



Analyzer Features Tour

Getting Personal with Your Environment

Introduction

Ellisys Bluetooth products are loaded with features and innovations designed to help engineers efficiently understand challenges and optimize performance of their designs and implementations. This Ellisys Expert Note provides a quick walk-through of many of the Ellisys application software capabilities. Refer to the User Guide (located in the **Help** menu) for detailed information on these features.

The Big Picture

Ellisys analyzers are capable of capturing and characterizing BR/EDR, Bluetooth LE, Wi-Fi, raw spectrum information, various HCI interfaces (SPI, UART, USB), WPAN (802.15.4), generic communications interfaces (SPI, UART, I2C, WCI-2, and SWD). All of these can be captured concurrently and with precise central timing.

HELPFUL HINT: The easiest way to become familiar with the Ellisys Bluetooth analysis software is by opening one of the saved captured files provided. These capture samples can be loaded from the **File** menu by selecting Load Sample. Samples are included for both BR/EDR and Bluetooth Low Energy.



Innovative Data Groups

Instant Timing

Security Management



Note that the various analyzer models and configurations will have some variability in terms of what is supported (check the user guide for details).

To manage this broad spectrum of capture capabilities, the Ellisys Bluetooth software application provides a variety of features for analyses relating to timing, protocol operations, physical layer behaviors, audio applications, HCI operations, Wi-Fi and WPAN activities, throughput, statistical information, channel quality analyses, topology behaviors, and much more.

As alternatives to operation of the analyzer using the analyzer application software, users can employ an automation API or a command line interface (CLI). See the user guide for download links.

Ellisys Protocol Overviews

The Overviews are the central views of the analysis software. These views will show captured traffic ranging from the most primitive elements to the most complex and hierarchical transactions, and with a great variety of functionality and configurability. All enabled Overviews (i.e., selected in the **Recording Options** dialog) are populated concurrently, for example when capturing over-the-air (OTA) traffic and Host Controller Interface (HCI) traffic.

There is an Overview for each traffic type captured. Traffic types include BR/EDR, Bluetooth LE, HCI interfaces (SPI, UART, USB, injected), generic communications (I2C, UART, SPI, SWD), Wi-Fi, WPAN (15.4) and others. Note that capture of certain traffic types are model- or configuration-dependent.

An exceptional amount of configurability is provided, including protocol-specific views, powerful textual filtering, searching, colorizing, column add/remove/position, timing measurements, a variety of automated checks and advisories, summary information, and more.

Figure 1 shows traffic in the BR/EDR Overview.

HELPFUL HINT: To see your specific model and configuration, attach your unit to your computer, then check the serial number tab in Help > About.

2dpMusicStreaming.b	btt - Ellisys Bluetooth Analyzer			
e View Layout	Search Record Tools Help			
1 🧀 🗐 🖼 (A)	🕨 Record 🔹 🗉 Stop 🗃 Restart 🐺 Save & Continue 🦙 🙀 📲 🖉 Navigate 🔹 🖏 🧗	Markers 🔹 🚚 🖳 🌾 Filtering: Only Headset, Notebook 🔹 🍘		
	DR Overview Message Log Instant Spectrum			4
-	All layers + + + + + + 2 = + + 1 = 0 = 0 = 0 = 0 +	90 items displayed		Search -
		Communication	✓ Status	V LT ADDR
6.391 402 625	Paging ("Notebook" 00:02:76:1E:10:E6 > "Headset" 00:15:7F:01:E2:80, responded, 4.43 s)	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:60	OK	CT_ADDI
10.828 963 250	See UMP Features Exchange (49 Features > 30 Features)	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:B0	OK	1
10.835 213 375	G Main LMP Version Exchange (Master: 2.1 > Slave: 2.1)	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:80	OK	;
10.842 714 625		Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:80	OK	1
10.861 463 750		Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:80	OK	1
10.877 090 125	⊕ 📽 LMP Setup Complete	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:80	OK	1
10.890 214 250	⊕ 🖷 LMP Set AFH (□=79, 0x7047382, as CLK[27-0]: 0xE08E704, AFH enabled)	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:B0		1
11.041 466 125	⊕ @ LMP Max Slot (5 slots = 3.125 ms)	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7E:01:E2:B0		1
11.042 717 125	⊕ 🐨 LMP Max Slot Request (5 slots = 3.125 ms > Accepted)	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:B0	ОК	1
11.043 966 250	⊕ ee LMP Auto Rate	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:B0		1
11.044 591 875	E BE LMP Auto Rate	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:B0		1
11.045 216 250	⊕ 🎪 L2CAP Connection (Src=0x0040, PSM=SDP + Dst=0x0040)	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:B0	OK	1
11.045 842 000		Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:B0	OK	1
11.047 092 000	⊕	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:B0		1
11.048 342 000		Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:B0	OK	1
11.058 966 500		Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:80	OK	1
11.075 842 750	⊞ 🧠 LMP Features Exchange (30 Features > 49 Features)	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:B0	OK	1
11.081 466 750	🗄 🐟 L2CAP Configure (Dst=0x0040, MTU=1'612, Flush T/o=Infinite amount of retransmissions > Src=0	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:B0	OK	1
11.085 216 750	Geoge LMP Clock Offset Transaction (0x4E03)	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:B0	OK	1
11.086 466 875	⊕ Supervision Timeout (11'200 slots = 7.000 s (7.000 s))	Master: "Notebook" 00:02:76: 1E: 10:E6 <-> Slave: "Headset" 00: 15: 7F: 01:E2:B0		1
11.099 592 750	🛞 🛖 L2CAP Configure (Dst=0x0040, MTU=48 > Src=0x0040)	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:B0	OK	1
11.103 967 000	B A SDP Service Search Transaction (Headset: 0x00010003)	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:B0	OK	1
11.141 467 625	🛞 🚎 LMP Increase Power Request	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:B0	OK	1
11.146 467 625	🛞 🚑 SDP Service Attribute Transfer (0x00010003: Headset Generic Audio L2CAP RFCOMM Ch 2 Heads	Master: "Notebook" 00:02:76:1E:10:E6 <-> Slave: "Headset" 00:15:7F:01:E2:B0	OK	1
** *** ***	m A man far far fared Treasurers (A. A. Fall, A. ARAMARAN)	Hansen Bisseland An An Artifician Price Planet Bisselant An Artifician Phila	~~	

Figure 1 BR/EDR Overview.

HELPFUL HINT: Try a right-click in an Overview and explore the options/selections.

Note the parenthetical summary information provided in the Item column. These can serve as a quick idea as to what sort of information is being exchanged.



	Search Record Tools Help Record B Stop Restart Save & Continue Record Record	arkerr - 🦪 🕞 🔰 Filtering: Evolude Rackeround - 🕼			
	Energy Overview Message Log Hanstant Spectrum			_	4 0
	All layers + + + + + + + + + + + + + + + + + + +			Search	
		Communication	Payload	Status	100.0
14.819 765 125	Connectable ("Keyfob" 3C:20:87:84:06:67, Initiator "Dongle" 29:CD:00:99:FF:56, 11.3 s)	Master: "Keyfob" 3C: 2D:87:84:06:67 <-> Slave: "Dongle" 29:CD:00:99:FF:56	V Payload V	OK	
26,243 929 125	ATT Find Information Transaction (1 - Max Handle: Primary Service > Characteristic Dediration > De	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67	20 bytes (01 00 00 28 0		
26.323 926 875	ATT Find Information Transaction (6 - Max Handle: Characteristic Declaration > Peripheral Privacy Flag >		20 bytes (06 00 03 28 0		
26,403 925 000	ATT Find Information Transaction (11 - Max Handle: Peripheral Preferred Connection Parameters > P		20 bytes (08 00 04 2A 0		
26.463 924 375	Karacteristic Declaration > 0xFFF1 > Characteristic Declaration > 0xFFF1 > Characteristic	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67	20 bytes (10 00 03 28 1		
26.523 922 500	ATT Find Information Transaction (21 - Max Handle: Characteristic User Description - Characteristic	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67	20 bytes (15 00 01 29 1		
26.583 924 125	🚯 🧱 ATT Find Information Transaction (26 - Max Handle: 0xFFF4 > Client Characteristic Configuration > C	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67	20 bytes (1A 00 F4 FF 1		
26.643 924 875	🛞 🍓 ATT Find Information Transaction (31 - Max Handle: 0xFFE1 > Client Characteristic Configuration > C	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67	12 bytes (1F 00 E1 FF 2	OK	
26.683 699 375	🕀 🏣 ATT Find Information Transaction (34 - Max Handle; Attribute Not Found)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67		OK	
26.783 926 625	😥 📴 ATT Read (Primary Service: Generic Access)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:B7:84:06:67	2 bytes (00 18)	OK	
26.863 924 000	🗉 📴 ATT Read (Characteristic Declaration: Read, Handle=3, UUID=Device Name)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67	5 bytes (02 03 00 00 2A)	OK	
26.923 926 875	🗉 🚋 ATT Read (Device Name: "Simple BLE Peripheral")	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67	21 bytes (53 69 6D 70 6	OK	
27.003 928 500	🕀 🍖 ATT Read (Characteristic Declaration: Read, Handle = 5, UUID = Appearance)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67	5 bytes (02 05 00 01 2A)	OK	
27.063 926 125	🕀 🍘 ATT Read (Appearance: Unknown)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:B7:84:06:67	2 bytes (00 00)	OK	
27.183 924 375	🛞 👺 ATT Read (Characteristic Declaration: Read, Write, Handle = 7, UUID = Peripheral Privacy Flag)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67	5 bytes (0A 07 00 02 2A)	OK	
27.263 921 500	🛞 🕵 ATT Read (Peripheral Privacy Flag: Disabled)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67	1 byte (00)	OK	
27.323 921 375	🕃 👺 ATT Read (Characteristic Declaration: Read, Write, Handle=9, UUID=Reconnection Address)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67	5 bytes (0A 09 00 03 2A)	OK	
27.383 922 375	🛞 👺 ATT Read (Reconnection Address: 0)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67	6 bytes (00 00 00 00 00	OK	
27.503 923 125	🛞 💺 ATT Read (Characteristic Declaration: Read, Handle=11, UUID=Peripheral Preferred Connection Par	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67	5 bytes (02 08 00 04 2A)	OK	
27.583 922 375	🛞 💺 ATT Read (Peripheral Preferred Connection Parameters: Min=100 ms, Max=200 ms, Latency=0, Mul	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67	8 bytes (50 00 A0 00 00	OK	
27.663 924 250	🕢 🔯 ATT Read (Primary Service: Generic Attribute)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67	2 bytes (01 18)	OK	
27.723 924 375	🕢 💺 ATT Read (Characteristic Declaration: Indicate, Handle=14, UUID=Service Changed)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:B7:84:06:67	5 bytes (20 0E 00 05 2A)	OK	
27.763 692 250	🛞 👺 ATT Read (Service Changed)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:B7:84:06:67		OK	
27.843 923 250	📧 👺 ATT Read (Primary Service: 0xFFF0)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob" 3C:2D:87:84:06:67	2 bytes (F0 FF)	OK	
27 002 010 500	M . ITTALIJ / Construction Conditions and Mars 11. 2. 17 (1975) C. COTA	11-11-1 Paralation of an an an original and a state of the second state of the	FL (01 +1 00 F+ FF)	~	and i

Figure 2 Bluetooth Low Energy.

Figure 2 shows Bluetooth Low Energy Overview.

The Overviews are made to be easily readable. Traffic is grouped hierarchically into protocol layers. The protocol "stack-up" can be easily reviewed by navigating into the tree nodes. Packet-only, Baseband, L2CAP, and Link Layer views are also available.

Let's look at **Figure 3**. We can see a BR/EDR AT HFP transaction consisting of an AT command, an AT response, and an AT handshake.

Each AT packet is transported with RFCOMM frames, which is on L2CAP, which is on baseband. This stack-up can be seen very easily in the BR/EDR Overview.

	Search Record Tools Help ▶ Record • ■ Stop ■ Restart ጫ Save & Continue ▶ # • 📆 🛃 Navigate • 🔜	Markers • J B. 17 Filtering: Exclude Background •		
	R Overview Message Log H Instant Spectrum			4 Þ
Protocol: Single -	All layers + + + == 🛶 🖇 🖉 🖢 😤 🖑 + 🮝 🎰 🚳 💷 🖾 📖 🚳 🚱 🚽	a 📰 🛛 216 items displayed		Search •
Time 🗸	Item	 Communication 	Status	V LT_ADDR ·
1.584 997 500	RECOMM DLC Parameter Negotiation (Channel=2, Initial Credits=R: 0 1: 0)	Master: "Mobile Nokia" 00: 1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00: 1A: 7D: 21: 38:CD	OK	1
1.672 497 375	RECOMM Connect (Channel=2)	Master: "Mobile Nokia" 00:1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00:1A:7D:21:38:CD	OK	1
1.738 122 500	🕀 🤕 RFCOMM Modem Status (Channel=2, Data Valid=No No)	Master: "Mobile Nokia" 00:1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00:1A:7D:21:38:CD	OK	1
1.739 996 375	RFCOMM Modem Status (Channel=2, Data Valid=No No)	Master: "Mobile Nokia" 00: 1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00: 1A:7D: 21: 38:CD	OK	1
1.743 746 375	RFCOMM UIH Frame (Channel=2, Credits=I: 0 R: 0+10=10)	Master: "Mobile Nokia" 00: 1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00: 1A:7D: 21: 38:CD	OK	1
1.748 747 125	⊕ 😓 L2CAP Connection (Src=0x0041, PSM=SDP + Dst=0x0088)	Master: "Mobile Nokia" 00: 1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00: 1A: 7D: 21: 38:CD	OK	1
1.784 996 375	⊕ 😓 L2CAP Configure (Dst=0x0088, MTU=65'535 × Src=0x0041)	Master: "Mobile Nokia" 00:1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00:1A:7D:21:38:CD	OK	1
1.799 372 750	🕀 🛖 L2CAP Configure (Dst=0x0041, MTU=48 > Src=0x0088)	Master: "Mobile Nokia" 00:1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00:1A:7D:21:38:CD	OK	1
1.804 997 125	⊕ 🚑 SDP Service Search Transaction (Audio Sink)	Master: "Mobile Nokia" 00:1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00:1A:7D:21:38:CD	OK	1
1.843 124 250	R S LMP Preferred Rate (FEC, BR=No preference, EDR=Use DM1 packets, Pref=No preference)	Master: "Mobile Nokia" 00:1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00:1A:7D:21:38:CD		1
1.843 748 250	🛞 💠 L2CAP Disconnection (Src=0x0041, Dst=0x0088)	Master: "Mobile Nokia" 00: 1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00: 1A:7D: 21: 38:CD	OK	1
1.911 874 250	AT HFP Supported Features: AT +BRSF=26/r + /r/n + +BRSF: 495/r/n/r/n + OK/r/n	Master: "Mobile Nokia" 00:1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00:1A:7D:21:38:CD	OK	1
1.911 874 250	🖃 🍕 AT String: AT+BRSF=26	Master: "Mobile Nokia" 00: 1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00: 1A:7D: 21: 38:CD	OK	1
1.765 624 000	RFCOMM UIH Frame (Channel=2, Credits=I: 0+15=15 R: 10)	Master: "Mobile Nokia" 00: 1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00: 1A: 7D:21:38:CD	OK	1
1.911 874 250	RFCOMM UIH Frame (Channel=2, Credits=I: 15 R: 10-1=9)	Master: "Mobile Nokia" 00: 1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00: 1A: 7D:21:38:CD	OK	1
1.916 248 250	R 🤹 AT String: 👘	Master: "Mobile Nokia" 00:1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00:1A:7D:21:38:CD	OK	
1.916 248 250	RFCOMM UIH Frame (Channel=2) [Part]	Master: "Mobile Nokia" 00:1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00:1A:7D:21:38:CD	OK	
1.916 248 250	R 🍕 AT String: +BRSF: 495	Master: "Mobile Nokia" 00: 1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00: 1A: 7D:21:38:CD	OK	
1.916 248 250	🛱 ன RFCOMM UIH Frame (Channel=2) [Part]	Master: "Mobile Nokia" 00: 1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00: 1A: 7D: 21: 38:CD	OK	
1.916 248 250	🛱 🚔 L2CAP SDU (Basic, Service=RFCOMM)	Master: "Mobile Nokia" 00:1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00:1A:7D:21:38:CD	OK	
1.916 248 250	🗟 🚔 L2CAP B-Frame (Service = RFCOMM)	Master: "Mobile Nokia" 00:1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00:1A:7D:21:38:CD	OK	
1.916 248 250	🗃 🖕 🔁 Start/Complete ACL-U Transfer	Master: "Mobile Nokia" 00: 1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00: 1A: 7D:21:38:CD	OK	1
1.916 248 250	🖂 🚘 📌 DH1 Unit (ACL-U, 1 Mbps)	Master: "Mobile Nokia" 00:1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00:1A:7D:21:38:CD	OK	1
1.916 248 250	DH1 packet (ACL-U, 1 Mbps)	Master: "Mobile Nokia" 00:1A:DC:66:C8:F4 <-> Slave: "AudioSource" 00:1A:7D:21:38:CD	OK	1
<	· · · ** ** · · · · · · · · · · · · · ·	Market Reality subjection as the residence of the data of the data substances and the second	~	

