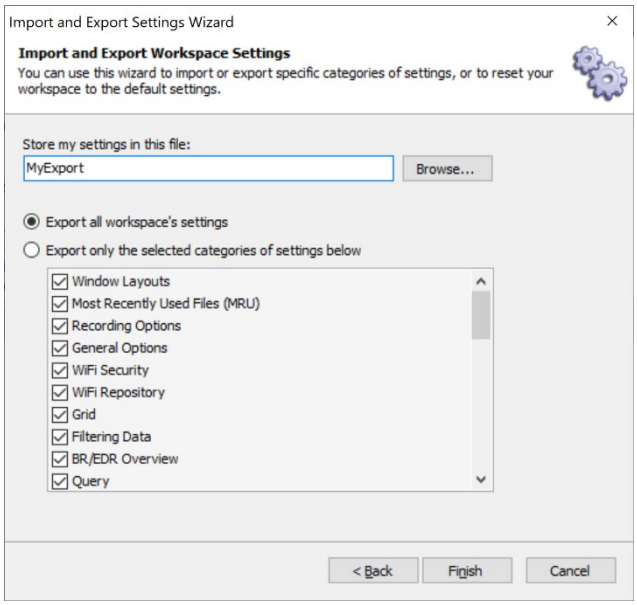
The *Import and Export Settings* Wizard menu appears:



2. Select **Export settings**.

3. Click on **Next**.

The *Export* menu appears:



4. Select **Export all workspace's setting** or alternatively, select **Export only the selected categories of settings below** and check the desired categories.

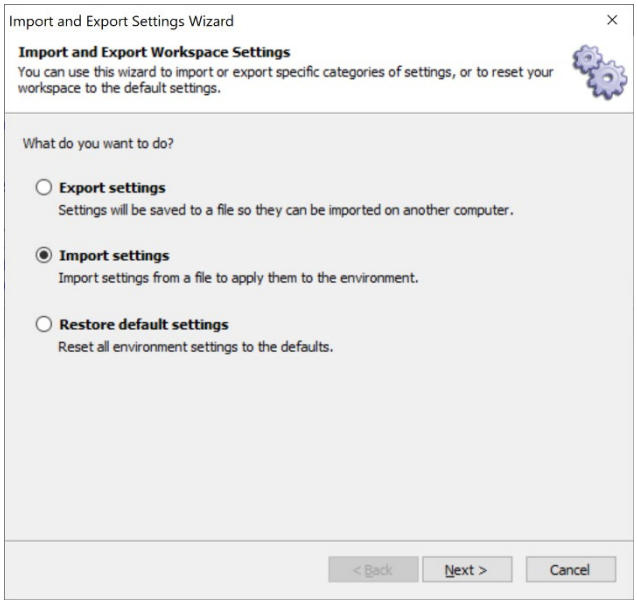
5. Select **Browse** to specify a location to name and save the file.

6. Click on **Finish**.

To import a Workspace settings file:

1. Select **File | Import and Export Settings** from the menu.

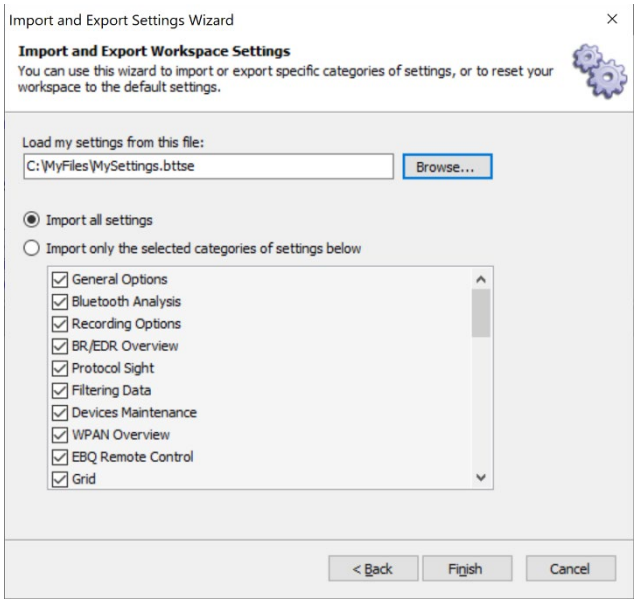
The *Import and Export Settings Wizard* menu appears:



2. Select **Import settings**.

3. Click on **Next**.

The *Import* menu appears:



4. Select Import all settings or alternatively, select Import only the selected categories of settings below and check the desired categories.

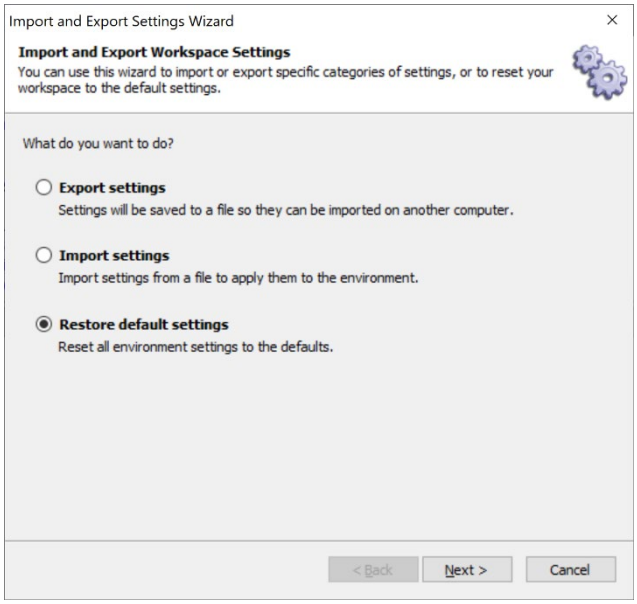
5. Select Browse to specify a location to name and save the file.

6. Click on Finish.

To restore default Workspace settings:

1. **Select File | Import and Export Settings** from the menu.

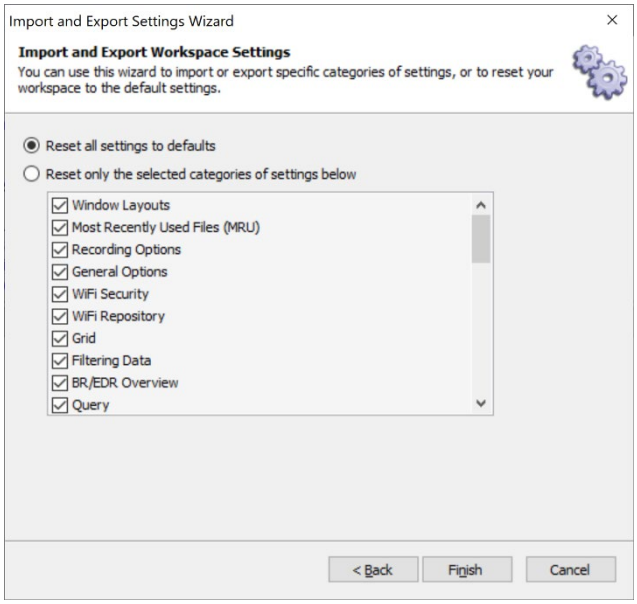
The *Import and Export Settings Wizard* menu appears:



2. Select **Restore default settings**.

3. Click on **Next**.

The *Reset* default menu appears:



4. Select **Reset all settings to defaults** or alternatively, select **Reset only the selected categories of settings below** and check the desired categories.

5. Click on **Finish**.

6.2 Using Layouts

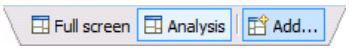
Layouts can be used to customize the size and position of the application's various panes and windows. Layouts can also be used to customize which panes and windows are displayed.

Two default layouts are provided (Analysis and Full Screen), but users may add additional layouts as desired. Layouts are auto saved, in that as changes are made to the active layout, they are saved to that layout without any further action required.

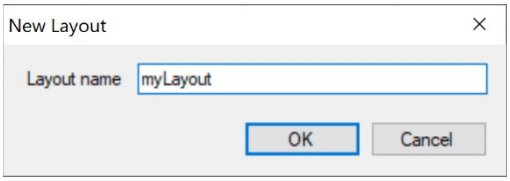
A reset feature is provided in the **Layout** menu to set a layout to its original factory default parameters.

To create a new layout:

1. Select **Layout | New Layout** from the menu or click on the **Add...** button in the Layout Quick-Menu, located at the top-right of the application interface:



The *New Layout* dialog appears:



2. Enter a name for the layout and click on **OK**.

The new layout is created and is now accessible in the **View | Layout** menu and in the Layout Quick-Menu:

To reset a layout to factory default:

1. Select **Layout | Reset Layout** from the menu.

The layout is reset to the factory default.

To delete a layout:

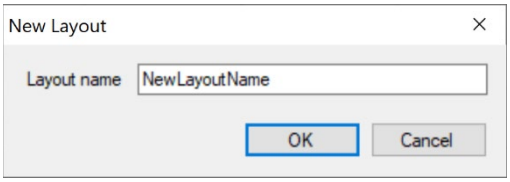
1. Select **Layout | Delete Layout** from the menu.

The active layout is deleted and removed from the layouts listed in the **View | Layout** menu.

To rename a layout:

1. Select **Layout | Rename** Layout from the menu.

The *New Layout* dialog appears:



2. Type the name desired in the dialog and click on **OK**. The layout is renamed.

The Default Analysis layout cannot be renamed or deleted.

7. Capturing Traffic

Supported wireless traffic in the vicinity of the analyzer and/or supported wired traffic attached to the analyzer is not recorded until the user acts to capture this traffic (typically by clicking the **Record** button in the analyzer software). Wireless traffic is captured over the antennas or via a conducted recording directly to the antenna SMA antenna port. Wired traffic is captured at the Logic/GPIO connector and the USB HCI connection (Explorer and Vanguard).

Traffic captured by the analyzer is temporarily buffered on the analyzer hardware then uploaded over the Control Connection to the hard drive on the Control Computer, giving the user ample capture depth. For very long capture sessions, an automatic segmentation feature allows the user to automatically separate one long capture into smaller, more manageable captures by rolling a capture over from one to the next based on time, file size, or both (see **Recording Options | Capture Management**).

An alternative browser-based remote capture feature is also provided (see *Section 7.14. Using the Web Control Interface.* Traffic may also be captured using the remote API or CLI, which can be downloaded from a link provided in *Section 26, Remote API and CLI*.

The analyzer is designed such that little to no configuration is required to take a capture, although the **Recording Options** menu provides for inclusion and exclusion of selected traffic types as well as an optional user designation of pins to be used for captures taken using the wired Logic/GPIO Connection.

7.1 Analyzer Hardware Setups

The basic setups for taking a wireless (over-the-air) recording are described in this section. The analyzer is connected over the Control Connection to the Control Computer that hosts the analyzer application. The Control Connection is used to program the analyzer for any capture characteristics selected by the user, and to upload traffic to the analyzer application. Depending on the model, this connection may also be used to power the unit (Tracker and Vanguard).

When successfully connected, the analyzer's serial number will be visible in **Record | Select an Analyzer**.

7.2 Basic Power and Control Setups

The general setup used for connecting and powering the analyzer varies by the model used (Tracker, Explorer, or Vanguard). General connectivity and power requirements for each model are discussed below.

Explorer Setup

The Explorer requires the supplied DC Power Supply. Explorer connects to the Control Computer using a supplied USB 2.0 Standard-A to Standard-B cable.

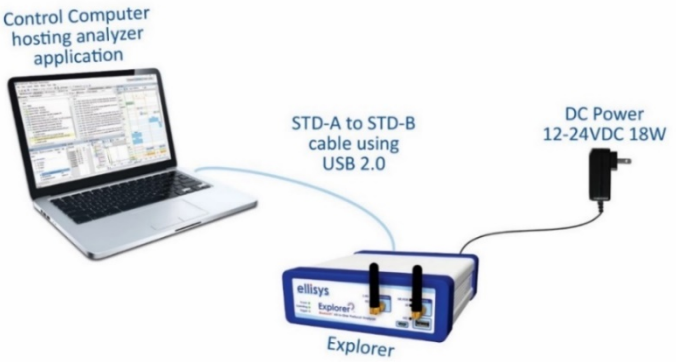


Figure 9 Basic Setup for Explorer (USB and DC PWR)

Tracker Setup

The Tracker does not use an external DC "brick" power supply and can be both powered and controlled over the supplied USB STD-A to Micro-B cable in most cases.

If the USB port on the Control Computer is not enough to power the unit, the analyzer application will post a message to alert the user to add the auxiliary power cable (not shown in illustration below).

Most modern computers supply enough power over USB to operate the unit. The auxiliary power cable (USB Standard-A to plug) is provided to augment the power provided over the USB Standard-A to Micro-B cable. The auxiliary power cable attaches from any Standard-A port on the Control Computer to a jack adjacent to the Control Port on the Tracker.

Figure 10 Basic Setup for Tracker (USB for Control and Power)

Vanguard Setup

Vanguard can be connected to the Control Computer either directly or through a local area network (LAN). These connections are established using the GbE receptacle or the Type-C receptacle, located on the back panel of the unit. The GbE connection can be made directly to the Control Computer, to a LAN port, or to a LAN port on a wireless router, to which the Control Computer would then connect to via the Wi-Fi network created by the router.

For the Ethernet connection direct to the Control Computer, the Control Computer will require a DHCP server application installed in order to assign an IP address to the analyzer. These applications are commonly available and Ellisys does not provide any recommendations on which application is used.

The DC Power Supply is required for Vanguard if the analyzer is not being powered over the data connection using Power-over-Ethernet (PoE) for the GbE connection or USB Power Delivery for the Type-C connection, or powered by the internal battery, if so equipped.

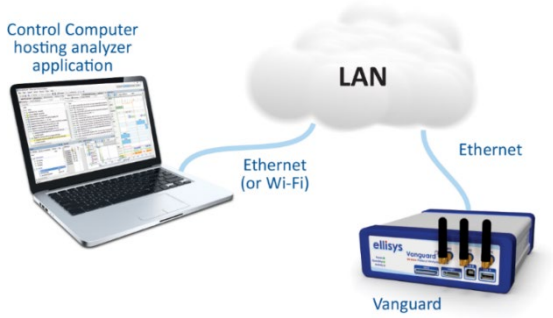


Figure 11 Basic Setup for Vanguard using a Local Area Network Connection

In the figure below, a Type-C to Type-C cable is used (as one of the two possible direct connection approaches). Type-C to Type-C cables may support USB Power Delivery, which can power Vanguard, assuming the Control Computer supports USB Power Delivery and supports enough power to operate Vanguard. A USB STD-A to Type-C cable can also be used – in which case the external (supplied) power supply is required.

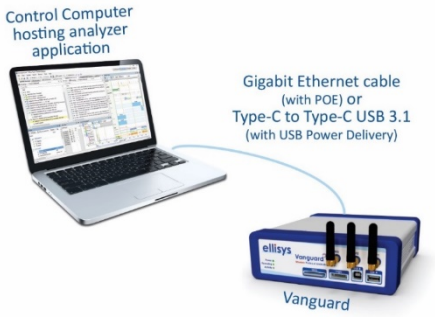


Figure 12 **Basic Setup for Vanguard using a Direct Connection (Ethernet or USB)**

7.3 Bluetooth Capture Diversity

Vanguard employs a unique capture characteristic called Bluetooth Capture Diversification. This technique involves a co-operational replication of the Ellisys whole-band capture engine (used on all Ellisys Bluetooth analyzers).

No menu selections are required to enable this feature; it is enabled whenever Bluetooth is selected for capture in the **Recording Options** menu, either Classic BR/EDR or Bluetooth Low Energy.

In this approach, both antennas (the two right-most antennas, as shown below) can be:

1. Angularly displaced on the analyzer unit to differentiate reception characteristics.

2. Externally cabled (using SMA cables and antenna stands, not supplied) and placed at optimal locations by the user to improve the spatial volume of the reception.

3. Externally cabled (using SMA cables and antenna stands, not supplied) to be placed nearer specific devices under test to reduce packet error rate (contrasted to a single-antenna approach, where the analyzer/single antenna is generally placed at a mid-point between the devices).

Bluetooth packets can be degraded and missed by Bluetooth test equipment due to antenna positioning, signal strength issues, or RF interferences such as Wi-Fi, WPAN technologies, and a variety of consumer electronics operating in the same band as Bluetooth. Certain packet exchanges are critical to the accurate processing and characterization of Bluetooth connections, encryption processes, and applications.

Smart software algorithms are applied to the dual capture channels, and when combined with spatial and angular flexibilities provided by this technique, can significantly improve the capture process and result in reductions in received packet error rates.

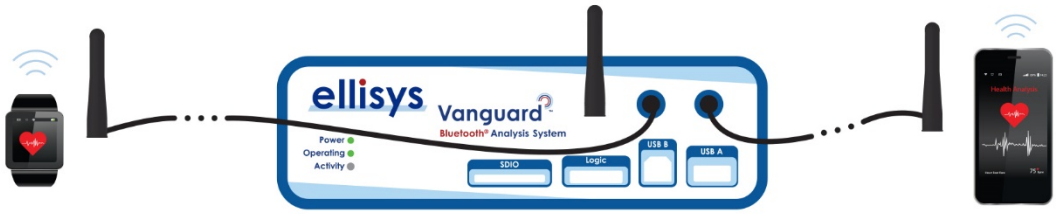


Figure 13 Bluetooth Capture Diversity - Externally Cabled

7.4 Recording Options

The *Recording Options* menu provides for control of the wireless and wired capture characteristics of the analyzer hardware during a recording, including the sensitivity of the analyzer's capture, and segmentation of captures. Multiple selections are available in the *Recording Options* menu.

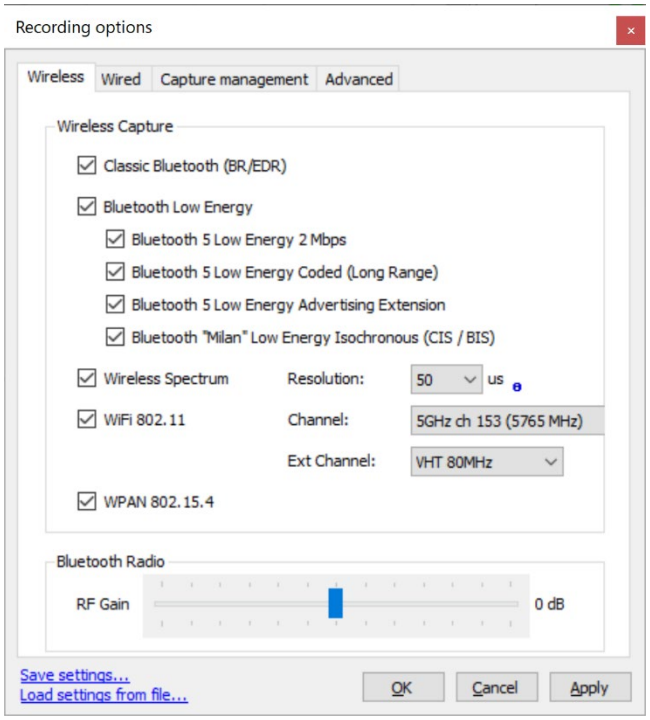
The *Recording Options* menu controls the capture of the following wired and wireless traffic types (some selections are model-dependent and/or configuration-dependent). See *Section 1.6, How to Check the Analyzer's Model, Edition* to determine your model and licensed features.

- Classic Bluetooth (BR/EDR)
- Bluetooth Low Energy
- Wi-Fi
- WPAN 802.15.4
- Raw wireless spectrum energy
- HCI traffic (UART, SPI, and/or USB)
- Generic communications (I2C, SWD, UART, SPI)
- Wireless Coexistence Interface (WCI-2) traffic
- Audio I2S (Inter-IC Sound)
- Logic signals

To access the Recording Options menu:

1. Select **Record | Recording Options** from the menu.

The *Recording Options* menu appears (**Wireless** tab shown below):



The resolution setting for the wireless spectrum capture is selectable from 1us to 200us. At lower (higher-resolution) settings, the amount of data captured can be extremely high (exceeding 80MB/s), potentially resulting in an automated cessation of the spectrum capture process due to the high volume of data being captured and processed (especially if the Control Computer is USB 2.0, default on Tracker and Explorer). If the higher resolution provided by these lower settings is not needed, a moderate setting of 100us or higher is suggested.

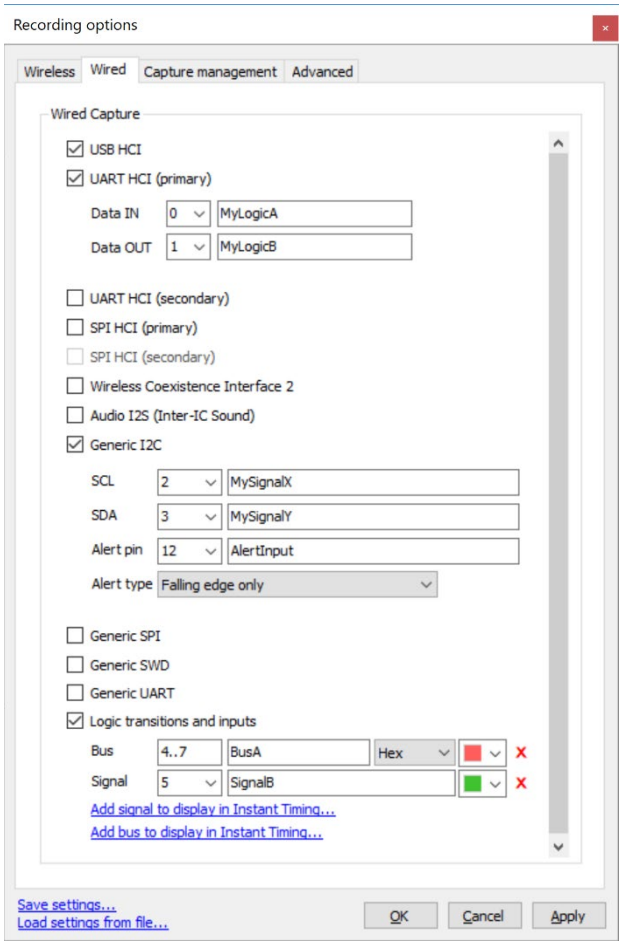
To capture wireless traffic:

1. Select the **Wireless** tab.
2. Check the appropriate check box(s).
3. Click **OK**.
4. Click on **Record** on the toolbar.

To capture wired traffic:

Capture of UART HCI, SPI HCI, WCI-2, Audio I2S, generic I2C, SWD, and UART, and logic signals requires the use of the Flying Leads Cable to adapt to the Logic/GPIO connector. See *Section 24, Flying Leads Probe – Explorer,* or *Section 25, Flying Leads Probe – Tracker and Vanguard* for details. Default pin assignments are provided upon selection, but the user may specify custom pin assignments.

1. Select the **Wired** tab. The **Wired** tab appears:



Various features are model-dependent and/or configuration-dependent (i.e., licensed). See *Section 1.6, How to Check the Analyzer's Model, Edition* to determine your model and licensed features.

2. Check the appropriate check box(s).

3. Connect the Flying Leads probe to the Logic connector on the analyzer (also called IO probe on the Explorer). Take care to connect wires on the Flying Leads probe to match the signal selections in the **Recording Options | Wired** menu.

4. Click **OK**.

5. Click on **Record** on the toolbar.

To capture USB HCI:

1. Select the **Wired** tab.

2. Check the **USB HCI** check box.

3. Click **OK**.

4. On the front panel (Vanguard and Explorer), connect the USB-B receptacle to the host side, and the USB-A receptable to the radio side of the USB HCI under test. On Vanguard, the USB-A receptacle is USB STD-A, and on Explorer, it is USB Micro-B. Use the supplied USB cables. USB HCI capture is not available on Tracker.

5. Click on **Record** on the toolbar.

The analyzer is designed to capture only Bluetooth device class traffic (USB Device Class = Bluetooth) through the USB front-panel ports, or vendor-specific USB traffic adhering to Bluetooth class structure. Capture of USB traffic not using Bluetooth device class or structure is not supported.

To capture logic signals:

Captured logic signals are displayed in the *Instant Timing* pane individually and with any user-defined 4-signal buses. Up to 16 logic signals may be captured. The Flying Leads cable is used to connect to logic signals. See *Section 24, Flying Leads Probe – Explorer,* or *Section 25, Flying Leads Probe – Tracker and Vanguard* for details.

1. Select the **Wired** tab.

2. Check the **Logic Transitions and Inputs** box

3. Select **Add Input to Display in Instant Timing** (repeat for additional inputs).

4. Use pin assignments shown in *Recording Options* or select custom pin assignments. Assign custom names to inputs as desired.

5. Attach the Flying Leads Cable between the **Logic** connector on the analyzer and the logic signal(s) to be monitored. See *Section 24, Flying Leads Probe – Explorer,* or *Section 25, Flying Leads Probe – Tracker and Vanguard* for details.

The naming conventions for the receptacle used for capturing wired signals varies from model to model. On Vanguard, this is labelled **Logic** (located on the front-panel), for Explorer it is labelled **IO Probe** (located on the back-panel), and for Tracker, is referred to as **Logic/GPIO** in some illustrations. The functionality is essentially identical, regardless of model. These terms may be used interchangeably in this User Guide.

6. Click on **Record** on the toolbar.

The analyzer will capture up to 16 logic lines and will compress the logic transitions with a very efficient engine, but the throughput of the compressed data will be directly related to the frequency of the lines. The more lines that are toggling fast, the higher the throughput requirement, and at some point, the internal buffer allocated to the logic stream can saturate and the capture will stop for that stream (the other streams are independent and will continue).

There are a few ways to improve the efficiency of the logic capture:

- Use a latest-generation processor with a fast SSD and make sure that the PC is not busy doing other tasks during the capture.
- Make sure that the faster lines are connected on the lower indexes. For example, the fastest transitioning line should be connected to input 0, the second fastest to input 1, etc.
- If signals with high "glitch" rates (such as noisy signals) are received on the logic capture, this will increase the required throughput. These glitches can be avoided or reduced with better grounding and increased spacing between the wires.
- If glitches are seen on unused inputs, it is recommended to connect these inputs to ground.

7.5 Radio Sensitivity

The sensitivity of the analyzer's Bluetooth and Wi-Fi 2.4G receivers can be adjusted. Sensitivity can be increased to improve reception, or decreased, often to remove distant/weak packets from the capture. By default, sensitivity is set to a nominal value (0dB) which is appropriate for most cases.

To increase or decrease the sensitivity of the analyzer's receivers:

1. In **Record | Recording Options | Wireless**, slide the **Radio RF Gain** slide bar to the right (to increase sensitivity) or to the left (to decrease sensitivity).

The position of the wireless device under test relative to the analyzer is important to consider. On the analyzer application's Welcome screen, (View menu > Other Windows > Welcome) please see the Expert Note entitled *EEN_BT04 – Optimal Placement of Your Analyzer* for information on how to position the analyzer relative to your devices for optimal captures. For Vanguard, please review *Section 7.3, Bluetooth Capture Diversity*.

2. Click **OK**.

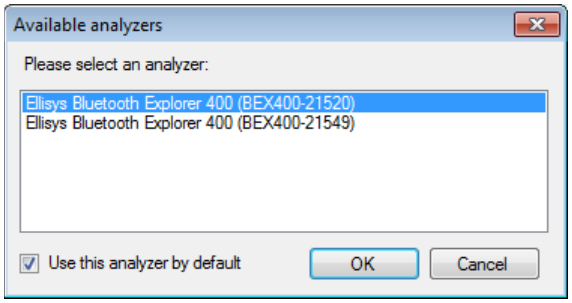
7.6 Selecting an Analyzer

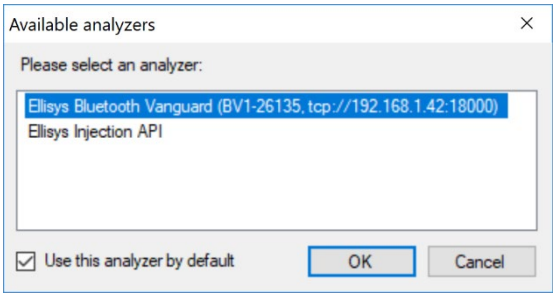
It is possible that multiple analyzers may be attached to a single PC hosting the analyzer desired for recording.

To select an analyzer:

1. Select **Record | Select an analyzer** from the menu. Alternatively, select the drop-down arrow located on the **Record** button located on the toolbar.

The *Available analyzers* dialog appears (shown: Explorer connected over USB and Vanguard connected over Ethernet):





2. Select the desired analyzer.

3. Click on **OK**.

If a recording is initiated without having first selected an analyzer, the *Available analyzers* dialog will pop up to request the user to select an analyzer. Selecting the **Use this analyzer by default** checkbox in this dialog will conveniently force the automatic selection of the specified analyzer on each new recording.

7.7 Ellisys Injection API

The analyzer application supports an Injection API, selectable in the *Available Analyzers* dialog, located in the **Record** menu (once it is enabled in the **Tools** menu – see below).

There are two services provided:

- Injected User Log Service - displayed in the *Message Log Overview*.
- HCI Injection Service - displayed in the *HCI Overview (Injection)* once the Ellisys Injection API recording is initiated.

The Ellisys Injection API is designed to transport client messages to the analyzer application, and events and message handling status back to clients.

Messages are packet-oriented and use TCP or UDP as the transport layer. Each message packet links several possible information objects into one message. The possible objects are defined by the different log services, while reusing standard object types as much as possible. All messages are addressed to specific log services that define the required / allowed objects in the messages and might be stateful or stateless

In addition, injection of the user's log messages is supported. This feature allows for the user's "*printf*" debug messages to be displayed in the *Message Log Overview* (**View | Overviews**), concurrent with any HCI traffic being captured by the analyzer's hardware. The analyzer hardware is not required to capture injection sources.

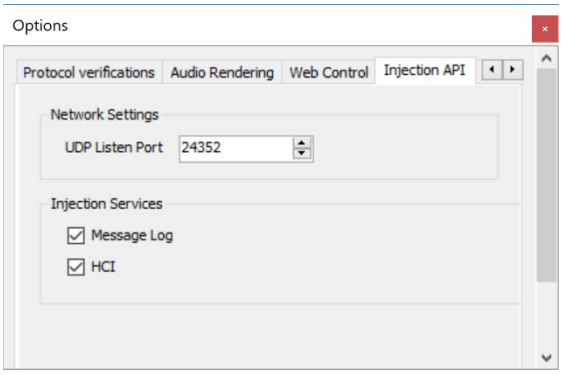
Injection API Download

Use the link below to download helpful documents on the Injection API, including samples and instructions.
http://www.ellisys.com/better_analysis/bex400a_injection_api.zip

To enable the Injection API:

1. Select **Tools | Options** from the menu, then select the **Injection API** tab.

The **Injection API** tab appears:

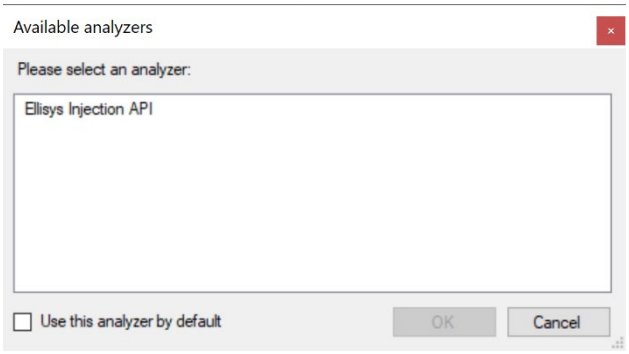


2. Under *Network Settings*, specify the **UDP Listen Port**.
3. Under *Injection Services*, check **Message Log** and/or **HCI** as desired.
4. Click on **OK**.

To initiate recording of Injected HCI traffic:

1. Select **Record | Select an analyzer** from the menu or alternatively select the drop-down arrow located on the **Record** button located on the toolbar.

The *Available Analyzers* dialog appears:



2. Select **Ellisys Injection API**.
3. Click on **OK**.

7.8 Initiating a Recording

A recording can be initiated using the GUI, API, CLI, or Web Control Interface.

The Web Control Interface is a browser-based remote capture feature (see *Section 7.14, Using the Web Control Interface).* For more information on the Remote API or CLI, see *Section 26, Remote API and CLI* .

To initiate a recording (GUI):

1. Click on **Record** on the toolbar or alternatively, select **Record | Start Recording** (Ctrl+R) from the menu.

Recording is initiated per settings in the **Record | Recording Options** menu.

7.9 Stopping a Recording

A recording can be stopped using the GUI, API, CLI, or Web Control Interface.

To stop a recording (GUI):

1. Click on **Stop** on the toolbar or alternatively, select **Record | Stop Recording** (Ctrl+Shift+R) from the menu.

The recording is stopped. Any traffic remaining in the analyzer's memory is uploaded to the PC hosting the analyzer application.

Clicking the **Stop** button a second time cancels the upload of any remaining traffic still located on the analyzer's memory.

7.10 Restarting a Recording

A recording in progress can be restarted using the GUI, API, CLI, or Web Control Interface. The analyzer will stop capturing new data, the data already captured will be discarded, a new capture will be created, and the analyzer recording will be started again.

To restart a recording (GUI):

1. Click on **Restart** on the toolbar or alternatively, select **Record | Restart Recording** from themenu. The capture in progress is halted, traffic captured is discarded, and a new recording is initiated.

7.11 Using the Auto-Segmentation Feature

The analyzer application provides an automatic method to restart and save successive captures based on a specified period and/or the number of bytes captured. Bluetooth contextual information, such as connection parameters, are maintained from capture to capture. This feature can be quite useful for reducing one long capture into several smaller, more manageable captures, and can provide extremely long capture duration.

An indicator is provided on the main toolbar to indicate the progress of the current capture, based on a ratio of capture volume to a maximum capture time or maximum capture bytes, as specified by the user.

Successive captures are automatically time/date stamped and placed in a user-defined directory. File names may be provided a user-defined prefix and suffix.

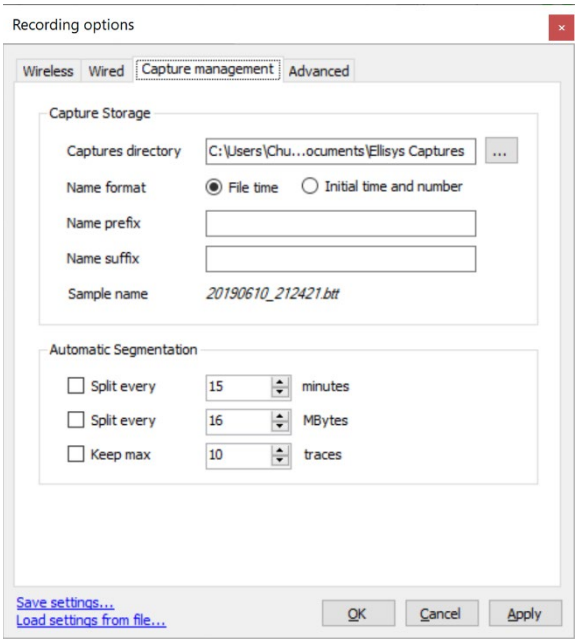
As a capture progresses, the user may elect to manually stop the current capture and initiate the next capture, using the **Save and Continue** button on the toolbar.

To enable auto-segmentation:

1. Select **Record | Recording Options** from the menu (or select the **Configure** button on the toolbar to open **Recording Options** directly to the **Capture Management** tab).

2. Select the **Capture Management** tab.

The **Capture Management** tab appears:



3. Specify a **Captures Directory** for storage of the captures.

4. Select a **Name Format**: Select **File Time** to name each capture file with a time/date stamp as it is saved to disk, or select **Initial Time and Number** to name each capture with a time/date stamp based on capture start (along with a serialized/incremental number for each capture).

5. Optionally, add a **Name Prefix** and/or **Name Suffix** (these will be prepended/appended to each capture file name).

6. Select a method for the segmentation to split, **Minutes** or **Mbytes**.

7. Optionally, select a finite number of traces to store, using **Keep Max**.

8. Click **OK**.

9. Click on **Record** on the toolbar.

As captures progress, an indicator on the toolbar provides status information (based on minutes or Mbytes, as selected in **Recording Options**):

To manually halt an auto-segmentation capture and start a new capture:

1. Click on **Save and Continue** Save & Continue on the toolbar.

The current captured is halted and saved, and a new capture is initiated.

7.12 Recovering a Capture

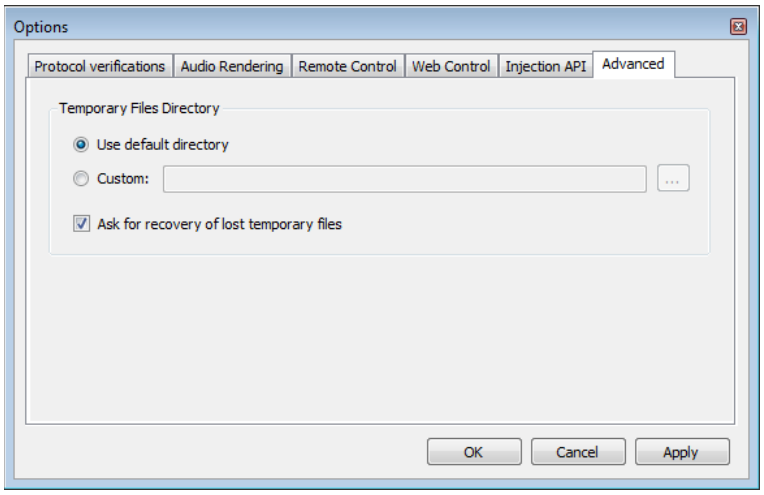
During recording, the analyzer software stores the captured data to a temporary capture file. In the event of a system or application crash, this temporary capture file can be recovered if necessary.

The software stores the temporary capture files to the **Temporary Files Directory**. By default, this directory is in the user's *Documents and Settings* directory, under *Application Data/Ellisys/Ellisys Bluetooth Analyzer*.

Depending on the system configuration, it may not always be desirable to have temporary captures stored on the main hard disk. In that case, it is possible to change this directory as follows:

1. Select **Tools | Options** from the menu.

The *Options* menu appears:



2. Select the **Advanced** tab.

3. Click on **Custom** and browse to the desired directory.

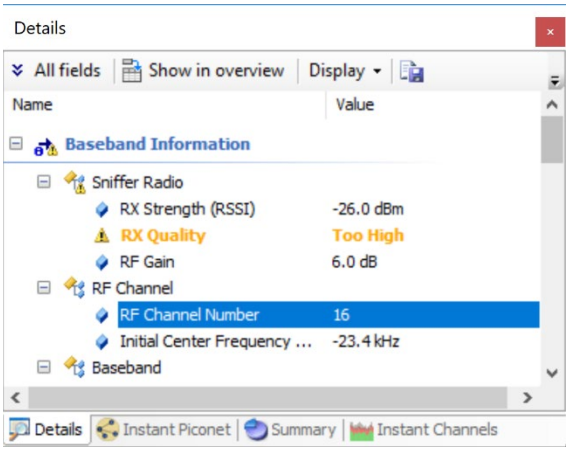
4. Click **OK**.

Check the **Ask for recovery...** check box to program the application to prompt the user to recover temporary files after a crash. This box is enabled by default.

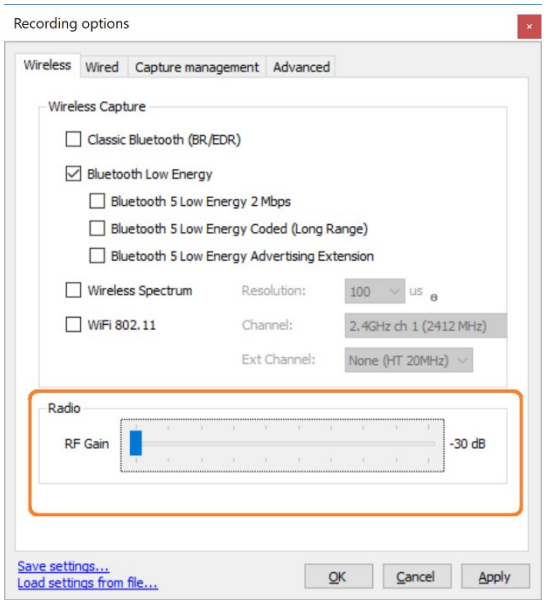
7.13 Conducted Recordings

In some cases, users may require a cabled connection between the analyzer's SMA connector and the system under test, in lieu of antenna reception. This is referred to as *conducted* recording. This setup is particularly useful to avoid interferences (and thereby decrease the packet error rate).

Some care must be taken with such a setup to not saturate the receivers of the devices under test and the analyzer. When the analyzer's receiver is getting too much power, the reception quality will drop, and the capture file may be unusable. In that case, the **RSSI** field for the packets (shown in the *Details* pane) will be indicated as **Too High** (shown below).



Setting up a correct configuration is left to the user, but usually this involves adding external attenuation for the devices and the analyzer. The analyzer has an additional capability to add attenuation up to -30 dB (**Recording Options | Wireless**), which may eliminate the need for external attenuation.



For performing conducted testing, users typically use a "Y" cable (not supplied) to connect 2 devices + the analyzer. The Y cable itself introduces some attenuation, and thus, additional attenuation is usually not necessary. Contact Ellisys (support@ellisys.com) for recommendations on third-party Y cables.

7.14 Using the Web Control Interface

The *Web Control Interface* feature provides a convenient method to control the analyzer's capture processes remotely, over a local area network (LAN), using a browser. This feature must first be enabled in the **Tools** menu.

Supported processes include:

- Start capture
- Stop and save capture
- Abort capture
- Add a link key

A typical remote setup for the *Web Control Interface* is shown below (this feature can also be employed directly/locally from a PC to the analyzer).

Note this illustration is for Explorer; Vanguard and Tracker control/power connections to the Remote Computer will vary (see *Section 7.1 Analyzer Hardware Setups* for details).

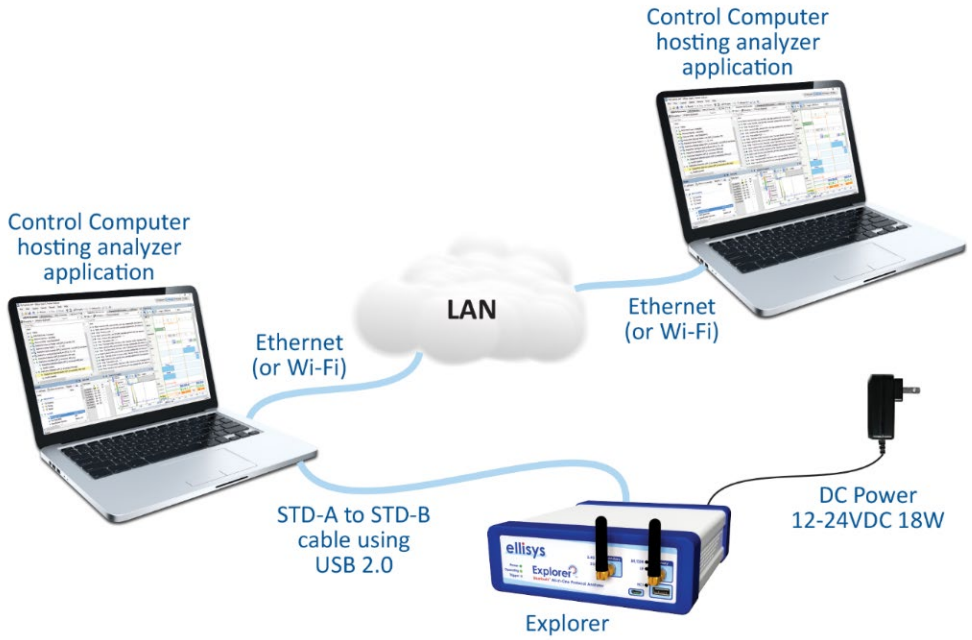
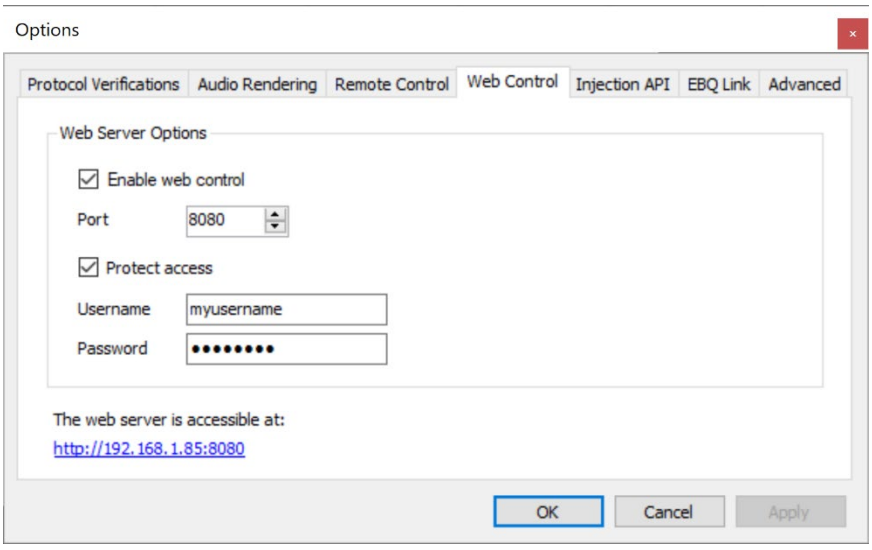


Figure 14 Figure 14 Web Control Interface (Explorer setup shown)

To enable the Web Control Interface:

1. From **Tools | Options**, select the **Web Control** tab.

The *Options* window appears:



2. Check the **Enable web control** box.

3. Set the port number as desired (default is 8080).

4. Click **Apply**.

To protect access to the remote computer hosting the analyzer hardware, check the **Protect Access** box and supply a **Username** and **Password**.

