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Better Analysis.

Bluetooth® Explorer™ 400
All-in-One Protocol Analysis System

User Manual

PROTOCOL TEST SOLUTIONS

UWB Frame

USB Wireless USB

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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.

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Warranty Period

The warranty begins on the date of purchase and covers a period of two (2) years.

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.

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1.   Analyzer Overview

1.1   Introduction

The Ellisys Bluetooth Explorer 400, employing the revolutionary Ellisys Rainbow™ All-Channel Capture Technology, is a full-spectrum protocol analysis system which provides for concurrent and synchronous capture and analysis of Classic Bluetooth technology (BR/EDR) and Bluetooth low energy (LE) technology (Bluetooth Smart), as well as Host Controller Interface (HCI) traffic, logic signals, wireless spectrum information, Audio I2S (Inter-IC Sound), and Wireless Coexistence Interface traffic (WCI-2).

The analyzer non-intrusively records all neighboring Bluetooth traffic, RF energy within the Bluetooth spectrum, and any attached HCI, WCI-2, Audio I2S, or logic signals and presents this captured traffic to the user in easy-to-understand and comprehensive formats, using the associated BEX400 software application.

Captured traffic is presented real-time to the user, and includes various advanced analytical presentations, including detailed packet, profile, and protocol information, protocol error detection, topology analysis, security features, throughput characterizations, audio analysis, timing characterizations, transmission errors, spectrum energy characteristics, and other related information.

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.

Figure 1-1 Bluetooth Explorer 400 (BEX400) All-in-One Protocol Analysis System

1.2 Main Features and Capabilities

The analyzer includes the following main features capture features. All capture features shown below can be captured concurrently. Certain features may be optional, or provided only with certain configurations. The Help menu (About) in the application will provide a list of features enabled when the unit is attached to the controlling PC.

Wireless Capture:

- Bluetooth Basic Rate/Enhanced Data Rate (BR/EDR)
- Bluetooth Low Energy (LE)/Bluetooth Smart Technology
- Raw Spectrum information in the 2.4 GHz ISM band

Wired Capture:

- Universal Serial Bus (USB 2.0) HCI
- Serial Peripheral Interface (SPI) HCI
- Universal Asynchronous Receiver/Transmitter (UART) HCI
- Wireless Coexistence Interface 2 (WCI-2)
- Logic Signals
- Audio I2S (Inter-IC Sound)

The analyzer includes the following major capabilities:

- *Instant Piconet*™ - visualization of the evolution of piconets and scatternets
- *Instant Timing*™ - visualization of packets with 1/8th symbol accuracy
- *Instant Spectrum*™ - visualization of raw spectrum information
- *Instant Audio*™ - integrated audio analysis
- *Instant Channels*™ - per-channel characterization of retransmissions and errors
- *Instant Throughput*™ - performance characterization
- HCI Injection API – software-based capture of UDP-injected HCI
- Export of captured data to various formats, including Message Sequence Chart (MSC)
- Detailed decodes on Bluetooth protocols and profiles
- Automatic PIN code deciphering and associated link key calculation
- Support for Secure Simple Pairing (SSP)
- Automatic support for SSP Debug Mode
- Automated link key extraction from HCI Captures
- Protocol error detection

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2. Installing the Application

2.1 Software Prerequisites

Before installing the Bluetooth Explorer 400 analyzer software application, please ensure the computer system on which it will reside meets the following minimum requirements.

- Microsoft Windows XP SP1 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 2.0 or later.

- Intel Core, 1.5 GHz or compatible processor, or better.

- 512 MB RAM or more.

- 1280 x 1024 screen display resolution with 65,536 colors, or better.

- USB 2.0 EHCI Host Controller.

The Bluetooth Explorer 400 analyzer requires several software components. Ellisys recommends that you visit the following web pages as needed, to update your versions of Microsoft .NET Framework and Windows:

- www.microsoft.com/net to download the Microsoft .NET Framework version 2.0.

- www.update.microsoft.com to update your version of Windows. When using the Windows update service it will automatically download and install the Microsoft .NET Framework version 2.0.

See your system administrator for more information about updating Microsoft .NET Framework and Windows.

2.2 Software Installation

1. Insert the CD-ROM that accompanies the product into the computer's CD-ROM drive, or alternatively, download and run the setup application from a link provided by Ellisys.
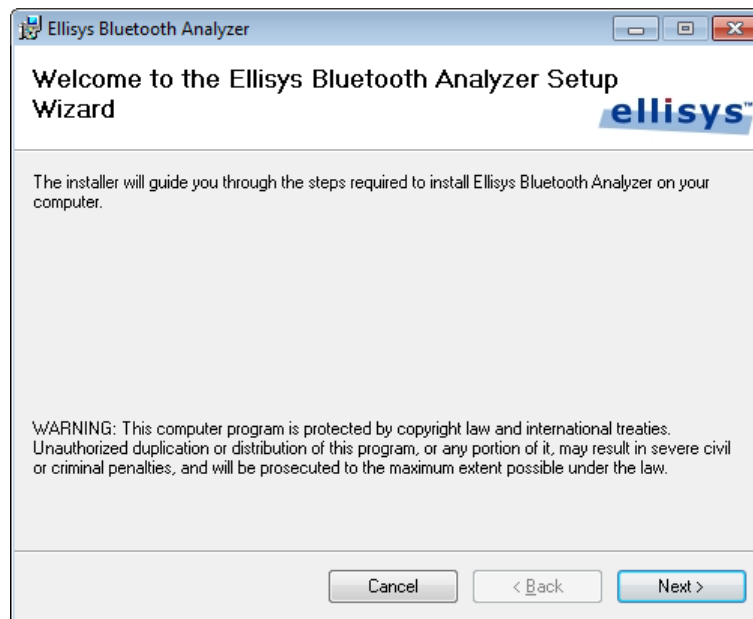
    To request the application software from Ellisys, please visit the Downloads section on the Ellisys website at www.ellisys.com or contact support@ellisys.com.

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

The Ellisys Bluetooth Analyzer *Setup Wizard* screen appears:

> If the Ellisys Bluetooth Explorer Analyzer Setup Wizard does not appear automatically, click the START button on your Windows toolbar, then RUN, and type *d:\setup.exe* (change *d:* to match the drive letter designation of your CD-ROM drive as needed), then click OK.

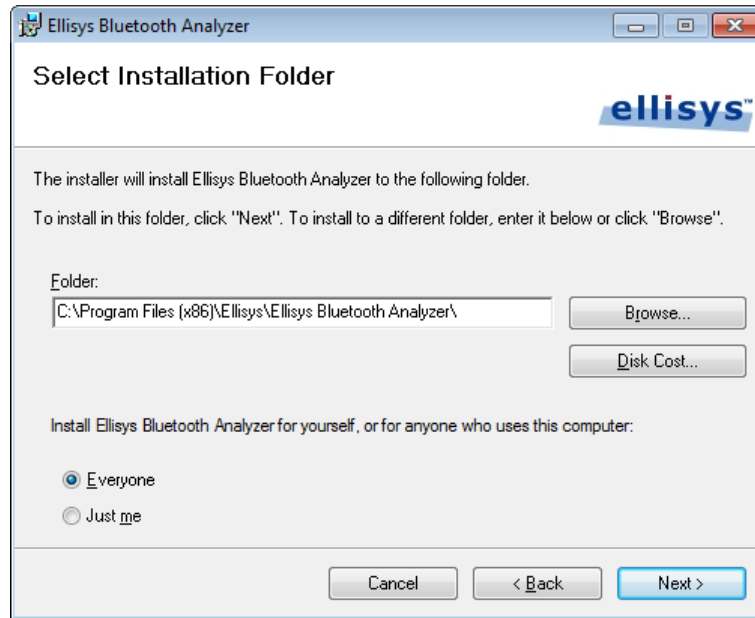2. Read the WARNING note and click on **Next**.

The Ellisys Bluetooth Analyzer *License Agreement* screen appears:

3. Read the License Agreement carefully, and then select **I Agree**.

4. Click on **Next**.

The *Select Installation Folder* screen appears:

5. The default installation folder appears in the *Folder* field. Ellisys recommends that you use the default folder, however if you wish to change this folder, click on **Browse** and navigate to the folder required.

6. Select whether anyone or only the user currently logged on can access the software by selecting either **Everyone** or **Just me**. Click on **Next**.

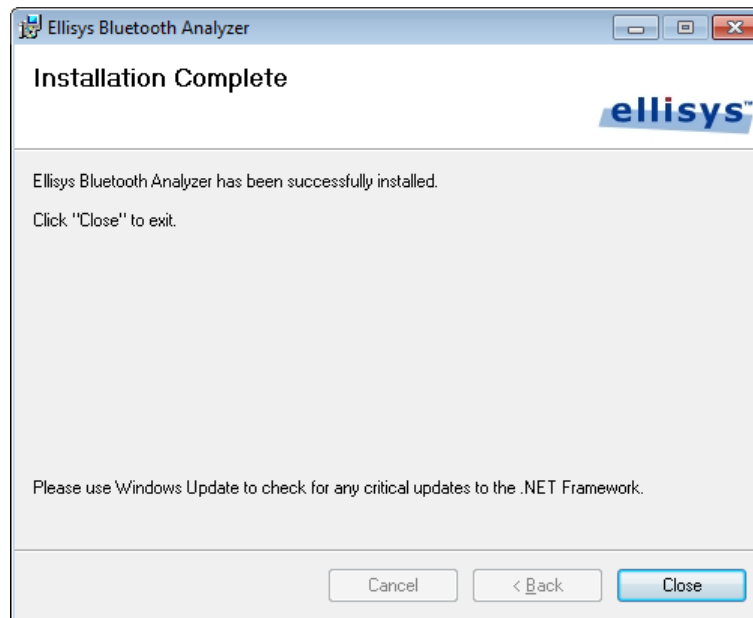The *Confirm Installation* screen appears:

Analyzer User Guide
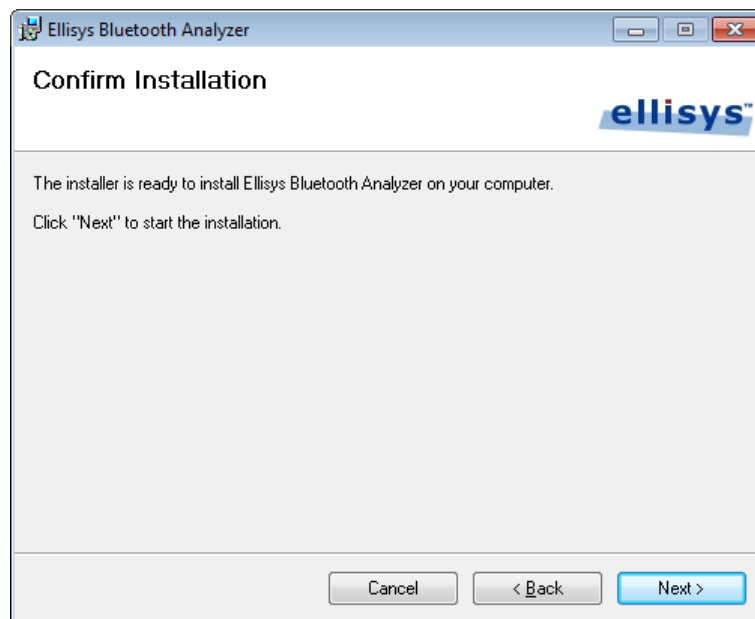
7. Click on **Next** to continue the installation.

An Installation Progress screen appears:
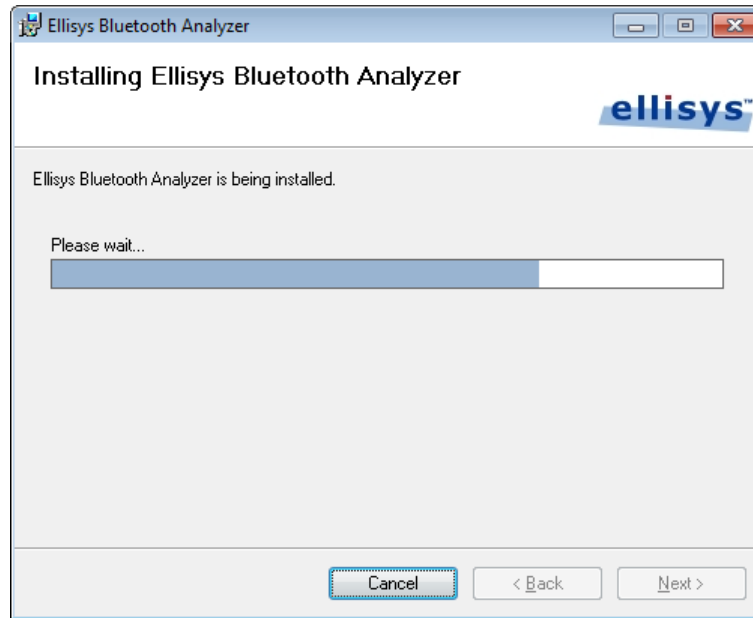
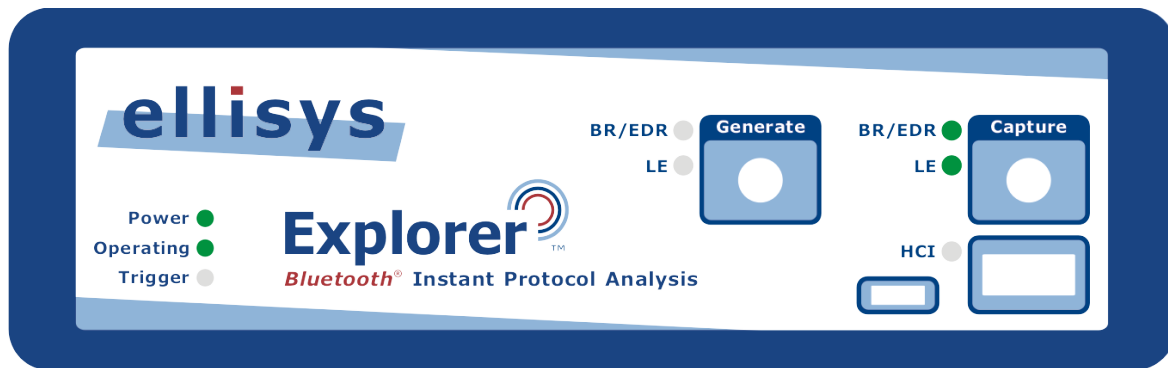When the software has been installed, the *Installation Complete* screen appears:

8. Click on **Close**.

The Bluetooth Explorer 400 Analyzer software is now installed.

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2.3   Front Panel Overview

The front panel of the Bluetooth Explorer 400 Analyzer is shown below:

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

Capture Connector

The (Standard SMA) Capture connector is used to connect the antenna (supplied) for capture of BR/EDR and LE traffic.

Generate Connector

The (Standard SMA) Generate connector is for future implementations (not currently used).

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 12VDC/2A power adapter <u>and</u> connected to the control computer (with USB driver installed).

🟢 **Constant green:** DC-powered and USB-connected, ready to operate.

🟢 **Flashing green:** DC-powered but not USB-connected.

🔴 **Flashing red:** USB-connected but not DC-powered.

⚪ **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 trigger.

- **Red:** Memory full, downloading; or trigger occurred, downloading.

Trigger LED

The Trigger LED indicates whether a trigger event has occurred.

- **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 Smart (LE) traffic, irrespective of whether a recording is underway.

- **Off:** No Bluetooth Smart (LE) traffic detected.

- **Flashing green:** Bluetooth Smart (LE) traffic detected.

Generate BR/EDR LED

Reserved for future implementation.

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Generate LE LED

Reserved for future implementation.

2.4   Back Panel Overview

The back panel of the Bluetooth Explorer 400 Analyzer is shown below:

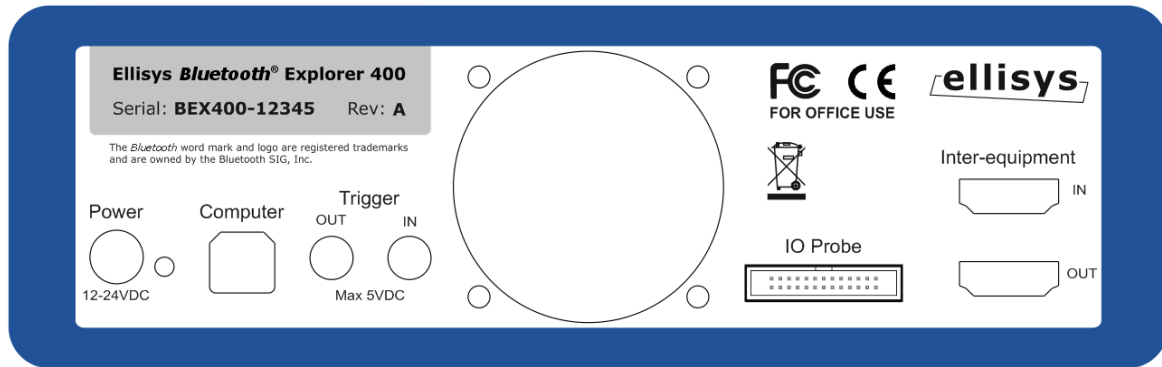> ⚠ When connecting the USB cable <u>DO NOT</u> force the connector into the unit. The metal part of the connector should not be inserted completely into the connection port. Forcing the connector or inserting all of the metal part of the connector will break the port connection and is not covered by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

Computer

Type B USB 2.0 receptacle. Attaches to the control computer.

Trigger OUT

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

Trigger IN

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

IO Probe

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

Inter-equipment IN and OUT

Reserved for future extensions.

2.5   Connecting to the Control Computer

The Bluetooth Explorer 400 Analyzer is controlled over a high-speed USB 2.0 connection by a PC hosting the Analyzer application, enabling the use of any notebook or desktop computer.

The USB driver must be installed before the analyzer can be used.

Driver installation procedures may vary depending on the user's Operating System. Therefore, no specific driver installation procedures are described herein. 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 installed with the application software, and is located as described in the note below.

> 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.

> Although the unit can upload or download data on a full speed USB 1.1 connection, Ellisys strongly recommends that you connect it to a high speed USB 2.0 port or a SuperSpeed USB 3.0 port (which will default to USB 2.0 high speed) to obtain optimal performance. If you experience connection problems with the Bluetooth Explorer 400, please ensure it is connected on a high speed USB 2.0 or USB 3.0 host controller before contacting technical support.

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3. User Interface Reference

The user interface of the Bluetooth Explorer 400 Analyzer application provides various windows, panes, menus, toolbars, and other visual 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.
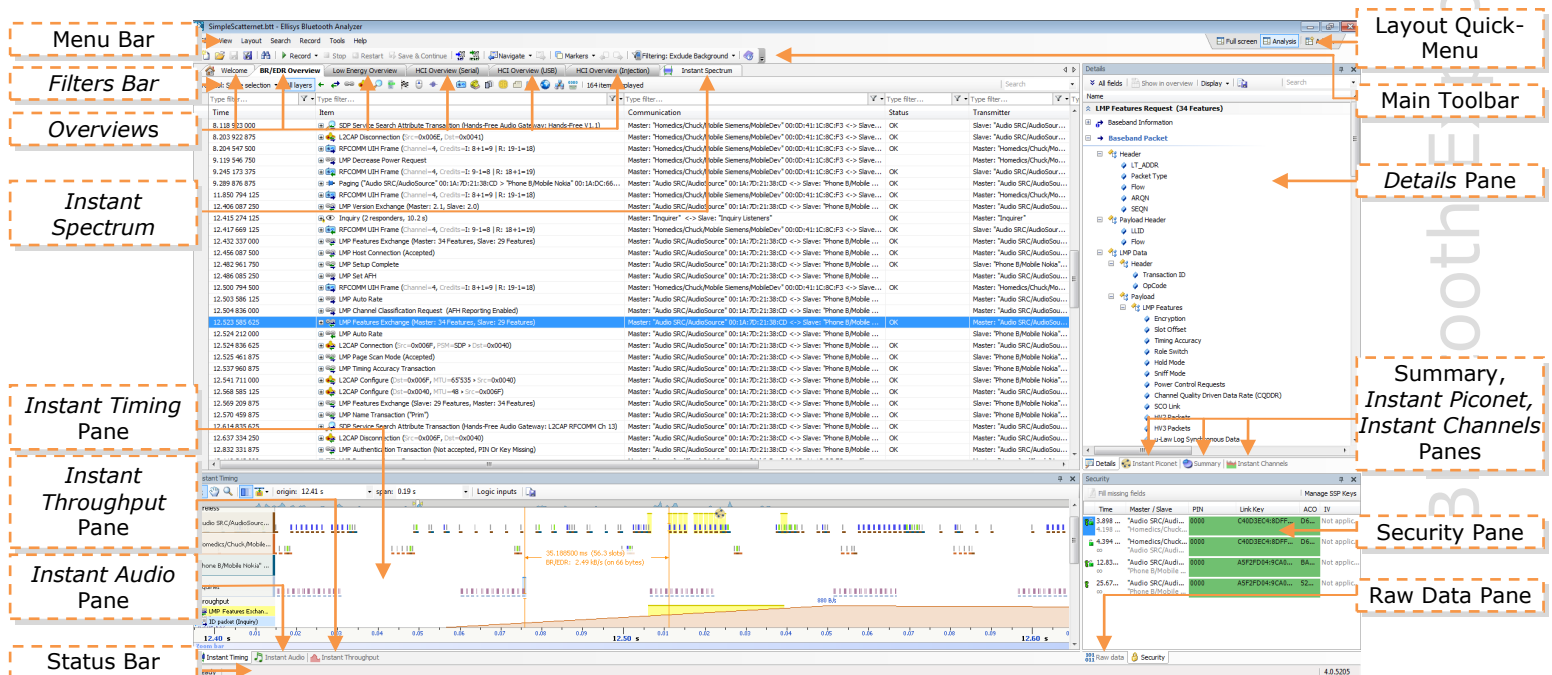
The Analyzer application displays several windows and panes in the default layout. Each pane displays specific information or allows the user to interact with the software for a given task:

- **Overviews (BR/EDR, Low Energy, HCI, WCI-2)** – Displays chronological records of BR/EDR, LE, USB / UART / SPI HCI, and WCI-2 traffic and events.

- **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 highlighted here.

- **Instant Timing Pane** – Displays a graphical representation of through-the-air, HCI, and logic signals captured, and allows for various timing analyses and measurements.

- **Instant Spectrum** – Displays spectral RF energy characteristics concurrent with Bluetooth packets.

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

- **Instant Throughput Pane** – Displays various data throughput characteristics.

- **Summary Pane** – Displays a statistical summary of traffic captured.

- **Security Pane** – Displays security information and allows for user input of Link Keys.

- **Message Log** – Displays *printf* user inputs associated with the *HCI Injection API*.

3.1 Organizing Panes

The various panes provided can be shown or hidden, moved, docked, and resized to suit the user's preferences. See 5.2, 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.
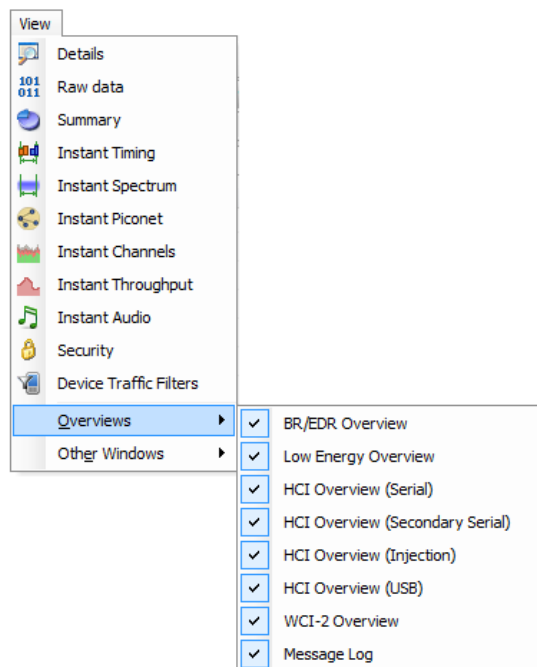
The selected pane opens.

To close a pane:

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

The pane closes.

To hide a pane:

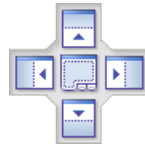1. Click on **Auto-Hide** 📌 positioned at the top-right corner of the title bar.

The pane is hidden and the pane's name now appears 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.

3.2 Main Toolbar

The table below shows the Bluetooth Explorer 400 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	Saves a filtered capture file (by selected devices).
	Search	Opens the Search dialog.
	Start Recording	Starts a recording on the selected analyzer.
	Stop Recording	Stops the current recording.
	Restart	Aborts current recording and restarts a new one.
	Set Time Reference	Sets the line selected in an Overview at 0.000 000 000
	Reset Time Reference	Resets the time reference to its original value.
	Navigate Backward	Navigate to the previous selection history.
	Navigate Forward	Navigate to the next selection history.
	Markers	Opens the Markers menu.
	Find Previous Marker	Jumps to previous marker.
	Find Next Marker	Jumps to next marker.
	Filtering	Opens the Device Traffic Filters menu.
	Save & Continue	Saves the current capture and starts the next.
	User Manual	Opens the User Manual.

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3.3   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	Allows user to 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.
	Summary	Opens the *Summary* 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.
	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.*
Message Log	Opens the *Message Log*.

View | Other Windows

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

Layout

	Analysis	Changes the layout to the Analysis layout.
	Full Screen	Changes the layout to the Full Screen layout.
	Rename Layout	Renames the existing layout.
	Reset Layout	Resets the existing layout to default.
	Delete Layout	Deletes the user-defined layout.
	New Layout	Creates a new layout based on the current layout.

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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	During segmentation, 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 Ellisys *Web Capture Control* interface in the default browser
	Set Time Reference (Ctrl+T)	Sets the time of the line selected in the current Overview at 0.000 000 000.
	Reset Time Reference (Ctrl+Shift+T)	Resets the time reference to its original value.
	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.
	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.

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4. Managing Capture Files

4.1 Opening a Capture File

To open a capture file:

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

The *Open* menu appears:
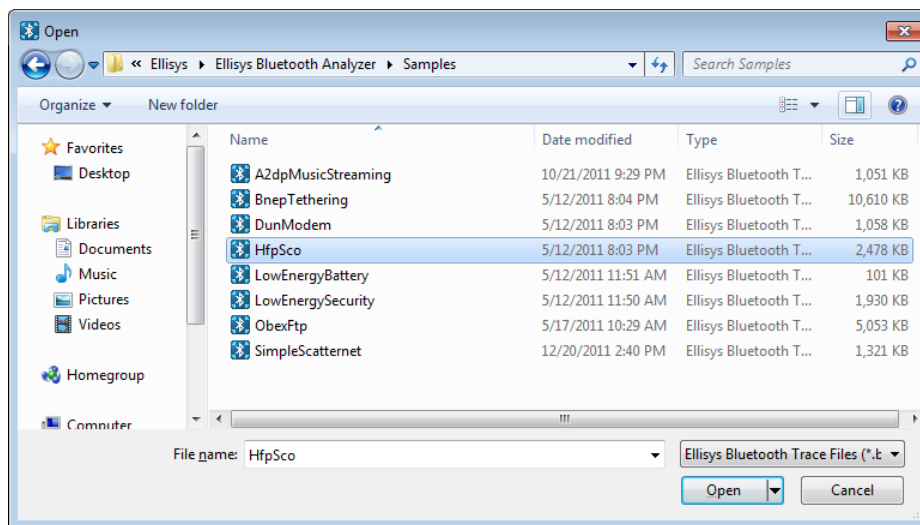
1. Select the file required and click **Open**.

The selected file opens in the software.

4.2 Saving a Capture File

To save a capture file:

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

The file is saved.

To save a capture file with a new name:

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

The *Save As* menu appears:
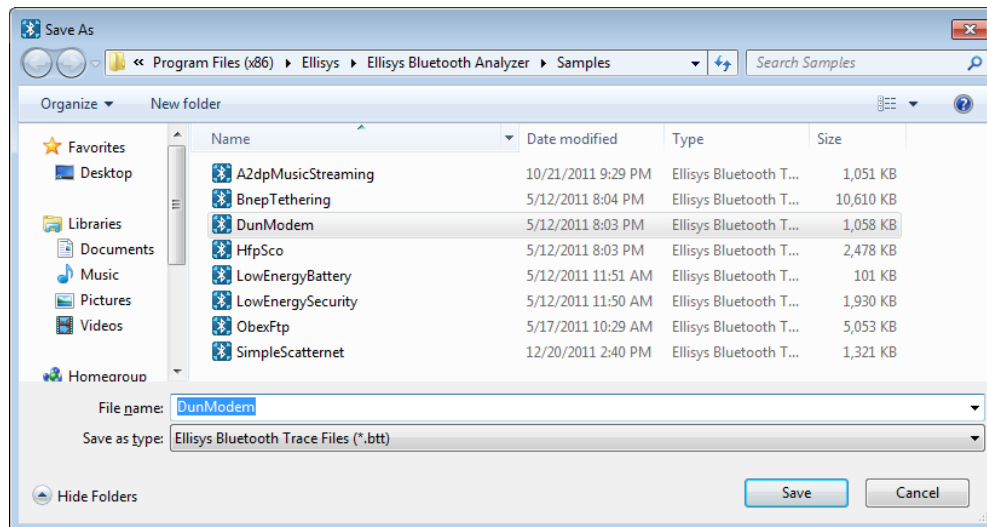
1. Navigate to the directory where the file is to be saved.

2. Enter the desired name of the file in the **File name** field and click on **Save**.

The file is saved with the modified name and the original file is not modified.

4.3 Saving a Filtered Copy of a Capture File

The analyzer captures traffic from all neighboring devices. The application provides a Device Traffic Filter to allow the user to display only the device(s) of interest (see Section 8.4 Device Traffic Filter). Once this filter is configured, the user can save a filtered version of the capture containing just the traffic involving the selected devices.

> The Save Filtered Copy feature is based only on the Device Traffic Filter. To create traces based on other filtering approaches requires the use of the Export feature. See Section 4.9 Export Options for details.

To save a filtered version of a capture file based on the Device Traffic Filter:

1. Configure the Device Traffic Filter as desired.

2. Select **File | Save Filtered Copy** in the menu.

The *Save As* window appears:
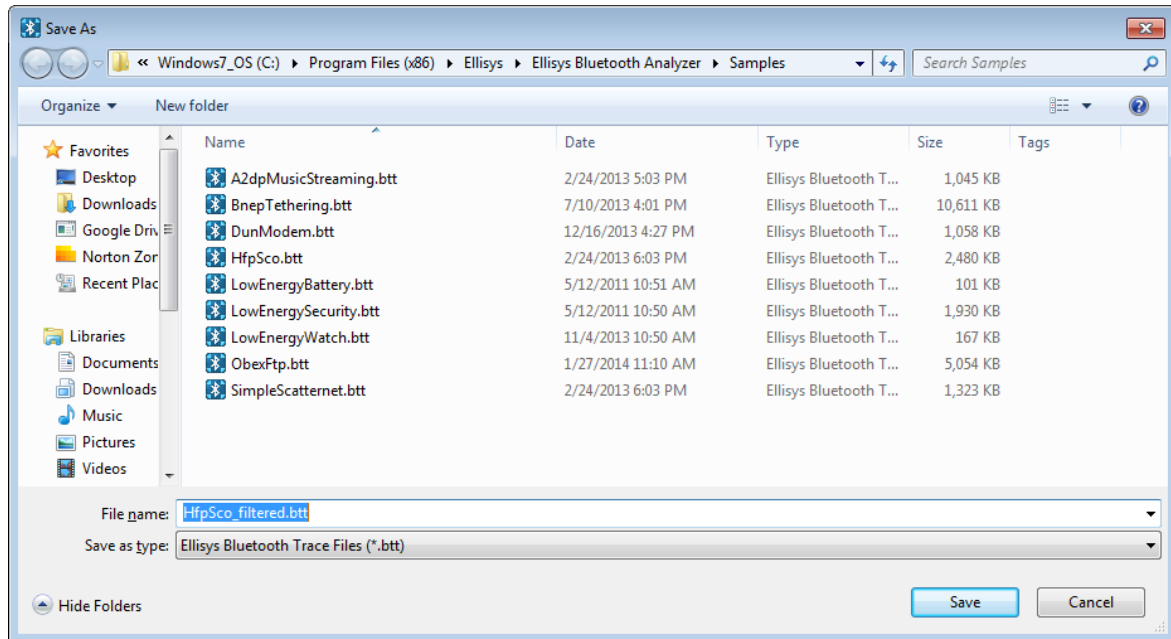
3. Enter a file name.

   ✅ When selecting **Save Filtered Copy**, the *File Name* box in the *Save As* dialog is appended with *_Filtered* in order to avoid potentially overwriting the original file.

4. Click Save.

4.4   Opening a Sample Capture File

Several sample capture files are included with the application.

To open a sample file:

1. Select **File | Load Sample** in the menu.

2. Click on the desired sample.

4.5   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.