Figure 3 Tree Node Structure of an AT BR/EDR Transaction.



e View Layout	Search Record Tools Help					
1 🗃 🖬 📾 🐴	🕨 Record 🔹 🗟 Stop 🔯 Restart 👼 Save & Continue 🦙 🎲 🖓 - 🎇 🚚 Navigate	• 🖏 🛅 Markers • 🦨 👒 🍓 Filtering: Exclude Background	- 3			
Welcome Low	Energy Overview Message Log 🚽 Instant Spectrum					4 Þ ;
- Protocol: Single	- All layers + 🛹 👄 🐓 🍸 🦸 💑 🦓 💮 278 items displayed				Search	- 03
Time	/ Item	 Communication 	×	Payload 🗸	Status	~
28.383 919 750	😑 🎍 ATT Read (Characteristic User Description: "Characteristic 3")	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	16 bytes (43 68 61 72 6	OK	
28.383 919 750	🖃 👺 ATT Read Transaction (Characteristic User Description: "Characteristic 3")	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	16 bytes (43 68 61 72 6	OK	
28.363 690 750	🖃 🚋 ATT Read Request Packet (Characteristic User Description)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67		OK	
28.363 690 750	😑 🛶 L2CAP SDU (Basic, Service = ATT)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	3 bytes (0A 18 00)	OK	
28.363 690 750	🗃 d L2CAP B-Frame (Service=ATT)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	3 bytes (0A 18 00)	OK	
28.363 690 750	🗃 🍙 🕁 Start/Complete LE-U Transfer	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	7 bytes (03 00 04 00 0A	. OK	
28.343 690 875	(ii) ⊆ 🚅 Empty LE Unit	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	No data	OK	
28.363 690 750	🕀 🍵 🔁 Start/Complete LE-U Unit	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	7 bytes (03 00 04 00 0A	. OK	
28.363 690 750	G → Start/Complete LE-U Packet	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	7 bytes (03 00 04 00 0A	. OK	
28.363 976 875	🔓 🔶 Empty LE Padret	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	No data	OK	
28.383 919 750	🖃 🚉 ATT Read Response Packet (Description = "Characteristic 3")	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	3C:2D:87:84:06:67	16 bytes (43 68 61 72 6	OK	
28.383 919 750	🖨 🍁 L2CAP SDU (Basic, Service = ATT)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	3C:2D:87:84:06:67	17 bytes (0B 43 68 61 7	OK	
28.383 919 750	🖃 🛖 L2CAP B-Frame (Service «ATT)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	17 bytes (0B 43 68 61 7	OK	
28.383 919 750	😑 🚆 🖨 Start/Complete LE-U Transfer	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	21 bytes (11 00 04 00 0	OK	
28.363 976 875	⊞	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67		OK	
28.363 976 875	田 🖞 🕂 Empty LE Unit	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	No data	OK	
28.383 690 125	🛞 🏭 🕁 Empty LE Unit	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	No data	OK	
28.383 919 750	😑 🚡 🐔 Start/Complete LE-U Unit	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	21 bytes (11 00 04 00 0	OK	
28.383 690 125	🚆 🔶 Empty LE Padiet	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	No data	OK	
28.383 919 750	Start/Complete LE-U Packet	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	3C:2D:87:84:06:67	21 bytes (11 00 04 00 0	OK	
28.443 920 125	🛞 👺 ATT Read (Characteristic Declaration: Notify, Handle=26, UUID=0xFFF4)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	5 bytes (10 1A 00 F4 FF)	OK	
28.483 691 000	🛞 👺 ATT Read (0xFFF4)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	3C:2D:87:84:06:67		OK	
28.583 919 625	🙃 📴 ATT Read (Client Characteristic Configuration)	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	2 bytes (00 00)	OK	
28.643 916 875	🛞 👺 ATT Read (Characteristic User Description: "Characteristic 4")	Master: "Dongle" 29:CD:00:99:FF:56 <-> Slave: "Keyfob	* 3C:2D:87:84:06:67	16 bytes (43 68 61 72 6	OK	
	m 🛋 arroad Malaan Cantan A Frent	Massar Presidet on children or critery and class. Bra All	100.00.03.04.06.63	- L /	~	-

Figure 4 Tree Node Structure of a Low Energy ATT Read Request.

HELPFUL HINT: As you click through the tree, selecting different protocol layers, for example L2CAP or Link Layer, or packets-only, the level of hierarchy in the Details view follows, i.e., if selecting a packet, the Details view (described in the next section) shows the packet elements, and if selecting the ATT transaction, the Details view will show the request and the response (where applicable), and if selecting just the request, the Details view shows just the request. Try this out – the operation will seem intuitive and sensible after a little experimentation.

For the rest of our tour walk-through we will start out with the **LowEnergyWatch.btt** trace sample, which contains ATT traffic between a watch and a mobile phone (see **Figure 4**). Similar to **Figure 3**, notice the tree node structure for Bluetooth Low Energy.

Note that there is a high-level hierarchy that includes (where applicable) a request/response pair on the highest element. The individual parts of the transaction can be seen by opening the tree as shown in **Figure 4**. Note also that this highest-level line includes some parenthetical summary hints as to what is "underneath," potentially saving you some time. This highest level can be removed to show the request/response pair as the highest element. This is done by deselecting Group Transactions in the **Protocol** drop-down menu at top-left of an Overview.

Details View

The line selected in an Overview can be reviewed in extensive detail within the Details view. The following screenshot shows the details of an ATT Write Request (see **Figure 5**), and below that, the associated ATT Response. As you can see, not only is the ATT Write Request displayed, but the lower layers (such as RF, Link Layer and L2CAP) are also displayed. The lower layers are closed and summarized by default, but these lines can be expanded in order to review every detail.

If we take a closer look at the selected ATT Write Request, we see quite a bit of information readily available, starting with lower layer items at the top (RSSI, RF channel, encryption, retransmission statistics, timings, etc.) then a progression through the L2CAP layer, and finally to the protocol (ATT) at the bottom.

Length 4 bytes © Destination CID 0x004 (ATT) © Payload 4 bytes L2CAP SDU Basic, 4 bytes ATT Packet © Opcode Write Request: Attribute Handle S0 Attribute Handle S0	Il fields 📑 Show in overview Display		-
Iuk-Layer Information 91 Suffer Rado 92 Suffer Rado 93 Enclamed 93 Enclamed 94 Suffer Rado 95 Enclamed 95 Link Layer 95 Suff Time 54.080 692 375 9 Detation 176 us 9 Detation Previous 12.271 ms (19.6 slots) 9 Detation Event Counter 22 93 Actionedgement and Plow Control 42 94 Statistics 0 9 Data Retries 0 9 Data Retries 0 9 Total Retries 0 9 Total Retries 0 9 Total Retries 0 9 ND 0 9 SN 0 9 Data Retries 0 9 Data Retries 0 9 Data B bytes 12 Data B bytes 12 Data B bytes 12 Data B bytes 12 Data Dotal Retries 9 Destonation CDD 0x0004 (ATT) 9 State Headee 10 9 Decode Write Request 12 CAPA SUL Bace, Hy			-1
Pic Sonffer Rado Strik Layer Strik Layer Distance Daration Science Station Accomption Data Data Data Data Data Data Data	IT Write Request Packet (Alert Level)	fild)	
9 Br Channel 9 Start Time 54,080 692 375 9 Data Time 54,080 692 375 9 Data Time 176 us 9 Data from Previous 12.271 mc (19.6 slots) 9 Connection Interval 22 9 Data from Previous 42 9 Data from Previous 42 9 Data Retries 0 9 Emby Retries 0 9 Emby Retries 0 9 Data Retries 0 9 Emby Retries 0 9 Start Pragment / Completing 0 9 ND 0 9 Stata 2 9 Data 2 9 Da	Link-Layer Information		
If your Layer If the Layer If the Layer If the Layer If the Layer Data Time Data to more than the Layer If the four Previous Data to more than the Layer If the four Previous If the four Pre	🖂 Sniffer Radio		
Image 94 Start Time 54,000 692 375 Datation 125 us Datation 125 us 2271 ms (39.6 slots) 200 concetton Interval 200 concetton Event Counter 22 22 3 Adronetdon Interval Reception Ack Retraininision Information 4 Concetton Event Counter 22 3 Adronetdon Event Counter 22 3 Adronetdon Event Counter 24 3 Adronetdon Event Counter 4 Reception Ack Retraininision Information 4 Data Retries 0 4 Total Retries 0 4 Total Retries 0 4 Total Retries 0 5 Start Pragment / Completion 4 Data Retries 0 5 Start Pragment / Completion 9 Data Retries 0 5 Start Pragment / Completion 9 Data 8 bytes 12 5 Data 8 bytes 12 5 Data 8 bytes 12 Data 12 Dat	RF Channel		
Start Time 54,080 692.275 Duration 175 us Duration 126 us Data from Previous 2.271 ms (13.6 slots) Connection Event Counter 22 Stocking 22 Stocking 23 Stocking 23 Stocking 24 Stocking 22 Stocking 0 Stocking <t< td=""><td></td><td></td><td></td></t<>			
Duration Reception Ack Retransmission Information Duration Duration			
Delta from Previous 12.271 ms (19.6 slots) Connection Event Counter 2 Connection Event Counter 4 Count			
Connection Interval Connection Event Counter Connection Event Connection Event Connection Event Counter Counter	the second second second second second second		
Correction Event Counter Correction Event Counter Security Securit		12.271 ms (19.6 slots)	
Implements Ack Implements Ack Recepton Ack Retransmission Information 0 Implements 0 Implement 0 Implements<			
Image: Security Image: Securit		22	
Image: Standard Standa			
	Reception	Ack	
● Emply Revies 0 ● Total Revies 0 ■ Total Revies 0 ■ Total Revies 0 ■ Intel® Vacuum 0 ■ ILDD L2CAP Start Pragment / Completing ● INSN 0 ● SN 0 ● Dota 0 ● Data 8 bytes € LCAP Frame 4 bytes ● Longth 12 ● Destination CID 0x0004 (ATT) ● Destination CID 0x0004 (ATT) ● LCAP SOU Base, 4 bytes ● LCAP SOU Base, 4 bytes ● Attribute Handle 50 ● Attribute Handle 50 ● Attribute Handle S0 ● Attribute Handle Mid Alert	Retransmission Information		
Total Retries 0 tink-Layer Packet Int Int	Data Retries	0	
Link-Layer Packet ILD L2CAP Start Fragment / Complete ILD L2CAP Start Fragment / Complete ILD L2CAP Start Fragment / Complete SN 0 D CP D CP Data 8 bytes LICAP Frame 0 Deta 8 bytes LICAP Frame 0 Deta 0x0004 (ATT) Payload 4 bytes LICAP Frame 0x0004 (ATT) Payload 4 bytes ATT Packet 0 Opcode Write Request Attribute Handle 50 Attribute Handle Mid Alert	Empty Retries	0	
Itesder LLCAP Start Fragment / Complete NESN 0 SN 0 MD 0 OP 0 Payload Data Length 12 Data 8 bytes CCAP Frame 0 LCCAP Start Fragment / Complete 0 Payload Data Length 12 Data 8 bytes CCAP Frame 0x000+ (ATT) Payload 4 bytes LCCAP SOU Basic, 4 bytes LCCAP SOU Basic, 4 bytes ATT Packet Vinte Request V Attribute Handle 50 Attribute Handle S0 Attribute Handle Mid Alert	Total Retries	0	
• LLD L2CAP Start Fragment / Complete • NESN 0 • SN 0 • Data 0 • Data 8 bytes • LCCAP Frame 0 • Length 4 bytes • LCCAP Start Fragment / Complete 0 • Data 8 bytes • Data 8 bytes • LCCAP Frame 0x000+ (ATT) • Payload 4 bytes • LCAP SDU Basic, 4 bytes • Copcode Write Request • Attribute Handle 50 • Attribute Handle S0 • Attribute Handle Mid Alert	Link-Layer Packet		
ULD L2CAP Start Fragment / Complete NESN 0 SN 0 MD 0 CP 0 Payload Data Length 12 Data 8 bytes CCAP Frame 0 Verify 4 bytes CCAP Start Fragment / Complete 0 Payload Data Length 12 Payload Data Length 4bytes CACAP Start Frame 0x0004 (ATT) Payload 4bytes 12 LCAP SDU Basc, 4 bytes ATTPOLY Handle 50 Attribute Handle 50 Attribute Handle Mid Alert	Render		
Atribuce Handle So		L2CAP Start Fragment / Con	noiete
• MD 0 • GP 0 • Payload Data Length 12 • Data 8 bytes • L2CAP Frame 5 • Length 4 bytes • Desthastion CID 0x000+ (ATT) • Payload 4 bytes • CacAP SDU Basc, 4 bytes • Opcode Write Request • Attribute Handle 50 • Attribute Handle 50			
OP Payload Data Length 12 Data Boytes LCAP Frame Longth Destination CID Ox0004 (ATT) Payload 4bytes LCAP SOU Basic, 4 bytes ATT Packet Opcode Write Request Attribuce Handle S0 Alert Level Mid Alert	SN	0	
Payload Data Length 12 Data 8 bytes LOCAP Frame 5 Destination CID 0x004 (ATT) Payload 4 bytes LCAP SOU Basic, 4 bytes LCAP SOU Basic, 4 bytes ATT Packet 70 Opcode Write Request Attribute Handle 50 Attribute Handle S0 Attribute Handle Mid Alert	Ø MD	0	
Data B bytes LPORT Frame Longth 4 bytes Destination CID 0x0004 (ATT) Payload 4 bytes LCAP SOU Base, 4 bytes ATT Packet Opcode Write Request Attribute Handle 50 Alert Level Mid Alert	OP CP	0	
LCAP Frame Length 4 bytes Destination CID 0x0004 (ATT) Payload 4 bytes LCAP SDU Basic, 4 bytes ATT Packet Opcode Write Request Attribute Handle 50 Attribute Handle 50 Alert Level Mid Alert	Payload Data Length	12	
	🧼 Data	8 bytes	
Ø Destination CED Ø Payload Ø Payload 4 Payles ZCAP SOU Basic, 4 bytes ZATAF SOU Basic, 4 bytes ATT Packet Write Request ATT Packet Write Request Attribute Handle SO Attribute Handle SO	L2CAP Frame		
Payload 4 bytes LCAP SOU Basic, 4 bytes LTP Acket Opcode Write Request ATT Packet Opcode S0 Attribute Handle S0 Alert Level Nild Alert	Length	4 bytes	
LCAP SOU Basic, 4 bytes ATT Packet	Destination CID	0x0004 (ATT)	
Opcode Write Request Attrbute Handle 50 Alert Level Mild Alert	Payload	4 bytes	
Opcode Write Request Attribute Handle 50 Alert Level Mild Alert	L2CAP SDU	Basic, 4 bytes	
Attribute Handle 50 Alert Level Mild Alert	ATT Packet		
Alert Level Mild Alert	Opcode	Write Request	
	Attribute Handle	50	
TT Write Response Packet	Alert Level	Mid Alert	
	TT Write Response Packet		

Figure 5 Details View.



The ATT Write Response is detailed similarly to the ATT Write Request. It clearly shows the returned ATT Write Response quite effectively; however, if you know Link Layer, you also know that it is a very flexible protocol, requiring many fields to describe this dynamic protocol.