Ensure your firewall allows access to the port specified and to the analyzer application. Contact your IT administrator as needed.

5. Click **OK**.

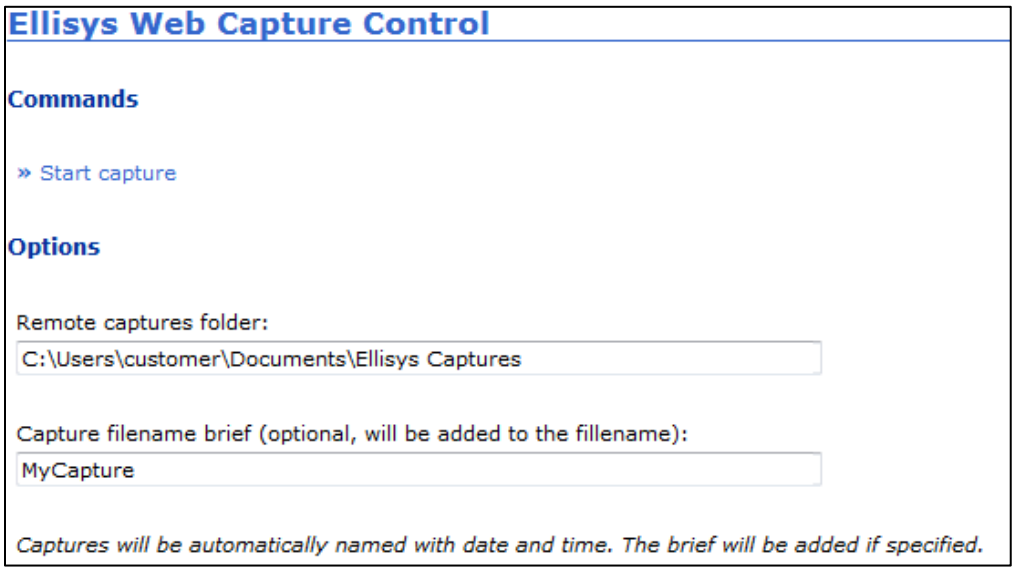
To initiate a capture using the Web Control Interface:

1. Launch the web server from your browser using the link provided in the *Options* dialog above (e.g., http://192.168.1.20:8080).

The default browser opens and displays the page below:

2. Select **Control capture**.

The page updates as shown below.

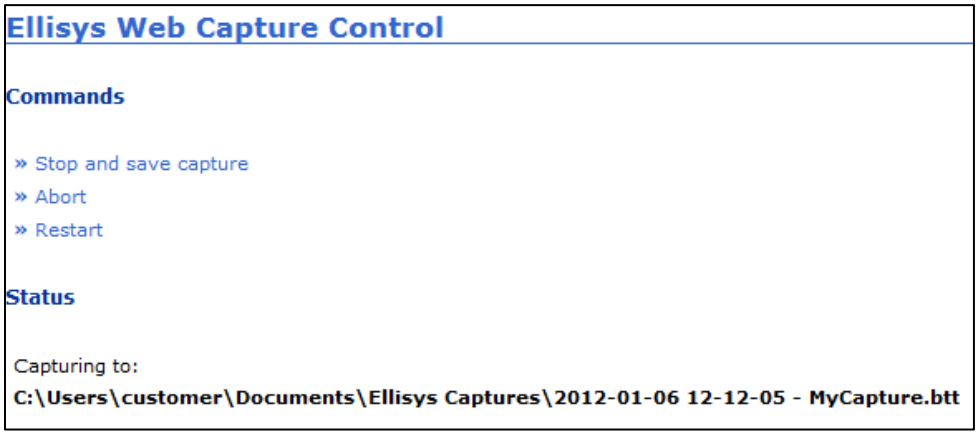


3. Select a folder destination for the remote captures.

4. If desired, add a filename brief.

5. Select **Start Capture**.

The capture is now started and the page updates as below:



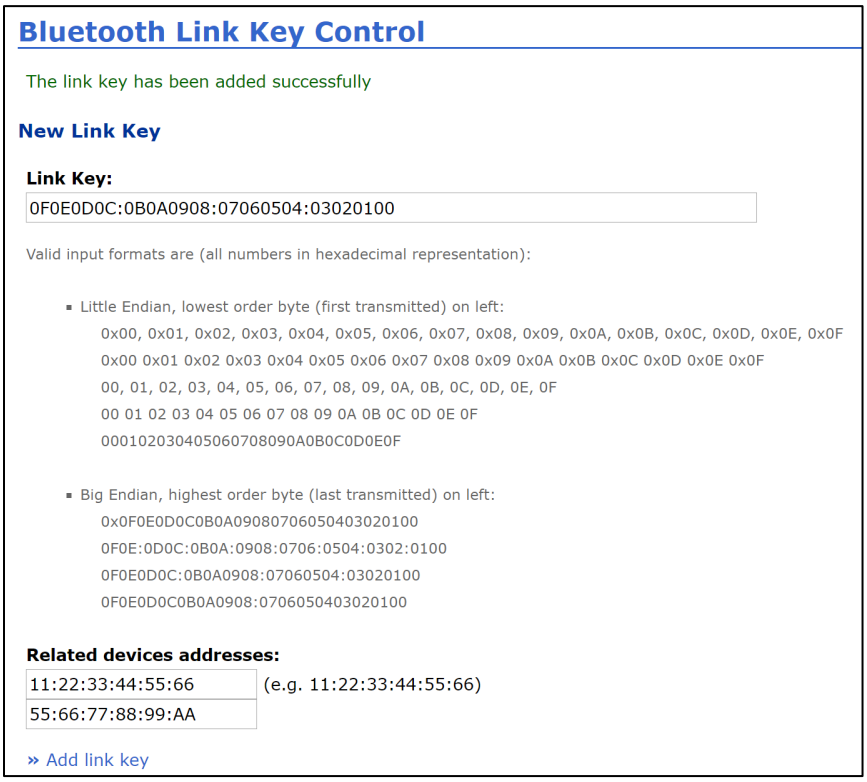
6. Select **Stop and Save Capture**, **Abort**, or **Restart** as needed.

- If **Save Capture** is selected, the capture file will be saved to the destination previously specified.
- If **Abort** is selected, the capture is stopped and not saved.
- If **Restart** is selected, the capture restarts without saving the prior capture.

To add a link key to a device connection:

1. Launch the web server from your browser using the link provided in the *Options* dialog above (e.g., http://192.168.1.20:8080).

The page updates as below:



2. Type or paste the link key into the **Link Key** box.

3. Add the Bluetooth Addresses in the **Related devices addresses** boxes.

4. Select **Add link key**.

The link key is added to the specified connection.

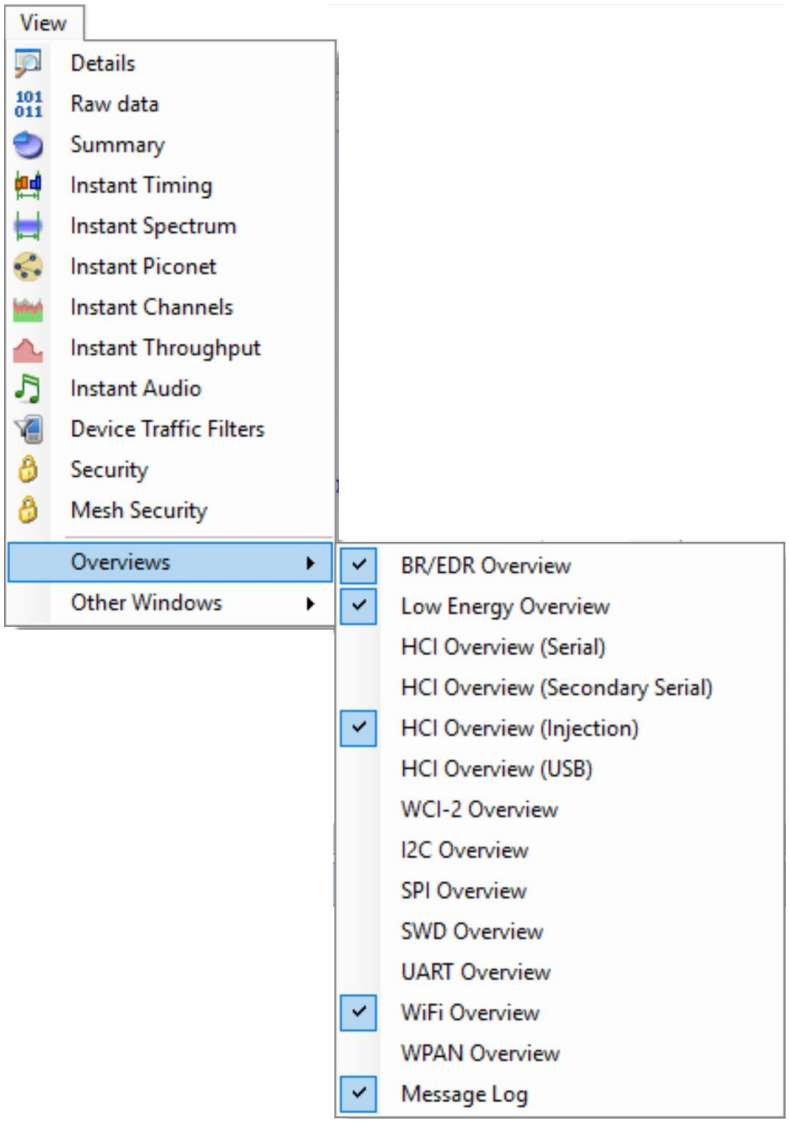
8. Overviews

The Overviews are the primary viewer windows, providing a real-time, chronological, user-configurable display of events and traffic. Overviews also provide searching, filtering, timestamps, bookmarks, coloring, high-level protocol and profile abstractions, and other features.

To display an Overview:

1. Select **View | Overviews** from the menu.

A selection of Overviews is provided:



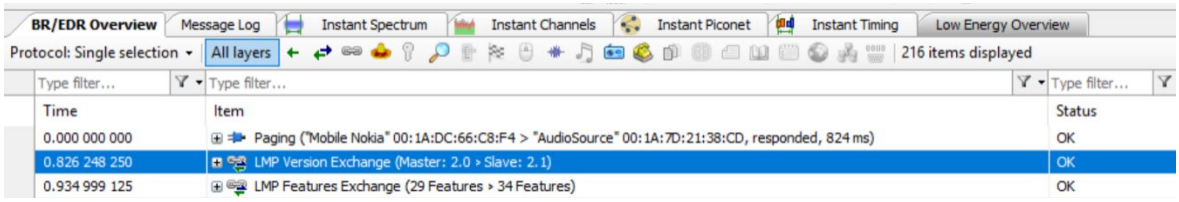
2. Select the desired Overview(s).

The selected Overview(s) is/are displayed.

The Overviews are linked to other panes, such as the *Instant Timing*, *Security*, *Details*, *Instant Spectrum*, *Instant Audio*, *Instant Channels*, *Instant Throughput*, and *Instant Piconet* panes. Additionally, the analyzer is designed such that the applicable *Overview(s)* will populate in real-time as traffic is captured.

The Overview windows will automatically scroll (append) as new traffic is captured, with the newest traffic appearing at the bottom of the Overview, but (by design) selecting an event in an Overview will halt the scrolling effect (traffic is still being captured). To resume the scrolling effect, select CTRL + END or alternatively, click the double-down arrows located at top-right of the Overviews.

Using the default Full Screen Layout or Analyzer Layout (available in the **Layout** menu), the Overviews are "stacked" as selectable tabs, as shown below, with only one of the Overviews visible. The user can configure the layout to show multiple Overviews simultaneously, for example side-by-side or top/bottom, by dragging the desired Overview tab to another location.



8.1 Configuring the Overview Columns

A default set of columns are displayed in each Overview, but the user can add additional columns to customize an Overview to user preferences. This is an important and valuable feature, allowing precise customization of the Overview columns. Columns can be pinned, to fix their position even when scrolling horizontally through the Overview.

Columns can be added to an Overview in two ways:

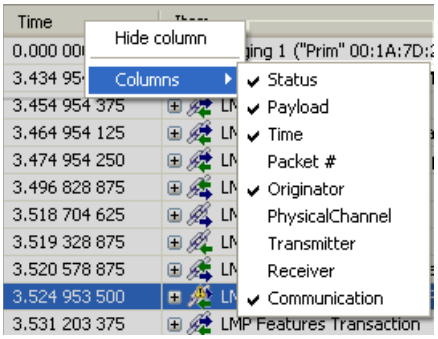
1. Add a column from a default list available with a right-click from the Overview column header.

2. Add a field to the Overview from the *Details* pane, by dragging the desired field into the Overview or using the **Show in Overview** button on the *Details* view title bar.

To add a column to an Overview from the Overview header:

1. Right-click on any column header (e.g., **Item**, **Time**, etc.).

A selection of default columns appears:



2. Select the desired item.

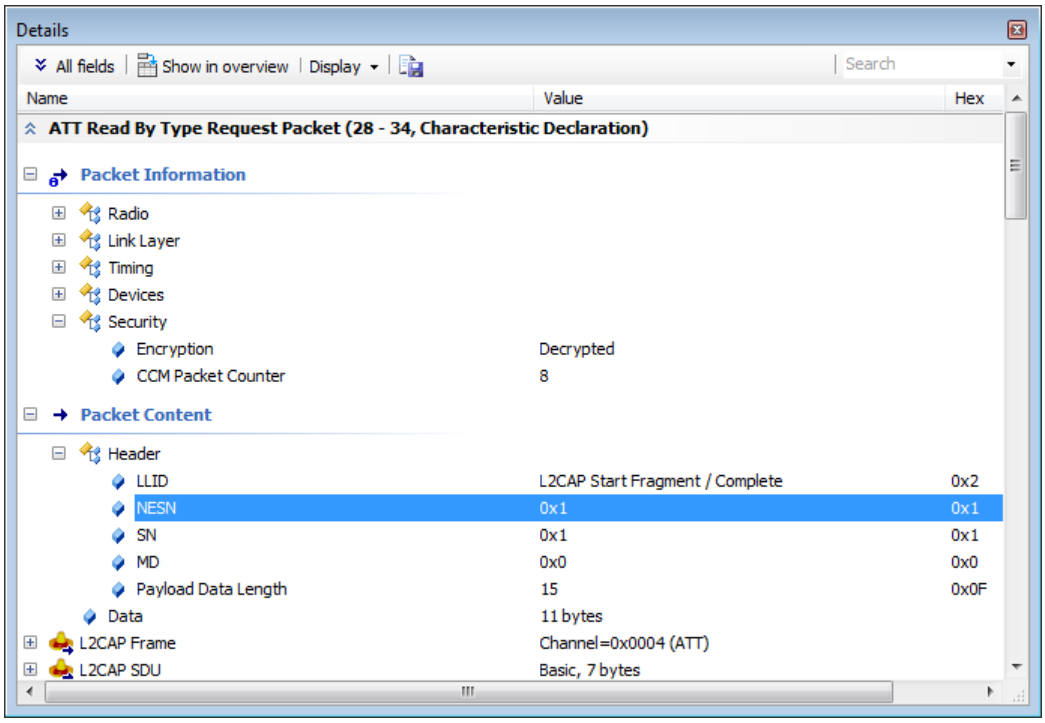
A new column appears in the Overview at the location selected and is populated with the relevant data.

To add a column to an Overview from the Details pane:

1. Select an item of interest in the Overview.

The *Details* pane is populated as per the selected/highlighted line in the Overview.

2. Select the field of interest from the *Details* pane:

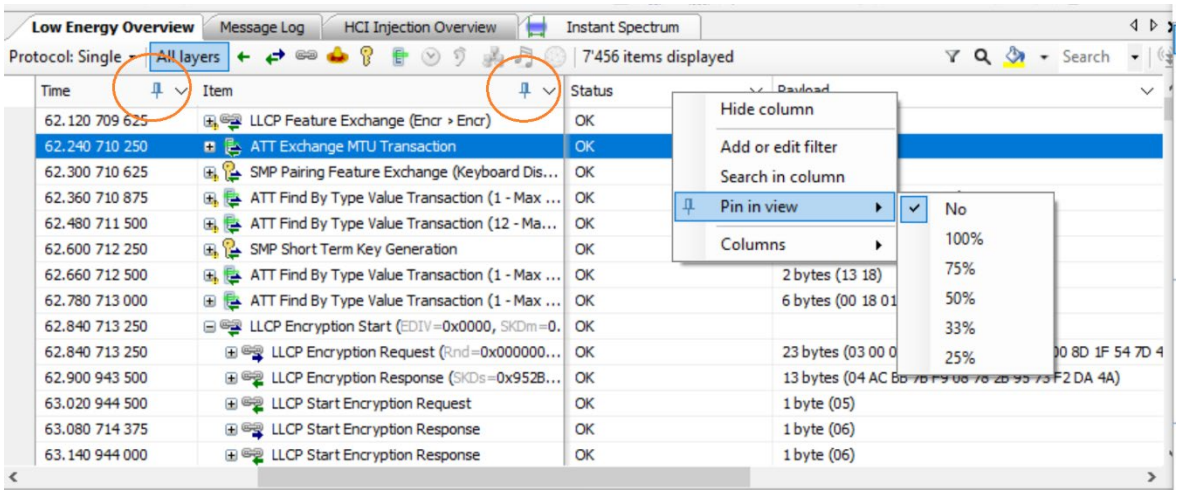


3. Click **Show in overview** on the *Details* toolbar or alternatively, drag and drop the desired field into the Overview (grab the blue icon adjacent to the desiredfield).

A new column is created in the Overview and populated with the relevant data.

To pin a column:

1. Right-click in the header of the desired column and select **Pin in View**:



2. Select the desired column width percentage.

A pin icon now appears in the selected column a thicker vertical separation line is applied to assist visually during scrolling.

To unpin a column:

1. Click on the pin icon in the header of the desired column.

To resize a column in an Overview:

2. Position the mouse pointer at the vertical line border at the left or right of the desired column.

3. When the mouse pointer changes to a resize indicator, left click and drag to the desired size.

The column is resized.

To hide a column:

1. Right click on the desired column header.

2. Select **Hide Column** or alternatively, right-click on any column header.

3. Select **Columns**.

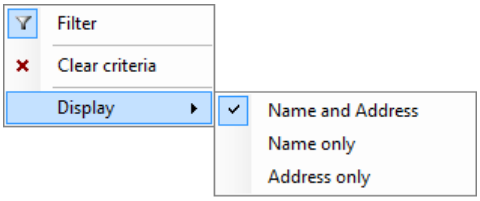
4. Deselect the desired column from the list.

The column is hidden.

To control information displayed in the Overview's Communication column:

1. Select the drop-down arrow located in the **Communication** column.
2. Select **Display**.

Options are presented for showing **Name and Address**, **Name Only**, and **Address Only**:



3. Select the desired option to configure the information displayed in the **Communication** column.

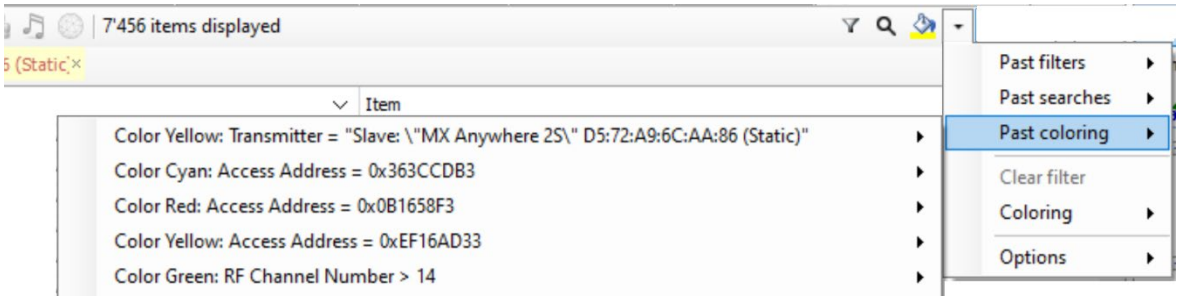
To hide a column:

1. Right click on the desired column header.
2. Select **Hide Column** or alternatively, select **Columns** and deselect the desired column from the list.

The column is hidden.

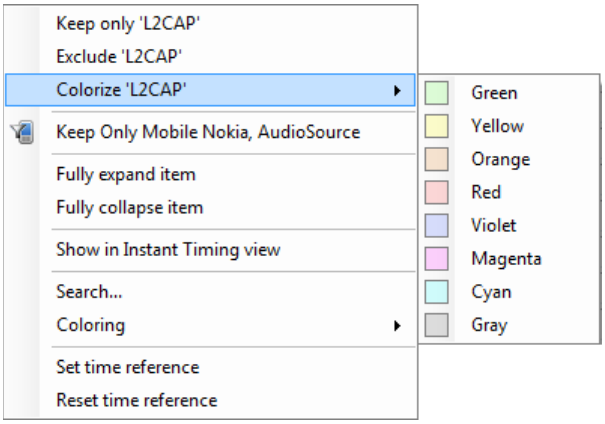
8.2 Color-Coding an Overview

Adding color to Overview items can help greatly with at-a-glance identification of specified protocols, profiles, events, statuses, etc. Coloring can be added with a convenient right-click or using the query-based feature for searching, filtering, and coloring. located at top-right of the Overview:



To add coloring using the right-click option:

1. Select the desired line in the Overview.
2. Position the mouse pointer over the desired column on the selected line.
3. Right-click the mouse and select **Colorize '*'**, where **'*'** will equate to the contents of the selected line/column.



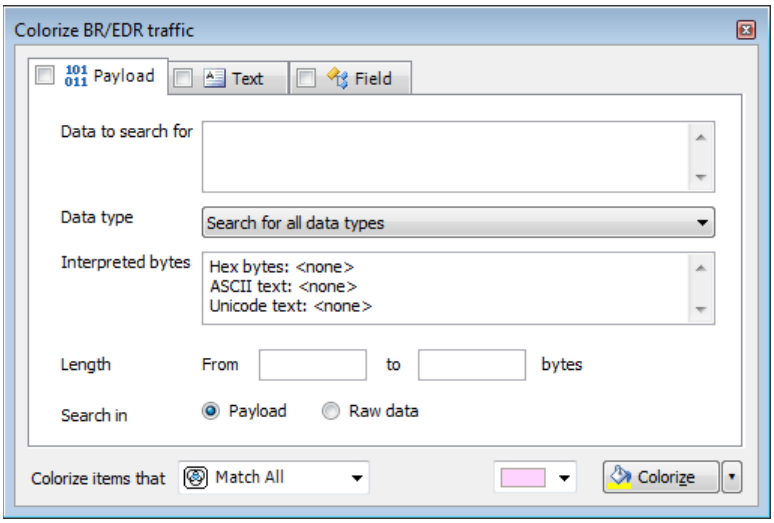
4. Select the color desired.

The Overview is updated to colorize the selected line/column.

To add color-coding using the *Colorize* menu:

1. Right-click in the desired Overview and select **Coloring | Add Color.**

The *Colorize* dialog appears:



To colorize events by payload content:

1. Select the **Payload** tab.
2. Enter **Data to search for** and/or a payload **Length** range.
3. Select **Data Type** as needed.
4. Select **Search in Payload** or **Search in Raw Data** to highlight matching packets.
5. Select the desired match type in the **Colorize items that** drop-down menu.

- **Match All** – Finds items that match all selected criteria.
- **Match Any** – Finds items that match any of the criteria.
- **Don't Match All** – Finds items that do not match all the selected criteria (opposite of Match All).
- **Don't Match Any** – Finds items that do not match any of the selected criteria (opposite of Match Any).

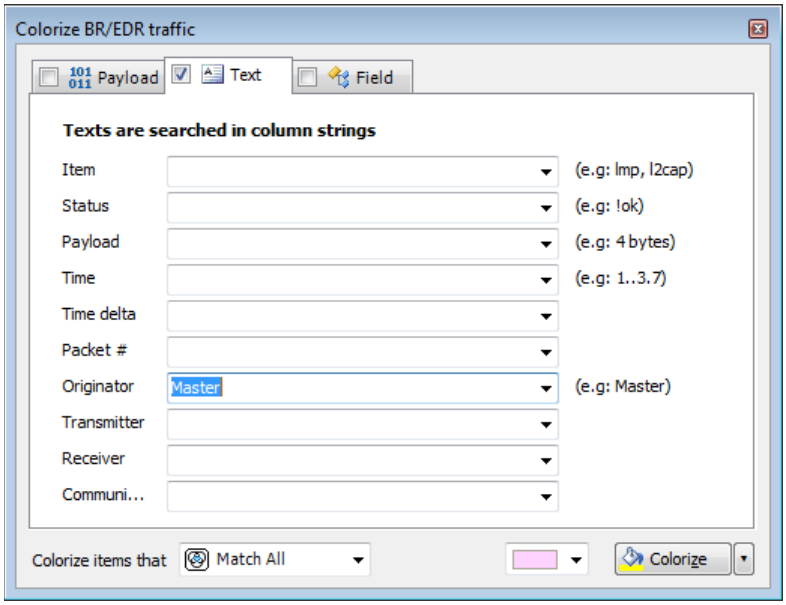
6. Select the desired color and click on **Colorize**.

Events matching are colorized in the Overview.

To colorize events by text string:

1. Select the **Text** tab.

The **Text** tab appears:



2. Use the one or more text string drop-down menus provided to characterize the color search.

Text entered into the various boxes by selecting an item in the drop-down menus can be edited, or text may simply be entered directly into the boxes without selecting the drop- down menus. Use commas to separate OR items on any line. Use of the ! (not) symbol will exclude a text string from the search.

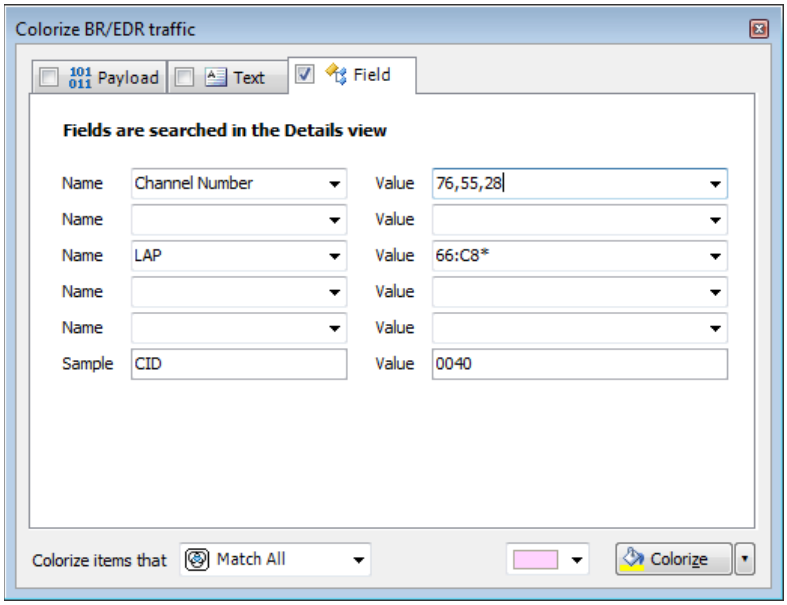
3. Select the desired color and click on **Colorize**.

Events matching are colorized in the Overview.

To colorize events by field value:

1. Select the **Field** tab.

The **Field** tab appears:



Values in the **Name** boxes are synchronized to the selected event in the Overview, which is synchronized to the Details view. The **Value** boxes reflect data elements displayed in the Details View. Users may type strings (values, wildcards, or ranges) directly into the **Value** boxes.

2. Select one or more items from the **Name** boxes.
3. Select corresponding items from the **Value** boxes.
4. Select the desired match type in the **Colorize items that** drop-down menu.
5. Select the desired color and click on **Colorize**.

Events matching are colorized in the Overview.

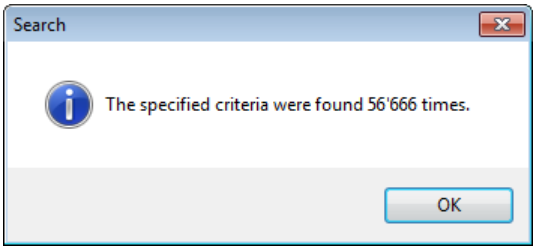
To display a count of matching criteria:

1. Define the search/colorize criteria from the **Payload**, **Text**, and/or **Field** tabs.
2. Select the drop-down arrow at the bottom-right of the **Colorize** dialog.
3. Select **Count**.

The **Colorize** button changes to a **Count** button:

4. Click on **Count**.

A count of items matching the criteria is displayed:



8.3 Grouping and Ungrouping

The application provides an option to group or ungroup protocols and profiles as displayed in the Overview. This allows the user to view traffic in hierarchical abstractions (e.g., RFCOMM) or to drill down to mid-level abstractions (e.g., L2CAP) or lower layers such as baseband and packet levels. An option to group or not group procedures and transactions is also provided.

Additional options to control the displayed protocols, profiles, and other filtering options are described in *Section 9, Display Filters.*

To collapse or expand protocols and profiles in the Overview:

Select the desired item in the Overview.

Select the **+** icon associated with the item to expand (or double-click) or select the **–** icon associated with the desired item to collapse (or double-click).

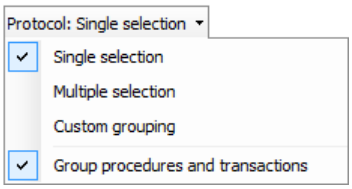
The selected item is expanded or collapsed as shown:

⊞ LMP Increase Power Request	"Notebook" 00:02:76:1E:10:E6 <-> "Phone" 04:1E:64:63:03:6B	Slave	OK	
⊟ LMP Extended Features Exchange	"Notebook" 00:02:76:1E:10:E6 <-> "Phone" 04:1E:64:63:03:6B	Master	OK	
⊟ LMP Extended Features Request	"Notebook" 00:02:76:1E:10:E6 <-> "Phone" 04:1E:64:63:03:6B	Master	OK	
⊟ ACL-C transfer	"Notebook" 00:02:76:1E:10:E6 <-> "Phone" 04:1E:64:63:03:6B	Master	OK	12 bytes (FE 03 01 01 01 00 00 ...
⊟ DM1 unit (ACL-C, 1 Mbps)	"Notebook" 00:02:76:1E:10:E6 <-> "Phone" 04:1E:64:63:03:6B	Master	OK	12 bytes (FE 03 01 01 01 00 00 ...
→ DM1 packet (ACL-C, 1 Mbps)	"Notebook" 00:02:76:1E:10:E6 <-> "Phone" 04:1E:64:63:03:6B	Master	OK	12 bytes (FE 03 01 01 01 00 00 ...
← NULL packet (ACL, 1 Mbps)	"Notebook" 00:02:76:1E:10:E6 <-> "Phone" 04:1E:64:63:03:6B	Slave	OK	
⊞ LMP Extended Features Response	"Notebook" 00:02:76:1E:10:E6 <-> "Phone" 04:1E:64:63:03:6B	Slave	OK	
⊞ LMP Increase Power Request	"Notebook" 00:02:76:1E:10:E6 <-> "Phone" 04:1E:64:63:03:6B	Master	OK	

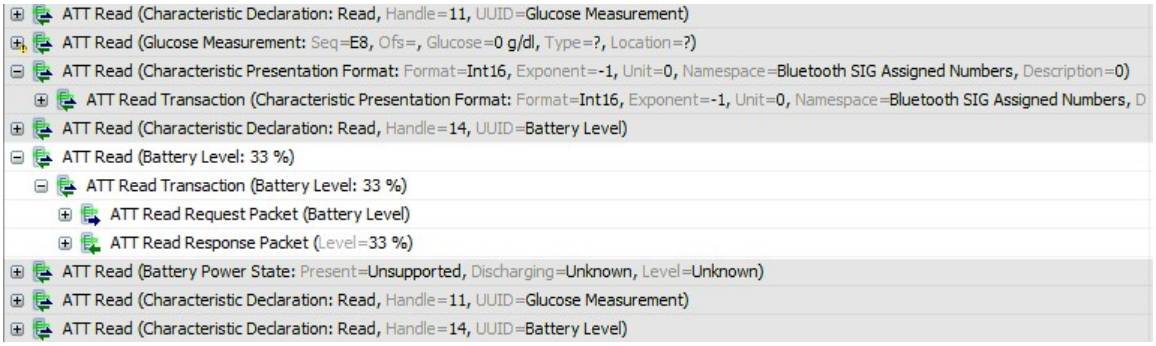
When grouping is enabled, the number of consecutive events is listed in parentheses along with the grouped item, as shown on the NULL packet in the figure above.

To enable grouping of procedures and transactions:

1. Select **Group Procedures and Transactions** from the **Protocol:** drop-down menu on the Tool Bar:

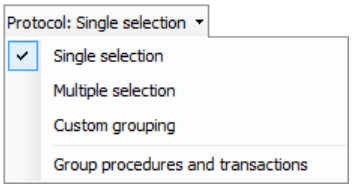


Transactions and procedures are grouped:

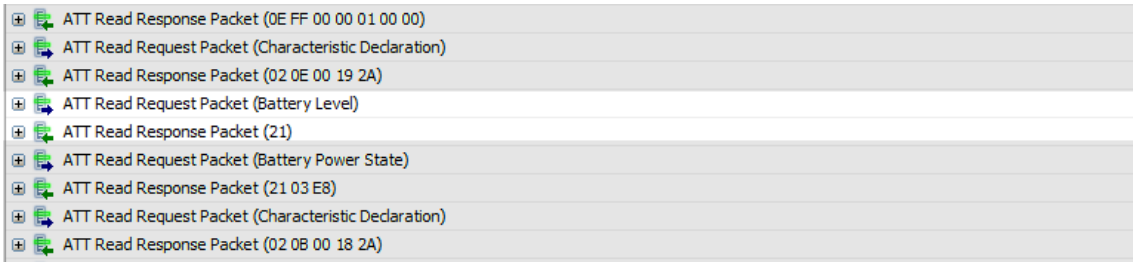


To disable grouping of procedures and transactions:

1. De-select **Group Procedures and Transactions** from the **Protocol** drop-down menu on the Tool Bar:



Transactions and procedures are not grouped:



The Overview may show grayed out packets that are duplicated. A single packet can have two concurrent functions: it can start a data transaction, and it can acknowledge a data transaction started by another device. In order to correctly group and display the protocol, the software will duplicate the packets having such functions.

8.4 Overview Timing Measurements

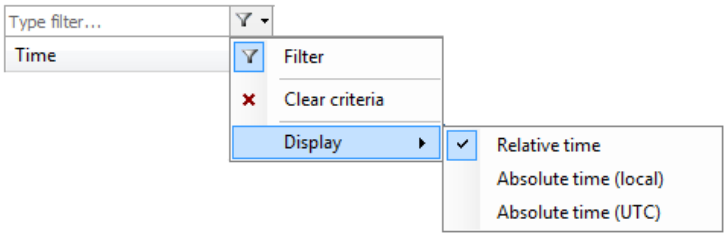
The Overviews include precision timestamps associated with each event captured. These are displayed in the **Time** column. The default timestamp format is a relative (Delta) time format, shown as *sec.milli.micro.nano.* Additionally, two absolute time formats are available, including UTC time and local system time.

The Overviews can be linked and unlinked to the *Instant Timing, Instant Audio, Instant Channels, Instant Channels, and Instant Throughput* panes as well as the *Instant Spectrum* view. By default, the active Overview is linked to these panes, and events selected in an Overview are instantly displayed in them. Timing measurements are easily made in the *Instant Timing* pane and *Instant Spectrum* view. See *Section 10, Instant Timing Pane* or *Section 11, Instant Spectrum View* for more information.

To set a time format:

1. Click on the Filter selection icon  associated with the **Time** column.
2. Select **Display**.

The *Time Format* menu appears:



3. Select the time format desired.

The Overview's **Time** column is populated with the selected time format.

To set a zero-time reference for Delta time:

1. Right-click anywhere in the Overview.
2. Click on **Set Time Reference**.

The selected event in the Overview is assigned a timestamp of zero. Events occurring after the zero-stamped event are incremented with positive timestamps, and events occurring before the zero-stamped event are incremented with negative timestamps. Other linked views are updated with the new timestamp value.

To reset a time reference to the original value:

1. Right-click anywhere in the Overview.

2. Select **Reset Time Reference**.

The events captured are reset with the timestamp values originally when the capture was taken.

8.5 Synchronization to Other Panes

By default, the Overviews are automatically synchronized to other panes to give the user a comprehensive understanding of traffic captured, and to ease navigation. Navigation through an Overview will cause synchronized tracking in the *Instant Timing* pane, the *Details* pane, the *Instant Channels* pane, the *Instant Spectrum* view, *Instant Channels* pane, *Instant Throughout* pane, *Instant Audio* pane, and the *Raw Data* pane.

Conversely, selection of timestamps located in the *Security* pane and *Instant Piconet* pane allow the user to jump to relevant locations in the Overviews.

A double click on the graphical audio representations in the *Instant Audio* pane will force the pertinent Overview to navigate to the location where the double click is made.

If the *Instant Timing* pane is configured to disable synchronization with the Overview(s), i.e., to not track selections made in the Overview(s), the user can force the *Instant Timing* pane to jump to the selected Overview event as described below.

To force the selected event in an Overview to display in the Instant Timing pane:

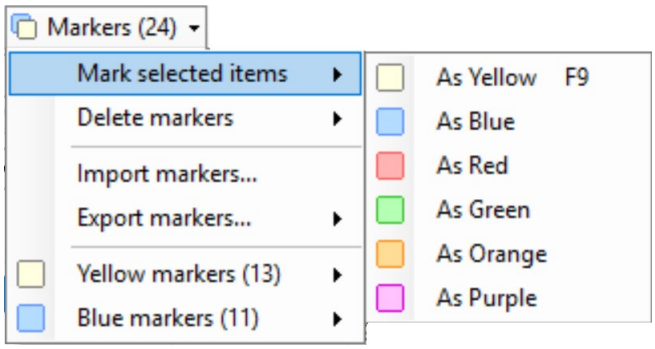
1. Right-click in the desired Overview.

2. Select **Show in Instant Timing view**.

The *Instant Timing* pane jumps to the event selected in the Overview.

8.6 Using Markers in Overviews

Items selected in the Overviews can be annotated with markers and saved with a capture. Markers are also quite useful for remote collaboration among users. Markers can be edited to add descriptive notes. More than one marker can be placed on an event. They can be color-coded to differentiate among the various users creating the markers or color-coded in groups of selected markers. Markers can be added to single events in an Overview, to contiguous events (using SHIFT), or to non-contiguous events (using CTRL).



Markers can also be exported and imported to/from a capture, alleviating the need to send capture files between collaborators who may already have the original capture file. Further, markers can be sent and retrieved over the Ellisys secure cloud (see *Section 5.5, Sharing a Capture File to the Cloud)*. Markers placed in an Overview are automatically replicated in the *Instant Timing* pane, the *Instant Throughout* pane, the *Instant Audio* pane, and the *Instant Spectrum* view.

To add a marker in an Overview:

1. Select the event to be marked in the Overview and then click on the **Markers** button (F9) on the toolbar.

2. Alternatively, left-click or right-click in the gray vertical column at the far-left of the Overview adjacent to the item desired for marking.

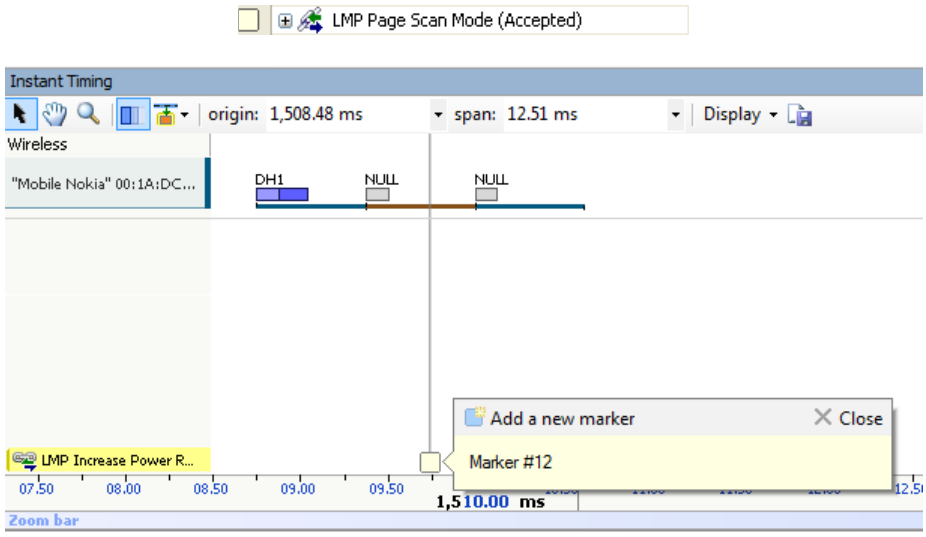
The *Add a new marker* dialog appears:

1. Add comments as desired.

2. Select a color for the marker as desired.

3. Click on **Close**.

A marker is placed adjacent to the event in the Overview and in other relevant panes as described above:



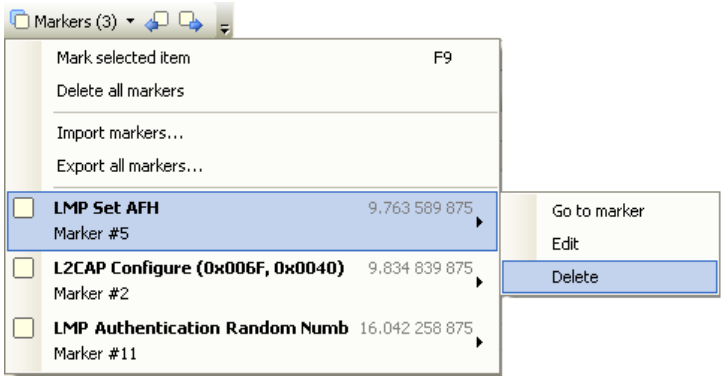
Multiple markers may be placed on a single event. Use of the color-coding can facilitate technical "conversations" between users by assigning assorted colors to different users.

To delete a marker:

1. Position the mouse pointer over the marker to be removed.

2. Right-click and select **Remove marker** or alternatively, select the **Markers** button (F9) on the toolbar 

.



3. Position the mouse pointer over the desired marker:

4. Select **Delete**.

The marker is removed.

To edit a marker:

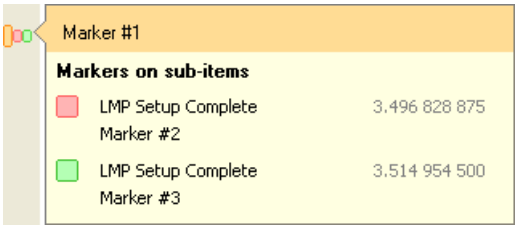
1. Position the mouse pointer over the marker to be edited.
2. Left-click the marker (or right-click and select **Edit Marker**) or alternatively, select the **Marker** button on the toolbar.
3. Select the desired marker.
4. Select **Edit**.

The selected marker opens for editing.

To access markers embedded in Sub-Items (Grouped Items):

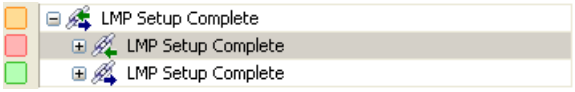
1. Place the mouse pointer over the marker(s) at the left of the desired event.

The *Markers on sub-items* menu appears:



2. Select the desired marker.

The grouped item expands, with the marked item adjacent to the selected marker highlighted:

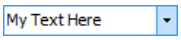


8.7 Search Features

Several search features are provided to enable searching the selected Overview. These include *a query-based search feature (also used for filtering and colorizing)* a configurable search menu, and several *Go-To* features.

To enable the Instant Search:

1. Type the text string desired in the *Instant Search* box located at the top-right of the selected Overview or select **Search | Instant Search** (Ctrl+I) from the menu to place the cursor in the *Instant Search* box.



2. Select ENTER

The line where the string is found is highlighted in the Overview.

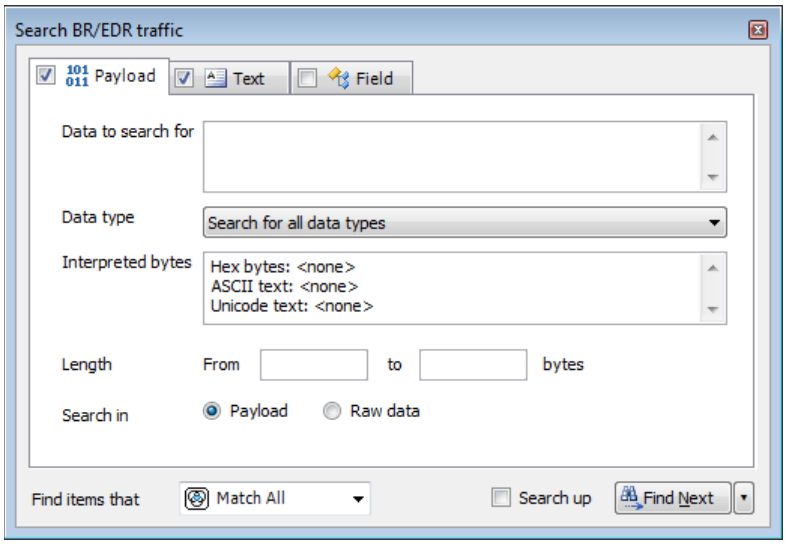
Press F3 to search next.

Use commas to separate multiple search values. Wildcards (*) can be used.