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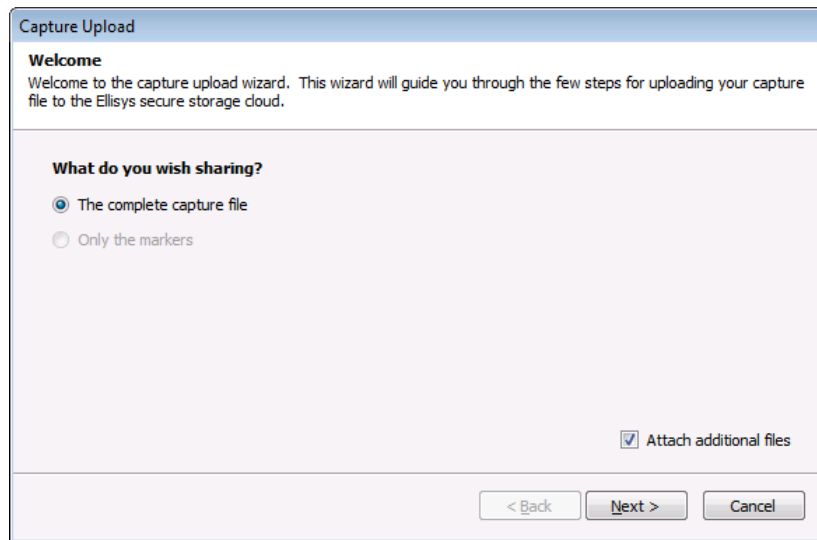
3. Select the **Attach additional files** checkbox if files in addition to the capture files are to be uploaded to the Cloud, then click **Next**.

The *Capture Upload* dialog shows **Upload in progress**:
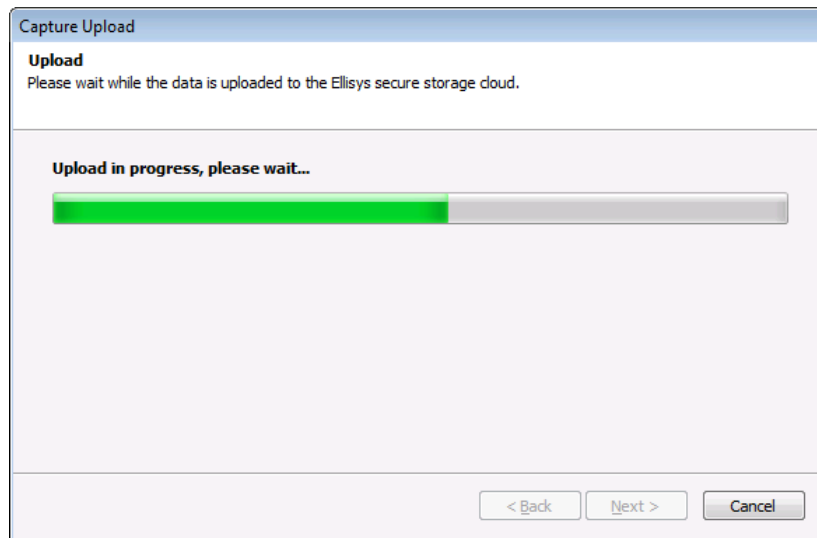
When the upload is complete, the *Capture Upload* dialog shows **Upload Completed**:
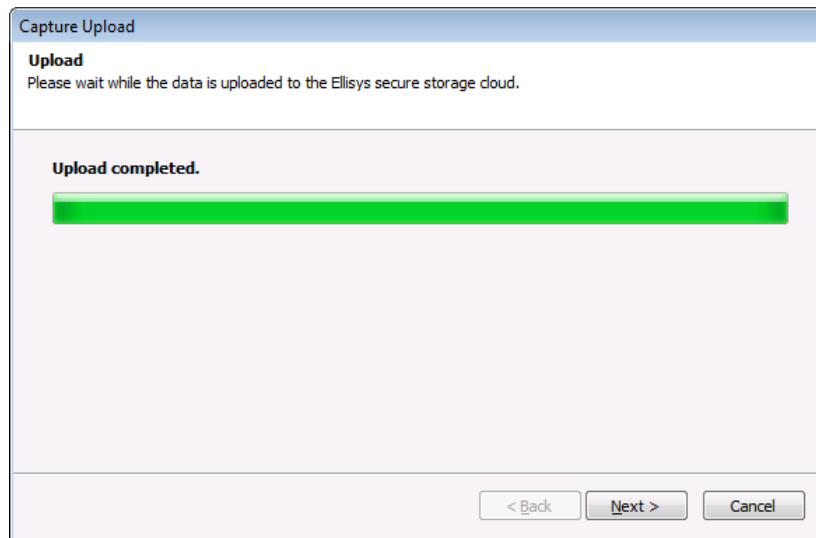
4. Click **Next**.

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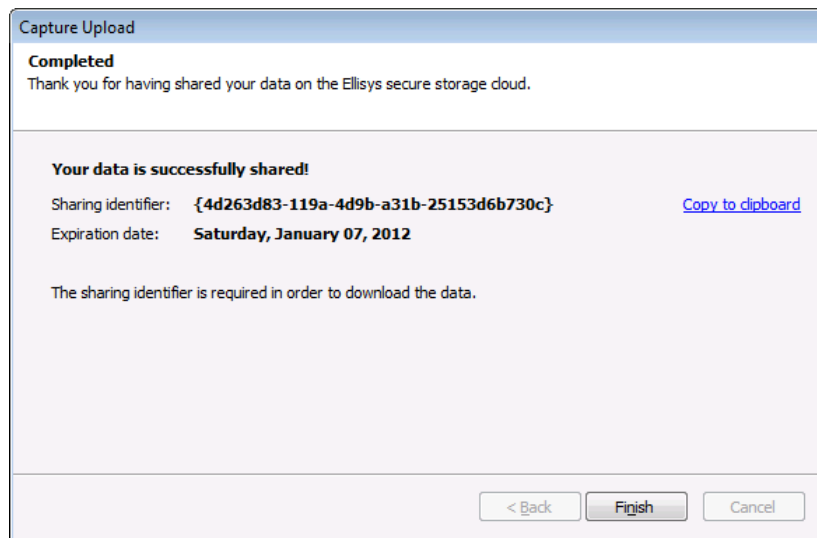
8. If desired, click on **Copy to clipboard** to copy the *Sharing Identifier* to your system's clipboard. This identifier is needed to retrieve the shared file(s).

9. Click **Finish**.
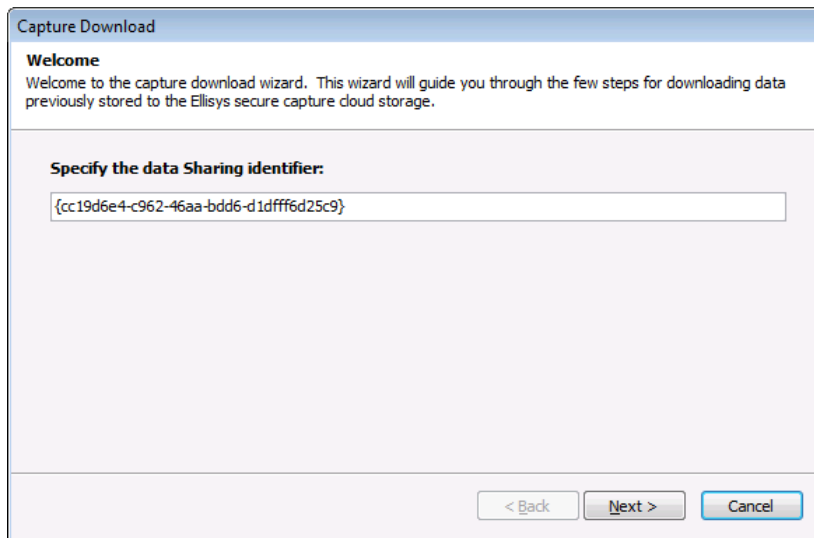
4.6   Retrieving a Shared Capture File from the Cloud

Once a capture file is uploaded to the Cloud, it is accessible to anyone having the sharing identifier (produced during the upload) and the Bluetooth Explorer 400 application.

To retrieve a shared file:

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

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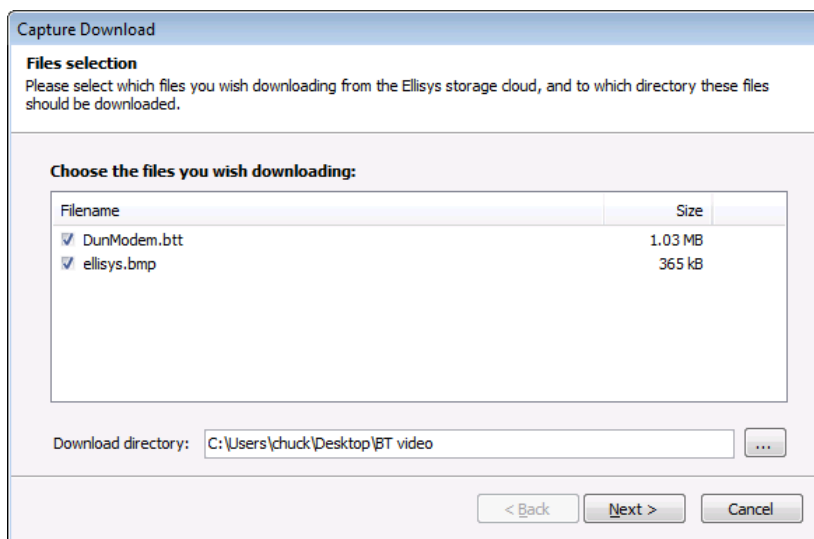
The *Capture Download* dialog appears:

2. 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
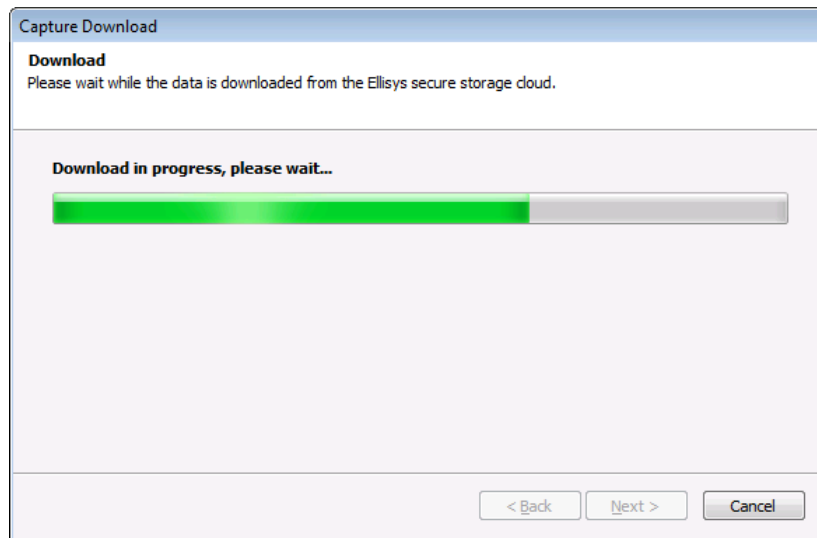
When the download completes, the *Capture Download Completed* dialog appears:
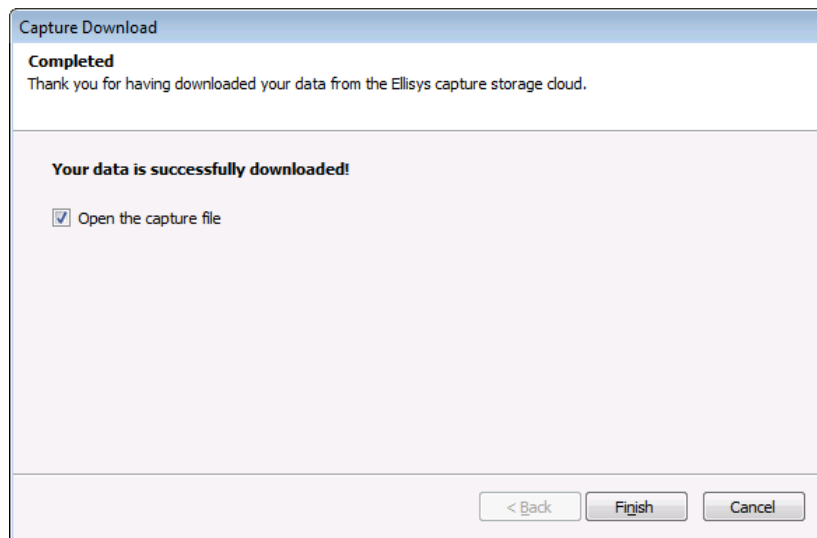
6. If desired, check **Open the Capture File** checkbox to open the shared capture file.

7. Click **Finish**.

4.7   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.

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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.

The *Print* window appears:
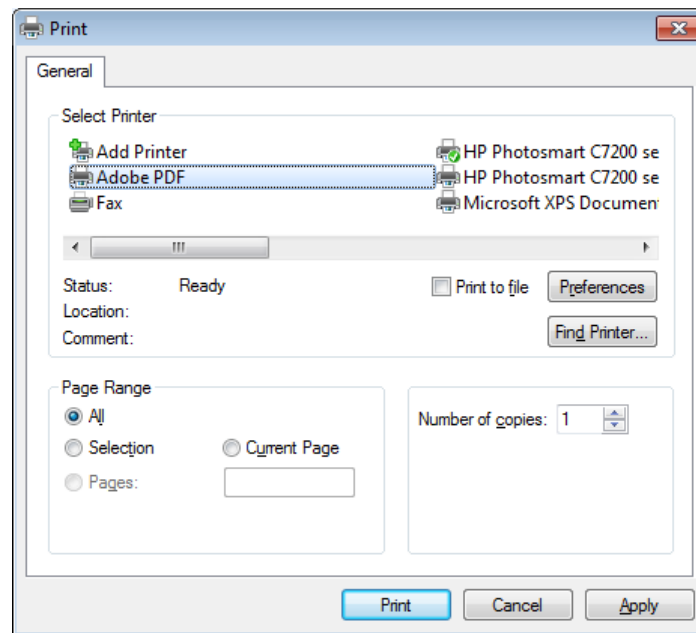
2. Select the printer and printer setup if required.

3. Select **Print**.

The file is printed.

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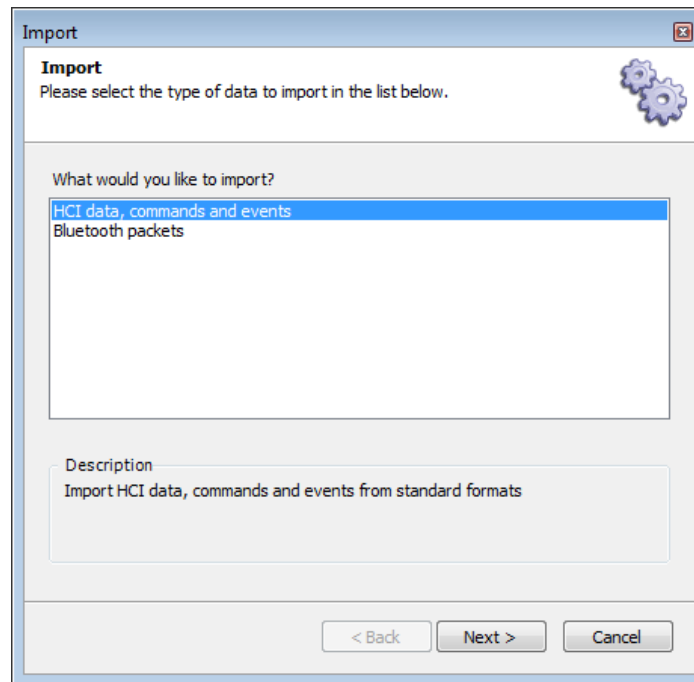
2. Select **HCI commands and events** or **Bluetooth packets**.

3. Click on **Next**.

The *Import File and Format* Menu appears:
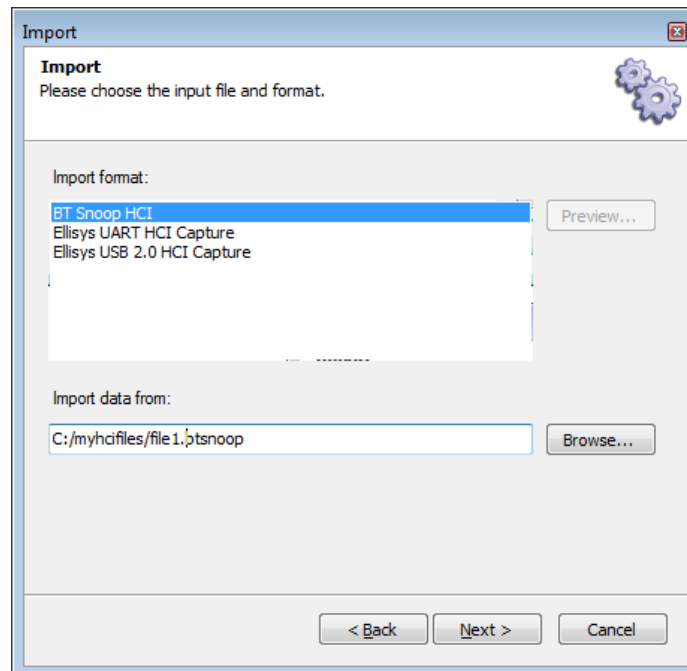
4. Browse to the desired file, and **Next**.

5. If importing HCI Commands and Events in USB format, proceed to the next step, otherwise proceed to step 7.

The *Data Rate* menu appears:
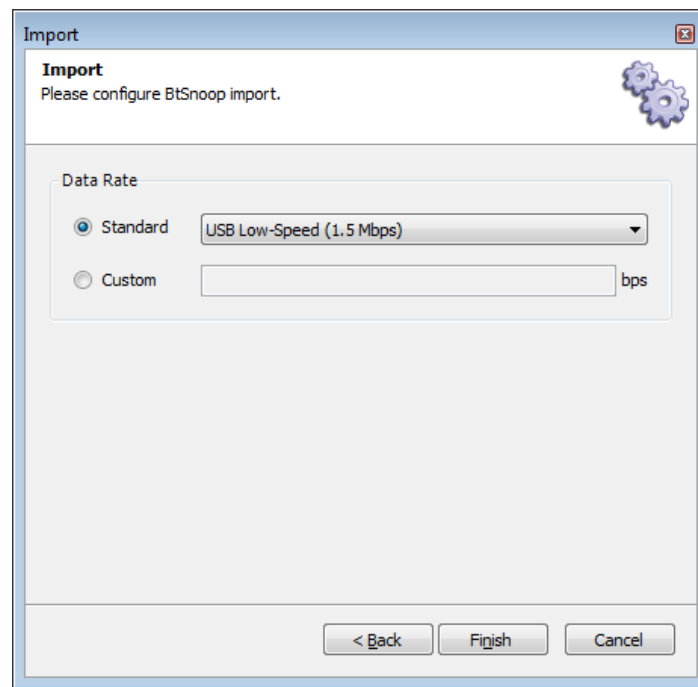
6. Select the desired data rate.

7. Select **Finish** to complete the import.

The application now displays the imported data.

4.9   Export Options

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

Export Type	Export Options	Export Format	Comments/Usages
Low Level Data	Start Time Trace Length (Bytes, seconds, items)	Ellisys trace (*.btt)	Exports data from the lowest protocol level (baseband packets). Allows for exporting specific portions of the trace to create a new Ellisys trace as defined by the export options.
Low Level Data	Start Time Trace Length (Bytes, seconds, items)	Libpcap HCI (Wireshark)	Exports data from the lowest protocol level (baseband packets). Allows for exporting specific portions of the trace to Wireshark format as defined by the export options.
Filtered trace based on *Overview*	None	Ellisys trace (*.btt)	Exports trace to a new Ellisys trace based on display filters installed on the currently active Overview.
Bluetooth raw data and payload	Fields (Name, Time, Data) Hierarchy (Root items, All items, Up to specific level)	Text, CSV, XML, Binary	Exports raw data or payload from items in the Overview.
Active Overview Rows	Columns Export Displayed Export All	CSV, XML	Exports data as displayed in the rows of the active Overview (Item, Time, etc.)
Bluetooth raw packet import format	None	ASCII	Exports Bluetooth raw packets to the Ellisys raw packet format.
Bluetooth Audio	PCM Synchronization buffer length	WAV	Exports all SCO, eSCO, and A2DP audio streams available in the trace.
Bluetooth *Mobile Phone Data*	Single File One file per transfer/item	Mobile Phone Data, *.vcf	Exports Mobile Phone Data such as VCard and Messages.
Message Sequence Chart	Procedures, scale, orientation, various display options	*.PDF, *.PNG	Exports the active overview into a message sequencing chart.

Internet Protocol	None	Wireshark	Exports filtered IP carrier protocols like DUN, BNEP from active Overview
Spectrum	None	CSV	Exports spectrum RSSI samples fopr each channel.
Logic Signals	None	CSV	Exports logic signal transitions.

To use the export feature:

1. Open the desired capture file.

2. Select **File | Export** from the menu.

The *Export* menu appears:
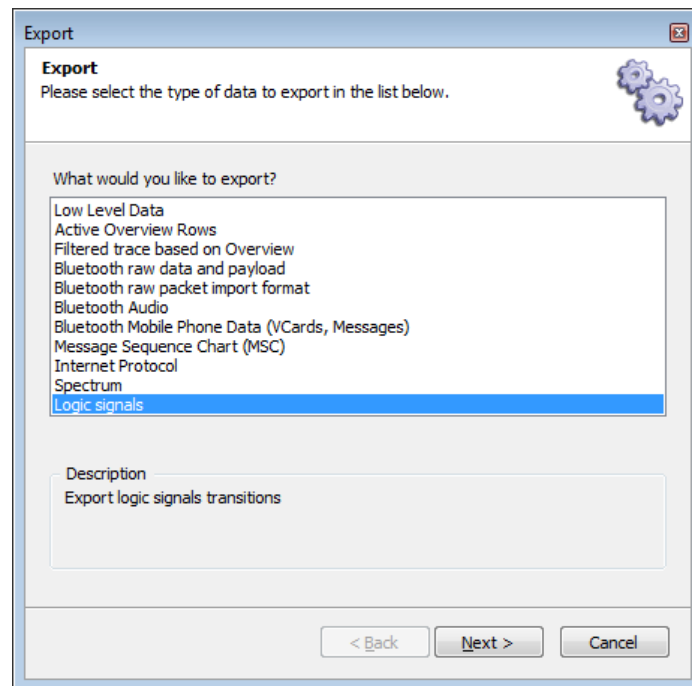
3. Select the desired export method.

4. Click on **Next**.

5. Select any export options as applicable and click on **Next**.

The *Export* menu appears:
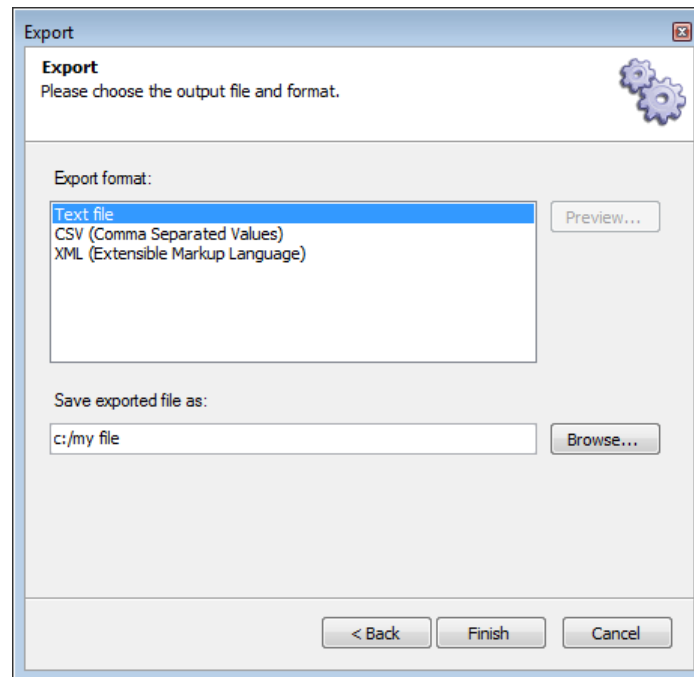
6. Select an export format.

7. Select **Browse** to set a file name and destination.

8. Click on **Finish**.

The export is complete.

> 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 of Low Level Data

With this selection, the user has the option to export in the Ellisys trace format or in Wireshark format. Wireshark is a third-party open source software application and is available for download at http://www.wireshark.org. The Wireshark export applies only to HCI captures.

When selecting the Ellisys trace format, the user has options to control the length of the export (items, bytes, or seconds) using a user-specified starting point based on a timestamp.

Export of Active Overview Rows

With this selection, the user can export from the Overview that is selected (active). The user may specify the particular columns to be exported, or may specify that all displayed columns be exported. See Section 7.1 Configuring the Overview Columns for information on adding columns to an Overview. CSV and XML export formats are provided.

Export Filtered Trace Based on Overview

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

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 Audio

With this selection, the user can quickly export any captured SCO, eSCO, and A2DP 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 WAV files.

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 master/slave 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:
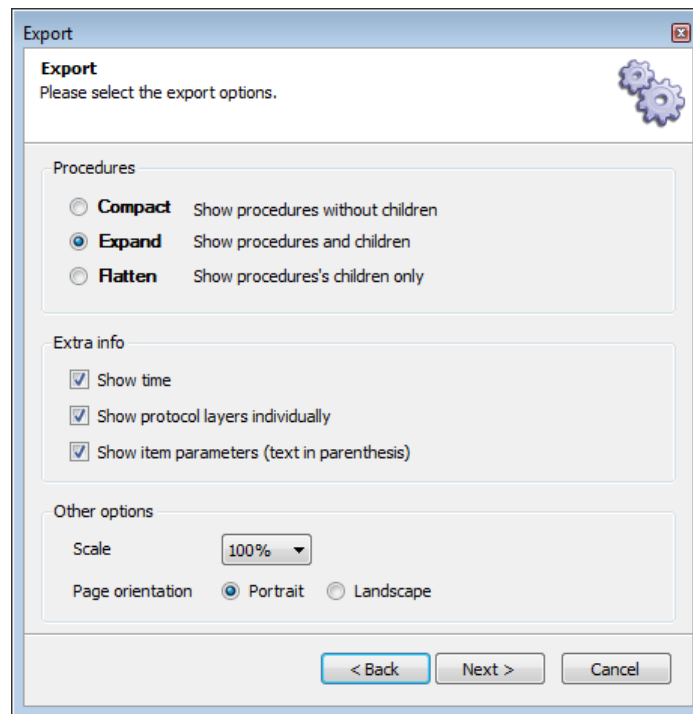
Compact (Shows Procedures without Children). LMP only is displayed for simplicity.
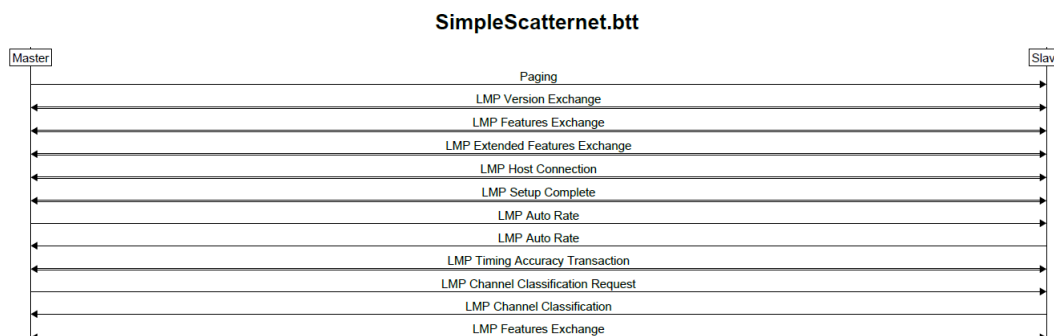
Expand (Shows Procedures and Children). LMP only is displayed for simplicity.
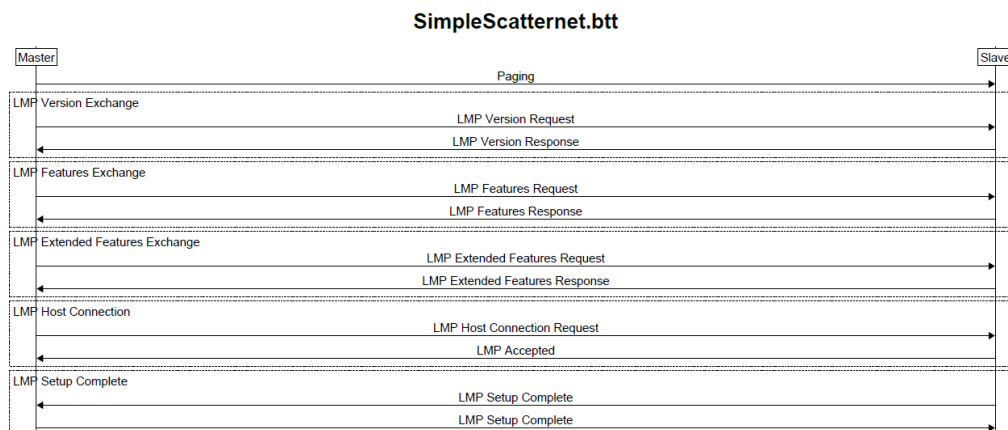
Flatten (Shows Procedures' Children Only). LMP only is displayed for simplicity.

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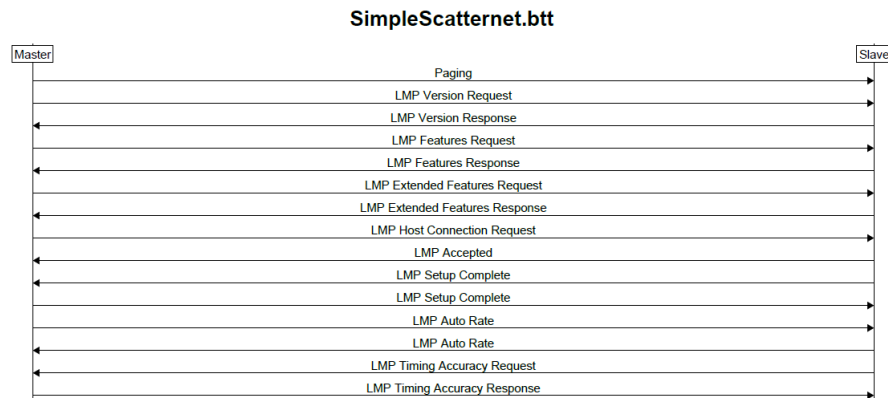
Below is an example of an MSC export, using the **Compact** selection, showing timestamps, item parameters, and procedures involving Baseband, L2CAP, SDP, RFCOMM, and OBEX. The option **Show Protocol Layers Individually** is selected.

ObexFtp.btt

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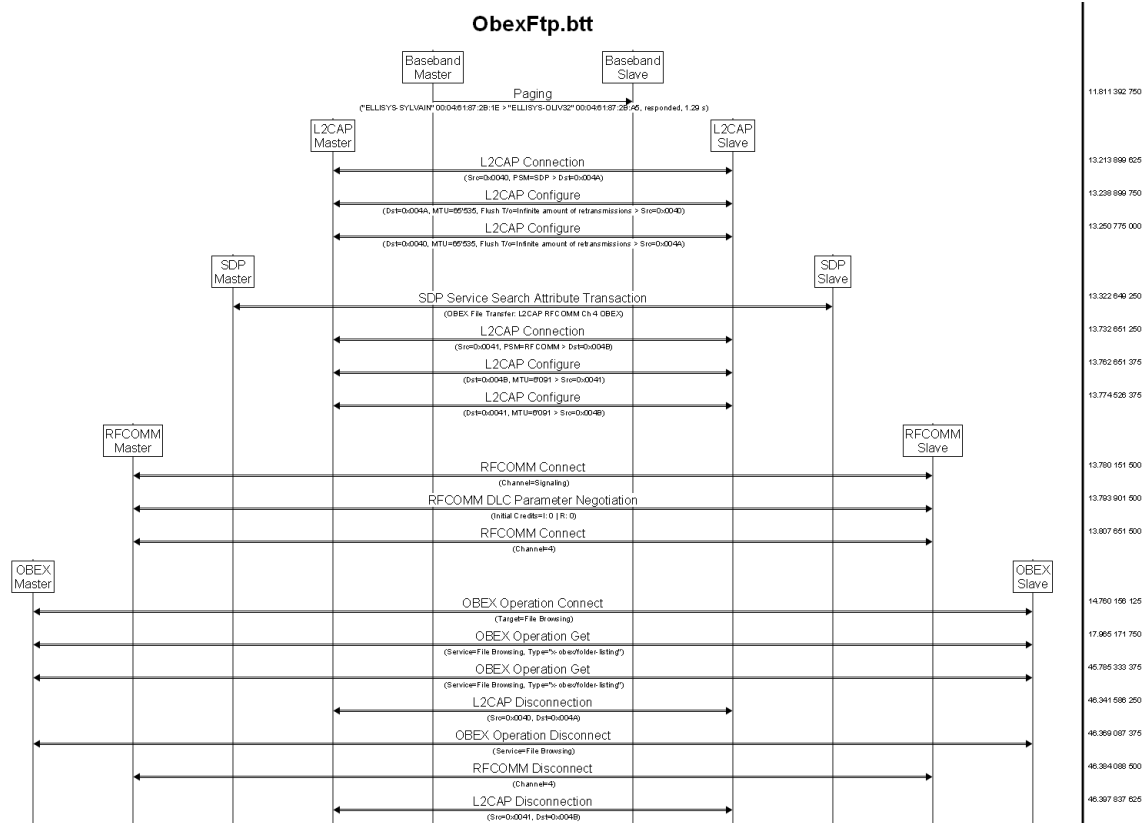
Below is an example of an MSC export, using the **Compact** selection with no layers. The option **Show Protocol Layers Individually** is unselected. Item parameters are displayed.

