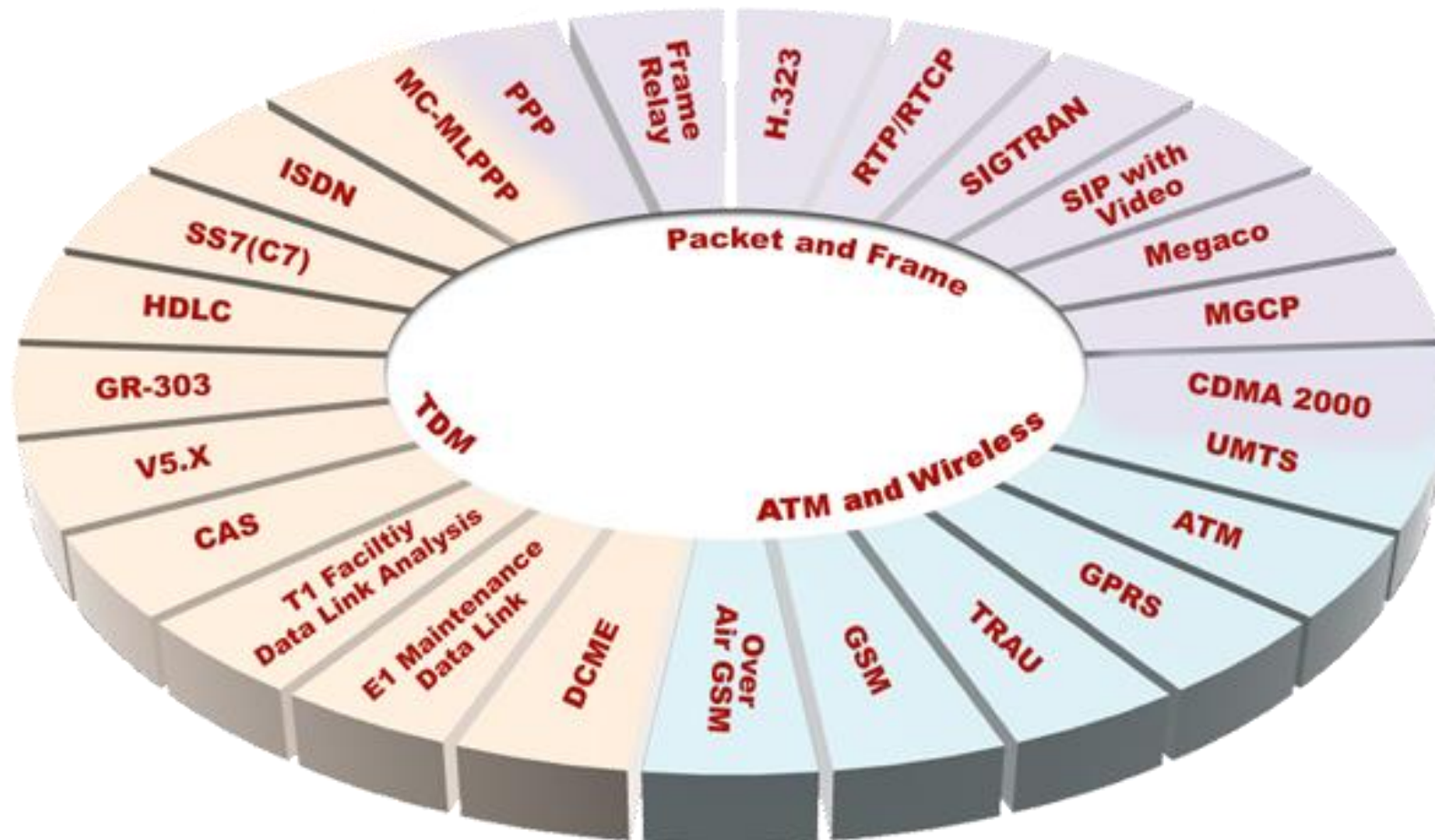

TRAU Emulation and Analysis



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Website: <https://www.gl.com>

TDM, Wireless, and VoIP Protocol Analysis

- GL Communications provides a host of protocol analyzers for testing a variety of protocols
- Analysis may be done both in real-time and offline

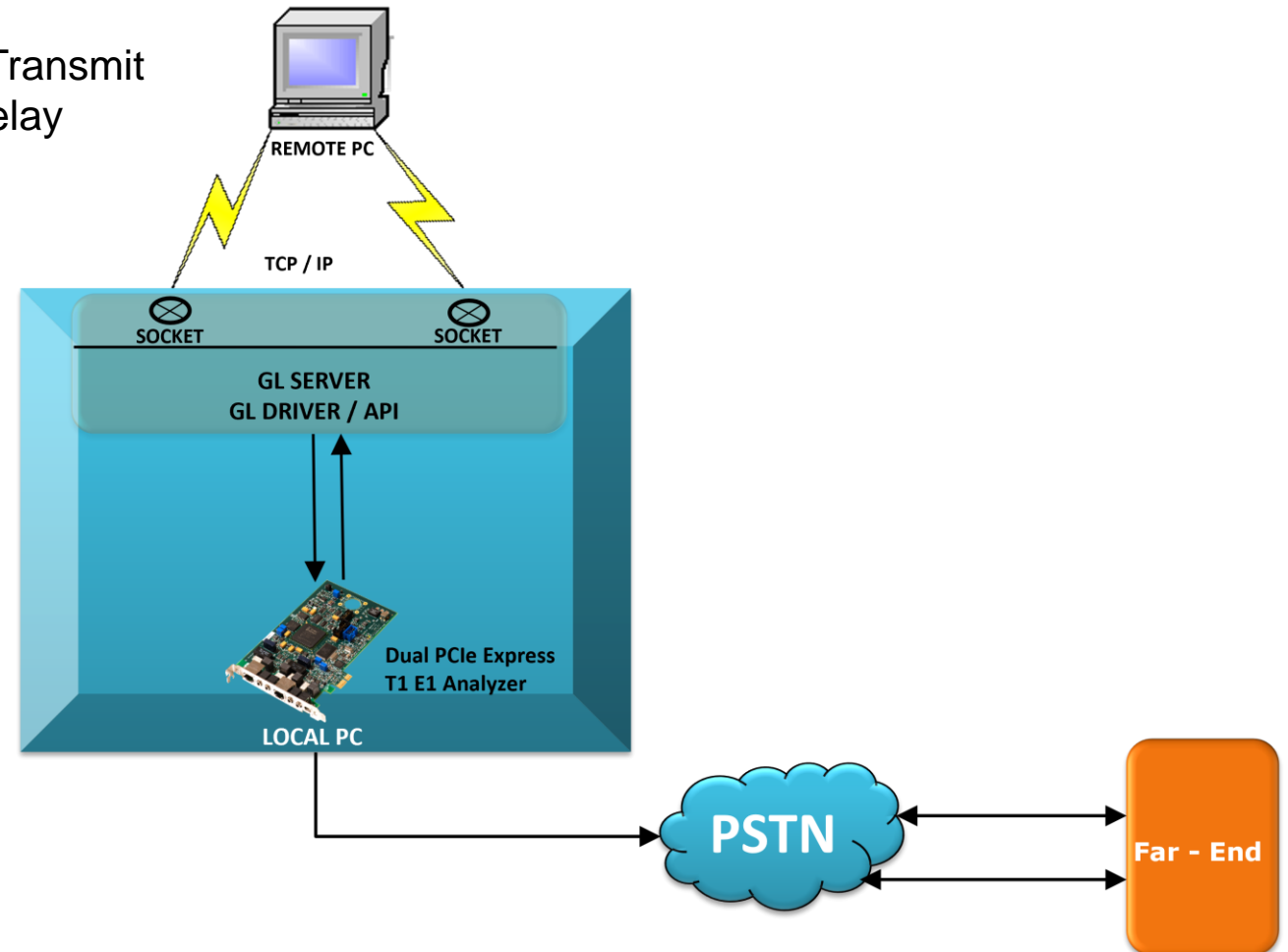


Types of Testing

Intrusive and Non-Intrusive

Intrusive Testing

- Example Applications:
 - BER Testing, Transmit Tone, Gaussian Noise, Transmit Multi frames, Signaling Bits, Error Insertion, Delay Measurement, Protocol Emulation