To use the Search menu:

1. Right-click in the Overview and select **Search** or select **Search | Search** (Ctrl+F) from the menu.

The *Search* Bluetooth dialog appears:



To search events by payload content:

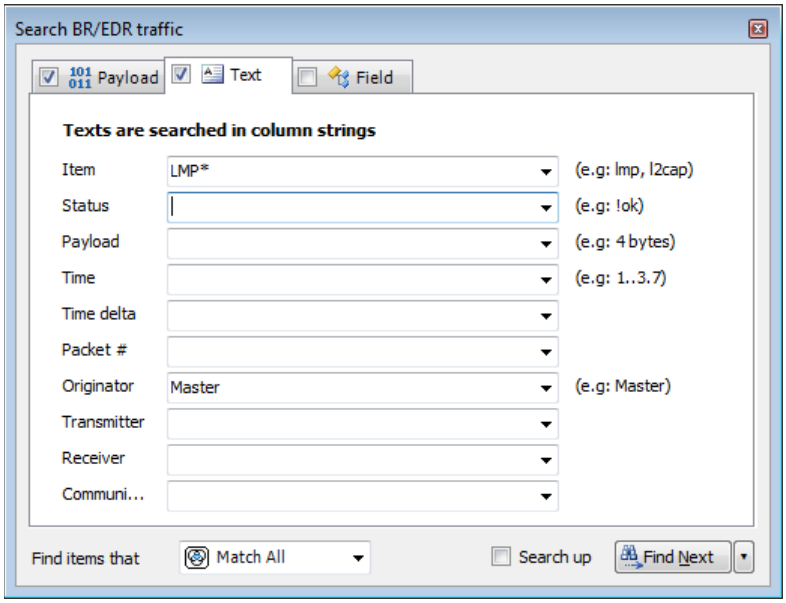
1. Select the **Payload** tab.
2. Enter **Data to search for** and/or a payload **Length** range.
3. Select **Data Type** as needed.
4. Select **Search in Packets** or **Search in Transactions** to search packets or transactions.
5. Select the desired match type in the **Find items that** drop-down menu.
6. Click on **Find Next**. 

The next event matching the search criteria is highlighted in the Overview.

To search events by text string:

1. Select the **Text** tab.

The **Text** tab appears:



Use one or more text string drop-down menus provided to characterize the search.

Text entered into the various boxes by selecting an item in the drop-down menus can be edited, or text may simply be entered directly into the boxes without selecting the drop- down menus. Use commas to separate OR items on any line. The "!" (not) symbol will exclude a text string from the search.

2. Select the desired match type in the **Find items that** drop-down menu.

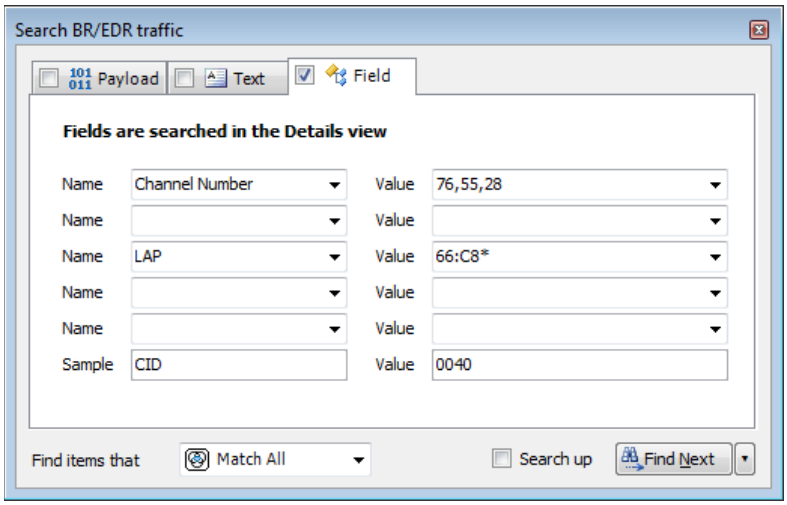
3. Click on **Find Next.** 

The next event matching the search criteria is highlighted in the Overview.

To search events by field value:

1. Select the **Field** tab.

2. The **Field** tab appears:



Values in the **Name** boxes are synchronized to the selected event in the Overview, which is synchronized to the *Details* pane. The **Value** boxes reflect data elements displayed in the *Details* pane. Users may type strings (values, wildcards, or ranges) directly into the **Value** boxes.

3. Select one or more items from the **Name** boxes.

4. Select corresponding items from the **Value** boxes.

5. Select the desired match type in the **Find items that** drop-down menu.

6. Click on **Find Next**. 

The next event matching the search criteria is highlighted in the Overview.

To display a count of matching criteria:

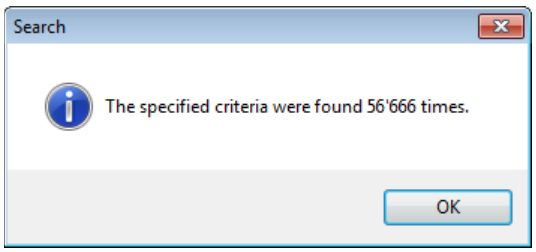
1. Define the search criteria from the **Payload**, **Text**, and/or **Field** tabs. \

2. Select the desired match type in the **Find items that** drop-down menu.
3. Select the drop-down arrow at the bottom-right of the *Search* dialog.
4. Select **Count.** Σ Count

The **Find Next** button changes to a **Count** button. Σ Count

5. Click on the **Count** button.

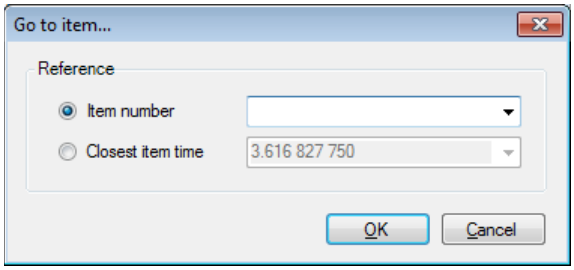
A count of items matching the criteria is displayed:



To search using an Item Number or Item Time:

1. Select **Search | Go To** (Ctrl+G) from the menu.

The *Go to item* dialog appears:



2. Select **Item number** and enter an item number or alternatively, select **Closest item time** and enter a timestamp in *x.xxx xxx* format.

The **Closest item time** value may be entered as an abbreviated timestamp, such as x.xxx or x.x, to approximate the search.

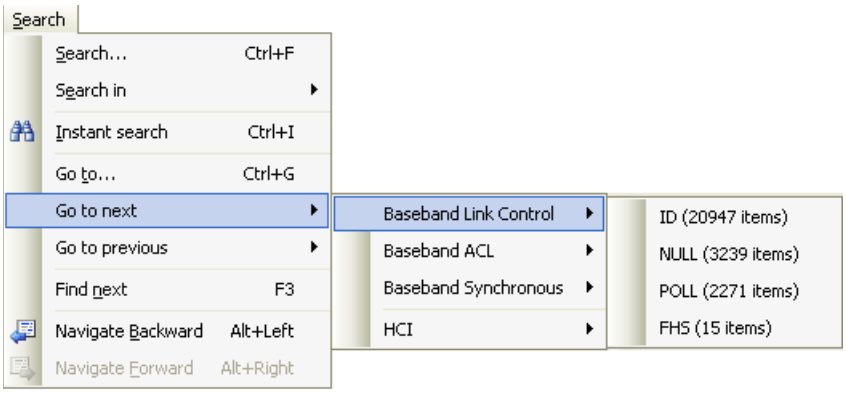
3. Click on **OK**.

The item found is highlighted in the Overview.

The **Item Number** correlates to the **Packet Number** column, which is available in the Overview. If it is not displayed, right-click on the column header to add this column.

To use a content-sensitive search:

1. Select **Search | Go to next or Search | Go to previous** from the menu, as desired.
2. A content-sensitive menu of searchable items appears:



3. Click on the item desired.

Note that a count of searchable items is included. Events not captured in the capture are not listed or may be grayed out.

The selected event is highlighted in the Overview.

9. Display Filters

The analyzer employs a powerful all-channel digital radio for Bluetooth capture. Additionally, the analyzer captures a wide variety of wired traffic, WPAN 802.15.4, and Wi-Fi (if configured and licensed). Consequently, it is often important to be able to quickly and efficiently filter/drill-down in the analyzer application to isolate the communications of interest.

The analyzer software provides several methods to filter the various displays to the user's requirements.

On the Welcome Screen, (**View | Layout | Welcome**), please see the Expert Note entitled *EEN_BT08 – Separating the Wheat from the Chaff* for more information on how to use the various display filters.

9.1 Filters Available

The table below lists the various filters available, where to access, and the intended function:

Filter Type	Filter Location	Purpose of Filter
Overview Instant Filters	Atop each Overview	Highly flexible query-based filter used to include, exclude or otherwise execute a variety of programmatic operations on items displayed in any *Overview* column or in the *Details* view.
Overview Keep and Exclude Filters	Column/row-sensitive right-click selection in Overview	Filters traffic in active overview to show or hide based on item selected (populates *Instant Filter* box with filter created).
Overview Device Keep Only and Keep Involving Filters	Right-click selection in Overview	Allows for keeping only the traffic between the two communicating devices or involving the traffic of either of the two communicating devices.
Bluetooth Protocol / Profile Filters	Filter Bar on Overview toolbar	Single, Multiple, and Custom Grouping Selections. Allows for display in all panes of only selected protocol(s), profile(s). Also allows for selection of baseband and packet-only views.

Filter Type	Filter Location	Purpose of Filter
Instant Piconet Keep Only and Keep Involving Filters	Right-click on *Instant Piconet* pane	Filters all panes to show only piconet(s) or connection(s) of interest.
Instant Piconet Broadcast Filter	Instant Piconet Toolbar	Removes broadcast traffic from Instant Piconet view (inquiries, advertisements, etc.).
Bluetooth Device Traffic Filter	Main toolbar	Provides a list of all Bluetooth devices in the current capture and a database of previously captured Bluetooth devices. Allows for show/hide of specific device communications. Allows for exclusion of background traffic (default). Affects all panes.
Wi-Fi Device Traffic Filter	Wi-Fi Overview toolbar	Provides a list of all Wi-Fi devices in the current capture and a database of previously captured Wi-Fi devices. Allows for show/hide of specific device communications. Allows for exclusion of background traffic (default).
Wi-Fi Protocol Filter	Filter Bar on Wi-Fi Overview toolbar	Single, Multiple, and Custom Grouping Selections. Allows for display in all panes of only selected Wi-Fi protocol(s). Also allows for selection of packet-only views.
Instant Timing Display Filter	Display button on *Instant Timing* toolbar	Shows/hides establishment traffic, idle traffic, and information pop-ups in the *Instant Timing* pane.
Instant Timing Traffic Type Filters	Buttons on *Instant Timing* Toolbar	Allows user to show or hide traffic types, including Bluetooth, Wi-Fi, WPAN, HCI, WCI, Logic, I2C, Generic UART, SPI, and SWD.
Instant Timing Keep-Only Filter	Right-click on packet in *Instant Timing* view	Allows user to keep only the indicated devices. Affects all panes.
Instant Spectrum Keep-Only Filter	Right-click on packet in *Instant Spectrum* view	Allows user to keep only the indicated devices. Affects all panes.

Filter Type	Filter Location	Purpose of Filter
Instant Spectrum Display Filter	Display button on *Instant Spectrum* toolbar	Shows/hides Establishment traffic and Idle traffic in the *Instant Spectrum* pane.
Instant Spectrum Traffic Type and Power Filters	Buttons on *Instant Spectrum* Toolbar	Allows user to show or hide power indications and traffic types, including BR/EDR, Low Energy, WPAN, and Wi-Fi. Can also be used to show/hide statistics.

To determine the current Filter status:

Filter status is displayed atop most of the selected Overviews, indicating how many line items are displayed, and how many have been filtered from view:

9.2 Definition of Keep Only and Keep Involving

In many areas of the analyzer software, the terms **Keep Only** and **Keep Involving** are used to define approaches to filtering. These filters are generally device-based (address-based) and are found with right-clicks in most panes/windows. They are also used in the *Device Traffic Filter* configuration dialog (main toolbar).

Keep Only: A **Keep Only** filter is fully deterministic, i.e., when it is active the user is assured that the traffic remaining in the capture pertains to communications *between* the devices specified in the filter.

Keep Involving: A **Keep Involving** filter is partially deterministic, i.e., when it is active, the user is assured that traffic remaining in the capture pertains to communications between the devices specified in the filter *and* traffic that those devices send and receive to and from *any other device*.

Once a device filter is in place, the user can use **File | Save Filtered Copy...** to save just the traffic matching the filter (excluding all other Bluetooth traffic). The original capture is not replaced (a new capture file is created). For more information, see *Section 5.3, Saving a Filtered Copy of a Capture File*.

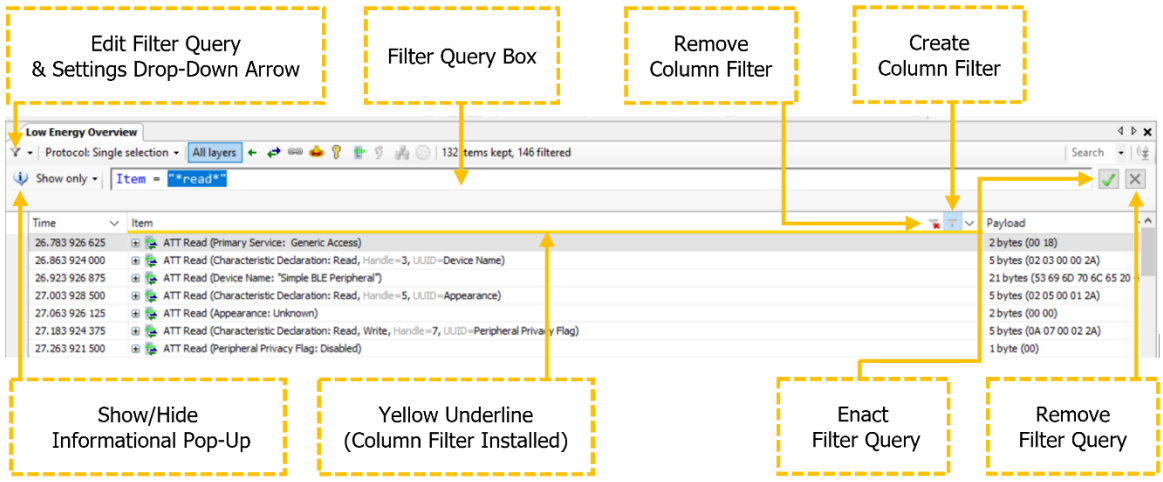
9.3 Instant Filters

*Instant Filter*s are enacted as query-based entries in the *Filter Query* box located atop the columns in the Overviews. The query approach is also used to colorize and search. These filters are quite powerful and can be used to efficiently and precisely locate and display information of interest during capture or on saved captures, using a variety of operators and comparators. A helpful pop-up is provided to guide the user in creating these filters.

Filters can be stored, recalled, and annotated as favorites.

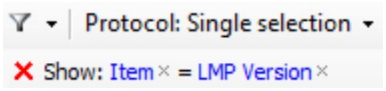
Data and information on which these filters operate can be in the active Overview or in the *Details* view; it is not required to place fields from the *Details* view into the Overview to use these fields in a filter query.

Instant Filter Menus and Controls



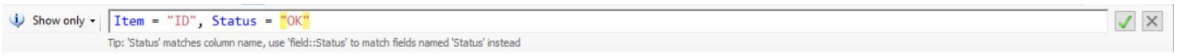
Opening the *Filter Query* Box

The *Filter Query* box (CTRL+H) is not visible until it is enabled, although a reduced version (shown below) is visible if a filter is enabled and the user deselects the **Hide Filter Bar** option in the **Edit Filter Query** drop-down.



Once a filter is created and enabled, the *Filter Query* box is hidden.

The *Filter Query* box can also be placed into view by clicking on the **Create Column Filter** icon in any column header (viewable with a mouse-over), by selecting the **Edit Filter Query** button, or by opening a previously used filter (**Past Filter**) from the **Edit Filter Query** drop-down arrow or the main **Search** menu.



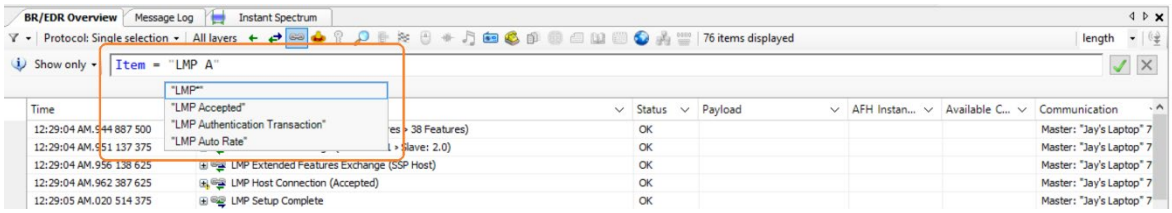
If **Hide Filter Bar** is deselected in **Edit Filter Query**, the reduced version of the *Filter Query* box remains visible after the filter is enabled, shown below. The entire filter can be cleared (removed) here, using the larger red X, and the elements comprising the filter can be selected to open the *Filter Query* box for editing. Clicking the smaller X associated with these elements will remove that element from the filter.

Columns can be added to an Overview by dragging the desired field from the *Details* view to the Overview, however, it is not necessary to have the column in the Overview to be able to include its contents in an Instant Filter.

The user can also add other filter types to enhance the approach, such as a protocol or profile filter, or a device-based filter (see *Section 9.4, Protocol / Profile Filters or Section 9.6, Bluetooth Device Traffic Filter* for details).

Auto-Complete Feature

When beginning to type in the *Filter Query* box, the application will suggest selections that can be selected for inclusion in the filter. These selections are intended to be comprehensive, based on Bluetooth specifications, and selected items may or may not be present in the trace.



Instant Filters Operators and Comparators

*Instant Filter*s are comprised of one or more characters and can be modified by a variety of operators and comparators. They are not case-sensitive. *Instant Filter*s may be used on a static capture, saved capture, during recording, and can be saved, recalled, forced to stay active for all traces, and prioritized as favorites.

Operator or Comparator	Function
&&	And
||	Or
*	Any
=	Equals
!	Not
!=	Does Not Equal
<	Less Than
>	Greater Than
<=	Less Than or Equal
>=	Greater Than or Equal
<<	Left Shift
>>	Right Shift

The comma is accepted as an OR operator for backward compatibility with a former *Instant Filter* approach. For clarity it is better to use the && and || operators, or at least to avoid missing the comma and these operators.

It is possible to create expressions comparing one field to another field (not only to constants). For example, if the user types "payload =", this produces a list of all existing fields, because the software suggests matching payload with any other field.

Instant Filter Values and Syntax

Values can be numbers, text (in double quotes), or computations using other fields. Text can use a star (*) to represent any character. An exclamation mark can be used before values to create a Not condition. Two periods (..) can be used to create a time range in time-based columns.

Instant Filter Syntax, Operators, and Comparators Examples

Item = "Text*"	Keeps lines where the Item column starts with **Text**
Item = !"*Text*"	Excludes lines where the Item column contains **Text**
Status = **"OK"**	Keeps lines where the Status column is exactly **OK**
Foo = **1, 0x03, 7..10**	Keeps lines where Foo is either **1, 3, 7, 8, 9,** or **10**
Foo >= **0x0F,** << **2, 4**+**5** && (**Bar** = **1** || **Status** != **"OK"**	Keeps lines where Foo is bigger than 9 and either Bar is 1 or Status is not OK
Payload = 0x[0A 0B 0C*]	Keeps lines where the first three bytes of Payload are 10, 11, 12

Foo (pronounced FOO) is an informal term used by programmers as a placeholder name. This is also known as a *metasyntactic variable*.

Item = **!"Text"** can also be written **!="Text"**. This approach may be more natural to some users.

Informational Pop-Up

The **Informational Pop-Up** is useful as a reference guide in creating Instant Filters. This includes information on proper syntax and example implementations of various filter approaches.

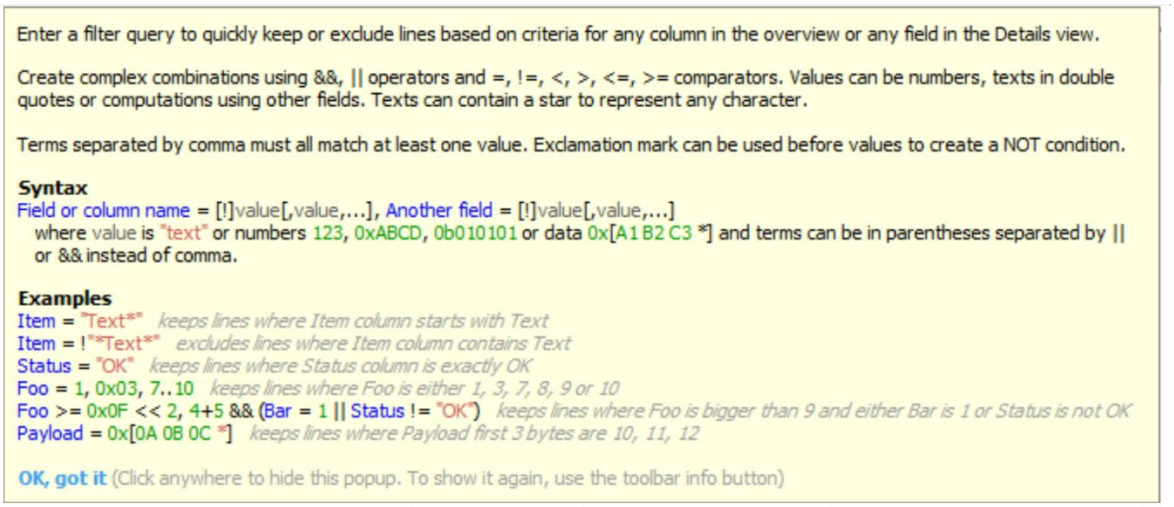
To enable the Instant Filter Informational Pop-Up

1. Place the mouse pointer on any column header and select the filter icon that appears:

The *Query Filter Bar* appears:

2. Select the **Display Information Pop-Up** button at left of the Query Filter bar.

The *Informational Pop-Up* appears:



Creating an Instant Filter

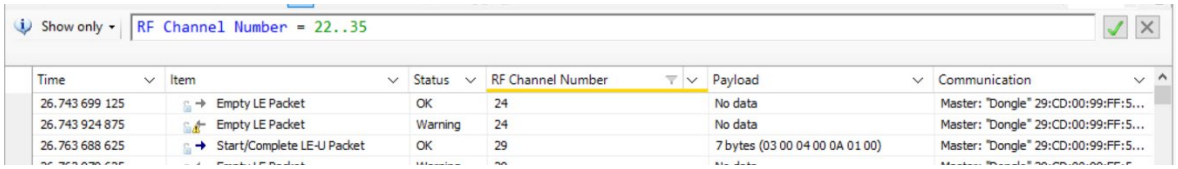
There are three ways to create an *Instant Filter*:

- Open the *Filter Query* box (CTRL+H) and type the desired filter.
- Recall a previously used query.
- Right-click on a column/row intersection in the desired Overview and select the available option to apply an *Instant Filter* (such as **Show Only**, **Exclude**).

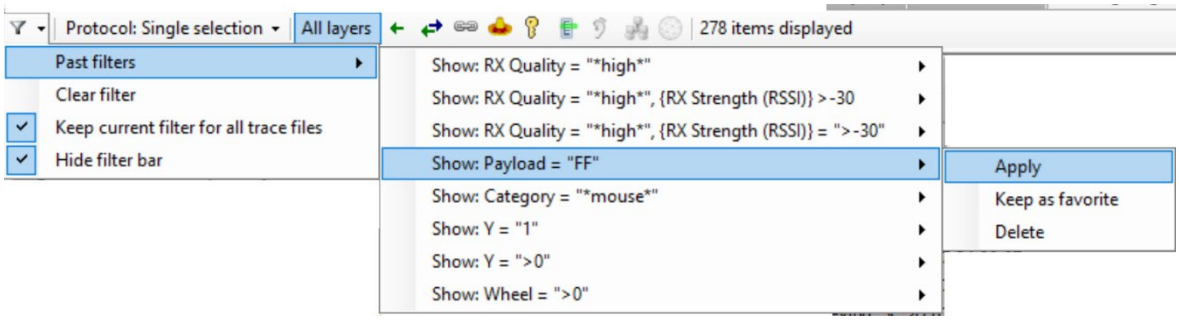
To create an *Instant Filter*:

1. Click on an *Instant Filter* icon (mouse-over to see) from one of the columns in the desired Overview.
2. Type the desired filter and click the green check ✓ or press ENTER.

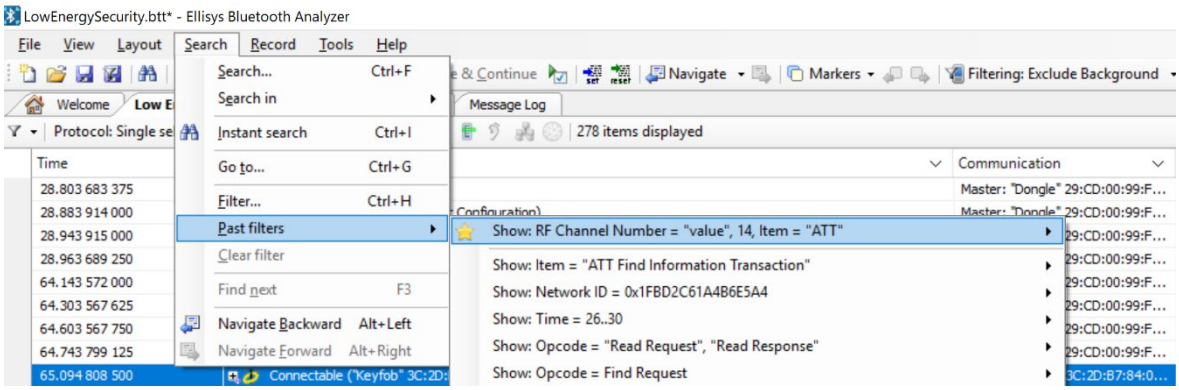
Columns having an *Instant Filter* applied and active will be highlighted with yellow underlining, as shown below.



3. Alternatively, select a stored filter (**Past Filter**) from the **Edit** ***Filter Query*** drop-down menu:



The **Past filters** selections are also accessible from the main **Search** menu, located on the main tool bar. Use ALT+S to open the Search menu, then **P** to expose the **Past filters** selections:



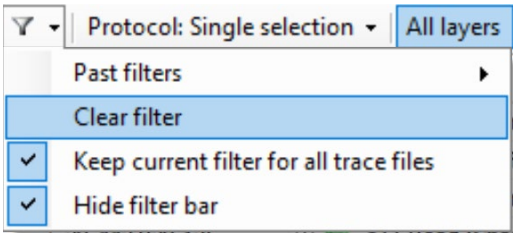
4. Alternatively, right-click over a column/row intersection and select the desired options, such as **Keep Only** or **Exclude**. The *Instant Filter* will be created in the relevant column. These options will vary depending on the type of data in the selection.

Clearing an Instant Filter

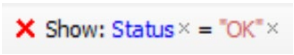
Filters are cleared either entirely or by removing individual elements of a filter.

1. To clear an element of an *Instant Filter*, click the red **Filter Clear** icon that appears when the mouse is placed in the column header.

2. To clear the entire filter, select **Clear Filter** from the **Edit** ***Filter Query*** drop-down menu:



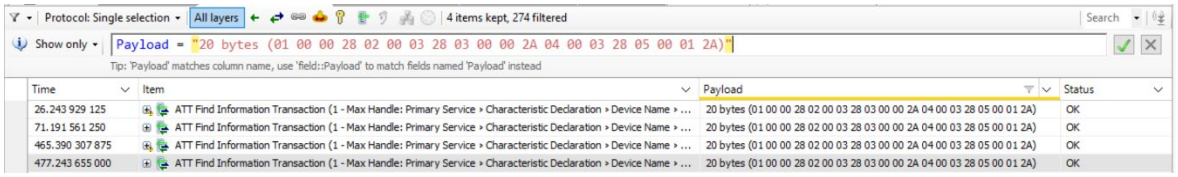
3. Alternatively, to clear the entire filter, click the larger red X associated with the reduced version of the *Filter Query*.



Examples

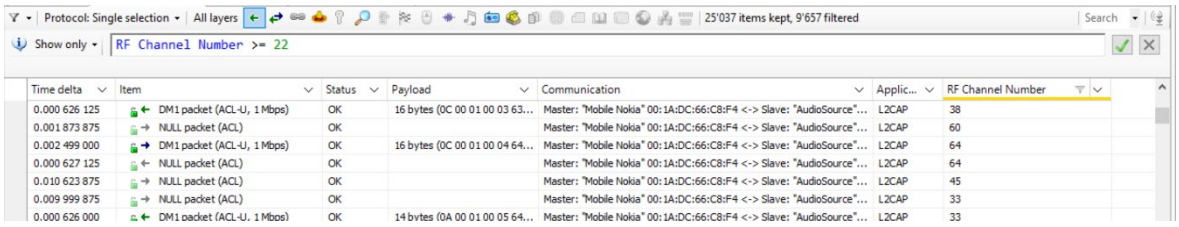
Example 1 – Show-Only a Specific Payload

The Show-Only example below will remove all items in the Overview that do not match the payload specified. Note that this filter can be typed manually into the *Instant Filter* box or applied with a right-click over the desired row in the **Payload** column. The **Show Only** selection can be toggled to **Hide** as needed, using the **Show Only/Hide** button at left of the *Filter Query* box.



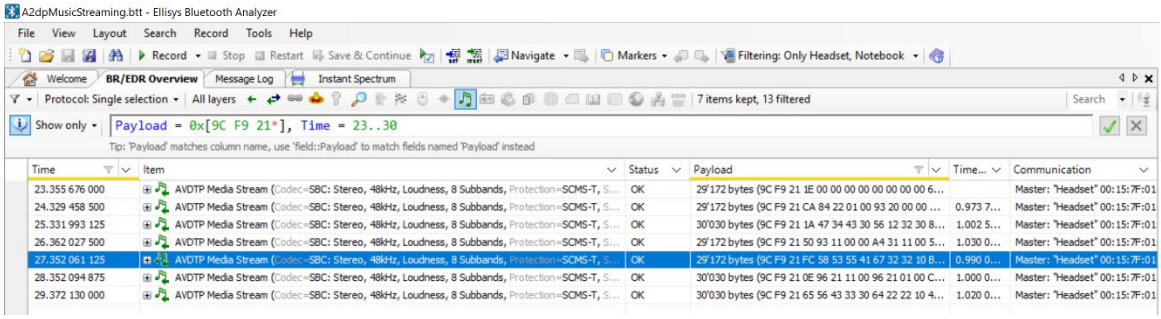
Example 2 – Show Only Channels Equal to or Greater Than

In the example below, a packets-only filter is applied (single-arrow icon in the *Protocol/Profile* tool bar), the **RF Channel** field is added from the *Details* view to the Overview, and an *Instant Filter* is added to show only RF channels equal to or greater than 22.



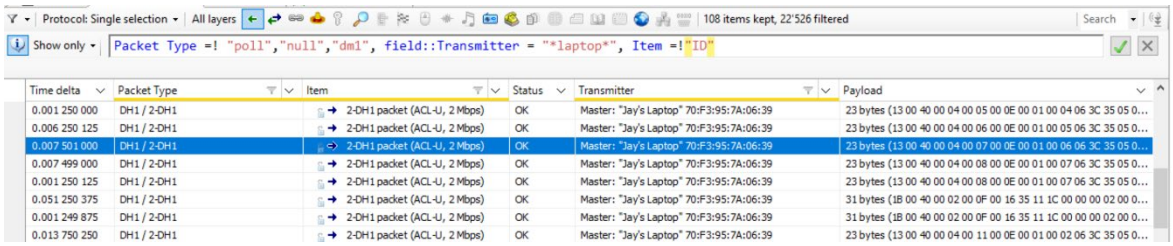
Example 3 – Using Multiple Filter Types Concurrently

In the example below, several filters are working together to give precision to the information being displayed. A device-based filter is applied in the **Filtering:** menu (Headset, Notebook), a protocol filter (Audio / Video) is applied on the Protocol/Profile tool bar, and two *Instant Filters* are applied – a time filter showing events between 23 and 30 seconds, and a payload filter showing only lines with payloads beginning with 0x 9C F9 21.



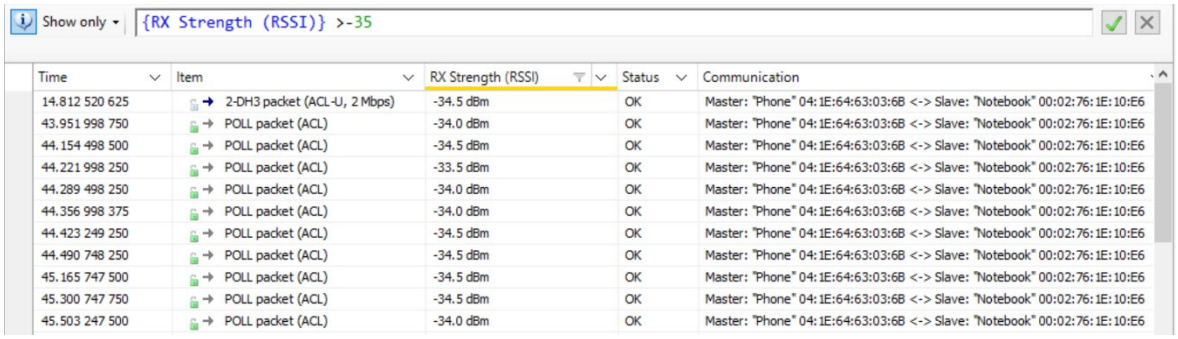
Example 4 – Specific Packet Types from a Particular Transmitter

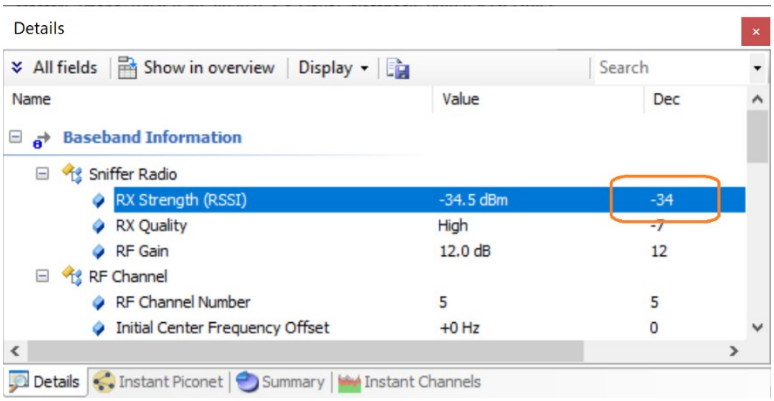
In the example below, three columns have Instant Filters applied: Packet Type, Item, and Transmitter. Three packet types are excluded, a single device's transmissions are kept, and ID packets are excluded. Note that the packets-only filter is applied (single-arrow icon in the Protocol/Profile tool bar).



Example 5 – Filtering in RSSI Values

In the example below, the user is looking for devices that are sending packets with an RSSI value greater (stronger) than -35dBm (as measured at the analyzer's antenna). Note the filter is using the decimal value (as shown in the *Details* view below) rather than the textual value that is default for this column (the user can also elect to use the textual value). Columns are coded for use of multiple formats by the *Instant Filter*.





9.4 Protocol / Profile Filters

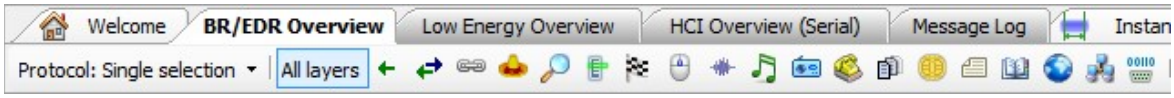
A selection of protocol and profile filter icons is available on the **Filter** bar (on most Overviews). These filters allow the user to show or hide specific protocols and profiles and includes baseband and packet-only options. The available filter options vary depending on the Overview selected.

The associated **Protocol**: drop-down menu allows for selection of a single protocol/profile, multiple protocols/profiles, or a custom selection.

Note that selection of any given protocol or layer on the Filter bar will affect which columns are displayed in the Overview. The columns displayed in the Overview are based on the item selected on the **Protocol** bar.

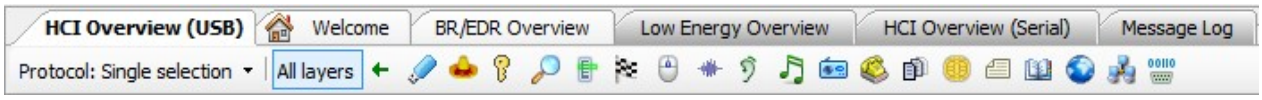
Use a fly-over on the Protocol/Profile filter icons to see a text string indicating the protocol or profile function.

The protocol/profile filters available for the *BR/EDR Overview* are shown below:



The protocol/profile filters available for the *Low Energy Overview* are shown below:

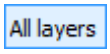
The protocol/profile filters available for the *HCI Serial* and *HCI USB* Overviews are shown below:



The protocol/profile filters for the Wi-Fi Overview is shown below:

Filter Icons and Function

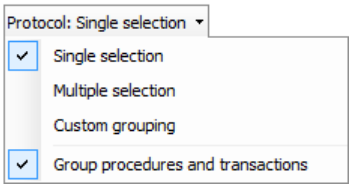
The table below describes the various filter icons and their functions:

Icon	Function	Overview	Protocol: Selection
	Shows all protocols and profiles	BR/EDR LE HCI Wi-Fi	Single
	Shows packets-only view	BR/EDR LE HCI Wi-Fi	Single
	Show/Hide Baseband	BR/EDR	Single, Custom
	Show/Hide Link Layer	LE	Single, Custom
	Show/Hide Wi-Fi Traffic	Wi-Fi	Single
	Show/Hide Internet Traffic	Wi-Fi	Single
	Show/Hide LMP	BR/EDR	Single, Multiple, Custom
	Show/Hide LLCP	LE	Single, Multiple, Custom
	Show/Hide L2CAP	BR/EDR LE HCI	Single, Multiple, Custom
	Show/Hide SDP	BR/EDR HCI	Single, Multiple, Custom
	Show/Hide A2MP	BR/EDR HCI	Single, Multiple, Custom
	Show/Hide RFCOMM	BR/EDR HCI	Single, Multiple, Custom
	Show/Hide AT	BR/EDR HCI	Single, Multiple, Custom
	Show/Hide SAP	BR/EDR HCI	Single, Multiple, Custom
	Show/Hide SCO/eSCO	BR/EDR HCI	Single, Multiple, Custom

Icon	Function	Overview	Protocol: Selection
	Show/Hide Audio	BR/EDR LE HCI	Single, Multiple, Custom
	Show/Hide OBEX	BR/EDR HCI	Single, Multiple, Custom
	Show/Hide MAP	BR/EDR HCI	Single, Multiple, Custom
	Show/Hide PBAP	BR/EDR HCI	Single, Multiple, Custom
	Show/Hide CTN	BR/EDR HCI	Single, Multiple, Custom
	Show/Hide DUN	BR/EDR HCI	Single, Multiple, Custom
	Show/Hide BNEP	BR/EDR HCI	Single, Multiple, Custom
	Show/Hide HID	BR/EDR HCI	Single, Multiple, Custom
	Show/Hide Serial Port	BR/EDR HCI	Single, Multiple, Custom
	Show/Hide ATT	LE HCI	Single, Multiple, Custom
	Show/Hide SMP	LE/HCI	Single, Multiple, Custom
	Show/Hide Hearing Aid	LE/HCI	Single, Multiple, Custom
	Show/Hide IPSP	LE/HCI	Single, Multiple, Custom
	Show/Hide HCI	HCI	Single, Multiple, Custom
	Show/Hide HTTP	Wi-Fi	Single
	Show/Hide Mesh	LE/HCI	Single, Multiple, Custom

To enable or disable a Protocol/Profile filter:

1. Select the desired Overview.
2. Select the desired feature from the **Protocol**: drop-down menu:

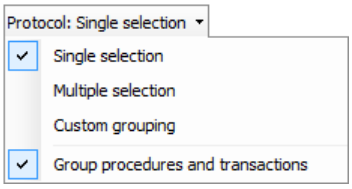


3. Select or deselect the desired filter icon(s) as desired.

The Overview updates with the selected setting.

To remove all Protocol/Profile filters:

1. Select the desired Overview.
2. Click on the down-arrow associated with the **Protocol:** drop-down menu.
3. Select the **Single selection** feature from the **Protocol**: drop-down menu:

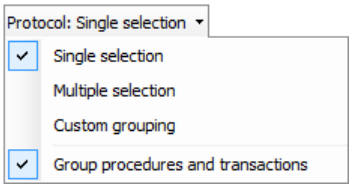


4. Select **All Layers**. 

The Overview updates to remove all protocol/profile filters.

To show only packets (to remove all protocol/profile grouping):

1. Select the desired Overview.
2. Click on the down-arrow associated with the **Protocol:** drop-down menu.
3. Select the **Single selection** feature from the **Protocol**: drop-down menu:



4. Select the **Packets** icon.

The Overview updates to show only individual packets.

9.5 Instant Piconet Keep-Only and Keep Involving Filters

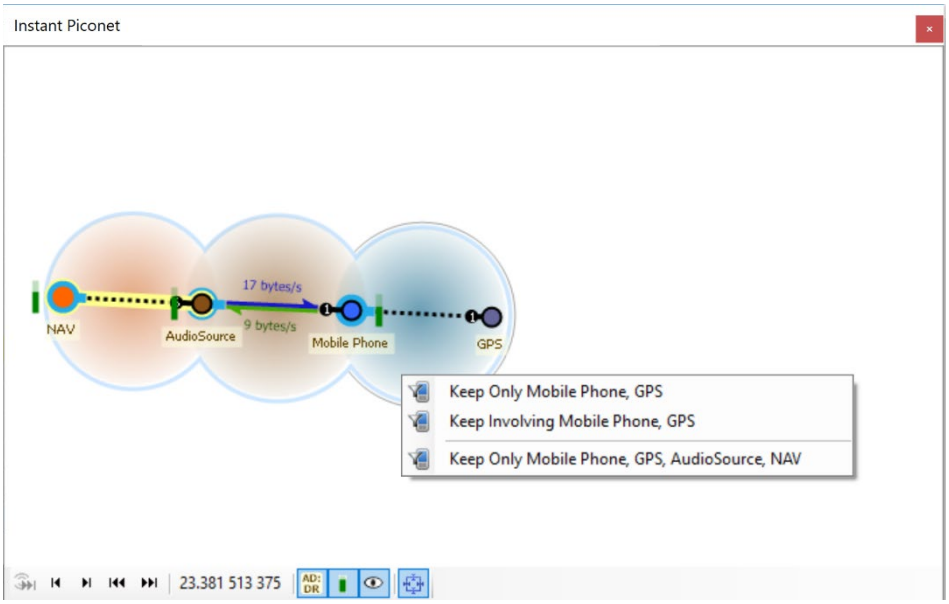
The *Instant Piconet* pane provides filtering that enables the user to show/hide selected piconets, scatternets, paging events, and inquiry events. This filter will update all displays and panes. For more information on the *Instant Piconet* pane, see *Section 16, Instant Piconet Pane*.

To set an Instant Piconet Keep Only or Keep Involving Filter:

1. Position the mouse pointer over the desired piconet or scatternet and right-click.

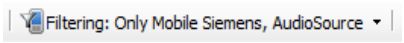
Navigate to a piconet event (so that it will be displayed in the *Instant Piconet* pane) by selecting an associated event in the Overview (or other panes) or by using the navigation buttons located at the bottom-left of the *Instant Piconet* pane.

A **Keep Only / Keep Involving** filter dialog appears as shown below:



2. Select the desired option to keep the selected piconet or scatternet.

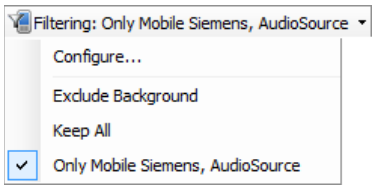
All displays and panes are updated to remove all but the selected piconet or scatternet traffic. The **Filtering** button (on the Main Tool Bar) updates to show the selected filter:



To clear an Instant Piconet Keep Only / Keep Involving Filter:

1. Select the down-arrow associated with the **Filtering** button on the Tool Bar.

The **Filtering** menu appears:



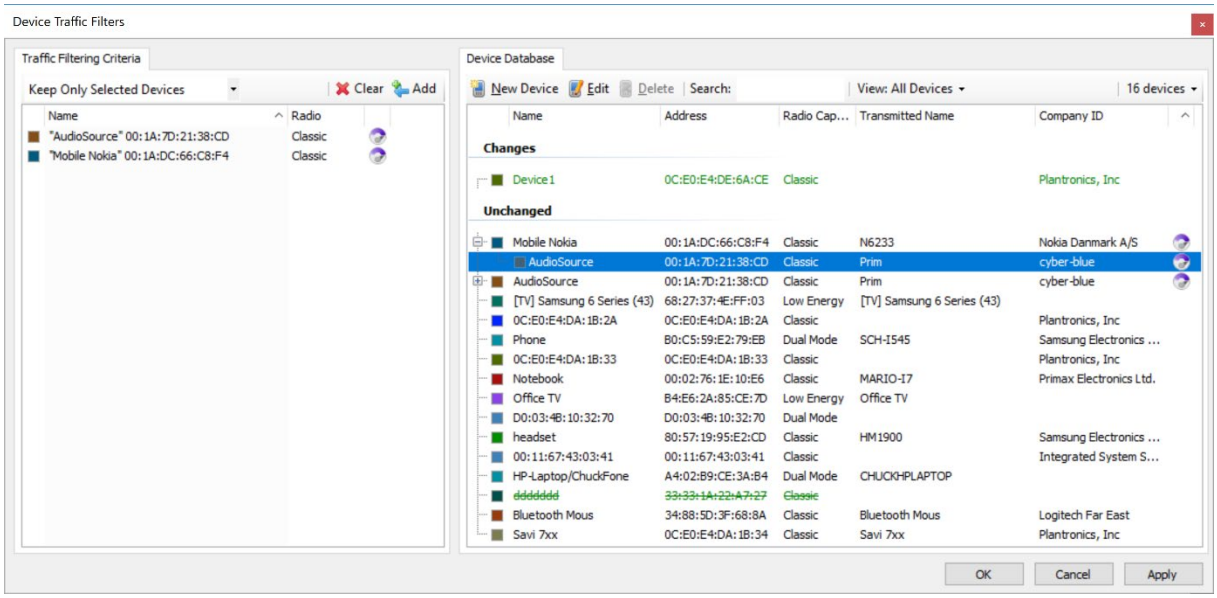
2. Select **Exclude Background** (this is the default setting).