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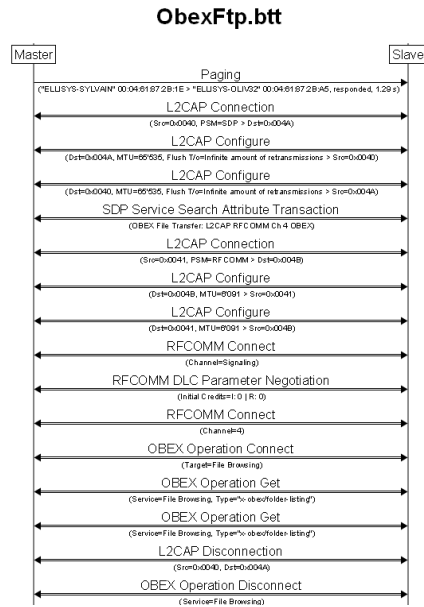
Below is an example of an MSC export, using the **Expand** selection, showing timestamps, item parameters, and procedures involving Baseband, L2CAP, SDP, RFCOMM, and OBEX.
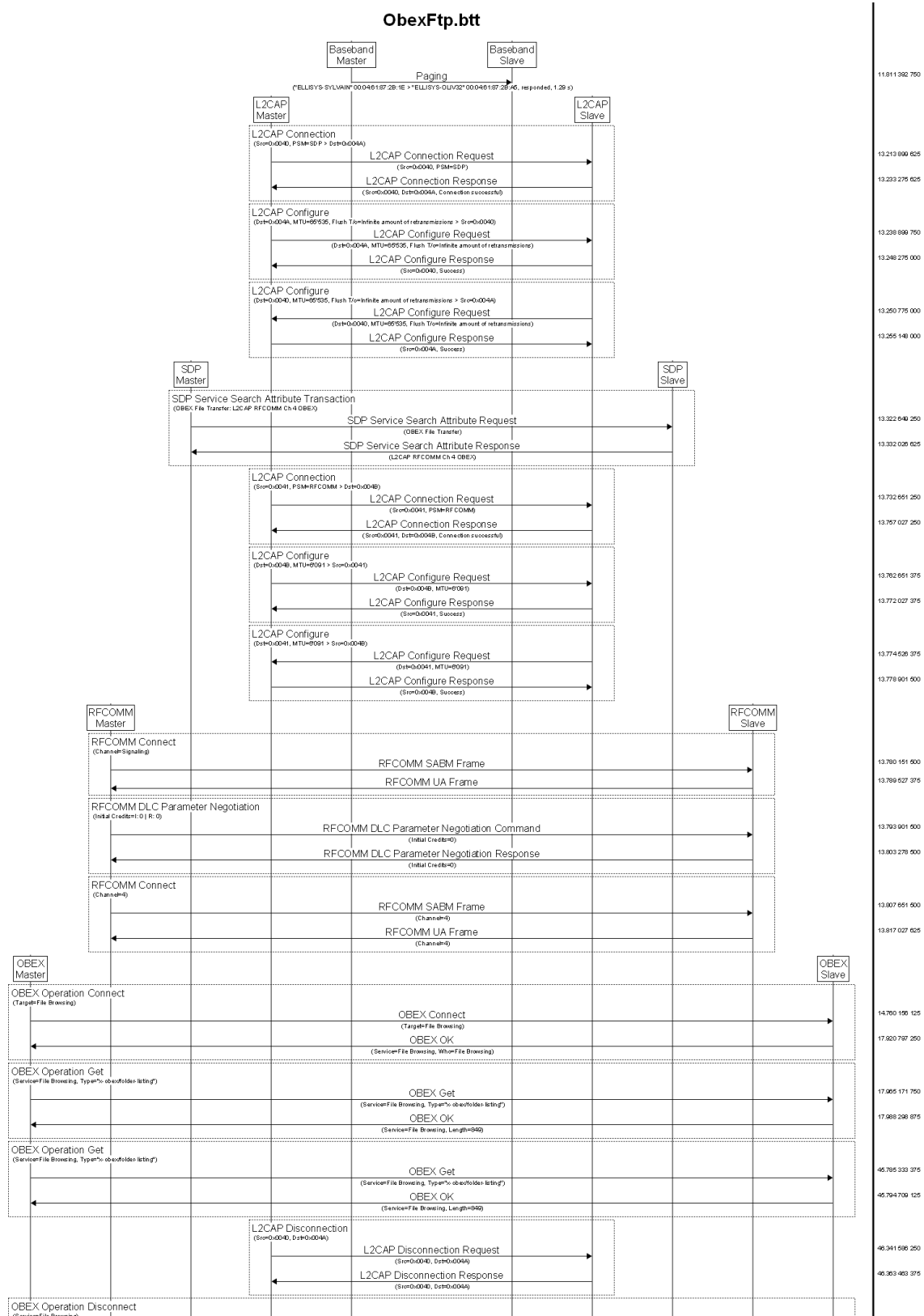
Below is an example of an MSC export, using the **Flatten** selection, showing timestamps, item parameters, and procedures involving Baseband, L2CAP, SDP, RFCOMM, and OBEX.

ObexFtp.btt
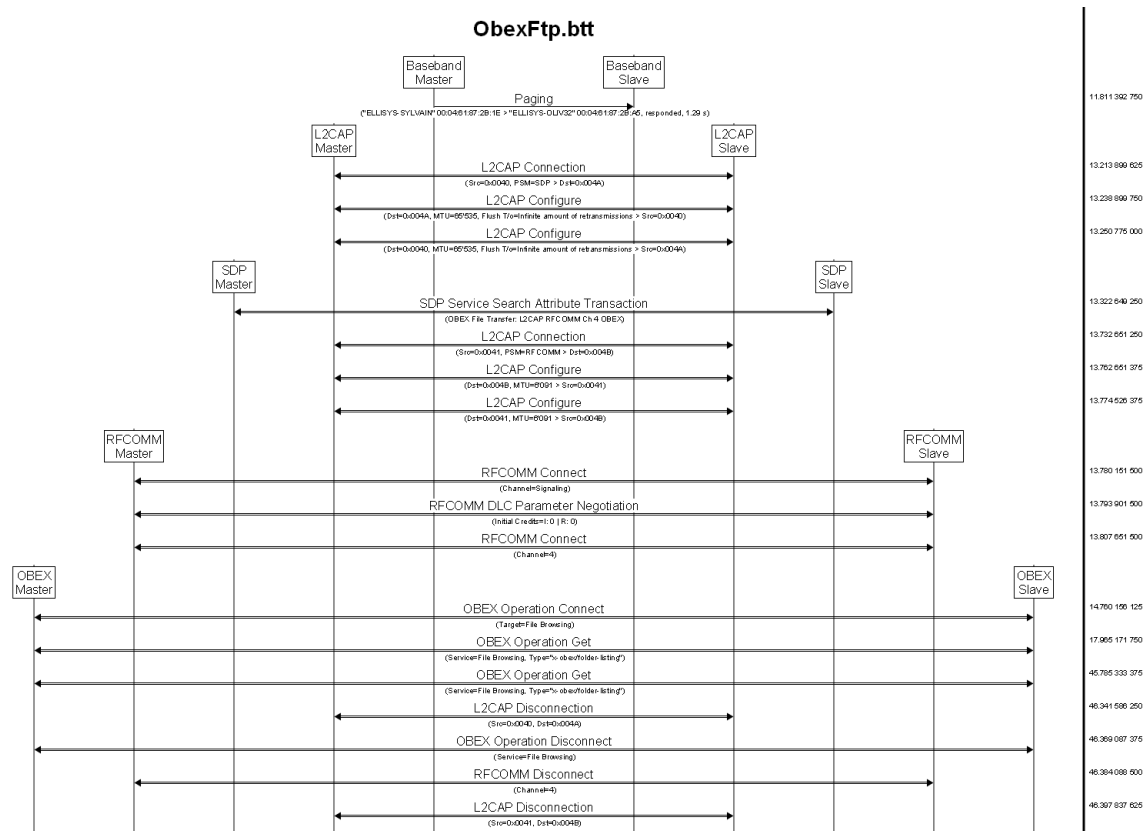
Export of Internet Protocol

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 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 BEX400 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 ogf 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 BEX400 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.

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5.   Workspaces and Layouts

5.1   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. A non-exhaustive list of items affected by Workspace settings is shown below:

>   General options
>   Window layouts
>   Most recently used (MRU) files
>   Recording options
>   *Overview*s (BR/EDR, LE, HCI, WCI-2, Injection)
>   *Details* pane
>   Protocol Sight
>   *Instant Audio* pane
>   *Instant Channels* pane
>   *Instant Throughou*t pane
>   *Instant Spectrum* view
>   *Raw Data* pane
>   *Summary* pane
>   *Instant Timing* pane
>   Bluetooth analysis
>   Remote Control

To create a new Workspace:

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

The *Workspace* menu appears:
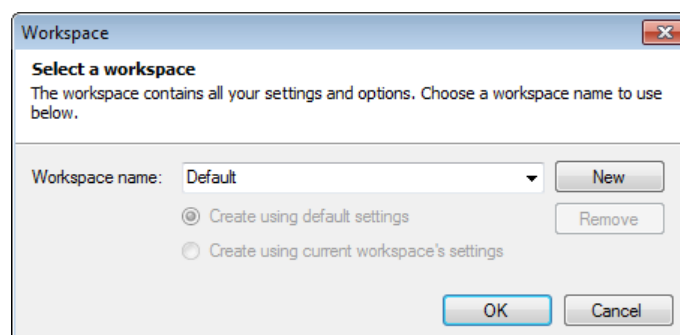
2. Click on **New.**

A new **Workspace name** appears:
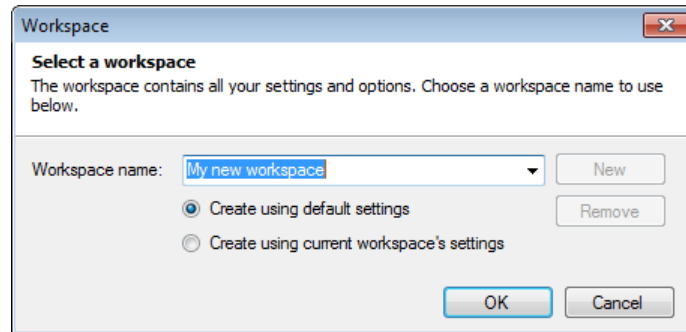
3. Accept the name provided by the application, or type in a new name in the **Workspace name** box. Select **Create using default settings** to establish a new Workspace based on the default settings.

    Alternatively, select **Create using current workspace's settings** to establish the new workspace based on the current settings.

4. Select **OK**.

To change from one Workspace to another:

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

The *Workspace* menu appears:
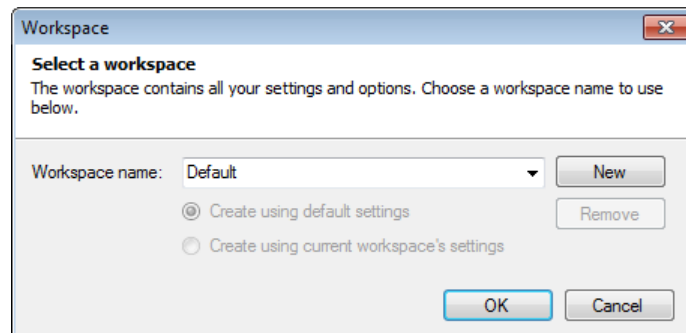
2. Select the **Workspace name** drop-down arrow.

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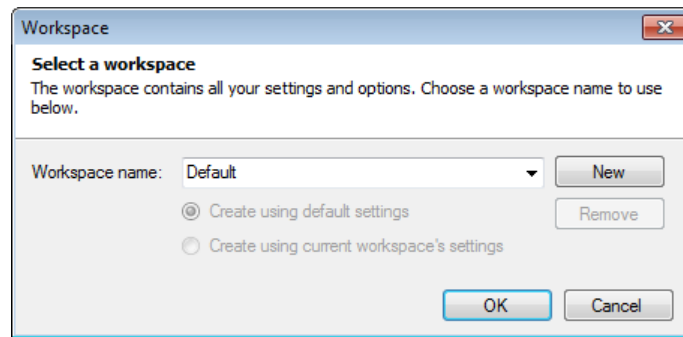
2. Select the **Workspace name** drop-down arrow.

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 and Export Settings** from the menu.

The *Import and Export Settings Wizard* menu appears:
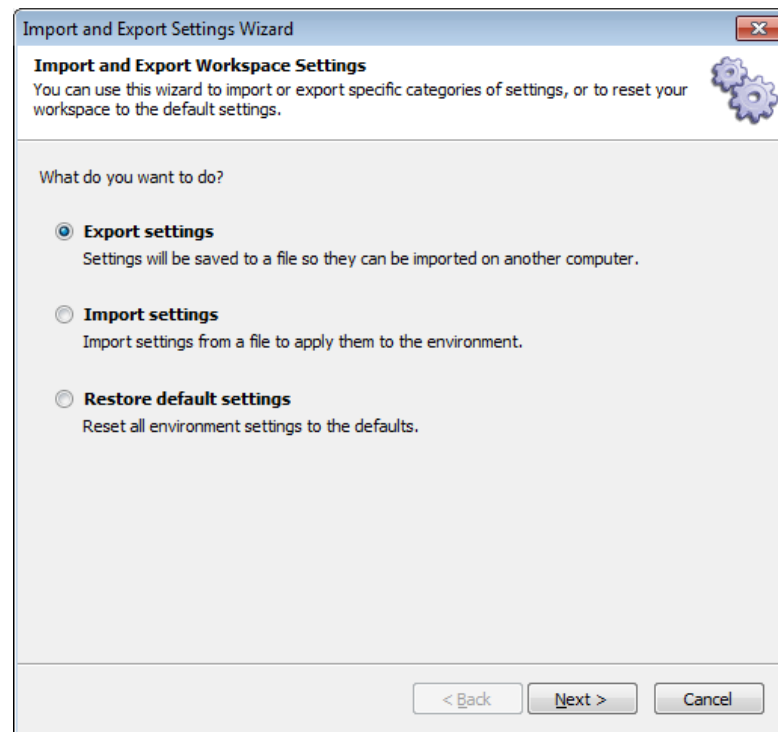
2. Select **Export settings**.

3. Click on **Next**.

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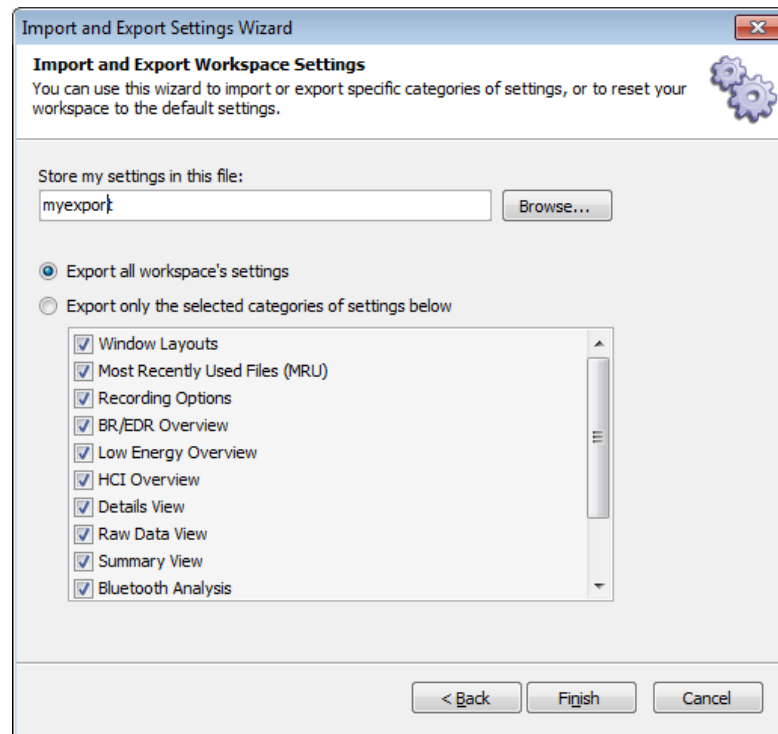
Select **Export all workspace's setting** or alternatively, select **Export only the selected categories of settings below** and check the desired categories.

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

5. Click on **Finish**.

To import a Workspace settings file:

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

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The *Import and Export Settings Wizard* menu appears:
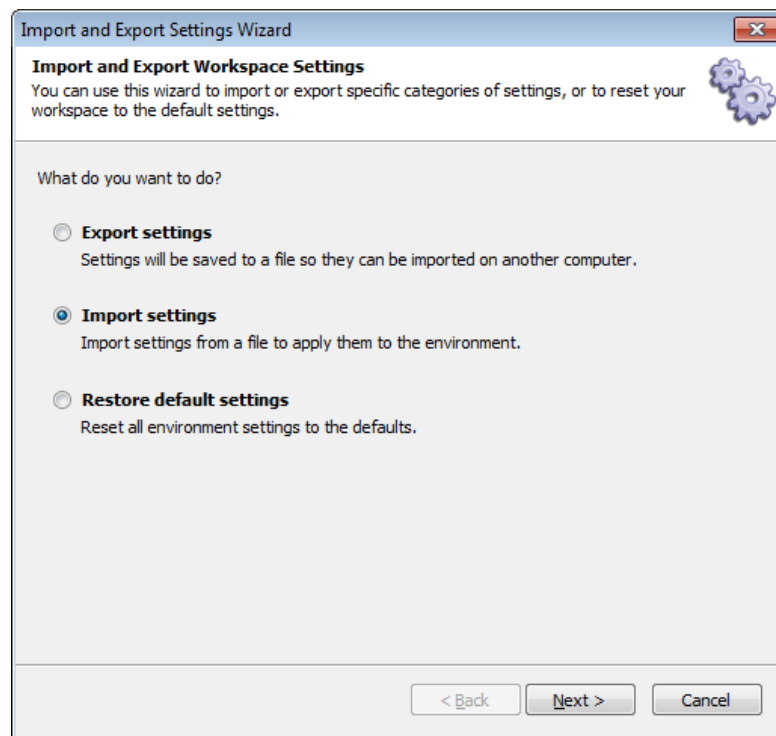
2. Select **Import settings**.

3. Click on **Next**.

The *Import* menu appears:
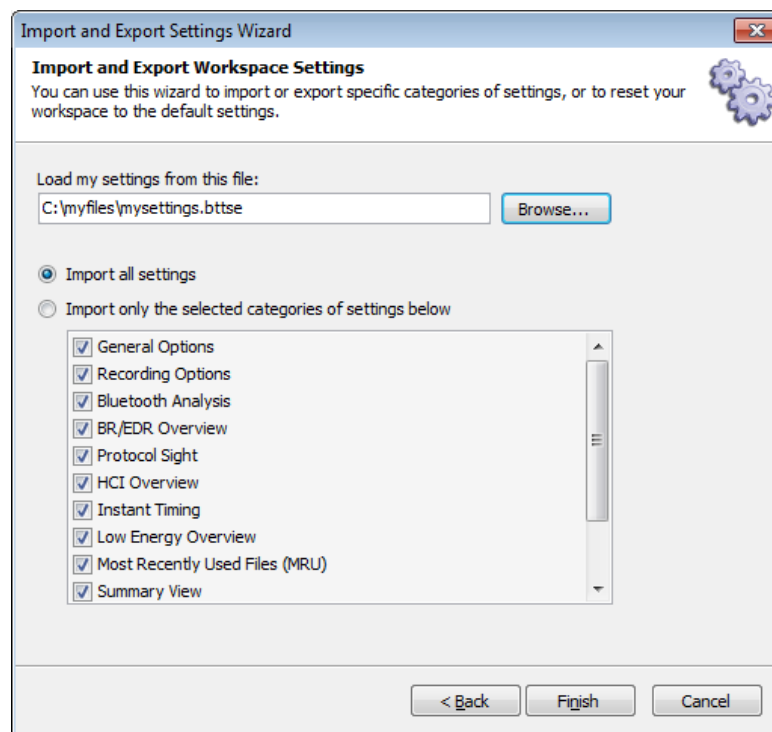
4. Select **Import all settings** or alternatively, select **Import only the selected categories of settings below** and check the desired categories.

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:
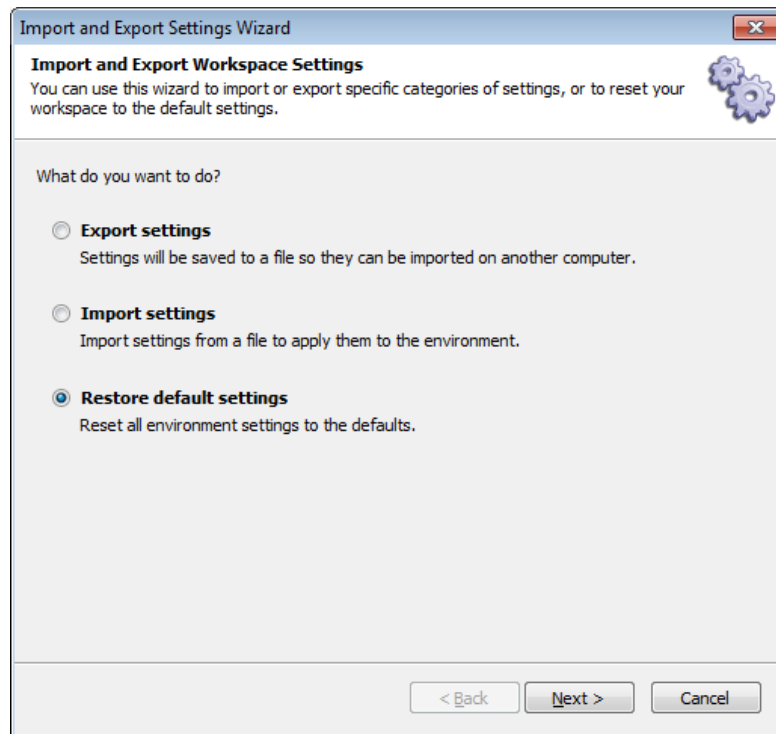
2. Select **Restore default settings.**

3. Click on **Next**.

The reset default menu appears:
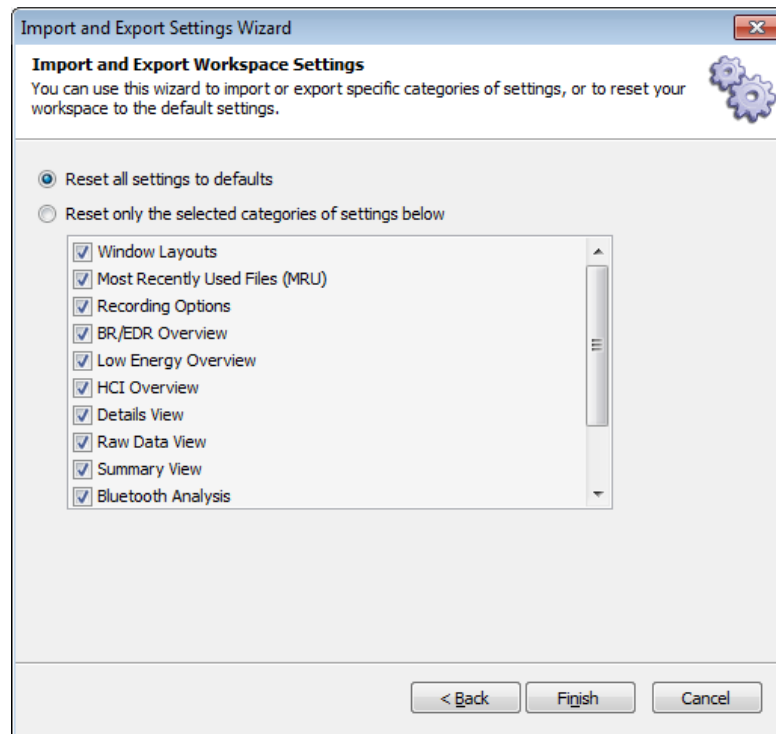
4. Select **Reset all settings to defaults** or alternatively, select **Reset only the selected categories of setting below** and check the desired categories.

5. Click on **Finish**.

5.2   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.

On installation of the analyzer application, a default layout is provided, 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 by the user.

A reset feature is provided 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:
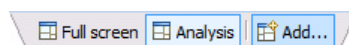
The *New Layout* dialog appears:
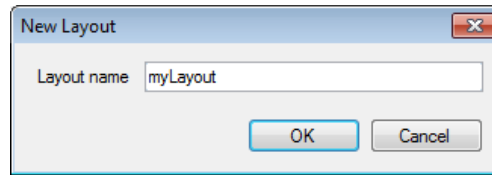
2. Enter a name for the layout and click on **OK**.

The new layout is created and is now accessible in the **View | Layout** menu and in the Layout Quick-Menu:
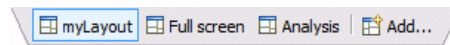
To reset a layout to factory default:

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:
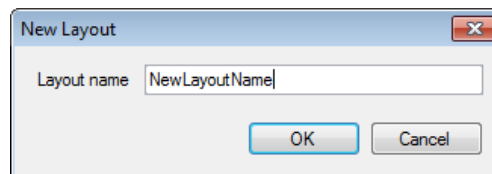
2. Type the name desired in the dialog and click on **OK**.

The layout is renamed.

The Default layout cannot be renamed or deleted.

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6.   Capturing Traffic

Bluetooth and Bluetooth Low Energy (Bluetooth Smart) traffic in the vicinity of the analyzer, raw spectrum energy, and/or HCI, WCI-2, Audio I2S, HCI Injection, and logic signal traffic attached to the analyzer is not recorded until the user takes action to capture this traffic (simply by clicking the **Record** button in the analyzer software).

An alternative browser-based remote capture feature is also provided (see Section 6.9, Taking Captures Using the Web Control Interface).

Traffic captured by the analyzer is temporarily buffered on the analyzer hardware then uploaded over the USB connection to the hard drive on the controlling computer, giving the user extremely long capture depth. For even longer capture depth, an automatic segmentation feature allows the user to automatically segment one long capture into smaller, more manageable captures.

The analyzer is designed such that no configuration is required in order 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 IO connector on the back of the unit.

> When a recording is initiated, the front panel Operating LED will be illuminated. The BR/EDR and LE LEDs near the Capture antenna port will illuminate whenever BR/EDR or LE traffic is present in the vicinity of the analyzer, irrespective of whether a recording has been initiated.
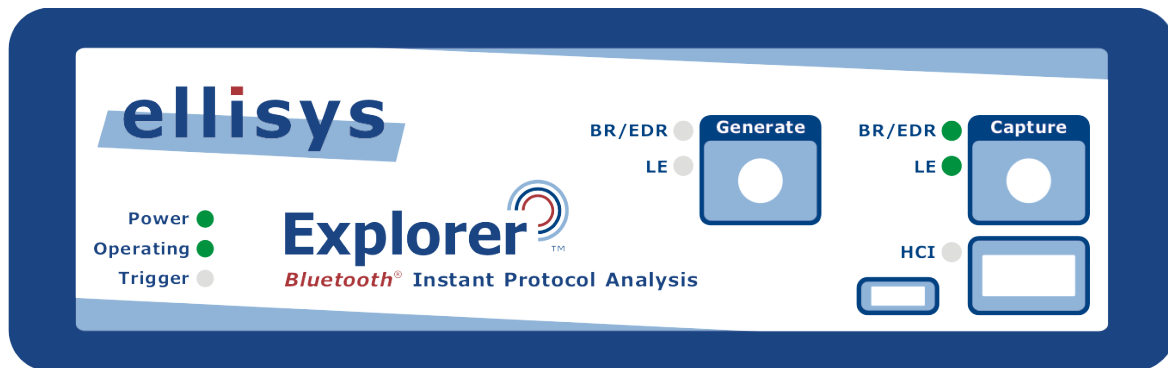
6.1   Analyzer Hardware Setup

The basic setup for taking a recording is as shown below. The analyzer is connected over a USB high-speed connection to a computer that hosts the analyzer application. The USB connection is used to program the analyzer for any capture characteristics selected by the user, and to upload traffic to the analyzer application.

> To prevent damage to the analyzer, <u>DO NOT</u> over-tighten the antenna when connecting it to the analyzer. Screw on the antenna to a light finger-tight

torque only. Use <u>ONLY</u> the supplied antenna.

Control Computer
hosting BEX400
application

DC Power
12-24VDC 18W

USB cable

BEX400 analyzer
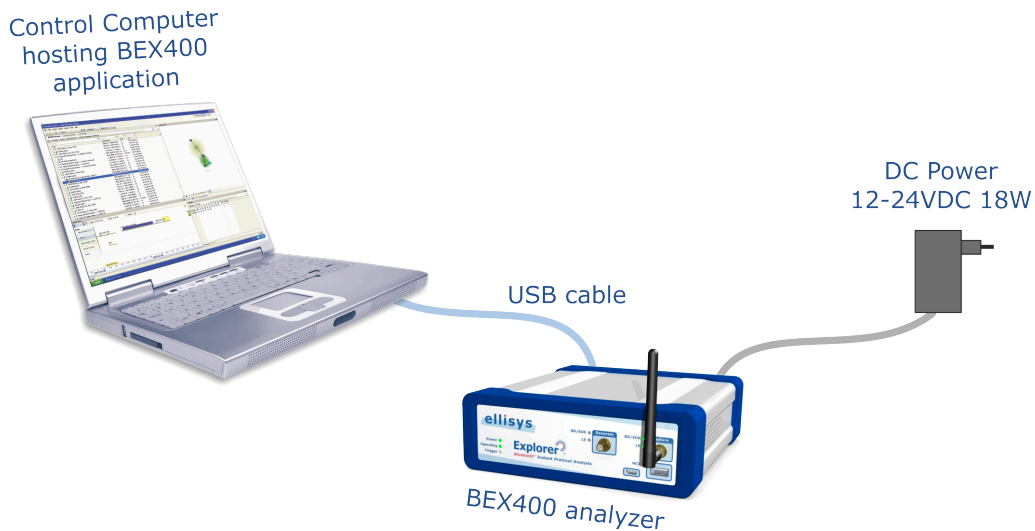
Basic Analyzer Setup

> On the 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.

6.2   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 may be made in the
Recording Options menu.

The *Recording Options* menu controls the capture inclusion and exclusion of the following wired
and wireless traffic types:

- Classic Bluetooth (BR/EDR)
- Bluetooth Low Energy
- Wireless spectrum energy
- HCI traffic (UART, SPI, and/or USB)
- Wireless Coexistence Interface (WCI-2) traffic
- Audio I2S (Inter-IC Sound)
- Logic signals

Capture of UART, SPI, WCI-2, Audio I2S, and logic signals requires the use of the Flying Leads
Cable to adapt to the back-panel IO connector. See *Appendix A – Flying Leads Cable* for
details. Default pin assignments are provided upon selection, or the user may specify custom in
assignments.

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To access the Recording Options menu:

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

2. The *Recording Options* menu appears (**Wireless** tab shown below):
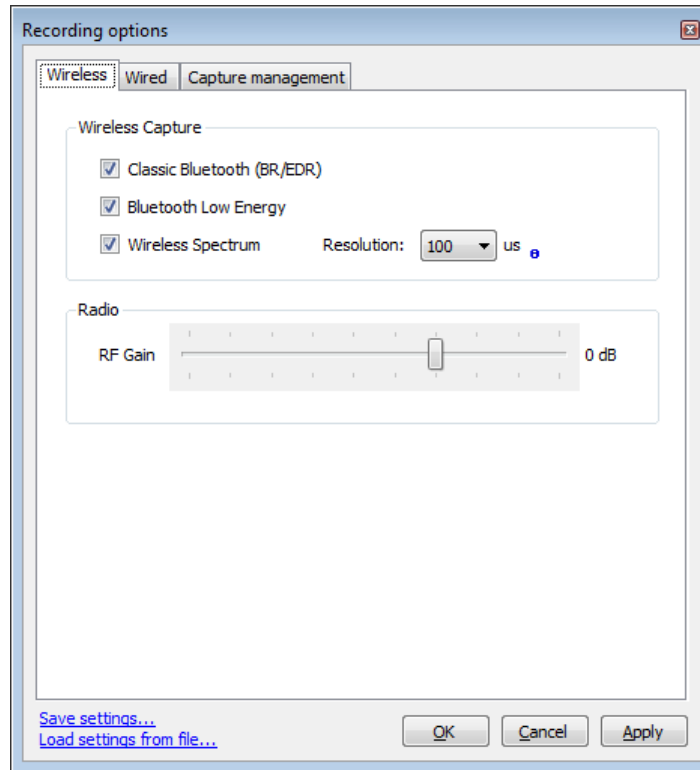
⚠️ The resolution setting for the wireless spectrum capture is selectable from 1us to 200us. At lower (higher-resolution) settings, the amount of data captured can be extremely high (exceeding 80MB/s), resulting in an automated cessation of the capture process due to the high volume of data being captured and processed. These lower settings can be used, but the length of the capture will be limited. If the higher resolution provided by these lower settings is not needed, a moderate setting of 100us or higher is suggested.