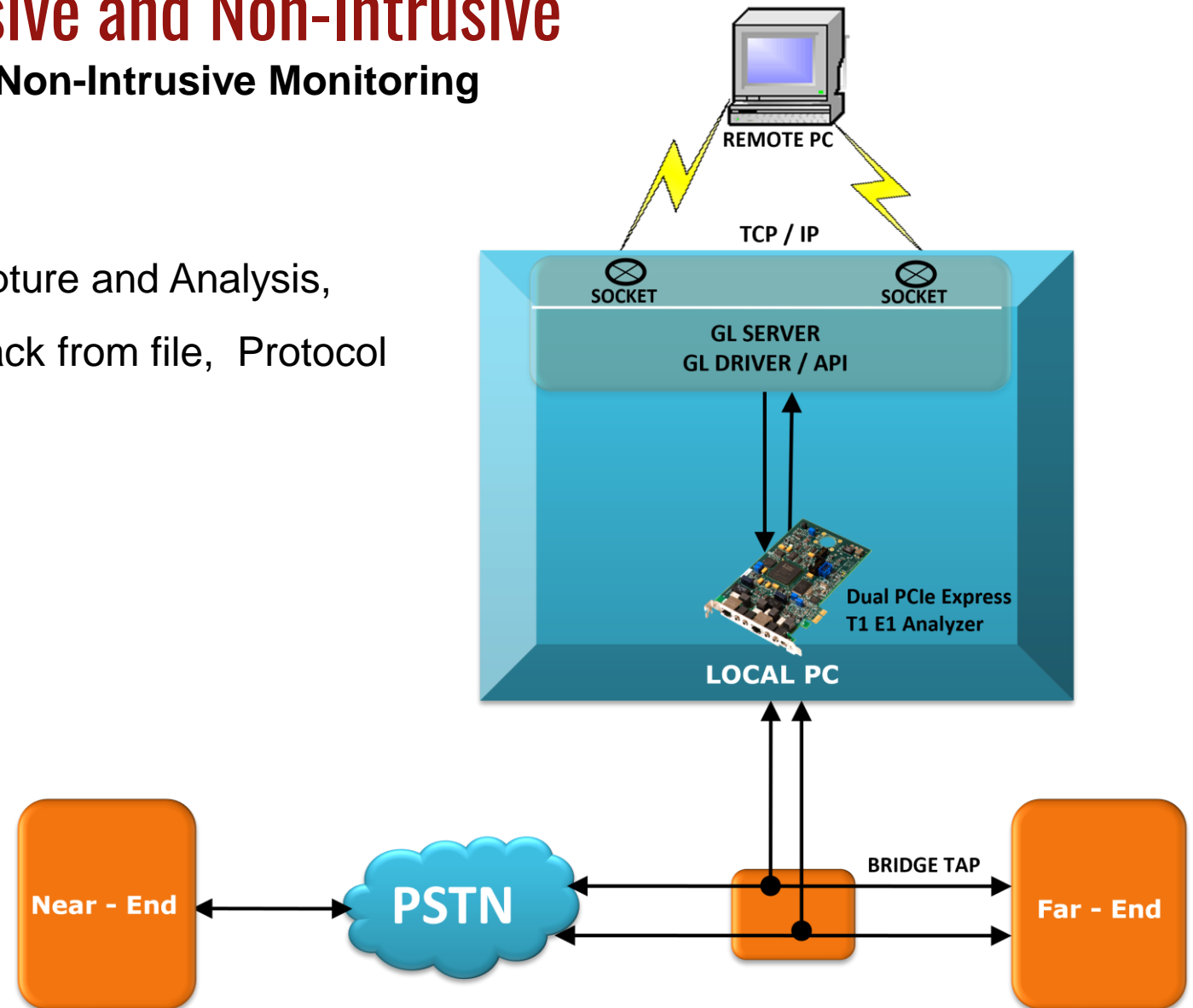


Types of Testing

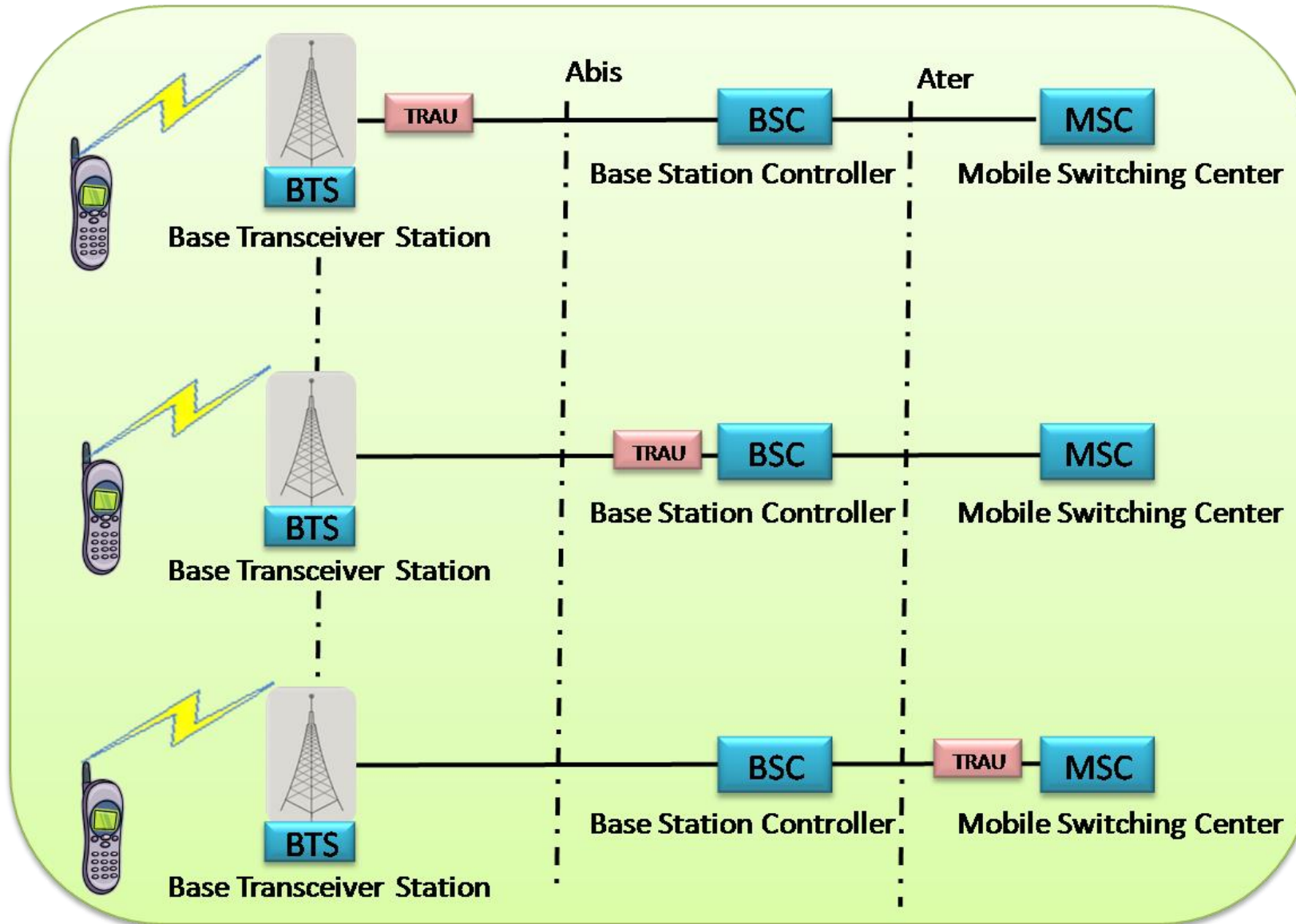
Intrusive and Non-Intrusive

Non-Intrusive Monitoring

- Example Applications:
 - Capture and Dialed digits, Call Capture and Analysis, Automated record playback, Playback from file, Protocol Analysis, and many more



Overview TRAU in Cellular Network

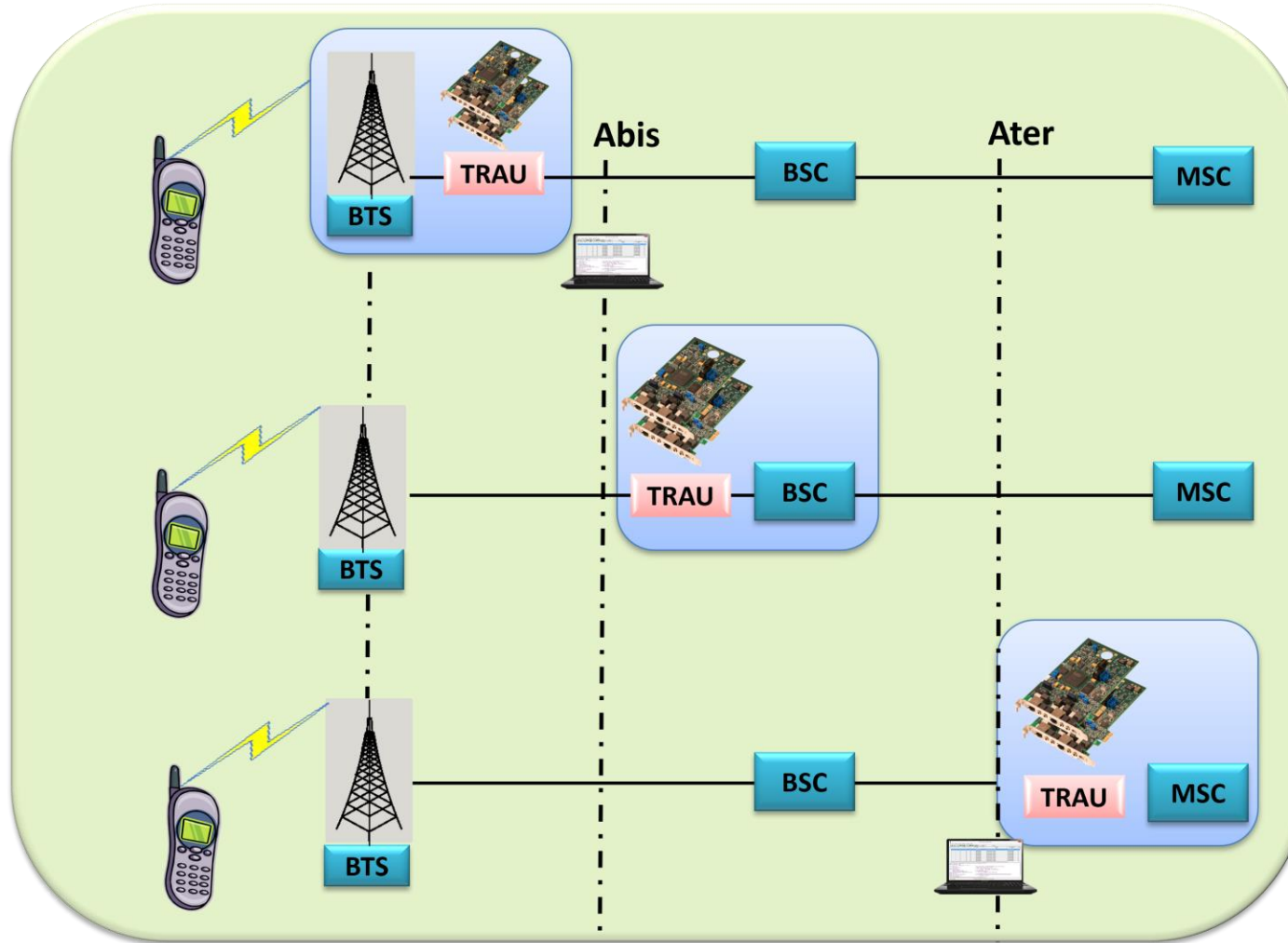


- TRAU (Transcoder/Rate Adaptor Unit) placed between the BTS and BSC/MSC perform compression/decompression of speech channels within the radio cellular network
- TRAU carries speech, data, O&M frames at Full Rate (16Kbps) or Half Rate (8kbps), and control information in a GSM network
- TRAU may be positioned at BTS site, the MSC site , or at the BSC site of BSS

Elements

- Mobile Station (MS): The MS is the physical equipment used by a subscriber, most often a normal hand-held cellular telephone
- Base Transceiver Station (BTS): A GSM network element that provides radio interface of the network. The BTS comprises the radio transmission and reception devices and manages the signal processing related to the air interface
- Base Station Controller (BSC): A GSM network element that handles radio resource control. The BSC manages the radio interface, mainly through the allocation, release, handover and power control of radio channels
- Mobile Services Switching Center (MSC): Many BSCs are connected to the MSC via the A-interface. The MSC is very similar to a regular digital telephone exchange and is accessed by external networks

TRAU Emulation and Analysis



GL's TRAU Analyzer



GL's TRAU Emulator

BTS – Base Transceiver Station
BSC – Base Station Controller
MSC – Mobile Switching Center
TRAU – Transcoder and Rate Adapter Unit

GL Communications supports the following types of TRAU based applications for emulation and analysis of GSM network :

- TRAU ToolBox™: Allows to create, monitor, and terminate multiple TRAU / GSM traffic (TRAU sessions)
- TRAU Traffic Playback : Allows to playback the recorded TRAU file(s) on selected channels
- Automated TRAU Emulation & Analysis (using client-server)
 - File based Record/Playback is a command line-based client application that allows Capture / Playback of TRAU traffic
 - WCS TRAU Tx/Rx Test is a GUI based as well as command line-based client application that can simulate TRAU / CCU (BTS or BSC end) on GL's T1 E1 cards
- TRAU Real-time and Offline Analyzer
 - TRAU Analyzer is used to non-intrusively monitor TRAU frames at the Abis interface (between the BTS (CCU) and the TRAU node at BSC / MSC)

TRAU ToolBox™

Key Features

- Ideal tool to test network elements at A-bis and A-ter interface
- Can be used to test the backhaul network
- Create, monitor, and terminate multiple TRAU / GSM traffic (TRAU sessions)
- Generate and analyze different kinds of audio / voice / digits on GSM call with various codecs
- Time Alignment - delay or advance the TRAU frames
- Other features allow the user to generate and analyze test tones, in-band signaling tones such as DTMF, MF, R2, playback and record voice files
- Capability to apply DTX to EFR and AMR codec
- Idle speech frames can be generated in case of GSM and EFR downlink codec if there is no speech frames to transmit

- Supports multiple sessions of Uplink or downlink in 8/16 Kbps data rate
- Supports all speech codec for verification of correct voice transmission which includes GSM codecs such as GSM 6.10(FR), Half Rate (HR), Enhanced full rate (EFR), Adaptive Multi Rate (AMR - Rates 4.75, 5.15, 5.90, 6.70, 7.4, 7.95, 10.2, & 12.2 kbps), Adaptive Multi Rate-Wide Band (AMR-WB –Rates 6,60, 8,85, 12,65 kbps), and the Data codec which includes Data, Data 14.5kbps Sync, and Data 14.5kbps (Extended Data)

Trau Tool - GL Communication

File View Monitor Special Application Help

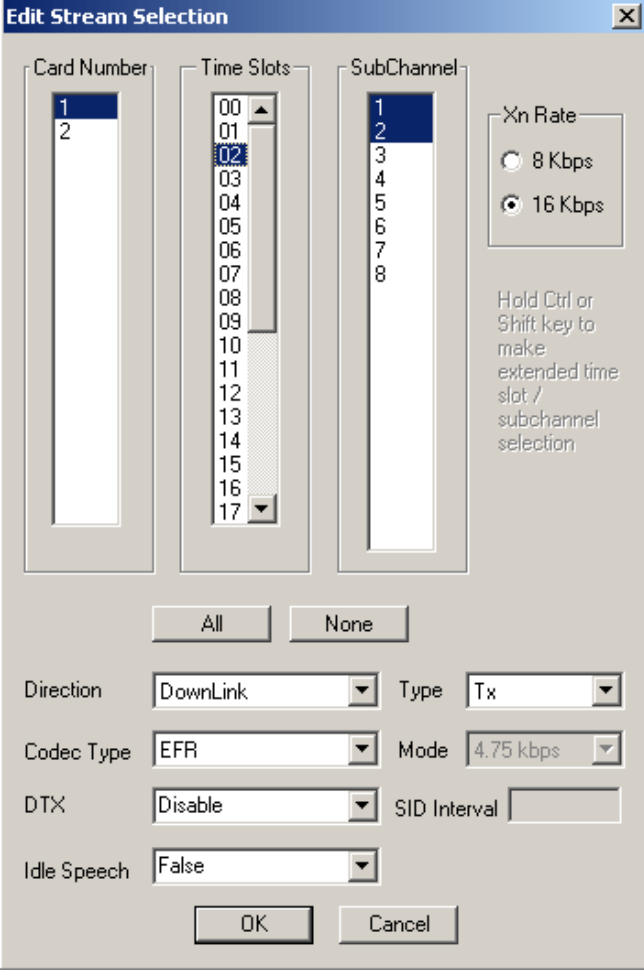
123 456

SI no	Xn Rate	Device No	Channel No	Sub Channel	Direction	Type	Codec Type	Status	Profile	Impairments	Actions
1	16kbps	1	1	1-2	DownLink	Tx	EFR	Start	Time Alignment	Impair	Terminate
2	16kbps	2	1	1-2	UpLink	Rx & Tx	EFR	Start	Time Alignment	Impair	Terminate
3	16kbps	1	2	1-2	DownLink	Tx	AMR	Stop	Time Alignment	Impair	Terminate
4	16kbps	2	2	1-2	UpLink	Rx & Tx	AMR	Stop	Time Alignment	Impair	Terminate
5	16kbps	1	1	3-4	UpLink	Tx	GSM 610	Start	Time Alignment	Impair	Terminate
6	16kbps	2	1	3-4	DownLink	Rx	GSM 610	Start	Time Alignment	Impair	Terminate