All displays and panes are updated.

9.6 Bluetooth Device Traffic Filter

The analyzer application provides a powerful *Device Traffic Filters* feature designed to allow the user to be precise in controlling the device-based Bluetooth traffic displayed throughout the application. A similar feature is available for Wi-Fi devices (located on the menu bar of the *Wi-Fi Overview*).

The *Device Traffic Filters* dialog is accessible from the Main toolbar and includes two tabs - the **Device Database** and **Traffic Filtering Criteria**, shown below.



The **Device Database** is a searchable record of all Bluetooth devices captured by the analyzer, including historically captured devices and active devices (i.e., devices captured in the current trace). Each listed device includes ancillary information, including LMP Name, BD_ADDR, Radio type, and Company ID. An activity intensity indicator is also provided for each active device.

The user can use the *Device Traffic Filter* to rename devices for easy recognition in other areas of the application, and to re-color the default color associated with any/each device used throughout the application. Users may also manually add new devices to the *Device Database* or add an IRK to a selected device (**Edit** button).

The user can select a device listed in the **Device Database** to edit an incomplete BD ADDR to fill in missing values, in those cases where the analyzer capture is started after the connection process occurs (i.e., when the full BD ADDR is not captured). This can possibly assist with the analyzer's decryption routines to enable traffic decryption, assuming all other factors used in the decryption process are known and captured.

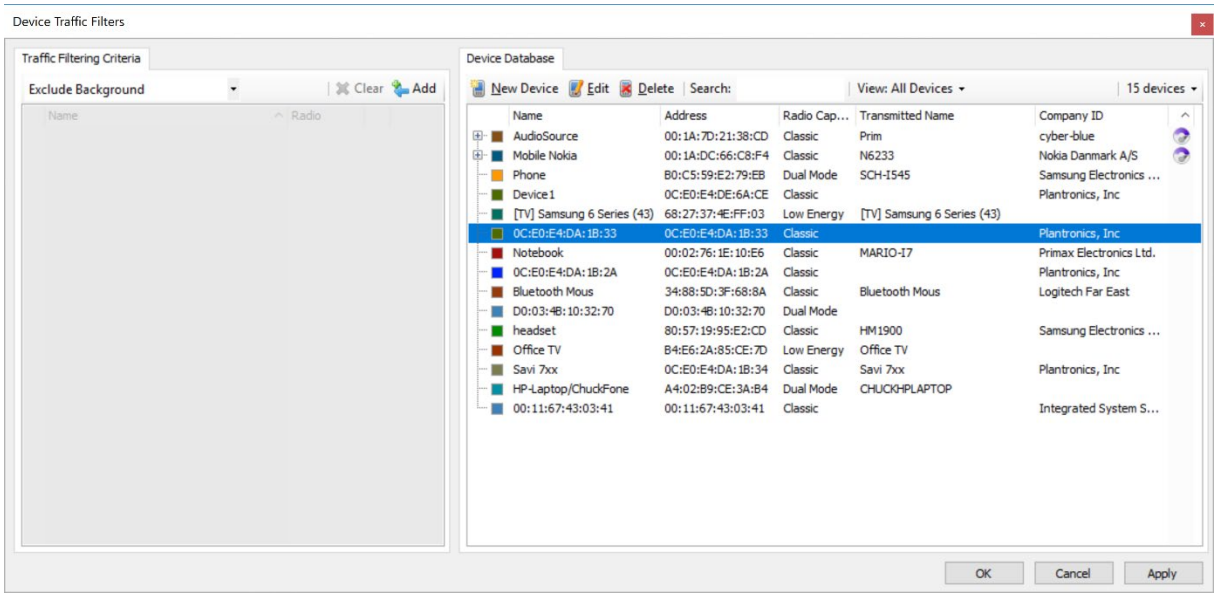
The **Traffic Filtering Criteria** tab allows user to select the criteria on which selected devices will be filtered, as detailed below:

Selection	Function
Keep All	No Filtering is applied by the *Device Traffic Filter*
Exclude Background	Default setting. Background traffic is removed. All other traffic is displayed. This filter is aimed at removing "background noise." Various conditions are included in this filter. The application software does a complete topology reconstruction and analysis, and if captured packets do not belong to "good piconets", these packets are hidden by this filter. There are also other conditions related to RSSI, de-whitening, HCS, FCS, and decryption.
Keep Involving Selected Devices	Communication involving the devices selected and any other devices will be kept. All other traffic is hidden.
Keep Only Selected Devices	When two or more devices are selected, only the communications between these selected devices will be kept. All other traffic is hidden.

To open the Bluetooth Device Traffic Filter:

1. Click on the **Filtering** button located on the Tool Bar or select **Device Traffic Filters**  from the **View** menu

The *Device Traffic Filter* window appears:



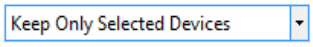
To keep only specified devices:

1. Click on the **Filtering** button located on the Tool Bar.

2. In the *Device Traffic Filters* dialog, double-click the desired devices in the **Device Database** to add these devices to the **Traffic Filtering Criteria,** or select the desired device and click on the **Add** button in the **Traffic Filtering Criteria**.

Devices selected are populated into the **Traffic Filtering Criteria** tab.

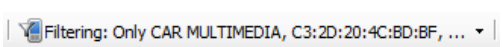
Note that **Keep Only Selected Devices** will be the automated selection with two or more devices added, but this can be changed as desired. With a single device added, the default will be **Keep Involving**.



3. Click **OK**.

All panes in the application are updated to show only the selected devices (if present). Devices not included in the **Traffic Filtering Criteria** will be captured but hidden.

The **Filtering** button is updated to show the filter created:



To use the Search devices feature:

1. Click on the **Filtering** button located on the Tool Bar.

The *Device Traffic Filter* window appears:

2. Type the desired text string in the **Search** box relating to any of the columns shown in the **Device Database** (**BD_ADDR**, **Name**, **Radio**, **LMP Name**, and **Company ID**).

Devices matching the text string are left in view; all others are hidden.

3. Press ENTER on the keyboard to add the matching devices to the **Traffic Filter Criteria**.

The **Search** box allows use of a wildcard (*), a comma (to add additional search criteria), and a not sign (!) to exclude. The **Search** box is not case-sensitive.

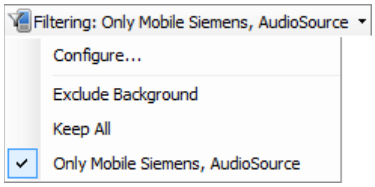
- Example 1: To search for devices that have a Company ID = Smith and devices having a Company ID = Jones, type `smith, jones` in the **Search** box.
- Example 2: To search for devices that have an LMP Name that includes "IDG" (e.g., "Widget") and devices having a Company ID of Smith, type `*idg, smith` in the **Search** box.
- Example 3: To search for devices that have a BD_ADDR beginning with 00:01, and devices not having a Company ID = smith, type `00:01,!smith` in the **Search** box.

4. Click **OK**.

To clear Device Traffic Filters:

1. Select the down-arrow associated with the **Filtering** button on the Tool Bar:

The **Filtering** menu appears:



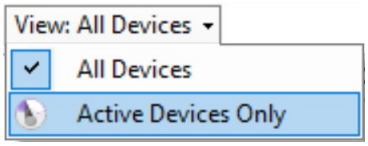
2. Select **Exclude Background** (this is the default setting).

All displays and panes are updated.

To view only devices in the current trace:

1. Click on the **Filtering** button located on the Tool Bar.
2. The *Device Traffic Filter* window appears.
3. In the **Device Database**, select the **View** down-arrow.

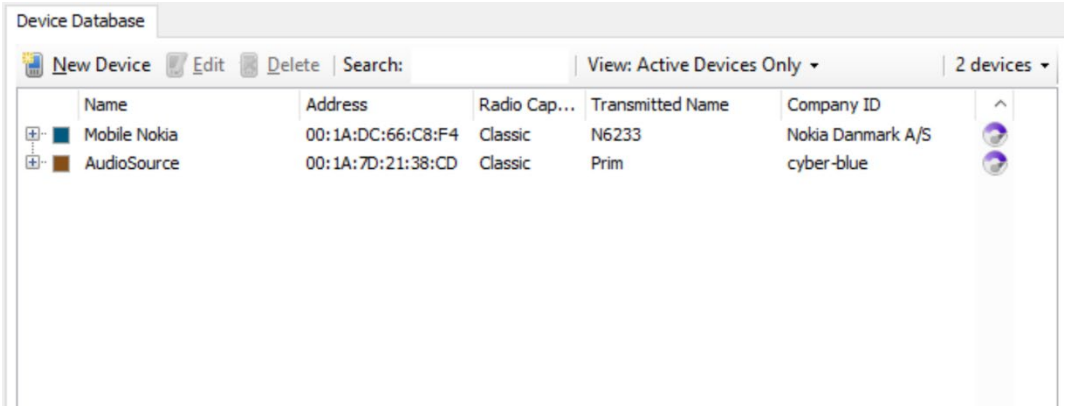
The **View** drop-down menu appears:



The **View** drop-down menu is grayed out if a capture is not open or a capture is not in process.

4. Select **Active Devices Only**.

The **Device Database** is updated to show only those devices in the current trace:



5. Click **OK**.

Devices captured in the current trace are indicated with the icon and include an expandable tree (+), showing other devices which have communicated with that device.

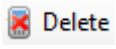
To remove a device from the Device Database:

1. Click on the **Filtering** button located on the Tool Bar.

The *Device Traffic Filter* window appears.

2. In the **Device Database**, select the device desired for deletion.

To delete multiple devices, hold the keyboard CTRL button while selecting, or the SHFT button to select contiguous device entries.

3. Click the **Delete** button 

or right-click the selection and select **Delete Device**.

To edit device parameters in the Device Database (BD_ADDR, Name, Color, and Radio):

1. Click on the **Filtering** button located on the Tool Bar.

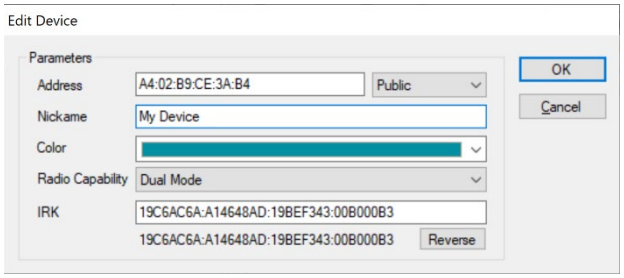
The *Device Traffic Filter* window appears.

2. In the **Device Database**, select the device desired for editing.

3. Click on **Edit** 

or right-click the selection and select **Edit Device**.

The **Edit Device** dialog appears:



4. Edit the desired properties (**BD_ADDR**, **Nickname**, **Color**, **IRK**, or **Radio**) as desired.

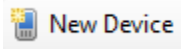
The IRK (Identity Resolving Key), if captured, will be populated in the **IRK** box. It may also be manually added to this dialog (to resolve private addresses).

5. Click **OK**.

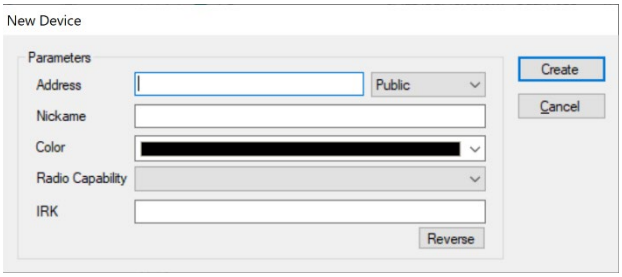
To manually add a new device to the Device Database:

1. Click on the **Filtering** button located on the Tool Bar.

The *Device Traffic Filter* window appears.

2. Click on New Device in the Device Database. 

The *New Device* dialog appears:



3. Edit the **Parameters** as desired.

4. Click **Create**.

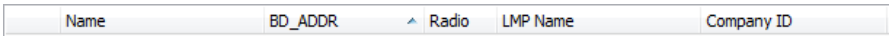
The new device is added to the **Device Database**.

To sort the Device Database:

1. Click on the **Filtering** button located on the Tool Bar.

The *Device Traffic Filter* window appears.

2. Click on the header above the column desired:



The **Device Database** is sorted in alpha-numeric order.

Clicking again on a column header will reverse the alpha-numeric order.

The **Color** column does not include a title on the column header but clicking on this column will sort the **Device Database** by color.

To exclude background traffic:

1. Click on the **Filtering** button located on the Tool Bar.

The *Device Traffic Filter* window appears.

2. In **Device Filtering Criteria**, select **Exclude Background** from the drop-down menu.

3. Click **OK**.

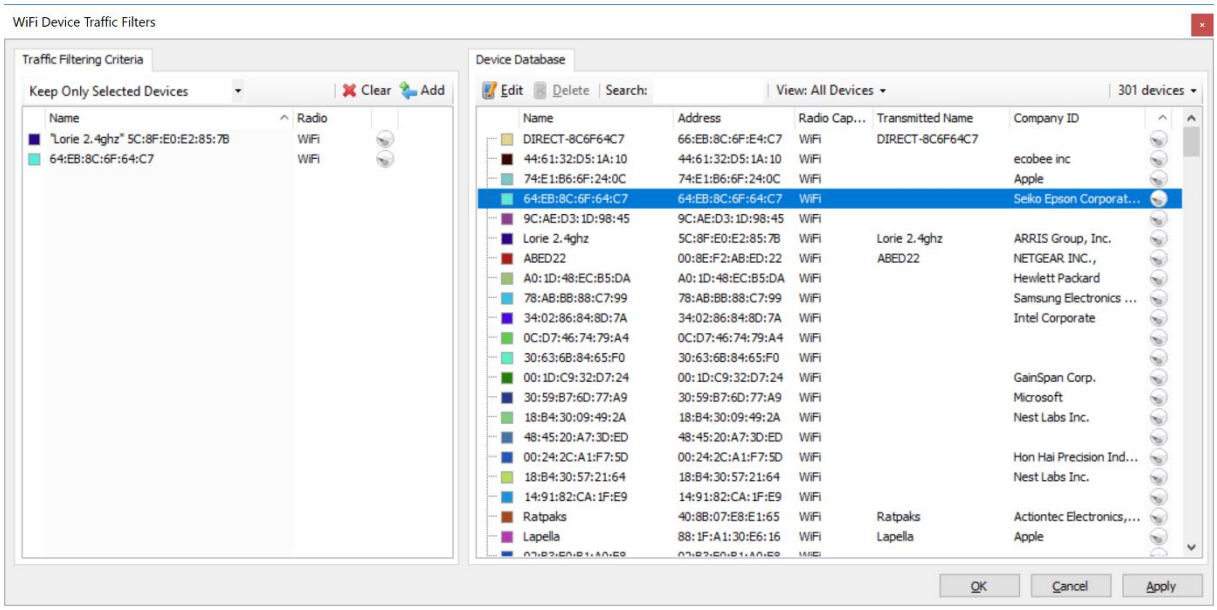
Background traffic is removed from the capture.

The **Exclude Background** filter is enabled by default. This filter is aimed at removing "background noise." Various conditions are included in this filter. The application software does a complete topology reconstruction and analysis, and if captured packets do not belong to "good piconets", these packets are hidden by this filter. There are also other conditions related to RSSI, de-whitening, HCS, FCS, decryption.

9.7 Wi-Fi Device Traffic Filter

The analyzer application provides a powerful *Device Traffic Filters* feature designed to allow the user to be precise in controlling the device-based Wi-Fi traffic displayed throughout the application. A similar feature is available for Bluetooth devices (located on the Main Tool Bar).

The *WiFi Device Traffic Filters* dialog is accessible from the menu bar of the *Wi-Fi Overview* (**View | Overviews**) and includes two tabs - the **Device Database** and **Traffic Filtering Criteria**, shown below.



The **Device Database** is a searchable record of all Wi-Fi devices captured by the analyzer, including historically captured devices and active devices (i.e., devices captured in the current trace). Each listed device includes ancillary information, including Name, Address, Radio Capability, Transmitted Name, and Company ID. An activity intensity indicator is also provided for each active device.

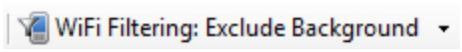
The user can use the *Device Traffic Filter* to rename devices for easy recognition in other areas of the application, and to re-color the default color associated with any/each device used throughout the application.

The **Traffic Filtering Criteria** tab allows user to select the criteria on which selected devices will be filtered, as detailed below:

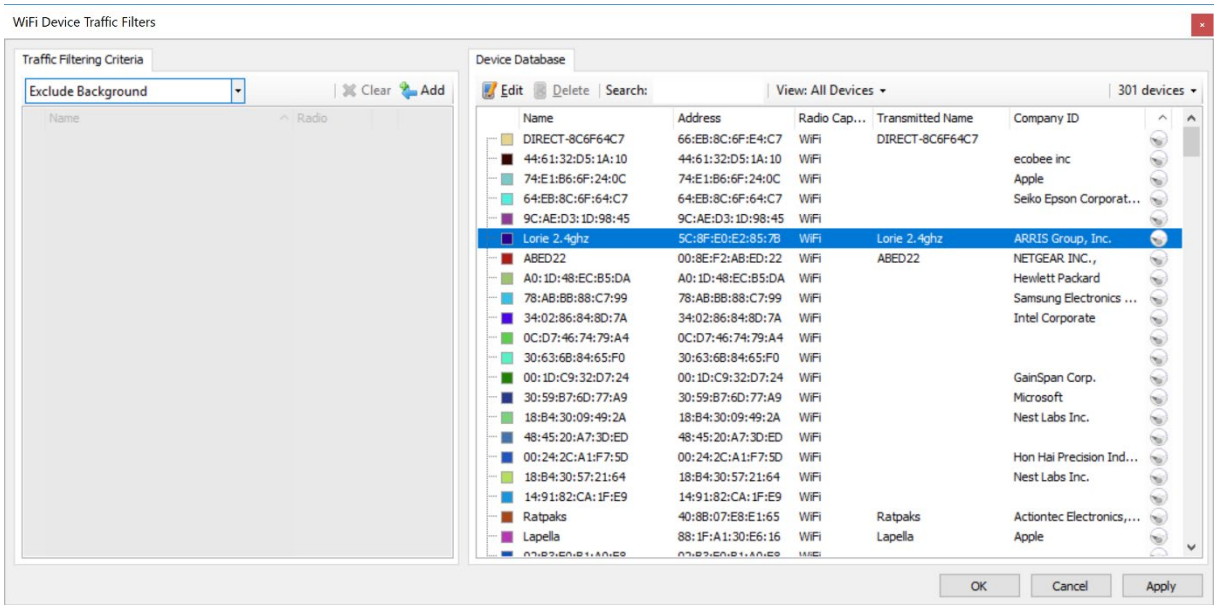
Selection	Function
Keep All	No Filtering is applied by the *Device Traffic Filter*
Exclude Background	Default setting. Background traffic is removed. All other traffic is displayed.
Keep Involving Selected Devices	Communication involving the devices selected and any other devices will be kept. All other traffic is hidden.
Keep Only Selected Devices	When two or more devices are selected, only the communications between these selected devices will be kept. All other traffic is hidden.

To open the Wi-Fi Device Traffic Filter:

1. Click on the **WiFi Filtering:** button located on the *Wi-Fi Overview* title bar.



The *Device Traffic Filters* window appears:



To keep only specified devices:

1. Click on the **WiFi Filtering** button located on the *Wi-Fi Overview* title bar.

2. In the *Device Traffic Filters* dialog, double-click the desired devices in the **Device Database** to add these devices to the **Traffic Filtering Criteria,** or select the desired device and click on the **Add** button in the **Traffic Filtering Criteria**.

Devices selected are populated into the **Traffic Filtering Criteria** tab.

4. Click **OK**.

All panes in the application are updated to show only the selected devices (if present). Devices not included in the **Traffic Filtering Criteria** will be captured but hidden.

The **WiFi Filtering** button is updated to show the filter created:

To use the Search devices feature:

1. Click on the **WiFi Filtering** button located on the *Wi-Fi Overview* title bar.

The *Device Traffic Filter* window appears:

2. Type the desired text string in the **Search** box relating to any of the columns shown in the **Device Database** (**Name**, **Address**, **Radio Capability**, **Transmitted Name**, and **Company ID**).

Devices matching the text string are left in view; all others are hidden.

3. Press ENTER on the keyboard to add the matching devices to the **Traffic Filter Criteria**.

The **Search** box allows use of a wildcard (*), a comma (to add additional search criteria), and a not sign (!) to exclude. The **Search** box is not case-sensitive.

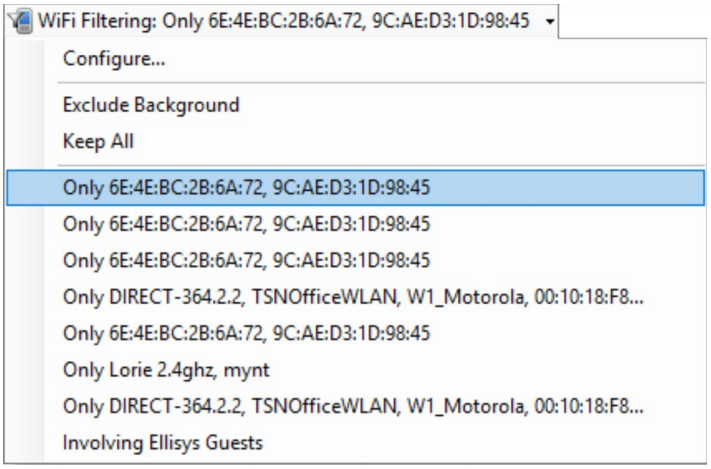
- Example 1: To search for devices that have a Company ID = Smith and devices having a Company ID = Jones, type `smith, jones` in the **Search** box.
- Example 2: To search for devices that have an LMP Name that includes "IDG" (e.g., "Widget") and devices having a Company ID of Smith, type `*idg, smith` in the **Search** box.
- Example 3: To search for devices that have a BD_ADDR beginning with 00:01, and devices not having a Company ID = smith, type `00:01,!smith` in the **Search** box.

4. Click **OK**.

To clear Device Traffic Filters:

1. Select the down-arrow associated with the **WiFi Filtering** button (located on the *Wi-Fi Overview* title bar):

The **WiFi Filtering** menu appears:



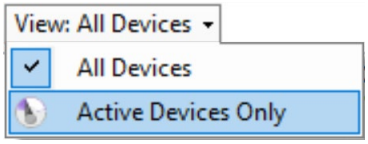
3. Select **Exclude Background** (this is the default setting).

All displays and panes are updated.

To view only devices in the current trace:

1. Click on the **WiFi Filtering** button (located on the *Wi-Fi Overview* title bar).
2. The *WiFi Device Traffic Filters* window appears.
3. In the **Device Database**, select the **View** down-arrow.

The **View** drop-down menu appears:



The **View** drop-down menu is grayed out if a capture is not open or a capture is not in process.

4. Select **Active Devices Only**.

The **Device Database** is updated to show only those devices in the current trace:

5. Click **OK**.

Devices captured in the current trace are indicated with the icon.

To remove a device from the Device Database:

1. Click on the **WiFi Filtering** button (located on the *Wi-Fi Overview* title bar).

The *WiFi Device Traffic Filter* window appears.

2. In the **Device Database**, select the device desired for deletion.

To delete multiple devices, hold the keyboard CTRL button while selecting, or the SHFT button to select contiguous device entries.

3. Click the **Delete** button Delete or right-click the selection and select **Delete Device**.

To edit device parameters in the Device Database (Name, Address, Radio Capability, Transmitted Name, and Company ID):

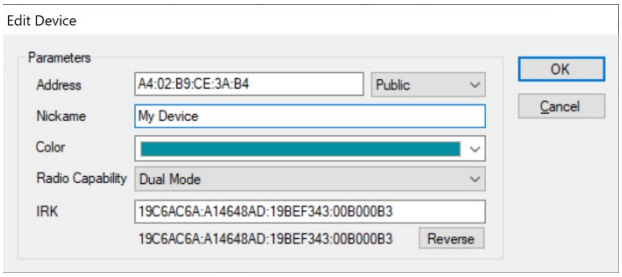
1. Click on the **Filtering** button located on the Tool Bar.

The *WiFi Device* Traffic Filter window appears.

2. In the **Device Database**, select the device desired for editing.

3. Click on **Edit** Edit or right-click the selection and select **Edit Device**.

The **Edit Device** dialog appears:



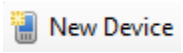
4. Edit the desired properties (**BD_ADDR**, **Name**, **Color**, or **Radio**) as desired.

5. Click **OK**.

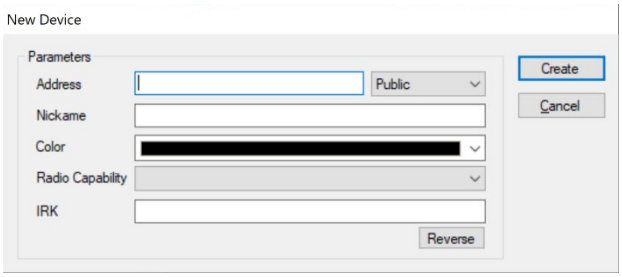
To manually add a new device to the Device Database:

1. Click on the **Filtering** button located on the Tool Bar.

The *Device Traffic Filter* window appears.

2. Click on New Device in the Device Database. 

The *New Device* dialog appears:



3. Edit the **Parameters** as desired.

4. Click **Create**.

The new device is added to the **Device Database**.

To sort the Device Database:

1. Click on the **Filtering** button located on the Tool Bar.

The *Device Traffic Filter* window appears.

2. Click on the header above the column desired:

The **Device Database** is sorted in alpha-numeric order.

Clicking again on a column header will reverse the alpha-numeric order.

The **Color** column does not include a title on the column header but clicking on this column will sort the **Device Database** by color.

To exclude background traffic:

1. Click on the **Filtering** button located on the Tool Bar.

The *Device Traffic Filter* window appears.

2. In **Device Filtering Criteria**, select **Exclude Background** from the drop-down menu.

3. Click **OK**.

Background traffic is removed from the capture.

The **Exclude Background** filter is enabled by default. This filter is aimed at removing "background noise." Various conditions are included in this filter. The application software does a complete topology reconstruction and analysis, and if captured packets do not belong to "good piconets", these packets are hidden by this filter. There are also other conditions related to RSSI, de-whitening, HCS, FCS, decryption.

9.8 Instant Timing Display Filter

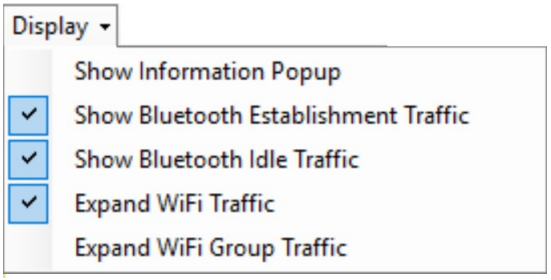
The *Instant Timing* pane (see *Section 10, Instant Timing Pane*) provides display filters for show/hide of Bluetooth inquiries, paging events, and advertisements, and show/hide of Bluetooth idle traffic (ID, Null, Poll and empty packets), and Wi-Fi display options. A flyover on any of the filter selections describes its purpose.

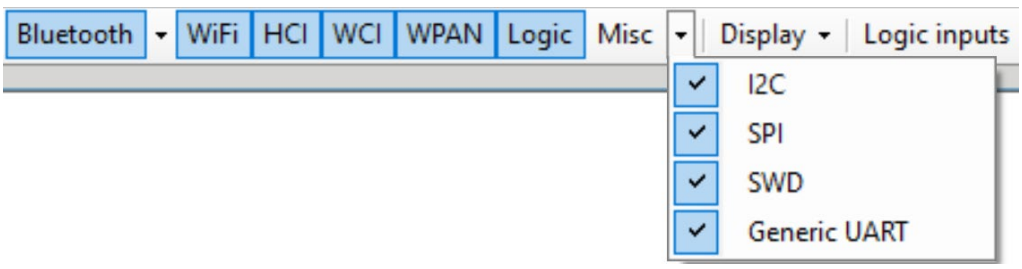
Other filters are available to hide specific traffic types and the throughput and statistics lines in the Instant Timing pane.

These filters are available from the *Instant Timing* pane tool bar.

To enable any of the filters in the Instant Timing pane:

1. Select the **Display** button or other applicable traffic type button as shown below) on the tool bar.





9.9 Instant Spectrum Display Filter

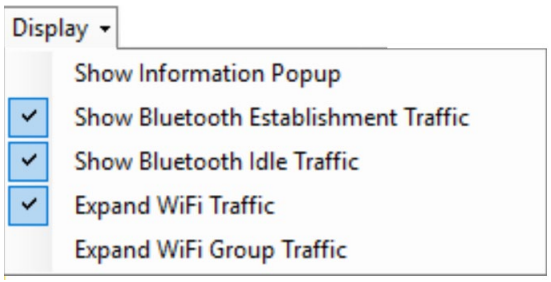
The *Instant Spectrum* View provides display filters for show/hide of Bluetooth inquiries, paging events, and advertisements, and show/hide of Bluetooth idle traffic (ID, Null, Poll and empty packets). A flyover on any of the filter selections describes its purpose.

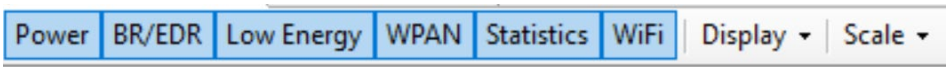
Other filters are available to hide specific traffic types, raw power spectrum indications, and statistics bars located on the right side of the *Instant Spectrum* pane.

These filters are available from the *Instant Spectrum* tool bar.

To enable any of the filters in the Instant Timing pane:

1. Select the Display **button** or other applicable traffic type button as shown below on the tool bar.





9.10 Overview Keep-Only Filter

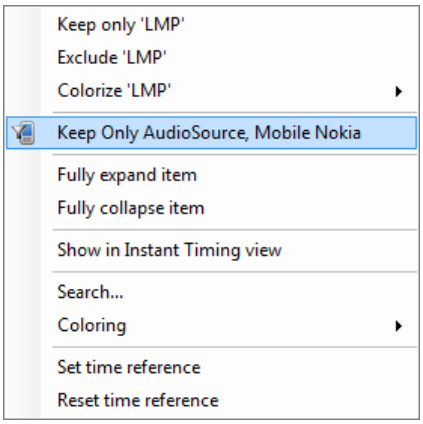
The Overviews provide a convenient right-click **Keep-Only** filter that enables the user to keep only the communicating devices shown on the line selected. All other communications are hidden. This filter affects all panes.

To enable an Overview Keep-Only filter:

1. Select the desired Overview.

2. Select the line desired in the Overview.

3. Right-click, and select **Keep Only 'xx and yy',** where **xx** and **yy** are the two communicating devices, as shown below:



The Overview and all panes are updated with the **Keep-Only** selection.

10. Instant Timing Pane

The *Instant Timing* pane provides a unique and intuitive way to understand various timing characteristics of Bluetooth traffic as well as all other traffic types captured by the analyzer, including logic signals.

Bluetooth packets are presented chronologically left to right and are uniquely color-coded per the packet's sender. For Bluetooth, each master device is provided its own line (row), with packets to and from the master device shown horizontally across the *Instant Timing* pane.

Additionally, the *Instant Timing* pane displays Wi-Fi, WPAN, and HCI traffic, generic communications (UART, SPI, SWD, I2C), logic signals, a representation of throughput, and statistical information, all in synchronization.

The *Instant Timing* pane provides for quick and easy timing measurements, slot timing, timing cursors, zoom and pan features, detailed packet flyovers, color-coded assignments to devices, and other navigation tools.

A throughput graph tracks data-rate characteristics for L2CAP and SCO/eSCO transfers. In the *Navigator* bar, the user is provided with a global summary of throughput over the entire capture, as well as a bracketed window that can be used to pan and zoom the *Instant Timing* display.

A statistical graph provides a synchronized understanding of retransmissions, packet errors, and header errors.

The *Instant Timing* pane is linked to the Overviews and the *Instant Spectrum* view. It is manually linked to the *Instant Piconet* pane by the *Instant Piconet* cursor, which when scrolled, updates the *Instant Piconet* view per its current location. Conversely, when events are selected in the Overview or the *Instant Spectrum* view, this cursor is re-positioned accordingly.

Note that since the analyzer is designed to be passive (does not interact with or synchronize to Bluetooth device clocks), timing measurements will be extremely precise.

To access the Instant Timing pane:

1. Select **View | *Instant Timing*** from the menu.

The *Instant Timing* pane appears:

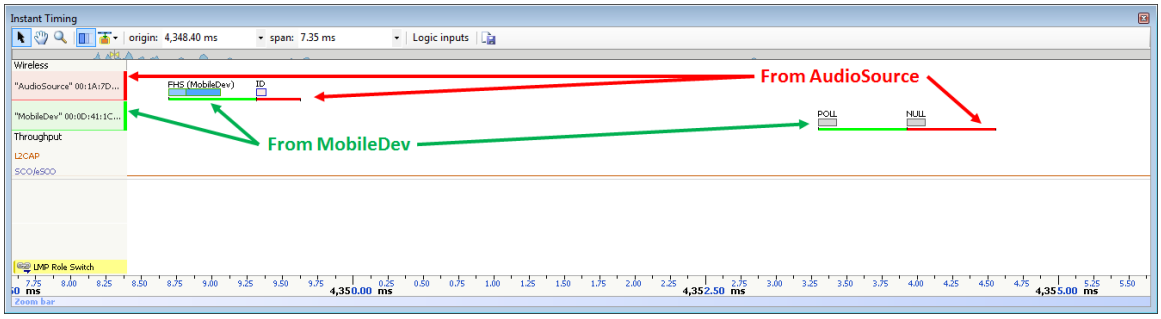
10.1 Device and Packet Color-Coding

Bluetooth packets shown in the *Instant Timing* pane are color-coded based on which device is sending the packet. Each device (and its associated packets) is assigned a unique color. This color can be user-defined if desired (see 8.4 Device Traffic Filter).

Wi-Fi packets are also color-coded and may or may not be shown on multiple lines, depending on the user's selections in the **Display** dialog located on the Instant Timing toolbar.

Master or central devices are shown at the left of the *Instant Timing* display and are provided a background color which is also represented on packets shown in the body of the *Instant Timing* pane. Slave or peripheral devices along a given master's line will have their own assigned color.

This color-coding is consistent throughout other areas of the analyzer software, including the *Devices* window and the *Instant Piconet* pane.



10.2 User Controls and Toolbar

The *Instant Timing* pane provides various user controls for navigation. The table below lists the *Instant Timing* toolbar buttons and their actions:

	**Pointer Mode**		Switches to Pointer Mode.
	**Pan Mode (Hold Shift)**		Switches to Pan Mode.
	**Zoom Mode (Hold Ctrl)**		Switches to Zoom Mode.
	**Enable/Disable Smooth Scrolling**		Enables and disables the smooth scrolling.
	**Highlighting Options**		Controls highlighting and synchronization with the Overviews
		**Highlight Active *Overview* Selection**	When enabled, the *Instant Timing* pane will be synchronized to the active Overview selection.
		**Highlight Bluetooth BR/EDR *Overview* Selection**	When enabled, the item selected in the *BR/EDR Overview* is highlighted in the *Instant Timing* pane.
		**Highlight Bluetooth Low Energy *Overview* Selection**	When enabled, the item selected in the *Low Energy Overview* is highlighted in the *Instant Timing* pane.
		**Highlight Bluetooth HCI UART Selection**	When enabled, the item selected in the HCI Overview (Serial) is highlighted in the *Instant Timing* pane.
		**Highlight Bluetooth HCI UART (Secondary) Selection**	When enabled, the item selected in the HCI Overview (Secondary Serial) is highlighted in the *Instant Timing* pane.
		**Highlight USB2.0 Overview Selection**	When enabled, the item selected in the HCI Overview (USB) is highlighted in the *Instant Timing* pane.
		**Highlight Bluetooth WCI Overview Selection**	When enabled, the item selected in the WCI-2 Overview is highlighted in the *Instant Timing* pane.
		**Highlight HCI Injection Overview Selection**	When enabled, the item selected in the *HCI Injection Overview* is highlighted in the *Instant Timing* pane.

	Highlight User Log Overview Selection	When enabled, the item selected in the *Message Log Overview* is highlighted in the *Instant Timing* pane.
	Follow *Overview* Selection	When enabled, the *Instant Timing* pane is synchronized to the active Overview selection.
origin:	**Origin Box**	Displays the timestamp origin of the *Instant Timing* pane. Allows for user input of timestamp for jumping.
span:	**Span Box**	Displays the length of the *Instant Timing* window.
Bluetooth	**Bluetooth Toggle**	Toggles Bluetooth traffic on/off.
WiFi	**Wi-Fi Toggle**	Toggles Wi-Fi traffic on/off.
HCI	**HCI Toggle**	Toggles HCI traffic on/off.
WCI	**WCI-2 Toggle**	Toggles WCI-2 traffic on/off.
Logic	**Logic Toggle**	Toggles logic signals on/off.
Misc	**Generic Communications Toggle**	Toggles generic communications (UART, SPI, I2C, and SWD) on/off.
Display	**Display Menu**	Provides various filters and display options for Bluetooth and Wi-Fi.
Logic inputs	**Logic Menu**	Allows for selection and configuration of logic signals captured.

Panning Left and Right

Various methods are available to pan (scroll) the *Instant Timing* pane to the left or right, including use of the mouse, the keyboard, and the *Navigator* bar.

To use the mouse to pan:

1. Position the mouse over the time scale at the bottom of the *Instant Timing* pane (recommended) or alternatively, click on **Pan**  .

The pointer changes to a pan (hand) symbol.

2. Press and hold the left **mouse** button and drag left or right as desired.

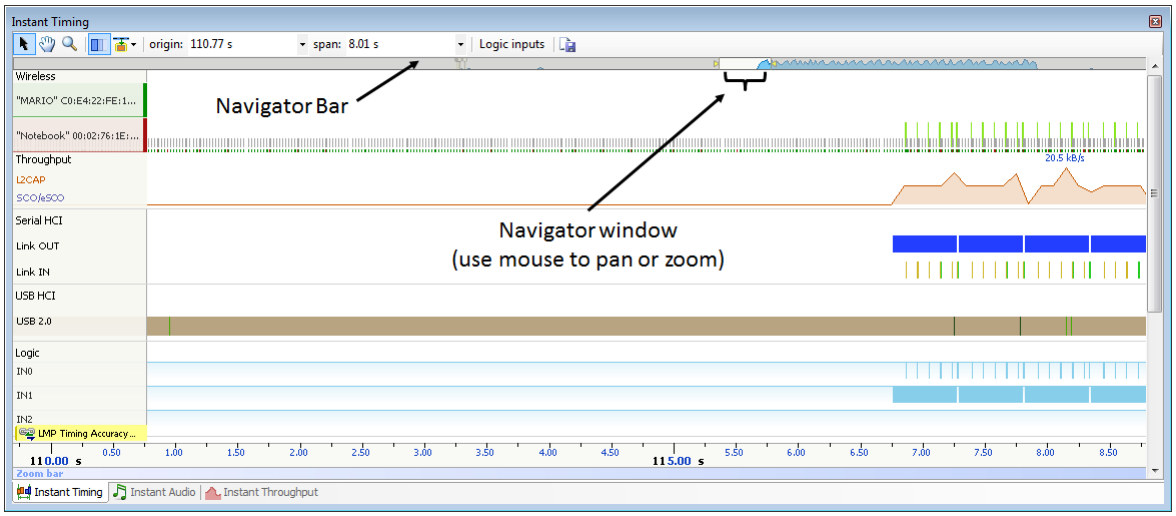
The mouse cursor automatically rolls around the screen, such that the user can smoothly scroll substantial amounts of time without having to press and release the mouse button several times.

To use the keyboard to pan:

1. Press LEFT or RIGHT Arrow to move incrementally left or right.

To use the Navigator bar to pan:

1. Position the mouse over the middle of the Navigator window, as shown below.



2. Press and hold the left mouse button and drag left or right as desired to pan left or right.

To jump to another location:

1. Press HOME to jump to the start of the capture, or END to jump to the end of the capture.

2. Alternatively, use the *Navigator* bar to jump to a selected location by double-clicking at the desired location in the *Navigator* bar.

To define a new timing view origin:

1. Enter a timestamp value in the *origin* box.

The following values are allowed: s – seconds

ms – milliseconds ns – nanoseconds ps – picoseconds

If a unit is not specified, then the previously displayed unit is used.

2. Press ENTER

The *Instant Timing* pane is updated with the new origin.

The analyzer application retains new timing origin entries. Click the Down arrow in the origin field to view and select previously entered timing origin entries.

Zooming In and Out

The *Instant Timing* pane provides a zoom feature to expand or contract the display to view information from a high level or low level.

To use the mouse to zoom:

1. Place the pointer over the *Zoom* bar, located at the bottom of the display (recommended) or alternatively, click on **Zoom** .

The pointer changes to a spyglass .

2. Press and hold the left mouse button and drag the pointer to the right to zoom in and expand the display or drag to the left to zoom out and contract the display.

The mouse cursor automatically rolls around the screen, such that the user can smoothly scroll substantial amounts of time without having to press and release the mouse button several times.

The mouse wheel can be used to zoom in and zoom out by moving the wheel forward to zoom in and backwards to zoom out. The zoom is centered at the mouse position.

To use the keyboard to zoom:

1. Press the UP-Arrow key to zoom in, and the DOWN Arrow key to zoom out.

To use the Navigator bar to zoom:

1. Position the mouse over the left or right edge of *Navigator w*indow:

2. Press and hold the left mouse button and drag left or right as desired to zoom in or out.

To define a new time span:

1. Type the new timing span in the *span* field.

The following values are allowed:

s – seconds

ms – milliseconds

ns – nanoseconds

ps – picoseconds

If a unit is not specified, then the previously displayed unit is used.

2. Press ENTER.

The *Instant Timing* display is updated with the new span value.

The analyzer application retains new time span entries. Click the Down arrow in the span field to view and select previously entered time span entries.

Making Time Measurements

The *Instant Timing* pane provides quick and simple methods to manually characterize timing between events as well as automatic flyover slot timing measurements. Timing cursors can be duplicated or frozen with a right-click, to enable the addition of more cursors.

Timing cursors available include:

1. Timing Cursors (mouse left-click/drag)

2. A-B Independent Cursors

To make a timing measurement:

1. Select the pointer icon at the top left of the *Instant Timing* pane. 

2. Left click in the desired location or on the desired event.

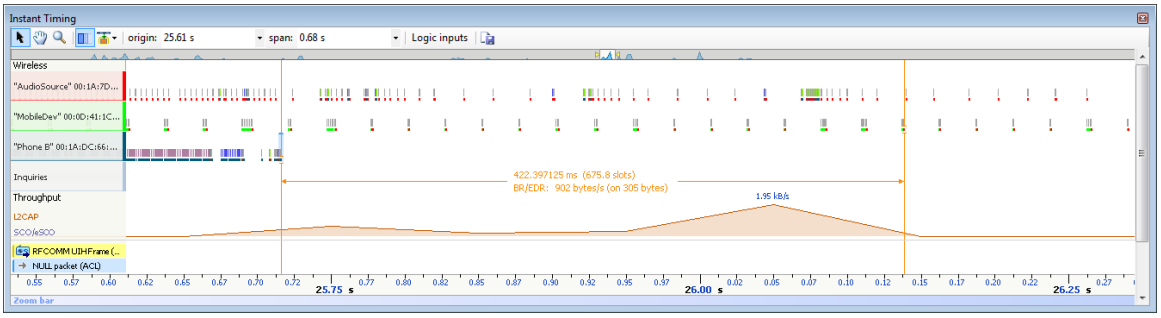
The vertical lines associated with the *Instant Timing* cursors are waved if not attached to an event, and straight when attached. To adjust cursor position, place the mouse pointer over either cursor and left click and drag to adjust position horizontally.

Right Line Not Attached

Both Lines Attached

3. Drag the mouse to the desired location or desired event.

The time between the cursors is displayed along with an equivalent slot number count. A count of payload is also provided:



The vertical position of the displayed timing information, including the horizontal arrows, can be changed by selecting the information with the mouse pointer, then dragging to the desired position.