For wired connections:

1.   Select the **Wired** tab.

The **Wired** tab appears:
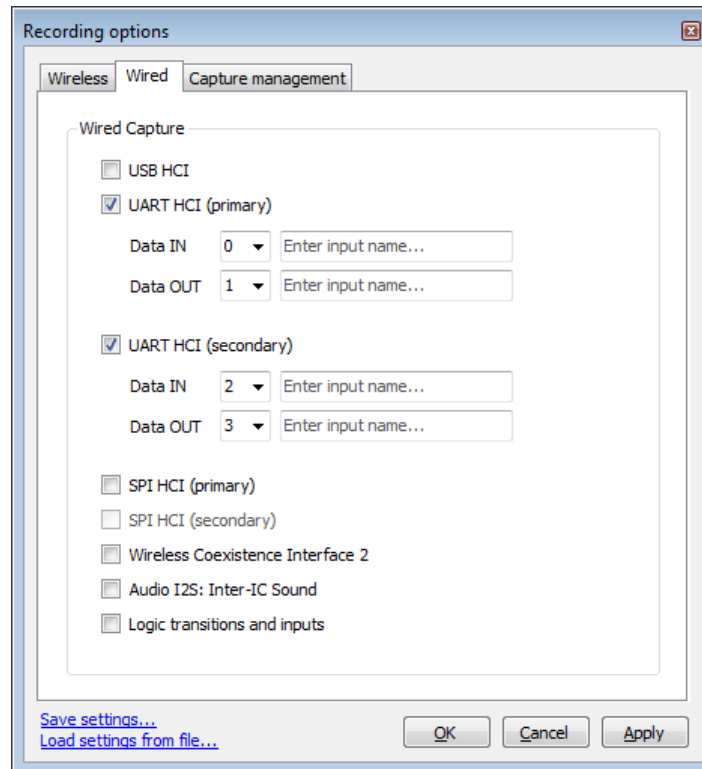
To capture BR/EDR and/or LE traffic:

1.   Select the **Wireless** tab.

2.   Check the appropriate check box(s).

3.   Click **OK**.

4.   Click on **Record** ▶ on the toolbar.

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To capture USB HCI:

1. Select the **Wired** tab.

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

3. Click **OK**.

4. On the front panel, connect the both sides of this interface to the USB STD-A and USB Micro-B connectors on the analyzer's front panel.

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

> *(i)* 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 UART HCI:

1. Select the **Wired** tab.

2. Check **UART HCI (Primary)** check box.

3. Click **OK**.

4. Attach the Flying Leads Cable between the IO Probe connector on the analyzer's back-panel and the signal and GND lines on the UART HCI. Use default pin assignments shown in *Recording Options*, or select custom pin assignments. Assign custom names to inputs as desired. See Appendix A – Flying Leads Cable for details.

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

To capture a second instance of UART HCI:

1. Select the **Wired** tab.

2. Check **UART HCI (Secondary)** check box.

3. Click **OK**.

4. Attach the Flying Leads Cable between the IO Probe connector on the analyzer's back-panel and the signal and GND lines on the UART HCI. Use pin assignments shown in *Recording Options*, or select custom pin assignments. Assign custom names to inputs as desired. See Appendix A – Flying Leads Cable for details.

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

To capture SPI HCI:

1. Select the **Wired** tab.

2. Check the **SPI HCI (Primary)** check box.

3. Click **OK**.

4. Attach the Flying Leads Cable between the IO Probe connector on the analyzer's back-panel and the SPI interface. Use pin assignments shown in *Recording Options*, or select custom pin assignments. Assign custom names to inputs as desired. See Appendix A – Flying Leads Cable for details.

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

To capture a second instance of SPI HCI:

1. Select the **Wired** tab.

2. Check the **SPI HCI (Secondary)** check box.

3. Click **OK**.

4. Attach the Flying Leads Cable between the IO Probe connector on the analyzer's back-panel and the SPI interface. Use pin assignments shown in *Recording Options*, or select custom pin assignments. Assign custom names to inputs as desired. See Appendix A – Flying Leads Cable for details.

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

To capture WCI-2:

1. Select the **Wired** tab.

2. Check the **Wireless Coexistence Interface 2** check box.

3. Click **OK**.

4. Attach the Flying Leads Cable between the IO Probe connector on the analyzer's back-panel and the WCI-2 interface. Use pin assignments shown in *Recording Options*, or select custom pin assignments. Assign custom names to inputs as desired. See Appendix A – Flying Leads Cable for details.

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

To capture logic signals:

Captured logic signals are displayed in the *Instant Timing* pane. Up to 12 logic signals may be captured. The Flying Leads cable is used to connect to logic signals. See Appendix A – Flying Leads Cable 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 IO Probe connector on the analyzer's back-panel and the logic signal(s) to be monitored. See Appendix A – Flying Leads Cable for details.

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

> The analyzer will capture up to 12 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.

To capture Audio I2S (Inter-IC Sound):

Audio captured over the I2S interface is displayed in the *Instant Audio* pane.

1. Select the **Wired** tab.

2. Check the **Audio I2S: Inter-IC Sound** check box.

3. Click **OK**.

4. Attach the Flying Leads Cable between the IO Probe connector on the analyzer's back-panel and the Audio I2S interface. Use pin assignments shown in *Recording Options*, or specify desired pin assignments. See Appendix A – Flying Leads Cable for details.

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

1. Slide the **Radio RF Gain** slide bar to the right (to increase sensitivity) or to the left (to decrease sensitivity).

2. Click **OK**.

> The **Radio RF Gain** setting is set to a nominal default value, which is appropriate for almost all cases. In most cases, this slide bar will not need adjustment.

6.3   Selecting an Analyzer

It is possible that multiple Bluetooth Explorer 400 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:
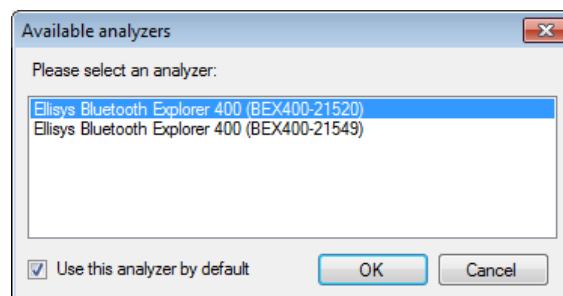
2. Select the desired analyzer.

3. Click on **OK**.

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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 default checkbox in this dialog will conveniently force the automatic selection of the specified analyzer on each new recording.

6.4   Injection API

The Bluetooth Explorer 400 application supports an HCI Injection API, selectable in the *Available Analyzers* dialog in the **Record** menu. The Injection API uses UDP (User Datagram Protocol) to push HCI traffic to the Bluetooth Explorer 400 software, which is displayed live in the *HCI Overview (Injection)*, just as if this traffic was being captured on one of the standard HCI capture ports on the analyzer.

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*, concurrent with any HCI traffic being captured by the BEX400 hardware. The BEX400 hardware is not required to capture injection sources.

Use the link below to download helpful documents on the Injection API, including samples.

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.

2.   The **Injection API** tab appears:
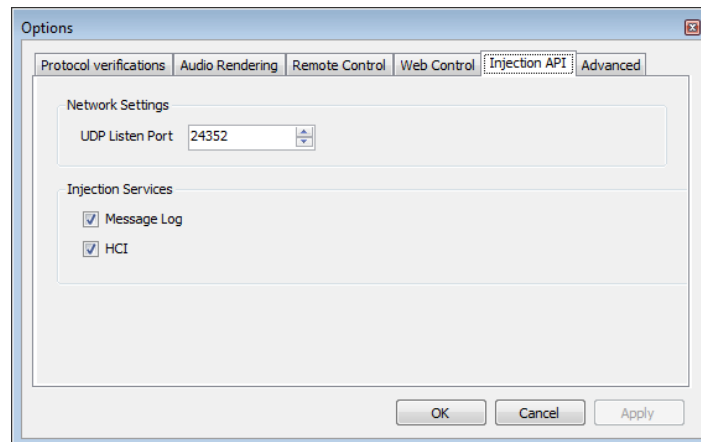
3.   Under *Network Settings*, specify the **UDP Listen Port**.

4.   Under *Injection Services*, check **Message Log** and/or **HCI** as desired.

5.   Click on **OK**.

Injected HCI on the specific UDP port can be viewed in the *HCI Overview (Injection)* once the Ellisys Injection API recording is initiated Any user debug messages are displayed in the *Message Log Overview*.

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:
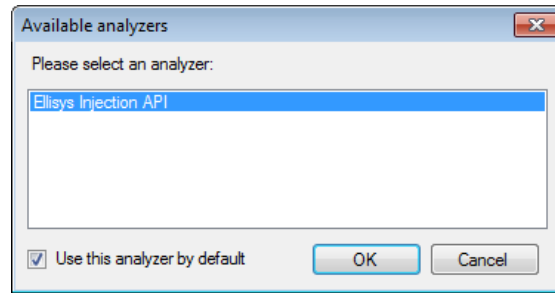
2. Select **Ellisys Injection API**.

3. Click on **OK**.

6.5   Initiating a Recording

A recording can be initiated from the toolbar, keyboard, or the menu.

To initiate a recording:

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

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

6.6   Stopping a Recording

A recording can be manually stopped from the toolbar, keyboard, or the menu.

To stop a recording:

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.

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

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6.7 Restarting a Recording

A recording in progress can be restarted from the toolbar or from the **Record** menu. The analyzer will stop capturing new data, the data captured until now will be discarded, a new capture will be created and the analyzer will be started again.

To restart a recording:

1. Click on **Restart** ![icon] on the toolbar or alternatively, select **Record | Restart Recording** from the menu.

The capture in progress is halted, traffic captured is discarded, and a new recording is initiated.

6.8 Using the Auto-Segmentation Feature

The Bluetooth Explorer 400 includes an automatic method to restart successive captures based on a specified period of time or 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 very long capture into several smaller, more manageable captures, and can provide extremely long capture duration.

An indicator is provided on the 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:
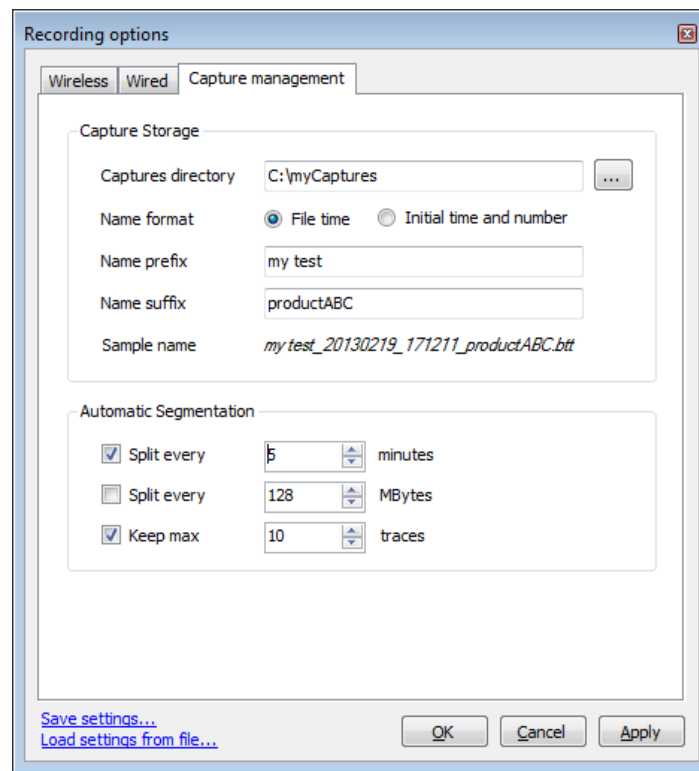
3. Specify a **Captures Directory** for storage of the captures.

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**):

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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.

6.9   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 located in the user's *Documents and Settings* directory, under *Application Data/Ellisys/Ellisys Bluetooth Analyzer*.

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

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

The *Options* menu appears:
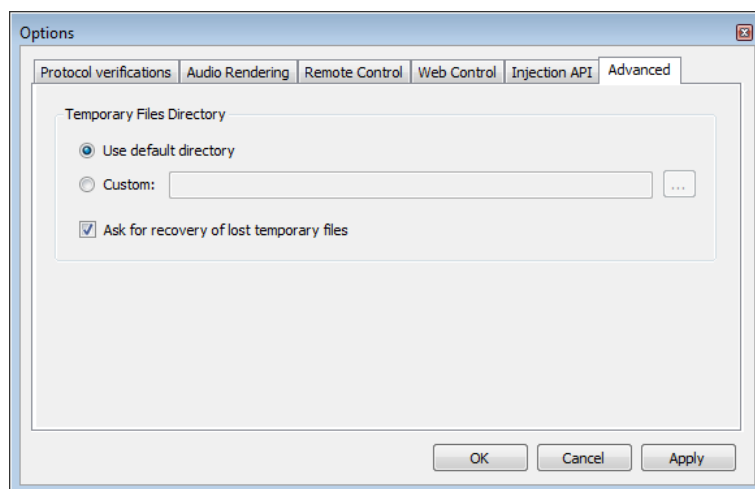
3. Select the **Advanced** tab.

4. Click on **Custom**, and browse to the desired directory.

5. 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.

6.10 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 in order to avoid interferences and thus decrease dramatically the packet error rate.

Some care must be taken with such a setup in order to not saturate the receivers of the devices under test and of 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 (in the *Details* pane) will be indicated as **Too High**.

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, which may avoid the need for external attenuation.

> Note that for performing conducted testing, the user will typically use a "Y" cable (not supplied) in order to connect 2 devices + the analyzer. The Y cable itself introduces some attenuation, and as a result, additional attenuation is usually not necessary. Contact Ellisys for recommendations on third-party Y cables.

6.11 Taking Captures Using the Web Control Interface

The *Web Control Interface* feature provides a method to control the analyzer's capture processes remotely, over a local area network (LAN). These processes include start capture, stop capture, and save capture. The default port access is **8080**, but the user can specify a different port as needed.

To setup the Web Control Interface, connect as shown below:
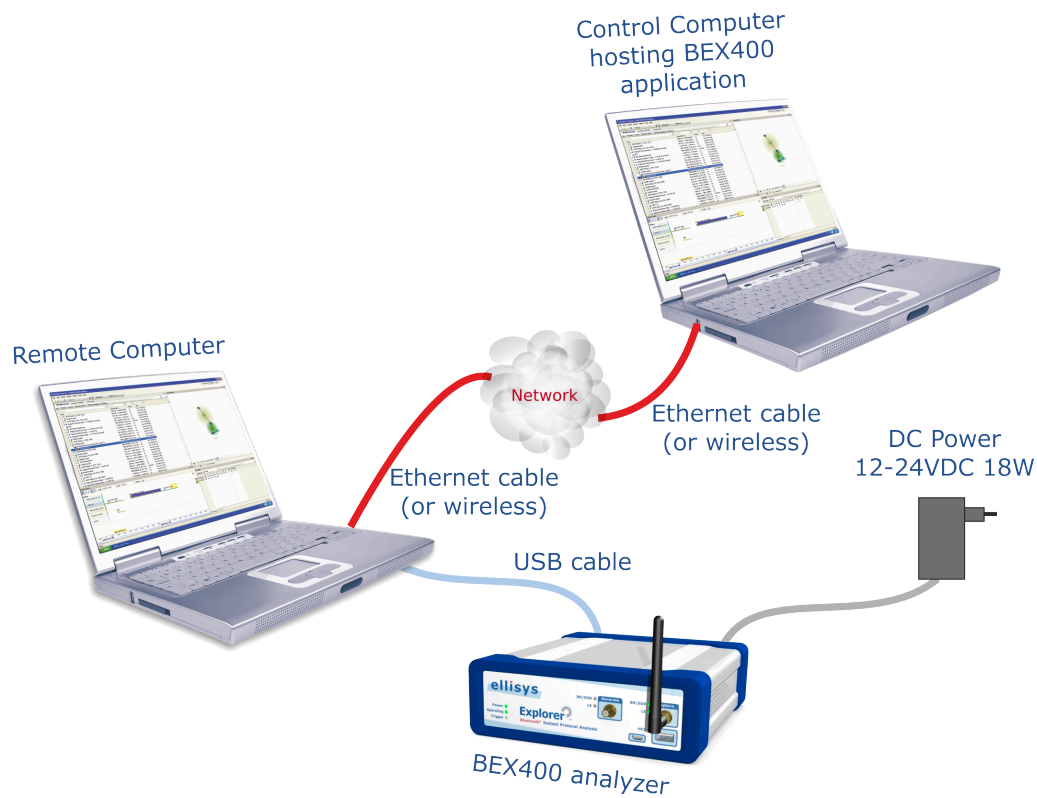
Web Control Interface Setup

To initiate a capture using the Web Control Interface:

1. Select **Tools | Web control interface** from the menu.

The default browser opens and displays the page below:

2. Select **Control capture**.

The page updates as shown below.

Ellisys Web Capture Control

Commands

» Start capture

Options

Remote captures folder:

C:\Users\customer\Documents\Ellisys Captures

Capture filename brief (optional, will be added to the fillename):

MyCapture

Captures will be automatically named with date and time. The brief will be added if specified.

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:

Ellisys Web Capture Control

Commands

» Stop and save capture
» Abort
» Restart

Status

Capturing to:

C:\Users\customer\Documents\Ellisys Captures\2012-01-06 12-12-05 - MyCapture.btt

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

If the capture is saved, the capture file will be saved to the destination previously specified. If aborted, the capture is stopped and not saved. If restarted, the capture restarts without saving the prior capture.

To change the default port:

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

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The *Options* menu appears:
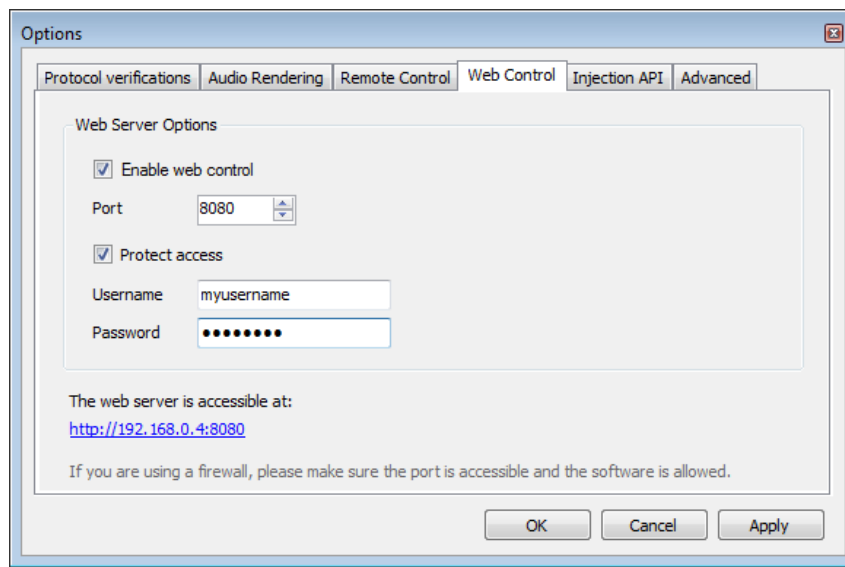
Select the **Web Control** tab.

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

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

> *i* To protect access to the remote computer hosting the BEX400 hardware, check the **Protect Access** box and supply a User Name and Password.

> *i* Ensure your firewall allows access to the port specified and to the BEX400 application. Contact your IT administrator as needed.

4. Click **OK**.

7.   Overview Windows

The analyzer software provides separate Overview windows for BR/EDR, Low Energy, HCI traffic (Injection, USB, UART, and SPI), WCI-2, and a Message Log (associated with the Injection API).

The Overviews are the primary viewer windows, providing a chronological, user-configurable display of all events and traffic. Overviews provide real-time display of events, 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:
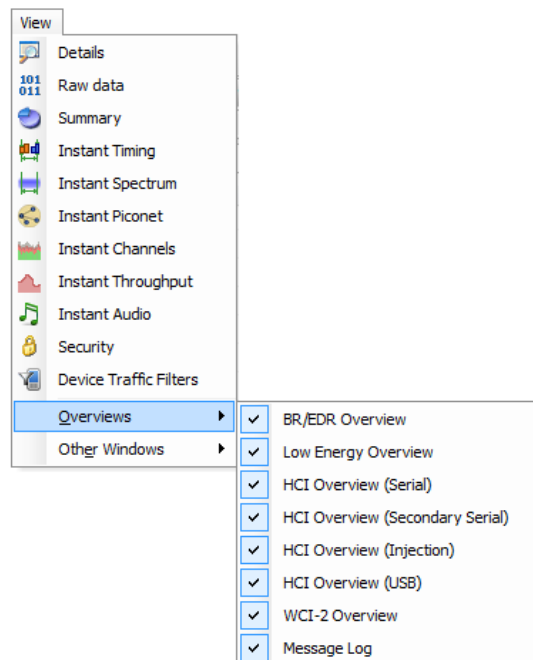
2.   Select the desired Overview(s).

3.   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 selecting an event in an Overview will halt the scrolling effect (traffic is still

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being captured). To resume the scrolling effect, select CTRL + END.

By default, 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.
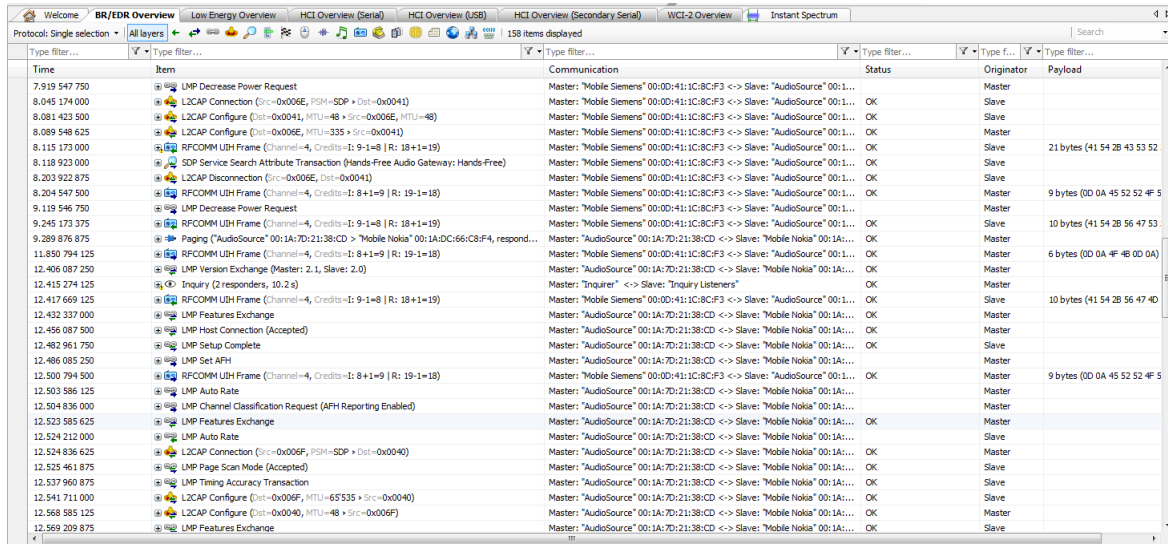
7.1   Configuring the Overview Columns

A default set of columns are displayed in each Overview, but the user can add additional columns to customize an Overview to a particular task. This is an important and valuable feature, allowing precise customization of the Overview columns.

Columns can be added in two ways:

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

● 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 [Show in overview] in the *Details* view.

> Using *Instant Filter*s in conjunction with adding columns to an Overview is especially powerful. *Instant Filter*s are the boxes located atop each column in an Overview. Note that the addition (or removal) of columns, and the application of *Instant Filter*s, can be done while a recording is in progress or on a static or saved capture.

> The columns displayed are particular to the **Protocols** selection that is in effect (i.e., the user can define a separate set of displayed columns for each selection). These selections are described in 8.2 Protocol / Profile Filters.

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:
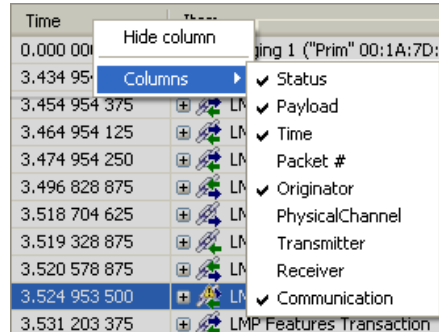
2. Select the desired item.

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** ![Show in overview] in the *Details* toolbar or alternatively, drag and drop the desired field into the Overview (grab the blue icon adjacent to the desired field).

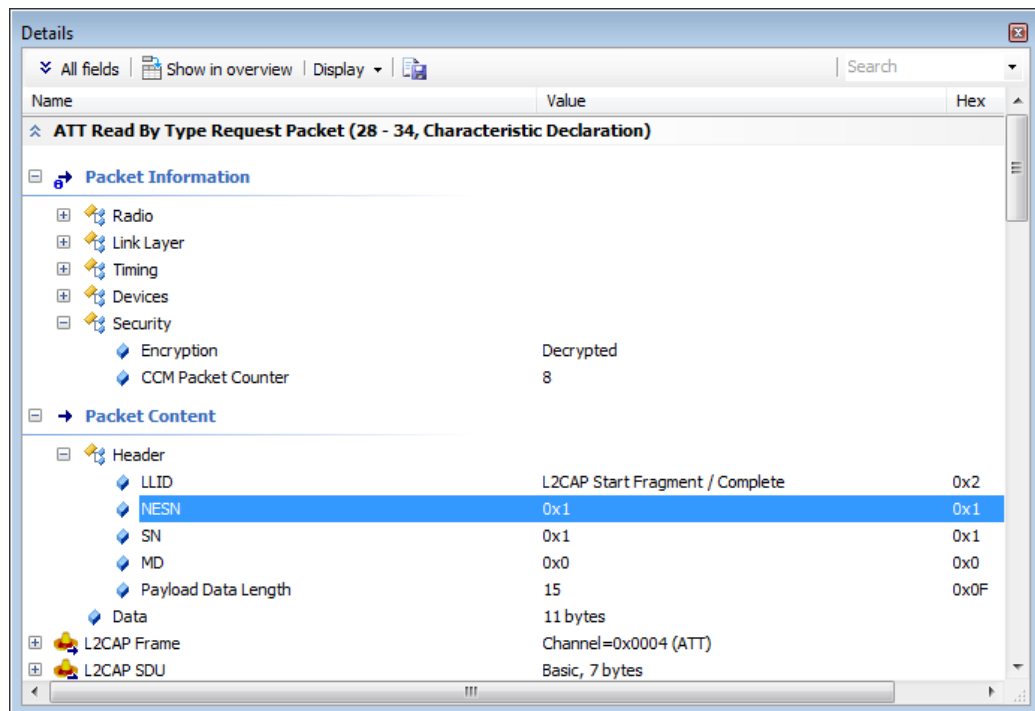A new column is created in the Overview and populated with the relevant data.

To resize a column:

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

2. 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**:
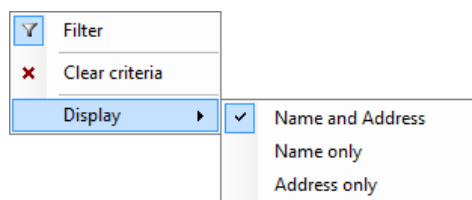
3. Select the desired option to configure the information displayed in the **Communication** column.

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.

7.2 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 *Colorize* menu.

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.
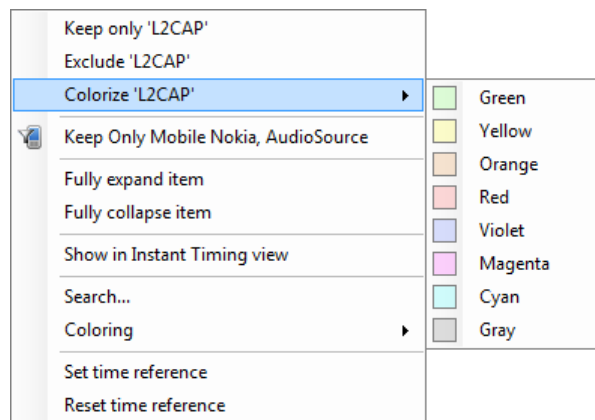
4. Select the color desired.

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.

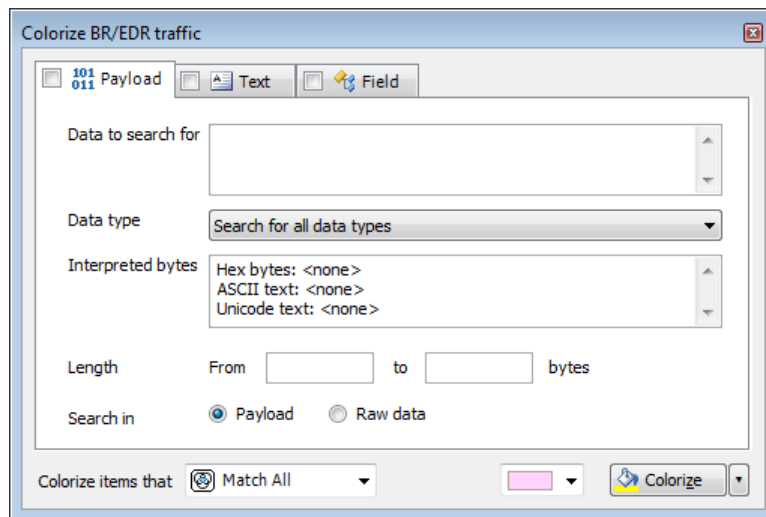2. Enter **Data to search for** and/or a payload **Length** range.

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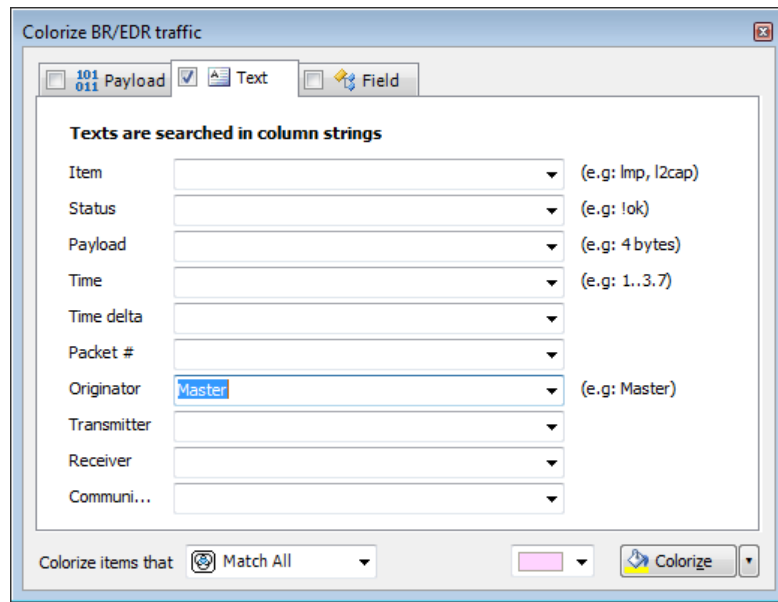
2. Use the one or more text string drop-down menus provided to characterize the color search.

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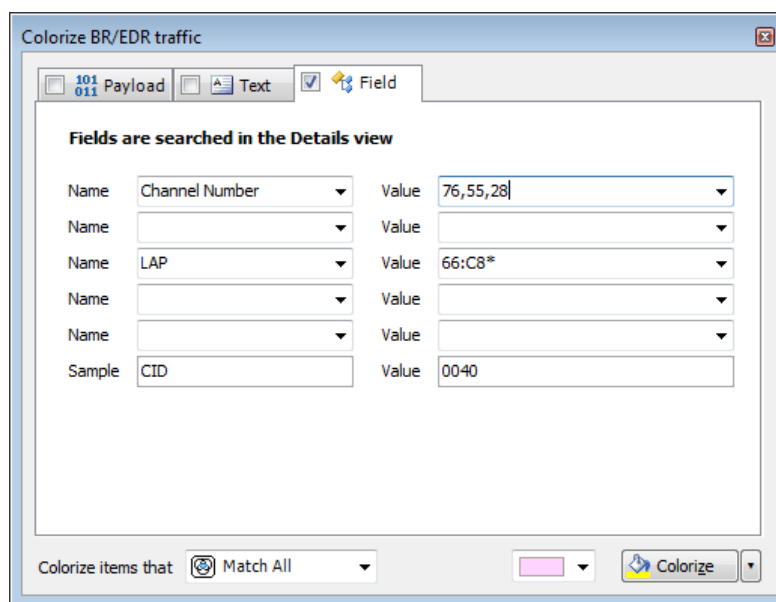
3. Select the desired color and click on **Colorize**.

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:
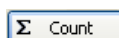
4. Click on **Count**.

A count of items matching the criteria is displayed:

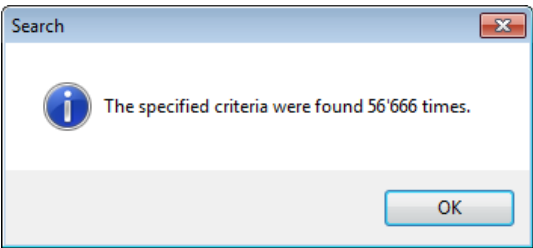# 7.3   Grouping and Ungrouping

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 high level 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 Chapter 8, Display Filters.

To collapse or expand protocols and profiles in the Overview:

1.   Select the desired item in the Overview.

2.   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:

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:

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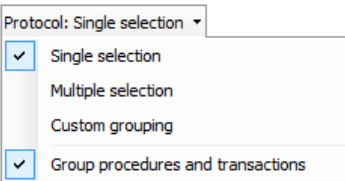
Transactions and procedures are grouped:

To disable grouping of procedures and transactions:

1. De-select **Group Procedures and Transactions** from the **Protocol** drop-down menu on the Tool Bar:
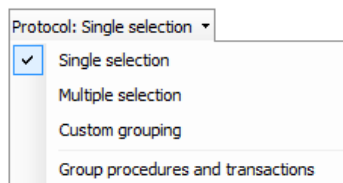
Transactions and procedures are not grouped:

7.4   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, 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 9, Instant Timing Pane or Section 10, 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**.

3. The *Time Format* menu appears:
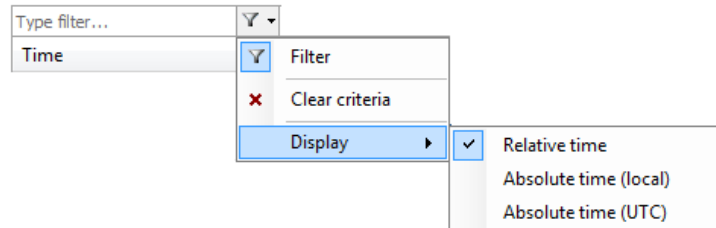
4. Select the time format desired.

5. 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. The *Instant Timing*, *Instant Piconet*, *Instant Spectrum* view, and *Security* panes 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.