Insert Add Delete Start All Stop All

NUM

- Selection of contiguous and non-contiguous channels is possible for both 16kbps and 8kbps transmission rates
- Sub-channel selection depending upon the Xn rate
- Work on Transmission (Tx) mode, only Receiving (Rx) mode, or on both Rx & Tx modes



The 'Edit Stream Selection' dialog box contains the following elements:

- Card Number:** A list box with options 1 and 2. Option 1 is selected.
- Time Slots:** A list box with options from 00 to 17. Option 02 is selected.
- SubChannel:** A list box with options 1 through 8. Option 1 is selected.
- Xn Rate:** Radio buttons for 8 Kbps and 16 Kbps. The 16 Kbps option is selected.
- Instructions:** Text stating 'Hold Ctrl or Shift key to make extended time slot / subchannel selection'.
- Buttons:** 'All' and 'None' buttons.
- Direction:** A dropdown menu set to 'DownLink'.
- Type:** A dropdown menu set to 'Tx'.
- Codec Type:** A dropdown menu set to 'EFR'.
- Mode:** A dropdown menu set to '4.75 kbps'.
- DTX:** A dropdown menu set to 'Disable'.
- SID Interval:** An empty text input field.
- Idle Speech:** A dropdown menu set to 'False'.
- OK/Cancel:** 'OK' and 'Cancel' buttons at the bottom.

Time Alignment Feature

- TRAU frames can be delayed or advanced by specified value in msec or μ Sec

Profile

Time Alignment

TA type: XT

TA Sequence

Delay/Advance

10 msec

0 usec

10.000 msec

Interval for every TA: 10 frames

Repeat Sequence: -1 times

Transit Frame with TA Delay/Advance

Phase Alignment Feature

- Selection of AMR or AMR-WB codec displays the Phase Alignment tab can be applied to AMR or AMR-WB modes to change the mode to the requested modes

Profile

Time Alignment | **Phase Alignment**

Interval: 4

Repeat Count: -1

Request mode

Mode

- 4.75
- 5.15
- 5.90
- 6.70
- 7.40

Enter -1 as the Interval to stop Phase alignment

Impairment

- Logical AND, OR or XOR impairments can be applied to each TRAU frames

The screenshot shows a software window titled "Impairment" with a close button (X) in the top right corner. The window is divided into two main sections: "Impairment Duration" and "Impairment Type".

Impairment Duration:

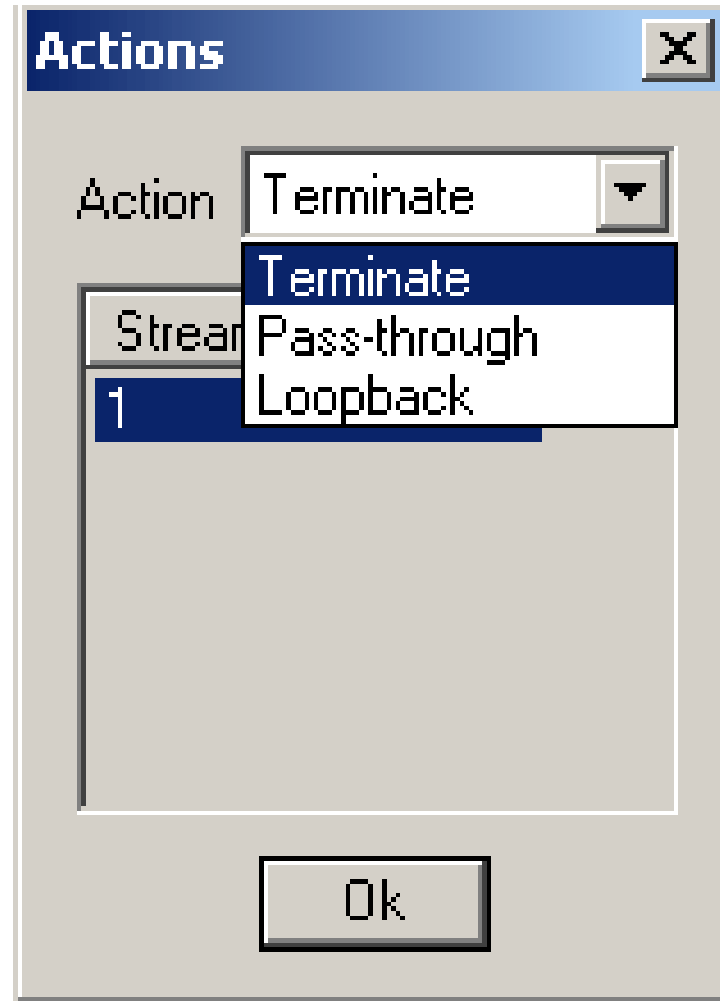
- There are two radio buttons: "Repeat" (which is selected) and "Continuous".
- Next to the "Repeat" radio button is a text input field containing the value "1".
- To the right of these options are two more text input fields: "Skip" containing "5" and "Offs" containing "10".

Impairment Type:

- There is a dropdown menu currently showing "AND". Below it, a list of options is visible: "OR", "AND" (highlighted), and "XOR".
- To the right of the dropdown is a section labeled "AND with" containing a text input field with the value "01".

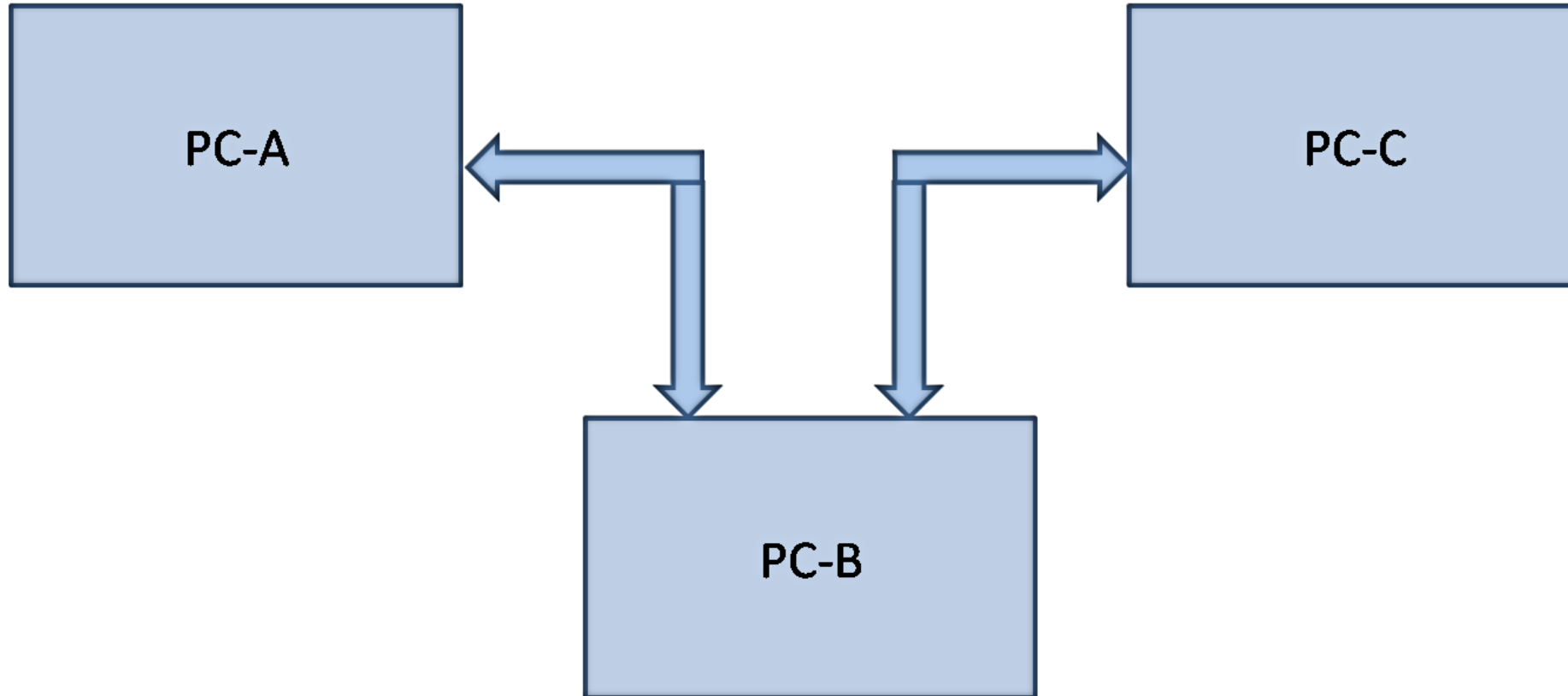
Actions

- Supports Loopback and Pass Through modes



Pass-through Mode

- Sends the received data through some other added stream



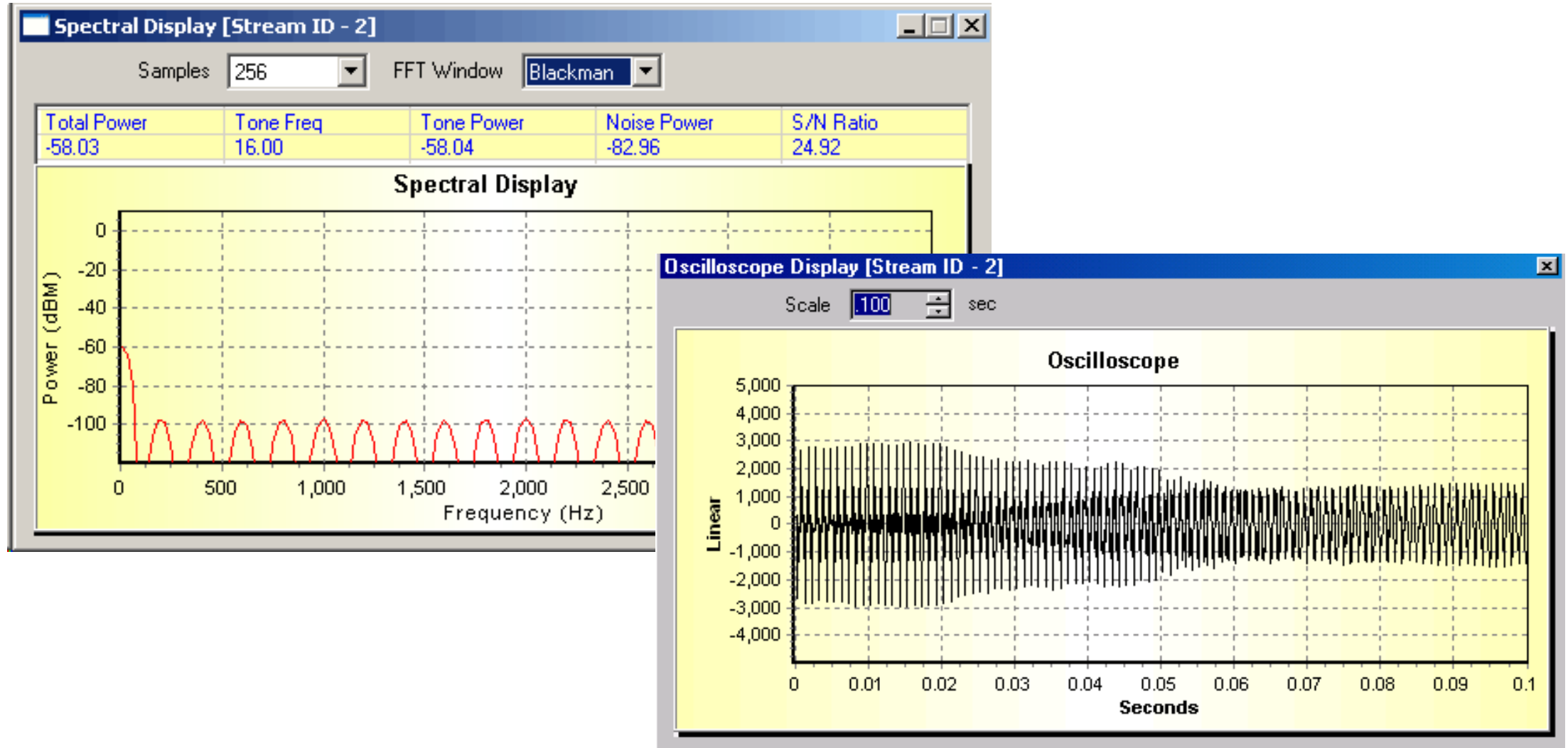
Loopback Mode

- The received uplink frame will be transmitted as downlink and vice versa



Monitoring Applications

- Monitor TRAU stream contents using an oscilloscope and spectrum analyzer



TRAU Traffic Generation

- Digit/Tone Generation - Sends tones or digits (DTMF / MF / MFR2 (Fwd/Bkwd)) on established sessions
- Playback From File - Supports transmitting voice files such as *.wav and *.pcm files
- Talk using Microphone - Real-time voice can be transmitted with the default audio device (microphone)