To add additional cursors:

1. Right click over an existing set of timing cursors.

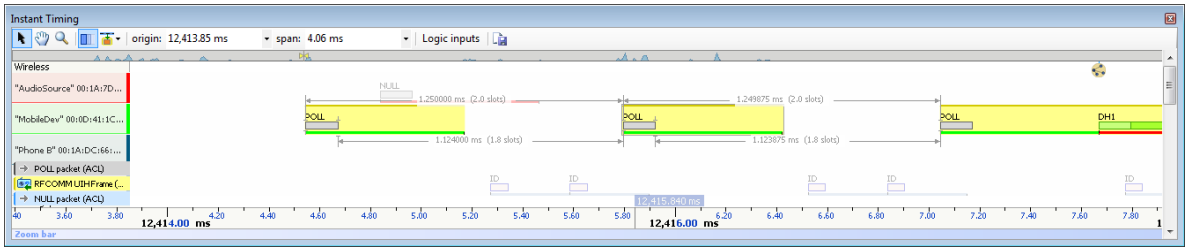
2. Select **Duplicate** to make available another set of cursors with the exact time spread as the original or select to fix the current cursor and enable placement of another cursor set as desired.

A new set of cursors appears (with Duplicate selected) and can be placed as desired. With **Freeze** selected, the original cursor set is grayed out and new cursors can be installed as described above.

To enable automated slot timing indicators:

1. To enable the automated slot timing measurement, place the mouse over any packet.

The number of slots from one packet to the next and to the previous (within the same horizontal by-master line) is indicated in grey text, along with timing in seconds.



To make time measurements using the A-B cursors:

Select the first desired location in the *Instant Timing* pane.

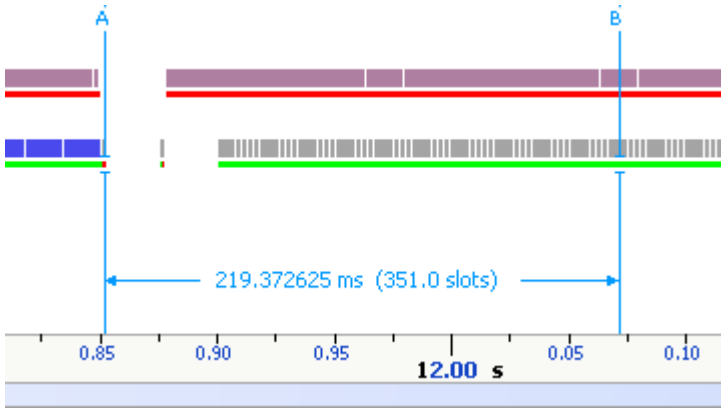
1. Right click and select Place Cursor A here.

The A cursor is placed at the location selected.

2. Select the second desired location in the *Instant Timing* pane.

3. Right click and select Place Cursor B here. 

The B cursor is placed at the location selected, and timing information is provided, including number of slots:



Time Scale Set and Reset

The time scale at the bottom of the *Instant Timing* pane will (by default) be synchronized to the Overview Time columns. The user can set and reset this time scale to force a zero timestamp at a selected location (set), or to revert to the original timescale value (reset).

Changing (setting or resetting) the time scale in the *Instant Timing* pane will force time indications in all other Overviews and panes throughout the application to follow.

To force a zero timestamp at a selected location:

1. Right click on the desired location or event in the *Instant Timing* pane.

2. Select Set Time Reference here.

The time scale forces a zero timestamp at the selected location, with time incrementing positive to the right of the selected location and decrementing to the left.

To reset the time scale to the default value:

1. Right click anywhere in the *Instant Timing* pane.

2. Select Reset Time reference.

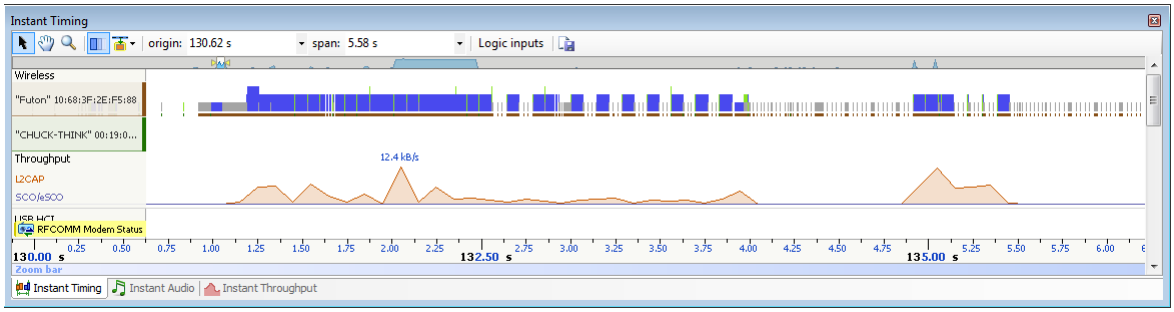
The time scale reverts to the original value.

Throughput Graph

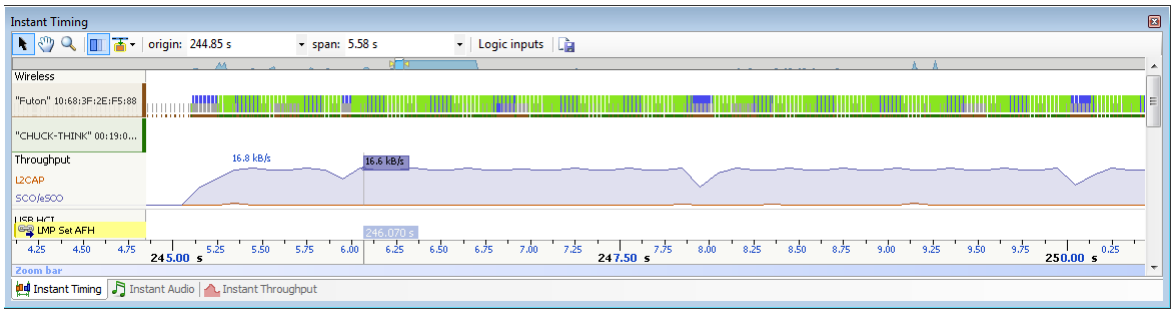
The *Instant Timing* throughput graph provides a characterization of L2CAP and SCO/eSCO data throughput in synchronization with all other information displayed in the *Instant Timing* pane.

A mouse fly-over provides a throughput indication. The two throughput indications (L2CAP and SCO/eSCO) are color-coded and may be superimposed if they occur at the same point intime.

L2CAP and SCO/eSCO throughput are differentiated by color as shown below.



L2CAP Throughput



SCO/eSCO Throughput

Using Markers

Markers may be added at any location within the *Instant Timing* pane. Markers can be edited to add textual content and can be color-coded. For information on adding markers to an Overview, see *Section 7.6, Using Markers.*

To add a marker in the Instant Timing pane:

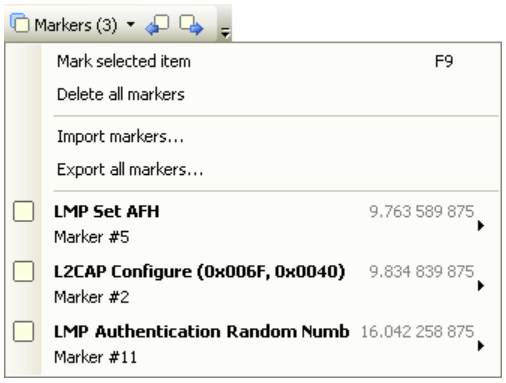
1. Right-click on a location or event in the *Instant Timing* pane.
2. Select Add New Marker Here.

A marker is placed at the selected event/location.

To search markers:

1. Click on the **Markers** button (F9) on the toolbar. 

A list of all markers installed appears:



2. Select the desired marker from the list.

The *Instant Timing* pane jumps to the selected marker.

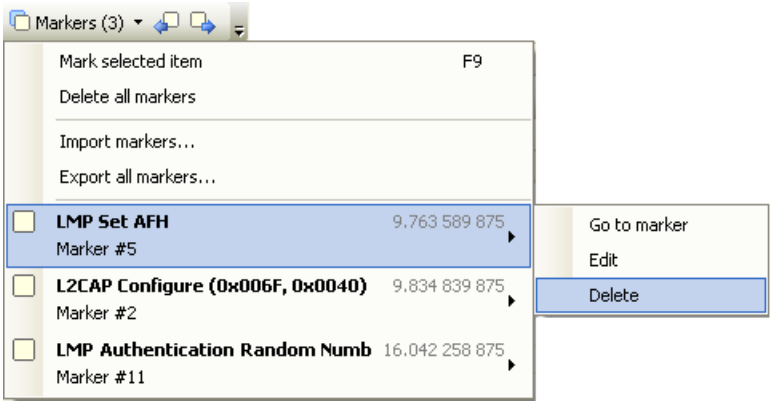
To delete a marker:

1. Position the mouse pointer over the marker to be removed.

2. Right-click and select **Remove marker** or alternatively, click on the **Markers** button (F9) on the toolbar 

.

Position the mouse pointer over the desired marker:



3. Select **Delete**.

The marker is removed.

To edit a marker:

1. Position the mouse pointer over the marker to be edited and left-click the marker, or alternatively right- click and select **Edit Marker** or select the **Marker** button on the toolbar.

2. Select the desired marker.

3. Select **Edit**.

The selected marker opens for editing.

Packet Fly-Over and Identifiers

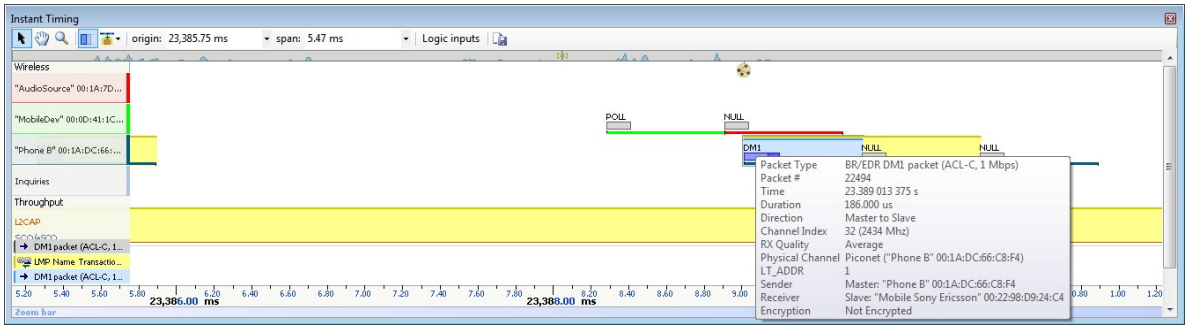
The *Instant Timing* pane provides various automated indications to the user, including detailed packet information, timing information, and identifiers that are used to indicate packet selections in the *Instant Timing* pane (selected packet and mouse position) and the Overview.

To enable automated packet flyover information:

1. Position the mouse over the desired packet slot.

The packet slot is highlighted in gray, then blue when selected (if not selected in the Overview already, in which case it will be already highlighted in yellow).

A detailed flyover appears:

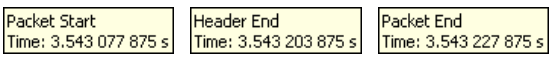


To view packet start, header end, or packet end times:

1. Place the mouse pointer directly on packet.

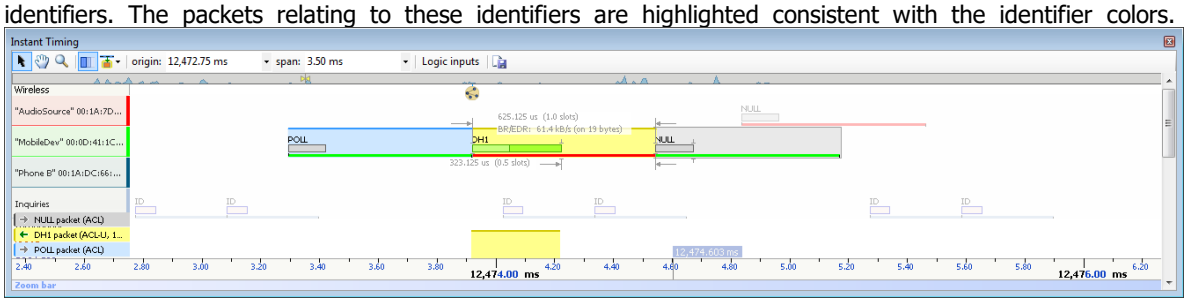
2. Slide the mouse pointer left and right slightly:

Depending on horizontal positioning of the mouse pointer, Packet Start, Header End, or Packet End time will appear:



Packet identifiers:

Color-coded packet identifiers are located at the lower left of the *Instant Timing* pane. There are three such identifiers. The packets relating to these identifiers are highlighted consistent with the identifier colors.



Identifier	Highlight color
Mouse flyover location in *Instant Timing*	NULL packet (ACL, 1 Mbps)
Selected Overview event	DH1 packet (ACL-U, 1 Mbps)
Selected *Instant Timing* event	POLL packet (ACL, 1 Mbps)

Display of Wired Traffic

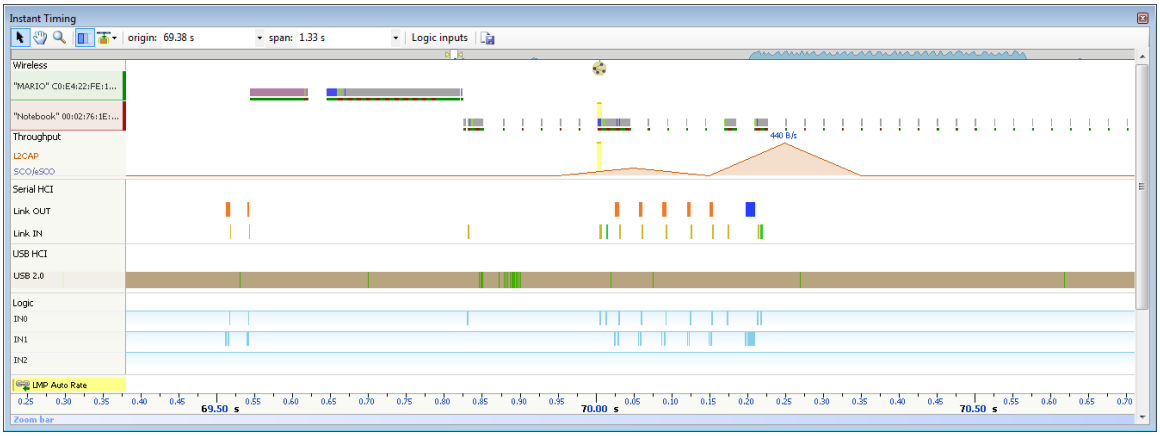
In addition to wireless traffic, the *Instant Timing* pane also displays any captured HCI, WCI-2 traffic, generic communications (UART, SPI, SWD, I2C), as well as logic signals.

HCI (UART and SPI), WCI-2 traffic, as well as logic signals are captured using the Flying Leads adapter, attached to the Logic/IO Probe connector. See *25, Flying Leads Probe – Explorer* or *26, Flying Leads Probe – Tracker and Vanguard*, for details. USB HCI is captured using the available front panel USB ports (Vanguard and Explorer).

HCI and logic inputs can be configured for recording in the **Wired** tab of the *Recording Options* menu, see *Section 6.2, Recording Options.*

Precise timing measurements can be made across any events shown in the *Instant Timing* pane, for example, HCI events to over-the-air events.

Any attached HCI traffic is displayed as below:



Zooming IN shows more detail (such as the Token/Data/Handshake sequence of USB):

Improving the efficiency of the logic capture: The analyzer will capture up to 16 logic lines and will compress the logic transitions with a very efficient engine, but the throughput of the compressed data will be directly related to the frequency of the lines. The more lines that are toggling fast, the higher the throughput requirement, and at some point, the internal buffer allocated to the logic stream will get full and the capture will stop for that stream (the other streams are independent and will continue).

There are a few ways to improve the efficiency of the logic capture:

1. Use a latest generation processor with a fast SSD and make sure that the PC is not busy doing other tasks during the capture.

2. Make sure that the faster lines are connected on the lower indexes. For example, the fastest transitioning line should be connected to input 0, the second fastest to input 1, etc.

3. If signals with high "glitch" rates (such as noisy signals) are received on the logic capture, this will increase the required throughput. These glitches can be avoided or reduced with better grounding and increased space between the wires. If glitches are seen on unused inputs, it is recommended to connect these inputs to ground.

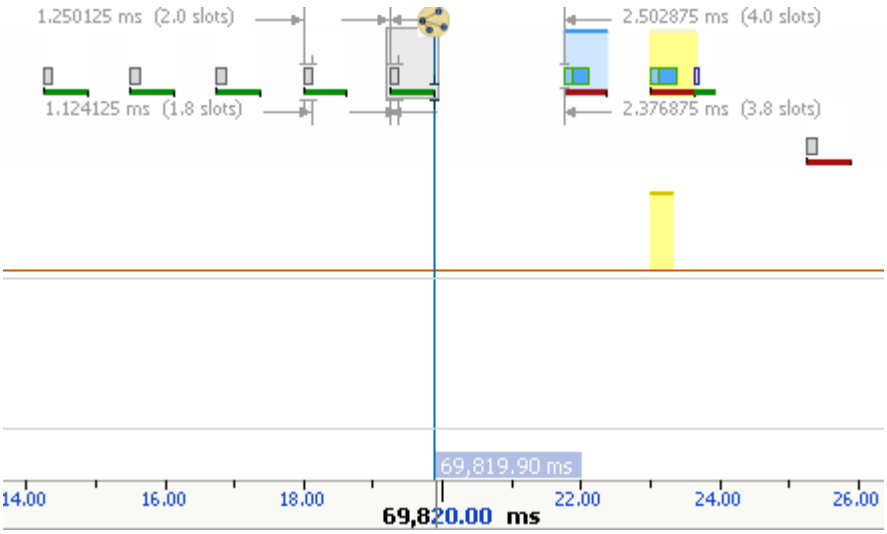
Instant Piconet Cursor

The *Instant Timing* pane provides a unique cursor that allows the user to force the *Instant Piconet* pane to update as the *Instant Piconet* cursor is moved. This is useful for various cases, such as to visualize a role switch by dragging the *Instant Piconet* cursor across this event.

To use the Instant Piconet cursor:

1. Right click in the *Instant Timing* pane and select **Place Instant Piconet Cursor here**, or alternatively double-click over any packet in the *Instant Timing* pane.

The *Instant Piconet* cursor appears:



2. Select and drag the *Instant Piconet* cursor while observing the *Instant Piconet* pane.

The *Instant Piconet* pane updates per the position of the *Instant Piconet* cursor.

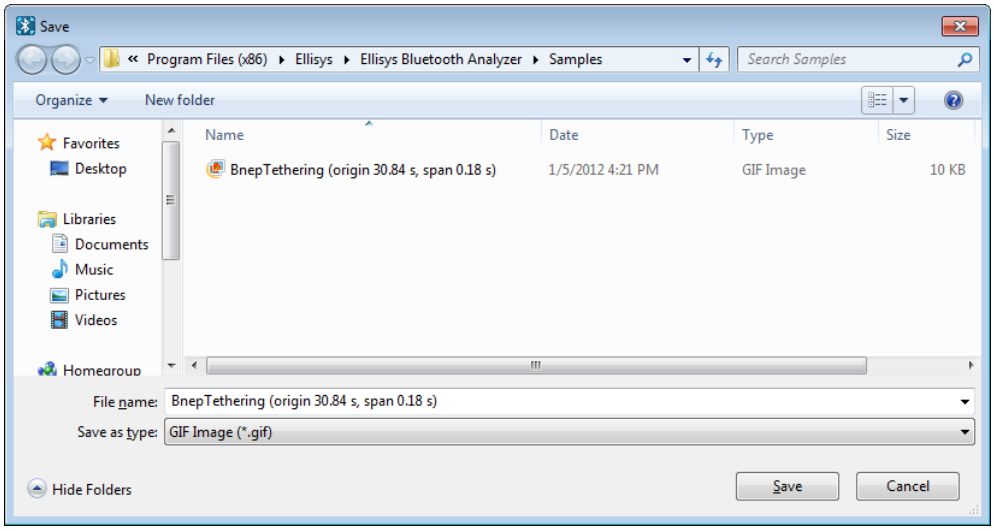
Ensure the **Follow in Real Time** button in the *Instant Piconet* pane is not selected (not bordered) to use the *Instant Piconet* cursor.

Exporting Images

The *Instant Timing* display can be exported into various graphics formats.

To export the Instant Timing display to a graphics format:

1. Click on the **Export Image** icon located on the *Instant Timing* toolbar. The *Save* menu appears:



Images to be exported are automatically assigned a file name that includes the origin and span values.

2. Accept the default file name or assign a new file name.
3. Select a directory location.
4. Select the file type in **Save as type** drop-down (e.g., *.gif, *.png, *.jpg,*.bmp).
5. Click on **Save.**

The file is exported in the desired format to the selected directory.

Synchronizing to Other Views

The *Instant Timing* pane is synchronized to other views, either directly or indirectly, to provide the user with cohesive navigation:

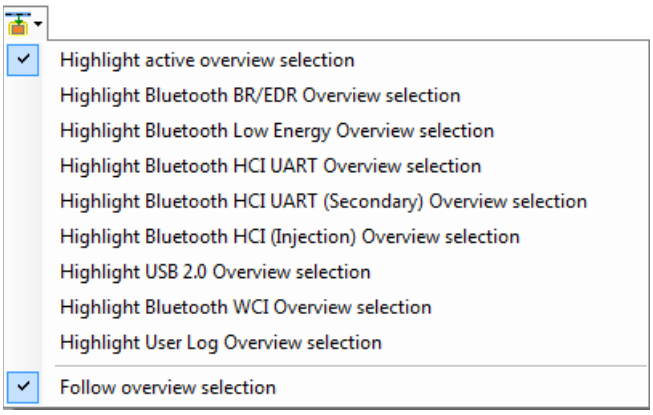
1. Double-clicking an event in the *Instant Timing* pane will cause the Overview, *Instant Channels* pane, and the *Instant Spectrum* view to jump to the selected event/location.
2. Double-clicking an event in the *Instant Timing* pane will force the *Instant Piconet* cursor to appear at the double-click location and will therefore cause the *Instant Piconet* pane to jump to the selected event.
3. Selecting timestamps in the *Instant Piconet* pane will cause the *Instant Timing* pane to jump to the selected timestamp location.

4. Selecting a timestamp in the *Security* pane will cause the *Instant Timing* pane to jump to the selected timestamp location.

5. Selecting an event in an Overview or the *Instant Spectrum* view will cause the *Instant Timing* pane to jump to the selected event.

To enable synchronization with the active Overview:

1. Select the highlighting options drop-down in the *Instant Timing* toolbar:



2. Select **Follow Overview** selection.

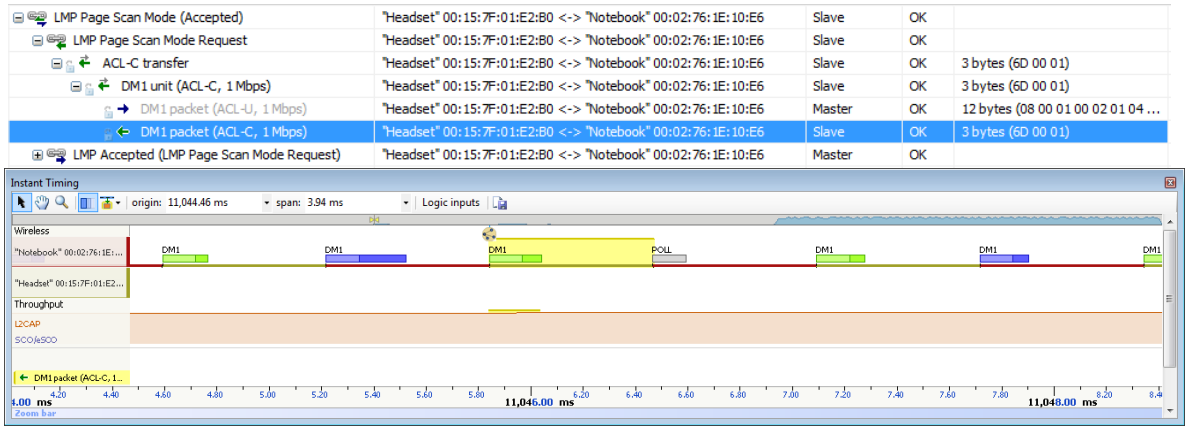
The *Instant Timing* pane will now move in synchronization with selections made in the Overview.

To highlight an Overview selection in the Instant Timing pane:

1. Ensure **Follow Overview selection** is enabled as described above.

2. Select any line in the desired Overview.

The selected line is highlighted in the Overview and in the *Instant Timing* pane.



When selecting a higher-level abstract event, such as a request, response, command, etc., all associated packets comprising these events are highlighted.

To unsynchronized with the Overview:

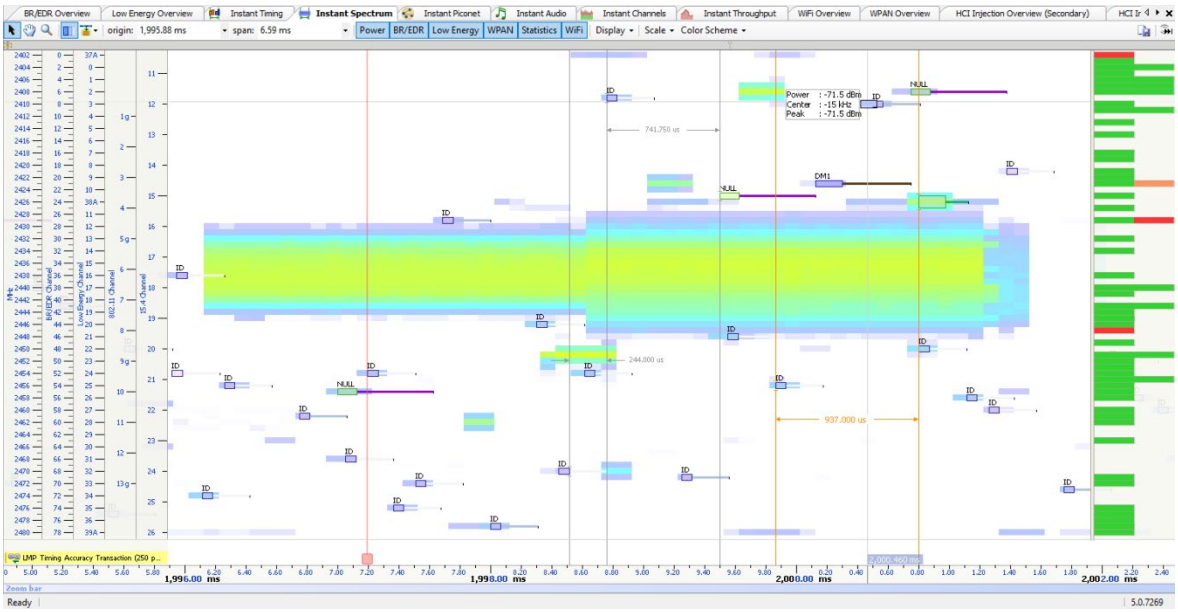
1. Select the highlighting options drop-down in the *Instant Timing* toolbar.
2. De-select **Follow Overview selection**.

The *Instant Timing* pane will no longer follow selected lines in the Overview.

11. Instant Spectrum View

The *Instant Spectrum view* provides a unique and intuitive way to understand the spectral and other behaviors of Bluetooth, Wi-Fi, and WPAN traffic, including all other RF events within the ISM spectrum that is used by Bluetooth.

Bluetooth, Wi-Fi, and WPAN packets are presented chronologically left to right on the channel they are transmitted and are uniquely color-coded per the packet's sender. On the right, graphical per-channel statistics on Bluetooth packet errors and retransmissions are presented in a graphical format. A variety of color-scheme options are available to represent signal strength.



Note that certain features are included only with the optional Raw Spectrum feature. See *Section 1.1, Models, Editions, and Configurations* for details.

The *Instant Spectrum* view is commonly used for characterization of wireless coexistence, hopping patterns, AFH behaviors, a packet's transmission frequency/channel, or simply for visualizing the RF environment. It displays the RSSI of all RF events in all Bluetooth channels with a configurable precision of up to 1 microsecond and displays this information in synchronization with Bluetooth and Wi-Fi packets.

Raw RF energy is displayed in blue, in an overlay fashion with captured Bluetooth and Wi-Fi packets. The RF energy associated with Bluetooth packets is characterized by its relationship to its nominal channel frequency with a fly-over.

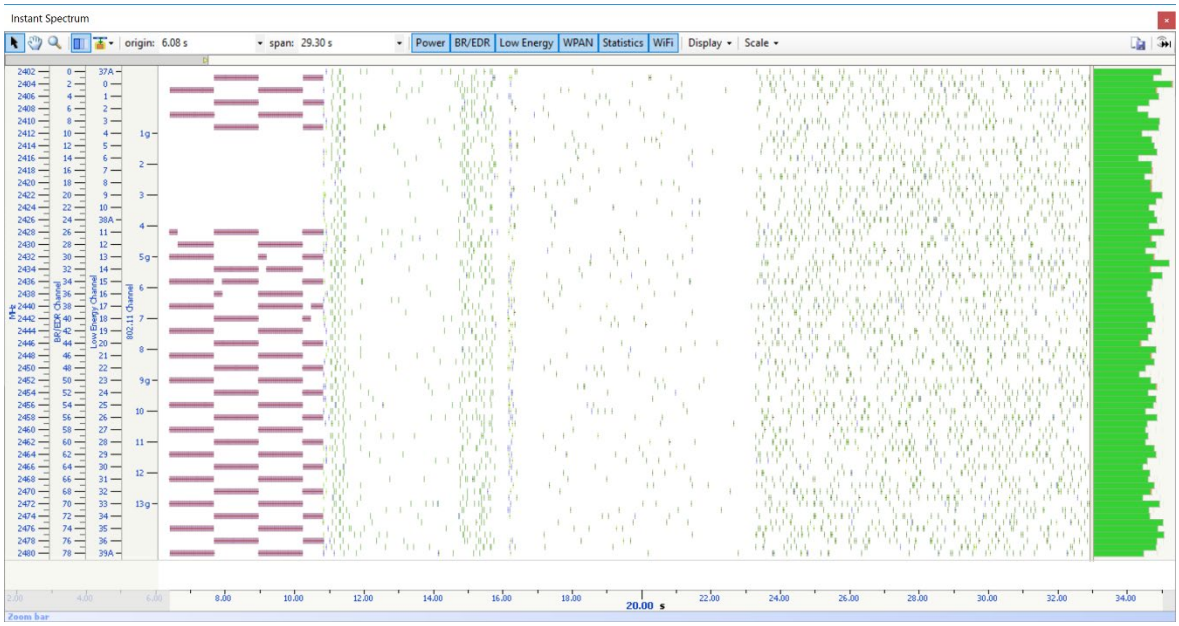
The *Instant Spectrum* view provides for quick and easy timing measurements, slot timing, timing cursors, frequency offset, zoom and pan features, detailed packet flyover, color-coded assignments to devices, and other navigation tools.

The *Instant Spectrum* view is linked to the Overviews as well as the *Instant Timing* pane. It is manually linked to the *Instant Piconet* pane by the *Instant Piconet* cursor, which when scrolled, updates the *Instant Piconet* view per its current location. Conversely, when events are selected in an Overview or the *Instant Timing* view, this cursor is re-positioned accordingly.

Automated highlighting of spectrum areas (channels) precluded by Adaptive Frequency Hopping (AFH) is provided. Several scales are available from the **Scale** drop-down selection on the Tool Bar, including MHz, BR/EDR Channel, Low Energy Channel, WPAN (802.15.4) Channel, and 802.11 Channel. Other features include zoom and pan.

To access the Instant Spectrum view:

1. Select **View | Instant Spectrum** from the menu The *Instant Spectrum* view appears:



Device and Packet Color-Coding

Packets shown in the *Instant Spectrum* view are color-coded based on which device is sending the packet. Each device (and its associated packets) is assigned a unique color. This color can be user-defined if desired (see *Section 9.6, Bluetooth Device Traffic Filter* for details).

This color-coding is consistent throughout other areas of the analyzer software, including the *Devices* window, *Instant Timing* pane, and the *Instant Piconet* pane.

User Controls and Toolbar

The *Instant Spectrum* view provides various user controls for navigation. The table below lists the *Instant Spectrum* toolbar buttons and their actions

Panning Left and Right

Various methods are available to pan (scroll) the *Instant Spectrum* view to the left or right.

To use the mouse to pan:

1. Position the mouse over the time scale at the bottom of the *Instant Spectrum* view (recommended) or alternatively, click on **Pan**. 

The pointer changes to a pan (hand) symbol.

2. Press and hold the left mouse button and drag left or right as desired.

The mouse cursor automatically rolls around the screen, such that the user can smoothly scroll substantial amounts of time without having to press and release the mouse button several times.

To use the keyboard to pan:

1. Press LEFT or RIGHT Arrow to move incrementally left or right.

To use the Navigator bar to pan:

1. Position the mouse over the middle of the *Navigator* window.
2. Press and hold the left mouse button and drag left or right as desired to pan left or right.

To jump to another location:

1. Press keyboard HOME to jump to the start of the capture, or END to jump to the end of the capture
2. Alternatively, use the *Navigator* bar to jump to a selected location by double-clicking at the desired location in the *Navigator* bar.

To define a new timing view origin:

1. Enter a timestamp value in the *origin* box.

The following values are allowed:

s – seconds

ms – milliseconds

ns – nanoseconds

ps – picoseconds

If a unit is not specified, then the previously displayed unit is used.

Press ENTER.

The *Instant Spectrum* view is updated with the new origin.

The analyzer application retains new timing origin entries. Click the Down arrow in the origin field to view and select previously entered timing origin entries.

Zooming In and Out

The *Instant Spectrum* view provides a zoom feature to expand or contract the display to view information from a high level or low level.

To use the mouse to zoom:

1. Place the pointer over the *Zoom* bar, located at the bottom of the display.
2. Alternatively, click on **Zoom**

The pointer changes to a spyglass .

3. Press and hold the left mouse button and drag the pointer to the right to zoom in and expand the display or drag to the left to zoom out and contract the display.

The mouse cursor automatically rolls around the screen, such that the user can smoothly scroll substantial amounts of time without having to press and release the mouse button several times.

The mouse wheel can be used to zoom in and zoom out by moving the wheel forward to zoom in and backwards to zoom out. The zoom is centered at the mouse position.

To use the keyboard to zoom:

1. Press the UP-Arrow key to zoom in, and the DOWN Arrow key to zoom out.

To use the Navigator bar to zoom:

1. Position the mouse over the left or right edge of *Navigator w*indow:

2. Press and hold the left mouse button and drag left or right as desired to zoom in or out.

To define a new time span:

1. Type the new timing span in the *span* field.

The following values are allowed:

s – seconds

ms – milliseconds

ns – nanoseconds

ps – picoseconds

If a unit is not specified, then the previously displayed unit is used.

2. Press ENTER.

The *Instant Spectrum* display is updated with the new span value.

The analyzer application retains new time span entries. Click the Down arrow in the span field to view and select previously entered time span entries.

Making Time Measurements

The *Instant Spectrum* view provides quick and simple methods to manually characterize timing between events, as well as automatic flyover slot-timing measurements. Timing cursors can be duplicated or frozen with a right-click, to enable the addition of more cursors.

Timing cursors available include:

Standard Timing Cursors

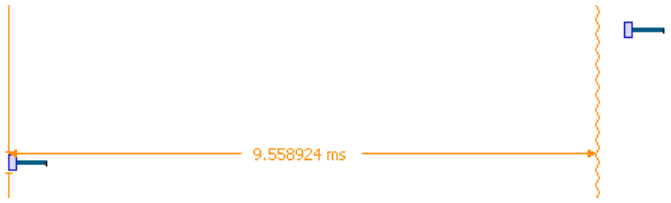
A-B Independent Cursors

To make a timing measurement:

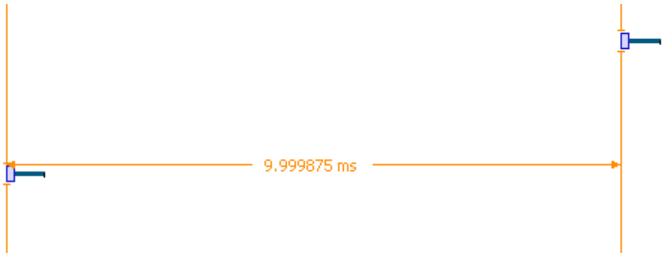
1. Select the pointer icon at the top left of the *Instant Spectrum* view.

2. Left click in the desired location or on the desired event.

The vertical lines associated with the *Instant Spectrum* cursors are waved if not attached to an event, and straight when attached. To adjust cursor position, place the mouse pointer over either cursor and left click and drag to adjust position horizontally.



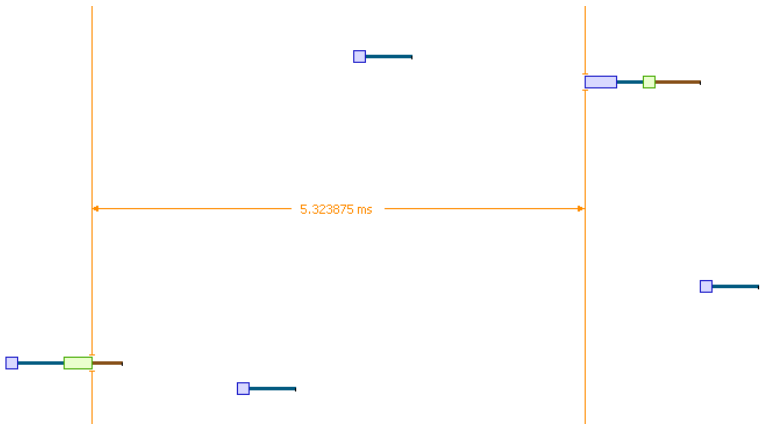
Right Line Not Attached



Both Lines Attached

3. Drag the mouse to the desired location or desired event.

The time between the cursors is displayed:



The vertical position of the displayed timing information, including the horizontal arrows, can be changed by selecting the information with the mouse pointer, then dragging to the desired position.

To add additional cursors:

1. Right click over an existing set of timing cursors.
2. Select **Duplicate** to make available another set of cursors with the exact time spread as the original or select to fix the current cursor and enable placement of another cursor set as desired.

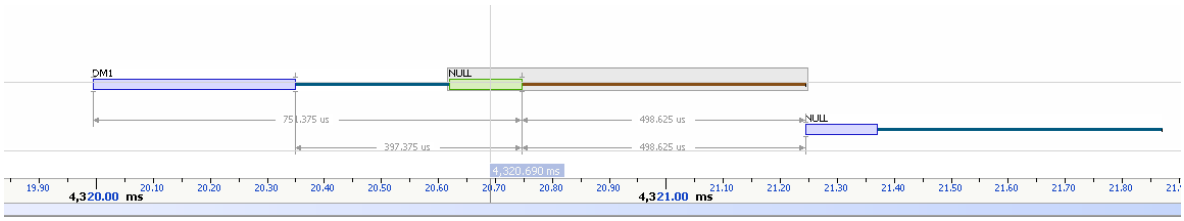
A new set of cursors appears (with **Duplicate** selected) and can be placed as desired.

With **Freeze** selected, the original cursor set is grayed out and new cursors can be installed as described above.

To enable automated timing indicators:

1. To enable the automated timing measurement, place the mouse over any packet.

The time from one packet to the next and from the previous packet is indicated in grey text.



To make time measurements using the A-B cursors:

The A-B cursors are especially useful when the two events being measured are far apart, such that one cursor can be set, then the user can scroll or search as needed to the other event to set the second cursor.

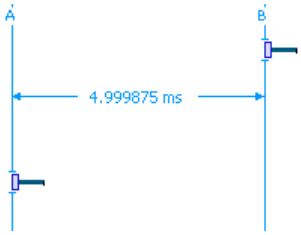
1. Select the first desired location in the *Instant Spectrum* view.
2. Right click and select **Place Cursor A here.**

The A cursor is placed at the location selected.

3. Select the second desired location in the *Instant Spectrum* view.

4. Right click and select **Place Cursor B here.** 

The B cursor is placed at the location selected, and timing information is provided, including number of slots:



Time Scale Set and Reset

The time scale at the bottom of the *Instant Spectrum* pane will (by default) be synchronized to the Overview Time columns. The user can set and reset this time scale to force a zero timestamp at a selected location (set), or to revert to the original timescale value (reset).

Changing (setting or resetting) the time scale in the *Instant Spectrum* pane will force time indications in all other Overviews and panes throughout the application to follow.

To force a zero timestamp at a selected location:

1. Right click on the desired location or event in the *Instant Spectrum* pane.
2. Select **Set Time Reference here**.

The time scale forces a zero timestamp at the selected location, with time incrementing positive to the right of the selected location and decrementing to the left.

To reset the time scale to the default value:

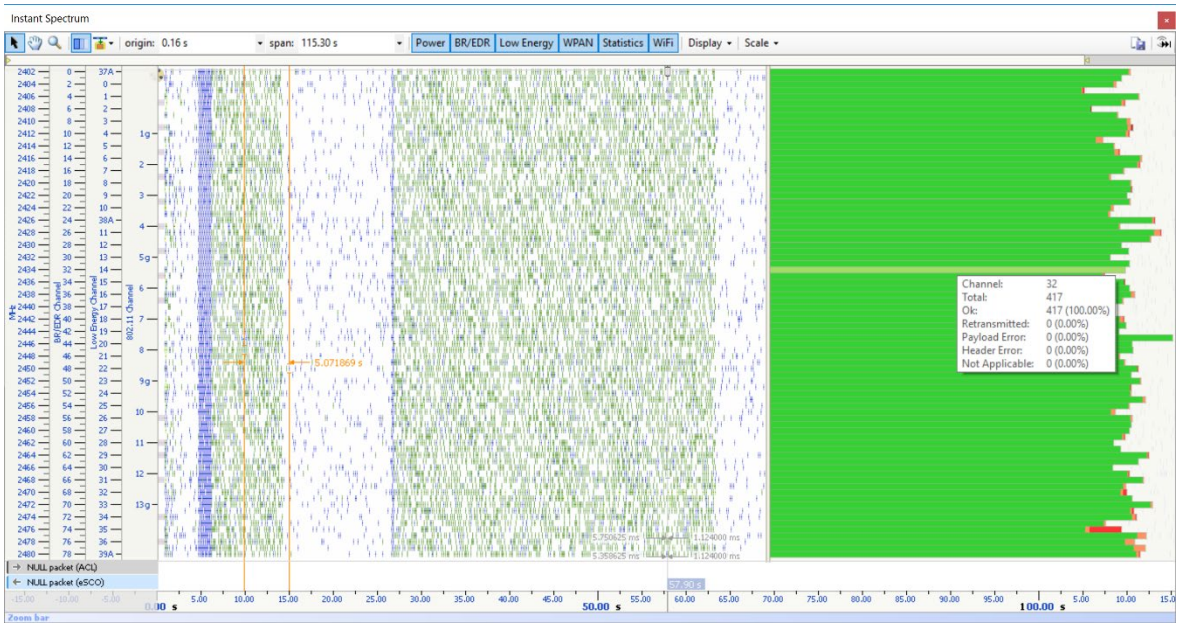
1. Right click anywhere in the *Instant Spectrum* pane.
2. Select **Reset Time reference**.

The time scale reverts to the original value.

Channel Statistics

The *Instant Spectrum* view employs a graphical per-channel statistics feature that characterizes payload errors, header errors, and retransmissions. The *Channel Statistics* uses a stacked-bar chart approach and operates identically to the *Instant Channels* feature (see *Section 13, Instant Channels* for more information).

The *Channel Statistics* feature is displayed at the right side of the *Instant Spectrum* view. The *Channel Statistics* view will scale in time per the time span selected.



Using Markers

Markers may be added at any location within the *Instant Spectrum* view. Markers can be edited to add textual content and can be color-coded. For information on adding markers to an Overview, see Section 7.6 Using Markers.

To add a marker in the Instant Spectrum view:

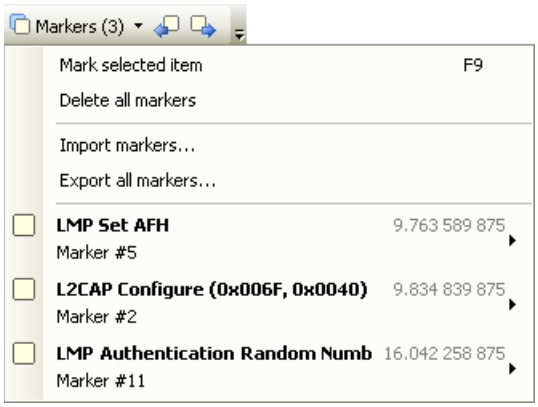
1. Right-click on a location or event in the *Instant Spectrum* view.
2. Select Add New Marker Here.

A marker is placed at the selected event/location.

To search markers:

1. Click on the **Markers** button (F9) on the toolbar. 

A list of all markers installed appears:

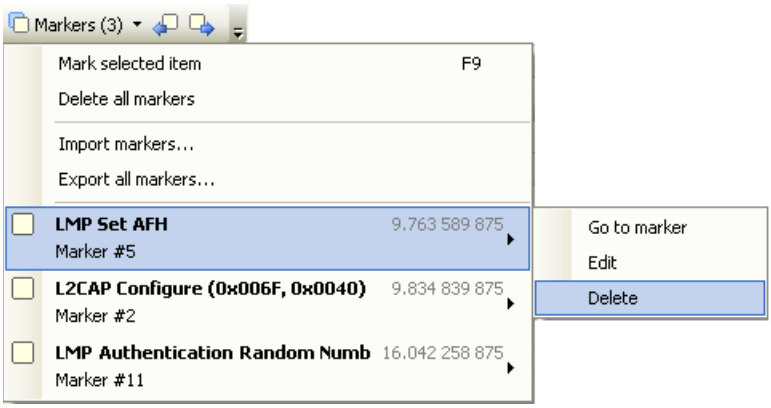


Select the desired marker from the list.