The Details view in **Figure 5** looks somewhat abbreviated, and it actually is. By default, the Ellisys software only displays the most relevant information, and hides information which is not generally useful for understanding, such as valid CRCs, lengths, reserved fields, etc. Of course these hidden fields can be shown as needed (see the **All Fields** toggle in the **Details** toolbar), and will automatically be displayed if there is anything wrong with them (so an incorrect CRC will not be missed for example).

In **Figure 6**, the same ATT Write Response event is shown with all fields enabled. The grayed lines are those that are hidden by default.

Ellisys Protocol Toolbar

As seen in **Figures 5 and 6**, the Details view conveniently displays all protocols in a single view. This is very useful in understanding the sequence of events and protocol inter-relationships. For example, it's easy to see the ATT request, the L2CAP connection, ATT response and the ATT data. But sometimes you need to focus on a particular protocol, or traffic with specific characteristics. There are two features that are quite useful for this purpose — the Overview's protocol toolbar (described in this section), and the Instant Filters (described in the next section).

A protocol toolbar is located atop all Overviews and is customized to fit the characteristics of the particular Overview. This is very useful for switching between Bluetooth protocols, like Attribute protocol, L2CAP, Security Manager

× I	All fields	Show in overview	Display -	Ph .	Search	
Nar			1	Value	1.	
		e Request Packet (Ale	rt Loval: Mild	1000		-
~ '	ATT WHO	e Request Packet (Ale	IL LEVEL FIND	,		
Ξ,	€ Link-	Layer Information				
	🖃 🔩 Sn	iffer Radio				
	4	RX Strength (RSSI)		-31.5 dBr	m	
	4	RX Quality		High		
	4	RF Gain		0.0 dB		
	🕀 🔧 RF	Channel				
	🕀 🔩 Lin	ik Layer				
	🕀 🔩 Tir	ning				
	🕀 🔩 De	vices				
	🗄 🔧 Se	curity				
	🗄 😤 Ac	knowledgement and Flow	Control			
Đ,	+ Retrar	nsmission Information				
8	→ Link-	Layer Packet				
	🖂 🔩 He	ader				
	9	LLID		L2CAP St	art Fragment / Comp	lete
	4	NESN		0		
	4	SN		0		
	4	MD		0		
	4	CP		0		
	4	RFU		Reserved	d (0x00)	
	4	Payload Data Length		12		
	🥥 Da	ita		8 bytes		
	🥥 MI	C		Valid		
	Y CF	C		Valid		
	🗄 🔧 Ra	w Content				
		P Frame				
	🧳 Le	ngth		4 bytes		
	🥥 De	stination CID		0x0004 (ATT)	
	A Pa	vload		4 bytes		

Figure 6 Details View (Expanded).

Protocol (SMP), RFCOMM, etc., or between protocol layers, like Link Layer, baseband, packet-only view, etc.

By default the **All Layers** button is enabled, showing all protocol layers. While this is very useful for understanding the global sequence of events, sometimes it is useful to focus on a single protocol layer.

HELPFUL HINT: Add the "Originator," "Transmitter," and/or "Receiver" fields as an Overview column to see device roles at a glance (you can even colorize these if desired). This can be done by dragging that field from the Details view (the lower protocol layers will show a "Devices" section that includes this field) and dropping it into the Overview, or just right click on the Overviews header and select the desired field(s).

You can also see highlighting of the selected packet or transaction in the Instant Timing view (discussed later), and a flyover there on the packet of interest will produce a pop-up with quite a bit of information.



· View Layout	Search Record Tools Help ▶ Record • ■ Stop ■ Restart ■ Save & Continue 🍢 🕸 • 🙀 💭 Navigate • 🐘 🖸 Markers • 💭 👒	Filtering: Keen All						
and the second second	Energy Overview Message Log H Instant Spectrum	The intering the pro-					٩	Þ 3
	All layers 🔶 🚓 🥧 🖗 🛐 🖗 🎝 💮 21 items displayed						Search •	04
and the second		Attribute Data	Alert Level	~	Status 🗸	Payload ~	Communication	~
54.005 922 500	😦 🎥 ATT Read (Alert Level: None)	1 byte	No Alert		OK	1 byte (00)	Master: 38:8F:33:0	18:0
54.030 923 625	🛞 📴 ATT Read (Alert Level: Mild)	1 byte	Mild Alert	-	OK	1 byte (01)	Master: 38:BF:33:0	08:0
54.055 924 375	🛞 🚋 ATT Read (Tx Power Level: 0 dB)	1 byte			OK	1 byte (00)	Master: 38:8F:33:0	38:0
54.080 692 375	🛞 📴 ATT Write Transaction (Alert Level: Mid)	1 byte	Mild Alert		OK	1 byte (01)	Master: 38:8F:33:0	38:0
54.130 922 000	🛞 📴 ATT Read (Alert Level: None)	1 byte	No Alert		OK	1 byte (00)	Master: 38:8F:33:0	18:0
73.105 781 875	🛞 🗽 ATT Read (Supported New Alert Category: Simple, Email, News, Call, Missed, ShortMsg, VoiceMail, Schedule)	2 bytes			OK	2 bytes (FF 00)	Master: 38:8F:33:0	38:0
73. 193 283 000	🕫 💺 ATT Read (Supported Unread Alert Category)	2 bytes			OK	2 bytes (00 00)	Master: 38:8F:33:0	18:
73.256 013 125	🛞 🗽 ATT Write Transaction (Alert Notification Control Point: Command=Enable New Incoming Alert Notification, Category=255)	2 bytes			OK	2 bytes (00 FF)	Master: 38:8F:33:0	38:
73.368 279 250	🕫 💺 ATT Read (Alert Status)	1 byte			OK	1 byte (00)	Master: 38:BF:33:0	18:
73.443 282 500	🛞 🕵 ATT Read (Ringer Setting: Normal)	1 byte			OK	1 byte (01)	Master: 38:8F:33:0	38:
73.555 784 375	🛞 🧱 ATT Read (Local Time Information: Time Zone=UTC+9:00, Offset=Standard)	2 bytes			OK	2 bytes (24 00)	Master: 38:8F:33:0	18:
73.655 783 875	🗃 🌉 ATT Read (Current Time: 2013, Jan, 4, 16 h, 49 min, 4 s, Day=Sat, Fractions=0 s, Manual)	10 bytes			OK	10 bytes (DD 07 01	Master: 38:BF:33:0	18:
73.755 785 875	🛞 🎉 ATT Read (Current Time: 2013, Jan, 4, 16 h, 49 min, 5 s, Day=Sat, Fractions=0 s, Manual)	10 bytes			OK	10 bytes (DD 07 01	Master: 38:8F:33:0	38:0
84.708 625 875	🛞 🚋 ATT Write Command Packet (Alert Level: High)	1 byte	High Alert		OK	1 byte (02)	Master: 38:8F:33:0	38:0
94.897 216 125	🛞 🕵 ATT Write Command Packet (Alert Level: None)	1 byte	No Alert		OK	1 byte (00)	Master: 38:8F:33:0)8:0
96.895 728 625	🛞 🏪 ATT Write Command Packet (Alert Level: High)	1 byte	High Alert		OK	1 byte (02)	Master: 38:8F:33:0	18:
100.893 222 625	🛞 🚉 ATT Write Command Packet (Alert Level: None)	1 byte	No Alert		OK	1 byte (00)	Master: 38:BF:33:0	38:
140.868 125 375	🕀 🚉 ATT Notification Packet (New Alert: Category=Email, New=1, Info="ጋ"ሶንጵን")	20 bytes			OK	20 bytes (01 01 EF	Master: 38:BF:33:0	18:0
180.843 039 500	😠 🏩 ATT Notification Packet (New Alert: Category=Call, New=1, Info=""// በንት	20 bytes			OK	20 bytes (03 01 EF	Master: 38:8F:33:0	18:0
188.838 041 250	🗃 🏂 ATT Notification Packet (New Alert: Category=Missed, New=1, Info="ሽ/ቢን?")	20 bytes			OK	20 bytes (04 01 EF	Master: 38:8F:33:0	38:
188.838 519 250	# t ATT Write Command Packet (Ringer Control point: Mute Once)	1 byte			OK	1 byte (02)	Master: 38:8F:33:0	38:

Figure 7 Protocol Toolbar – ATT Only.

For example, if we want see what is going on at the ATT level, we can just click the **ATT button** and we quickly get this view (see **Figure 7**).

As you may notice, the complement of columns is fully configurable and independent between the different protocol selections, which is quite handy when working extensively with several protocols at the same time.

Then let's say we wish to look at only L2CAP, so just click the L2CAP button and we get the following (see Figure 8).

le View Layout	Search Record Tools Help					
A 16 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	🕨 Record • 🖩 Stop 🔄 Restart 🞼 Save & Continue 🦙 👾 • 🐄 💷 Navigate	- 116 I CO.M	larkers 🔹 🥔 👒 🛛 🔏 Filtering	: Keep All 🔹 🎆		
Welcome Low	Energy Overview Message Log He Instant Spectrum					
	- All layers + 😝 📾 🎑 🖗 🍷 🦻 🔏 🎝 💮 35 items displayed					Search
Time	Item	Status 🗸	Payload 🗸	Communication ~	Application ~	Destination CID v
73.081 011 625	⊕ 🛖 L2CAP SDU (Basic, Service=ATT)	OK	3 bytes (0A 18 00)	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
73.105 781 875	🗄 🧙 L2CAP SDU (Basic, Service=ATT)	OK	3 bytes (08 FF 00)	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
73.168 974 000	L2CAP SDU (Basic, Service=ATT)	OK	3 bytes (0A 1D 00)	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
73.193 283 000	🗄 🛶 L2CAP SDU (Basic, Service=ATT)	OK	3 bytes (08 00 00)	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
73.256 013 125	🔀 🛖 L2CAP SDU (Basic, Service = ATT)	OK	5 bytes (12 22 00 00 FF)	Master: 38:8F:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
73.293 283 125	🗄 🛶 L2CAP SDU (Basic, Service=ATT)	OK	1 byte (13)	Master: 38:8F:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
73.343 512 500	E 🚓 L2CAP SDU (Basic, Service=ATT)	OK	3 bytes (0A 34 00)	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
73.368 279 250	🗄 🛶 L2CAP SDU (Basic, Service=ATT)	OK	2 bytes (08 00)	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
73.418 517 125	L2CAP SDU (Basic, Service=ATT)	OK	3 bytes (0A 37 00)	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
73.443 282 500	🛞 🛶 L2CAP SDU (Basic, Service = ATT)	OK	2 bytes (08 01)	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
73.543 512 875	L2CAP SDU (Basic, Service = ATT)	OK	3 bytes (0A 40 00)	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
73.555 784 375	🕀 🛶 L2CAP SDU (Basic, Service=ATT)	OK	3 bytes (0B 24 00)	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
73.631 014 250	L2CAP SDU (Basic, Service «ATT)	OK	3 bytes (0A 3D 00)	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
73.655 783 875	🗄 🛶 L2CAP SDU (Basic, Service=ATT)	OK	11 bytes (08 DD 07 01 04 1	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
73.731 015 250	🕀 🛶 L2CAP SDU (Basic, Service=ATT)	OK	3 bytes (0A 3D 00)	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
73.755 785 875	🗄 🛶 L2CAP SDU (Basic, Service=ATT)	OK	11 bytes (08 DD 07 01 04 1	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
74.968 520 875	⊕ 🛖 L2CAP Parameter Update (Min=1.370000 s, Max=1.390000 s, Lat=0, T/o=6.000 s)	OK		Master: 38:BF:33:08:C9:15 <-> Sla	L2CAP	0x0005 (Signaling)
84.708 625 875	🗃 🛶 L2CAP SDU (Basic, Service = ATT)	OK	4 bytes (52 2E 00 02)	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
94.897 216 125	🗉 🛶 L2CAP SDU (Basic, Service = ATT)	OK	4 bytes (52 2E 00 00)	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
96.895 728 625	🕃 🛶 L2CAP SDU (Basic, Service=ATT)	OK	4 bytes (52 2F 00 02)	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
100.893 222 625	🕃 🛶 L2CAP SDU (Basic, Service=ATT)	OK	4 bytes (52 2F 00 00)	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
140.868 125 375	L2CAP SDU (Basic, Service=ATT)	OK	23 bytes (1B 1A 00 01 01 EF	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
180.843 039 500	E 🚖 L2CAP SDU (Basic, Service=ATT)	OK	23 bytes (1B 1A 00 03 01 EF	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
188.838 041 250	(a de L2CAP SDU (Basic, Service ≈ ATT)	OK	23 bytes (1B 1A 00 04 01 EF	Master: 38:BF:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)
188.838 519 250	L2CAP SDU (Basic, Service = ATT)	OK	4 bytes (52 3A 00 02)	Master: 38:8F:33:08:C9:15 <-> Sla	ATT	0x0004 (ATT)

Figure 8 Protocol Toolbar – L2CAP Only.

HELPFUL HINT: Use the Protocol: drop-down menu to specify whether you want to see one protocol selection at a time or any combination of multiple protocols.



wEnergyWatch.btt	* - Ellisys Bluetooth Analyzer	i i	i.					Ť.
	t Search Record Tools Help							1
		a seconda ha de la	65 [E] Mardanta [2]	Audum - D. D. St Ellusion Kan All -				i.
			🔐 🛵 Navigate 🖡 📖	🕐 Markers 👻 🥼 🖓 Filtering: Keep All 🔹 🥎			_	1
Welcome Low	v Energy Overview Message Log	and the second						4
Protocol: Single	- All layers + 🚓 📾 🎃 🖇 🏠 🦻	A J 14 items kept	t, 25 filtered				Searc	h i -
Show only -	tem = "ATT Read" "ATT Noti-	Firstion Packet"						1
Show only .	Cell - All head II part hour	TEBELON FOCKEL						V
	Neb .							
Time 🗸	Item		\forall	Communication	\times	Payload	~ St	tatus
54.005 922 500	🕀 👺 ATT Read (Alert Level: None)	•		Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A ** DB:84:7D:38:A1:8C (Static)		1 byte (00)	C	ж
54.030 923 625	🕀 🔯 ATT Read (Alert Level: Mild)			Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" DB:84:7D:38:A1:8C (Static)		1 byte (01)	C	Ж
54.055 924 375	🕀 🙀 ATT Read (Tx Power Level: 0 dB)	1		Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A *" DB:84:7D:38:A1:8C (Static)		1 byte (00)	C	ж
54.130 922 000	🗄 👺 ATT Read (Alert Level: None)			Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" DB:84:7D:38:A1:8C (Static)		1 byte (00)	C	ж
73.105 781 875	🗄 🏂 ATT Read (Supported New Alert Catego	ry: Simple, Email, News, Call, M	issed, ShortMsg, VoiceM	Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" DB:84:7D:38:A1:8C (Static)		2 bytes (FF 00)	C	Ж
73.193 283 000	🗄 🏂 ATT Read (Supported Unread Alert Cate	egory)		Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A *" DB:84:7D:38:A1:8C (Static)		2 bytes (00 00)	C	Ж
73.368 279 250	🗉 🚋 ATT Read (Alert Status)	I.		Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" DB:84:7D:38:A1:8C (Static)		1 byte (00)	C	Ж
73.443 282 500	🗉 🚉 ATT Read (Ringer Setting: Normal)			Master: 38:8F:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" D8:84:7D:38:A1:8C (Static)		1 byte (01)	C	Ж
73.555 784 375	🕃 🚉 ATT Read (Local Time Information: Time	Zone=UTC+9:00, Offset=Star	ndard)	Master: 38:8F:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" DB:84:7D:38:A1:8C (Static)		2 bytes (24 00)	C	ж
73.655 783 875	🕃 🚊 ATT Read (Current Time: 2013, Jan, 4,	16 h, 49 min, 4 s, Day=Sat, Fra	actions =0 s, Manual)	Master: 38:8F:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" D8:84:7D:38:A1:8C (Static)		10 bytes (DD 07 01 04 1	C	ж
73.755 785 875	🕃 🚉 ATT Read (Current Time: 2013, Jan, 4,	16 h, 49 min, 5 d, Day=Sat, Fra	ctions =0 s, Manual)	Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" DB:84:7D:38:A1:8C (Static)		10 bytes (DD 07 01 04 1	C	ж
140.868 125 375	🕀 🏩 ATT Notification Packet (New Alert: Cat	egory=Email, New=1, Info="]	h7977	Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" DB:84:7D:38:A1:8C (Static)		20 bytes (01 01 EF BD B.	C	ж
180.843 039 500	🕀 🏩 ATT Notification Packet (New Alert: Cali	egory=Call, New=1, Info=为化	ロシブ	Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" DB:84:7D:38:A1:8C (Static)		20 bytes (03 01 EF BD B.	C	Ж
188.838 041 250	🕀 🚉 ATT Notification Packet (New Alert: Cat	egory=Missed, New=1, Info=7	570277	Master: 38:8F:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" DB:84:7D:38:A1:8C (Static)		20 bytes (04 01 EF BD B.	C	ж
		I.						
		i i i						
		1						

Show/Hide Information Pop-Up

Yellow Underline (Column Filter Installed)

Remove Filter Query

Figure 9 Instant Filters.