TRAU Traffic Generation

Digit/Tone Generation [Stream ID - 3]

Dig	F1	P1	F2	P2	Pwr	Twist	C
5	770	-13.01	1336	-13.01	-10.00	0.00	1
2	697	-13.01	1336	-13.01	-10.00	0.00	1
3	697	-13.01	1477	-13.01	-10.00	0.00	1
6	770	-13.01	1477	-13.01	-10.00	0.00	1
4	770	-13.01	1209	-13.01	-10.00	0.00	1

Digit Power
Power: -10 dB
Twist: 0
Duration: 3600 ms
☒ Continuous Transmission

Digit Cadence
On Time: 100 ms
Off Time: 100 ms
Short Pause: 2000 ms
Long Pause: 5000 ms

Generation Parameters
Sample Rate: 8000 /sec
☐ Randomize Starting Phase Angle
☐ Mix White Noise
-10 dB

DTMF Digits | MF Digits | MFR2 (Fwd) Digits | MFR2 (Bkwd) Digits | Tones | MultiTones

Status: Sending DTMF Digits

Start Stop

Talk Using Microphone [Stream ID ...]

Talk Stop

Output Codec Name: GSM610
Input Codec Name: PCM
Output Byte Count: 495360
Output Packet Count: 60662
Input Byte Count: 496000

Playback From File [Stream ID - 3]

Audio File: C:\Program Files\GL Communications Inc\Usb
☒ Continuous Transmission

☒ None
☐ Limit Transmit (Bytes)
☐ Limit Transmit (Time)

☐ Synchronize Operation
☐ Master ☐ Slave

Start Stop

Output Codec Name: AMR_WB
Input Codec Name: PCM
Output Byte Count: 97280
Output Packet Count: 27405
Input Byte Count: 105332

TRAU Traffic Detection

- Capture Digits/ Tones - Detects digits / tones, and view all activities during capture
- Record data to file - Records the incoming data on a session to a file (*.pcm)
- Play to Speaker - Plays incoming voice directly to the system's speaker

TRAU Traffic Detection

Capture Digits/Tones [Stream ID - 4]

Options

☒ Digits Only ☐ All Activity ☐ Show Latest

TimeStamp	Type	Event	On	Power	Freq1/Power1	Freq2/Power2
10:40:32.064	DTMF	2	102	-14.96	697/-20.16	1338/-17.28
10:40:32.458	DTMF	6	105	-16.66	771/-21.09	1479/-20.00
10:40:33.267	DTMF	0	90	-15.10	947/-18.73	1346/-22.32
10:40:35.658	DTMF	2	102	-14.96	697/-20.16	1338/-17.28
10:40:36.052	DTMF	6	105	-16.66	771/-21.09	1479/-20.00
10:40:36.861	DTMF	0	90	-15.10	947/-18.73	1346/-22.32
10:40:39.252	DTMF	2	102	-14.96	697/-20.16	1338/-17.28
10:40:39.649	DTMF	6	105	-16.66	771/-21.09	1479/-20.00
10:40:40.458	DTMF	0	90	-15.10	947/-18.73	1346/-22.32
10:40:42.849	DTMF	2	102	-14.96	697/-20.16	1338/-17.28
10:40:43.246	DTMF	6	105	-16.66	771/-21.09	1479/-20.00
10:40:44.055	DTMF	0	90	-15.10	947/-18.73	1346/-22.32
10:40:46.446	DTMF	2	102	-14.96	697/-20.16	1338/-17.28
10:40:46.840	DTMF	6	105	-16.66	771/-21.09	1479/-20.00
10:40:47.649	DTMF	0	90	-15.10	947/-18.73	1346/-22.32

Save Events

☐ Captured Event to file

Play to Speaker [Stream ID - 2]

Output Codec Name	PCM
Input Codec Name	GSM610
Output Byte Count	68480
Input Byte Count	7410
Input Packet Count	227
Input Error Packet Count	0

Record Data To File [Stream ID - 4]

Format

☒ PCM (16bit Linear) ☐ Native

Audio File

C:\Program Files\GL Communications Inc\Usb E1

☒ None

☐ Limit Capture (Bytes)

☐ Limit Capture (Time)

☐ Synchronize Operation

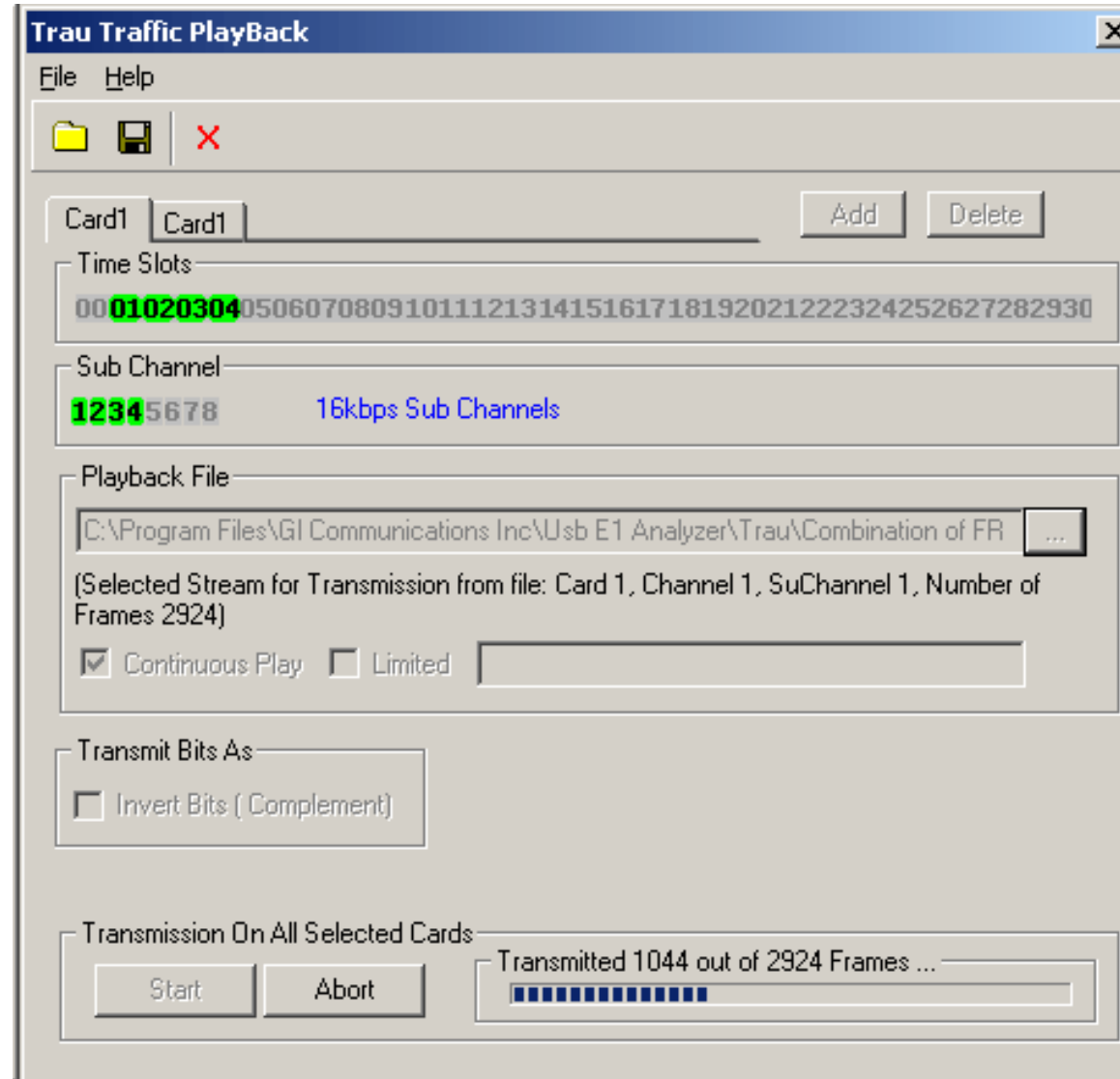
☐ Master ☐ Slave

Output Codec Name	PCM
Input Codec Name	AMR_WB
Output Byte Count	511360
Input Byte Count	48739
Input Packet Count	799
Input Error Packet Count	0

TRAU Traffic Playback

TRAU Traffic Playback

- Transmits recorded trace files on specific channels / sub-channels



Key Features

- Data transmission rates supported includes 16kbps and 8 kbps
- Trace files can include TRAU frame types such as EFR, FR (GSM 6.10), HR, AMR-WB, AMR, O&M, Data, Data 14.5 and Idle Speech frame types, which are stored in the recorded TRAU files, can be used for transmission
- Other options include - Bit Inversion, Continuous transmission, Limited transmission

TRAU Real-time and Offline Analysis

Key Features

- Captures and analyzes TRAU frames at the Abis interface (between the BTS (CCU) and the TRAU node at BSC/MS)
- Decodes TRAU frames as per the specifications GSM 08.60 V 8.2.0 & GSM 08.61 V 8.1.0
- Supported codec – FR, HR, EFR, AMR-WB, AMR, O&M, and Data
- Data transmission rates supported includes 16kbps and 8 kbps
- Extracts speech data from TRAU frames, play the speech data on PC soundcard, or, record voice to a file, after decompressing TRAU speech data to 16-bit linear PCM
- Decodes & displays frame synchronization bits, data bits and control bits
- Ability to configure .INI file for decoding based on user-defined raw capture values
- Remote monitoring capability using GL's Network Surveillance System

Different Views

TRAU Protocol Analysis TRAU

File View Capture Statistics Database Configure Help

0 GoTo

Dev	TS...	Su...	Frame#	TIME (Relative)	Len	TRAU Fram...	TRAU Frame...	Frame Sy...	Speech Fra...	Time Ali...	CRC	RIF	AMRmode
✓ 2	1	1-2	3	00:00:00.060000	40	Uplink (User)	Adaptive Mul...	Valid	Good Speech	No cha...	Valid CRC	Indicati...	Codec_Mode 5.15...
✓ 2	1	1-2	4	00:00:00.080000	40	Uplink (User)	Adaptive Mul...	Valid	Good Speech	No cha...	Valid CRC	Indicati...	Codec_Mode 5.15...
✓ 2	1	1-2	5	00:00:00.100000	40	Uplink (User)	Adaptive Mul...	Valid	Good Speech	No cha...	Valid CRC	Indicati...	Codec_Mode 5.15...
✓ 2	1	1-2	6	00:00:00.120000	40	Uplink (User)	Adaptive Mul...	Valid	Good Speech	No cha...	Valid CRC	Indicati...	Codec_Mode 5.15...
✓ 2	1	1-2	7	00:00:00.140000	40	Uplink (User)	Adaptive Mul...	Valid	Good Speech	No cha...	Valid CRC	Indicati...	Codec_Mode 5.15...
✓ 2	1	1-2	8	00:00:00.160000	40	Uplink (User)	Adaptive Mul...	Valid	Good Speech	No cha...	Invalid CRC	Indicati...	Codec_Mode 5.90...