The *Instant Spectrum* view jumps to the selected marker.

To delete a marker:

1. Position the mouse pointer over the marker to be removed.
2. Right-click and select **Remove marker** or alternatively, click on the **Markers** button (F9) on the toolbar. 



3. Position the mouse pointer over the desired marker:
4. Select **Delete**.

The marker is removed.

To edit a marker:

1. Position the mouse pointer over the marker to be edited.

2. Left-click the marker (or right-click and select **Edit Marker**) or alternatively, select the **Marker** button on the toolbar.

3. Select the desired marker.

4. Select **Edit**.

The selected marker opens for editing.

Packet Fly-Over and Identifiers

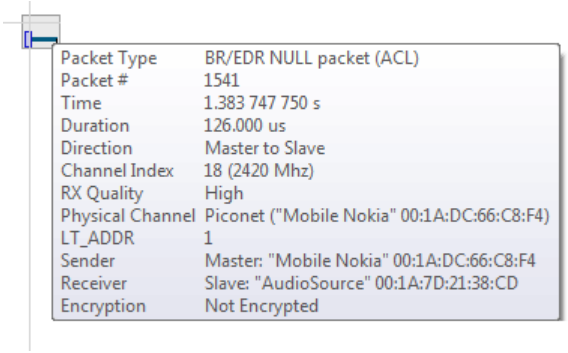
The *Instant Spectrum* view provides various automated indications to the user, including detailed packet information, timing information, and identifiers that are used to indicate packet selections in the *Instant Spectrum* view (selected packet and mouse position) and the Overview.

To enable automated packet flyover information:

1. Position the mouse over the desired packet slot.

The packet slot is highlighted in gray, then blue when selected (if not selected in the Overview already, in which case it will be already highlighted in yellow).

A detailed flyover appears:

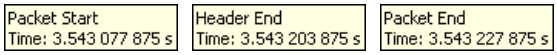


To view packet start, header end, or packet end times:

1. Place mouse pointer directly on packet.

2. Slide the mouse pointer left and right slightly:

Depending on horizontal positioning of mouse pointer, Packet Start, Header End, or Packet End time will appear:



Packet identifiers:

Color-coded packet identifiers are located at the lower left of the *Instant Spectrum* view. There are three such identifiers. The packets relating to these identifiers are highlighted consistent with the identifier colors.

Identifier	Highlight color
Mouse flyover location in *Instant Spectrum*	NULL packet (ACL, 1 Mbps)
Selected Overview event	DH1 packet (ACL-U, 1 Mbps)
Selected *Instant Spectrum* event	POLL packet (ACL, 1 Mbps)

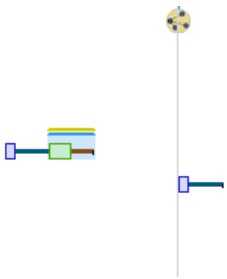
Instant Piconet Cursor

The *Instant Spectrum* view provides a unique cursor that allows the user to force the *Instant Piconet* pane to update as the *Instant Piconet* cursor is moved. Conversely, this cursor is positioned in *Instant Spectrum* as the user navigates through other panes, such as an Overview or the *Instant Timing* pane.

To use the Instant Piconet cursor:

1. Right click in the *Instant Spectrum* view and select **Place Instant Piconet Cursor here** or alternatively, double-click over any packet in the *Instant Spectrum* view.

The *Instant Piconet* cursor appears:



2. Select and drag the *Instant Piconet* cursor while observing the *Instant Piconet* pane.

The *Instant Piconet* pane updates per the position of the *Instant Piconet* cursor.

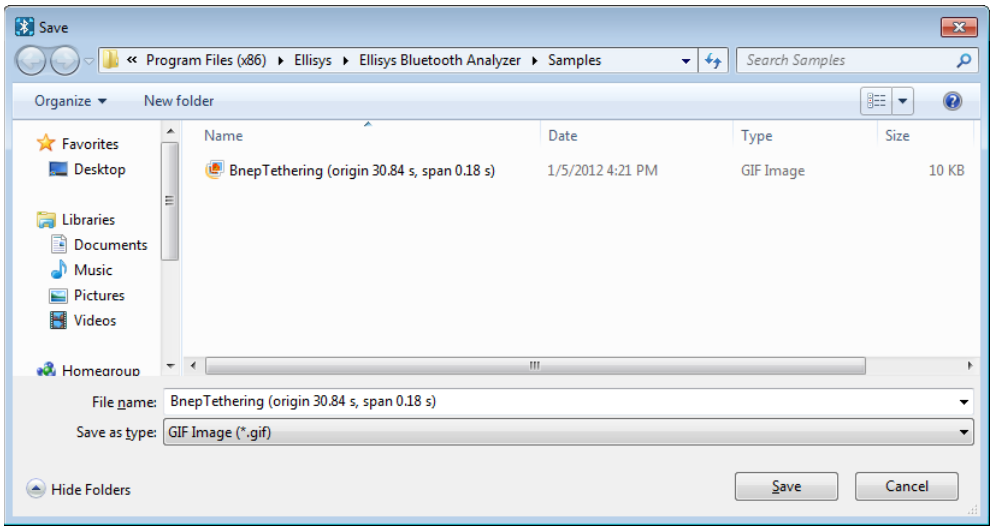
Ensure the **Follow in Real Time** button in the *Instant Piconet* pane is not selected (not bordered) to use the *Instant Piconet* cursor.

Exporting Images

The *Instant Spectrum* display can be exported into various graphics formats.

To export the Instant Spectrum display to a graphics format:

1. Click on the **Export Image** icon located on the *Instant Timing* toolbar.  The *Save* menu appears:



Images to be exported are automatically assigned a file name that includes the origin and span values.

2. Accept the default file name or assign a new file name.
3. Select a directory location.
4. Select the file type in **Save as type** drop-down (e.g., *.gif, *.png, *.jpg,*.bmp).
5. Click on **Save.**

The file is exported in the desired format to the selected directory.

Synchronizing to Other Views

The *Instant Spectrum* view is synchronized to other views, either directly or indirectly, to provide the user with cohesive navigation:

Double-clicking an event in the *Instant Spectrum* view will cause the Overview and the *Instant Timing* pane to jump to the selected event.

Double-clicking an event in the *Instant Spectrum* view will force the *Instant Piconet* cursor to appear at the double-click location and will therefore cause the *Instant Piconet* pane to jump to the selected event.

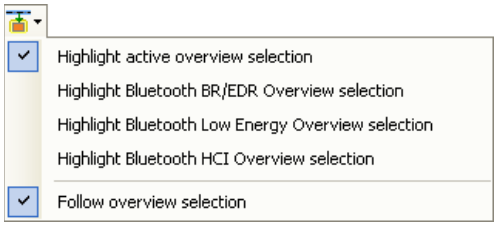
Selecting timestamps in the *Instant Piconet* pane will cause the *Instant Spectrum* view to jump to the selected timestamp location.

Selecting a timestamp in the *Security* pane will cause the *Instant Spectrum* view to jump to the selected timestamp location.

Selecting an event in an Overview or the *Instant Timing* pane will cause the *Instant Spectrum* view to jump to the selected event.

To enable synchronization with the active Overview:

1. Select the highlighting options drop-down in the *Instant Spectrum* toolbar:



2. Select **Follow overview selection**.

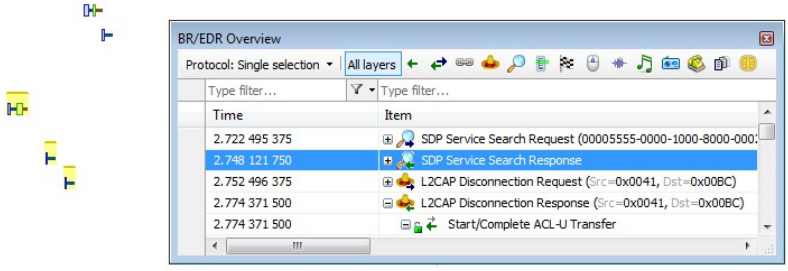
The *Instant Spectrum* view will now move in synchronization with selections made in the Overview.

To highlight an Overview selection in the Instant Spectrum view:

1. Ensure **Follow overview selection** is enabled as described above.

2. Select any line in the desired Overview.

The selected line is highlighted (blue) in the Overview and in the *Instant Spectrum* pane (yellow):



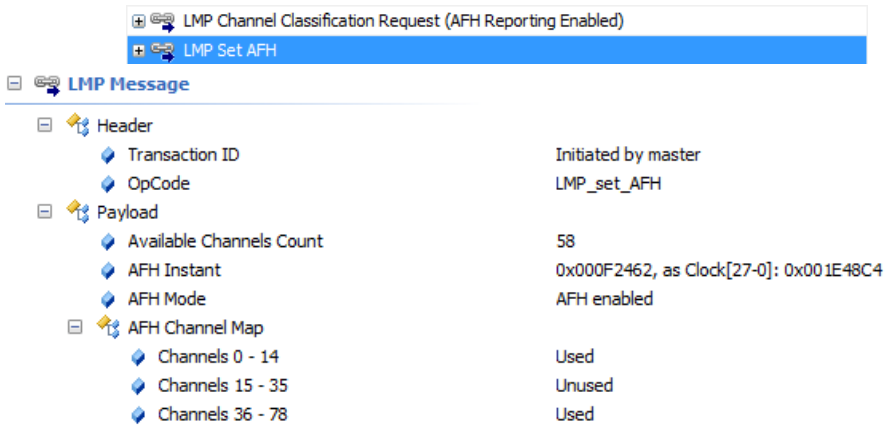
AFH Highlighting

The *Instant Spectrum* view provides a unique feature that highlights the channels blocked by AFH at any given point in time. The AFH Highlighting feature tracks AFH commands throughout the capture process and provides a visually highlighted spectral area in the *Instant Spectrum* view that indicates those channels blocked by AFH at the point selected.

See *Section 10.12, Wireless Spectrum Capture* for details on viewing AFH Highlighting with Wireless Spectrum capture enabled.

To view the AFH Highlighting:

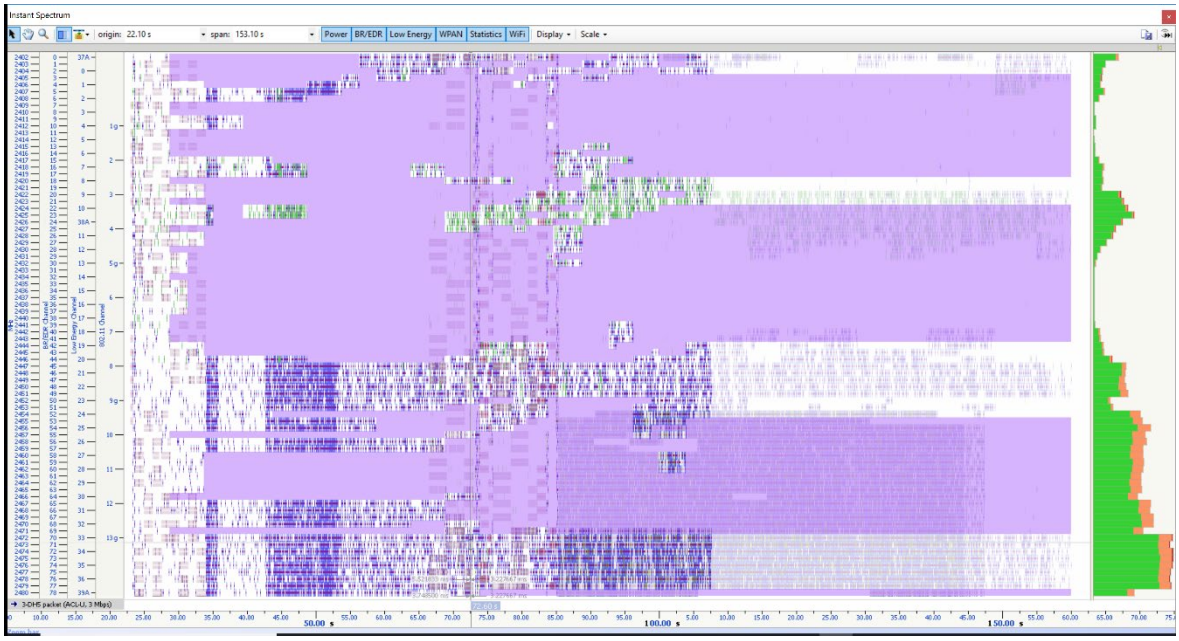
1. Open a capture with active AFH, i.e., one that includes AFH Commands as shown below:



Select **View | Instant Spectrum**

1. Select a packet at the desired location in the *Instant Spectrum* view.

The channels precluded by the active AFH command are now highlighted:



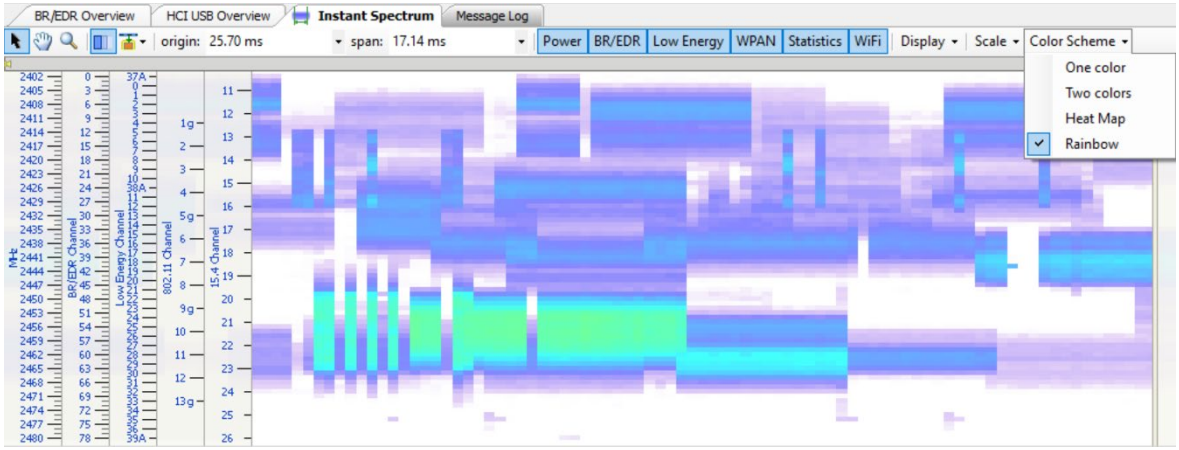
Wireless Spectrum Capture

In addition to spectral display of captured Bluetooth, Wi-Fi, and WPAN packets, the *Instant Spectrum* view can also display raw RF energy present within the Bluetooth spectrum. Spectrum energy is typically seen from Wi-Fi sources, but can also be generated by various other wireless technologies or commercial equipment.

Wireless Spectrum information is presented in the *Instant Spectrum* view according to the selected color scheme, settable on the toolbar using the **Color Scheme** drop-down. RSSI is indicated with a fly-over.

Changing the Color Scheme

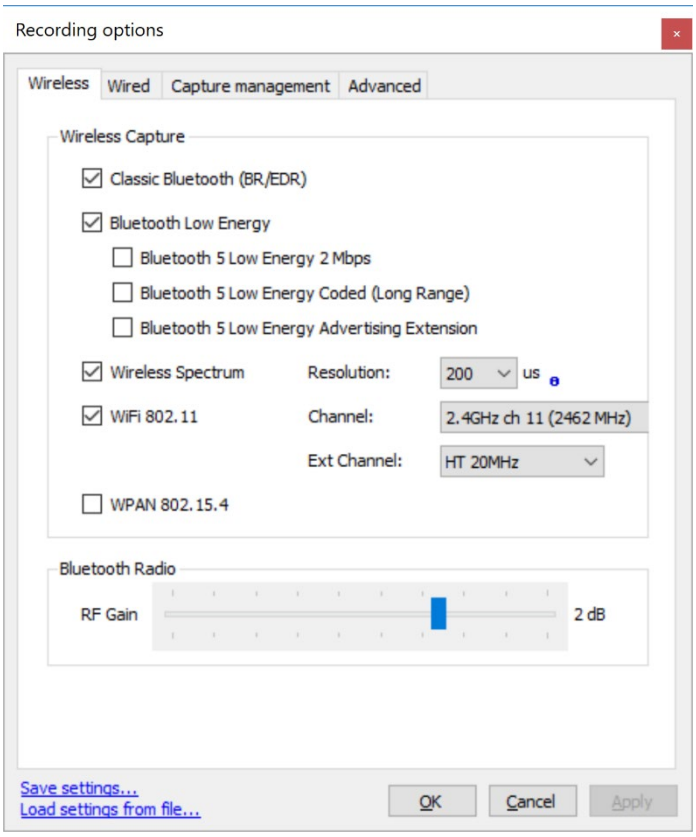
A variety of color schemes are available to suit the preferences of the user, available from the **Color Scheme** drop-down in the Instant Spectrum toolbar. These color schemes apply varying shades to RF characteristics, based on signal strength (the **Rainbow** color scheme is shown below).



Wireless Spectrum capture is an optional feature. As needed, contact Ellisys to upgrade your analyzer to include this feature. No hardware change is needed; updates are done with a software enable file.

To enable Wireless Spectrum capture:

1. Check the Wireless Spectrum box in the **Recording Options** menu (**Record | Recording Options**).

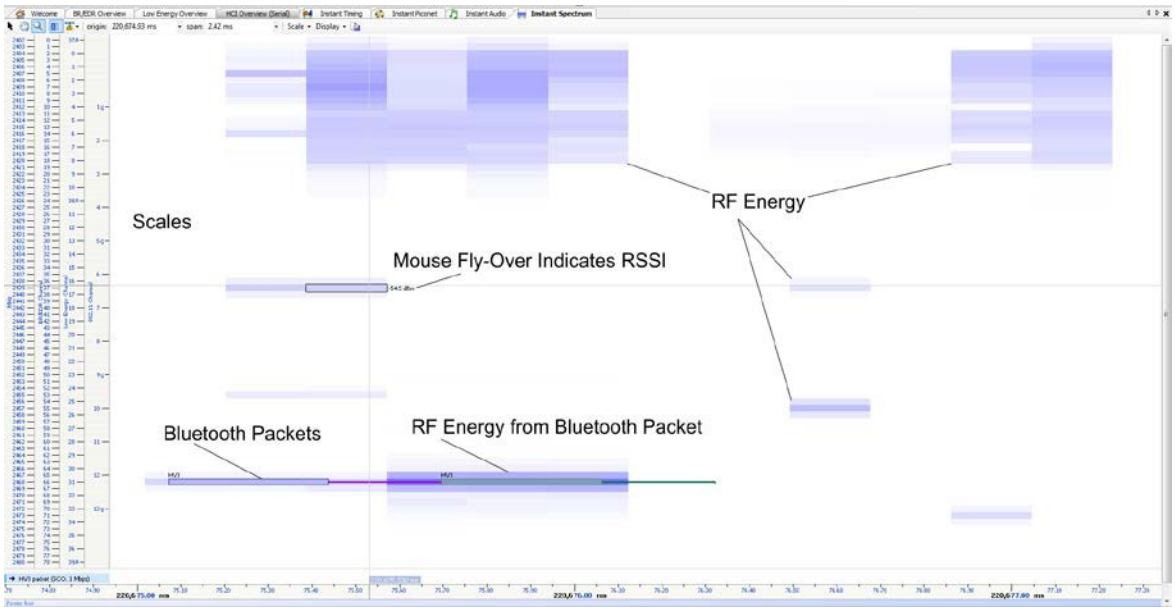


2. Select a **Resolution** and click **OK**.

3. Click on **Record** on the toolbar or Select **Record | Start Recording** (Ctrl+R) from the menu.

4. Open the *Instant Spectrum* view (**View | Instant Spectrum**) and select the desired packet (or mouse- over).

Captured wireless spectrum information is displayed along with any captured Bluetooth, Wi-Fi, and WPAN packets:



12. Instant Audio

The *Instant Audio* feature provides a visual representation of captured audio traffic that can be played real-time (during recording) or post-capture, looped, or configured to play selected user-defined ranges. As audio is played, a vertical cursor tracks the present position of the audio being played. Various control features are provided, including rewind, looping, pausing, enable and disable of selected streams, and other controls. Any available sound devices installed on the controlling PC can be selected for use by this feature.

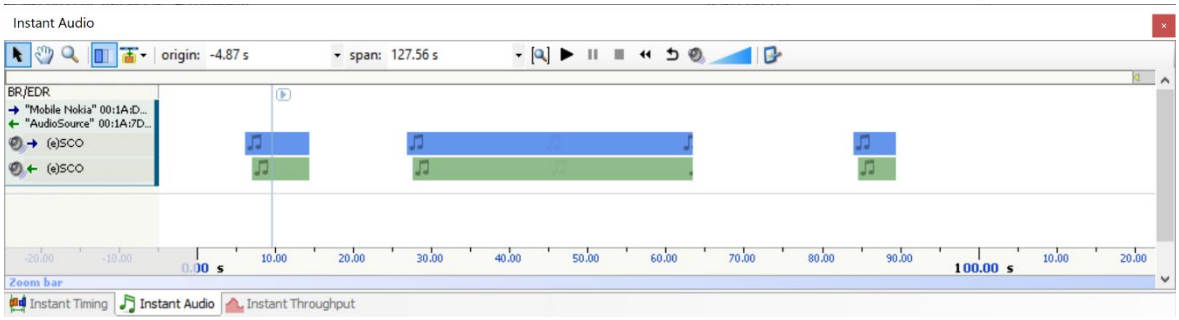
For LE Audio, two proprietary features are included. These include Auto-Detect for the LC3 codec (detects and decodes LC3 traffic, even without capture of configuration parameters), and tZERO Tracking Technology (Vanguard model only, delivers high-fidelity capture of isochronous traffic from the initial instance of isochronous traffic).

To better ensure optimal reception by the analyzer of audio traffic, please review Expert Note *EEN_BT04, Optimal Placement of Your Analyzer*, located in the Welcome view of the application.

To export audio to WAV format, see Export of Bluetooth Audio in Section 4.9.

To access the Instant Audio pane:

1. Select **View | Instant Audio** from the menu The *Instant Audio* pane appears:



User Controls and Toolbar

The *Instant Audio* pane provides various user controls. The table below lists the Instant *Audio* toolbar buttons and their actions:

	Pointer Mode	Switches to Pointer Mode.
	Pan Mode (Hold Shift)	Switches to Pan Mode.

	**Zoom Mode (Hold Ctrl)**	Switches to Zoom Mode.
	**Enable/Disable Smooth Scrolling**	Enables and disables the smooth scrolling.
	**Highlighting Options**	
	 **Highlight Active *Overview* Selection**	When enabled, the *Instant Audio* pane will be synchronized to the active Overview selection.
	 **Follow *Overview* Selection**	When enabled, the *Instant Audio* pane is synchronized to the active Overview selection.
	**Origin Box**	Displays the timestamp origin of the *Instant Audio* pane. Allows for user input of timestamp for jumping.
	**Span Box**	Displays the time span (zoom level) of the *Instant Audio* pane. Allows for user input to adjust span.
	**Audio Enable/Disable**	Toggle on/off for enable/disable of playback for audio stream(s) selected.
	**Zoom**	Zooms Out the *Instant Audio* display
	**Play**	Initiates play of audio
	**Pause**	Pauses the playing of audio
	**Stop**	Stops the playing of audio
	**Rewind**	Reestablishes the initial play point of the audio to the *Instant Audio* cursor
	**Loop Playback**	Repeats the audio or range of audio selected

	Mute	Mutes audio
	Volume	Slide bar to adjust volume up or down
	Options	Open **Options** dialog

Playing Audio

The *Instant Audio* feature allows for playing of captured audio during recording as well as playback of audio from a saved capture. Individual audio streams from either over-the-air sources or HCI sources can be enabled or disabled as desired.

Be sure relevant Codecs are supported on your Operating System as without such support, playback on your computer will not properly function.

Audio streams are represented by graphical bars, with time progressing left to right. The user can zoom or pan using the controls in the Tool Bar, using the Zoom Bar at the bottom of the pane, or using the Navigation Bar at the top of the pane.

The user may select various features to set playback characteristics. These include setting a range of audio for playback, looping a selected portion of audio, and selecting an initial playback starting point.

To play captured audio during a recording:

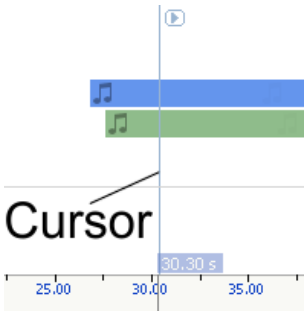
1. During a recording, which includes decrypted audio traffic, select the **Follow Live** button .

Audio is played as the capture progresses.

To establish the initial playback starting point:

1. Left click anywhere in the *Instant Audio* pane or select the *Instant Audio* cursor and drag to the desired location.

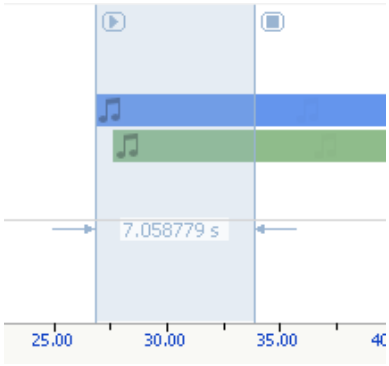
The *Instant Audio* cursor appears at the selected position:



To select a range of audio to play:

1. Left click at the desired starting position and drag to select therange desired.

The select range is highlighted and characterized with a time indication:



To enable or disable playback from a selected audio stream:

1. Select the speaker icon associated with the desired audio stream .
2. Click once to toggle the present mode (enabled or disabled). When disabled, the speaker icon will appear as .

To loop audio:

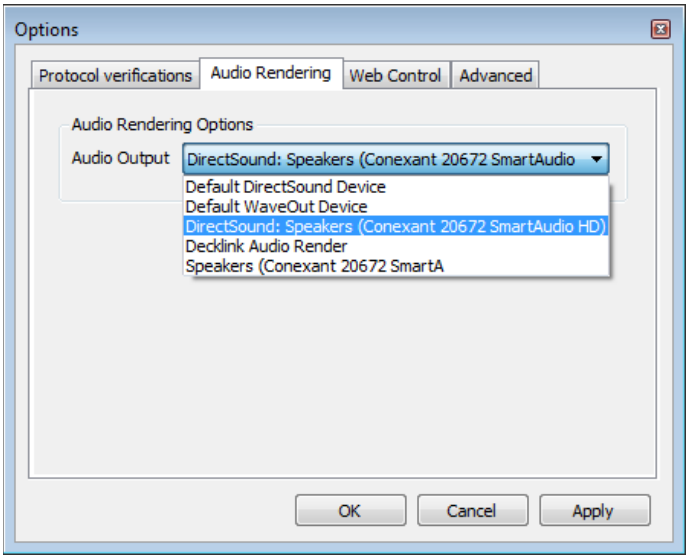
1. Initiate playback by selecting the **Play** button .
2. Select the **Loop Playback** button .

Audio is looped from the beginning of the *Instant Audio* cursor, or if a range is selected, loops the selected range.

To set Instant Audio options:

1. Select the **Options** icon on the *Instant Audio* toolbar .

The **Options** dialog opens:

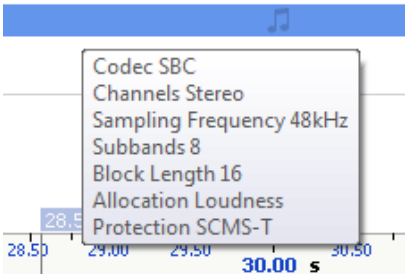


2. Select the desired device and click **OK**.

Audio Stream Flyover and Details

1. To see details on a captured audio stream, place the mouse over the desired location in the *Instant Audio* pane.

Details on the selected audio are displayed in a fly-over:



Using Markers

Markers may be added at any location within the *Instant Audio* pane. Markers can be edited to add textual content and can be color-coded. Markers placed in the *Instant Audio* pane are replicated in various views throughout the application.

To add a marker in the Instant Audio pane:

1. Right-click on a location or event in the *Instant Audio* pane.

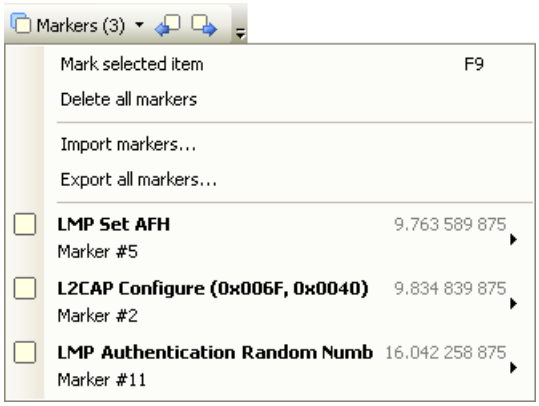
2. Select **Add New Marker Here**.

A marker is placed at the selected location.

To search markers:

1. Click on the **Markers** button (F9) on the toolbar. 

A list of all markers installed appears:



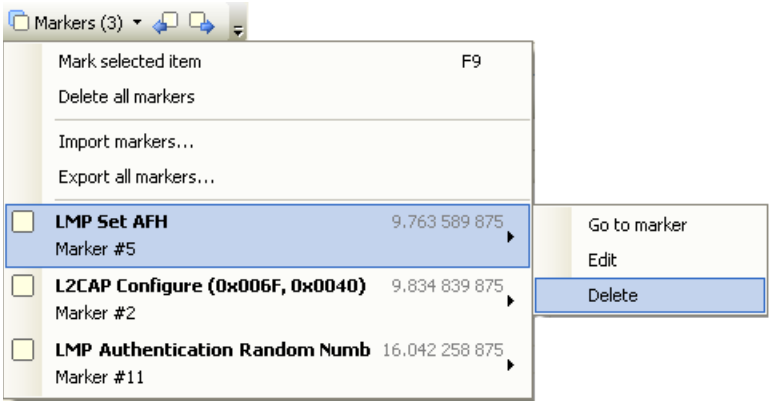
2. Select the desired marker from the list.

The *Instant Audio* pane jumps to the selected marker.

To delete a marker:

1. Click on the **Markers** button (F9) on the toolbar. 

2. Position the mouse pointer over the desired marker:



3. Select **Delete**.

The marker is removed.

To edit a marker:

1. Position the mouse pointer over the marker to be edited.
2. Left-click the marker (or right-click and select **Edit Marker**) or alternatively, select the **Marker** button on the toolbar.
3. Select the desired marker.
4. Select **Edit**.

The selected marker opens for editing.

Panning Left and Right

Various methods are available to pan (scroll) the *Instant Audio* pane to the left or right.

To use the mouse to pan:

1. Position the mouse over the time scale at the bottom of the *Instant Audio* pane (recommended) or alternatively, click on **Pan**. 

The pointer changes to a pan (hand) symbol.

2. Press and hold the left mouse button and drag left or right as desired.

The mouse cursor automatically rolls around the screen, such that the user can smoothly scroll substantial amounts of time without having to press and release the mouse button several times.

To use the keyboard to pan:

1. Press LEFT or RIGHT Arrow to move incrementally left or right.

To use the Navigator bar to pan:

2. Position the mouse over the middle of the *Navigator* window.
3. Press and hold the left mouse button and drag left or right as desired to pan left or right.

To jump to another location:

4. Press keyboard HOME to jump to the start of the capture, or END to jump to the end of the capture or alternatively, use the *Navigator* bar to jump to a selected location by double-clicking at the desired location in the *Navigator* bar.

To define a new timing view origin:

1. Enter a timestamp value in the *origin* box.

The following values are allowed:

s – seconds

ms – milliseconds

ns – nanoseconds

ps – picoseconds

If a unit is not specified, then the previously displayed unit is used.

2. Press ENTER.

The *Instant Audio* pane is updated with the new origin.

The analyzer application retains new timing origin entries. Click the Down arrow in the origin field to view and select previously entered timing origin entries.

Zooming In and Out

The *Instant Audio* pane provides a zoom features to expand or contract the display to view information from a high level or low level. Zoom can be done using the mouse, the keyboard, the Zoom button on the toolbar, the span window, or using the Navigation bar.

To use the mouse to zoom:

1. Place the pointer over the *Zoom* bar, located at the bottom of the display (recommended) or alternatively, click on **Zoom** .

The pointer changes to a spyglass .

Press and hold the left mouse button and drag the pointer to the right to zoom in and expand the display or drag to the left to zoom out and contract the display.

The mouse cursor automatically rolls around the screen, such that the user can smoothly scroll substantial amounts of time without having to press and release the mouse button several times.

The mouse wheel can be used to zoom in and zoom out by moving the wheel forward to zoom in and backwards to zoom out. The zoom is centered at the mouse position.

To use the keyboard to zoom:

1. Press the UP-Arrow key to zoom in, and the DOWN Arrow key to zoom out.

To use the Navigator bar to zoom:

2. Position the mouse over the left or right edge of *Navigator w*indow:

3. Press and hold the left mouse button and drag left or right as desired to zoom in or out.

To define a new time span:

1. Type the new timing span in the *span* field.

The following values are allowed:

s – seconds

ms – milliseconds

ns – nanoseconds

ps – picoseconds

If a unit is not specified, then the previously displayed unit is used.

2. Press ENTER.

The *Instant Audio* pane is updated with the new span value.

The analyzer application retains new time span entries. Click the Down arrow in the span field to view and select previously entered time span entries.

Making Time Measurements

The *Instant Audio* pane provides quick and simple methods to manually characterize timing between or within audio streams. Timing cursors can be duplicated or frozen with a right-click, to enable the addition of more cursors.

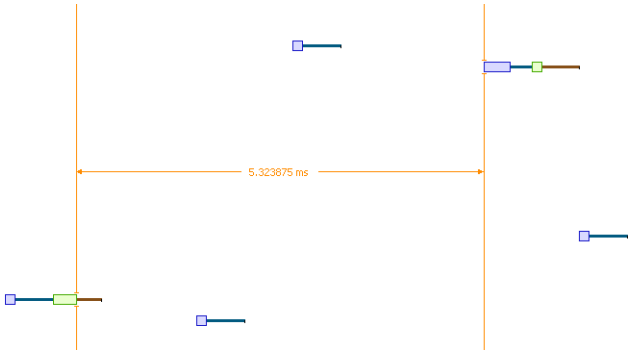
Timing cursors available include:

1. Range Select Timing Cursors
2. A-B Independent Cursors

To make a timing measurement:

1. Select the pointer icon in the toolbar  .
2. Left click in the desired location in the *Instant Audio* pane.
3. Drag the mouse to the desired location or desired event.

The time between the cursors is displayed:



The vertical position of the displayed timing information, including the horizontal arrows, can be changed by selecting the information with the mouse pointer, then dragging to the desired position.

To add additional cursors:

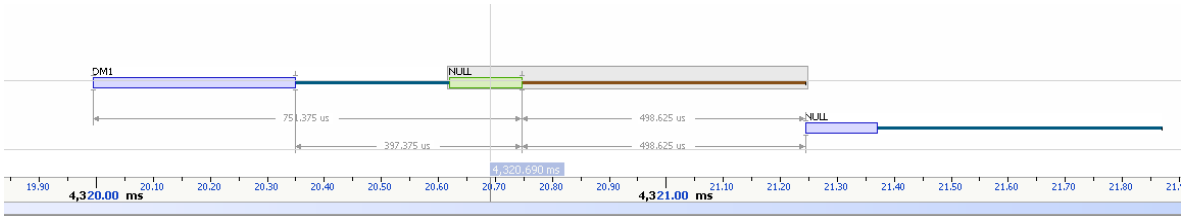
1. Right click over an existing set of timing cursors.
2. Select **Duplicate** to make available another set of cursors with the exact time spread as the original or select to fix the current cursor and enable placement of another cursor set as desired.

A new set of cursors appears (with **Duplicate** selected) and can be placed as desired. With **Freeze** selected, the original cursor set is grayed out and new cursors can be installed as described above.

To enable automated timing indicators:

1. To enable the automated timing measurement, place the mouse over any packet.

The time from one packet to the next and from the previous packet is indicated in grey text.



To make time measurements using the A-B cursors:

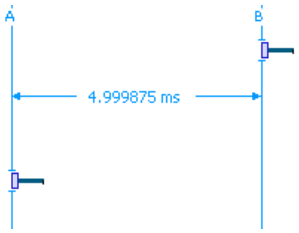
The A-B cursors are especially useful when the two events being measured are far apart, such that one cursor can be set, then the user can scroll as needed to the other event to set the second cursor.

2. Select the first desired location in the *Instant Spectrum* view.
3. Right click and select **Place Cursor A here.**

The A cursor is placed at the location selected.

4. Select the second desired location in the *Instant Spectrum* view.
5. Right click and select **Place Cursor B here.**

The B cursor is placed at the location selected, and timing information is provided, including number of slots:



13. Instant Channels

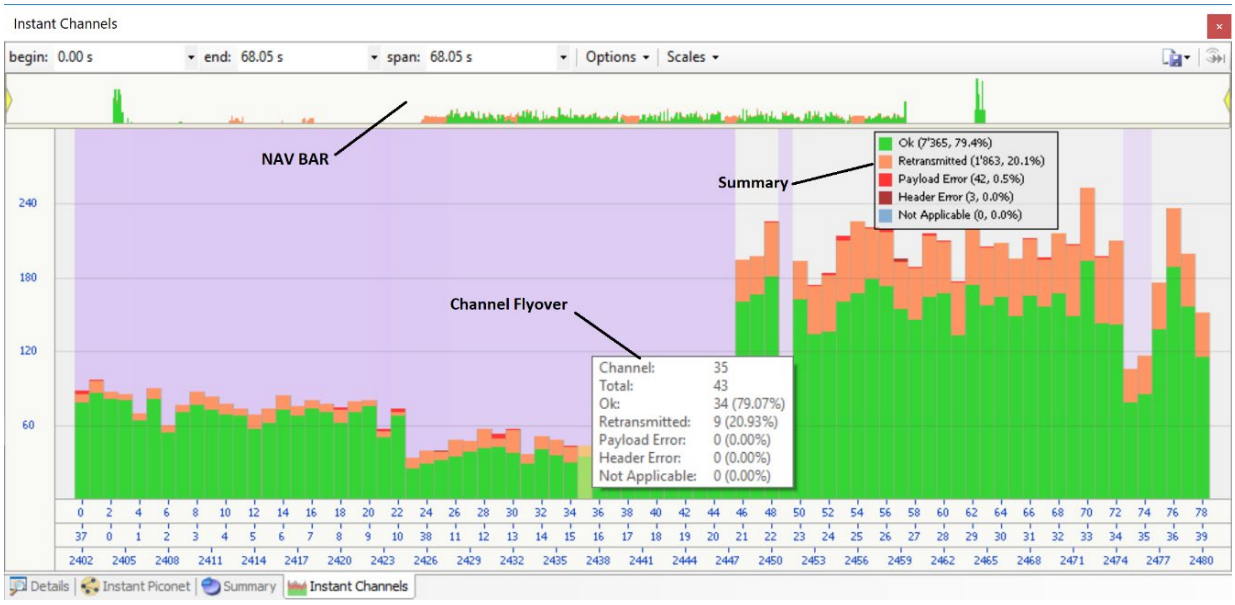
The *Instant Channels* feature provides visual and statistical analyses on various per-channel transmission characteristics, including packet retransmissions, header errors, AFH indications, and payload errors. A summary of the selected span shows a count and percentage of categorized packets. Options are provided to show/hide any combination of LE ADV, BR/EDR, and/or LE DATA. In addition to counts, the user can also select Normalize to view results on a percentage basis.

The *Instant Channels* feature will track Bluetooth packets from all devices being displayed in the application. To narrow the *Instant Channels* display down to specific devices, use a Device Filter to show only the devices of interest. See *Section 9.6, Bluetooth Device Traffic Filter* for more information on filtering the display.

To access the Instant Channels pane:

1. Select **View | Instant Channels** from the menu.

The *Instant Channels* pane appears:



13.1 Color-Coding

Each Bluetooth channel is listed across the bottom of the *Instant Channels* pane, increasing from left to right. Scales are provided (in the **Scales** drop-down menu) for Frequency, BR/EDR channel, Bluetooth Low Energy channel, Wi-F channel, and 802.15.4 (WPAN) channel.

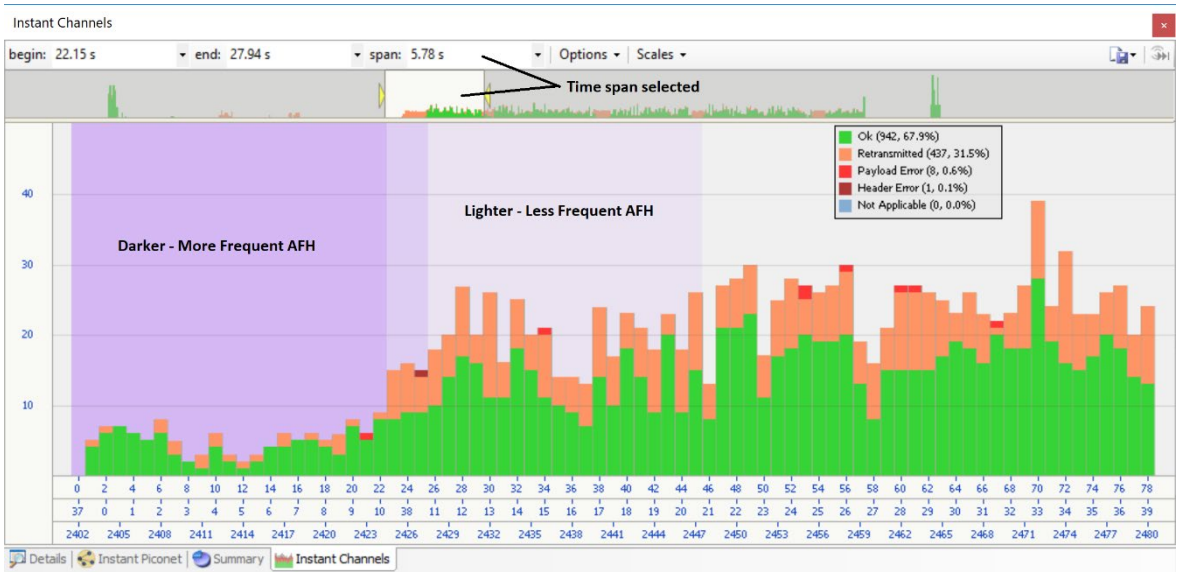
Stacked vertical bars are associated with each Bluetooth channel and are color-coded to indicate:

1. OK packets GREEN
2. Retransmissions ORANGE
3. Packet header errors (HEC errors) BROWN
4. Payload errors (CRC errors) RED
5. Not applicable (encrypted) BLUE

13.2 AFH / Channel Mapping Indications

AFH (Adaptive Frequency Hopping) and Channel Mapping are indicated by a lighter-to-darker range of magenta shading covering one or more channels. Lighter shading means less active AFH activity over the selected time span, and darker means more active AFH activity over the selected time span.

By default, the time span will cover the entire capture, but it can be precisely selected by entering a value in the **span** box on the toolbar or by using a click and drag approach in the Navigation bar.



13.3 Navigation Bar

The *Instant Channels* pane includes a *Navigation* bar atop the window, which allows for global pan and zoom to traffic concentrations of interest. All traffic captured is represented in the *Navigation* bar.

To use the Navigator bar to pan:

1. Position the mouse over the middle of the *Navigator* window. The Navigator window will reflect the entire contents
2. Press and hold the left mouse button and drag left or right as desired to pan left or right.

To use the Navigator bar to zoom:

1. Position the mouse over the left or right edge of *Navigator w*indow:

2. Press and hold the left mouse button and drag left or right as desired to zoom in or out.

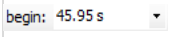
13.4 Packet and Header Errors vs. Retransmissions

A packet with an incorrect CRC (payload error) or header error (incorrect HEC) that is subsequently retransmitted successfully will be counted as a retransmission, not as a payload or header error. If no retransmission is captured, then the packet is counted as a payload error or header error.

13.5 User Controls and Toolbar

The *Instant Channels* feature will track Bluetooth packets from all devices being displayed in the application. To narrow the *Instant Channels* display down to specific devices, use a Device Filter to show only the devices of interest. See *Section 9.6, Bluetooth Device Traffic Filter* for more information on filtering the display.

User Controls and Toolbar

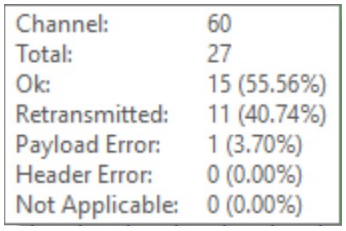
	**Timestamp Begin**	Tracks *Navigator* selection and can also be used to manually enter a timestamp origin.
	**Timestamp End**	Tracks *Navigator* selection and can also be used to manually enter a timestamp end.
	Span	Tracks *Navigator* selection and can also be used to manually enter a display span.

span: 4.00 s		
Options	**Options**	Enables and disables display options including show/hide categories for the Nav Bar (**Overview Histobars**) and the primary view (**Main Histobars**).
Scales	**Scales**	Scales available include MHz, BR/EDR Channel, Low Energy Channel, WPAN (802.15.4) Channel, and 802.11 Channel.