Instant Filters

Edit Eilter Query and

Understanding the various filter approaches throughout the application is key to becoming an expert with the tool. The User Guide (located in Help > User Guide) describes all filtering approaches in detail.

One of the most common filters customers use is the Instant Filters, which operate on the selected Overview. These filters are enacted as guery-based textual entries in the Filter Query box located atop the columns in the Overviews. See Figure 9.

Instant Filters are quite powerful and can be used to efficiently and precisely locate and display information of interest during capture or on saved captures, using a variety of operators, comparators, and expressions. A helpful pop-up is provided to guide the user in creating these filters. See Figure 10.

Enter a filter query to quickly keep or exclude lines based on criteria for any column in the overview or any field in the Details view.

Create complex combinations using &&, || operators and =, !=, <, >, <=, >= comparators. Values can be numbers, texts in double quotes or computations using other fields. Texts can contain a star to represent any character.

Terms separated by comma must all match at least one value. Exclamation mark can be used before values to create a NOT condition.

Syntax

Field or column name = [!]value[,value,...], Another field = [!]value[,value,...] where value is "text" or numbers 123, 0xABCD, 0b010101 or data 0x[A1B2C3 *] and terms can be in parentheses separated by || or && instead of comma.

Examples

Text** keeps lines where Item column starts with Text Item = Item = !"*Text*" excludes lines where Item column contains Text Status = "OK" keeps lines where Status column is exactly OK Foo = 1, 0x03, 7..10 keep 3, 7, 8, 9 or 10 Foo >= 0x0F << 2, 4+5 && (Bar = 1 || Status != "OK") keeps lines where Foo is bigger than 9 and either Bar is 1 or Status is not OK Payload = 0x[0A 0B 0C *] keeps lines where Payload first 3 bytes are 10, 11, 12 OK, got it (Click anywhere to hide this popup. To show it again, use the toolbar info button)

Figure 10 Instant Filters Pop-Up Guide.

Filters can be stored, recalled, and annotated as favorites. Data and information on which these filters operate can be in the active Overview or in the Details view, but it is not required to place fields from the Details view into the Overview to use these fields in a filter query.

Instant Filters are based on simple text patterns and accept a variety of common operators, including wildcards (*). They can be created by typing the desired filter or conveniently, by using a right-click on a column-row intersection in the Overview.

HELPFUL HINT: The auto-complete feature means you'll never have to remember specific packet types, commands, etc. Just start typing in the Filter Query box and the application will suggest options.



Let's walk through a simple example. We want to keep only ATT commands, but we want to filter even further on just the 'ATT Read' traffic.

We can simply type "ATT Read" in the Item column's Instant Filter box.

Item = "ATT Read"

This will keep/show any line beginning with "ATT Read", as shown in **Figure 11** below.

It is also possible to exclude traffic by using the NOT sign (!), for example: by typing "!att". This will exclude/hide lines beginning with "att" and leave all other traffic displayed.

Item != "ATT"

Add a comma separator to include another term in the filter, for example:

Item ! = "ATT" "SMP".

Ranges are supported in numeric columns. A range is specified such as start..stop (i.e., separated by two periods). For example, to keep/show items occurring between 0 and 1 second, simply type "0..1" in the Time column's Instant Filter box.

See the User Guide for more examples and additional details.

	w Energy Overview Message Log 📃 Instant Spectrum			earch	4		
🝸 • Protocol: Single • All layers + 🚓 🖦 📤 🖇 🏚 🦿 🎼 🗊 👔 7							
J Show only - Item = "ATT Read" "ATT Notification Packet"							
me 🗸	ltem T V	Communication	Payload ~	Statu	15		
4.005 922 500	🛞 🚰 ATT Read (Alert Level: None)	Master: 38:8F:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" DB:84:7D:38:A1:8C (Static)	1 byte (00)	OK			
4.030 923 625	🛞 🚰 ATT Read (Alert Level: Mid)	Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" DB:84:7D:38:A1:8C (Static)	1 byte (01)	OK			
4.055 924 375	🛞 🏠 ATT Read (Tx Power Level: 0 dB)	Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A#" DB:84:7D:38:A1:8C (Static)	1 byte (00)	OK			
4.130 922 000	🛞 🚋 ATT Read (Alert Level: None)	Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A ** DB:84:7D:38:A1:8C (Static)	1 byte (00)	OK			
3.105 781 875	🛞 🍓 ATT Read (Supported New Alert Category: Simple, Email, News, Call, Missed, ShortMsg, VoiceM	Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A *" DB:84:7D:38:A1:8C (Static)	2 bytes (FF 00)	OK			
3. 193 283 000	🛞 🏪 ATT Read (Supported Unread Alert Category)	Master: 38:8F:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" DB:84:7D:38:A1:8C (Static)	2 bytes (00 00)	OK			
3.368 279 250	🛞 💺 ATT Read (Alert Status)	Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" DB:84:7D:38:A1:8C (Static)	1 byte (00)	OK			
3.443 282 500	🛞 🚋 ATT Read (Ringer Setting: Normal)	Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" DB:84:7D:38:A1:8C (Static)	1 byte (01)	OK			
3.555 784 375	Karal (Local Time Information: Time Zone=UTC+9:00, Offset=Standard)	Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" DB:84:7D:38:A1:8C (Static)	2 bytes (24 00)	OK			
3.655 783 875	🗉 🅦 ATT Read (Current Time: 2013, Jan, 4, 16 h, 49 min, 4 s, Day=Sat, Fractions=0 s, Manual)	Master: 38:8F:33:08:C9:15 <-> Slave: "CASIO GB-5600A*" DB:84:7D:38:A1:8C (Static)	10 bytes (DD 07 01 04 1	OK			
3.755 785 875	🛞 🌺 ATT Read (Current Time: 2013, Jan, 4, 16 h, 49 min, 5 s, Day=Sat, Fractions=0 s, Manual)	Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A *" DB:84:7D:38:A1:8C (Static)	10 bytes (DD 07 01 04 1	OK			
40.868 125 375	🛞 🚋 ATT Notification Packet (New Alert: Category=Email, New=1, Info="コドクタク")	Master: 38:BF:33:08:C9:15 <-> Slave: "CASIO GB-5600A *" DB:84:7D:38:A1:8C (Static)	20 bytes (01 01 EF BD B	OK			
80.843 039 500	🛞 🚋 ATT Notification Packet (New Alert: Category=Call, New=1, Info="方伯シウ	Master: 38:8F:33:08:C9:15 <-> Slave: "CASIO GB-5600A *" DB:84:7D:38:A1:8C (Static)	20 bytes (03 01 EF BD B	OK			
88.838 041 250	😠 💺 ATT Notification Packet (New Alert: Category=Missed, New=1, Info="ກໍ່ໃນ>່າ)	Master: 38:8F:33:08:C9:15 <-> Slave: "CASIO GB-5600A ** DB:84:7D:38:A1:8C (Static)	20 bytes (04 01 EF BD B	OK			

Figure 11 Instant Filters.

HELPFUL HINT: An easy way to specify a filter is by right-clicking on a line at a specific column/row position, and the contextual menu will offer to keep or exclude the traffic type/field selected.



Details II St	Traffic Filtering Criteria		Device Database					
Raw data	Keep All	• 🛛 🖓 Clear 🖏 Add	New Device 🖉 Edit 📗 Delete	Search:	Vie	ew: All Devices 🝷	64 dev	ices •
Instant Timing Instant Spectrum Instant Spectrum Instant Piconet Instant Channels Instant Throughput Instant Audio Device Traffic Filters Security Mesh Security WPAN Security WPAN Security Overviews Other Windows Locz S55 783 875 Security Aler Aler Cure	/Here -		Name CASI 0 G8-5600A* CASI 0 G8-5600A* CASI 0 G8-5600A* CASI 0 G8-5300B-C5:15 CASI 0 G8-62 SoundLink Adex's Aversome QC3s CQ3s CQ3s CQ3S CQ3S CASI 0 G23s CASI 0 G8-00A+ CA	8479324322 0452247705289 0452247705289 04522477052750 04522477527527 0452247752752 0452247752752 04522477525 0452247754252 045224754252 045224754252 04522475425 04522475425 04522475425 04522475425 04522475425 04522475425 04522475425 04522475425 04522475425 04522475425 04522475425 04522475425 04522475425 0452247545 0452475455 0452475455 045257545 045257545	Low Energy Low Energy Low Energy Dual Mode Low Energy Low Energy Low Energy Low Energy Low Energy Low Energy Low Energy Low Energy Dual Mode Low Energy Dual Mode Low Energy Low Energy Low Energy Low Energy Low Energy Low Energy Low Energy	UCK Bose AE2 SoundLink Alex's Amesome QC35s QC35 CSR Smart Remote Bose QuietComfort 35 LE-Bose Revolve + So LE-Bose Revolve + So	Company ID NEC CASIO Mobile C Ubigati Networks Inc. Bose Corporation Bose Corporation Bose Corporation Cambridge Silcon Radio Bose Corporation Bose Corporation	, vo

Figure 13 Device Traffic Filter Displaying All Devices.

HELPFUL HINT: In most windows where you see a Bluetooth Device Address (such as an Overview, the Instant Piconet, or the Security window), you can use a right click to install a device-based filter.

Filtering by Devices

When using a wideband sniffer, all device activity in the area will be captured. A devicebased (BD_ADDR-based) filter is the "biggest" filter available, and can be useful when you want to focus only on particular devices and/or communications of interest.

In addition, you can get even more creative with device filters by using the **Device Traffic Filter** feature. This is available from the **View menu** (see **Figure 12**) or from the **Filtering**: drop-down selection at the top of the UI.

By default, all devices are displayed, (See **Figure 13**) which is consistent with the

Device Traffic Filters Traffic Filtering Criteria Device Database Keep All 💥 Clear 🐁 Add 📲 New Device 🖉 Edit 📗 Delete | Search: View: All Devices -64 devices Radio Cap... Transmitted Name Company ID Address E CASIO G8-5600A* D8:84:70:38:A1:8... Low Energy CASIO G8-5600A - 38:8F:33:08:C9:15 38:8F:33:08:C9:15 Low Energy NEC CASIO Mobile C ... UCK B4:FB:E4:82:89:6A UCK Ubiquiti Networks Inc. Low Energy Bose AE2 SoundLink 08:DE: 1E: 51:E3:11 Dual Mode Bose AF2 Sound ink Bose Cornoration Alex's Awesome QC35s 04:52:C7:0C:88:B9 Alex's Awesome QC35s Low Energy Bose Corporation 04:52:C7:62:C7:CD Low Energy QC35 Bose Corporation 0035 Cambridge Silicon Radio CSR Smart Remote 00:02:58:00:89:2A Low Energy CSR Smart Remote Bose QuietComfort 35 Bose QuietComfort 35 04:52:C7:77:0C:89 Low Energy Bose Corporation LE-Bose Revolve + SoundLink 08:DF: 1F:FF:D7:E4 Low Energy LE-Bose Revolve + So ... Bose Corporation LE-Bose Revolve + SoundLink 08:DF:1F:FF:D7:3F Low Energy LE-Bose Revolve + So ... Bose Corporation QP 04:52:C7:64:2C:64 Low Energy QP Bose Corporation Low Energy E-Bose QuietControl 30 04:52:C7:02:E2:C8 LE-Bose QuietControl ... Bose Corporatio MY PC/MyPC A4:02:89:CE:3A:84 Dual Mode DESKTOP-88JTVLGIC ... Intel Corporate 04:52:C7:34:AB:24 LE-Eric QC 35 Low Energy LE-Eric QC 35 Bose Corporatio LE-SL R Office 04:52:C7:00:27:55 Low Energy LE-SL R Office Bose Corporation LE-Thunder Flash 04:52:C7:0A:C5:88 LE-Thunder Flash Bose Corporatio Low Energy **q**c35s 04:52:C7:5E:D4:E0 Dual Mode qc35s Bose Corporation LE-5 Low Energy 08:DF:1F:E6:26:2E LE-13 Bose Corporatio Low Energy HR-red beats 04:52:C7:6E:28:68 HR-red beats Bose Corporation 04:52:C7:3F:6A:2C Greane Machine Low Energy Greane Machine Bose Corporation I F.Man'r Daunhua QK Gancel



HELPFUL HINT: An easy approach to finding the devices desired is to type the Transmitted Name of the device (or Name), the Company ID, or the BD_ADDR in the Filter box. **See Figure 14**. Partial text entries will also work. This will reduce the list to devices matching what was typed in the box (and reduce what is displayed in the Overview to this list).

"Exclude Background" or **"Keep All"** selections in the **Filter:** drop-down menu at the top of the GUI (and also shown in the Traffic Filtering Criteria section of the Device Traffic Filters window. The Device Traffic Filters window will display all devices captured historically, as well as devices present in the current trace (an icon is provided to designate which devices are in the active/opened trace). A hierarchical list (annotated by a + sign) of the communications established between them is also available to display.