Summary View

Card2 TimeSlot=1 SubChannels=1-2 Frame=3 at 00:00:00.060000 OK Len=40

HDLC Frame Data + FCS

===== TRAU Layer =====

Frame Sync = Valid Frame Sync (00000000000000001111111111111111)

Frame Direction = Uplink (User)

Frame Type (Full Rate, 16kbps, C1-C5) = .00110.. Adaptive Multi-Rate Narrow Band Codec (AMR-NB) - Full R

Time Alignment (C6-C11) for TAC_AMR =00 0000.... No change in frame timing

Detail View

Hex Dump of the Frame Data

```

+-----+-----+-----+-----+
00 00 98 00 83 3F FF FF FF FF FF F3 B1 E1 EE 28      |  ?yyyyyyóái(
87 AF F8 0E E8 F0 8F 75 F0 1E F5 FF FF FF FF FF      |  |_ø èð!uš öyyyyy
FF FF FF FF FF FF FF FF                          |  yyyyyyyy
  
```

Hex Dump View

Device #	Frame Count(Speech Frame Classification)
2	206
total 2	206

Statistics View

C:\Program Files\GL Communications Inc\U: 206 Frames

Different Views

- Summary View: This displays timeslot, sub channel, frame#, device#, time relative, length, error, Trau Frame Direction and Type, Frame Sync, Speech Frame, Time Alignment, CRC, RIF, AMR Mode, and AMR-WB mode
- Detail View: This pane displays in detail about a frame in order to analyze and decode by selecting it in the summary view
- Hex Dump View: This pane displays the frame information in HEX and ASCII format
- Statistics View: This pane displays the statistics that are calculated based on the protocol fields

Real-time Analysis

Card & Stream Selection

Save Load Default

Capture File Options

Card & Stream Selection

Capture Filter

Gui & Protocol Options

Card and Time Slot Selection

1	2
00	00
01	01
02	02
03	03
04	04
05	05
06	06
07	07
08	08
09	09
10	10
11	11
12	12

UpLink(unchecked) / DownLink(checked)

Bit Inversion (1 <-> 0)

Data Transmission Rate

Subchannels 8-16 kbps

8k Subchannels

1
2
3
4
5
6
7
8

All

None

All TS

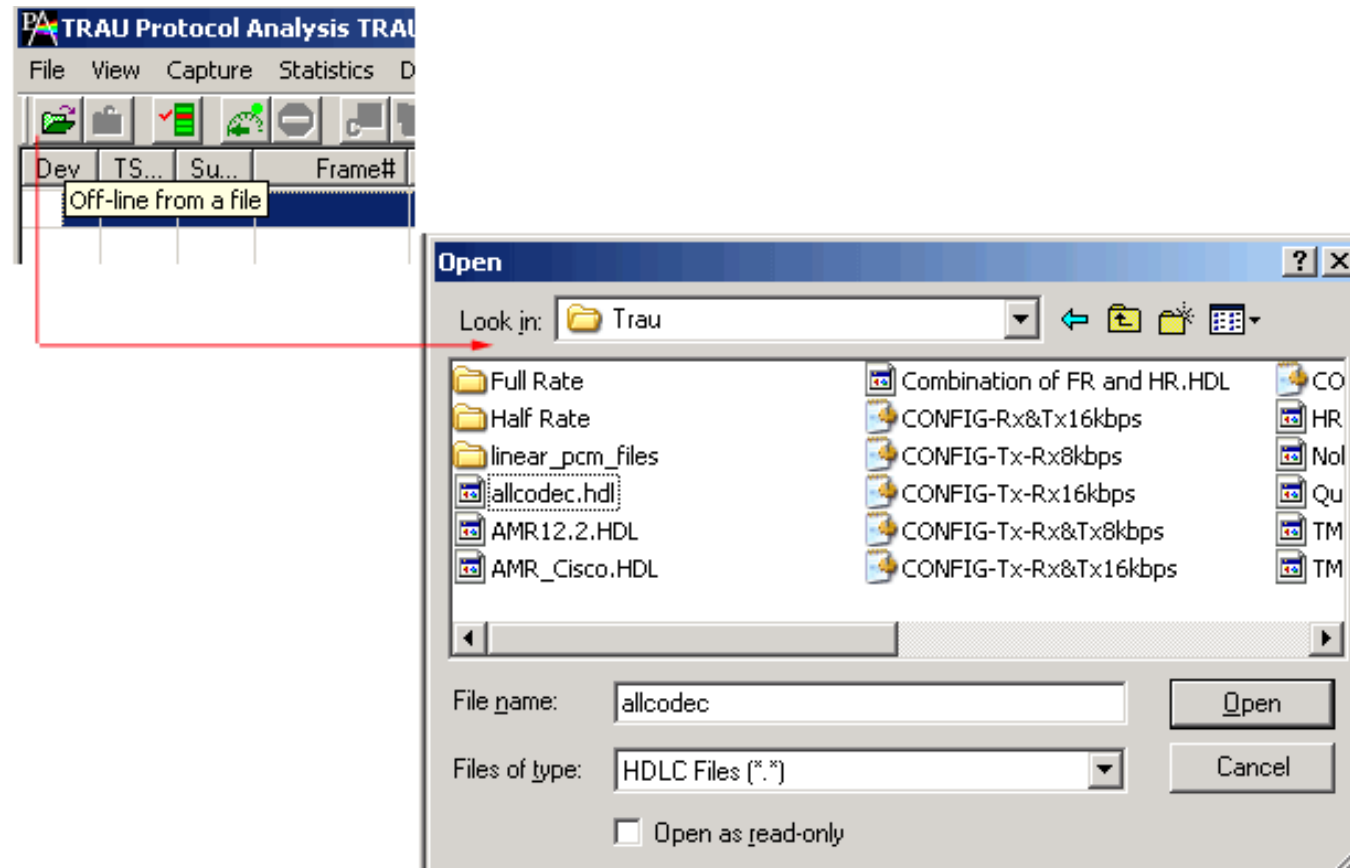
Clear TS

Real-time Analysis

- Frames can be captured on the selected time slots (contiguous or non-contiguous), sub-channels or full bandwidth 32 or 24 channels
- Frames may also be captured based on bit inversion & user/network side options
- Capture and decode TRAU frames such as FR (Full Rate GSM 6.10), HR (Half Rate), EFR (Enhanced Full Rate) , AMR (Adaptive Multi Rate), AMR-WB, O&M, Data
- Recorded trace file can then be analyzed offline
- Capability to export summary view details to comma separated values (CSV) format for subsequent import into a database or spreadsheet
- Capability to export detail decode information to an ASCII file

Offline Analysis

- Offline analysis is equivalent to decoding a captured file in pre-defined timeslots
- Captured frames or only the filtered frames can be exported to *.HDL file for the further offline analysis
- Trace file for offline analysis can be loaded either through analyzer GUI or through simple command-line arguments



Offline Analysis

- Trace files for offline analysis can be loaded through simple command-line arguments
 - **Command Syntax:** `trauprot trau\Filename.hdl`

The screenshot displays the TRAU Protocol Analysis TRAU application window. The main window has a menu bar (File, View, Capture, Statistics, Database, Configure, Help) and a toolbar. Below the toolbar is a table with columns: Dev, TS..., Su..., Frame#, TIME (Relative), Len, TR..., TRAU F..., Frame S..., Speech F..., Time Alig..., CRC, and RIF. The table contains several rows of data, with the first row highlighted. A command prompt window is open over the table, showing the following text:

```
D:\WINDOWS\system32\cmd.exe
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

D:\>cd D:\Program Files\GL Communications Inc\Trau Analyzer
D:\Program Files\GL Communications Inc\Trau Analyzer>trauprot trau\allcodec.hdl
D:\Program Files\GL Communications Inc\Trau Analyzer>
```

The command `trauprot trau\allcodec.hdl` is highlighted with a red circle. Below the command prompt, the application displays the following information:

Card1
HDLC F
====
Frame
Frame Direction = Downlink (Network)
Frame Type (Full Rate, 16kbps, C1-C5) = .00110.. Adaptive Multi-Rate Narrow Band Co
Time Alignment (C6-C11) for TAC_AMR =00 0000.... No change in frame timing
Req or Ind Flag-RIF (C12) for Downlink =0... Indication (Codec Mode)
Unlink Frame Error-UEF (C13) = 1 Unlink Frame received without Error

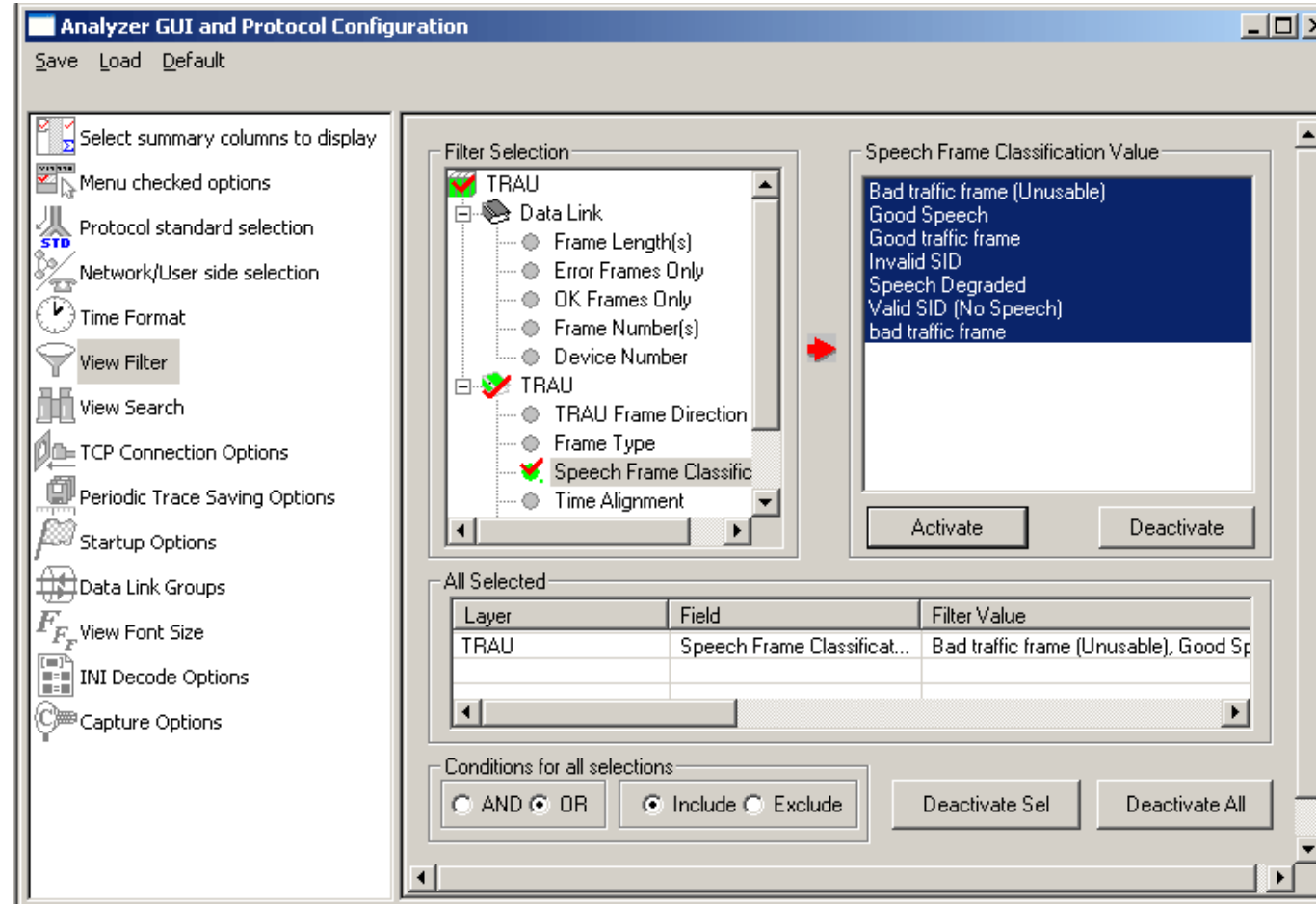
Below this information is a section titled "Hex Dump of the Frame Data" showing a hex dump of the frame data. The hex dump is as follows:

```
00 00 98 04 8F E1 85 4D DC B5 AA B5 C0 00 80 00
80 0B DA C3 FD 9A 86 F2 C7 12 80 41 AC 2A BC 43
0D AC 84 80 DC 7E D0 5F
```

At the bottom of the application window, there is a status bar with the text "Off-line Viewing" and "C:\Program Files\GL Communication 5556 Frames".