7.5   Synchronization to Other Panes

By default, the Overviews are automatically synchronized to other panes in order 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 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.

7.6   Using Markers in Overviews

Items in the Overviews can be annotated with markers and saved with a capture. Markers are also quite useful for remote collaboration among different users. Markers can be edited to add descriptive notes. More than one marker can be placed on an event and can be color-coded to differentiate among the various users creating the markers.

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 4.5, 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 click on the **Markers** button (F9) on the toolbar ⬚ Markers ▾ or 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:
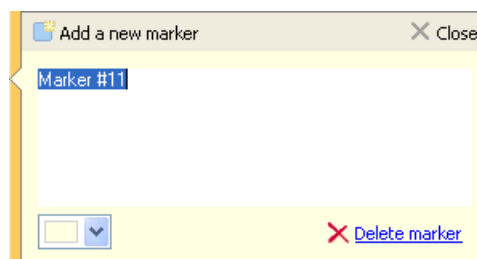
2. Add comments as desired.

3. Select a color for the marker as desired.

4. Click on **Close**.

A marker is placed adjacent to the event in the Overview and in other relevant panes as described above:
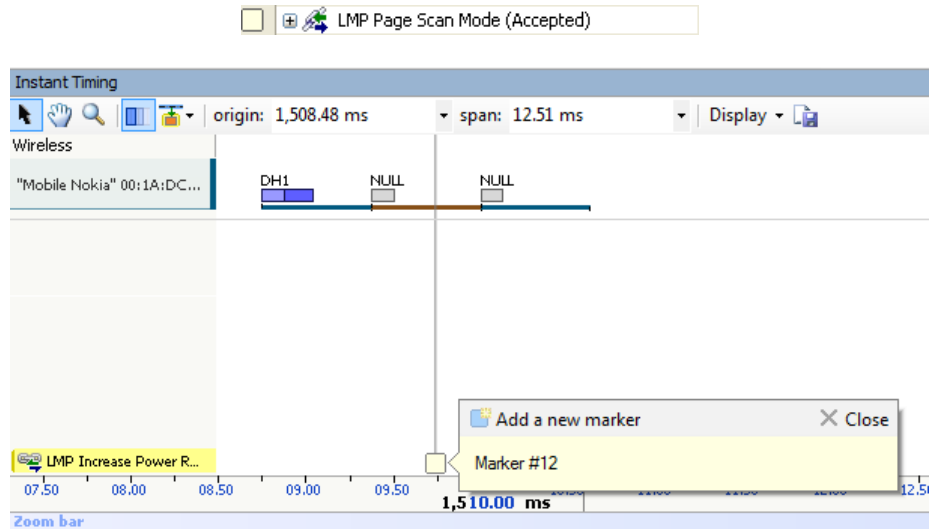
✅ Alternatively, right-click in the gray column at the far-left of the Overview to add a marker, or to add a marker with a note.
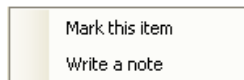
✅ Multiple markers may be placed on a single event. Use of the color-coding can facilitate technical "conversations" between users by assigning different colors to different users.

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.
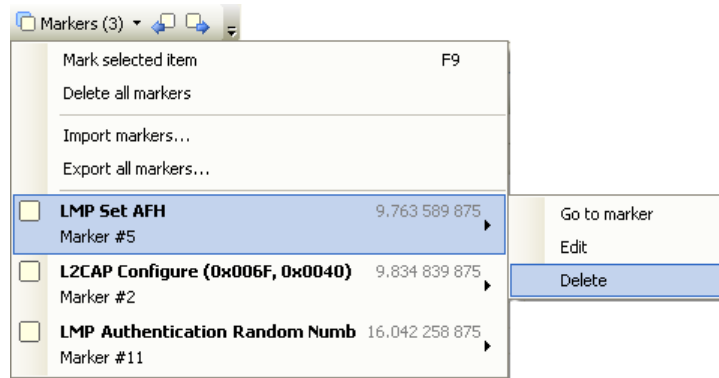
3. Position the mouse pointer over the desired marker:

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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.
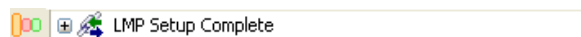
The *Markers on sub-items* menu appears:
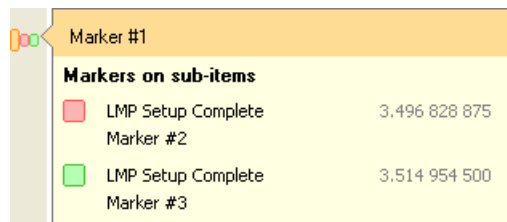
2. Select the desired marker.

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

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**. [Find Next]

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

To search events by text string:
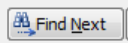
1. Select the **Text** tab.

The **Text** tab appears:
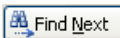
2. Use one or more text string drop-down menus provided to characterize the search.

> 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.

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

4. Click on **Find Next.** [Find Next]

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

To search events by field value:
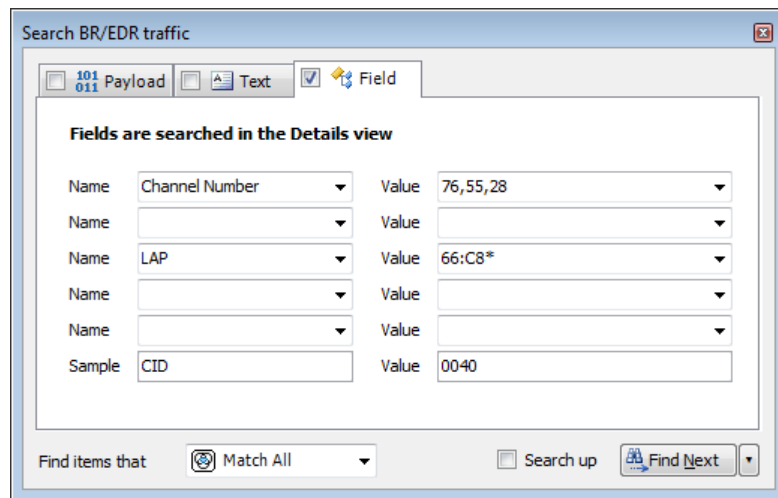
1. Select the **Field** tab.

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.

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 **Find items that** drop-down menu.

5. 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.**

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

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

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A count of items matching the criteria is displayed:
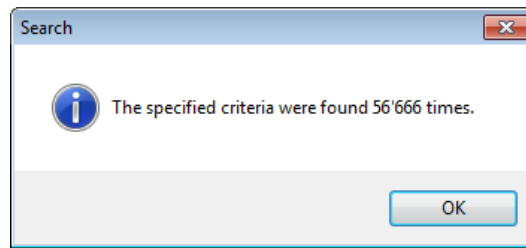
To search using an Item Number or Item Time:

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

The *Go to item* dialog appears:
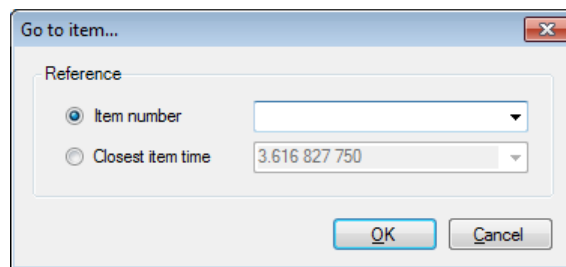
2. Select **Item number** and enter an item number or alternatively, select **Closest item time** and enter a timestamp in *x.xxx xxx xxx* format.

    The Closest item time value may be entered as an abbreviated timestamp, such as x.xxx or x.x, in order 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.

A content-sensitive menu of searchable items appears:
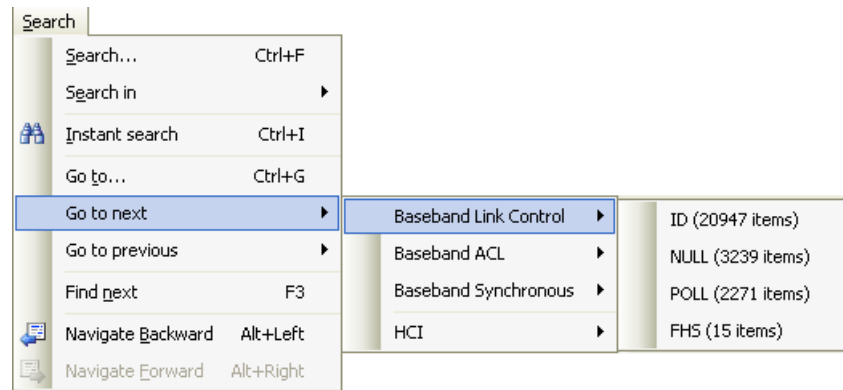
2. Click on the item desired.

The selected event is highlighted in the Overview.

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

8.   Display Filters

The Bluetooth Explorer 400 employs an extremely powerful all-channel digital radio, resulting in capture of all BR/EDR and LE traffic in the vicinity, along with any attached HCI, logic signals, Audio I2S, raw spectrum energy, and/or WCI-2 traffic. Consequently, it is often important to be able to quickly and efficiently filter/drill-down to particular piconets, LE connections, or other particular communications of interest.

The analyzer software provides several simple and convenient 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.

Filters Available

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

Filter Type	Filter Location	Purpose of Filter
Instant Filters	Atop each Overview column	Highly flexible text string filter used to include or exclude items displayed in any column.
Protocol / Profile Filters	Filter Bar in Overview toolbar	Single, Multiple, and Custom Grouping Selections. Allows for display in all panes of only selected protocol(s), profile(s).
Instant Piconet Keep-Only Filter	*Right-click on Instant Piconet* pane	Filters all panes to show only piconet(s) or LE Connection(s) of interest.
Device Traffic Filter	Main toolbar	Provides a list of all devices in the current capture and a database of previously captured devices, and allows for show/hide of specified device communications. Allows for exclusion of background traffic (default). Affects all panes.
Instant Timing Display Filter	Display button on *Instant Timing* toolbar	Shows/hides Establishment traffic and Idle traffic in the *Instant Timing* pane.
Instant Timing Keep-Only Filter	Right-click on packet in *Instant Timing* pane	Allows user to keep only the selected piconet. Affects all panes.
Overview Keep-Only Filter	Right-click menu on Overview	Line/Column (cell) context-sensitive filter to Keep or Exclude selected item.
Instant Spectrum Keep-Only Filter	Right-click on packet in Instant Spectrum view	Allows user to keep only the selected piconet. Affects all panes.
Instant Spectrum Display Filter	Display button on *Instant Spectrum* toolbar	Shows/hides Establishment traffic and Idle traffic in the *Instant Spectrum* pane.

To determine the current filter status:

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

8.1   Instant Filters

*Instant Filter*s are enacted as text strings in the *Instant Filter* boxes located atop the columns in the Overviews.

*Instant Filter*s provide a quick and easy way to remove specific information from the Overview using a simple syntax entered in the *Instant Filter* boxes located atop each column. *Instant Filter*s are comprised of a sequence of character chains and can be separated by commas for AND operations. *Instant Filter*s are not case-sensitive. *Instant Filter*s may be used on a static capture, saved capture, or during recording.

> Use of display filters can speed the process of uploading captured traffic to the PC. Filtering commonly occurring items that may not be required for the analysis task at hand can be helpful.

***Instant Filter*s Syntax**

The syntax of *Instant Filter*s is as shown below:

> filters = [!]filter[,filter,…]
> filter = string or wildcard range
> wildcard = string containing * or ? characters
> range = min..max

Wildcards can be used to perform advanced filtering operations. Use an interrogation point '?' to match to match any character, or an asterisk '*' to match any suite of characters. An asterisk is always implied at the end of any search string. A few examples:

> 0?FE will match any line that starts with 0 and end with FE.
> *data will match any line that contains the word data.
> E*r will match any line that starts with an E and contains an r.
> *read will match any line that contains read.

Filters also accept advanced criteria. For example, type 0..1 in the time column to keep only events that occur between 0 and 100 milliseconds.

Several criteria can be combined with a logical OR operation using a comma. For example, typing 2,4 in the device column will keep events having devices addresses beginning with 2 or 4.

A criteria can be inverted by using an exclamation point '!' as the first character in the filter. In this case, all events that would have been included are now excluded, and vice versa.

An informative Fly-Over is also useful in understanding how to use an *Instant Filter*.

To enable the Instant Filter Fly-Over:

1. Place the mouse pointer in any *Instant Filter* box and left-click.

The *Instant Filter* Fly-Over appears:

To apply an Instant Filter:

1. Select an *Instant Filter* box from one of the columns in the desired Overview.

2. Type the desired filter.

3. The selected *Instant Filter* box highlights in yellow.

> *Instant Filter*s can be applied to multiple columns, giving the user the ability to create very specific filters.

Examples

The example below will remove all items in the Overview that <u>do not begin</u> with the string "LMP", typically leaving only Link Manager Protocol visible.

The example below will remove all items from the Overview that <u>begin with</u> the string "LMP", typically leaving all items except for Link Manager Protocol.

The example below will remove all items that <u>do not begin with</u> the strings "L2CAP", "RFCOMM", and "LMP".

The example below will remove all items <u>except</u> those items taking place between timestamps located at 26 and 27 seconds.

The example below will remove all items <u>except</u> those items beginning with the string "Audio" in the **Items** column, <u>involving</u> the string "00:1A:7D" in the **Communication** column, and <u>beginning with</u> an "M" in the **Originator** column, typically audio transfers involving a particular device, where that device is master.

To remove a filter:

1. Click on the red cross adjacent to the filter desired for removal or alternatively, click on the down arrow next to the red cross .

A menu appears:

2. Click on **Clear Criteria**.

The selected filter is removed and the display updates.

8.2   Protocol / Profile Filters

A selection of protocol and profile filter icons is available on the Filter bar. These filters allow the user to show or hide specific protocols and profiles, including baseband and packet-level display options. The available filter options vary depending on the Overview selected (BR/EDR, Low Energy, and HCI).

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 particular item selected on the **Protocol** bar.

The protocol/profile filters available for the *BR/EDR Overview* are shown below:
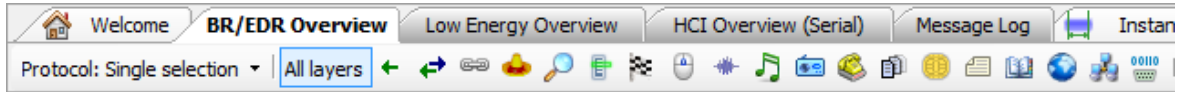
The protocol/profile filters available for the *Low Energy Overview* are shown below:
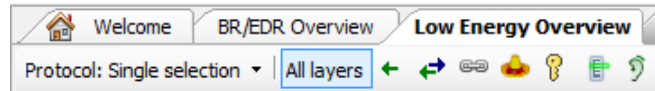
The protocol/profile filters available for the *HCI Serial* and *HCI USB* Overviews are shown below:

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

Icon	Function	Overview	Protocol: Selection
All layers	Shows all protocols and profiles	BR/EDR LE HCI	Single
←	Shows packets-only view	BR/EDR LE HCI	Single
⇆	Show/Hide Baseband	BR/EDR	Single, Custom
⇆	Show/Hide Link Layer	LE	Single, Custom
⊂⊃	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
♫	Show/Hide AVDTP/AVCTP	BR/EDR 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 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	BR/EDR LE HCI	Single, Multiple, Custom
	Show/Hide SMP	LE/HCI	Single, Multiple, Custom
	Show/Hide Hearing Aid	LE/HCI	Single, Multiple, Custom
	Show/Hide HCI	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:
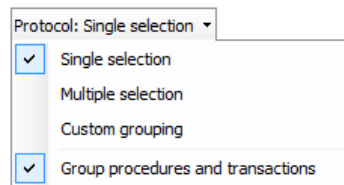
3. Select or deselect the desired filter icon(s) as desired.

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:
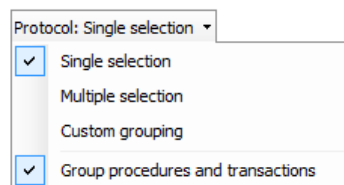
4. Select **All Layers.** All layers

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:
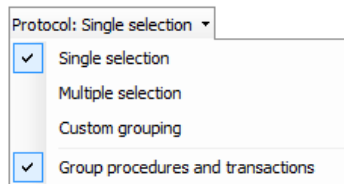
4. Select the **Packets** icon.

The Overview updates to show only individual packets.

8.3   Instant Piconet Keep-Only Filter

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 Chapter 12 Instant Piconet Pane.

To set an Instant Piconet Keep-Only Filter:

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

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

A **Keep-Only** filter dialog appears as shown below:
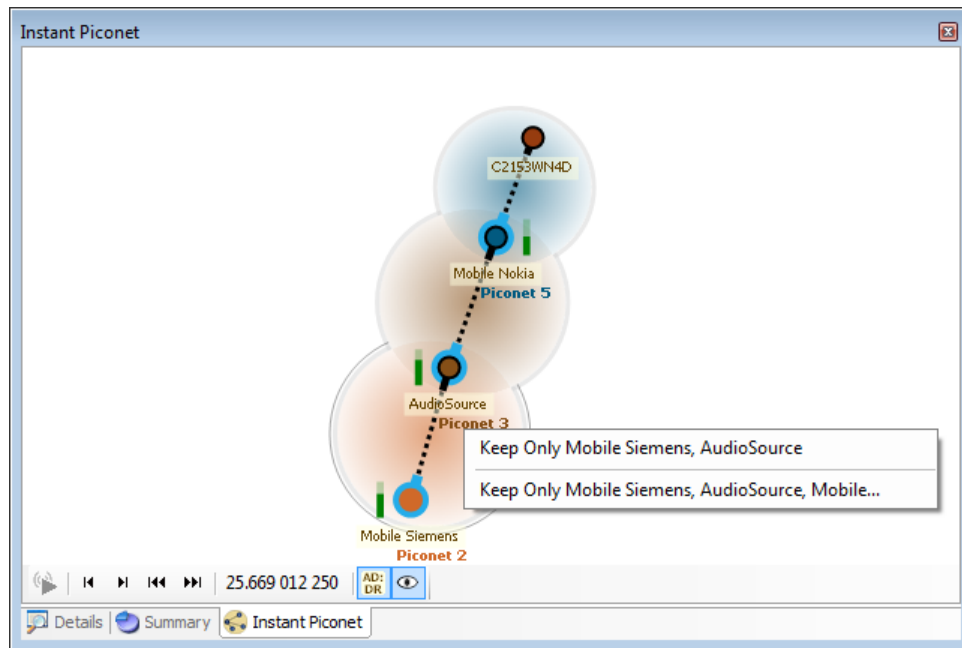
2. Select the desired **Keep-Only** option.

> The user may see more than one filter option displayed. To keep only the selected piconet, select the first option. If the piconet is part of a scatternet, select the second option to keep only the scatternet.

All displays and panes are updated to remove all but the selected piconet or scatternet traffic.

The **Filtering** button (on the Tool Bar) updates to show the selected filter:
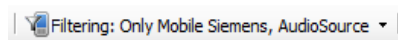
To clear an Instant Piconet Keep-Only Filter:

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

The **Filtering** menu appears:
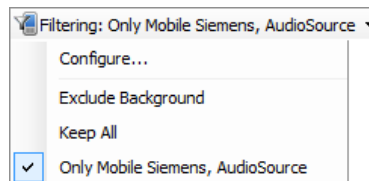
2. Select **Exclude Background** (this is the default setting).

All displays and panes are updated.

i Inquiry event and paging events can also be filtered in the manner described above for piconets and scatternets.

8.4   Device Traffic Filter

The Bluetooth Explorer 400 application provides a powerful *Device Traffic Filter* designed to allow the user to be very precise in terms of precisely controlling the device traffic displayed throughout all of the application's panes.

The *Device Traffic Filter* window provides a searchable database of all devices captured by the analyzer, including historically captured devices, located in the **Device Database** tab. Each listed device includes ancillary information, including LMP Name, BD_ADDR, Radio type, and Company ID.

The user can use the *Device Traffic Filter* to rename devices with user-defined names, 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.

✅ 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. 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.
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 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:
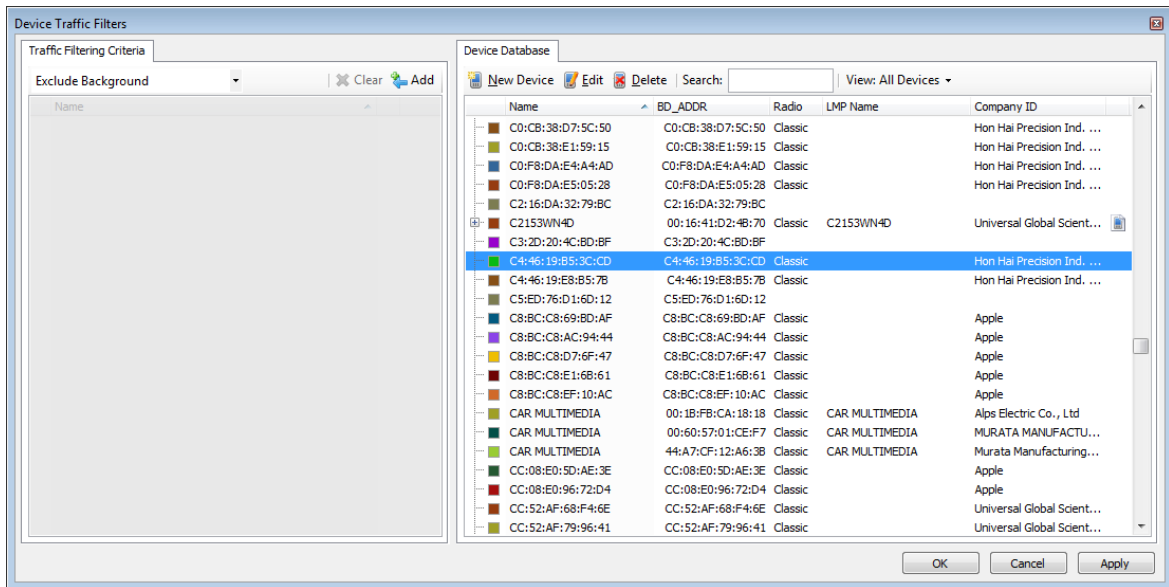
To keep only specified devices:

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

2. The *Device Traffic Filter* window appears.

3. Double-click the desired devices in the **Device Database** to add these devices to the **Traffic Filtering Criteria** Select the desired device and click on the **Add** button in the **Traffic Filtering Criteria**, as shown below:
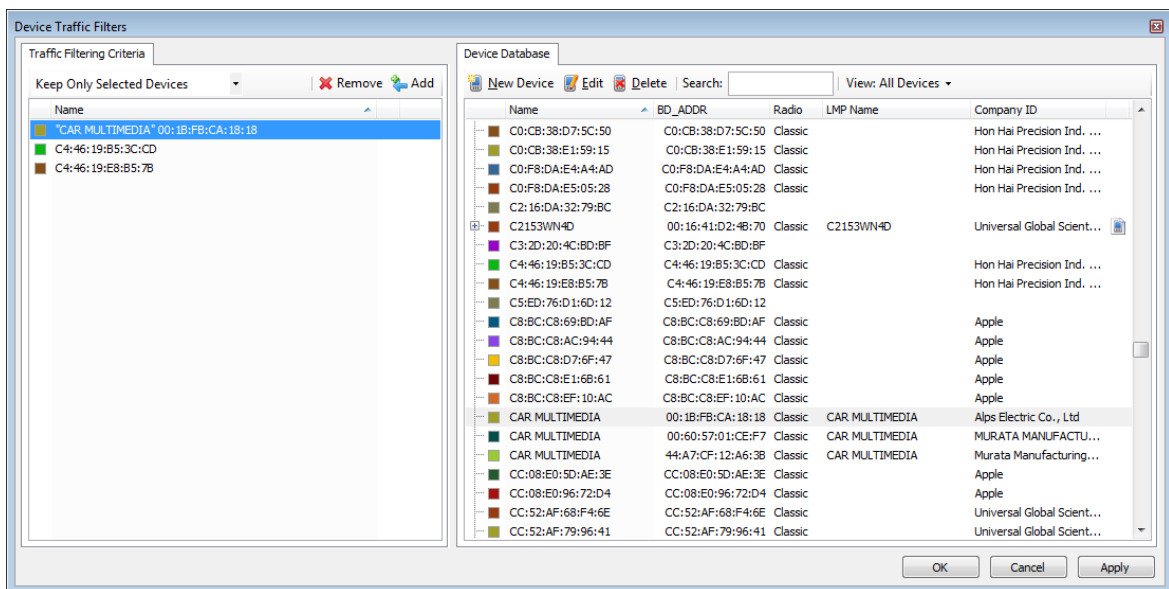
Devices selected are populated into the **Traffic Filtering Criteria**.

> Another useful method to add devices from the **Device Database** to the **Traffic Filtering Criteria** is to use the **Search** feature. See the section below

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titled To use the Search devices feature:

4. Select **Keep Only Selected Devices** in the **Traffic Filtering Criteria**:
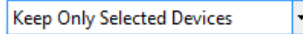
5. Click **OK**.

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 from the panes.

The **Filtering** button is updated to show the filter created:
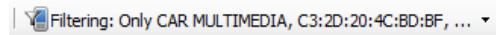
To use the Search devices feature:

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

2. The *Device Traffic Filter* window appears.

3. 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**).

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

5. 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.

6. 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:
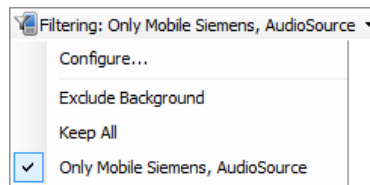
2. Select **Exclude Background** (this is the default setting).

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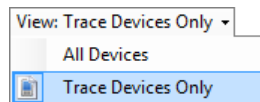
> *ⓘ* The **View** drop-down menu is grayed out if a capture is not open or a capture is not in process.

4. Select **Trace Devices Only**.

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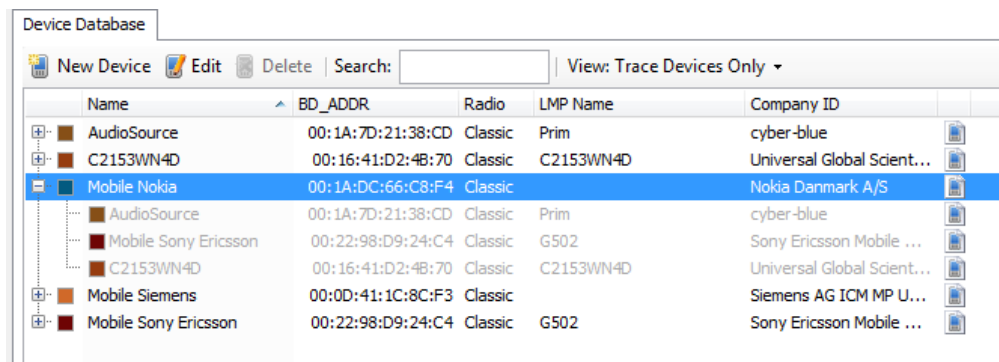
5. Click **OK**.

> *ⓘ* Devices captured in the current trace are indicated with the 📄 icon and include an expandable tree (+), showing other devices with which that device

has communicated.

To remove a device from the Device Database:

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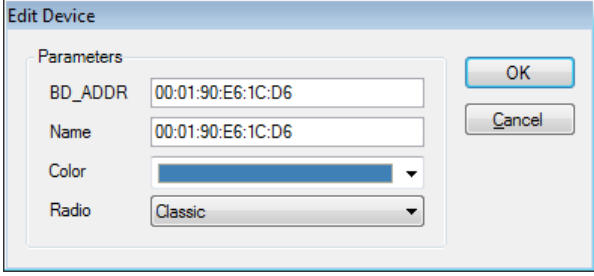
> To delete multiple devices, hold the keyboard CTRL button while selecting, or the SHFT button to select contiguous device entries.

4. Click the **Delete** button ![Delete] 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.

2. The *Device Traffic Filter* window appears.

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

4. Click on **Edit** ![Edit] or right-click the selection and select **Edit Device**.

5. The **Edit Device** dialog appears:
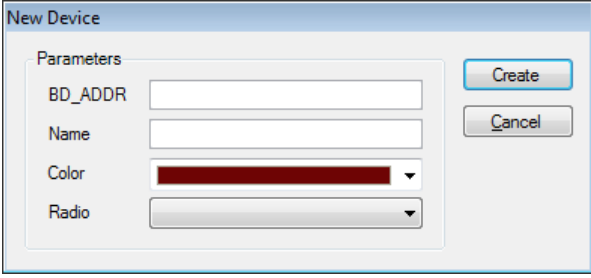
6. Edit the desired properties (**BD_ADDR**, **Name**, **Color**, or **Radio**) as desired.

7. Click **OK**.

To manually add a new device to the Device Database:

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

2. The *Device Traffic Filter* window appears.

3. Click on **New Device** in the **Device Database.** ![New Device]

The *New Device* dialog appears:

4. Edit the **Parameters** as desired.

5. 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.

2. The *Device Traffic Filter* window appears.

3. Click on the header above the column desired:

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

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

> *i* 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.

2. The *Device Traffic Filter* window appears.

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

4. Click **OK**.

Background traffic is removed from the capture.

> *i* This 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.

8.5   Instant Timing Display Filter

The *Instant Timing* pane (see Chapter 9, Instant Timing Pane) includes display filters for show/hide of **Establishment Traffic** (inquiries, paging events, and advertisements) and show/hide of **Idle Traffic** (ID packets, Null, Poll packets or empty packets). These filters are available from the **Display** button located on the *Instant Timing* toolbar, below. This filter applies only to the *Instant Timing* pane.
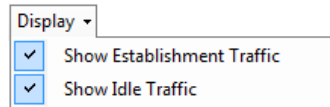
8.6   Instant Timing Keep-Only Filter

The *Instant Timing* pane provides a convenient Keep-Only filter that allows the user to select specific communications for display throughout the application, while hiding all other communications.

To enable the Instant Timing Keep-Only filter:

1.   Select a packet in the desired piconet line in the *Instant Timing* pane.
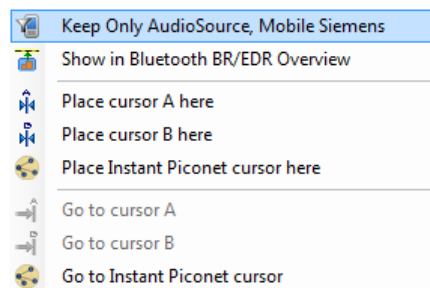
2.   Right-click and select the **Keep Only** option, as shown below.

All panes in the application update to show only the selected communications.

To clear the Instant Timing Keep-Only filter:

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

The **Filtering** menu appears:
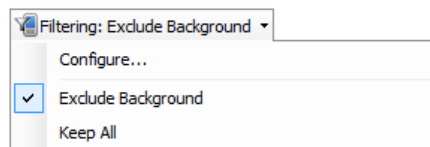
2.   Select **Exclude Background**.

All displays and panes are updated.

8.7   Instant Spectrum Display Filter

The *Instant Spectrum* view (see Chapter 10, Instant Spectrum View) includes display filters for show/hide of **Establishment Traffic** (inquiries, pagings, and advertisements) and show/hide of **Idle Traffic** (ID packets, Null, Poll packets or empty packets). These filters are available from the **Display** button located on the *Instant Spectrum* toolbar, below. This filter applies only to the *Instant Spectrum* view.
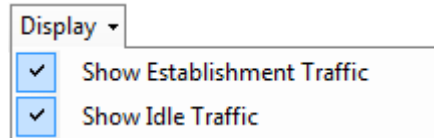
8.8   Instant Spectrum Keep-Only Filter

The *Instant Spectrum* view provides a convenient Keep-Only filter that allows the user to select specific communications for display throughout the application, while hiding all other communications.

To enable the Instant Spectrum Keep-Only filter:

1.   Select a packet in the *Instant Spectrum* view.

2.   Right-click and select the **Keep Only** option, as shown below.
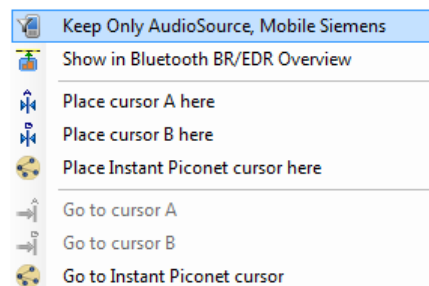
All panes in the application update to show only the selected communications.

To clear the Instant Spectrum Keep-Only filter:

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

The **Filtering** menu appears:

2.   Select **Exclude Background**.

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All displays and panes are updated.

8.9 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:
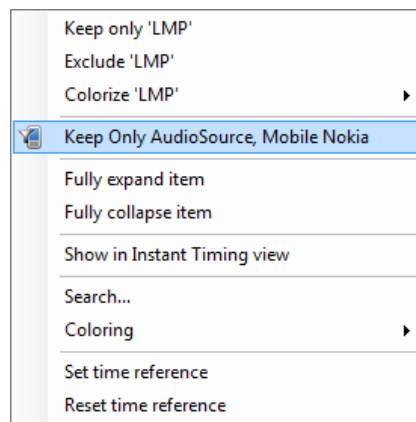
The Overview and all panes are updated with the **Keep-Only** selection.

9. Instant Timing Pane

The *Instant Timing* pane provides a unique and intuitive way to understand various timing characteristics of Bluetooth traffic, HCI traffic, and logic signals as well as throughput characteristics.