The device can then be added to the left area of the window (Traffic Filtering Criteria) in order to keep only the traffic between or amongst the specified devices, i.e., Keep Only or Keep Involving. If only one device is specified, then all the traffic to and from this device will be displayed. This is known as a Keep Involving filter, which will show all traffic to and from the selected device(s). A Keep Only filter is deterministic, i.e., these show traffic between the selected devices only.



	at Search Record Tools Help) 🖡 Record • 🗉 Stop 💷 Restart 🖏 Save & Continue 🧞 🐳 • 🎇 💭 Navigate - 📖 🍋	Markers • 🖉 🔍 💘 Filt	ering: Exclude Background 👻 👩	📑 bt02 📑 Analysis 📑 details		1
Welcome BF	REDR Overview Low Energy Overview WFi Overview WPAN Overview Message Log	Instant Spectrum	4 B X	Detais		
Protocol: Single	e - 🛛 All layers + 🚓 👘 👘 🦸 🏄 🎝 🕥 34 items displayed		Search • 🕅	S All fields 🗄 Show in overview Display •	Search	-
Time 🗸	Item	PDU Type	 Communication 	Name	Value	
0.014 414 750	€ 1 Connectable ("[LG] webOS TV UM6970PU8" 40:E7:1E:83:0C:EC (Resolvable), 4 Scanners, 2.6 mn)	ADV_IND	Master: "[LG] webOS TV UM6970PUB" 40:E7: 1E:83:0C:EC (Resolvable) <->			
0.032 816 250	Non-Connectable (29:98:30:0C:36:8F (Non-Resolvable), 2.6 min)	ADV_NONCONN_IND	Master: 29:96:30:0C:36:8F (Non-Resolvable) <-> Slave: "Scanning Device"	o let and a second second		
0.038 799 000	@ 1 Non-Connectable (18:1C:AD:25:70:80 (Non-Resolvable), 2.6 min)	ADV NONCONN IND	Master: 18:1C:AD:25:70:80 (Non-Resolvable) <-> Slave: "Scanning Device"	Link-Layer Information		
0.052 933 875	Connectable (4A:52:A9:BC:11:1F (Resolvable), 4 Scanners, 2.59 min)	ADV_IND	Master: 44:52:49:8C:11:1F (Resolvable) <-> Slave: "Scanning Device"	🗉 者 Sniffer Radio		
0.056 749 500	# 1 Connectable (44:C4:77:D1:DC:ED (Resolvable), 3 Scanners, 2.6 min)	ADV_IND	Master: 44:C4:77:D1:DC:ED (Resolvable) <-> Slave: "Scanning Device"	🗄 🔩 RF Channel		
0.084 118 125	Non-Connectable (18:11:CC: 1F:D3:AA (Non-Resolvable), 2.6 min)	ADV_NONCONN_IND	Master: 18:11:CC: 1F:D3:AA (Non-Resolvable) <-> Slave: "Scanning Device"	RF Channel Frequency	2402 Mbz	
0.086 336 250	Connectable (68:78:8A:40:8C:65 (Resolvable), 5 Scanners, 2.6 min)	ADV_IND	Master: 68:78:8A:40:8C:65 (Resolvable) <-> Slave: "Scanning Device"	RF Channel Number	0	
0.095 685 125	. Tonnectable ('Living Room TV" 4A:4A:4A:86:53:C4 (Resolvable), 4 Scanners, 2.6 mn)	ADV_IND	Master: "Living Room TV" 4A:4A:4A:86:53:C4 (Resolvable) <-> Slave:	RF Channel Index	37 (adv)	
0.165 087 500	B II Scannable (45:42:E1:A0:82:3E (Resolvable), 3 Scanners, 2.6 min)	ADV_SCAN_IND	Master: 45:42:E1:A0:82:3E (Resolvable) <-> Slave: "Scanning D	Initial Center Frequency Offset	+15.6 kHz	
0.175 344 500	B 1 Connectable (CC:D2:81:65:A1:0E, 4 Scanners, 2.6 min)		Master: CC:D2:81:65:A1:0E <-> Slave: "Scanning Device"	Get Link Layer		
0.202 820 125	Connectable (D0:03:48:10:32:70, 4 Scanners, 2.6 min)	ADV_IND	Master: D0:03:48:10:32:70 <-> Slave: "Scanning Device"	To Devices		
0.243 785 500	# 1 Advertisement (55:95:95:CB:EC:78 (Resolvable), 2 Scanners, 2.6 min)		Master: 55:95:95:CB:EC:78 (Resolvable) <-> Slave: "Scanning Device"	13 Dences		
0.247 186 375	Connectable (6A: 46:D9:F7:88:41 (Resolvable), 4 Scanners, 2.6 min)	ADV_IND	Master: 6A:46:D9:F7:B8:41 (Resolvable) <-> Slave: "Scanning Device"	'nk-Layer Packet		
0,560 397 500	Advertisement (53:0E:40:C9:C9:26 (Resolvable), Scanner 6A:27:98:56:1F:09 (Resolvable), 2.57 min)		Master: \$3:0E:40:C9:C9:26 (Resolvable) <-> Slave: "Scanning Device"	E Keader		
0.572 735 625	Advertisement (50:82:74:77:A4:3C (Resolvable), Scanner 6A:27:98:56:1F:09 (Resolvable), 2.59 min)		Master: 50:82:74:77:A4:3C (Resolvable) <-> Slave: "Scanning Device"	POU Type	ADV_IND	
0.652 292 625	■ Connectable (6F:38:1C:66:92:7D (Resolvable), 4 Scanners, 2.59 min)	ADV_IND	Master: 6F:38:1C:66:92:7D (Resolvable) <-> Slave: "Scanning Device"	RPU RPU	Reserved (0)	
2.918 905 625	H Non-Connectable (19:31:A2:4A:91:6F (Non-Resolvable), 46.3 s)	ADV_NONCONN_IND	Master: 19:31:A2:4A:91:6F (Non-Resolvable) <-> Slave: "Scanning Device"	Channel Selection Algorithm	#1 (Legacy)	
9,386 702 625	# 🚺 Advertisement (46:31:CF:A7:92:1D (Resolvable), Scanner 45:42:E1:A0:82:3E (Resolvable), 8.71:s)		Master: 46:31:CF:A7:92:1D (Resolvable) <-> Slave: "Scanning Device"	TxAdd	Random	
13.944 848 625	Advertisement (\$0:32:37:81:D3:8E, Scanner 45:42:E1:A0:82:3E (Resolvable), 14.5 s)		Master: 50:32:37:81:D3:8E <-> Slave: "Scanning Device"	RFU (RxAdd)	Reserved (0)	
13.987 302 250	Advertisement (77:C2:60:79:77:E9 (Resolvable), Scanner 6A:27:98:56:1F:09 (Resolvable), 176 us)		Master: 77:C2:60:79:77:E9 (Resolvable) <-> Slave: "Scanning Device"	Payload Length	30	
15.276 402 125	Non-Connectable Undirected Adv Packet (29:98:30:0C:36:8F (Non-Resolvable))	ADV_NONCONN_IND	Master: 29:98:3D:0C:36:8F (Non-Resolvable) <-> Slave: "Scanning Device"	 Advertiser Address 	4A:4A:4A:86:53:C4 (Resolv	rable;
25.851 394 375	Advertisement (7A:89:80:01:2D:5C (Resolvable), Scanner 6A:27:98:56:1F:09 (Resolvable), 9.76 s)		Master: 7A:89:80:01:2D:5C (Resolvable) <-> Slave: "Scanning Device"	🗄 🍕 Advertising Data		
28.398 601 875	🗑 📳 Advertisement (6E:C9:DA:D3:B3:F8 (Resolvable), Scanner 45:42:E1:A0:B2:3E (Resolvable), 176 us)		Master: 6E:C9:DA:D3:83:F8 (Resolvable) <-> Slave: "Scanning Device"	E 🔩 Rags	1.1	
34.047 424 000	B Von-Connectable (02:96:67:9A:F4:83 (Non-Resolvable), 248 us)	ADV_NONCONN_IND	Master: 02:96:67:9A:F4:83 (Non-Resolvable) <-> Slave: "Scanning Device"	✓ Length	2 These	
	The second descent and the second second manufacture second secon		Alexandre Britten Britten Brand alder all a Barrier Brander Britten	Data Type	Flags	



HELPFUL HINT: Errors are highlighted in the Item column using a color-coded icon and fly-over pop-up to indicate the relative severity of the error, summarized in a dedicated status column (such as "warning" in the figure above), and described in the Details view.

Customizing an Overview

Customizations of the Overview are achieved very easily, and there are many of these available. One of the more popular customizations is the drag/drop of a field from the Details view to create a new column in the Overview. Just take any field in the Details pane, drag-drop it to the Overview, and it will appear instantly in a new column. This is especially useful when combined with Instant Filters, although Instant Filters can operate on any field, whether or not the field is displayed in an Overview column. Figure 15 shows the Overview customized for reviewing PDU Type traffic.

Searching and Coloring

Items can be searched and colored (highlighted). The simplest search feature is the search box located on the top-right of the Overview, called Instant Search. Text patterns typed in this box will be searched in all active Overview items and columns.

More precise and advanced searches can be achieved in the Search dialog, accessible with CTRL+F. In **Figure 16**, the user searches for payloads that include 08 00 in payloads