Filters – Offline View Filter

- Isolates required frames from all frames
- Filter applies to the captured frames and is based on the data link and other decoded protocol field values such as frame type, time alignment, CRC, RIF, AMR mode and so on



Search Options

- Search features helps users to search for a particular frame based on specific search criteria

Filter Selection

- ☒ TRAU
 - ☐ Data Link
 - ☐ Frame Length(s)
 - ☐ Error Frames Only
 - ☐ OK Frames Only
 - ☐ Frame Number(s)
 - ☐ Device Number
 - ☒ TRAU
 - ☒ TRAU Frame Direction
 - ☐ Frame Type
 - ☐ Speech Frame Classific
 - ☐ Time Alignment

TRAU Frame Direction Value

- Downlink (Network)
- Uplink (User)**

Activate Deactivate

All Selected

Layer	Field	Filter Value
TRAU	TRAU Frame Direction	Uplink (User)

Conditions for all selections

☐ AND ☒ OR ☒ Include ☐ Exclude

Deactivate Sel Deactivate All

Statistics

- Numerous statistics can be obtained to study the performance and trend in the TRAU networks based on various protocol fields and parameters
- Statistics can be obtained for all frames both in real-time as well as offline mode

Statistics

Field Names

- RA bit rate
- Req or Ind Flag-RIF (C12) for
- Req or Ind Flag-RIF (C12) for
- Reserved for TFO
- SP(C16)
- Silence Descriptor Frame-SID
- Spare, reserved for TFO (C19)
- Spare, reserved for TFO (C19)
- Spare, reserved for TFO (C20)
- Speech Frame Classification**
- TAF (C15)
- TFO
- TFO Enabled-TFOE (C20)
- Time Alignment
- Time Alignment (C6-C11)
- Time Alignment (C6-C11) for
- Time Alignment (C6-C11) for
- Time Alignment (C6-C11) for

Speech Frame Classification

Use Type (single selection)

- Total
- Key
- Field**

Statistic Type(s) (calculated, multiple selection)

- Frame Count**
- Frame Percent
- Byte Count
- Byte Percent

Value Set

- Bad traffic frame (Unusable)**
- Good Speech
- Invalid SID
- Speech Degraded

☒ Cumulative ☐ Separate

Add/Mod Remove

Selected Statistic Information

Layer	Field Name	Use Type	Statistic Type
Physical ...	Device #	Total	
TRAU	Speech Frame...	Field	Frame Count

Remove Sel
Remove All
Apply

Saving a File

- Isolates required frames from all frames
- Filter applies to the captured frames and is based on the data link and other decoded protocol field values such as frame type, time alignment, CRC, RIF, AMR mode and so on

Periodic Trace Saving Options
Save Load Default

Select summary columns to display
Menu checked options
Protocol standard selection
Network/User side selection
Time Format
View Filter
View Search
TCP Connection Options
Periodic Trace Saving Options
Startup Options
Data Link Groups
View Font Size
INI Decode Options
Capture Options

Using View Filter
☒ All Frames (no filtering)
☐ Filtered Only (use view filter)

Save Directory
C:\

Save File Names
☒ Sequential File Names
file name prefix: 123
number of digits: 1
file name suffix: .HDL
☐ Date/Time Formatted Names
file name prefix: %Y%M%D_%H%M%S
file name suffix: .HDL

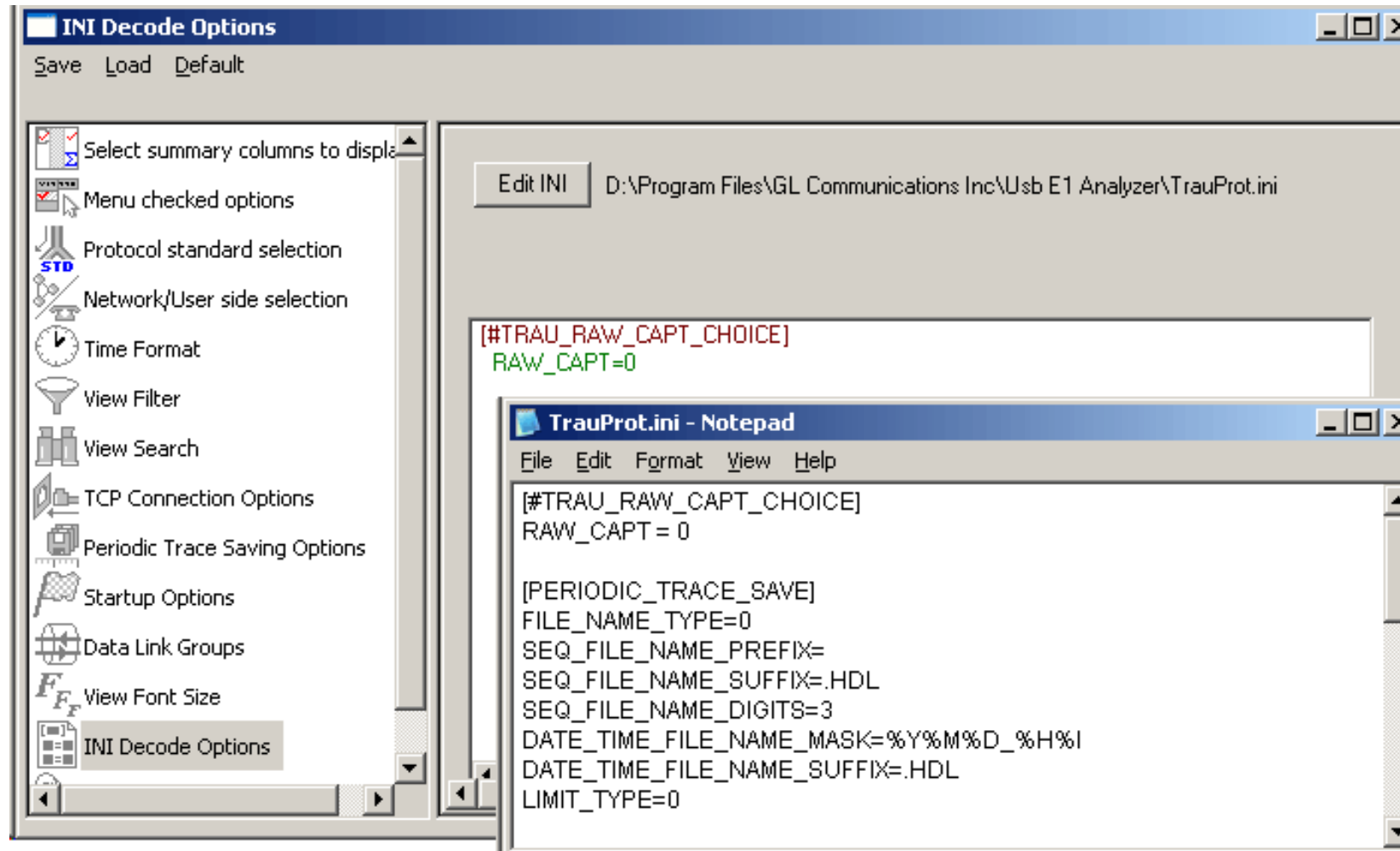
Create a New File After the Specified Limit Has Been Reached
☒ File Size Limit e.g. 1048576 or 1024K or 1M
☐ Frame Count Limit e.g. 1048576 or 1024K or 1M
☐ Time Limit e.g. 24:00 (HH:MM)

Limit Value
1000000

Restrict or Recycle After N Files Options
2147483647
☒ Keep N Latest Files
☐ Stop After N Files
☐ Unrestricted