Bluetooth packets are presented chronologically left to right and are uniquely color-coded according to the packet's sender. 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 HCI traffic, logic signals and a representation of throughput, all in synchronization with the through-the-air traffic.

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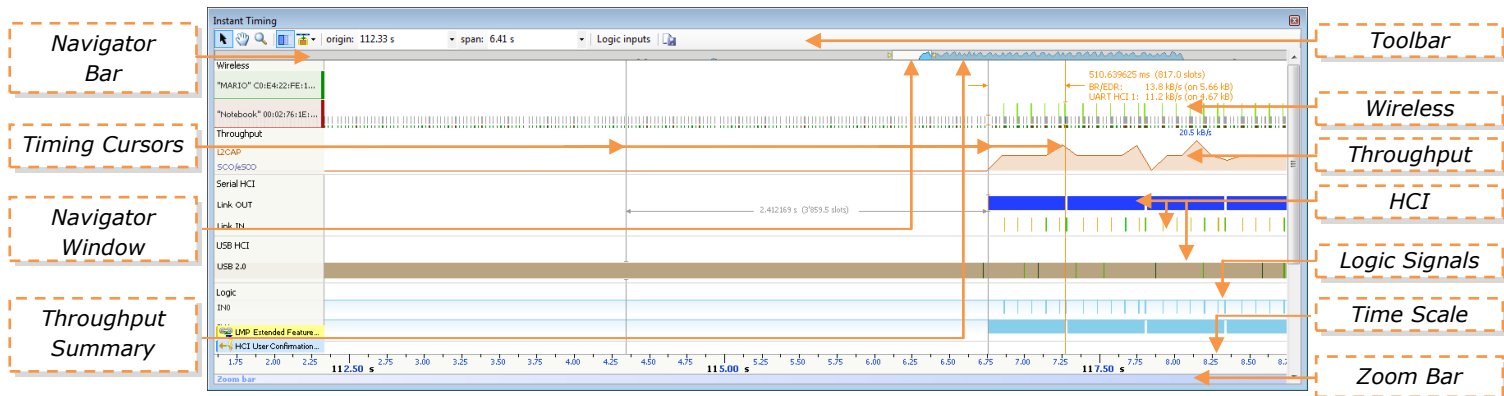
The *Instant Timing* pane is linked to the Overviews and also the *Instant Spectrum* view. It is manually linked to the *Instant Piconet* pane by the *Instant Piconet* cursor, which when scrolled, updates the *Instant Piconet* view according to its current location. Conversely, when events are selected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

> Note that since the Bluetooth Explorer 400 is designed to be purely passive (does not interact with Bluetooth devices/piconets) timing measurements will be extremely precise.

To access the Instant Timing pane:

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

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The *Instant Timing* pane appears:
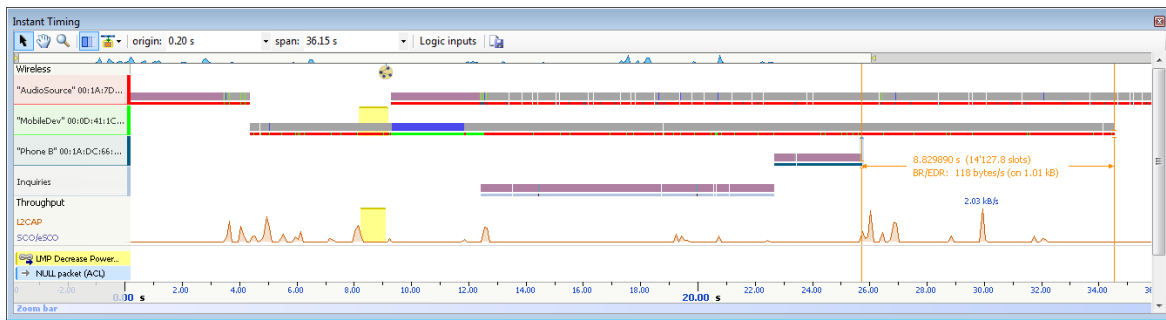
9.1   Device and Packet Color-Coding

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).

Master 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 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.

9.2   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	

	✓	**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 time span (zoom level) of the *Instant Timing* pane. Allows for user input to adjust span.
Display	**Display**		
	✓	**Show Establishment Traffic**	Shows/hides inquiries, pagings, and advertisements.
	✓	**Show Idle Traffic**	Shows/hides ID, Null, Polling and empty packets.
Logic inputs	**Logic Inputs**		Opens Logic Signals Dialog
🖬	**Export Image**		Exports the *Instant Timing* pane to an image file.

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	Navigation Bar	Global overview allowing for pan, zoom, and jump.

9.3   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** [hand icon].

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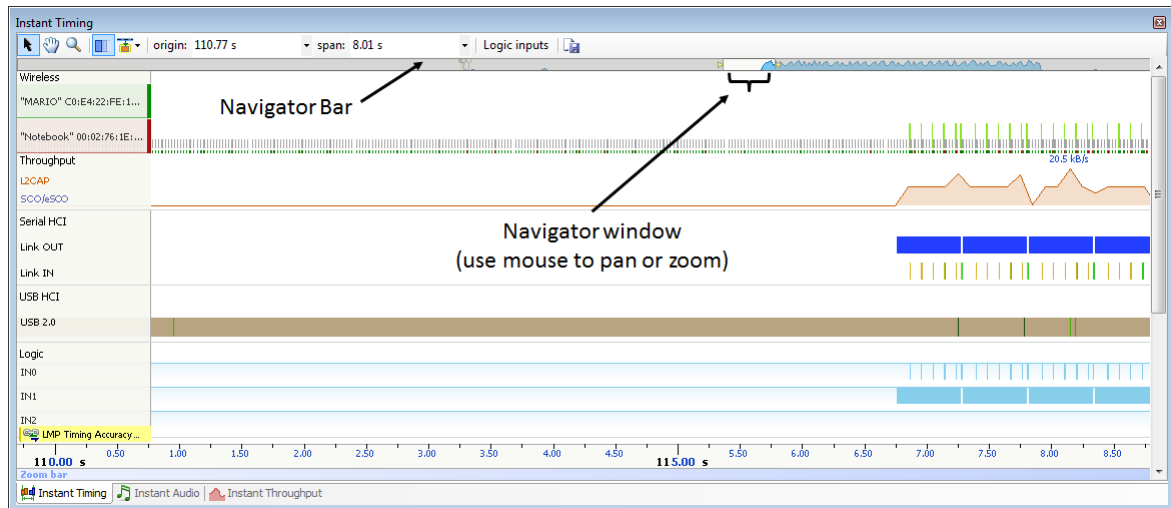
2. Press and hold the left mouse button, and drag left or right as desired to pan left or right.

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.

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.

origin: | 319,085.37 us | ▾ |

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.

9.4   Zooming In and Out

The *Instant Timing* pane provides a zoom feature to expand or contract the display in order 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 symbol 🔍.

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 large 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.

9.5   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:

- Timing Cursors (mouse left-click/drag)
- 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.
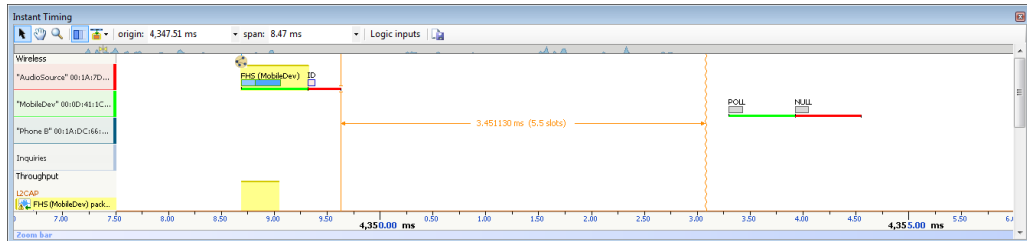
Right Line Not Attached
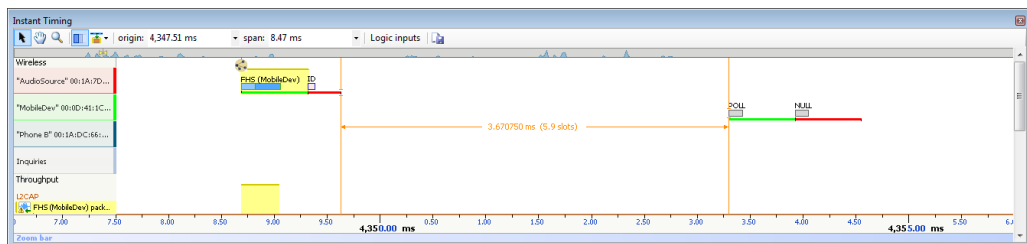
Both Lines Attached

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 **Freeze** ❄ 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.

2. 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.
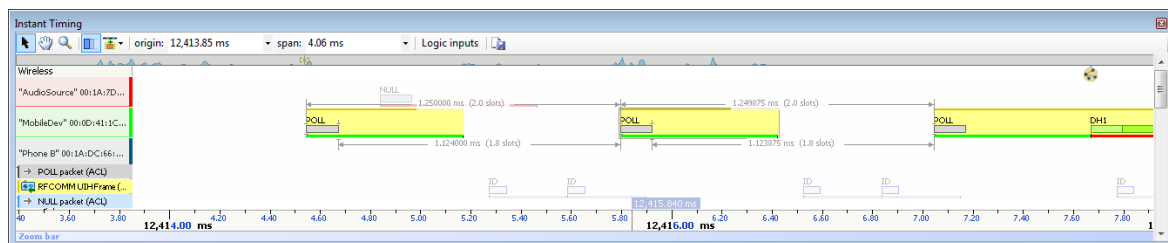
To make time measurements using the A-B cursors:

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 otherwise navigate as needed to the other event to set the second cursor.

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

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 Timing* pane.

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:
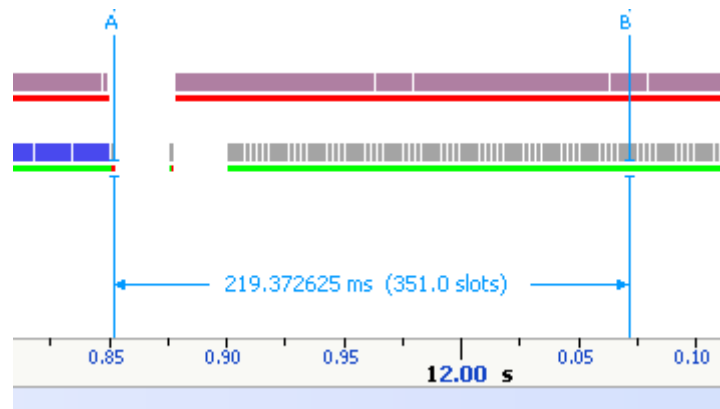
9.6   Time Scale Set and Reset

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.

9.7 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 in time.

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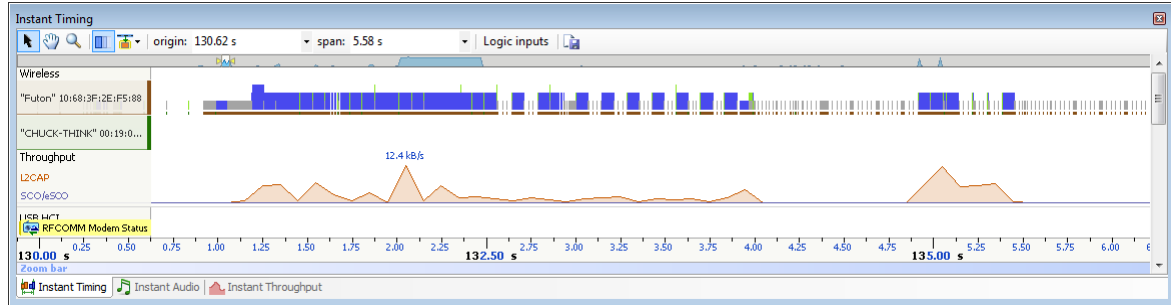
L2CAP Throughput
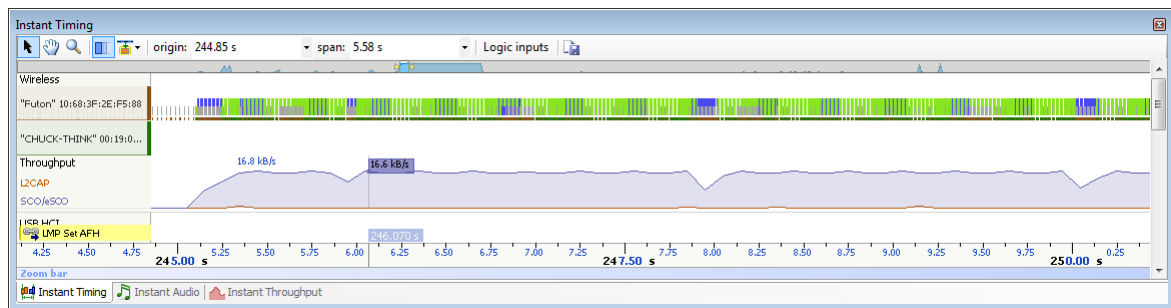
SCO/eSCO Throughput

9.8 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**.

3. A marker is placed at the selected event/location.

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To search markers:

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

A list of all markers installed appears:
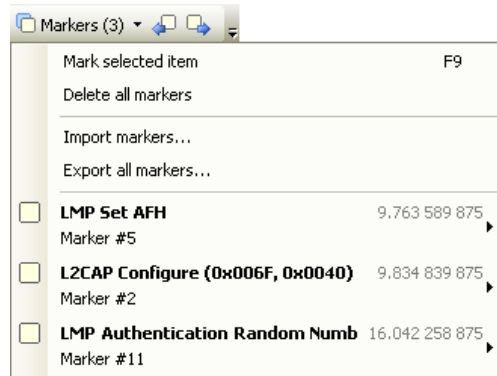
2. Select the desired marker from the list.

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 .

3. Position the mouse pointer over the desired marker:
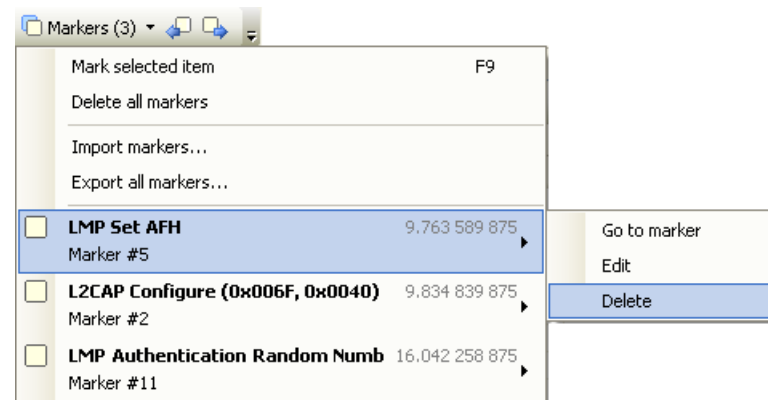
4. Select **Delete**.

The marker is removed.

To edit a marker:

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

9.9   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.

2. 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:
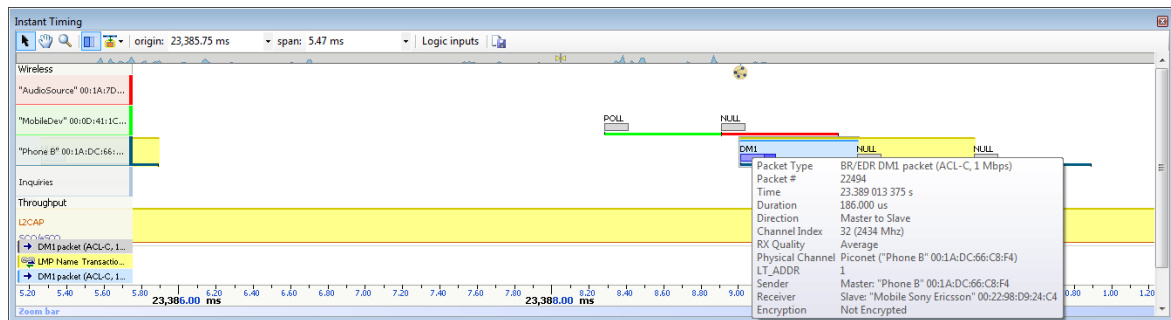
To view packet start, header end, or packet end times:

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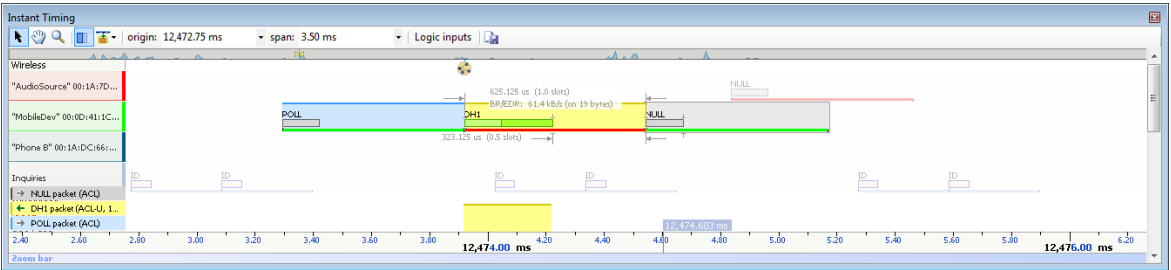
Identifier	Highlight color
Mouse flyover location in *Instant Timing*	→ NULL packet (ACL, 1 Mbps)
Selected Overview event	← DH1 packet (ACL-U, 1 Mbps)
Selected *Instant Timing* event	→ POLL packet (ACL, 1 Mbps)

9.10 Display of HCI, WCI-2, and Logic Signals

In addition to wireless traffic, the *Instant Timing* pane also displays any captured HCI or WCI-2 traffic, as well as logic signals.

HCI (UART and SPI) and WCI-2 traffic, as well as logic signals are captured using the Flying Leads adapter, attached to the IO Probe connector on the back of the unit. See Appendix A – Flying Leads Cable for details. USB HCI is captured using the available front panel USB ports.

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):
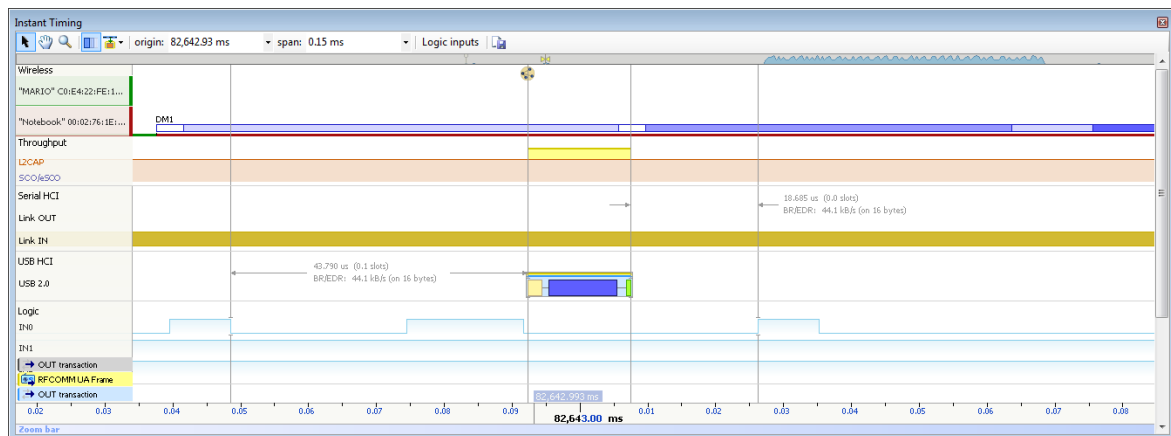
The analyzer will capture up to 12 logic lines and will compress the logic transitions with a very efficient engine, but the throughput of the compressed data will be directly related to the frequency of the lines. The more lines that are toggling fast, the higher the throughput requirement, and at some 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:

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

5. 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.

6. 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.

9.11 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.

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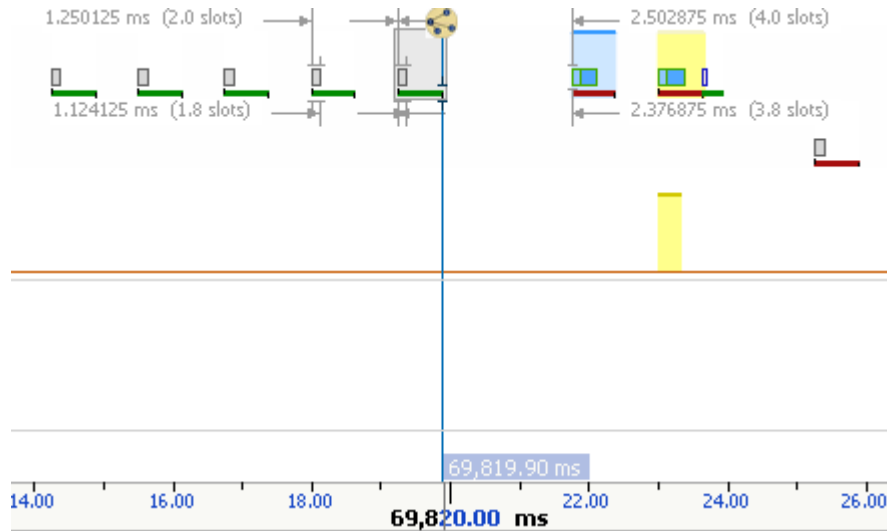
2. Select and drag the *Instant Piconet* cursor while observing the *Instant Piconet* pane.

The *Instant Piconet* pane updates according to the position of the *Instant Piconet* cursor.

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

9.12 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.**
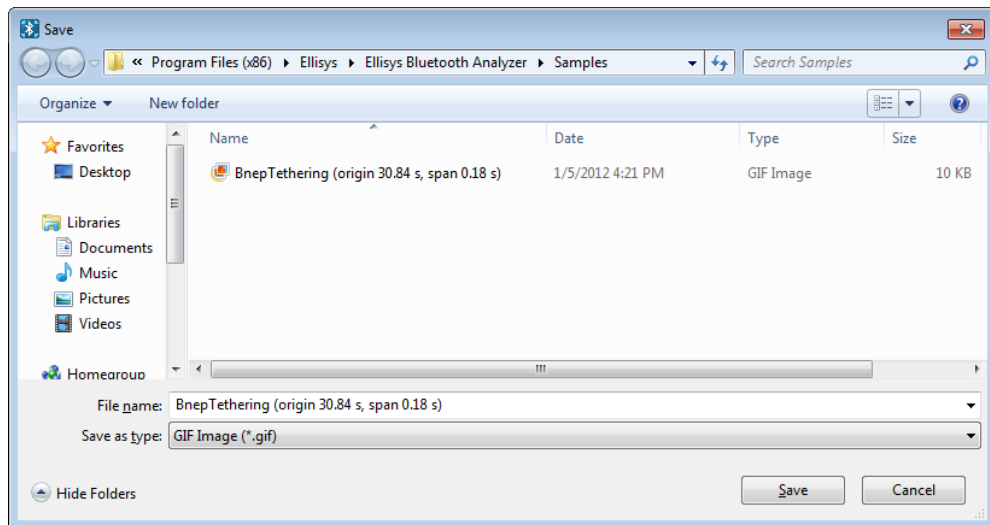
The file is exported in the desired format to the selected directory.

9.13 Synchronizing to Other Views

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

- 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.

- 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.

- Selecting timestamps in the *Instant Piconet* pane will cause the *Instant Timing* pane to jump to the selected timestamp location.

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

- 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.

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10. Instant Spectrum View

The *Instant Spectrum view* provides a unique and intuitive way to understand the spectral behavior of Bluetooth traffic as well as all RF traffic within the Bluetooth spectrum, and the inter-relationship of Bluetooth packets and events to RF energy events, such as WiFi.

Bluetooth packets are presented chronologically left to right on the channel they are transmitted and are uniquely color-coded according to the packet's sender. On the right, graphical per-channel statistics on packet errors and retransmissions are presented in a graphical format.
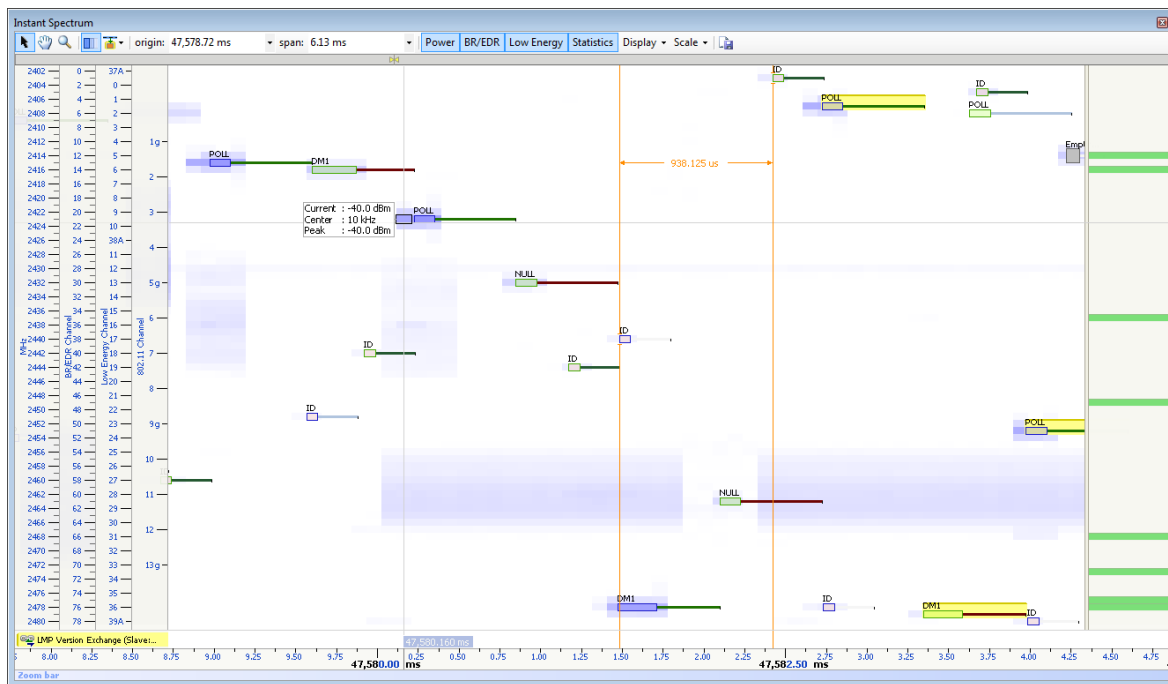
Note that certain features are included only with the optional Raw Spectrum feature. Contact Ellisys for details.

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 the Bluetooth packets.

Raw RF energy is displayed in blue, in an overlay fashion with captured Bluetooth 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 according to 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, including MHz, BR/EDR Channel, Low Energy 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:
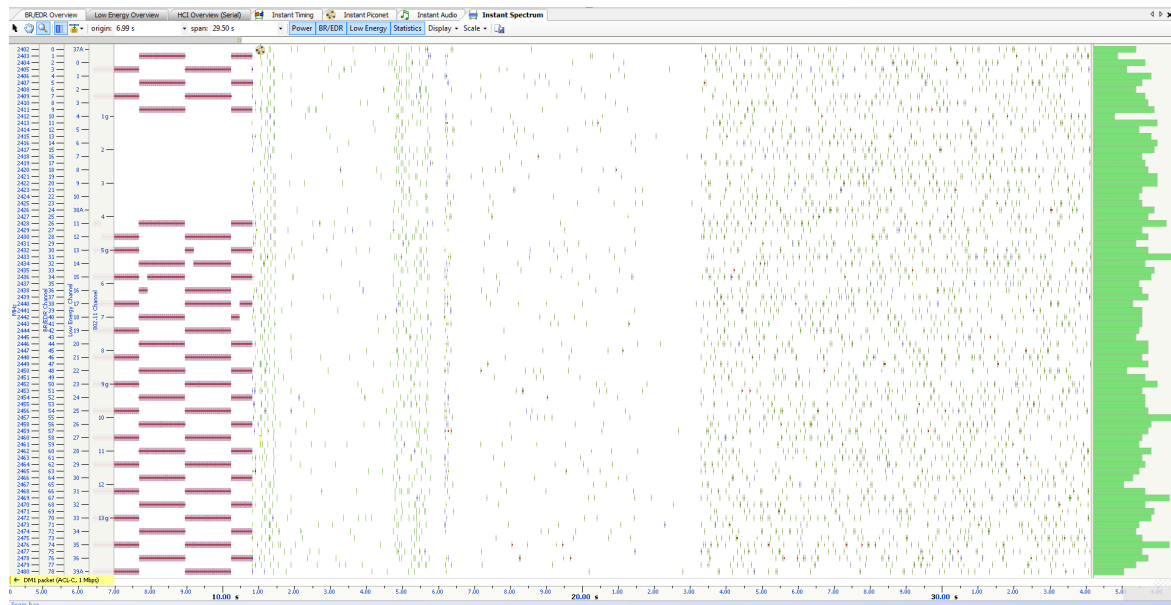
10.1 Device and Packet Color-Coding

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 8.4 Device Traffic Filter).

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

10.2 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:

		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 feature.
		Highlighting Options	
	✔	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.
	✔	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 time span (zoom level) of the *Instant Timing* pane. Allows for user input to adjust span.
Scale ▾		Scale	
		MHz	Display a scale showing the Bluetooth spectrum in MHz.
		BR/EDR Channels	Display a scale showing the Bluetooth spectrum by Bluetooth channels.
		Low Energy Channels	Display a scale showing the placement of Low Energy channels.
		802.11 Channels	Display a scale showing the placement of 802.11 channels.
		Higher Frequency on Top	Reverses the scaling to show highest frequencies at the top of the scales.
Display		Display	
	✔	Show Establishment Traffic	Shows/hides inquiries, pagings, and advertisements.
	✔	Show Idle Traffic	Shows/hides ID, Null, Polling and empty packets.
		Export Image	Exports the *Instant Timing* pane to an image file.

	Navigation Bar	Global overview allowing for pan, zoom, and jump.

10.3 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 large 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 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.

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2. 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.

10.4 Zooming In and Out

The *Instant Spectrum* view provides a zoom feature to expand or contract the display in order 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 or alternatively, click on **Zoom** 🔍 .

The pointer changes to a spyglass symbol 🔍 .

1. 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 large 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.

span: 0.49 ms

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.

10.5 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:

- 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 **Freeze** ✳ 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.

2. 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.

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:

10.6 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.

10.7 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 12 Instant Channels).

The *Channel Statistics* feature is displayed at the right side of the *Instant Spectrum* view. The *Channel Statistics* view will scale in time according to the time span selected.

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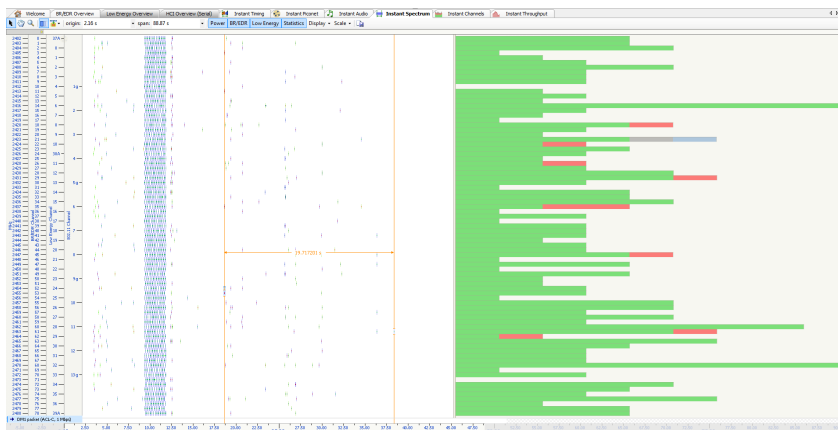
10.8 Using Markers

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**.

3. 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:
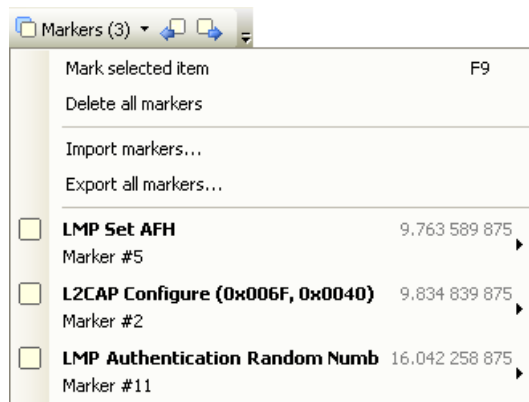
2. Select the desired marker from the list.

The *Instant 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.

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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.
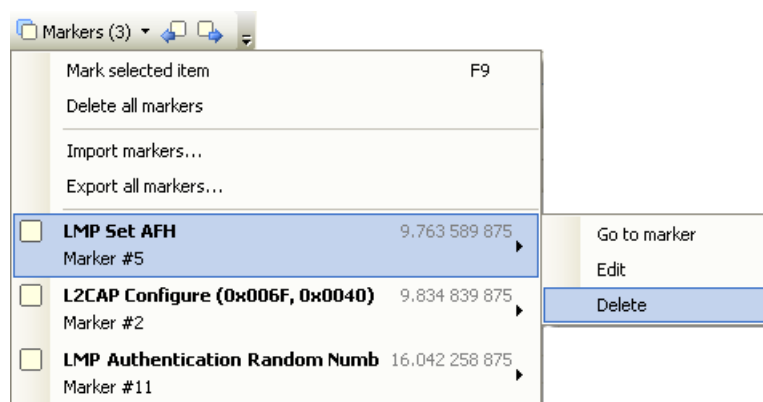
4. Select **Edit**.