Search Low Er	ergy traffic	Search Low Energy traffic			
D 101 Paylor	d 📔 🚵 Text 📔 🍕 Field 📔	D 101 Payload	🗹 🚵 Text 🛛 🗌 🔩 Field 🗍		
Data to se	arch for 08 00	Texts are se	earched in column strings	î	
	0	Item	Empty" v (e.g: lmp, l2c	ap)	
Data type	Search for all data types	Status	~ (e.g: lok)		
	search for all data types	Pavload	v (e.g: 4 bytes	i	
Interprete		Time	(e.g. 1.3.7)		
	ASCII text: 30 38 20 30 30 Unicode text: 30 00 38 00 20 00 30 00 30 00	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			
	Unicode text: 30 00 38 00 20 00 30 00 30 00	Time delta	~		
		Packet #			
Length	From 20 to 32 bytes				
	8 0	Originator	v (e.g: Master)		
Search in	Payload O Raw data	Transmitter	v	4	
		Communication		Status	
15.588 635 750	Connectable ("Battery VI.0" EB:83:7E:44:C0:DA (Static), Initiator "Dongle" 29:CD:00:99:FF:	Master: Battery V1.0 <-> Slave: Dongl		Status OK	
15.588 635 750 14.611 349 125		Master: Battery V1.0 <-> Slave: Dongi Master: Dongle <-> Slave: Battery V1.	0	OK	
15,588,635,750 14,611,349,125 18,291,551,000	Connectable ("Battery VL.0" E8:83:/E1:41:C0:DA (Static), Initiator "Dangle" 20:CD:00:99:FF1 B ₂ = 4 ² Empty LE Packets (x 341, 25 retries, 3:64 s)	Master: Battery V1.0 <-> Slave: Dongi Master: Dongle <-> Slave: Battery V1.	20 0 0 20 bytes (01 00 00 28 02 00 03 28 03 00 00 24 04 00 03 28 05 00 01 24)	OK OK	
5,588,635,750 H4.611 349 125 8.291 551 000 8.391 553 500	Bit Connectable ("Battlery V.L.0" EBIRS, RD:44.C0.DA (Static), Instants: "Dongle" 29:CD:000997F) Bit CD:000997F) Bit CD:00097F	Master: Battery V1.0 <-> Slave: Dongi Master: Dongie <-> Slave: Battery V1. Master: Dongie <-> Slave: Battery V1.	0 0 20 bytes (01 00 00 28 02 00 03 28 03 00 00 2A 04 00 03 28 05 00 01 2A) 0 0 20 bytes (06 00 03 28 07 00 04 2A 08 00 00 28 09 00 00 28 0A 00 03 28) 0<	OK OK	
5,588,635,750 14,611,349,125 8,291,551,000 8,391,553,500 8,371,322,875	Bit Convertable (Tentory VI. 0) En103 (EU44 C000A (State), Instato Tonryle 24 C0006 VI. State (VI. 24), States (VI. 24)	Master: Battery V1.0 <>> Slave: Dongl Master: Dongle <>> Slave: Battery V1. Master: Dongle <>> Slave: Battery V1. Master: Dongle <>> Slave: Battery V1. Master: Dongle <>> Slave: Battery V1.	0 0	ок ок ок	
3. 588 635 750 H-611 349 125 8. 291 551 000 8. 391 553 500 8. 371 322 875 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500	QL25 Construction (Calification of Calification 2014) (Calification Calification	Master: Battery VI.0 <<> Slave: Bottery VI. Master: Dongle <> Slave: Battery VI.	2 1 0 20 bytes (0:000 28 02 00 03 28 03 00 00 24 04 00 03 28 05 00 01 24) 0 0 20 bytes (0:6 00 28 07 00 04 24 06 00 00 28 06 90 00 28 06 00 03 28) 0 0 20 bytes (0:6 00 128 07 00 04 24 06 00 00 28 06 90 00 28 06 00 28 00 03 28) 0 0 20 bytes (0:6 00 128 07 00 04 24 06 00 00 28 06 90 00 28 06 00 28) 0 0 22 bytes (0:6 00 128 07 00 04 24 06 00 00 28 06 90 00 28 00 90 00 28 00 90 00 28 00 90 00 28 00 90 00 28 00 90 00 28 00 90 00 28 00 90 00 28 00 90 00 28 00 90 00 28 00 90 00 28 00 90 00 00 28 00 90 00 00 28 00 90 00 00 28 00 90 00 00 28 00 90 00 00 28 00 90 00 00 28 00 90 00 28 00 90 00 28 00 90 00 28 00 90 00 28 00 90 00 00 28 00 90 00 00 28 00 90 00 00 28 00 90 00 00 28 00 90 00 00 28 00 90 00 00 28 00 90 00 00 28 00 90 00 00 28 00 90 00 00 00 00 00 00 00 00 00 00 00	0K 0X 0X 0X 0X 0X	
3. 588 635 750 H-611 349 125 8. 291 551 000 8. 391 553 500 8. 371 322 875 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500	QLES Conversible (Ristory #1.0f Ell 63/n2:44 CODA (Dated.) Initiation Tomolof: "Disconders PF	Haster: Battery VI.0 <> Slave: Dong Master: Dongle <> Sinve: Battery VI. Master: Dongle <> Sinve: Battery VI.	2 bytes (01 000 28 02 00 03 28 03 000 02 A 04 00 03 28 03 00 01 2A) c) 20 bytes (06 00 03 28 07 00 04 2A 08 00 02 28 09 00 00 28 04 00 03 28) c) 20 bytes (06 00 03 28 07 00 04 2A 08 00 02 28 09 00 00 28 04 00 03 28) c) 20 bytes (06 00 03 28 07 00 04 2A 08 00 00 28 09 00 03 28 04 00 03 28) c) 20 bytes (05 01 06 00 23 28 07 00 04 2A 08 00 00 28 09 00 03 28 04 00 03 28) c) 20 bytes (05 01 06 00 23 28 07 00 04 2A 08 00 00 28 09 00 03 28 0A 00 32) c) 20 bytes (05 01 06 00 23 28 07 00 04 2A 08 00 00 28 09 00 03 28 0A 00 32) c) 21 bytes (05 01 06 00 23 28 07 00 04 2A 08 00 00 28 09 00 03 28 0A 00 32) c) 21 bytes (05 01 06 00 23 28 07 00 04 2A 08 00 00 28 09 00 03 28 0A 00 32) c) 21 bytes (05 01 06 00 23 28 07 00 04 2A 08 00 00 28 09 00 03 28 0A 00 32) c) 21 bytes (05 01 06 00 23 28 07 00 04 2A 08 00 00 28 09 00 03 28 0A 00 32) c) 21 bytes (05 01 06 00 23 28 07 00 04 2A 08 00 00 28 09 00 03 28 0A 00 32) c) 21 bytes (05 01 06 00 23 00 70 04 2A 08 00 00 28 00 00 38 04 00 28) c) 21 bytes (05 01 06 00 28 07 00 04 2A 08 00 00 28 00 00 38 04 00 28 00 00 28 0A 00 32) c) 21 bytes (05 01 06 00 28 07 00 04 2A 08 00 00 28 00 00 28 0A 00 32) c) 21 bytes (05 01 06 00 28 07 00 04 2A 00 00 28 00 00 28 0A 00 32) c) 21 bytes (05 01 06 00 28 00 00 28 0A 00 38 00 00 28 00 00 28 00 00 28 0A 00 00 28 00 00 28 0A 00 00 28 00 00 28 0A 00 00 28 00 00 00 28 0A 00 00 28 00 00 28 00 00 28 00 00 00 28 00	0K 0K 0K 0K 0K 0K	
S. 588 635 750 14.611 349 125 8.291 551 000 8.391 553 500 8.371 322 875 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500	QL25 Conversible Clastery set of Ed.3.3.4:4:4:0046 (color), hinter Tomple*20:00.0097F. Sig. of Depty LE Pedera (c. 34), 25 retres, 3.4:4:0 Sig. and Triad Information Transaction (c. 1-Max Handle: Primary Service + Okracteristic Dedication + Sig. and Trind Information Transaction (s. 1-Max Handle: Descubering). Dedication + Regifterial Pr Sig. B. AT Find Information Response Pedera (c. 34), 24 (c. 3	Naster: Danier y VI.0 <> Sines Dany Master: Danie <> Sines Batter VI. Naster: Danie <> Sines Batter VI. Master: Danie <> Sines Batter VI.	2 2 6 20 bytes (01 00 00 20 02 00 00 120 00 00 24 04 00 00 31 06 00 01 24) 6 20 bytes (06 00 73 18 07 00 04 24 08 00 00 20 04 00 00 31 06 00 00 126) 7 7 7 7 8 9 9 20 bytes (06 00 73 18 07 00 04 24 08 00 00 28 04 00 00 28 06 00 02 38 04 00 00 28 00 00 00 28 00 00 00 00 00 00 00 00 00 00 00 00 00	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	
15.588 635 750 14.611 349 125 18.291 551 000 18.391 553 500 18.391 553 500	QL25 Conversible (Distory VI.0*E8/37/0*E46/CD0A (Distor), Initiation Tomode" Shi Control (Pre- n), of "Dirphy LP Packes (J.41, 25 retrieve, 2.444) QL25 Control (LP Packes (J.41, 25 retrieve), 2.444) QL25 Control (LP Packes (J.41, 24 retrieve)) QL25 Control (LP Packes (J.21, 24 retrieve)) QL25 Start (Control (JE J.21) Transfer QL26 Start (JE J.21) Transfer	Idealizer (barlery VLI <> Slove: Dony) Master: Donyle <> Slove: Battery VL Master: Donyle <> Slove: Battery VL	2 bytes (01 00 00 28 02 00 03 28 03 00 00 2A 04 00 03 28 03 00 01 2A) 0 20 bytes (01 00 00 28 02 00 03 28 03 00 02 24 09 00 03 28 05 00 03 28 04 00 03 28) 0 0 0 20 bytes (06 00 28 02 00 04 2A 08 00 02 28 09 00 03 28 04 00 03 28) 0 <td>9 9 9 9 9 9 9 9 8 8 9 8 9 8 9 8 9 8 9 8</td>	9 9 9 9 9 9 9 9 8 8 9 8 9 8 9 8 9 8 9 8	
15,568,655,759 14,611,249,125 38,291,551,000 38,391,553,500 38,371,322,875 38,391,553,500 38,391,553,500 38,391,553,500 38,391,553,500 38,391,553,500	Ref. Construction Character Section 2014/00.000000000000000000000000000000000	Nation Bailey VL0 <> Silver Bory Maste: Dorgie <> Silve: Bistry VL Maste: Dorgie <> Silve: Bistry VL Master: Dorgie <> Silve: Bistry VL	2 1 6 20 bytes (01 00 02 30 02 00 01 28 01 00 00 28 04 04 00 31 30 05 00 128) 6 20 bytes (06 00 01 28 07 00 04 24 08 00 00 28 04 04 00 31 30 05 00 21 20) 7 7 7 7 8 5 9 20 bytes (05 00 03 28 07 00 04 24 08 00 00 28 04 00 00 28 04 00 00 28 04 00 00 28 04 00 00 28 04 00 00 28 04 00 00 28 04 00 00 28 04 00 00 28 04 00 00 28 04 00 00 28 04 00 00 28 04 00 00 28 04 00 00 28 04 00 00 28 04 00 00 28 04 00 00 28 04 00 00 00 28 04 00 00 00 28 04 00 00 00 28 04 00 00 00 28 04 00 00 00 28 04 00 00 00 28 04 00 00 00 28 04 00 00 00 28 04 00 00 00 28 04 00 00 00 28 04 00 00 00 28 04 00 00 00 28 04 00 00 00 28 04 00 00 00 28 04 00 00 00 28 04 00 00 00 00 00 00 00 00 00 00 00 00	999999999999	
15.588.655.790 14.611 349 125 18.291 551 000 18.391 553 500 18.391 553 500	QL25. Conversible (Distory #1.0° L28.30.2:45-0.04 (Distor), Initiator Tomple" 20:00:00 (PF- B), c ² (Dirph) LF Packes (1.47), 23 (Prime, 3.64)) B), aff The difference in Transaction (E. Heas Indee): Heaviering Conversion, Perphere Pr., B), aff The difference in Teacer State (Conversion): A transaction (E. Heas Indee): Perphere Pr., B), aff The difference in Teacer State (Conversion): A transaction (E. Heas Indee): Perphere Pre- B), aff The difference in Teacer State (Conversion): Perphere Pre- Perphere International Pre- B), aff The difference in Teacer State (Conversion): Perphere Pre- Perphere International Pre- B), aff The difference in Teacer State (Conversion): Perphere Pre- Perphere International Pre- B), aff The difference in Teacer State (Conversion): Perphere Pre- Perphere International Pre- B), aff The difference International Pre- B), aff The difference International Pre- B), aff The difference International Pre- Perphere Internation Pre- Perphere International Pre- Perphere Internatio	Nather Inder y VI-6 Ko-Silvet Doxy Maste: Doxyle <> Sine: Bistry VI. Maste: Doxyle <> Sine: Bistry VI.	2 20 0 20 bytes (01 00 00 28 02 00 03 28 03 00 00 24 04 00 03 28 05 00 01 24) 0 20 bytes (06 00 28 07 00 04 24 08 00 02 28 09 00 00 28 04 00 03 28 03 00 01 24) 0 20 bytes (06 00 12 80 700 04 24 08 00 00 28 09 00 03 28 04 00 03 28) 0 20 bytes (06 00 12 80 700 04 24 08 00 00 28 09 00 03 28 04 00 03 28) 0 22 bytes (05 10 06 00 28 07 00 04 24 08 00 00 28 09 00 28 04 00 03 28 04 00 0.28) 0 22 bytes (05 10 06 00 28 07 00 04 24 08 00 00 28 09 00 02 28 04 00) 0 24 bytes (15 00 04 00 05 10 06 03 28 07 00 04 24 08 00 00 28 09 00 02 28 04 00) 0 26 bytes (15 00 04 00 05 01 06 00 32 07 00 04 28 08 00 02 28 09 00) 0 26 bytes (16 00 04 00 05 01 06 00 32 07 00 04 28 08 00 02 28 09 00) 0 26 bytes (16 00 04 00 05 01 06 00 32 07 00 04 28 08 00 00 28 09 00) 0 26 bytes (16 00 04 00 05 01 06 00 32 07 00 04 28 08 00 00 28 09 00)	9 9 9 9 9 9 9 9 8 8 8 8 8 8 8 8 8 8 8 8	
15.588 6.55 750 H4.611 349 125 8.291 551 000 8.391 553 500 8.371 322 875 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500	Implies Constanting Vol Fill all 3: 4:14:00:00 (2014), hinduite Tounder 2010;00:0977-0000 Big of Theod Information Transaction (5: - Hear Handle Privary Service - Obstactional); Deductation : Big ATT Find Information Transaction (5: - Hear Handle Privary Service - Obstactional); Deductation : Big ATT Find Information Transaction (5: - Hear Handle Privary Service - Obstactional); Deductation : Big ATT Find Information Response Probe (1); Hear Handle (2); Desactional; Deductation : Peopheral Prefered Big ATT Find Information Response Probe (1); Hear Handle (2); Desactional; Deductation : Peopheral Prefered Big ATT Find Information Response Probe (1); Desactional; Deductation : Peopheral Prefered Big ATT Find Information Response Probe (1); Desactional; Deductation : Peopheral Prefered Big ATT Find Information (1); Desactional; Deductation : Deductation : Peopheral Prefered Big ATT Find Information (1); Desactional; Deductation : Deductation : Peopheral Prefered Big ATT Find Information (1); Desactional; Deductation : Deductation : Peopheral Prefered Big ATT Find Information (1); Desactional; Deductation : Peopheral Prefered Big ATT Find Information (1); Desactional; Deductational; Deductation : Peopheral Prefered Big ATT Find Information (1); Desactional; Deductation : Peopheral; Desactional; Desactional	Extern Device y Vol. < > Series Eccy Matter: Dovid <> Serie: Battery VJ. Matter: Dovid <> Serie: Battery VJ.	2 1 0 20 bytes (01 00 02 20 02 0 01 20 01 00 02 24 04 00 03 20 05 00 01 24) 0 20 bytes (06 00 03 20 07 00 04 24 08 00 00 20 06 00 03 20 05 00 02 20) 0 20 bytes (06 00 13 20 07 00 04 24 08 00 00 20 06 00 03 20 05 00 02 20) 0 20 bytes (05 00 03 20 07 00 04 24 08 00 00 20 06 00 03 20 06 00 03 20 05 00 02 20) 0 22 bytes (05 01 06 00 32 00 700 04 24 08 00 00 20 06 00 20 06 00 20 06 00 00 20 06 20 06 00 00 20 06 20 06 00 00 20 06 20 06 00 00 20 06 00 00 20 06	0X 0X 0X 0X 0X 0X 0X 0X 0X 0X 0X 0X 0X 0	
14.611 349 125 14.611 349 125 14.611 349 125 14.611 349 125 14.611 349 125 15.100 8.391 553 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.391 553 500 8.491 553 500 8.491 553 500	QC25 Conversible (Databary 1405 CER33 2014/CODA) (Initially Databar) (Databar) QC2 Depth LP Packets (r. 311, 25 retries, 3.64.5) QC3 Part Firld Mathemation Transaction (Initially Thema Service + Characteristic Deduction = Parphene Pro- reging and The Mathemation Transaction (Initialized Constrainting Deductions - Perphene Pro- ent), QC3 QC3 ATT Find Mathemation Transaction (Initialized Constrainting Deductions - Perphene Pro- ent), QC3 QC3 ATT Find Mathemation Transaction (Initialized Constrainting Deductions - Perphene) Professional Pro- ent), QC3 QC3 ATT Find Mathemation Transaction (Initialized Constrainting Deductions - Perphene) Professional Pro- ent), QC3 QC3 ATT Find Mathemation Transaction (Initialized Constrainting Deductions - Perphene) Professional Pro- ent), QC3 QC3 ATT Find Mathemation Transaction (Initialized Transfers) QC3 ATT Find Mathemation Transaction (Initialized Transfers) QC3 ATT Find Mathemation Transaction (Initialized Constent Messaurement + Object Statustic Pro- ing) QC3 ATT Find Mathemation Transaction (Initialized Constent Messaurement + Object Statustic Pro- gend Constent (Initialized Constent (Initialized Constent Messaurement + Object Statustic Pro- mathematic Transaction (Initialized Constent Messaurement + Object Statustic Pro- tent)	Nature Inter VI-16 Co Store Dory Nature: Doryle C Sime Battery VI. Nature: Doryle C Sime: Battery VI.	2 2 0 20 bytes (01 00 00 28 02 00 03 28 03 00 00 2A 04 00 03 28 05 00 01 2A) 0 20 bytes (05 00 02 18 07 00 04 2A 08 00 00 28 04 00 00 28 04 00 03 28) 0 20 bytes (05 00 01 28 07 00 04 2A 08 00 00 28 04 00 00 28 04 00 03 28) 0 20 bytes (05 00 01 28 07 00 04 2A 08 00 00 28 04 00 00 28 04 00 03 28) 0 20 bytes (05 01 06 00 28 07 00 04 2A 08 00 00 28 04 00 00 28 04 00 00 28 04 00 00 28) 0 20 bytes (05 01 06 00 28 07 00 04 2A 08 00 00 28 04 00 00 00 00 00 00 00 00 00 00 00 00	0K 0K 0K 0K 0K 0K 0K 0K 0K 0K 0K 0K 0K 0	
St. 0008 5.5 5.5 H-6.11 2.49 12.5 H-6.11 2.49 12.5 B. 291 5.55 100 B. 391 5.53 500 B. 391 55.3 551 B.551 551 551	Intel® Second District y 100 (Fill 83, 20:44) CBAR (Solid), Printing Tangle '20:000 (974) Signed Tangle Tangle Second Second District,	Extern Design 4: Color Server, Editry VL Matter: Dorogie <> Sine: Editry VL	2 2 0 20 0 20 0 20 0 20 0 20 0 20 0 20 0 20 0 20 0 20 0 20 0 20 0 20 0 20 0 20 20 bytes (06 00 23 80 700 04 24 08 00 02 28 07 00 02 28 06 00 23 80 700 28 04 00 00 28 06 00 28 06 00 28 06 00 28 06 00 28 06 00 28 06 00 28 06 00 00 28 06 00 00 28 06 00 00 28 06 00 00 28 06 00 00 28 06 00 00 28 06 00 00 28 06 00 00 28 06 00 00 28 06 00 00 28 06 00 00 28 06 00 00 28 06 00 00 28 06 00 00 28 00 00 00 00 00 00 00 00 00 00 00 00 00	0 0 0 0 0 0 0 0 0 0 0 0 0 0	
15.1008 6.5.5750 14.611 249 125 14.611 249 125 18.291 1551 000 18.791 553 500 18.791 553 500 18.791 553 500 18.791 553 500 18.791 553 500 18.791 553 500 18.791 553 500 18.791 553 500 18.791 553 500 18.791 553 500 18.791 553 500 18.791 553 500 18.791 553 500 18.791 553 500 18.791 553 500 18.791 553 500 18.791 553 500 18.791 553 500 18.791 551 515 18.51 515 515 <t< td=""><td>QC25 Conversible (Databary 1405 CER33 2014/CODA) (Initially Databar) (Databar) Qir 2⁻¹ Empty LE Packets (r. 31, 23 retries, 3.64.5) Name Qir 3⁻¹ Find Information Transaction (Initially Thema Yervice + Characteristic Deditation + Regriterial Pro- mission) Name Qir 3⁻¹ Find Information Transaction (Initially Databar) Name Name Qir 3⁻¹ Find Information Response Packet (Initially Deditation + Perpheral Preferred Pro- griterial Production (Initial Pro- duct (Initial Pro- que (ICAP) (Primer (Initial Product (Initial Pro- griterial Product (Initial Pro- ession) Name Qir 4⁻¹ Explore (Initial Pro- limiterial Product (Initial Pro- ession) Name Name Qir 4⁻¹ Explore (Initial Pro- state (Initial Pro- tect (Initial Pro- Pro- Prot (Initial Pro- Prot (Initial Protect (Initial Protect (Initial Protect (Initial Protect (Initial Pro- Prot (Initial Protect (Initial Pro</td><td>Nature Inter VI-16 Co Store Dory Nature: Doryle C Sime Battery VI. Nature: Doryle C Sime: Battery VI.</td><td>2 2 0 20 bytes (01 00 00 28 02 00 03 28 03 00 00 2A 04 00 03 28 05 00 01 2A) 0 20 bytes (06 00 28 07 00 04 2A 08 00 00 28 09 00 00 28 04 00 03 280) 0 20 bytes (06 00 28 07 00 04 2A 08 00 00 28 09 00 00 28 04 00 03 280) 0 20 bytes (05 00 03 28 07 00 04 2A 080 00 02 38 09 00 02 28 04 000 28 08 00 02 28 04 000 28 08 000 28 04 000 28 09 00 02 28 04 000 28 09 00 02 28 04 000 28 09 00 02 28 04 000 28 09 00 02 28 04 000 0 20 bytes (05 01 06 00 23 07 00 04 2A 080 00 02 28 09 00 02 28 04 00 32 bytes (16 00 04 00 05 10 06 03 28 07 00 04 2A 08 00 00 28 09 00 0 2b tytes (16 00 14 00 05 10 06 03 28 07 00 04 2A 08 00 02 28 09 00 0 2b tytes (16 00 14 00 05 10 06 03 28 07 00 44 2A 08 00 02 28 09 00 0 2b tytes (16 00 14 00 05 10 06 03 28 07 00 44 2A 08 00 02 28 09 00 0 2b tytes (16 00 14 20 05 10 60 03 28 07 00 44 2A 08 00 02 28 09 00 0 2b tytes (16 00 14 20 26 10 60 00 28 07 00 04 28 08 00 02 28 09 00 0 2b tytes (16 00 14 20 42 06 10 60 00 02 28 07 00 04 28 08 00 02 28 09 00 0 2b tytes (16 00 14 20 42 06 10 60 00 28 07 00 04 28 08 00 02 28 09 00 0 2b tytes (16 00 14 20 42 08 10 60 00 28 07 00 04 28 08 00 02 28 09 00 0 2b tytes (16 00 14 20 42 08 10 60 00 02 28 07 00 04 28 08 00 02</td><td>8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8</td></t<>	QC25 Conversible (Databary 1405 CER33 2014/CODA) (Initially Databar) (Databar) Qir 2 ⁻¹ Empty LE Packets (r. 31, 23 retries, 3.64.5) Name Qir 3 ⁻¹ Find Information Transaction (Initially Thema Yervice + Characteristic Deditation + Regriterial Pro- mission) Name Qir 3 ⁻¹ Find Information Transaction (Initially Databar) Name Name Qir 3 ⁻¹ Find Information Response Packet (Initially Deditation + Perpheral Preferred Pro- griterial Production (Initial Pro- duct (Initial Pro- que (ICAP) (Primer (Initial Product (Initial Pro- griterial Product (Initial Pro- ession) Name Qir 4 ⁻¹ Explore (Initial Pro- limiterial Product (Initial Pro- ession) Name Name Qir 4 ⁻¹ Explore (Initial Pro- state (Initial Pro- tect (Initial Pro- Pro- Prot (Initial Pro- Prot (Initial Protect (Initial Protect (Initial Protect (Initial Protect (Initial Pro- Prot (Initial Protect (Initial Pro	Nature Inter VI-16 Co Store Dory Nature: Doryle C Sime Battery VI. Nature: Doryle C Sime: Battery VI.	2 2 0 20 bytes (01 00 00 28 02 00 03 28 03 00 00 2A 04 00 03 28 05 00 01 2A) 0 20 bytes (06 00 28 07 00 04 2A 08 00 00 28 09 00 00 28 04 00 03 280) 0 20 bytes (06 00 28 07 00 04 2A 08 00 00 28 09 00 00 28 04 00 03 280) 0 20 bytes (05 00 03 28 07 00 04 2A 080 00 02 38 09 00 02 28 04 000 28 08 00 02 28 04 000 28 08 000 28 04 000 28 09 00 02 28 04 000 28 09 00 02 28 04 000 28 09 00 02 28 04 000 28 09 00 02 28 04 000 0 20 bytes (05 01 06 00 23 07 00 04 2A 080 00 02 28 09 00 02 28 04 00 32 bytes (16 00 04 00 05 10 06 03 28 07 00 04 2A 08 00 00 28 09 00 0 2b tytes (16 00 14 00 05 10 06 03 28 07 00 04 2A 08 00 02 28 09 00 0 2b tytes (16 00 14 00 05 10 06 03 28 07 00 44 2A 08 00 02 28 09 00 0 2b tytes (16 00 14 00 05 10 06 03 28 07 00 44 2A 08 00 02 28 09 00 0 2b tytes (16 00 14 20 05 10 60 03 28 07 00 44 2A 08 00 02 28 09 00 0 2b tytes (16 00 14 20 26 10 60 00 28 07 00 04 28 08 00 02 28 09 00 0 2b tytes (16 00 14 20 42 06 10 60 00 02 28 07 00 04 28 08 00 02 28 09 00 0 2b tytes (16 00 14 20 42 06 10 60 00 28 07 00 04 28 08 00 02 28 09 00 0 2b tytes (16 00 14 20 42 08 10 60 00 28 07 00 04 28 08 00 02 28 09 00 0 2b tytes (16 00 14 20 42 08 10 60 00 02 28 07 00 04 28 08 00 02	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	
13. 508 6.35 750 14-611.249 125 88.291 551 000 18. 391 553 500 88.391 553 500 18. 391 553 500 88.391 553 500 18. 391 553 500 88.391 553 500 18. 391 553 500 88.391 553 500 18. 391 553 500 88.391 553 500 18. 391 553 500 88.391 553 500 18. 391 553 500 88.391 553 500 18. 391 553 500 88.491 551 875 18. 491 553 551 875 86.431 222 875 18. 751 552 750 570 570 570	QL25 Conversible (Database year) (2018) 30: 445-0204 (Catabase), Initiative Tomode "2016/2014/07 PFF Sig. of Borby LE Packets (n. 241, 25 retrieve, 3.64 n) The Monitoria Tomacolicity, Units Andread, Themasy Service + Characteristic Declaration is Sig. ATT Priod Information Transaction (1): Heak Indirect Thimsy Service + Characteristic Declaration + Perpheral Prior, Sig. (2017) The Monitorian Tomacolicity, Sig. Heak Indirect (1): Heak Indirect Thimsy Service + Characteristic Declaration + Perpheral Prior, Sig. (2017) Sig. (2017) Sig. (2017) Sig. (2017) Sig. (2017) Sig. (2014) Sig. (2014) Sig. (2014) Sig. (2014) Sig. (2014)	Nature Instan (U.G. Co Silver Dony) Nature: Donyle < Sime: Battery VI. Nature: Donyle < Sime: Battery VI. Nature: Donyle <> Sime: Battery VI. Matter: Donyle <>> Sime: Sim	2 2 0 20 bytes (01 00 02 20 02 0 01 20 01 00 00 24 04 00 01 20 050 00 120) 0 20 bytes (04 00 01 20 07 00 04 14 08 00 00 20 06 00 01 20 050 00 120) 0 20 bytes (04 00 01 20 07 00 04 14 08 00 02 20 06 00 01 20 050 00 21 20 00 01 20 050 00 20 20 04 00 01 20 050 00 20 04 00 01 20 04 01 00 01 20 04 01 00 01 20 04 01 00 01 20 04 01 00 01 20 04 01 00 01 20 04 01 00 01 20 04 01 00 01 20 04 00 01 20 04 00 01 20 04 00 01 20 04 01 00 01 20 04 01 00 01 20 04 01 00 01 20 04 00 00 20 04 00	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	
13, 508, 635, 750 14, 611, 749, 125 14, 611, 749, 125 18, 291, 551, 000 18, 391, 553, 500 18, 391, 553, 550 18, 551, 551, 875 18, 651, 522, 875 18, 651, 522, 875 18, 651, 522, 875 18, 651, 552, 875 18, 652, 875 18, 652, 875 18, 651, 552, 875 18, 652, 875 18, 652,	Intel® 2004 Fills 30: 414 020 A Database Provide View 10 413 30: 414 020 A Database Provide View 10 413 31: 414 020 A Database Image: Provide View 10 413 31: 414 020 A Database Provide View 10 413 31: 414 020 A Database Provide View 10 413 413 413 413 413 413 413 413 413 413	Extern Drogic <> Since Estry VL Nater: Drogic <> Since Estry VL	2 2 0 20 bytes (01 00 02 80 02 00 03 28 03 00 00 24 04 00 03 28 05 00 01 24) 0 20 bytes (06 00 28 07 00 04 24 08 00 00 28 09 00 00 28 04 00 03 28) 0 20 bytes (06 00 28 07 00 04 24 08 00 00 28 09 00 00 28 04 00 03 28) 0 20 bytes (05 00 03 28 07 00 04 24 08 00 00 28 09 00 02 38 04 00 03 28 07 00 04 24 08) 0 20 bytes (05 01 05 00 03 28 07 00 04 24 08 00 00 28 09 00 02 38 04 00 00 28 09 00 02 38 04 00 00 28 09 00 02 38 07 00 04 28 08 00 00 28 09 00 02 38 00 00 00 28 09 00 02 38 00 00 00 28 09 00 02 38 00 00 00 28 09 00 02 38 00 00 00 28 09 00 02 38 00 00 00 28 09 00 02 38 00 00 00 28 09 00 02 38 00 00 00 28 09 00 02 38 00 00 00 28 09 00 02 38 00 00 00 28 09 00 02 38 00 00 00 28 09 00 02 38 00 00 00 28 09 00 02 28 09 00 00 00 28 09 00 00 00 00 00 00 00 00 00 00 00 00	CK CK CK CK CK CK CK CK CK CK CK CK CK C	
15.588 635 750 14.611 349 125 18.291 551 000 18.391 553 500 18.391 553 500	QL25 Science-studie (Database) Sci (SL23) 2014/COARD (Database), Initiative Tounder 2014/COARD (Database), Initiati	Nature Index (14.6 <> Since Barry VI. Nature: Conjel <> Since Barry VI.	2 2 0 20 bytes (01 00 02 20 02 0 01 20 01 00 00 24 04 00 01 20 050 00 120) 0 20 bytes (04 00 01 20 07 00 04 24 00 00 20 06 00 01 20 050 00 120) 0 20 bytes (05 00 120 07 00 04 24 00 00 20 06 00 00 20 04 00 00 00 20 04 00 00 20 04 00 00 00 20 04 00 00 00 20 04 00 00 00 20 04 00 00 00 20 04 00 00 00 20 04 00 00 00 20 04 00 00 00 20 04 00 00 00 20 04 00 00 00 20 04 00 00 00 20 04 00 00 00 20 04 00 00 00 20 04 00 00 00 00 00 00 00 00 00 00 00 00		
4.5.028 4.55.740 44.611 349 125 80.291 551 000 80.791 525 000 80.791 525 000 80.791 525 000 80.791 525 000 80.791 525 000 80.791 555 000 80.791 525 250 80.515 518 152 80.751 527 50 80.515 527 5	Image: Constant of Control (Control (Cont) (Contro) (Control (Control (Control (Control (Control (Contro)	Nature Index (14.6 G) Silvet Dory Matter: Doryde & Sine: Bistery VI. Matter: Doryde & Sine: Bistery VI.	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	CK CK CK CK CK CK CK CK CK CK CK CK CK C	