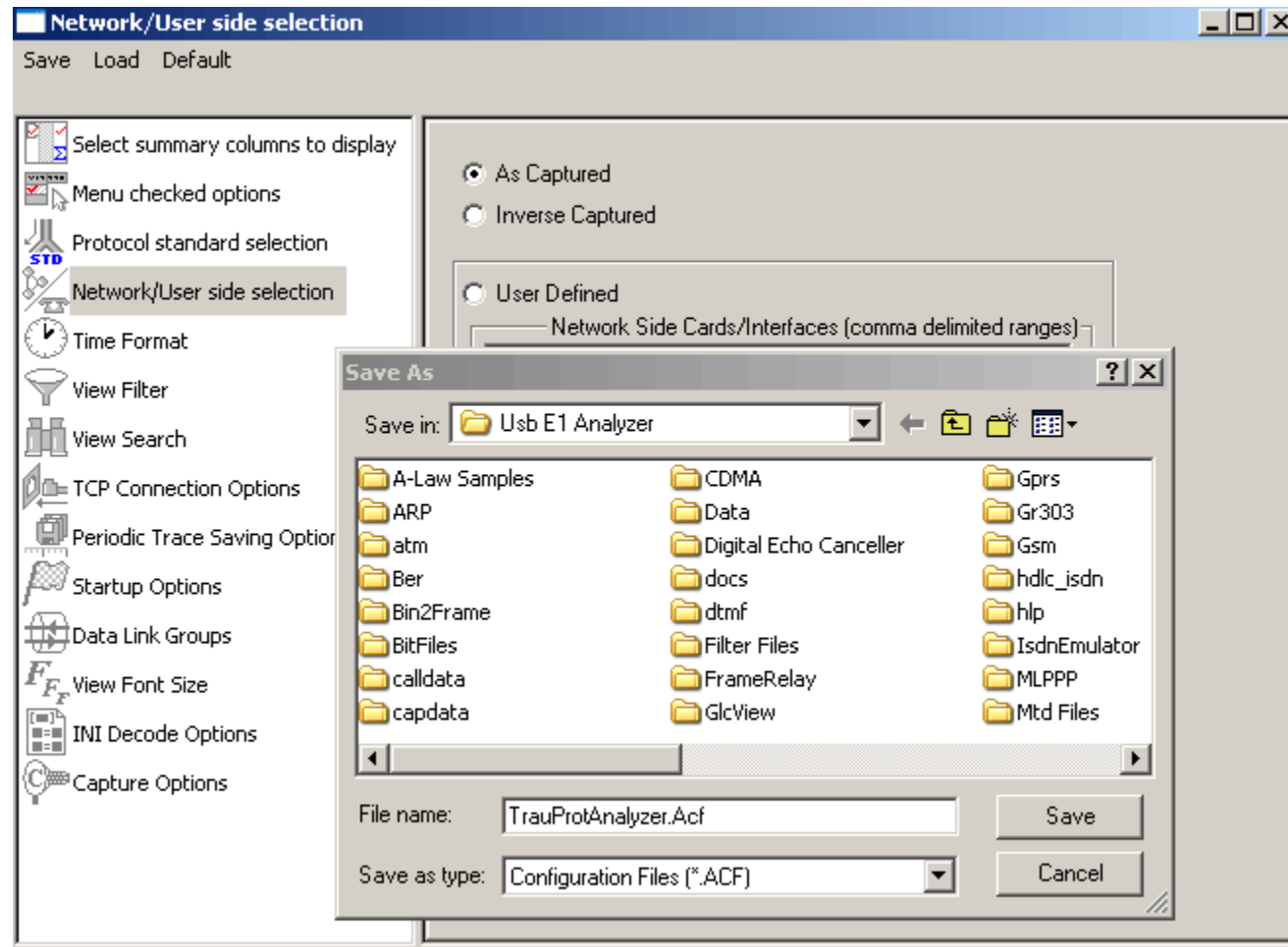
Configuring INI Decode Options

- INI configuration file enables the capturing raw bits for debugging purposes



Save/Load All Configuration Settings

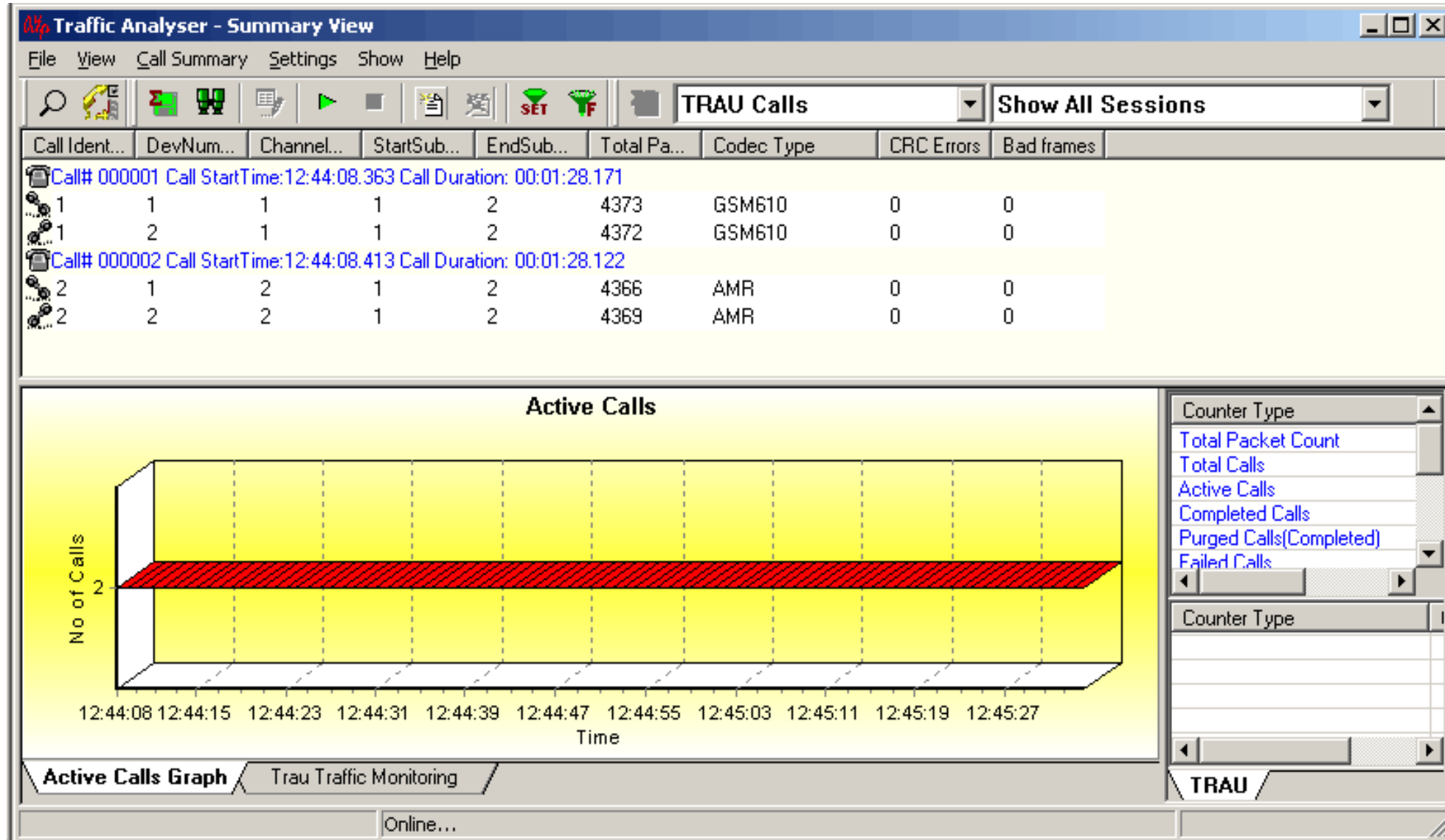
- Protocol configuration window provides a consolidated interface for all the settings required in the analyzer such as protocol selection, stream/interface selection, and so on
- Configuration settings can be saved to a file, loaded from a configuration file, or user may just revert to the default values using the default option



TRAU Traffic Analyzer (or Packet Data Analyzer)

- TRAU PDA displays analysis of TRAU calls, including detail statistics, wave graph, oscilloscope, spectral display for various codecs . It includes -
 - Summary view
 - Detail view

Summary View



Key Features

- View summary of data transmission in each direction including call identity, device number, channel Number, start sub channel, end sub channel, total packets, codec type CRC errors and bad frames
- Split and compare the two sessions of a call in Detail View
- Includes separate statistical counts on total packets, calls, and captured frames, and so on
- Provides graphs to view active calls over the duration of the call and TRAU Traffic Monitoring to analyze and classify traffic types in a real-time GSM network
- Extracts speech data from TRAU frames, play the speech data on PC soundcard, or, record voice to a file, after decompressing TRAU speech data to 16-bit linear PCM

Detail View

- Provides a detailed look at the two (or one) TRAU sessions that are part of a single call; left and right panes accommodate the two sessions
- Provide Wave and Spectral Display graphs for individual sessions

The screenshot shows the 'Traffic Analyser - Detail View' window. It features a menu bar (File, View, Detail View, Settings, Show, Help) and a toolbar with various icons. The main area is divided into two panes, each displaying a table of TRAU session data. The left pane shows frames 0 through 35, and the right pane shows frames 1 through 37. Below these tables are two identical summary tables, one for each session, showing statistics like Total Trau packets, Codec Type, CRC Error Frames Count, and Bad Frames Count. At the bottom, there are tabs for 'Statistics', 'Inband Events', 'Wave Graph', and 'Spectral Display', and a status bar with 'Online...'.

Frame...	Trau...	Fra...	FrameSy...	Spe...	TimeAlign...
0	Dow...	Full...	Valid Sync	Go...	No chang...
2	Dow...	Full...	Valid Sync	Go...	No chang...
4	Dow...	Full...	Valid Sync	Go...	No chang...
7	Dow...	Full...	Valid Sync	Go...	No chang...
11	Dow...	Full...	Valid Sync	Go...	No chang...
15	Dow...	Full...	Valid Sync	Go...	No chang...
19	Dow...	Full...	Valid Sync	Go...	No chang...
23	Dow...	Full...	Valid Sync	Go...	No chang...
27	Dow...	Full...	Valid Sync	Go...	No chang...
31	Dow...	Full...	Valid Sync	Go...	No chang...
35	Dow...	Full...	Valid Sync	Go...	No chang...

Frame...	Trau...	Fra...	FrameSy...	Spe...	TimeAlign...
1	Uplink	Full...	Valid Sync	Go...	No chang...
3	Uplink	Full...	Valid Sync	Go...	No chang...
5	Uplink	Full...	Valid Sync	Go...	No chang...
9	Uplink	Full...	Valid Sync	Go...	No chang...
13	Uplink	Full...	Valid Sync	Go...	No chang...
17	Uplink	Full...	Valid Sync	Go...	No chang...
21	Uplink	Full...	Valid Sync	Go...	No chang...
25	Uplink	Full...	Valid Sync	Go...	No chang...
29	Uplink	Full...	Valid Sync	Go...	No chang...
33	Uplink	Full...	Valid Sync	Go...	No chang...
37	Uplink	Full...	Valid Sync	Go...	No chang...

Heading	Value
Total Trau packets	14852
Codec Type	GSM610
CRC Error Frames Count	0
Bad Frames Count	0

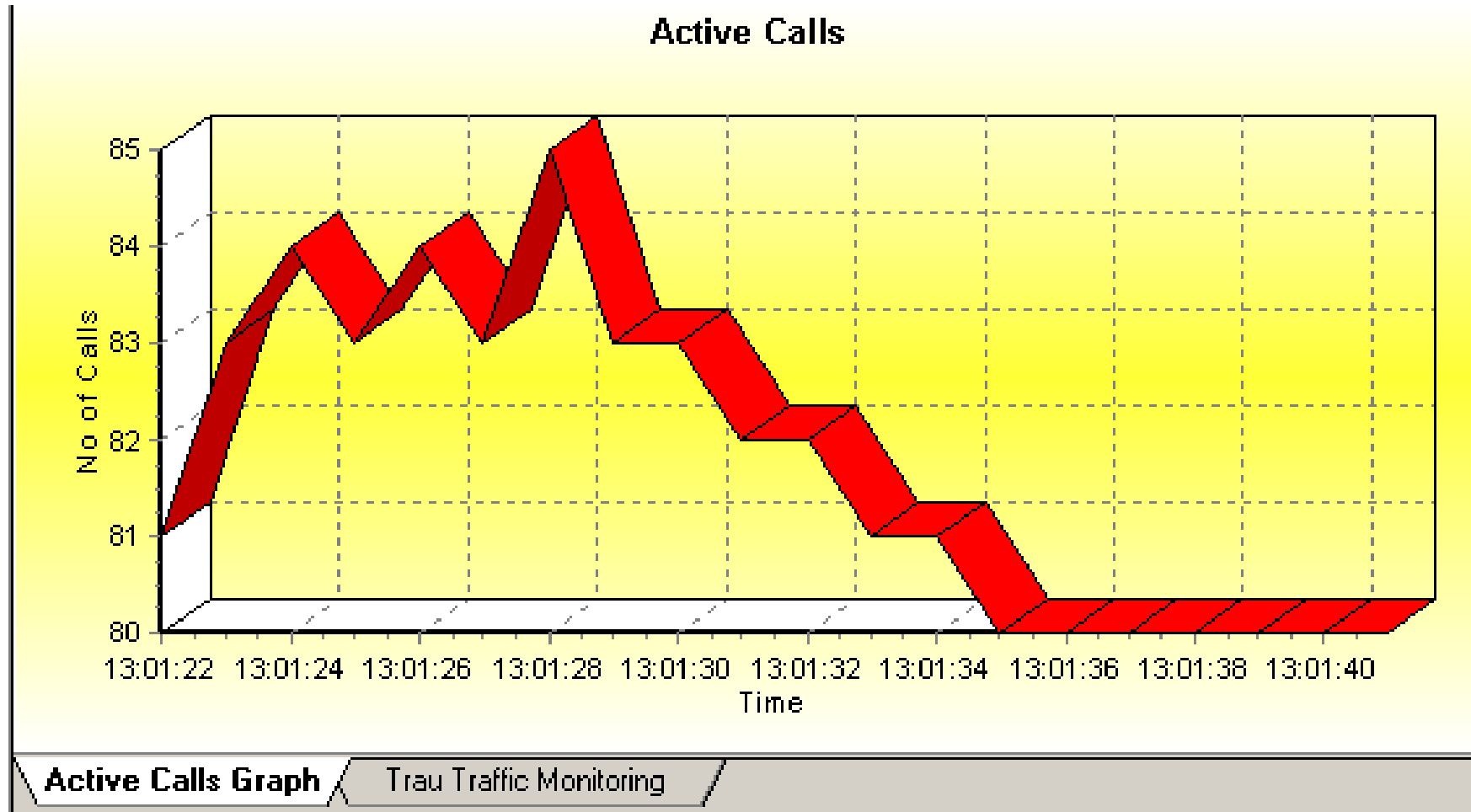
Heading	Value
Total Trau packets	14850
Codec Type	GSM610
CRC Error Frames Count	0
Bad Frames Count	0

Statistics Inband Events Wave Graph Spectral Display

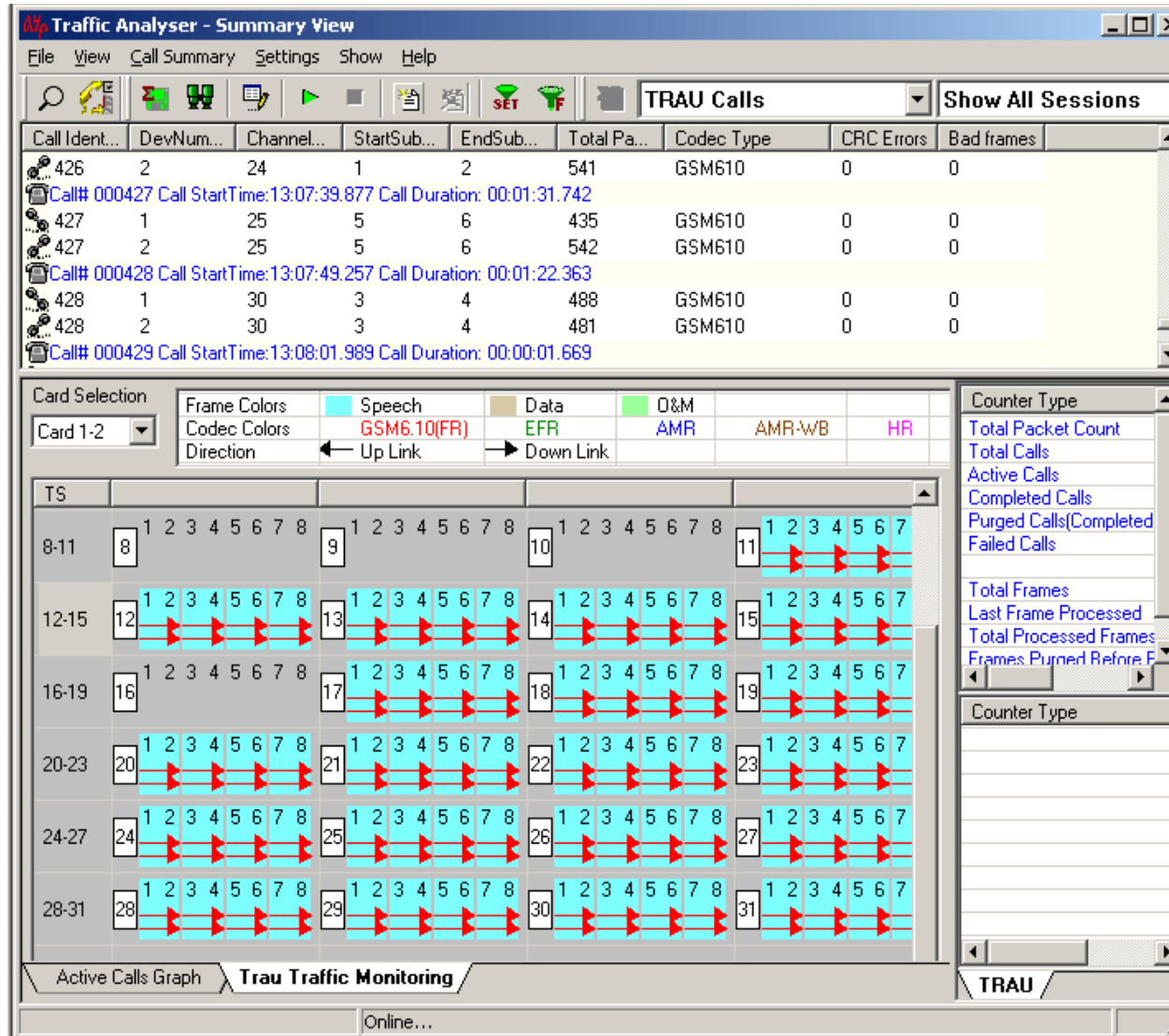
Online...