The selected marker opens for editing.

10.9 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.

2. 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:
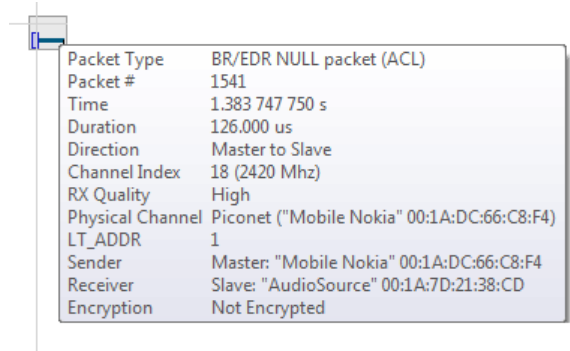
To view packet start, header end, or packet end times:

1. Place mouse pointer directly on packet.

2. Slide mouse point 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)

10.10   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.

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The *Instant Piconet* cursor appears:
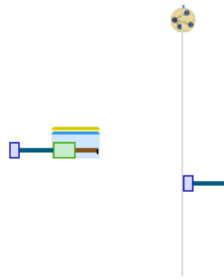
1. Select and drag the *Instant Piconet* cursor while observing the *Instant Piconet* pane.

The *Instant Piconet* pane updates according to the position of the *Instant Piconet* cursor.

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

10.11   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.**
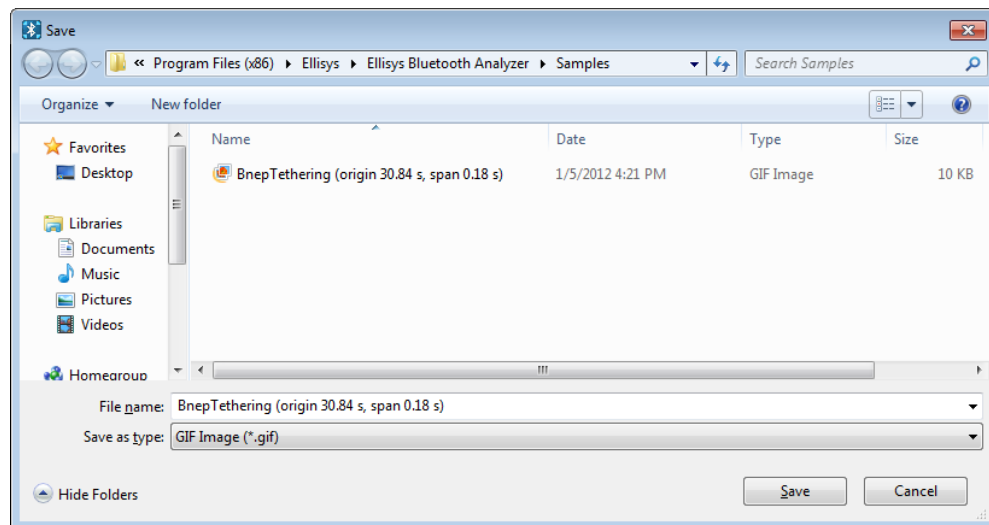
The file is exported in the desired format to the selected directory.

10.12   Synchronizing to Other Views

The *Instant Spectrum* view is synchronized to other views, either directly or indirectly, in order 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 in the Overview and in the *Instant Spectrum* pane:
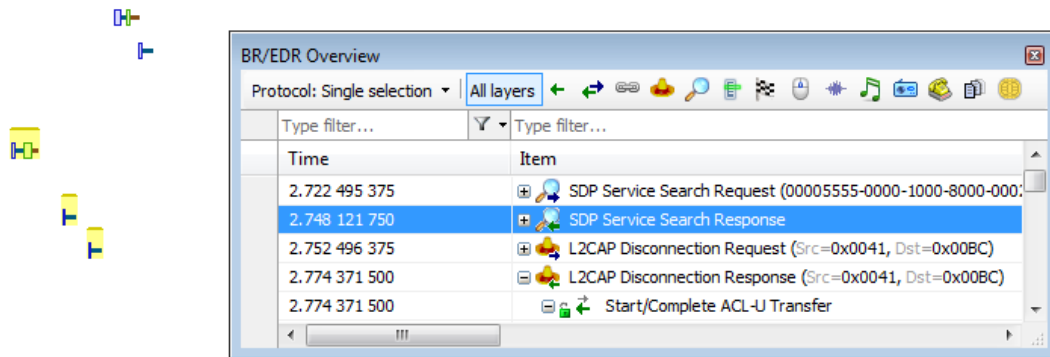
10.13 AFH Highlighting

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:
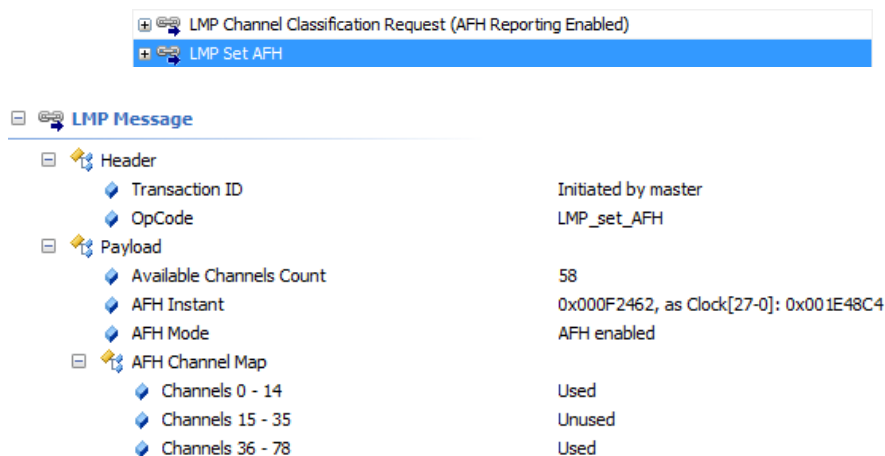
2. Select **View | Instant Spectrum**

3. Select a packet at the desired location in the *Instant Spectrum* view.

The channels precluded by the active AFH command are now highlighted:

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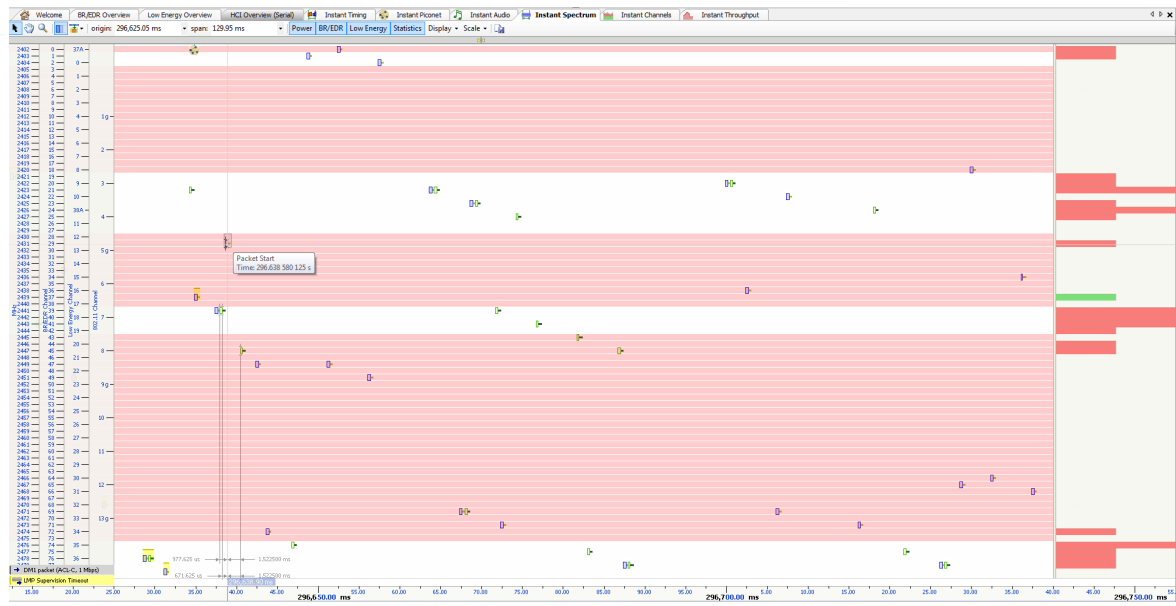
10.14   Wireless Spectrum Capture

In addition to spectral display of captured Bluetooth and Low Energy 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 as blue energy indicators, interspersed with any captured Bluetooth or Low Energy packets. The RSSI of this energy is indicated with a fly-over.

A color gradient is used to indicate the relative strength of captured RF. Darker blue energy indications indicate stronger RSSI, whereas lighter blue indications indicate weaker RSSI. A mouse-over on any RF event will display the precise RSSI.

> Wireless Spectrum capture is an optional feature. As needed, contact Ellisys to upgrade your BEX400 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**).
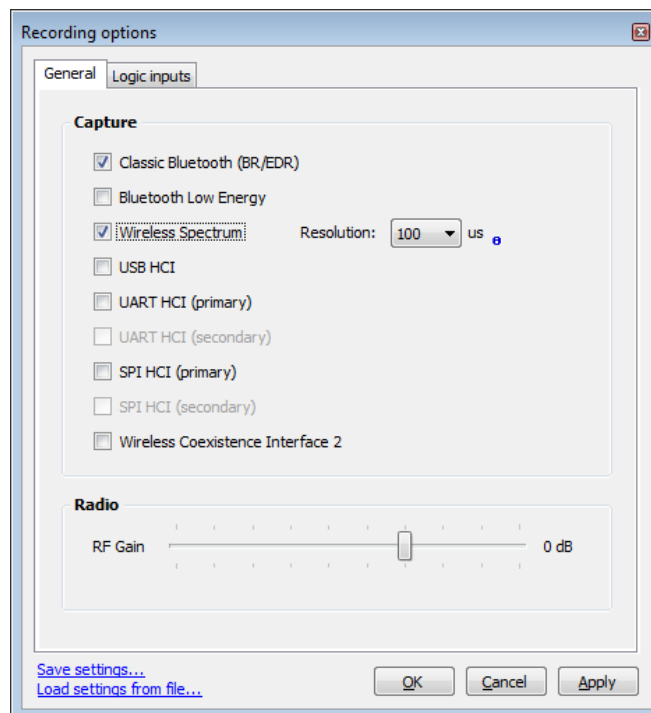
2. Select a **Resolution** and click **OK**.

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 capture Bluetooth packets:
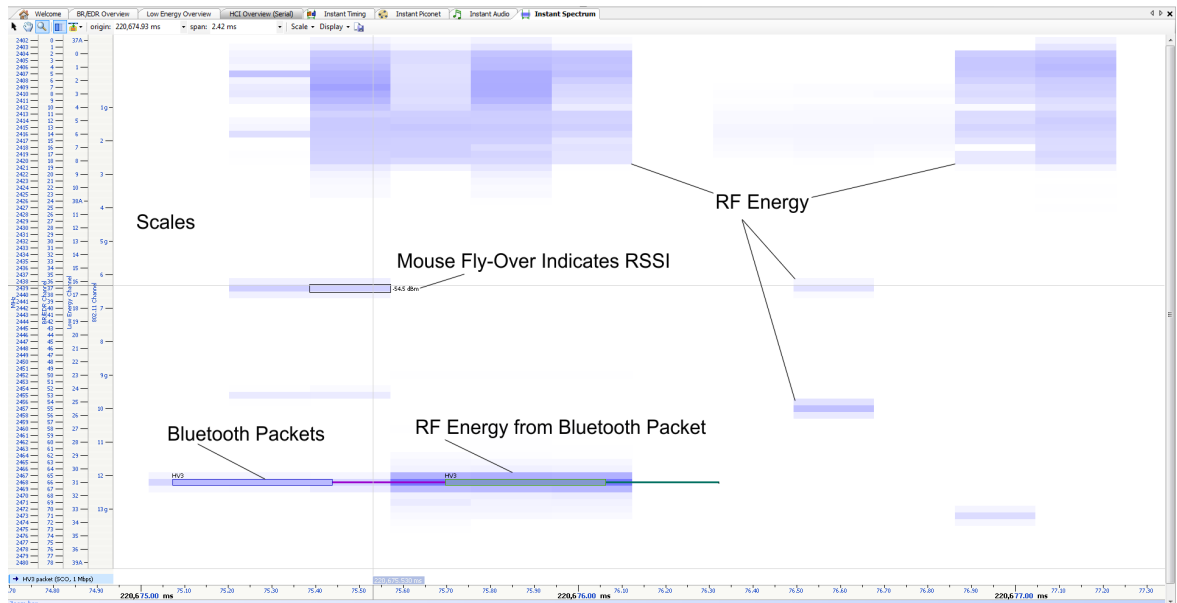
To view the AFH Highlighting with Wireless Spectrum Enabled:

1. Take a capture with **Wireless Spectrum** enabled, or open a capture that was taken with **Wireless Spectrum** capture enabled.

AFH Highlighting is displayed along with Wireless Spectrum information. In the figure below, the *Instant Spectrum* shows both raw RF energy and Bluetooth packets. Note the presence of Wi-Fi traffic in the highlighted areas and the absence of Bluetooth packets in these areas:

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11. 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 are can be selected for use by this feature.

> 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:
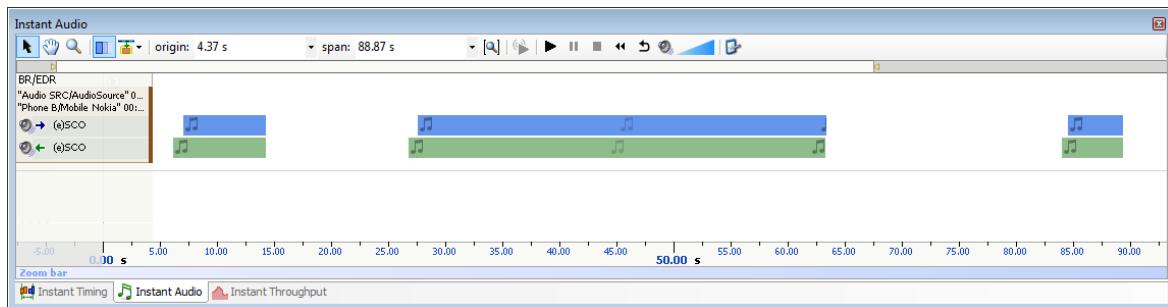
11.1 User Controls and Toolbar

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:	**Origin Box**	Displays the timestamp origin of the *Instant Audio* pane. Allows for user input of timestamp for jumping.
span:	**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
	Follow Live	Audio is played as it is captured
	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

11.2 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.

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:
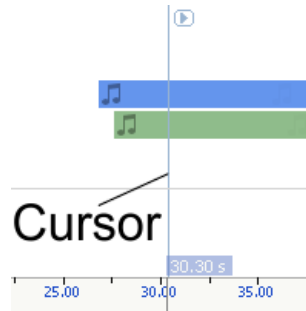
To select a range of audio to play:

1. Left-click at the desired starting position and drag to select the range desired.

The select range is highlighted and characterized with a time indication:
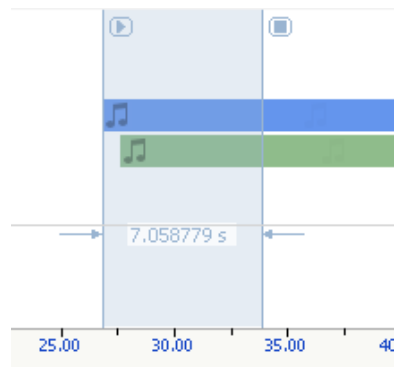
To enable or disable playback from a selected audio stream:

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.

11.3 Audio Options

To set Instant Audio options:

1. Select the **Options** icon on the *Instant Audio* toolbar 🔳.

The **Options** dialog opens:
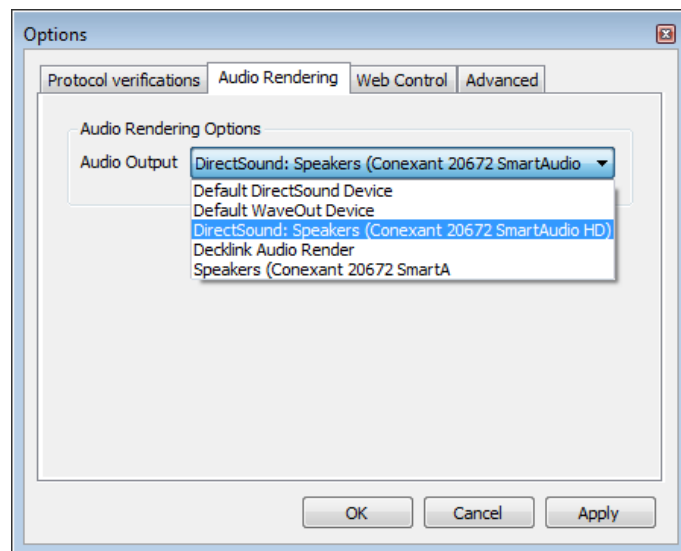
2. Select the desired device and click **OK**.

11.4 Audio Stream Flyover and Details

To see details on a captured audio stream:

1. Place the mouse over the desired location in the *Instant Audio* pane.

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Details on the selected audio are displayed in a fly-over:
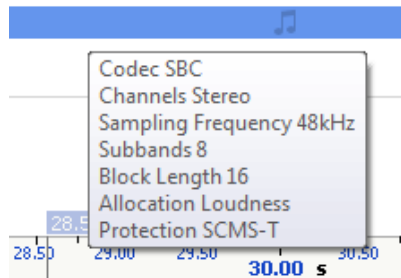
11.5 Using Markers

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**.

3. 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:
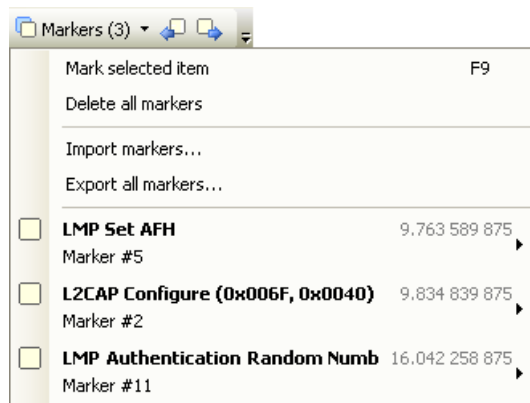
2. Select the desired marker from the list.

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:
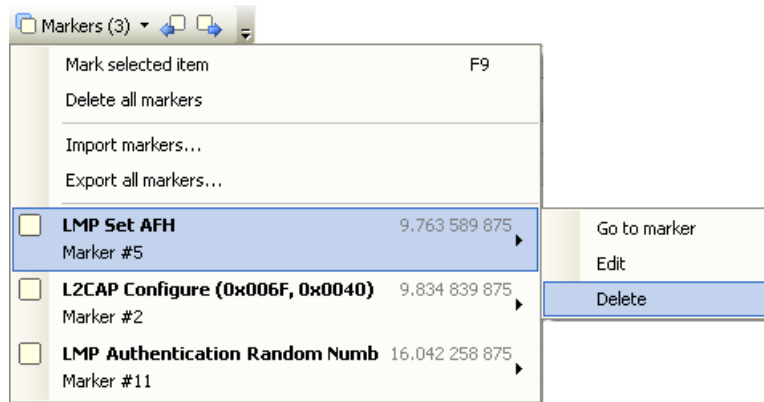
3. Select **Delete**.

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.

11.6 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 large 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 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.

origin: [319,085.37 us] ▼ :

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.

11.7 Zooming In and Out

The *Instant Audio* pane provides a zoom features to expand or contract the display in order 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 symbol .

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 large 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 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.

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11.8 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:

- Range Select Timing Cursors
- 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:

5.323875 ms

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 **Freeze** 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.

2. 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.

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:

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12. Instant Channels

The *Instant Channels* feature provides visual and statistical analyses on various per-channel transmission characteristics, including packet retransmissions, header errors, and payload errors.

The *Instant Channels* pane includes a *Navigator* bar, which allows for global pan and zoom to traffic concentrations of interest.

Each Bluetooth channel (0 through79) is listed across the bottom of the *Instant Channels* pane, increasing left to right. A histogram is associated with each channel and is color-coded to indicate OK packets (green), retransmissions (blue/original packet transmission and grey/retransmitted packet), and packet header and payload errors (red).

To access the Instant Channels pane:

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

The *Instant Channels* pane appears:
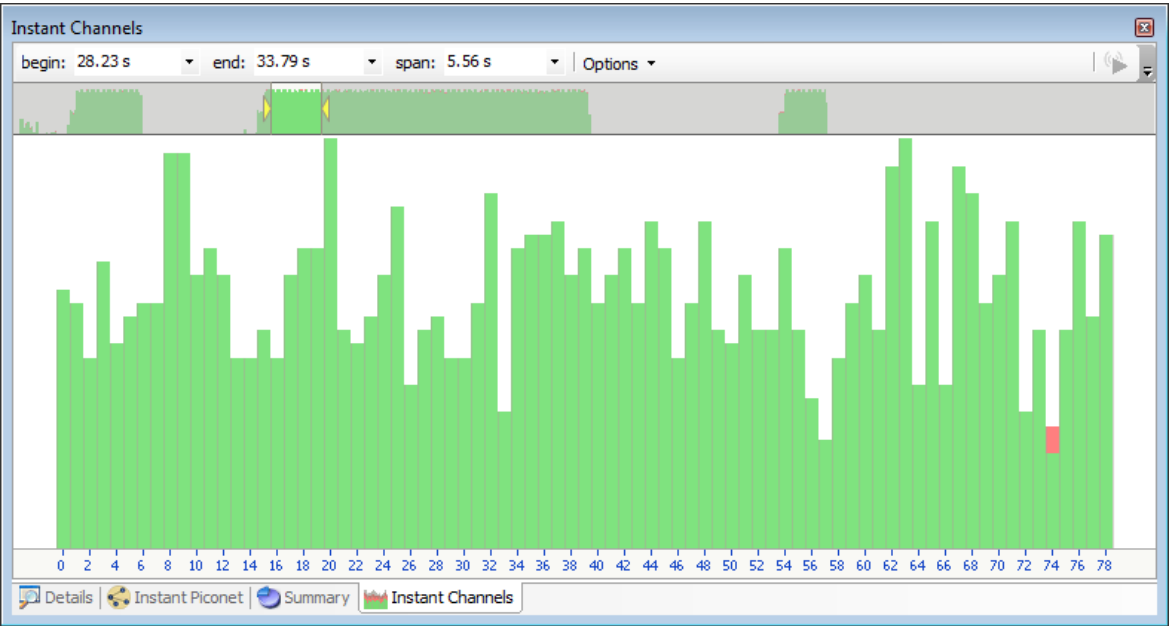
The *Instant Channels* feature will track all packets from all devices being displayed in the application. To narrow the *Instant Channels* display down to specific devices, use a Device Filter to show only the devices of interest. See Section 8.4 Device Traffic Filter for more information on filtering the display.

12.1 Users Controls and Toolbar

begin: 45.95 s	**Timestamp Begin**	Tracks *Navigator* selection and can also be used to manually enter a timestamp origin.

end: 49.95 s ▾ **Timestamp End**		Tracks *Navigator* selection and can also be used to manually enter a timestamp end.
span: 4.00 s ▾ **Span**		Tracks *Navigator* selection and can also be used to manually enter a display span.
Options ▾ **Options**		Enables and disables display options.

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:

```
Channel:          30
Not applicable:   0 ( 0.00% )
Retransmitted:    0 ( 0.00% )
Header errors:    0 ( 0.00% )
Payload errors:   1 ( 25.00% )
Ok:               3 ( 75.00% )
```

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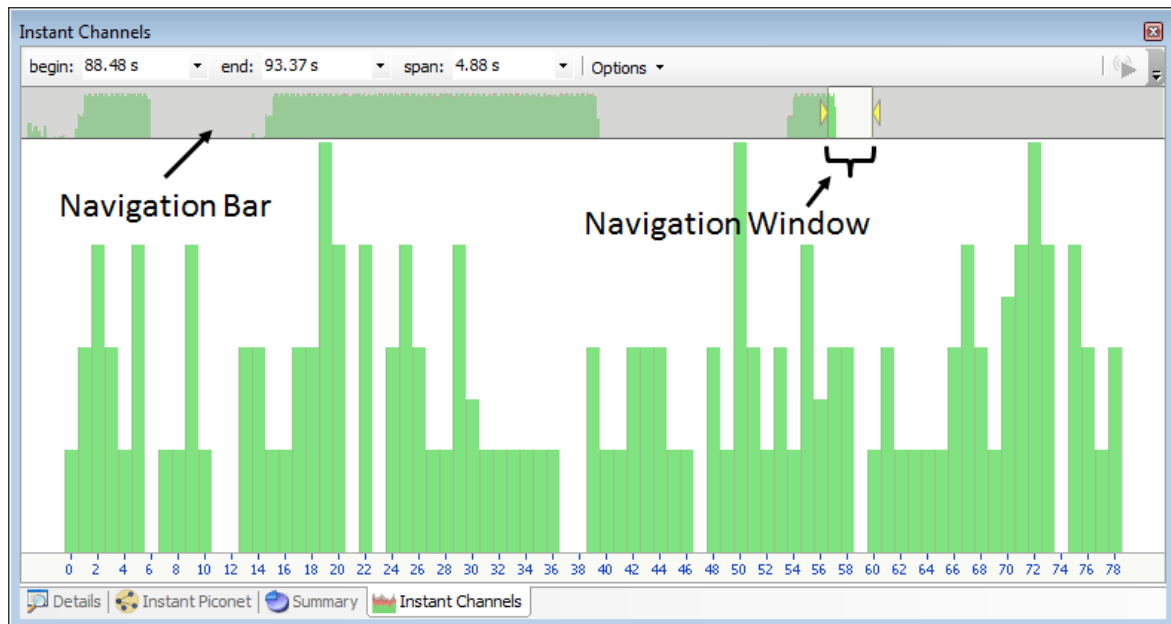
2. Press and hold the left mouse button, and drag left or right as desired to pan left or right.

To use the Navigator bar to zoom:

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

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

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To define a new time span:

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

span: 0.49 ms

2. 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.

12.2 Synchronizing to Other Views

The *Instant Channels* display is synchronized to the active Overview (*BR/EDR Overview* or *LE 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:

Options ▼
✔ Follow overview selection
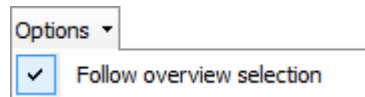
2. Select or de-select **Follow overview selection** as desired to follow or not follow selections made in the active Overview.

13. Instant Throughput

The *Instant Throughput* pane displays payload throughput by device and by protocol (L2CAP channel and SCO/eSCO). A color-coded scheme is used to differentiate these various device/protocol throughput indications. The user is able to 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 also allows the user to pan, zoom, and jump to any desired location.

Timing cursors are available in order 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	

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	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.

13.1 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 large 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.

origin: 319,085.37 us

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* 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.

13.2 Zooming In and Out

The *Instant Throughput* view provides a zoom feature to expand or contract the display in order 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 symbol.

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 large 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.

13.3 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

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.

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2. Select **Duplicate** ⏮ to make available another set of cursors with the exact time spread as the original, or select **Freeze** ❄ 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.

2. 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.

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:

14. Summary Pane
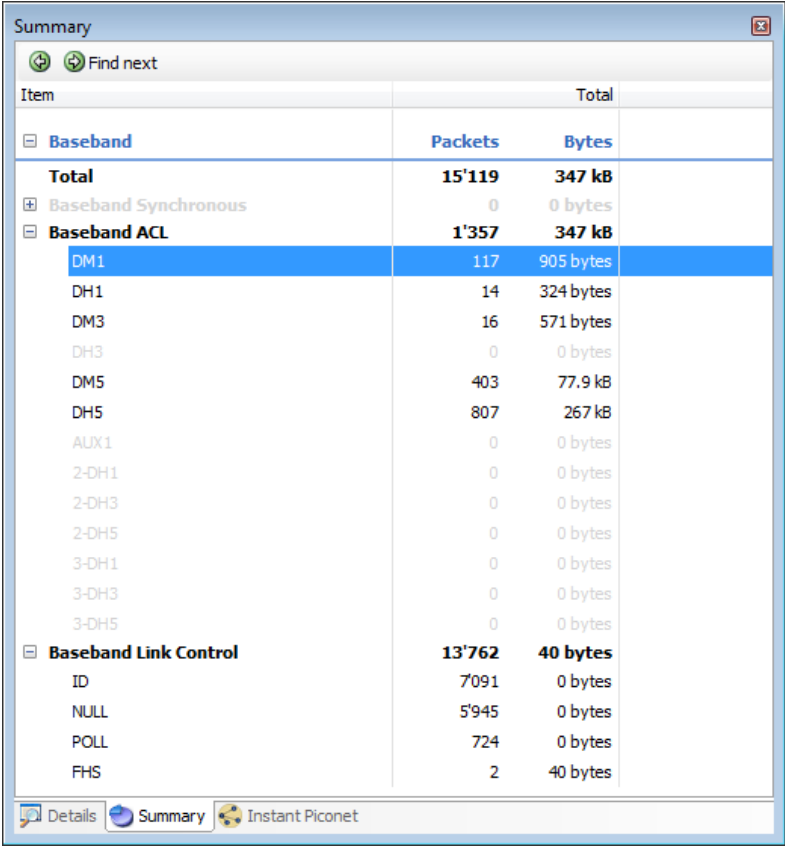
The *Summary* pane provides a summary of all baseband traffic recorded, including synchronous, ACL, and link control events. Selected events in the *Summary* pane will enable the **Find** arrows located at the top-left of the *Summary* pane, enabling the user to jump the Overview to the first, next, or previous such selected event.

The *Summary* pane will update real-time as traffic is captured.

To access the *Summary* pane:

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

The *Summary* pane appears:

    Items not captured will be grayed out in the Summary pane.

To find an event located in the Overview:

1.   Select the item or event desired in the *Summary* pane.

2.   Click on the **Find next** arrow ![Find next] to search forward, or the left arrow ![left] to search backward.

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The Overview orients to the searched item, highlighting it with a gray line.

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):

1. 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
```

To enter a link key in hex (highest order byte on left):

1. 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
```

DO NOT enter a link key like this: `01020304:05060708:090A0B0C:0D0E0F10`

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:

1. Left-click on the timestamp associated with any security event shown in the *Security* pane.

2. 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:

1.   Select **Manage SSP Keys** Manage SSP Keys from the *Security* pane toolbar.

The *Secure Simple Pairing Key Management* window opens:
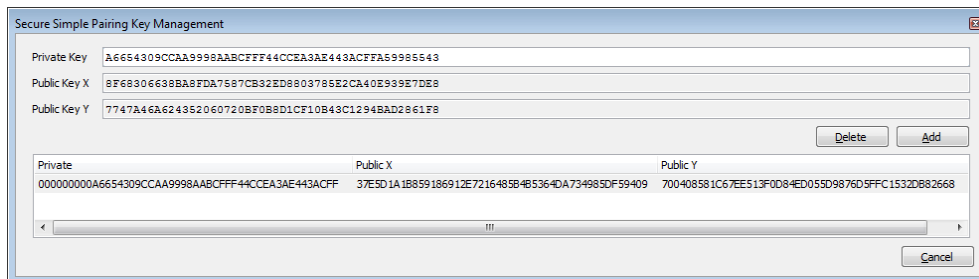
2.   Enter the private key in the **Private Key** box.

3.   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**).

4. 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 particular 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:

1. 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.
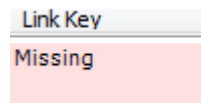
The *Security Details* window opens:

2. 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:

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

The *Instant Piconet* pane appears:
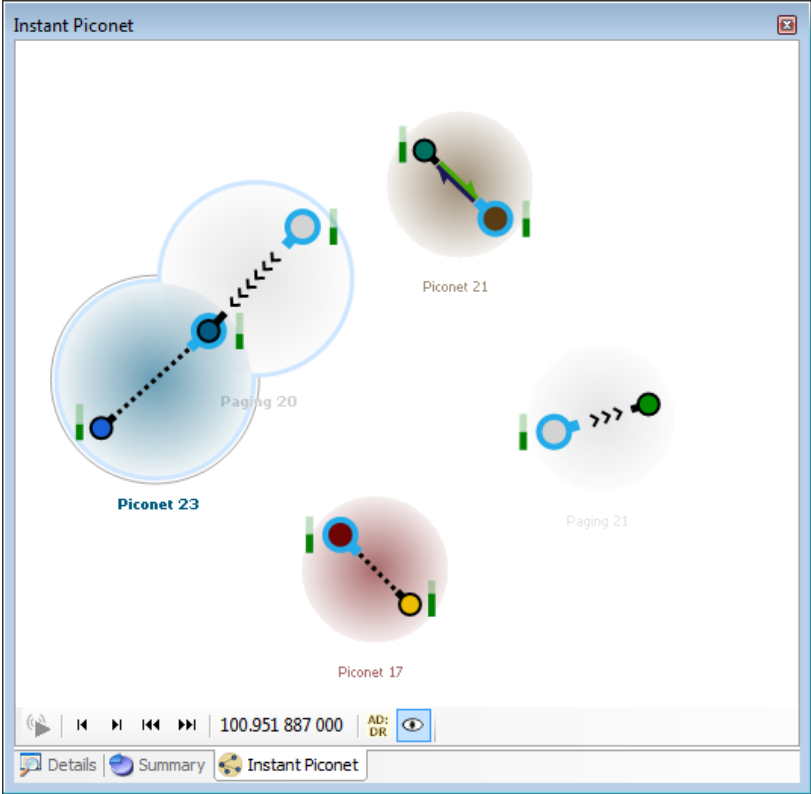
Instant Piconet pane toolbar:
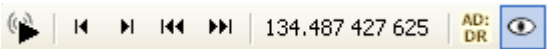
📡▶	Follow live. *Instant Piconet* tracks topology while capturing. **Note:** When active, *Instant Piconet* cursor in *Instant Timing* is disabled.
⏮	Previous change.