Figure 16 Using 'Colorize'.

having lengths from 20 to 32 bytes.

In addition to data searches, text and fields can be searched. Search criteria can be combined to create more advanced searches.

The Search box changed from Search to Colorize to colorize in any empty packet fields.

HELPFUL HINT: Data can be searched in multiple formats (e.g., hex, ASCII, Unicode). In addition to searching, the Search **dialog's function button** (bottom-right of the window) can be changed to count or colorize according to the criteria specified by the user.



Instant Timing

The Instant Timing pane displays packets with a precise temporal representation. Any packet captured is represented here, as are any logic signals captured. Throughput and statistical information are also presented. A measurement cursor appears when dragging the mouse in the packets area. Very precise measurements can be made between any captured events (e.g., Bluetooth to Bluetooth, Logic to Wi-Fi, HCI packet to Bluetooth Air packet, etc.).

The dynamic range of the Instant Timing pane is incredibly high. This view can display details with a hundred nanosecond precision (125ns to be exact, so 1/8th of symbol).

The view is configured by default in the "by master device" mode, so each line represents traffic exchanged between a master device and slave devices in the piconet (via BR/ EDR).

Figure 17 is a view of Bluetooth traffic, zoomed out a bit (note the throughput and statistics indications once "Laptop" begins to send data.) Or, **Figure 18** displays that it can drill down (zoom in) on precise traffic.







Figure 18 Precise Traffic.

As mentioned, everything captured is represented in **Figure 19**. Here, we see over-the-air traffic at the top, with Serial HCI and several logic signals.

HELPFUL HINT: This view can be zoomed with the mouse wheel, keyboard UP and DN arrows, or by dragging the zoom bar. This view can be also panned by dragging the scale bar, or with the LEFT and RIGHT arrows on the keyboard. Automatic packet detail quotes appear when placing the mouse over packet.



Figure 19 Over-the-air Traffic with HCI and Logic Signals.

HELPFUL HINT: Display filters can be selected from the **Display menu** button on the Instant Timing toolbar as well, in order to hide establishment traffic (such as inquiries, pagings, and advertisements) and idle traffic (such as poll / null packets and empty packets).



Instant Piconet

The Instant Piconet pane is designed to graphically display the topologies of all captured devices, piconets and scatternets. In addition to topology, the Instant Piconet pane displays inquiries, pagings, advertisements, broadcast events, generalized signal strength, and the data throughput of active connections.

This view works live (during capture) as is the case with all views in the Ellisys software, and can also be used in playback mode to replay captured traffic.

Figure 20 shows a rather complex scatternet in the Instant Piconet.

All views/panes are linked together, so changing the selected event in the Overview will update the Instant Piconet to this position. Clicking on the **timestamp** on the **Instant Piconet** toolbar will synchronize the Overview.





HELPFUL HINT: The Instant Timing has a special cursor showing the exact time of the Instant Piconet (moving this cursor will update the Instant Piconet).

Below is a quick summary of the various representations you can find in the Instant Piconet. See the User Guide for more details.



Represents an **idle connection** between a master and a slave. Master (or Central) devices always have a blue outline. Slave (or Peripheral) 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 an **inquiry** or **scanning**. 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.



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.

HELPFUL HINT: With today's typically high prevalence of Bluetooth LE devices and broadcast events and generally busy lab environments, the Instant Piconet view can get very busy with broadcast events. To add clarity, you can deselect the **Broadcast icon** (the eye on the Instant Piconet toolbar) to hide representations of broadcast devices and show only formed connections. Any device filter applied will also affect this view (and other views) by removing devices not included by the filter. Once Broadcast packets are hidden, and your device filter installed, re-enable broadcast events to see such events should they occur with devices selected in your filter.

Instant Channels

The Instant Channels feature provides visual cues and statistical analyses on various per-channel transmission characteristics, including packet retransmissions, header errors, AFH indications, and payload errors. A summary of the selected span shows a count and percentage of categorized packets.

The Instant Channels view provides immediate indications of the channels on which devices are communicating, which channels are being avoided, and important statistics like retransmissions, payload errors, and header errors.

In **Figure 21**, it is clear that the communications between the devices are avoiding three areas, which are typically occupied by Wi-Fi channels 1, 6, and 11 (see the scale at the bottom of the view). Note that the retransmission rate is fairly low, indicating that in this case, the devices are doing a good job of communicating in spite of Wi-Fi interferences.

In **Figure 22** the value of the Ellisys software really becomes apparent. We see AVDTP communications (audio) between a computer and a set of headphones, and characterizations of per-channel performance (Instant Channels), spectrum (Instant Spectrum), and we can actually hear the audio (Instant Audio) as it is recorded (or afterwards).

 760
 0 (12506, 97.7%)

 9 Allocation (106, 0.9%)

 <t

igure 21 instant channels view showing wi-Fi channels 1, 6, and 11 being Avoided.

HELPFUL HINT: The Instant Channel view, like most views, is sensitive to any device filters established. If no filters are established, then this view shows an aggregate performance characterization (i.e., all devices). When a device filter is established/active, all characterizations are particular to the devices included in the filter.



Figure 22 Feature Coherency.

HELPFUL HINT: The position of the analyzer relative to the devices being analyzer can affect payload and header error numbers. Retransmissions however are generally considered an excellent indicator of spectral-related performance. See Expert Note, EEN_BTO4 "Optimal Placement of Your Analyzer" for more information.

Note the color scheme in the Instant Spectrum view, as it indicates very strong (Wi-Fi) signals at the top, middle, and lower portions of the Bluetooth spectrum (Wi-Fi channels 1, 6, and 11). Two things are worth noting here: one, the performance indicated in Instant Channels is very good, especially considering the very busy spectrum (a fairly low percentage of retransmissions are indicated), and two, the audio (Instant Audio) plays back very well (no pops or noticeable quality issues). The value of multiple characterizations and friendly software that is easily configured is also apparent.

HELPFUL HINT: The various shades of magenta in the Instant Channels view are intended to indicate a relative frequency of channel avoidance over the time period selected (the entire trace in this case, about 107 seconds.) Use the Nav Bar at the top of the Instant Channels view to select a portion of the trace to characterize.



Instant Spectrum

As we saw in the prior section, the Instant Spectrum feature can be used to understand the physical environment and how it may be affecting your device's performance. This feature, another Ellisys innovation, provides a unique and intuitive way to understand the spectral behaviors of Bluetooth, Wi-Fi, and WPAN traffic, as well as all other RF events within the ISM spectrum that is used by Bluetooth (e.g., a microwave oven).

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

In **Figure 23**, note that there is heavy Wi-Fi traffic centered on channels 1, 6, and 10 (there is Wi-Fi on other channels as well). Note the Statistics at the right side as well, and the color-coded indications of retransmissions (orange) and payload errors (red).

In **Figure 24**, let's see which channels a given link is avoiding. This is done with a fly-over on a Bluetooth packet. Note that the Bluetooth packets displayed are generally in the regions (channels) where the Wi-Fi is present (such as Wi-Fi channel 1).

In **Figure 25**, let's take a look at Instant Channels side-by-side with Instant Spectrum. (Learning to re-position the windows like this is quite useful — the User Guide discusses this feature). Note the legend at top-right of the Instant Channels, and the percentages shown there. In this case, over a span of about 31 seconds, nearly 90% of the packets are "OK," and there is a retransmission rate of around 7.4%. Given the extremely busy physical spectrum (there are hundreds of devices

nearby), this seems a reasonably good result, although the user might wish to consider other factors, such as application-level performance. In this case, the application is audio, and we may wish to listen to the audio or export it to WAV for further analysis.



Figure 23 Heavy Wi-Fi on Channels on 1, 6, and 10.



Figure 24 Bluetooth Packets Avoiding Interferences.



Figure 25 Instant Channels Side-by-side with Instant Piconet.

The Instant Audio feature, discussed next, can be used to monitor audio live or post-capture. Audio can be exported from the **Export dialog**, located in the **File menu**. The end result here is that Bluetooth is really doing a great job avoiding problematic areas (channels) that are being utilized by other emitters, in this case a Wi-Fi emitter.



Instant Audio

The Instant Audio feature provides a visual representation of captured audio traffic (overthe air, HCI, or 12S) 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.



Figure 26 Instant Audio Showing Over-the-air Audio and HCI Audio Streams.