To view per-channel statistics:

1. Place the mouse over the histogram associated with the desired channel.

A statistical summary of the selected channel appears:



To define a new time span:

1. Type the new timing span in the *span* field.

The *Instant Channels* display updates to show the span specified.

To jump to another location:

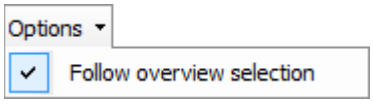
1. Use the *Navigator* bar to jump to a selected location by double-clicking at the desired location in the *Navigator* bar.

13.6 Synchronizing to Other Views

The *Instant Channels* display is synchronized to the active Overview (*BR/EDR Overview* or *Low Energy Overview*). As the user selects an event in these Overviews, the *Instant Channels* display will orient to the location selected.

To disable synchronization with the active Overview:

1. On the *Instant Channels* toolbar, select the **Options** drop-down:



2. Select or de-select **Follow overview selection** as desired to follow or not follow selections made in the active Overview.

14. Instant Throughput

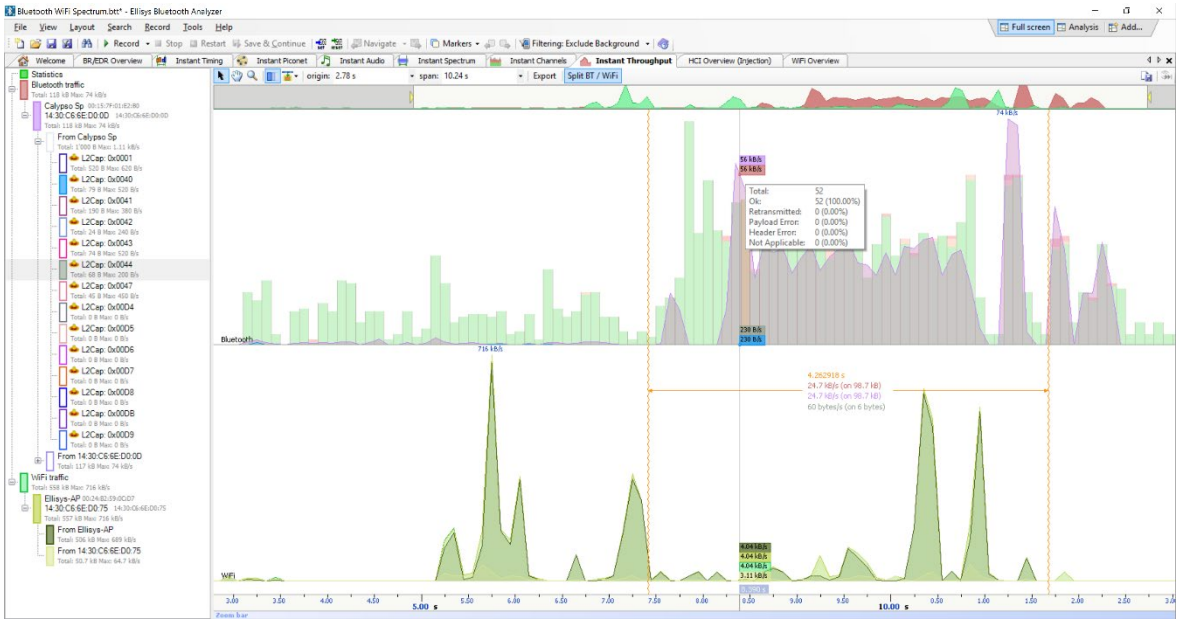
The *Instant Throughput* pane displays payload throughput by device and by protocol (L2CAP channel and SCO/eSCO). Wi-Fi throughput is also displayed. A color-coded scheme is used to differentiate these various device/protocol throughput indications. The user can select anywhere from a single throughput stream to all throughput streams for display (aggregate).

A hierarchy of all devices is shown at the left of the display, with the throughput graphs at the right. A *Navigation* bar is available at the top of the display, which shows a global indication of throughput and allows the user to pan, zoom, and jump to any desired location.

Timing cursors are available to make one or more timing measurements across one or more data streams. Markers can be placed at any point within the display and can be searched using the Markers feature.

To access the Instant Throughput pane:

1. Select **View | Instant Throughput** from the menu The *Instant Throughput* pane appears:



	**Pointer Mode**	Switches to Pointer Mode.
	**Pan Mode (Hold Shift)**	Switches to Pan Mode.

	**Zoom Mode (Hold Ctrl)**	Switches to Zoom Mode.
	**Enable/Disable Smooth Scrolling**	Enables and disables the smooth scrolling.
	**Highlighting Options**	
	 **Highlight Active *Overview* Selection**	When enabled, the *Instant Throughput* pane will be synchronized to the active Overview selection.
	 **Follow *Overview* Selection**	When enabled, the *Instant Throughput* pane is synchronized to the active Overview selection.
origin:	**Origin Box**	Displays the timestamp origin of the Instant Throughput pane. Allows for user input of timestamp for jumping.
span:	**Span Box**	Displays the time span (zoom level) of the *Instant Throughput* pane. Allows for user input to adjust span.
	**Follow Live**	Throughput is displayed as it is captured
	**Export Image**	Exports the *Instant Throughput* pane to an image file.

14.1 Panning Left and Right

Various methods are available to pan (scroll) the *Instant Throughput* view to the left or right.

To use the mouse to pan:

1. Position the mouse over the time scale at the bottom of the *Instant Throughput* view or alternatively, click on **Pan**. 

The pointer changes to a pan (hand) symbol.

2. Press and hold the left mouse button and drag left or right as desired.

The mouse cursor automatically rolls around the screen, such that the user can smoothly scroll substantial amounts of time without having to press and release the mouse button several times.

To use the keyboard to pan:

1. Press LEFT or RIGHT Arrow to move incrementally left or right.

To use the Navigator bar to pan:

1. Position the mouse over the middle of the *Navigator* window.
2. Press and hold the left mouse button and drag left or right as desired to pan left or right.

To jump to another location:

1. Press keyboard HOME to jump to the start of the capture, or END to jump to the end of the capture.
2. Alternatively, use the *Navigator* bar to jump to a selected location by double-clicking at the desired location in the *Navigator* bar.

To define a new timing view origin:

1. Enter a timestamp value in the *origin* box.

The following values are allowed:

s – seconds

ms – milliseconds

ns – nanoseconds

ps – picoseconds

2. Press ENTER.

If a unit is not specified, then the previously displayed unit is used.

The *Instant Throughput* view is updated with the new origin.

The analyzer application retains new timing origin entries. Click the Down arrow in the origin field to view and select previously entered timing origin entries.

14.2 Zooming In and Out

The *Instant Throughput* view provides a zoom feature to expand or contract the display to view information from a high level or low level.

To use the mouse to zoom:

1. Place the pointer over the *Zoom* bar, located at the bottom of the display (recommended or alternatively, click on **Zoom** .

The pointer changes to a spyglass .

2. Press and hold the left mouse button and drag the pointer to the right to zoom in and expand the display or drag to the left to zoom out and contract the display.

The mouse cursor automatically rolls around the screen, such that the user can smoothly scroll substantial amounts of time without having to press and release the mouse button several times.

The mouse wheel can be used to zoom in and zoom out by moving the wheel forward to zoom in and backwards to zoom out. The zoom is centered at the mouse position.

To use the keyboard to zoom:

1. Press the UP-Arrow key to zoom in, and the DOWN Arrow key to zoom out.

To use the Navigator bar to zoom:

1. Position the mouse over the left or right edge of *Navigator w*indow:

2. Press and hold the left mouse button and drag left or right as desired to zoom in or out.

To define a new time span:

1. Type the new timing span in the *span* field.

The following values are allowed:

s – seconds

ms – milliseconds

ns – nanoseconds

ps – picoseconds

If a unit is not specified, then the previously displayed unit is used.

2. Press ENTER.

The *Instant Throughput* display is updated with the new span value.

The analyzer application retains new time span entries. Click the **Down** arrow in the span field to view and select previously entered time span entries.

14.3 Making Time Measurements

The *Instant Throughput* view provides quick and simple methods to manually characterize timing between throughput events. Timing cursors can be duplicated or frozen with a right-click, to enable the addition of more cursors.

Timing cursors available include:

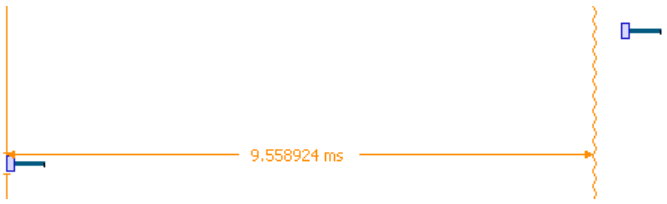
Timing Cursors

A-B Independent Cursors

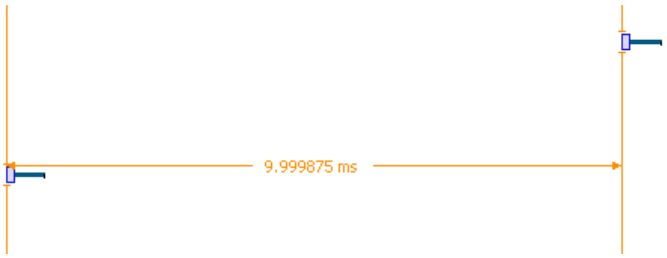
To make a timing measurement:

1. Select the pointer icon at the top left of the *Instant Throughput* view.
2. Left click in the desired location or on the desired event.

The vertical lines associated with the *Instant Throughput* cursors are waved if not attached to an event, and straight when attached. To adjust cursor position, place the mouse pointer over either cursor and left click and drag to adjust position horizontally



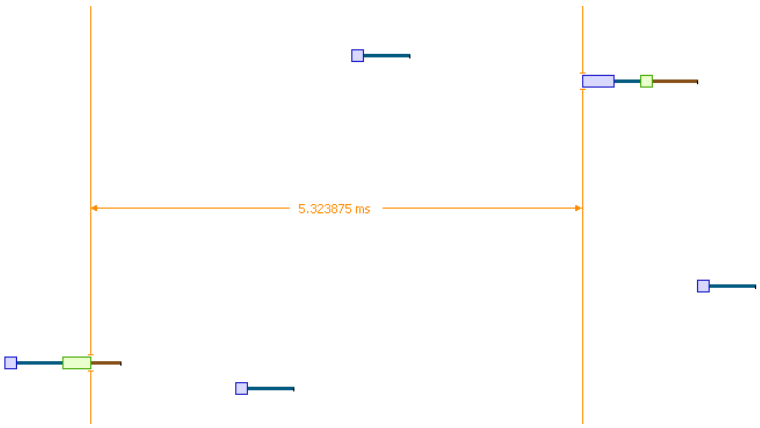
Right Line Not Attached



Both Lines Attached

Drag the mouse to the desired location or desired event.

The time between the cursors is displayed:



The vertical position of the displayed timing information, including the horizontal arrows, can be changed by selecting the information with the mouse pointer, then dragging to the desired position.

To add additional cursors:

Right click over an existing set of timing cursors.

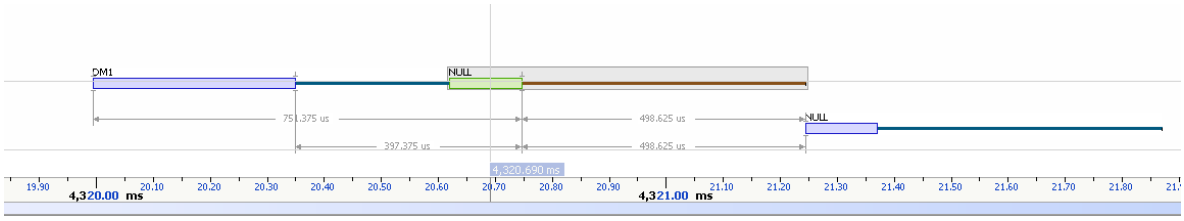
Select **Duplicate** to make available another set of cursors with the exact time spread as the original, or select to fix the current cursor and enable placement of another cursor set as desired.

A new set of cursors appears (with **Duplicate** selected) and can be placed as desired. With **Freeze** selected the original cursor set is grayed out and new cursors can be installed as described above.

To enable automated timing indicators:

To enable the automated timing measurement, place the mouse over any packet.

The time from one packet to the next and from the previous packet is indicated in grey text.



To make time measurements using the A-B cursors:

The A-B cursors are especially useful when the two events being measured are far apart, such that one cursor can be set, then the user can scroll as needed to the other event to set the second cursor.

Select the first desired location in the *Instant Spectrum* view.

Right click and select **Place cursor A here.**

The A cursor is placed at the location selected.

Select the second desired location in the *Instant Spectrum* view.

Right click and select **Place cursor B here.**

The B cursor is placed at the location selected, and timing information is provided, including number of slots.

15. Security Pane

The *Security* pane displays encryption-related information and allows for various user inputs. The *Security* pane will update as traffic is recorded, and can be saved with the capture, alleviating the need to re-enter link keys on successive captures. The *Security* pane also accepts user-entry of link keys, a private key, PIN codes, and user-defined device names.

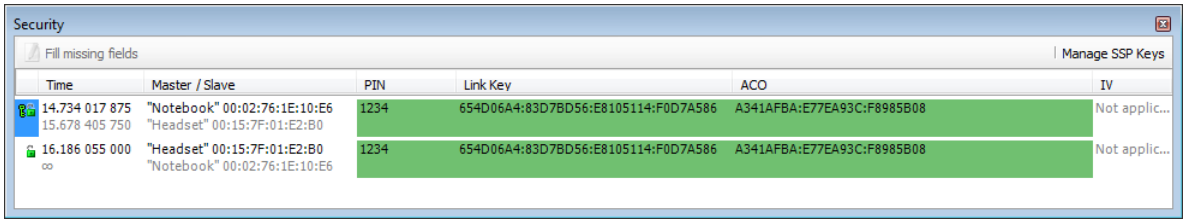
Security pane features include:

- Link key, authenticated ciphering offset (ACO), and PIN code displays
- Automatic deciphering of PIN codes and calculation of link keys from non-SSP pairings
- User entry of link keys to enable the software to decrypt related traffic
- Entry of friendly device names for easier recognition throughout the application
- Selectable timestamp indicators for pairings that are linked to the Overview
- Alerts for incomplete pairings, PIN code conflicts, missing link key, incorrect link key
- A utility to calculate public keys from a private key

To access the *Security* pane:

1. Select **View | Security** from the menu.

The *Security* pane appears:



15.1 SSP versus Non-SSP Pairings

For PIN-code pairings, the analyzer will decipher the PIN code, calculate the link key, and decrypt all related packets, all without user intervention.

For SSP pairings, the user can enter the link key during a recording, or on a static or saved capture. The software will then decrypt the traffic. If an HCI interface is being captured, the software will automatically extract the link key from the captured HCI traffic and use this for decrypting the traffic automatically.

15.2 Debug Mode

When Debug Mode is used, the analyzer will use the pre-defined Diffie Hellman private key and public keys that are used with this mode to automatically decrypt the traffic.

15.3 Proper Entry of Link Key

Entry of a link key into the *Security* pane may be needed to decrypt traffic, especially for SSP pairings. This can be done during a capture or after a capture is saved. Different methods for proper entry of a link key are discussed below.

To enter a link key in hex (lowest order byte on left):

Specify each byte of the Link Key in hex, starting with the lowest order byte on the left. In this case DO NOT use ":" as a separator and use either "0x" for every byte, or do not use it at all, as shown below:

```
0x01 0x02 0x03 0x04 0x05 0x06 0x07 0x08 0x09 0x0A 0x0B 0x0C 0x0D 0x0E 0x0F 0x10

01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F 10

01020304:05060708:090A0B0C:0D0E0F10
```

To enter a link key in hex (highest order byte on left):

Specify the Link Key as a big hex number, with highest order byte on the left. Use ":" as a separator and/or specify a single "0x" at the beginning, as shown below:

```
0x100F0E0D:0C0B0A09:08070605:04030201

100F0E0D:0C0B0A09:08070605:04030201

0x100F0E0D0C0B0A090807060504030201
```

15.4 Synchronization to Overviews

Each displayed security event is linked to the pertinent Overview by a timestamp column, includes an indication of the applicable master/slave connection, shows the calculated (or provided) link key, the PIN code (as applicable), and the authenticated ciphering offset (ACO).

To synchronize the Overview to a security event:

Left click on the timestamp associated with any security event shown in the *Security* pane.

The Overview jumps to the location of the selected timestamp.

15.5 Indicators and Icons

Various background colors are used to provide the user with an at-a-glance understanding of each security event.

Background	Description
0000 BAC304DC:95EA7EFA:2B7D2286:44D0E797	Link key and/or PIN code calculated
0000 881C52AE:65642081:3B5139A5:346F108A 00000 4CBE770A:5D7F6729:911AE9C8:B0952A69	Conflict with PIN code or incorrect link key entered (note the differing PIN codes at left)
Missing	Link key not entered

Various icons indicate pairing and decryption status:

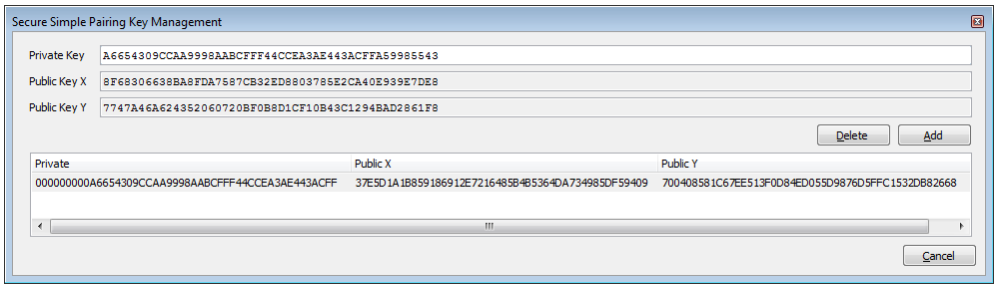
Icon	Meaning
	Incomplete pairing
	Pairing detected
	Decrypted
	Pairing detected, decrypted
	Incomplete pairing, not decrypted

15.6 Calculation of Public Keys from Private Key

The *Security* pane provides a simple utility to calculate public keys (X and Y) from a private key.

To calculate public keys from a private key:

Select **Manage SSP Keys**  from the *Security* pane toolbar.



The *Secure Simple Pairing Key Management* window opens:

Enter the private key in the **Private Key** box.

Select **Add**.

The public keys are calculated and displayed in the **Public Key X** and **Public Key Y** boxes. The public keys can now be copied to the clipboard by right-clicking either public key box and selecting **Select All** (or double-click and select **Copy**).

Close the *Key Management* window.

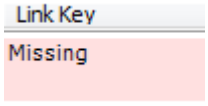
15.7 Entry of User-Defined Device Names

The *Security* pane provides a method to enter a user-defined text string to identify a device throughout various panes in the application.

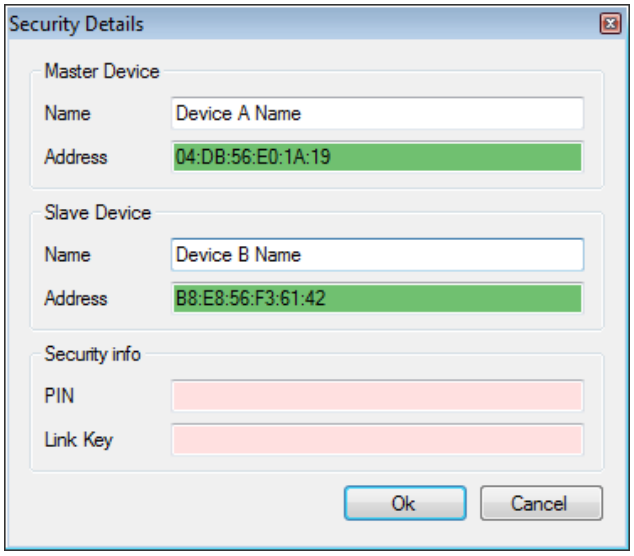
This entry is only accessible when a connection is captured, and the link key has not been entered (resulting in a "missing" indication in the Link Key column associated with the device). The primary approach to adding a user-defined name is to use the **Edit** button located in the *Device Traffic Filters* dialog. See Section 8.4 Device Traffic Filter for details.

To create a user-defined name for a device:

Double-click "Missing" on the line associated with the desired device pair as indicated in the Security pane or select the **Fill Missing Fields** button at top-left of the *Security* pane.



The *Security Details* window opens:



Enter the desired name in one or both device **Name** boxes.

The user-entered name now appears in the Security pane as well as throughout various panes in the application.

16. Instant Piconet Pane

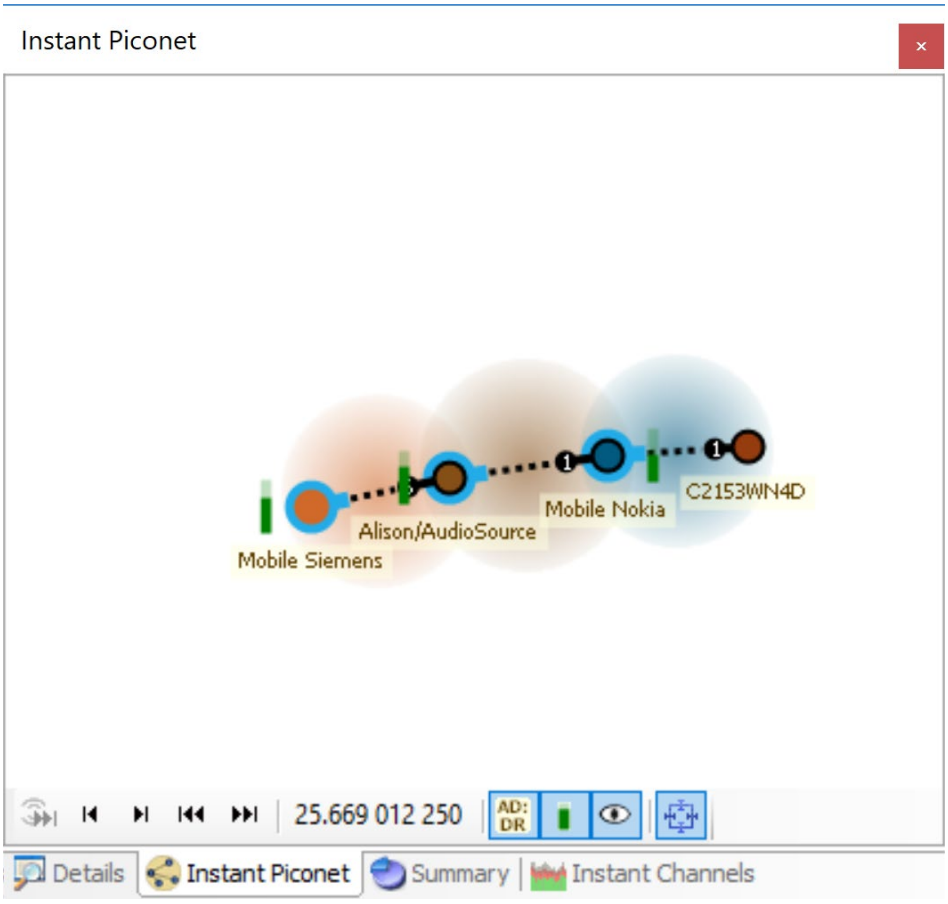
The *Instant Piconet* pane provides an instantaneous, dynamic, and graphical depiction of Bluetooth devices, events, and topologies captured by the analyzer. The *Instant Piconet* pane updates as traffic is captured and can also be used on saved captures to step through topology changes.

Features are provided to show/hide labels (BD ADDR, LMP name, or user-defined name) and to show/hide broadcast events. Mouse fly-over will present master/device information. A selectable timestamp is provided to force the Overview to align to the present *Instant Piconet* location.

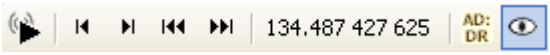
To access the Instant Piconet pane:

Select View | Instant Piconet from the menu.

The *Instant Piconet* pane appears:



Instant Piconet pane toolbar:

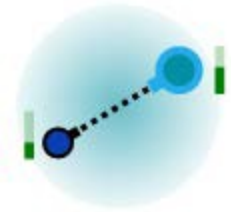


	Follow live. *Instant Piconet* tracks topology while capturing. **Note:** When active, *Instant Piconet* cursor in *Instant Timing* is disabled.
	Previous change.
	Next change.
	Previous data channel topology change.
	Next data channel topology change.
134.487 427 625	Timestamp of current view (links to Overview when selected).
AD: DR	Show/hide addresses/device labels.
	Show/hide broadcast events.

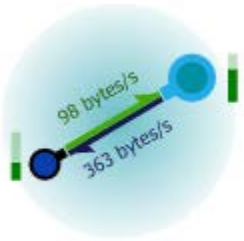
16.1 Instant Piconet Graphics and Icons

Various graphical elements are provided to give the user an understanding of events, including which devices are the master (always blue-bordered) or a slave, RSSI indications (green histogram), connection types such as paging and inquiry events, piconet indicators, and data transfers.

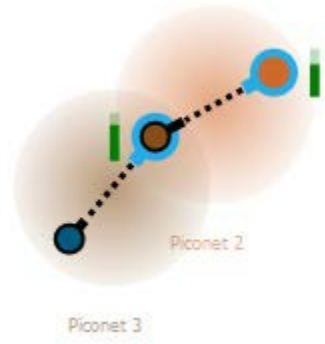
Here is a quick summary of the various representations you can find in the *Instant Piconet*:



Represents an **idle connection** between a master and a slave. Master devices always have a blue outline. Slave devices always have black outline. The gauge on the side represents the RSSI of the device.

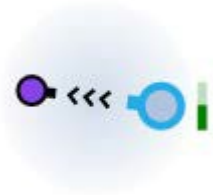


Represents an **active data connection**. Throughputs are indicated.



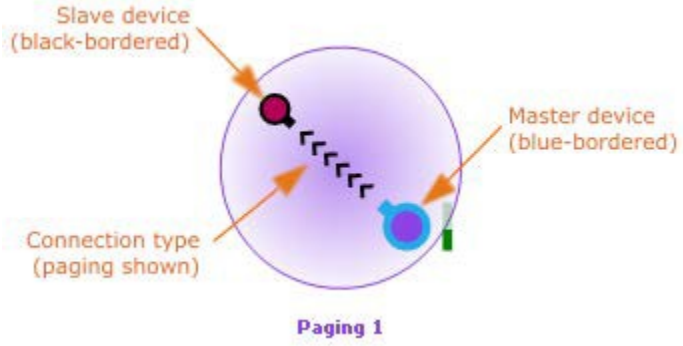
Represents a **scatternet** composed of two simple piconets. The device in the center is the slave of the device on the right, and the master of the device on the left.

Represents an **inquiry**. The inquirer device is represented with blue outline, like masters, while responding devices are represented with black outline.

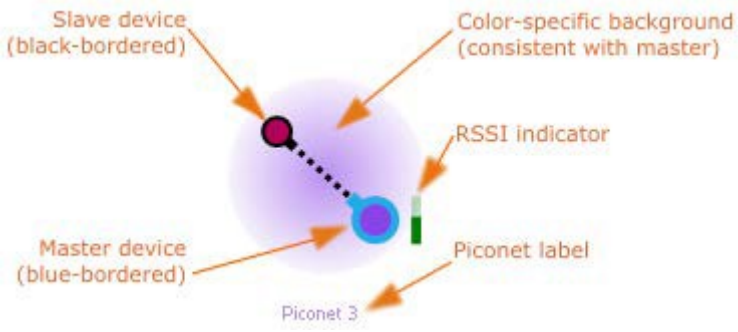


Represents a **paging**. The pager device is represented with blue outline, like masters, while the paged device is represented with black outline.

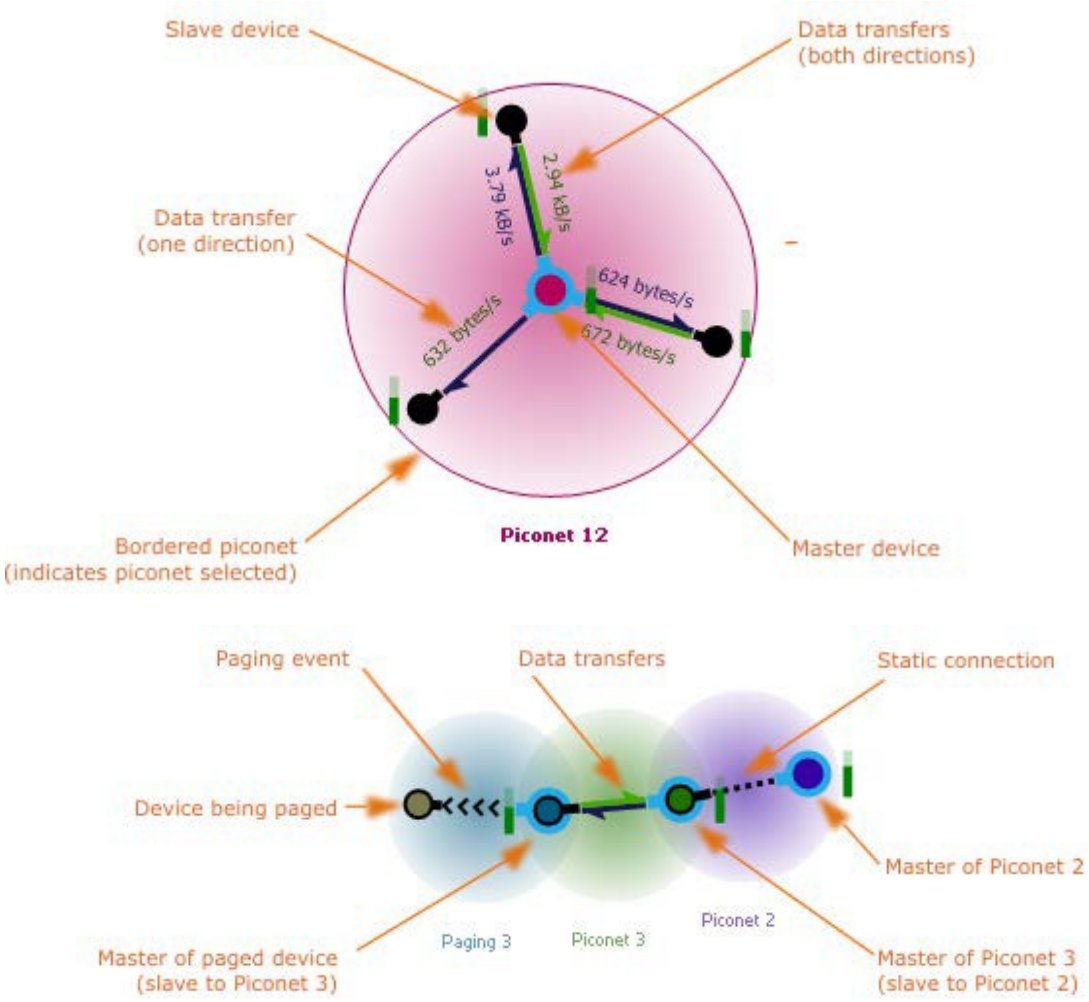
And here are a few more details about other visual elements:



Simple Piconet, Showing a Paging



Simple Piconet, Showing a still connection



Piconet, with data transfers shown Simple Scatternet

16.2 Display Features

To use the flyover:

Position the mouse over any device.

The flyover indicator appears, advising the user of the device's name, and master/slavestatus:

To show/hide BD ADDR, LMP Name, or user-provided name:

Toggle the ADDR button AD: DR in the *Instant Piconet* toolbar.

Each device shown will show/hide the BD ADDR. If an LMP name is available, this will be displayed. If the user has edited the device name in the *Devices* window, the edited name will be displayed.

To follow the topology in real-time, show/hide BD ADDR, LMP Name, or user-provided name:

Toggle the ADDR button AD: DR in the *Instant Piconet* toolbar.

Each device shown will show/hide the BD ADDR. If an LMP name is available, this will be displayed. If the user has edited the device name in the *Devices* window, the edited name will be displayed.

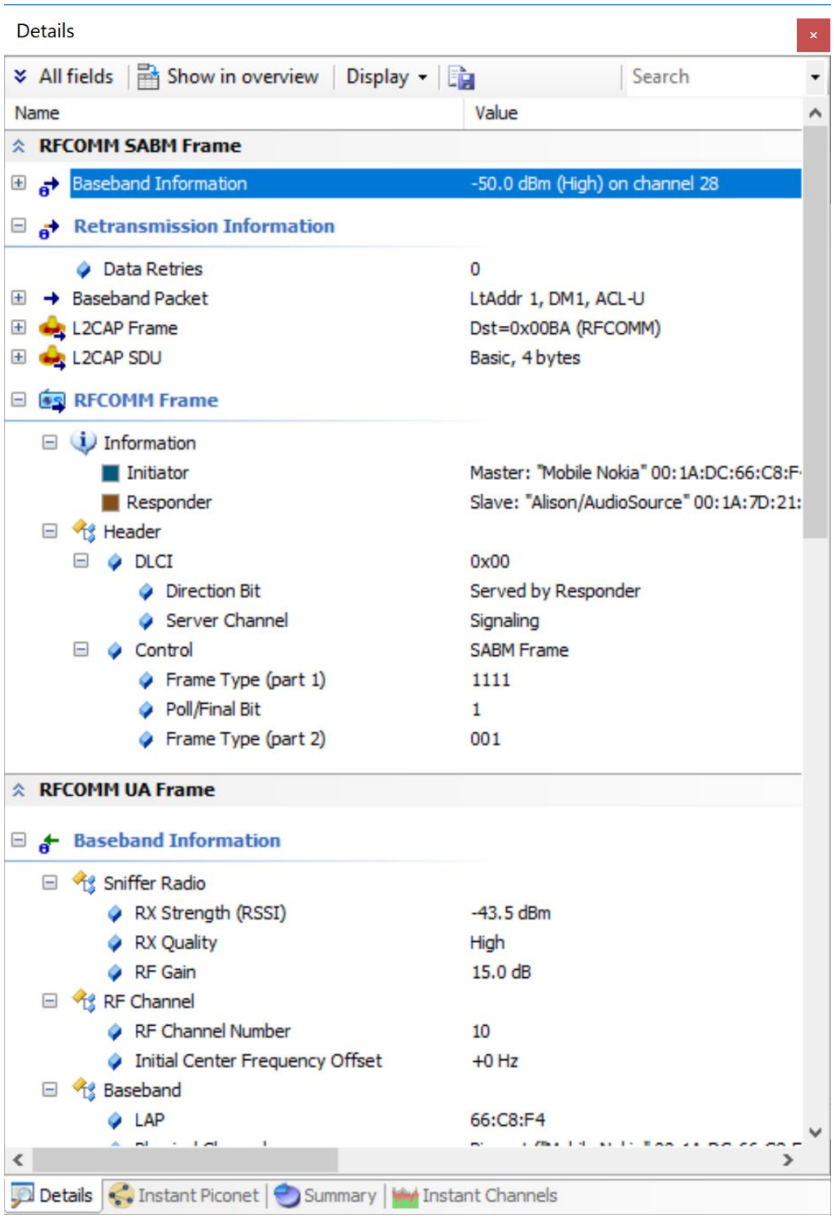
17. Details Pane

The *Details* pane provides detailed information on the event selected in the Overview, including protocol and profile decoding, baseband information, and various format options. The *Details* pane also provides a very useful feature allowing the user to re-populate the Overview, by allowing the user to add selected fields of interest into the Overview to create a new column.

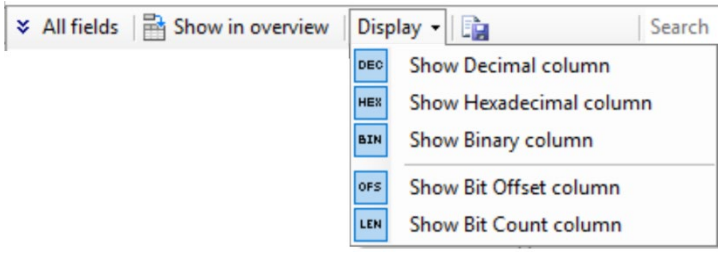
To access the Details pane:

1. Select **View | Details** from the menu.

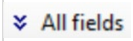
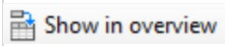
The *Details* pane appears:



Details toolbar:

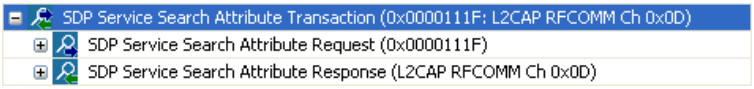


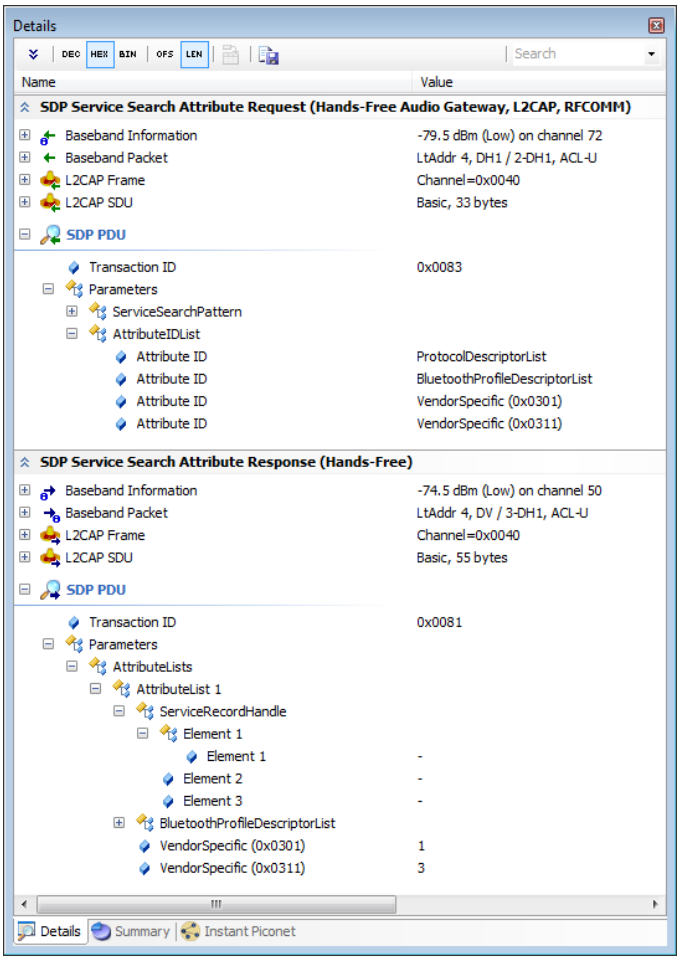
Functions available on the Details toolbar are described below:

	Show all fields. Some fields not typically needed (such as good CRC values) are hidden by default.
	Adds selected field to active Overview (you can also select/drag a field to an Overview)
	Show numeric values in decimal.
	Show numeric values in hexadecimal.
	Show numeric values in binary.
	Show fields' bit offset.
	Show fields' bit length.
	Export the *Details* pane (text or XML).

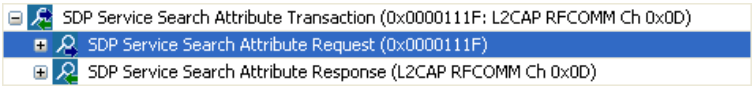
17.1 Abstraction and Relationship to Overviews

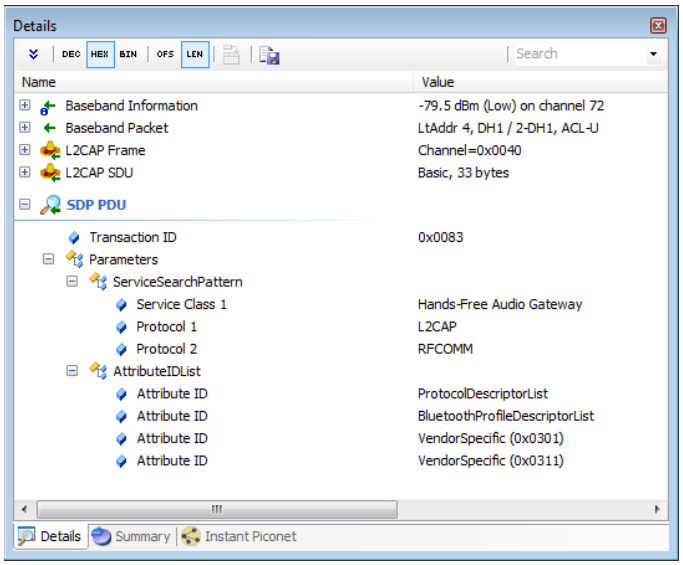
The *Details* pane will show all elements of higher level abstracts when these are selected, and as lower-level abstracts are exposed in the Overview and selected, the *Details* pane will drill-down to match the abstraction level selected (e.g., transaction, request, response, packet, etc.). For example, when selecting the **SDP Service Search Attribute Transaction** (below), the *Details* pane will show information on both the underlying request and response.



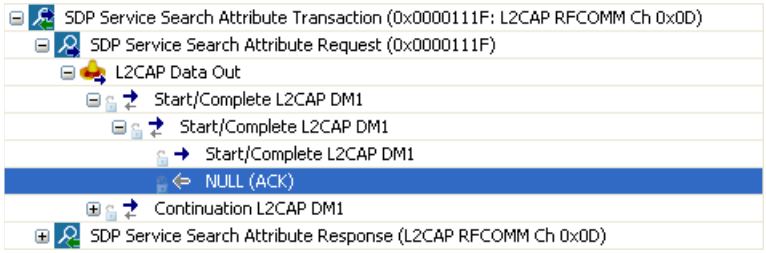


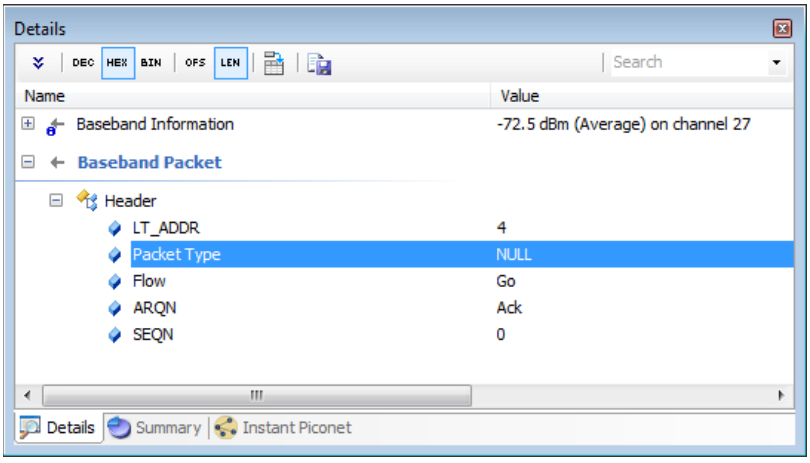
When selecting just the SDP Service Search Attribute Request, only this request (and underlying protocols, profiles, and packets) will be provided in the *Details* pane:



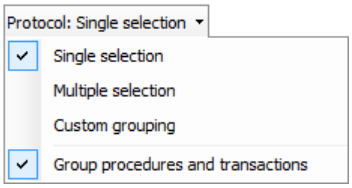


This concept holds true as each underlying Overview element is exposed, for example as shown below where a **NULL (ACK)** baseband packet is selected:

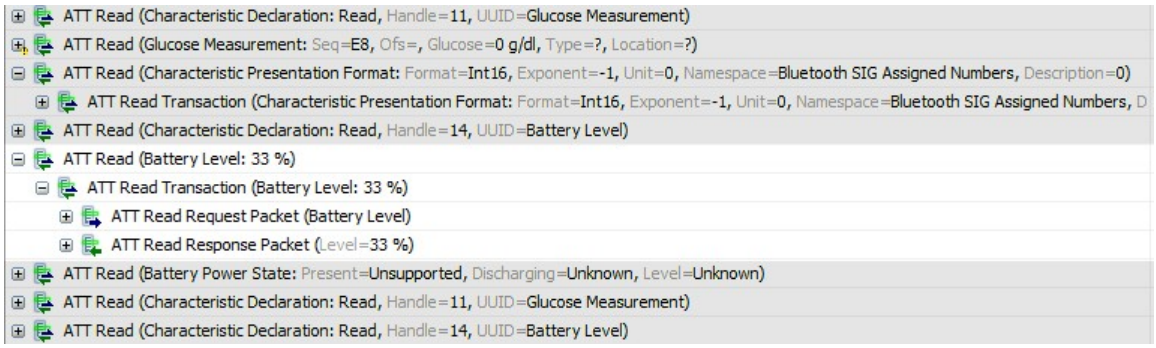




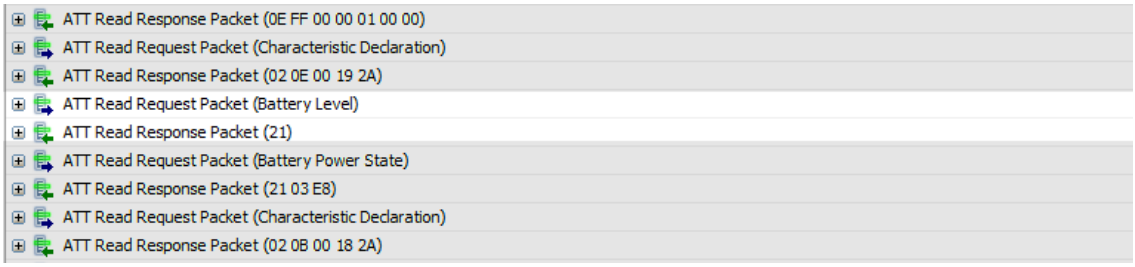
Grouping of procedures and transactions is enabled or disabled by selecting or deselecting the **Group Procedures and Transactions** selection, available in the **Protocol:** drop-down menu, shown below. This feature is enabled by default.