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▶I	Next change.
I◀◀	Previous data channel topology change.
▶▶I	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*:
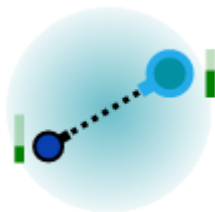
Represents an **idle connection** between a master and a slave. Master devices always have a blue outline. Slave devices always have black outline. The gauge on the side represents the RSSI of the device.
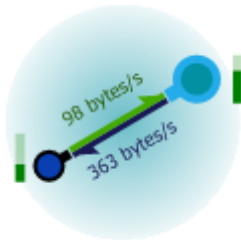
Represents an **active data connection**. Throughputs are indicated.
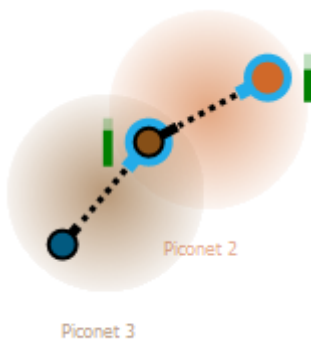
Represents a **scatternet** composed of two simple piconets. The device in the center is the slave of the device on the right, and the master of the device on the left.

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:
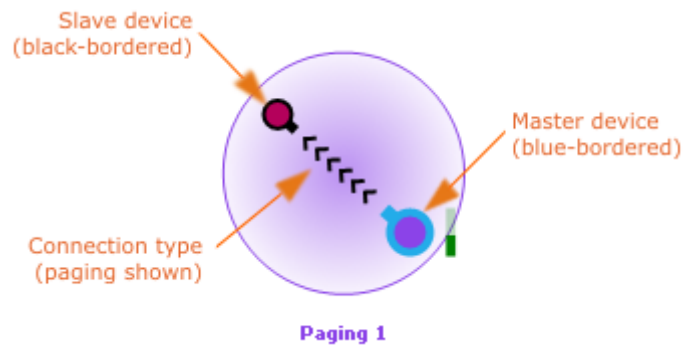
Simple Piconet, Showing a Paging
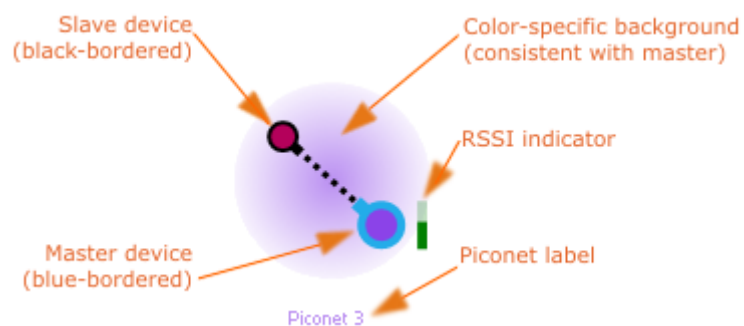
Simple Piconet, Showing a still connection

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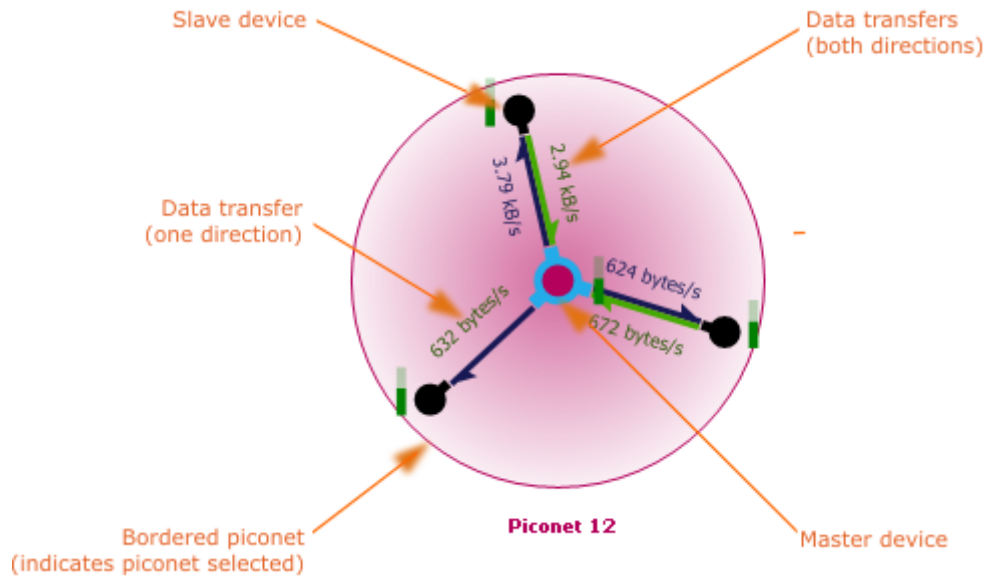
Piconet, with data transfers shown
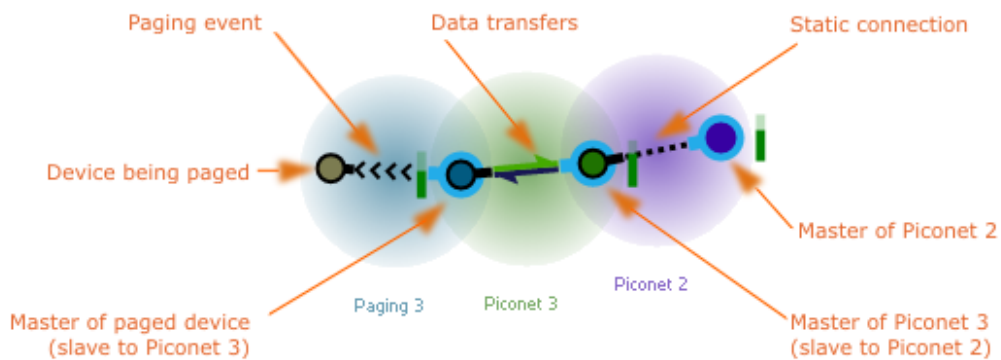
Simple Scatternet

16.2 Display Features

To use the flyover:

1. Position the mouse over any device.

2. The flyover indicator appears, advising the user of the device's name, and master/slave status:

To show/hide BD ADDR, LMP Name, or user-provided name:

1. Toggle the ADDR button 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:

1. Toggle the ADDR button ⬚ 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.

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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 drag 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:
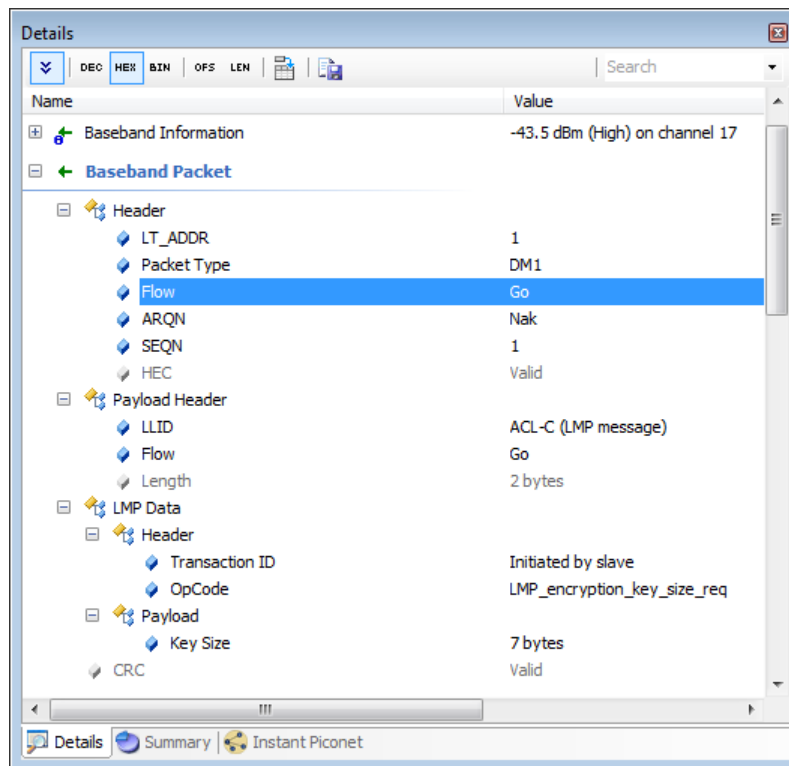
Details toolbar:

⤓	Show all fields. Some fields not typically needed (such as good CRC values) are hidden by default.
DEC	Show numeric values in decimal.
HEX	Show numeric values in hexadecimal.
BIN	Show numeric values in binary.
OFS	Show fields' bit offset.
LEN	Show fields' bit length.
⊞	Display selected field in Overview.
⊟	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.
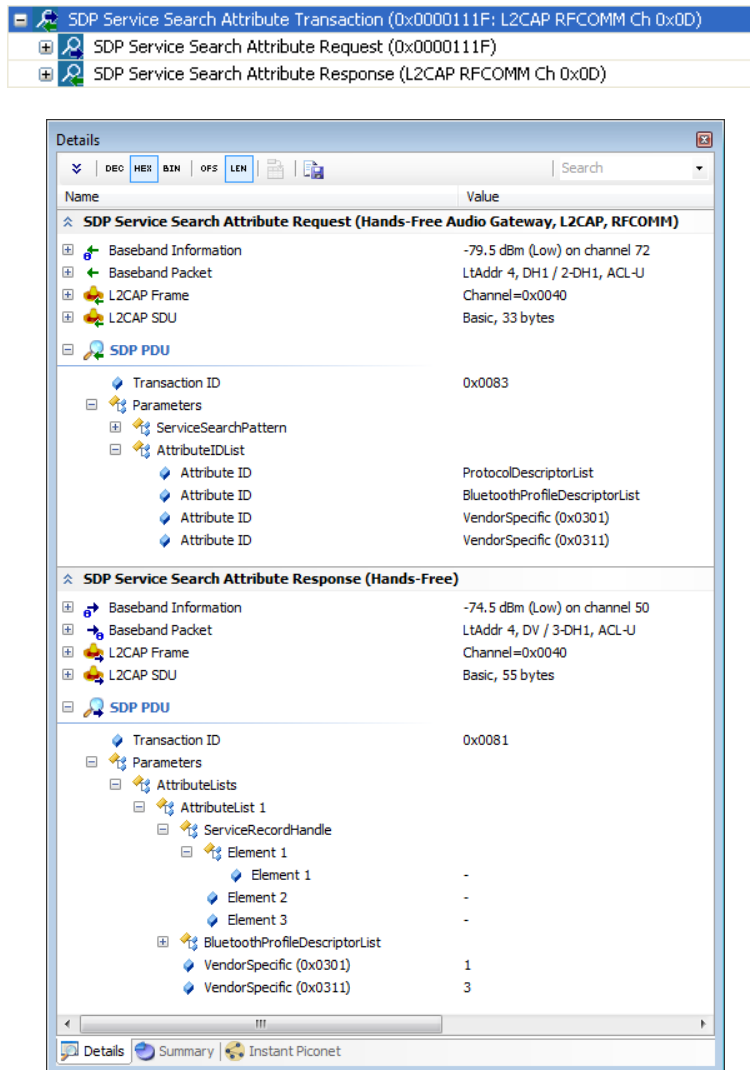
When selecting just the SDP Service Search Attribute Request, only this request (and underlying protocols, profiles, and packets) will be provided in the *Details* pane:
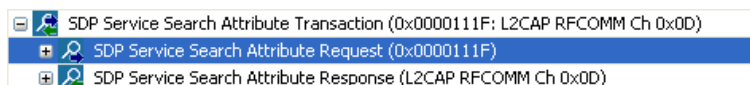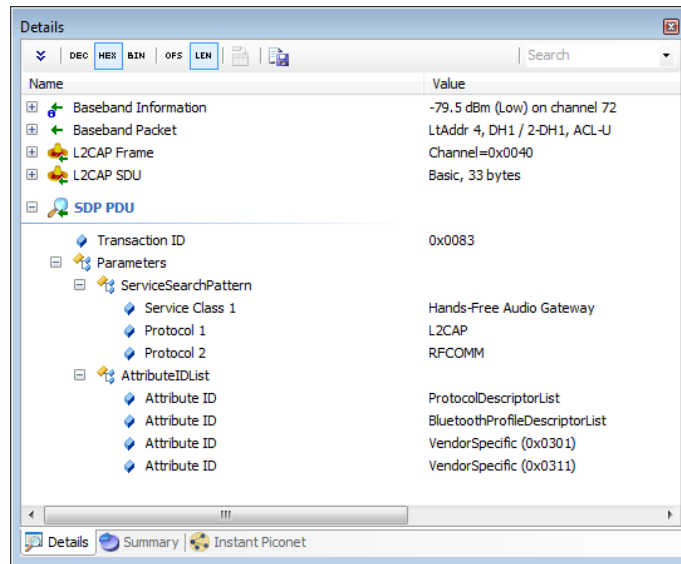
This concept holds true as each underlying Overview element is exposed, for example as shown below where a **NULL (ACK)** baseband packet is selected:
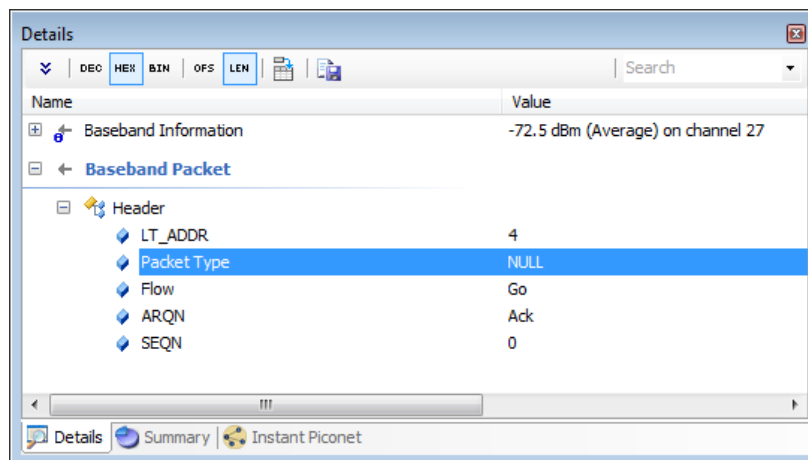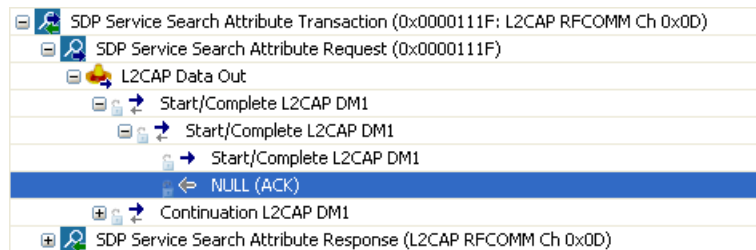
Grouping of procedures and transactions is enabled or disabled by selecting or deselecting the **Group Procedures and Transactions** selection, available in the **Protocol:** drop-down menu, shown below. This feature is enabled by default.
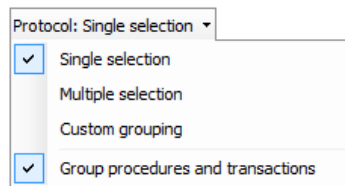
With **Group Procedures and Transactions** selected, transactional grouping is displayed at the highest level, such as shown below, where the ATT READ subsumes a transaction consisting of and ATT READ REQUEST and an ATT READ RESPONSE.
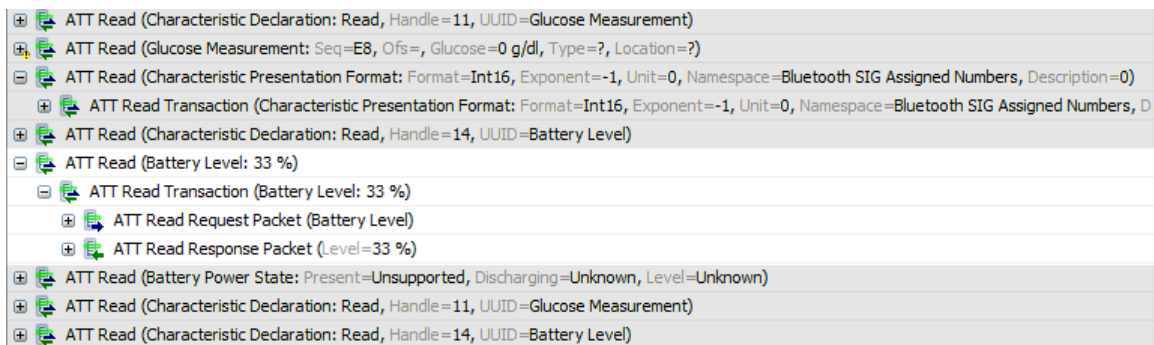
With **Group Procedures and Transactions** deselected, transactional grouping is reduced to the next lower level, such as shown below, where the ATT READ REQUEST and ATT READ RESPONSE are the highest abstraction.
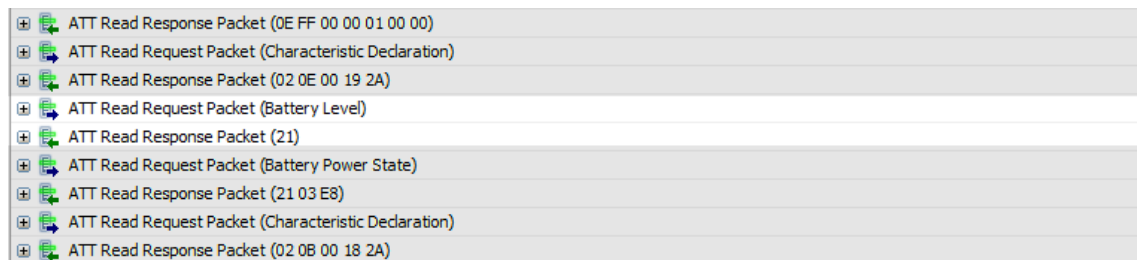
17.2 Adding Details Fields to an Overview

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.

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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:

```
Raw data                                                              ⊠
Data type:  Audio Stream              ▾    | Search                  ▾
            0  1  2  3  4  5  6  7  8  9  A   0123456789A
0x0000:    27 FA 44 C2 94 9B C4 1C AF C8 76   '.D.......v
0x000B:    EF 7C B7 19 C1 9A 86 33 C3 1E B4   .|.....3...
0x0016:    D5 4A 68 2A 94 C9 77 A5 A1 10 F7   .Jh*..w....
0x0021:    22 08 D3 05 13 37 03 90 42 DB B0   "....7..B..
0x002C:    15 93 C3 82 53 F2 94 1E B4 D5 4A   ....S.....J
0x0037:    68 2A 94 C9 77 A5 A1 AC 08 BC D5   h*..w......
0x0042:    CC DD C4 5F A1 E6 68 F4 26 B8 78   ..._..h.&.x
0x004D:    22 BD 91 D6 FC AC 04 F2 9A B5 C8   "..........
0x0058:    56 CB 4D 28 BA DE 61 7B 96 A9 01   V.M(..a{...
0x0063:    64 62 B3 1E B4 D5 4A 68 2A 94 C9   db....Jh*..
0x006E:    77 A5 A1 10 63 8B 15 3C 4C 21 A4   w...c..<L!.
0x0079:    E6 CA 7C 1C 54 4D C5 D2 46 5D 8F   ..|.TM..F].
0x0084:    DF 1E B4 D5 4A 68 2A 94 C9 77 A5   ....Jh*..w.
0x008F:    A1                                 .
101
011 Raw data    🔒 Security
```

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.

    or

    Select **Copy as Generator Hex Array** to copy in a format used by the USB Explorer 280 Generator. Note: This feature not yet implemented.

> 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.

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19. Protocol Error Verifications

The analyzer is designed to detect and display various errors and warnings. Errors of various 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:
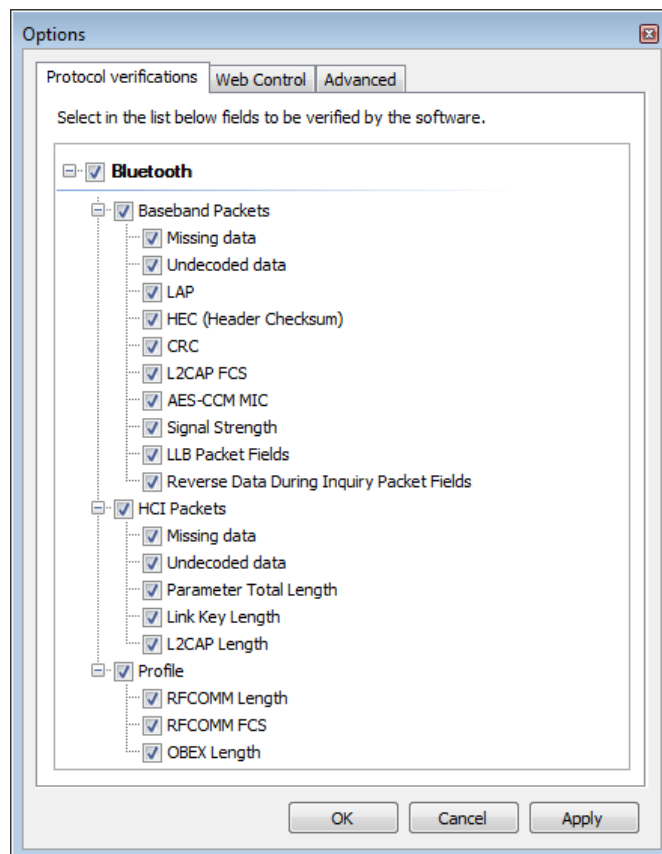
19.1 Enabling and Disabling Protocol Errors

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:
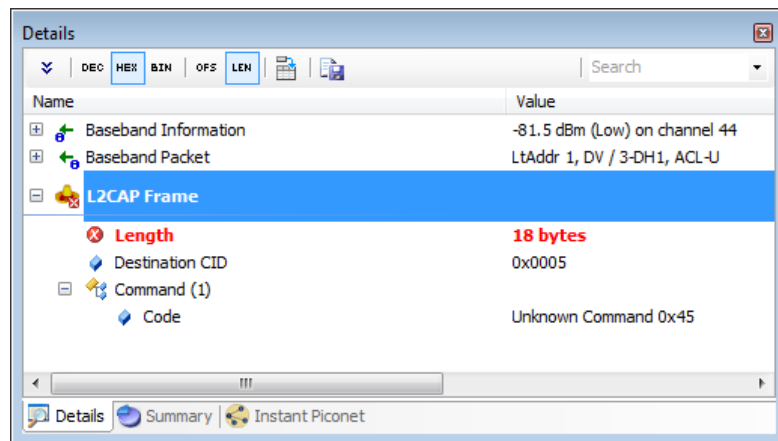
Display of Errors in the Overview:

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** are also flagged.
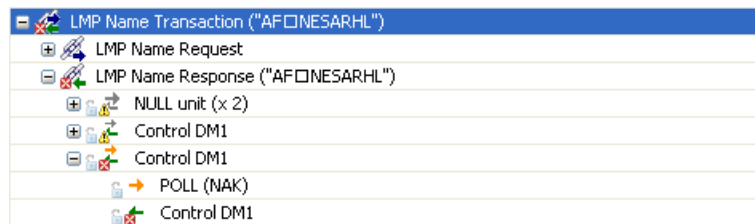
Placing the mouse over the flagged error provides an indication of the specific error:

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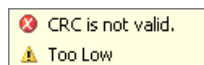
20. Task Pane

The *Task* pane provides the user with statuses on various actions initiated by the user and also allows the user to cancel tasks in progress.

To access the Task pane:

1. Select **View | Other Windows | Tasks** from the menu.

The *Task* pane appears:
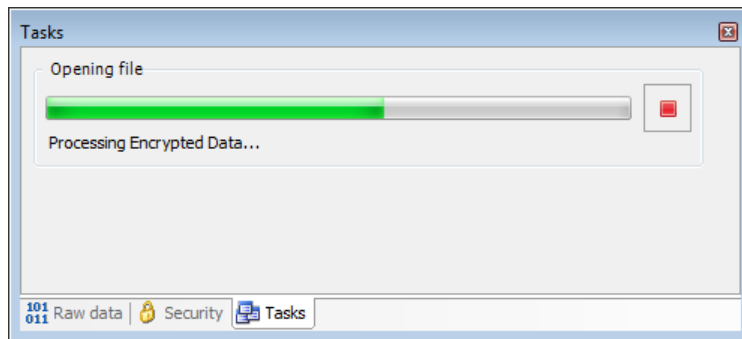
Task statuses provided by the Tasks pane include:

- File Open
- File Save
- Search
- Instant Search
- File Export
- File Import

21. Software and Support

The analyzer application provides a convenient method to access the latest updated software and access technical support from an Internet-connected PC. The application will check automatically for new major updates at a given specified interval (by default at every startup) and will notify new version if any.

The installed version of the software is displayed in **Help | About,** and is also displayed at the bottom-right of the GUI. When a new version is available, this bottom-right display will include a red background to prompt the user to update.

> *(i)* Only major versions will be notified to users, so for example if the software version changes from 2.0 to 2.1. Minor versions are not automatically notified, but can still be checked by doing a manual Check for Update.

21.1 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:
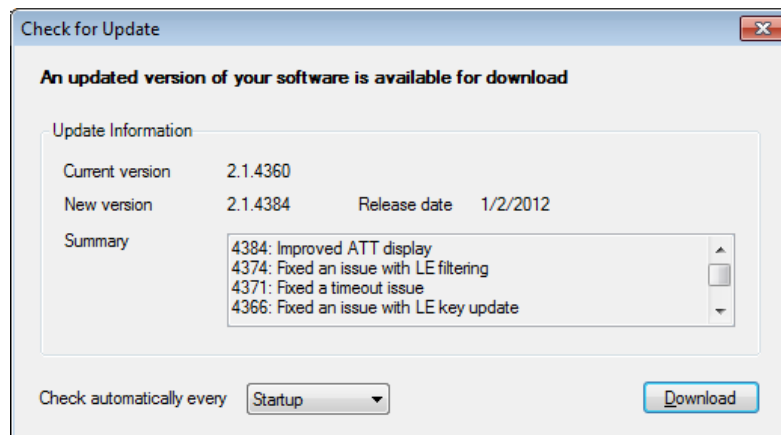
2. Follow the onscreen prompts to download and install the updated application software.

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.

> *(i)* Some networks require the use of proxy servers or other special configurations. The Ellisys software will automatically use Windows Internet

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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 to request that a link to the latest BEX400 software be sent to you.

21.2 Getting Technical Support

Ellisys technical support is available from the Ellisys website and E-mail, each accessible from the BEX400 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.

To access the technical support web page from the application:

1. Select **Help | Contact support** from the menu.
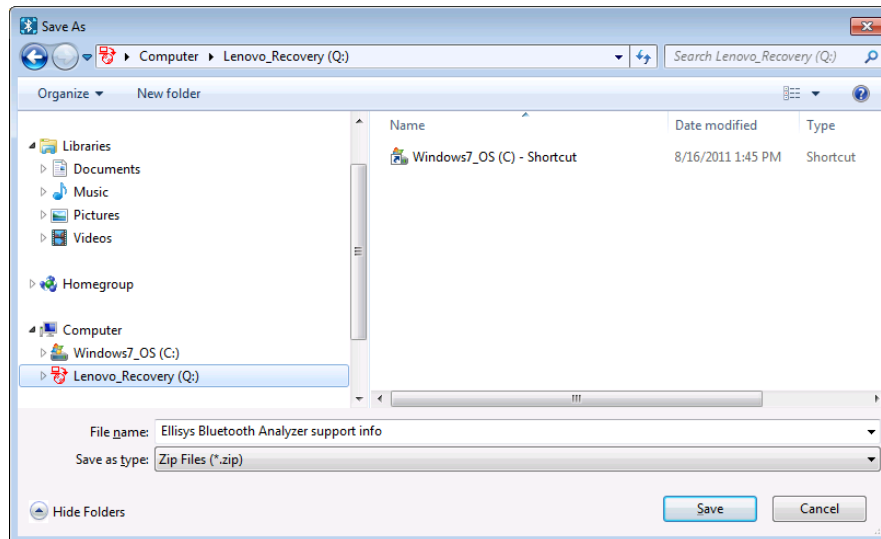
The default web browser opens to display the Ellisys technical support web page.

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.

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Appendix A – Flying Leads Cable

The Flying Leads Cable connects the IO Probe connector (located on the analyzer's back panel) to one or more external HCI, WCI-2, Audio I2S, or logic 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 IO Probe connector contains 26 pins (two rows of 13 pins), which mate with sockets on the mating connector of the Flying Leads Cable. Spacing is 1.27 x 1.27mm. Color-coded flying lead sockets will mate with pins from the user's HCI and/or logic implementation.
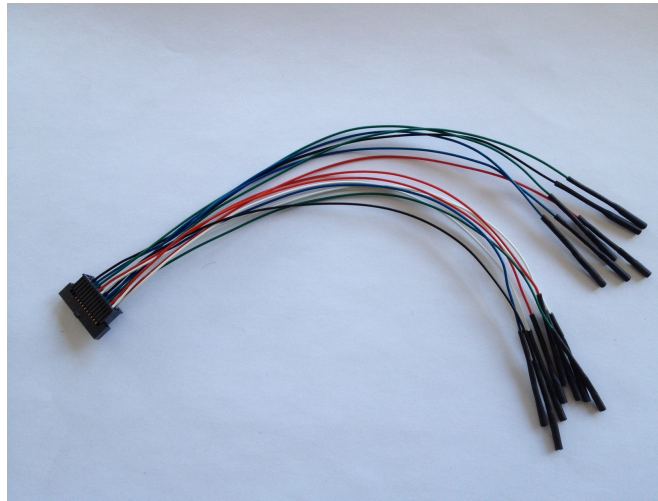
Flying Leads Cable
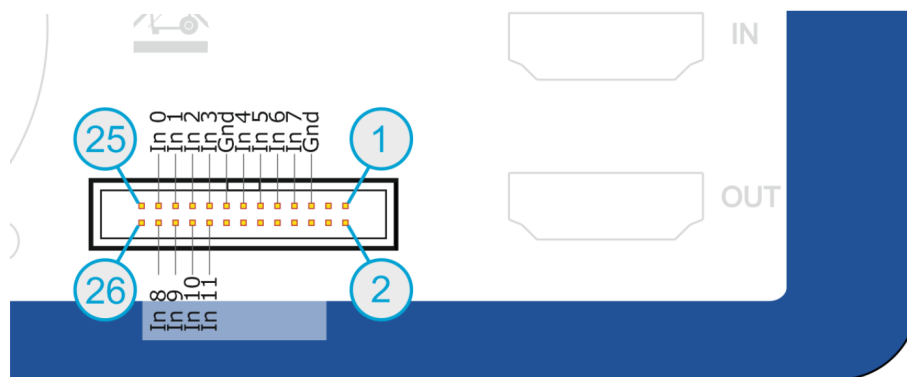
Pinout for IO Probe Connector

On the Flying Leads Cable, Inputs 0 and 1 are used for the primary UART capture, Inputs 2 and 3 are used for the secondary UART capture, and Inputs 4 and 5 are used for the WCI-2 capture. Use GND as shown. For UART, signal lines (Inputs 0,1 and 2,3) may be reversed, as the analyzer will auto-detect the polarity.

		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	

Pinout for Mating Connector on Flying Leads Cable

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Appendix B – Remote API

The BEX400 can be operated using a remote application programming interface (API) which allows for automated control of the application, including extraction of captured traffic.

The link provided below contains an introductory guide, the plug-in DLL, and sample code written in C#, using Microsoft Visual Studio 2010. Compatibility is Visual Studio 2005 or higher.

Link to download the Remote API:
http://www.ellisys.com/better_analysis/bex400a_remote_api.zip

Appendix C – 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 BEX400 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 in order 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 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 have an effect on the capture?

A. The position of the analyzer's antenna as well as the position of the device's antenna is pretty important for getting optimal captures. Each antenna has a specific radiation pattern which needs to be known in order 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 in order 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 in order to see the traffic decrypted?

A. Yes, the user is provided the option to save link keys when a capture is closed.

Appendix D – General Technical Data

RF Characteristics

- Ellisys Rainbow™: Wideband, concurrent capture of all BR/EDR/LE channels

- 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, p/4-DQPSK, 8-DPSK)

- Baseband: Support of *Bluetooth* 4.0, 4.1, upgradeable by software

Logic Capture Characteristics

- Maximum bandwidth: 50 MHz

- Sampling precision: 5 ns

- Supported input voltage: 1.8 to 7V

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

Timing

- Clock: ±1ppm frequency accuracy over -10 to +60 degrees Celsius range

- BR/EDR/LE timestamp accuracy: 125ns

- USB HCI timestamp accuracy: 16.7ns

- Logic timestamp accuracy: 5ns

Embedded Memory

- 128 MB of FIFO memory (HDD is ultimate destination)

- 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

Rear-Panel Connectors

- Computer: USB 2.0 Standard-B

- Power: 12-17 VDC, max 18 W

- Trigger: SMA in and out, 50 Ω, max 5VDC

- IO Probe: supports UART / SPI HCI, WCI-2 and logic analysis

- Inter-equipment: in and out, supports connection of several units

Power Supply

- Universal 100-240 VAC, 50-60 Hz

- 12 VDC, 18 W

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

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