Various control features are provided, including rewind, looping, pausing, enable and disable of selected streams, and other controls. Export is available from **File>Export**.

Any available sound devices installed on the controlling PC are can be selected for use by this feature. Bookmarks are available to add to this view, and bookmarks added in other views will appear here (there are two seen in the **Figure 26**).

In **Figures 26 and 27**, there are two audio streams represented, one over-the-air and the other via HCI (UART).

This is an ideal capture approach that can be quite useful in pinpointing audio issues to host or controller areas very quickly, as the two streams can be compared audibly, or via WAV analysis on export.

Conclusion

With its precision into a window of time and its visual cues provided, the Ellisys wideband sniffer provides the user a thorough understanding of the propensity of a given device, or an aggregate of devices, to debug and troubleshoot issues throughout the duration of an entire capture and with all of its views, can be configured to characterize all devices in the vicinity or specific devices.

File View Layout Search Record Tools Help				X	Analysis 🖸 Full screen 🔡 Add
🗋 🥁 🛃 🚰 🌗 🕨 Record • 🗏 Stop 🔛 Restart 🚳	Save & Continue 👔 🐕 📲 🖉 Naviga	ite - 🖳 🔯 Markers (1) • 🎝 🗔 🖓 Fi	itering: Only Laptop, GameDevice 🔹 🍓		
Welcome BR/EDR Overview Message Log 🗮 In	nstant Spectrum 4	K HCI Serial Overview		× Instant Piconet	9
' • Protocol: Single • All layers 🔸 🛹 🚥 🎃 🚏 🔎	1 * 0 + 1 和心的意思。	👔 🤘 🗸 • Protocol: Single • All layers	• / • ? • ? • ? * ? * ? A / B @ @ @ @		
Item		10 Item		A	
AVDTP Discover Command > Used=No, ACP=1		AVDTP Discover Command >	(ned-No, ACF-1		
AVDTP Get Capabilities (ACP-1) + Media Transport Audio	1 SBC: 48kHz		-1) + Media Transport Audio SBC: 48kHz		
AVDTP Set Configuration (ACP=1, 1HT=52, Media Transpor			P=1, INT=52, Media Transport Audio SBC: Joint Stereo, 44. SHz, Loudness, 8 S		
B AVDTP Open (ACP-1) + Accept		B AVDTP Open (ACP − 1) + Acce			
(# JA AVDTP Start (ACP=1) + Accept		AVDTP Start (ACP=1) + Acces	pt		
AVDTP Media Stream (Codec - SBC: Joint Stereo, 44.16Hz, L	Loudness, 8 Subbands, SegNum=033, Duration-4	98 🕢 🖓 AVDTP Media Stream (Codec	-SBC: Joint Stereo, 44. IkHz, Loudness, 8 Subbands, Sochum-033, Duration-98		
🗉 🥂 AVDTP Media Stream (Codec = SBC: Joint Stereo, 44. 1kHz, L	Loudness, 8 Subbands, Seglam - 34., 54, Durations	-6 🕞 🖓 AVDTP Media Stream (Codec	-SBC: Joint Stereo, 44. IkHz, Loudness, 8 Subbands, Seofkim-34., 50, Duration-5		
🛞 🦉 AVDTP Media Stream (Codec-SBC: Joint Stereo, 44.18Hz, 1	Loudness, 8 Subbands, Seathum-SS66, Duration-	-2 🗷 AVDTP Media Stream (Codec	-SBC: Joint Stereo, 44. 164z, Loudness, 8 Subbands, Sechum -5352, Duration -0		
🚓 🥂 AVDTP Media Stream (Codec-SBC: Joint Stereo, 44. 184z, 1	Loudness, 8 Subbands, Segtium -67110, Duration	AVDTP Media Stream (Codec	-SBC: Joint Stereo, 44. IkHz, Loudness, 8 Subbands, Sechum -53.,62, Duration -1		GameDevice
🕞 🐴 AVDTP Media Stream (Codec=SBC: Joint Stereo, 44. IkHz, I	Loudness, 8 Subbands, SergHam-111., 145, Darate	an- 🗄 🧞 AVDTP Media Stream (Codec	-SBC: Joint Stereo, 44. 1kHz, Loudness, 8 Subbands, Septem-6564, Duration-0	10	5
🛞 🦓 AVOTP Media Stream (Codec-SBC: Joint Stereo, 44. 1kHz, I	Loudness, 8 Subbands, SeqNum = 146., 180, Duratio	an 😥 🮝 AVDTP Media Stream (Codec	«SBC: Joint Stereo, 44. IkHz, Loudness, 8 Subbands, Sechum «65110, Curation»	Lap	nop
🛞 🦓 AVDTP Media Stream (Code: -SBC: Joint Stereo, 44.1kHz, 1	Loudness, 8 Subbands, Section - 181215, Our sto	arre 🗟 🦓 AVDTP Media Stream (Codec	-SBC: Joint Stereo, 44.1kHz, Loudness, 8 Subbands, Septem-111145, Our atom		
🕀 🐴 AVDTP Media Stream (Coder SBC: Joint Stereo, 44. 184z, 1	Loudness, 8 Subbands, Section - 216250, Christia	🐨 🦨 AVDTP Media Stream (Codec	-SBC: Joint Stereo, 44. IkHz, Loudness, 8 Subbands, SegNum-146., 180, Duration		
🗃 🐴 AVDTP Media Stream (Codec-SBC: Joint Stereo, 44. 1kHz, I	Loudness, 8 Subbands, SedNam-251285, Durate	🐨 🦓 AVDTP Media Stream (Codec	-SBC: Joint Stereo, 44. IkHz, Loudness, 8 Subbands, Sephim - 181215, Duration		
🛞 🖧 AVDTP Media Stream (Codec=SBC: Joint Stereo, 44. 184z, 1	Loudness, 8 Subbands, SegNum=286312, Duratio	art- 🕞 🦓 AVDTP Media Stream (Codec	=SBC: Joint Stereo, 44. IkHz, Loudness, 8 Subbands, Sechum=216250, Duration		
🕀 🐴 AVDTP Media Stream (Codec-SBC: Joint Stereo, 44. 16Hz, 1			-SBC: Joint Stereo, 44.1kHz, Loudness, 8 Subbands, Septem-251285, Duration		
Comparison (1 a) (2) and (1) and (3) (3) (4) (4) (4) (4) (4) (4)	1 1 A.A.11 1 - 1 - Max Ann - 1	> C		*	
<	1 1 a.a.11 1 - 1: A.a. A.a	>	,		
<		> <			375 🗮 🖬 🚳
<		> <	,	Бн. н н н н 112.243 519.	Description of Salari
< stant Audo		> <	,		Considered and failed
< <tr> Image: Audio Image: The second se</tr>	5.45s • [4] ► II = « ۲ 🗐 🗸	> < • Dr	,	Бн. н н н н 112.243 519.	stant Channels
Interface Image: State of the st	5.45s • [4] ► II = « ۲ 🗐 🗸	> < • Dr	,	Details 😵 Instant Piconet 📷 In	stant Ovannels Ø
 attent Audo attent Audo attent Audo attent Audo attent Audo attent Audo <!--</td--><td>5.45s • [4] ► II = « ۲ 🗐 🗸</td><td>> < • Dr</td><td>,</td><td>Im Im Im<</td><td>stant Osamels Ø</td>	5.45s • [4] ► II = « ۲ 🗐 🗸	> < • Dr	,	Im Im<	stant Osamels Ø
<	5.45s • [4] ► II = « ۲ 🗐 🗸	> < • Dr	,	Im H H4 H1 112.243 519 Ig2 Details Isstant Piconet Imm fine Security Fill missing fields Time Master / Slave PIN Im Vaster / Slave PIN 112.243 519 112.243 519	stant Channels g Manage Mesh Security Manage ECDH Kr Link Key ACO IV
Karri Audo Image: Start Audo Image: Start Audo Image: Start	5.45s • [4] ► II = « ۲ 🗐 🗸	> < • Dr	,	Im IM IM IM III.2243 519. IgD Details Instant Piconet. Imm In Security Fill missing fields Imm In Time Master / Slave PNN 12.22 "Campor Ber?-6Not	stant Channels 0 Manage Mesh Security Manage ECDH K Link Key ACO IV 973830FCIB062FAStan 0CEBFail Not appl
 Along the second sec	5.45s • [4] ► II = « ۲ 🗐 🗸	> < • Dr	,	H H H H HI 112,243 519 Detail is Instant Picenet in the Security Fill missing fields Transmit State / Save PIN Lotor 88:78Not Jubotor 88:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not	stant Orannels 0 Manage Mesh Security Manage ECDH K Link Key ACO IV 973830FC:B902FASH: OCEBF
stant Audo VECR Image: solution control Targets Bit Not Control Soco Bit Not Control	5.45s • [4] ► II = « ۲ 🗐 🗸	> < • Dr	,	Im IM IM IM III.2243 519. IgD Details Instant Piconet. Imm In Security Fill missing fields Imm In Time Master / Slave PNN 12.22 "Campor Ber?-6Not	stant Orannels 0 Manage Mesh Security Manage ECDH K Link Key ACO IV 973830FC:B902FASH: OCEBF
≤ stant Audo Stant Audo Image: Stant Audo <tr< td=""><td>5.45s • [4] ► II = « ۲ 🗐 🗸</td><td></td><td>,</td><td>H H H H HI 112,243 519 Detail is Instant Picenet in the Security Fill missing fields Transmit State / Save PIN Lotor 88:78Not Jubotor 88:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not</td><td>stant Channels 9 Manage Mesh Security Manage ECDH Kr Link Key ACO IV 973830FC:B902FA545 9CEBF</td></tr<>	5.45s • [4] ► II = « ۲ 🗐 🗸		,	H H H H HI 112,243 519 Detail is Instant Picenet in the Security Fill missing fields Transmit State / Save PIN Lotor 88:78Not Jubotor 88:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not	stant Channels 9 Manage Mesh Security Manage ECDH Kr Link Key ACO IV 973830FC:B902FA545 9CEBF
 ≤ attant Audo CERP Allow 0 Targer⁶ Molikof 000, annotevice 2016/01, "Sanadovice" 2016/	5.45s • [4] ► II = « ۲ 🗐 🗸		,	H H H H HI 112,243 519 Detail is Instant Picenet in the Security Fill missing fields Transmit State / Save PIN Lotor 88:78Not Jubotor 88:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not	stant Channels 0 Manage Mesh Security Manage ECDH K Link Key ACO IV 973830FCIB062FAStan 0CEBFail Not appl
 stant Audo a migin: 105.10 s → span: 55 (CRP	5.45s • [4] ► II = « ۲ 🗐 🗸		,	H H H H HI 112,243 519 Detail is Instant Picenet in the Security Fill missing fields Transmit State / Save PIN Lotor 88:78Not Jubotor 88:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not	stant Orannels 0 Manage Mesh Security Manage ECDH K Link Key ACO IV 973830FC:B902FASH: OCEBF
Kand Audo Image: Start Audo	5.45s • [4] ► II = « ۲ 🗐 🗸		,	H H H H HI 112,243 519 Detail is Instant Picenet in the Security Fill missing fields Transmit State / Save PIN Lotor 88:78Not Jubotor 88:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not	stant Channels 0 Manage Mesh Security Manage ECDH K Link Key ACO IV 973830FCIB062FAStan 0CEBFail Not appl
<pre></pre>	5.45s • [4] ► II = « ۲ 🗐 🗸		,	H H H H HI 112,243 519 Detail is Instant Picenet in the Security Fill missing fields Transmit State / Save PIN Lotor 88:78Not Jubotor 88:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not	start Channels 7 Manage Mesh Security Manage ECDH Ke Link Key ACO IV 973830FC:B962F634c 0CEBF Not applic
 stant Audo atant Audo	5.45s • [4] ► II = « ۲ 🗐 🗸		,	H H H H HI 112,243 519 Detail is Instant Picenet in the Security Fill missing fields Transmit State / Save PIN Lotor 88:78Not Jubotor 88:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not	stant Channels 9 Manage Mesh Security Manage ECDH Ke Link Key ACO IV 973830FC:B962F634cur 0CEBF Not applie
< stant Audo	5.45s • [4] ► II = « ۲ 🗐 🗸		,	H H H H HI 112,243 519 Detail is Instant Picenet in the Security Fill missing fields Transmit State / Save PIN Lotor 88:78Not Jubotor 88:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not	stant Channels 9 Manage Mesh Security Manage ECDH Ke Link Key ACO IV 973830FC:B962F634cur 0CEBF Not applie
 stant Audo atant Audo	5.45s • [4] ► II = « ۲ 🗐 🗸		,	H H H H HI 112,243 519 Detail is Instant Picenet in the Security Fill missing fields Transmit State / Save PIN Lotor 88:78Not Jubotor 88:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not	stant Channels 9 Manage Mesh Security Manage ECDH Kr Link Key ACO IV 973830FC:B902FA545 9CEBF
c stant Audo <pc audo<="" p="" stant=""> c stant Audo c stant Audo c st</pc>	5.45s • [4] ► II = « ۲ 🗐 🗸		,	H H H H HI 112,243 519 Detail is Instant Picenet in the Security Fill missing fields Transmit State / Save PIN Lotor 88:78Not Jubotor 88:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not	stant Orannels 0 Manage Mesh Security Manage ECDH K Link Key ACO IV 973830FC:B902FASH: OCEBF
Kamit Audo Image: Stand Audo <td>5.45x - [4] ► II = + 5 @ </td> <td></td> <td>,</td> <td>H H H H HI 112,243 519 Detail is Instant Picenet in the Security Fill missing fields Transmit State / Save PIN Lotor 88:78Not Jubotor 88:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not</td> <td>stant Channels 0 Manage Mesh Security Manage ECDH K Link Key ACO IV 973830FCIB062FAStan 0CEBFail Not appl</td>	5.45x - [4] ► II = + 5 @ 		,	H H H H HI 112,243 519 Detail is Instant Picenet in the Security Fill missing fields Transmit State / Save PIN Lotor 88:78Not Jubotor 88:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not Jubotor 78:78Not	stant Channels 0 Manage Mesh Security Manage ECDH K Link Key ACO IV 973830FCIB062FAStan 0CEBFail Not appl

Figure 27 Instant Audio, BR/EDR and HCI Overviews Filtered for Audio Protocols.

HELPFUL HINT: Click the speaker icon at left of the Instant Audio window to enable/disable the audio.



Capturing Traffic

Please consult our Expert Note, EEN_BT03 "Your First Wideband Capture" to learn how to properly configure and operate your analyzer to achieve a clean capture.

Getting the Software

The analyzer software is available upon request via Ellisys: <u>http://www.ellisys.com/products/bex400/download.php</u>. The download is subject to approval, but approval will likely be granted to any company that is part of the Bluetooth SIG or seriously involved in Bluetooth development.

Visit ellisys.com or email support@ellisys.com for more information.

Other Interesting Reading

- EEN_BT03 Your First Wideband Capture
- EEN_BT04 Optimal Placement of Your Analyzer
- EEN_BT05 Understanding Antenna Radiation Patterns
- EEN_BT06 Bluetooth Security Truths and Fictions
- EEN_BT07 Secure Simple Pairing Explained

More Ellisys Expert Notes available at: www.ellisys.com/technology/expert_notes.php

Feedback

Feedback on our Expert Notes is always appreciated. To provide comments or critiques of any kind on this paper, please feel free to contact us at expert@ellisys.com

ן ר
\mathbf{J}

Sales Contact:



USA: +1.866.724.9185 Asia: +852 2272 2626 Europe: +41 22 777 77 89









Copyright© 2021 Ellisys. All rights reserved. Ellisys, the Ellisys logo, Better Analysis, Bluetooth Explorer, Bluetooth Tracker, Bluetooth Vanguard, Ellisys Grid, and Bluetooth Qualifier are trademarks of Ellisys, and may be registered in some jurisdictions. The Bluetooth® word mark and logos are registered trademarks owned by the Bluetooth SIG, Inc. and any use of such marks by Ellisys is under license. Wi-Fi® and the Wi-Fi Alliance logo are trademarks of Wi-Fi Alliance. Other trademarks and trade names are those of their respective owners. Information contained herein is for illustrative purposes and is not intended in any way to be used as a design reference. Readers should refer to the latest technical specifications for specific design guidance.