With **Group Procedures and Transactions** selected, transactional grouping is displayed at the highest level, such as shown below, where the ATT READ subsumes a transaction consisting of and ATT READ REQUEST and an ATT READ RESPONSE.



With **Group Procedures and Transactions** deselected, transactional grouping is reduced to the next lower level, such as shown below, where the ATT READ REQUEST and ATT READ RESPONSE are the highest abstraction.

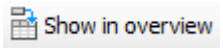


17.2 Adding Details Fields to an Overview

To place a Details field into the Overview:

1. Select the event desired in the Overview.

The *Details* pane repopulates to show details on the event selected.

2. Select the desired field in the *Details* pane.
3. Select the **Show in Overview** 

button in the *Details* toolbar. Or
4. Left click and drag the desired field from the *Details* pane and drop in the Overview.

The field from the *Details* pane is now shown in the Overview.

Adding fields from the *Details* pane into the Overview is especially powerful when combined with *Instant Filters*. This can be done during or after recording.

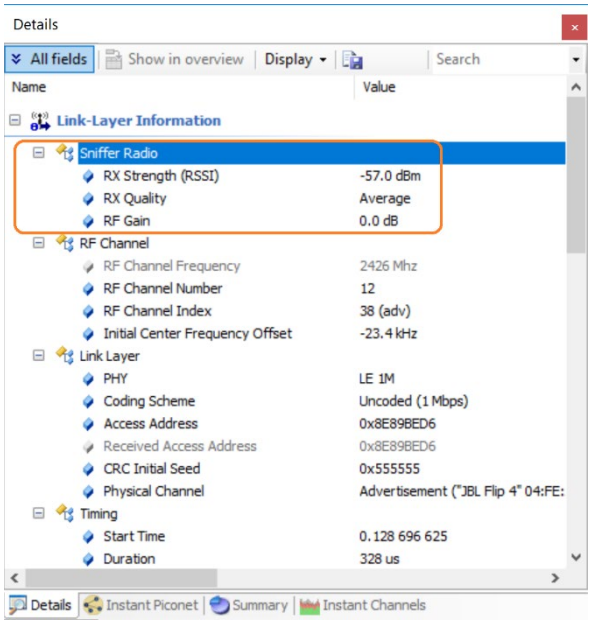
17.3 RSSI Strength Characterizations

In the *Details* pane, a categorical characterization is provided to advise the user of RSSI strength on a selected Bluetooth packet (BLE or BR/EDR). This measurement is made at the antenna on which the signal was received.

These characterizations are in the *Sniffer Radio* section of the *Details* pane. The sub-fields are *RX Strength (RSSI)*, *RX Quality*, and *RF Gain* (which is set by the user in **Recording Options | Wireless** menu).

Note that the **RF Gain** setting (**Recording Options | Wireless**), will offset the transition values of one category to/from the next/previous by the amount of the **RF Gain** Setting. The chart below assumes an **RF Gain** setting of 0dB.

Category	Values
Too Low	-70.5 dBm and weaker
Low	-60.5 dBm to -70 dBm
Average	-35.5 dBm to -60 dBm
High	-20.5 dBm to – 35 dBm
Too High	-20 dBm and stronger



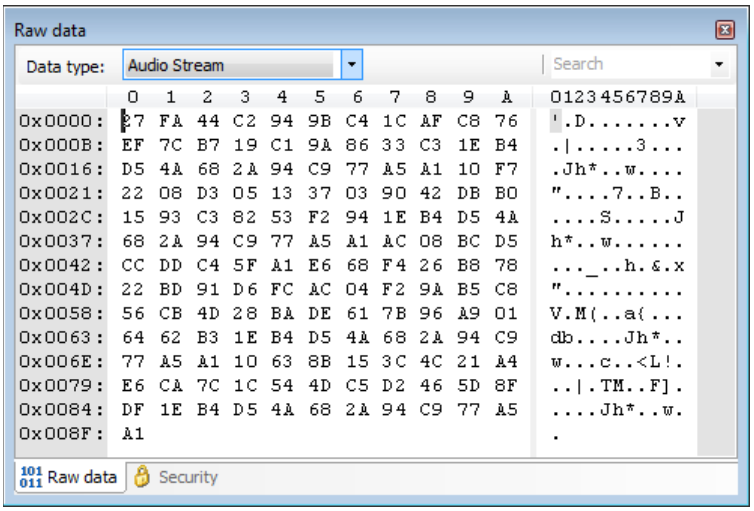
18. Raw Data Pane

The *Raw Data* pane provides a low-level data view of items selected in the Overview and includes various format and copy options. The *Raw Data* pane is linked to the *Details* pane, as fields selected in the *Details* pane are highlighted in the *Raw Data* pane, and therefore it is indirectly linked to the selection in the active Overview. Fields selected in the *Details* pane are highlighted in the *Raw Data* pane. The *Raw Data* pane also includes a search mechanism.

To access the Raw Data pane:

1. Select **View | Raw Data** from the menu.

The *Raw Data* pane appears, showing data from the item selected in the Overview:



18.1 Synchronization to Details Pane and Overviews

To highlight Details pane fields in the Raw Data pane:

1. Select the desired item in the Overview.

The *Details* pane displays all fields applicable to the item selected.

2. Select the desired field from the *Details* pane.

The selected field is highlighted in the *Raw Data* pane.

18.2 Searching the Raw Data Pane

To search the Raw Data pane:

1. Enter the desired text or hex value string in the **Search** box.

2. Press ENTER.

The left area of the *Raw Data* pane is searched. Strings found are highlighted in blue in the left and right areas.

18.3 Formatting the Raw Data Pane

To format the Raw Data pane display:

1. Right-click in the left or right areas in the *Raw Data* pane.
2. Set display options as per the table below:

Addresses	Sets left border addressing to hex or decimal.
Width	Sets horizontal length of data displayed.
Group by	Groups data in byte, word, long, or quad formats.
Left Area	Formats the left area in character, hex, binary, decimal, or octal.
Right Area	Formats the right area in character, hex, binary, decimal, or octal.
Text Size	Sets text size to small, medium, or large.

To copy data from the Raw Data pane:

1. Right-click in the left or right areas in the *Raw Data* pane
2. Select **Edit**.
3. Select **Copy as Displayed** (Ctrl+C) to copy data in the format presently displayed. Or
4. Select **Copy as Binary Data** (Ctrl+Shift+C) to copy data in a binary data format.

Copy actions will copy all data from the left area of the *Raw Data* pane, unless a mouse selection is made over specific data, in which case only the selected data is copied.

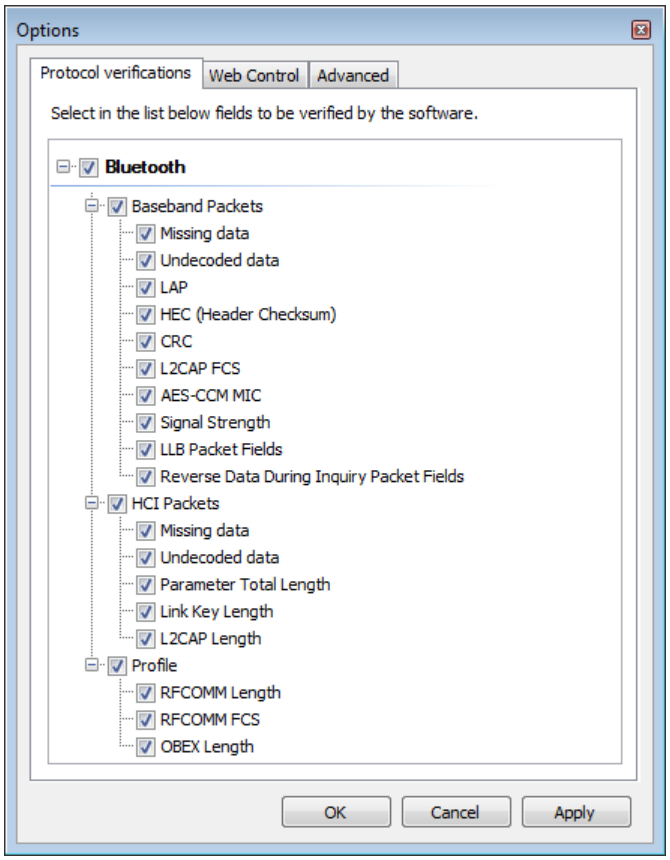
19. Protocol Error Verifications

The analyzer is designed to detect and display various errors and warnings. Errors of several types are flagged in the Overview and the *Details* pane. Detection and display of these errors can be disabled as desired.

To open the Protocol Verifications tab:

1. Select **Tools | Options** from the menu.

The *Options* menu appears:



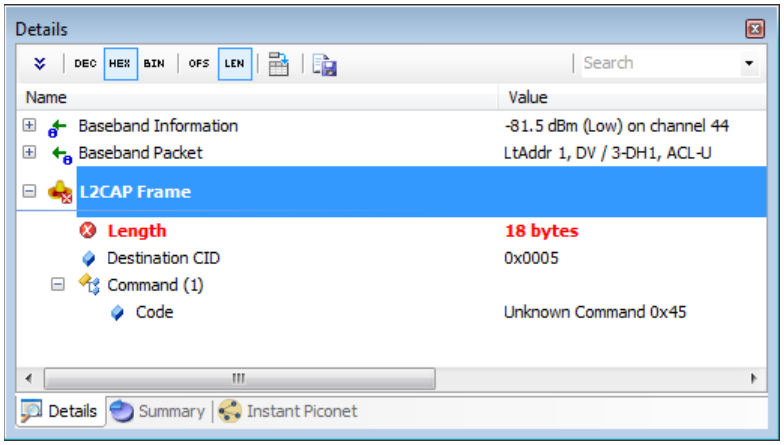
19.1 Enabling and Disabling Protocol Errors

To enable or disable display of protocol errors:

1. Under the *Protocol Verifications* tab, expand the categories to reveal the desired verification and uncheck the associated box.

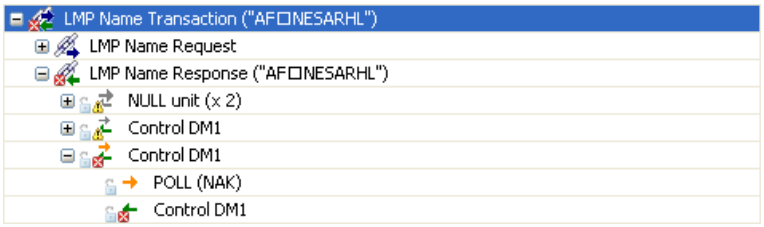
2. Click on **OK**.

Display of errors in the *Details* pane:

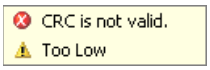


Errors are flagged on the lowest level element that contains the error, and up into the higher-level abstracts as shown below.

Warnings such as **RSSI Too Low** or **CRC is not valid** are also flagged.



Placing the mouse over the flagged error provides an indication of the specific error:



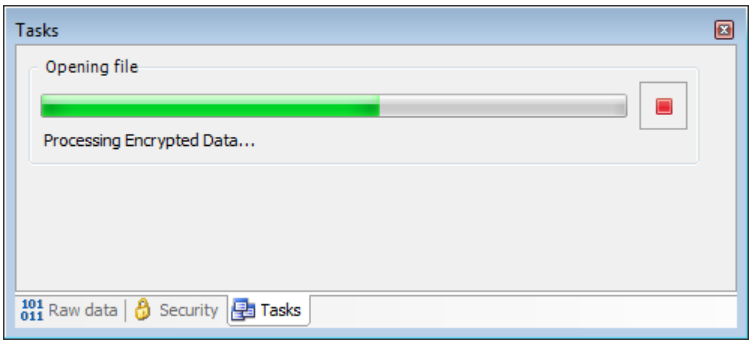
20. Tasks Pane

The *Tasks* pane provides the user with statuses on various actions initiated by the user and allows the user to cancel tasks in progress.

To access the Task pane:

1. Select **View | Other Windows | Tasks** from the menu.

The *Tasks* pane appears:



Task statuses provided by the *Tasks* pane include:

- File Open
- File Save
- Search
- Instant Search
- File Export
- File Import

21. BLE Hopping Sequence Calculator

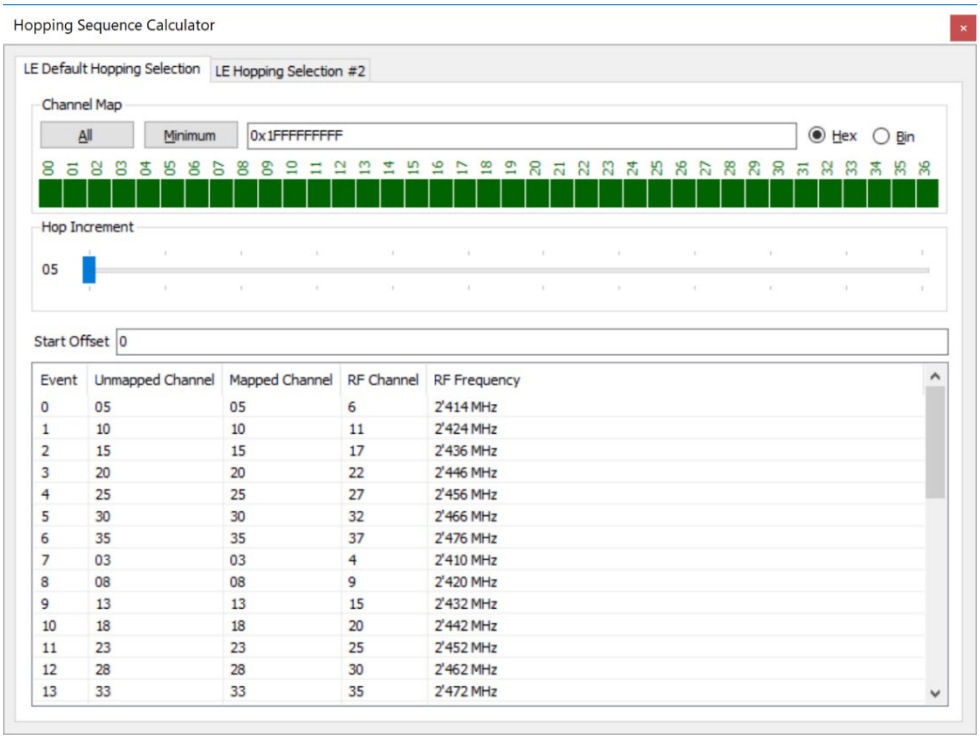
There are two types of channel hopping sequences defined for Bluetooth Low Energy. These hopping sequences are also called Channel Selection Algorithms (CSAs). The application provides a convenient tool to calculate a hopping sequence using either method.

The channels available for sending of packets are classified as used or as unused (this is called the channel map). The channel map is transmitted by the by the master device to the slave device in the CONNECTION_IND_PDU. After the connection is established, the channel map can be updated by the link layer command LL_CHANNEL_MAP_IND. The channel map value can be copied from the *Details* or *Raw Data* panes and pasted to the *Channel Map* field as needed.

To access the Hopping Sequence Calculator:

1. Select **Tools | Hopping Sequence Calculator** from the menu.

The *Hopping Sequence Calculator* window appears:

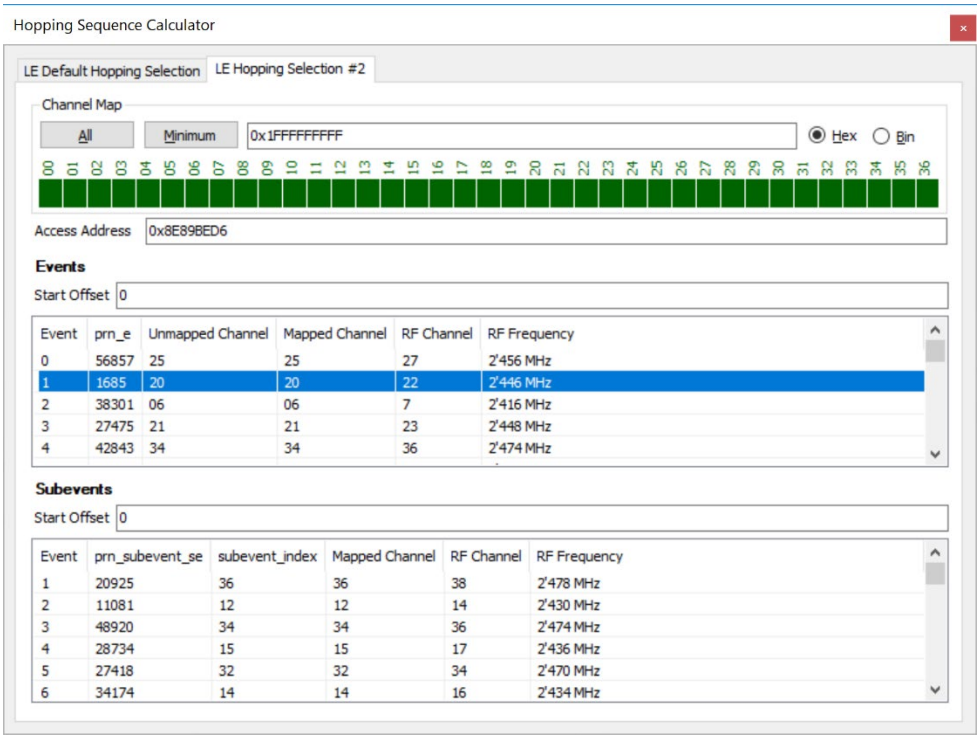


21.1 CSA#1

CSA#1 (**LE Default Hopping Selection** tab) adds a constant increment for each channel hop (called a Hop Increment). Selections are provided to enter the *Channel Map* manually (in hex or binary), by toggling the channels (00 through 36), or by selecting **All** or **Minimum** as desired. The *Hop Increment* slide bar is provided to set the desired increment.

21.2 CSA#2

CSA#2 (**LE Hopping Selection #2** tab), bases its hops on a pseudo-random number (PRN) generator, which is based on the access address. Selections are provided to enter the *Channel Map* manually (in hex or binary), by toggling the channels (00 through 36), or by selecting **All** or **Minimum** as desired. An entry is provided to enter the Access Address.



22. Software and Support

The software application is unified across all Ellisys platforms (Explorer, Tracker, and Vanguard). The user may request a link to the software application from Ellisys at https://www.ellisys.com/support/download.php.

The **Help** menu in the analyzer application provides convenient access to the latest updated software and technical support from an Internet-connected PC.

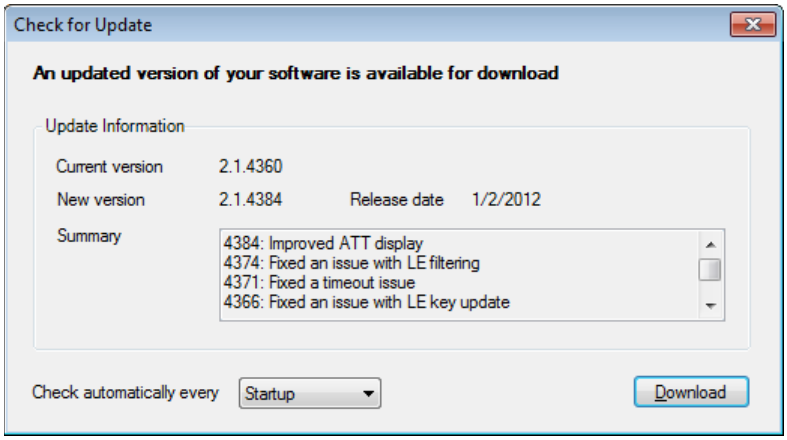
The installed version of the software is displayed in **Help | About and** is also displayed at the bottom-right of the GUI. When an updated version is available, this bottom-right display will include a red background to prompt the user to update.

22.1 Updating the Software

To check for the latest software:

1. Select **Help | Check for updates** from the menu or alternatively, double-click the version number at the bottom-right of the GUI.

The *Check for Update* window appears:



Follow the onscreen prompts to download and install the updated application software.

To be notified of new updates:

1. Select the desired notification interval under **Check automatically every** drop-down.

Upon opening the application, the user is notified when new update is available, and given an option to download the new update.

Some networks require the use of proxy servers or other special configurations. The Ellisys software will automatically use Windows Internet settings (which are configured in Internet Explorer). If Internet Explorer can access Internet, then most likely the update mechanism will work as well.

If your internal network will not allow access to the Ellisys software update site, or if you are otherwise unable to access this site, please contact Ellisys at support@ellisys.com or visit the website at https://www.ellisys.com/support/download.php to request that a link to the latest software application be sent to you.

23. Getting Technical Support

Ellisys technical support is available from the Ellisys website and E-mail, each accessible from the analyzer application. The user can access technical support from the Help menu, which will open the default browser to the Ellisys technical support web page. In the event of a software malfunction or crash, the user can easily and automatically compress pertinent application information to be E-mailed to the Ellisys support team.

Conveniently, you can also share trace files to Ellisys support by using the Share to Cloud feature, located in the File menu of the application. See *Section 5.5, Sharing a Capture File to the Cloud* for more information.

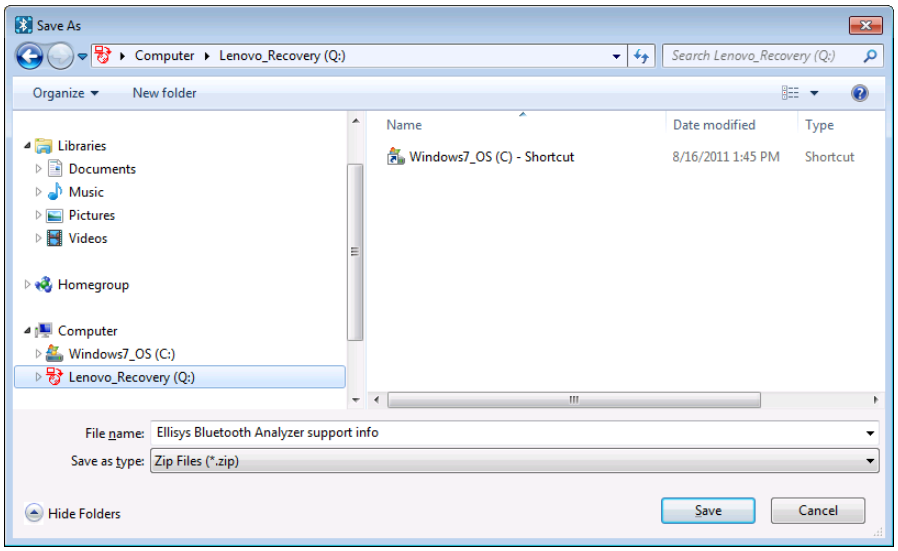
To access the technical support web page from the application:

1. Select **Help | Contact support** from the menu.

The default web browser opens to display the Ellisys technical support web page.

To send automated technical support information to Ellisys:

1. Select **Tools | Prepare support info** from the menu. The *Save-As* dialog appears:



2. Select a convenient destination directory and click **Save**.

3. E-Mail the saved file to Ellisys at support@ellisys.com.

24. Flying Leads Probe – Explorer

The Flying Leads Cable connects the IO Probe Connector receptacle (located on the back panel) to one or more external HCI, WCI-2, Audio I2S, generic communications (UART, SPI, SWD, and I2C), or logic signal implementations. This traffic will be captured concurrently with through-the-air traffic and will be displayed in the respective Overviews and other views as applicable (e.g., the *Instant Timing* View).

The user defines which pins will be used. This is done in **Recording Options | Wired**.

The IO Probe receptacle on the analyzer contains 26 pins (two rows of 13 pins), which mate with sockets on the mating connector of the Flying Leads Cable.

The Logic Probe is keyed for proper orientation to the Analyzer's IO Probe receptacle (sometimes referred to as the Logic Connection) on one end and has socketed connections on each wire on the other end.

The figures below illustrate the keyed female plug on the probe, the keyed receptacle on the analyzer, and the wire colors. N.C. = Not Connected.

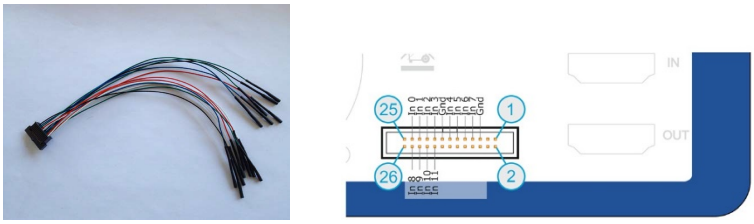


Figure 15 Flying Leads Probe and IO Probe Receptacle

			25	26		
Input 0			23	24		Input 8
Input 1			21	22		Input 9
Input 2			19	20		Input 10
Input 3			17	18		Input 11
GND			15	16		
Input 4			13	14		
Input 5			11	12		
Input 6			9	10		
Input 7			7	8		
GND			5	6		
			3	4		
			1	2		

Figure 16 Probe Pin and Color Assignments - Explorer

25. Flying Leads Probe – Tracker and Vanguard

The Flying Leads Cable connects the IO Probe Connector receptacle (located on the back panel) to one or more external HCI, WCI-2, Audio I2S, generic communications (UART, SPI, SWD, and I2C), or logic signal implementations. This traffic will be captured concurrently with through-the-air traffic and will be displayed in the respective Overviews and other views as applicable (e.g., the *Instant Timing* View).

The user defines which pins will be used. This is done in **Recording Options | Wired**.

The IO Probe receptacle on the analyzer contains 20 pins (two rows of 10 pins), which mate with sockets on the mating connector of the Flying Leads Cable.

The Logic Probe is keyed for proper orientation to the Analyzer's IO Probe receptacle (sometimes referred to as the Logic Connection) on one end and has socketed connections on each wire on the other end.

The figures below illustrate the keyed female plug on the probe, the keyed receptacle on the analyzer, and the wire colors. N.C. = Not Connected

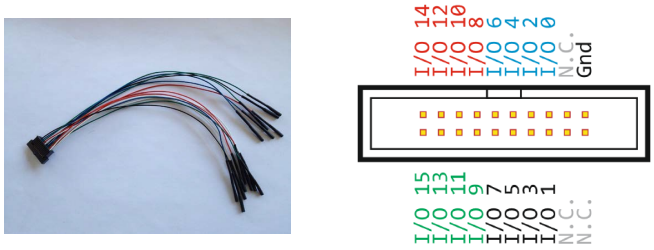


Figure 17 Flying Leads Probe and IO Probe Receptacle

I/O 14			19	20		I/O 15
I/O 12			17	18		I/O 13
I/O 10			15	16		I/O 11
I/O 8			13	14		I/O 9
I/O 6			11	12		I/O 7
I/O 4			9	10		I/O 5
I/O 2			7	8		I/O 3
I/O 0			5	6		I/O 1
			3	4		
GND			1	2		

Figure 18 Probe Pin and Color Assignments – Tracker and Vanguard

26. Remote API and CLI

26.1 Remote API

The Analyzer can be operated using a remote application programming interface (API), sometimes called an automation API which allows for automated control of the application, including precise extraction of captured traffic.

The link to download the Remote API is here: https://www.ellisys.com/better_analysis/bta_remote_api.zip.

The download includes an introductory guide for the API, the plug-in DLL, and sample code written in C# and Python, and pertinent "ReadMe" files. Compatibility is Visual Studio 2005 or higher. A CLI is included as well.

The Automation API can be used for many purposes, including:

- Controlling the capture start/stop, saving traces, and loading traces.
- Selecting the data source (controlling multiple analyzers accessible from the same control computer).
- Accessing the Overviews for parsing and detecting protocol conditions (either during live capture or with a previously captured trace).
- Adding markers at a specific time or on specific protocol items to flag conditions to be manually reviewed later.
- Injecting known link keys.
- Parsing logic signals captured by the analyzer, for example, to detect an electrical condition on an external signal to then be able to coordinate this event with concurrent HCI or air traffic.
- Parsing spectrum information, for example to determine if a retransmission is related to a particular "interference."

26.2 Command Line Interface

A Command Line Interface (CLI) is also available, which allows for a console approach to control the analyzer's functions, using Linux or Windows.

The CLI, called "btacli," is included in the *Binaries* folder of the Remote API download (linked above).

Using --help on any command will return the relevant arguments and options details. Please contact Ellisys if additional support is needed.

ReadMe text files are included with the download. These includes configuration and requirements information.

27. Frequently Asked Questions

Q. Why is the USB driver is not loading?

A. If the controlling PC does not detect the presence of the rear USB port on the analyzer (or if the driver otherwise fails to install), the user can manually install the USB driver by going to the operating system's Device Manager, typically located in the Windows Control Panel, selecting the attached Ellisys analyzer, and manually pointing via "Update Driver" to the Ellisys "Drivers" folder which installs with the Bluetooth Explorer application. This folder is typically located in your Program Files folder at [path]\Ellisys\Ellisys Bluetooth Analyzer\Drivers.

Q. How do I hide traffic?

A. A wide variety of filtering options are available. Please consult Chapter 8 Display Filters for more information about filtering or see Expert Note *EEN_BT08, Separating the Wheat from the Chaff*, located on the Welcome page of the application.

Q. Does the analyzer use the clock from the master device or otherwise participate actively in the Piconet?

A. The analyzer is purely passive. It does not require synchronization with any device under test and does not in any way participate actively in the Bluetooth environment.

Q. What do I need to do to update the software?

A. If your PC is connected to the Internet, go to the Help menu and select "Check for Updates." Otherwise, please contact support@ellisys.com or visit the Downloads section on the Ellisys website at www.ellisys.com to request the latest software.

Q. Is there a cost for upgrading the analyzer software?

A. There is never a cost for software updates. These are provided without cost for the life of the product.

Q. Does the position of the antenna influence the capture?

A. The position of the analyzer's antenna as well as the position of the device's antenna is important for getting optimal captures. Each antenna has a specific radiation pattern which needs to be known to avoid blind spots. Please consult the Ellisys *EEN_BT05 - Understanding Antenna's Radiation Pattern* Expert Note to get more information about antennas.

Q. Is there an optimal placement of devices that I am analyzing?

A. Please consult the Ellisys *EEN_BT04 - Optimal Placement of Your Analyzer* Expert Note to get more information about optimal placement.

Q. I captured traffic but do not see traffic being decrypted by the analyzer. What do I need to do to have traffic decrypted?

A. There are a few points to be considered to get the traffic decrypted. Please consult the Ellisys *EEN_BT03 - Your First Wide-band Capture* Expert Note to learn about conditions to get decryption.

Q. Are link keys stored so I don't have to re-capture a connection to see the traffic decrypted?

Yes, the software will provide the user the option to save link keys.

Q. Can I manually enter an IRK?

A. Yes, open the *Bluetooth Device Traffic Filter* (*Section 9.6*, *Bluetooth Device Traffic Filter*), select the device, and click on **Edit**.

Q. My capture file is showing blank windows with the text "This view is available as a software option."

A. In most cases, this is caused when the analyzer is detached from the Control PC before the capture is saved. License information is saved with the capture. Always leave the analyzer attached until the capture is saved. To fix this, attach your analyzer to your Control PC and re-save the capture file.

Q. What audio codecs and services are supported?

A. We support LC3, SBC, LDAC, MPEG4, AAC, aptX, G.722 NSpeex. Audio Streaming for Hearing Aid (ASHA) GATT is supported. Other codecs may be supported and added periodically as needs arise. Contact Ellisys for the latest details.

Q. Does the Radio Sensitivity slide bar in the Recording Options menu work for all radios?

A. On Vanguard, the sensitivity setting is for Bluetooth only. On Explorer and Tracker, it affects Wi-Fi in the 2.4G band, but not 5G.

Q. My file size is huge. How can I reduce it?

A. There are a few approaches. You can do a Save Filtered Copy (File Menu or Main Toolbar) to create a new trace file that includes only the devices subject to your device filter. You can also remove trace file components in the Save Filtered Copy dialog, like raw spectrum or one of the traffic streams (like HCI, BLE, BR/EDR, etc.). The Save Filtered Copy function does not replace the original file, it creates a new trace file. In the Export menu (File | Export) you can do an export that is based on a time range or the active overview. The raw spectrum capture (Recording Options | Wireless) is often the most aggressive user of memory. If this feature is not needed, it's best to leave it disabled. If the file is still too large, such as for e-mailing, use the Share to Cloud feature in the File menu to share the trace file.

Q. **My Wi-Fi capture is not decrypted.**

A. The software needs to see the Wi-Fi association in order to decrypt the encrypted traffic. The proper sequence would be to have the Wi-Fi client disconnected, start the capture, connect the Wi-Fi client, do the desired data exchange, then stop the capture. Be sure to enter the passkey as well (this is done using the Wi-Fi Security button, located on the toolbar of the Wi-Fi Overview).

Q. **Can I request a feature addition?**

A. Yes, please feel free to open a dialog with Ellisys on such requests. Contact us at support@ellisys.com.

28. Explorer Technical Characteristics

Bluetooth Capture Characteristics

- Ellisys Rainbow™: Industry's first wideband concurrent capture of all Bluetooth channels. Introduced in 2010.
- Frequency band: 2.402-2.480 GHz
- Sensitivity range: From -90 to +15 dBm
- Gain: Programmable from -30 to +15 dB
- Modulations: All BR/EDR/LE modulations (GFSK 1/2Mbps, p/4-DQPSK, 8-DPSK)
- Baseband: Support of Bluetooth 5, upgradeable by software. Preliminary support of non-released specifications available.

Wi-Fi Capture Characteristics

- 802.11 2x2 a/b/g/n (2 streams)
- Channel width 2.4GHz: 20MHz or 40MHz, configurable
- Channel width 5GHz: 20MHz or 40MHz
- 11n MCS 2.4GHz 20MHz channel: 0 to 15
- 11n MCS 2.4GHz 40MHz channel: 0 to 7
- 11n MCS 5GHz 20MHz channel: 0 to 7
- Guard Interval: 800ns and 400ns GI
- Frame encoding: BCC (LDPC not supported)
- Max AMPDU size: 16,384 bytes

Logic Capture Characteristics

- Maximum bandwidth: 20 MHz
- Sampling precision: 5 ns
- Supported input voltage: 1.8 to 7V

HCI Capture Characteristics

- USB HCI transport: Low, Full, and High Speed, with automatic detection
- UART HCI transport: Up to 8 Mbit/s, automatic detection of all parameters
- SPI HCI transport: Up to 8 Mbit/s, automatic detection of all parameters

Low-speed Serial Capture Characteristics

- UART: Up to 8 Mbit/s automatic detection of all parameters
- SPI: Up to 8 Mbit/s, automatic detection of all parameters
- I2C: Up to 1 Mb/s
- SWD: Up to 8 Mb/s

Timing

- Clock: ±10ppm frequency accuracy over -10 to +60 degrees Celsius range
- BR/EDR/LE timestamp accuracy: ±125ns
- Wi-Fi timestamp accuracy: ±1us
- USB HCI timestamp accuracy: ±16.7ns
- Logic timestamp accuracy: ±5ns

Embedded Memory

- 128 MB of FIFO memory
- Data is stored in highly optimized format
- Analyzed data is uploaded in real time through a USB 2.0 connection

Front-Panel Connectors

- Capture: Standard SMA female
- HCI: USB 2.0 Standard-A and Micro-B

Front-Panel Indicators

- Power: unit powered on
- Operating: unit performing requested task
- Trigger: trigger event detected (not implemented)
- Capture: BR/EDR and/or LE packet captured
- HCI: HCI packet captured

Rear-Panel Connectors

- Computer: USB 2.0 Standard-B
- Power: 12-24 VDC, max 18 W
- Trigger: SMA in and out, 50 Ω, max 5VDC (Not Implemented)
- IO Probe: supports UART / SPI HCI, WCI-2 and logic analysis
- Inter-equipment: in and out, supports connection of several units

Enclosure

- 174 x 111 x 58 mm (6.9 x 4.4 x 2.3'')
- 1.0 kg (2.0 lbs.)

Hardware Upgrade

- The Ellisys Rainbow™ engine is automatically updated with each software release (no user intervention required)

Maintenance and Licensing

- Free lifetime software updates – no maintenance fees
- Free full-featured viewer software – easily share annotated traces between computers and colleagues and replay captured traffic
- Use Ellisys hardware on any computer – no additional licenses needed

Warranty

- Two-year limited warranty [STD and PRO]
- Three-year limited warranty [ENT]

29. Tracker Technical Characteristics

Bluetooth Capture Characteristics

- Ellisys Rainbow™: Wideband capture of all BLE channels
- Frequency band: 2.402-2.480 GHz
- Sensitivity range: From -90 to +15 dBm
- Gain: Programmable from -30 to +15 dB
- Modulations: All BLE modulations (GFSK 1 Mbps and 2 Mbps)
- Baseband: Support of Bluetooth 5.0, upgradeable by software. Preliminary support of non-released specifications available.

Wi-Fi Capture Characteristics

- 802.11 1x1 a/b/g/n (1 stream)
- Channel width 2.4 GHz: 20 MHz
- Channel width 5 GHz: 20 MHz
- 11n MCS 2.4 GHz 20 MHz channel: 0 to 7
- 11n MCS 5 GHz 20 MHz channel: 0 to 7
- Frame encoding: BCC (LDPC not supported)
- Max AMPDU size: 16,384 bytes

Logic Capture Characteristics

- Maximum bandwidth: 50 MHz
- Sampling precision: 5 ns
- Supported input voltage: 1.8 to 3.3V

HCI Capture Characteristics

- UART transport: Up to 8 Mbit/s, automatic detection of all parameters
- SPI transport: Up to 8 Mbit/s, automatic detection of all parameters

Enclosure

- 75 x 75 x 17 mm (2.9 x 2.9 x 0.7'')
- 100 g (0.2 lbs.)

Embedded Memory

- 128 MB of FIFO memory
- Data is stored in highly optimized format
- Analyzed data is uploaded in real time through a USB 2.0 connection

Timing

- Clock: ±10 ppm frequency accuracy over -10 to +60 degrees Celsius range
- BLE timestamp accuracy: ±125 ns
- Wi-Fi timestamp accuracy: ±1 us
- Logic timestamp accuracy: ±5 ns

Connectors

- SMA: RF input for BLE, Wi-Fi and spectrum capture
- Logic: 16 logic signals capture
- Sync: Multi-unit synchronization ports
- Control: USB 2.0 connection to control PC
- Power: Optional 5V power input, max 3W

Hardware Upgrade

- The Ellisys Rainbow™ engine is automatically updated with each software release (no user intervention required)

Maintenance and Licensing

- Free lifetime software updates – no maintenance fees
- Free full-featured viewer software – easily share annotated traces between computers and colleagues and replay captured traffic
- Use Ellisys hardware on any computer – no additional licenses needed

Warranty

- Two years limited hardware warranty for Professional and Enterprise editions
- One-year limited hardware warranty for Basic and Standard editions

30. Vanguard Technical Characteristics

Bluetooth Capture Characteristics

- Ellisys Rainbow™: Industry's first wideband concurrent capture of all Bluetooth channels. Introduced in 2010.
- Frequency band: 2.402-2.480 GHz
- Sensitivity range: From -90 to +15 dBm
- Gain: Programmable from -30 to +30 dB
- Modulations: All BR/EDR/LE modulations (GFSK 1/2Mbps, p/4-DQPSK, 8-DPSK)
- Baseband: Support of Bluetooth 5, upgradeable by software. Preliminary support of non-released specifications available.

Wi-Fi Capture Characteristics

- IEEE 802.11 a/b/g/n/ac (3 streams)
- Channel width 2.4GHz: 20MHz, 40MHz
- Channel width 5GHz: 20MHz, 40MHz, 80MHz
- 11n MCS: 0 to 23 (up to 3 streams)
- 11ac MCS: 0 to 9 (up to 3 streams)
- Guard Interval: 800ns (long) and 400ns (short)
- Frame encoding: BCC, LDPC, STBC, Greenfield
- Max AMPDU size: 65,535 bytes
- Timing accuracy: 125 ns

WPAN Capture Characteristics

- IEEE 802.15.4-2011
- Channels: All 16 2.4 GHz channels (11 to 26)
- Data rate: 250 kbps
- Modulation: O-QPSK
- Timing accuracy: 125 ns

Logic Capture Characteristics

- Maximum bandwidth: 20 MHz
- Sampling precision: 5 ns
- Supported input voltage: 1.8 to 3.3V

HCI Capture Characteristics

- USB transport: Low, Full, and High Speed, with automatic detection
- UART transport: Up to 8 Mbit/s, automatic detection of all parameters
- SPI transport: Up to 8 Mbit/s, automatic detection of all parameters

Low-speed Serial Capture Characteristics

- UART: Up to 8 Mbit/s automatic detection of all parameters
- SPI: Up to 8 Mbit/s, automatic detection of all parameters
- I2C: Up to 1 Mb/s
- SWD: Up to 8 Mb/s

Timing

- Clock: ±10ppm frequency accuracy over -10 to +60 degrees Celsius range
- BR/EDR/LE timestamp accuracy: ±125ns
- Wi-Fi timestamp accuracy: ±125ns
- WPAN timestamp accuracy: ±125ns
- USB HCI timestamp accuracy: ±16.7ns
- Logic timestamp accuracy: ±5ns

Embedded Memory

- 512 MB of FIFO memory
- Data is stored in highly optimized format
- Analyzed data is uploaded in real time

Front-Panel Indicators

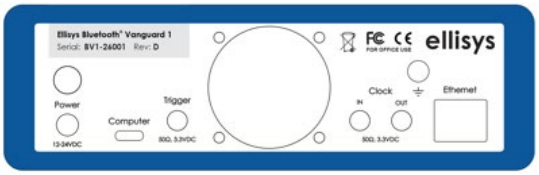
- Power: unit powered on
- Operating: unit performing requested task
- Activity: blinks when wireless or wired activity detected

Front-Panel Connectors

- RF (x3): Shared between Bluetooth, Wi-Fi and WPAN
- USB HCI: USB 2.0 Standard-A and Standard-B
- Logic: supports UART / SPI HCI, WCI-2, generic I2C / UART / SPI / SWD and logic analysis
- SDIO: Optional, for external trace storage and unit recovery

Rear-Panel Connectors

- Computer: USB 3.1 Gen 1 Type-C
- Ethernet: 1GbE, PoE+
- Power: 12-24 VDC
- Trigger: SMA in and out, 50 Ω, 3.3 VDC (not implemented)
- Clock IN: SMA, 50 Ω, 3.3VDC, 10 MHz
- Clock OUT: SMA, 50 Ω, 3.3VDC, 10 MHz
- Earth: Optional, to ground the unit



Power Inputs

- DC input (12-24 V)
- USB Type-C Power Delivery
- Power-over-Ethernet (PoE+)
- Internal Battery

Power Adapter

- Input: 100-240 VAC
- Output: 24 VDC
- Power: 40 W
- Plug: 5.5 x 2.1 x 12 mm barrel straight
- Safety: CB, TUV, UL, CCC, PSE
- EMI: CE, FCC, VCCI, RCM

Battery

- Type: Lithium Ion
- Assembly: Internal, not user accessible
- Operating time: 1.5 to 2.5 hours
- Cell: < 20 Wh
- Battery: 60 Wh

Enclosure

- 174 x 111 x 58 mm (6.9 x 4.4 x 2.3'')
- 1.5 kg (3.3 lbs.)

Hardware Upgrade

- The Ellisys Rainbow™ engine is automatically updated with each software release (no user intervention required)

Maintenance and Licensing

- Free lifetime software updates – no maintenance fees
- Free full-featured viewer software – easily share annotated traces between

computers and colleagues and replay captured traffic
- Use Ellisys hardware on any computer – no additional licenses needed

Warranty

- Two-year limited warranty [STD and PRO]
- Three-year limited warranty [ENT]

31. GATT Customizations

Source of Analyzer's GATT Definitions

The analyzer software uses the Generic Attribute (GATT) definitions that are developed and provided by the Bluetooth Special Interest Group (SIG). These are provided in XML format.

GATT Defined

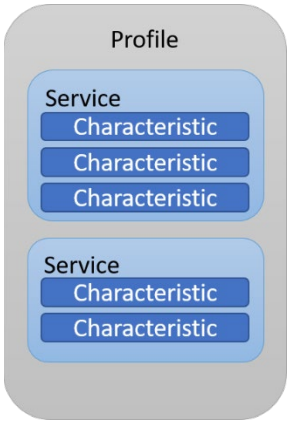
GATT is designed to operate upon Attribute Protocol (ATT). GATT defines a hierarchical data structure that provides a standardized method for discovery of device services and characteristics, which are used the manage the transfer of data between devices. GATT information is only exchanged after Bluetooth LE devices are connected.

Profiles, Services, and Characteristics

A Profile is a collection of one or more Services, defined by the SIG (standardized) or the device designer (custom). In the client-server model used by BLE, this information is resident on the GATT Server (peripheral) and is requested by the GATT Client (central).

Services define data by logical groups and are distinguished by a UUID, which can be 16 bits in length for SIG approved services, or 128 bits in length for custom services.

A Characteristic is the most basic element of a GATT transaction. A Characteristic defines a single data point or an array of related data. Characteristics also use either a 16-bit UUID or a 128-bite UUID as is done for Services.



Using Modified GATT XML

It is possible to customize GATT XML definitions to allow the Ellisys analyzer application to decode vendor-specific profiles or override existing profiles. Customized GATT XML files must be placed in the path below:

%USERPROFILE%\Documents\Ellisys Bluetooth Gatt\

Bluetooth SIG Resources

GATT specifications are located here:

https://www.bluetooth.com/specifications/gatt

To learn more about GATT specifications:

https://www.bluetooth.com/specifications/gatt/generic-attributes-overview