Active Calls Graph – Summary View

- View active calls over the duration of the capture



TRAU Traffic Monitoring – Summary View

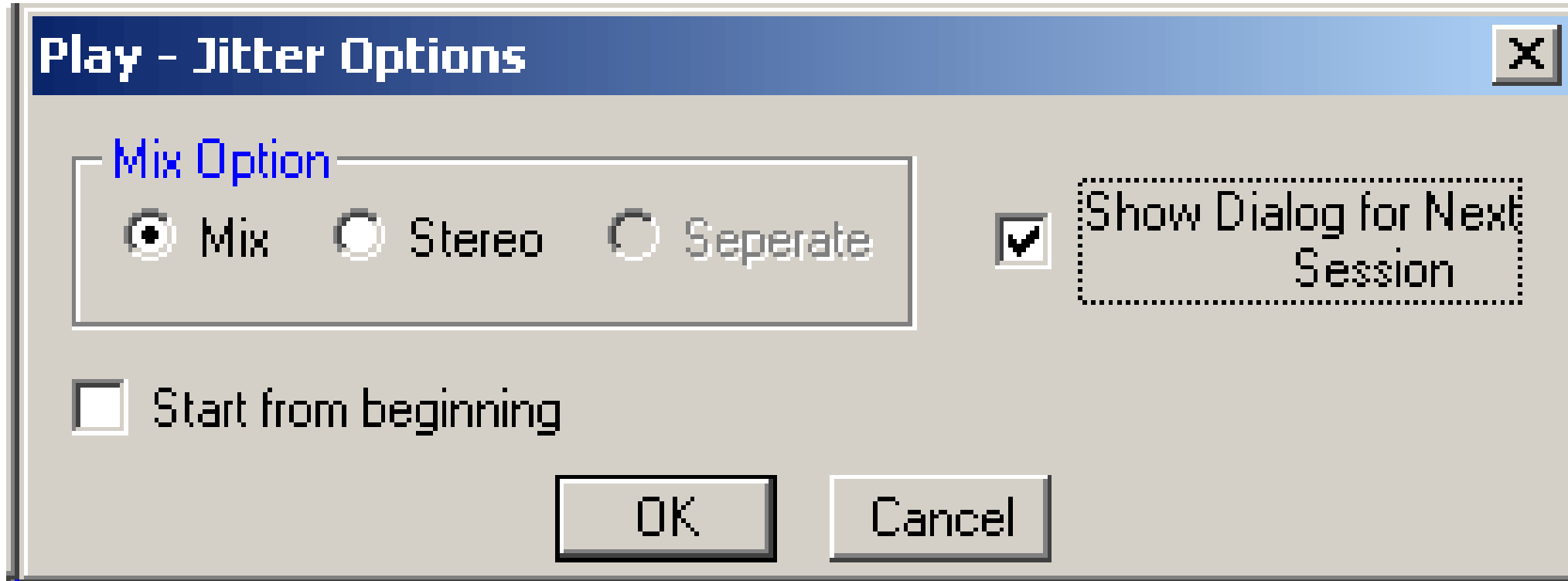


TRAU Traffic Monitoring

- Displays current status of traffic channels in Abis interface
- Analyzes and classifies traffic type such as Speech, Data, and O&M in a real-time GSM network
- Uses specific color codes to identify the frames, along with the direction of its transmission
- Each pictorial block indicates individual TRAU sessions
- For simulation purposes, sessions can be created using TRAU ToolBox™ or TRAU Traffic Playback

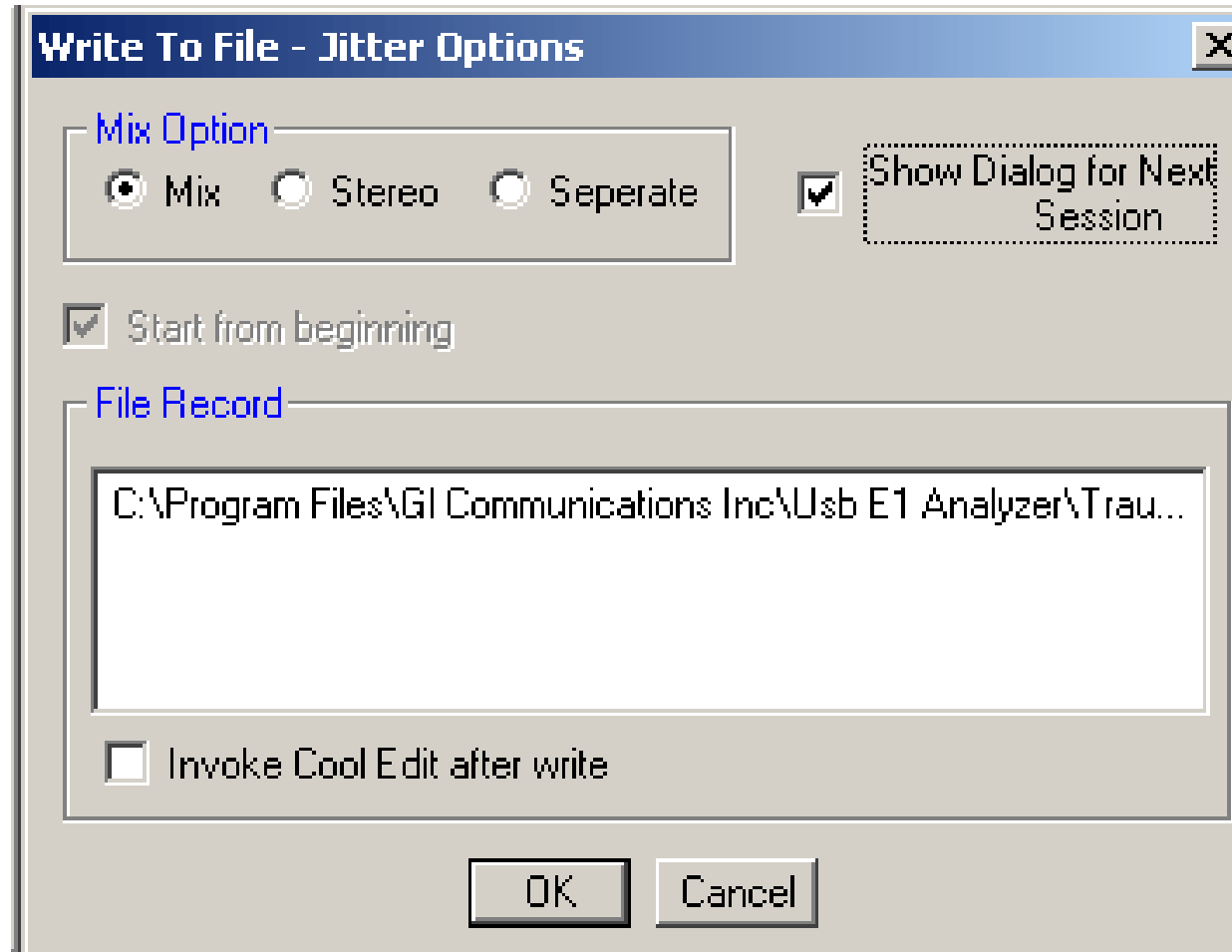
Play Audio

- Plays the selected call to the PC speaker
- A host of options are provided to the user before the actual play is started



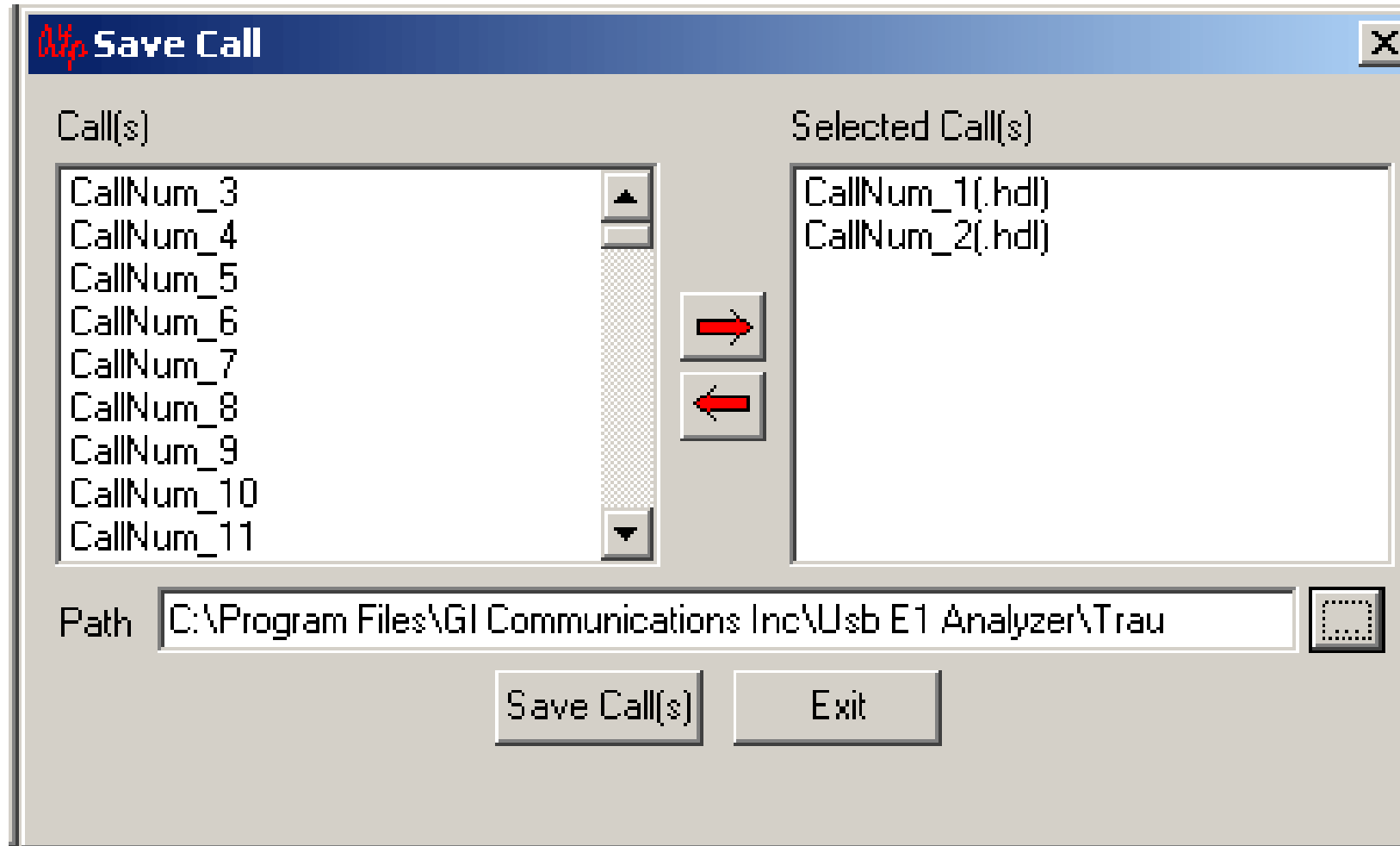
Write to File

- Provides various options to save the captured file in a required format
- Uses the files with voice quality analysis software to investigate more about the quality of voice in the network
- Records the TRAU stream to a file in *.wav format



Save Call

- Saves a particular call as a separate HDL file
- Helps in getting data from real-time traffic locations to the lab for detailed analysis



Export Displayed Summary

- Saves a particular call as a separate HDL file
- Helps in getting data from real-time traffic locations to the lab for detailed analysis

Export Displayed Summary

Export File Name: C:\Program Files\GL Communications Inc\Usb E1 Ana

Columns to Export:

- Call#
- DevNumber
- ChannelNumber
- StartSubChannel
- EndSubChannel
- Total Packets
- Codec Type
- CRC Errors
- Bad frames

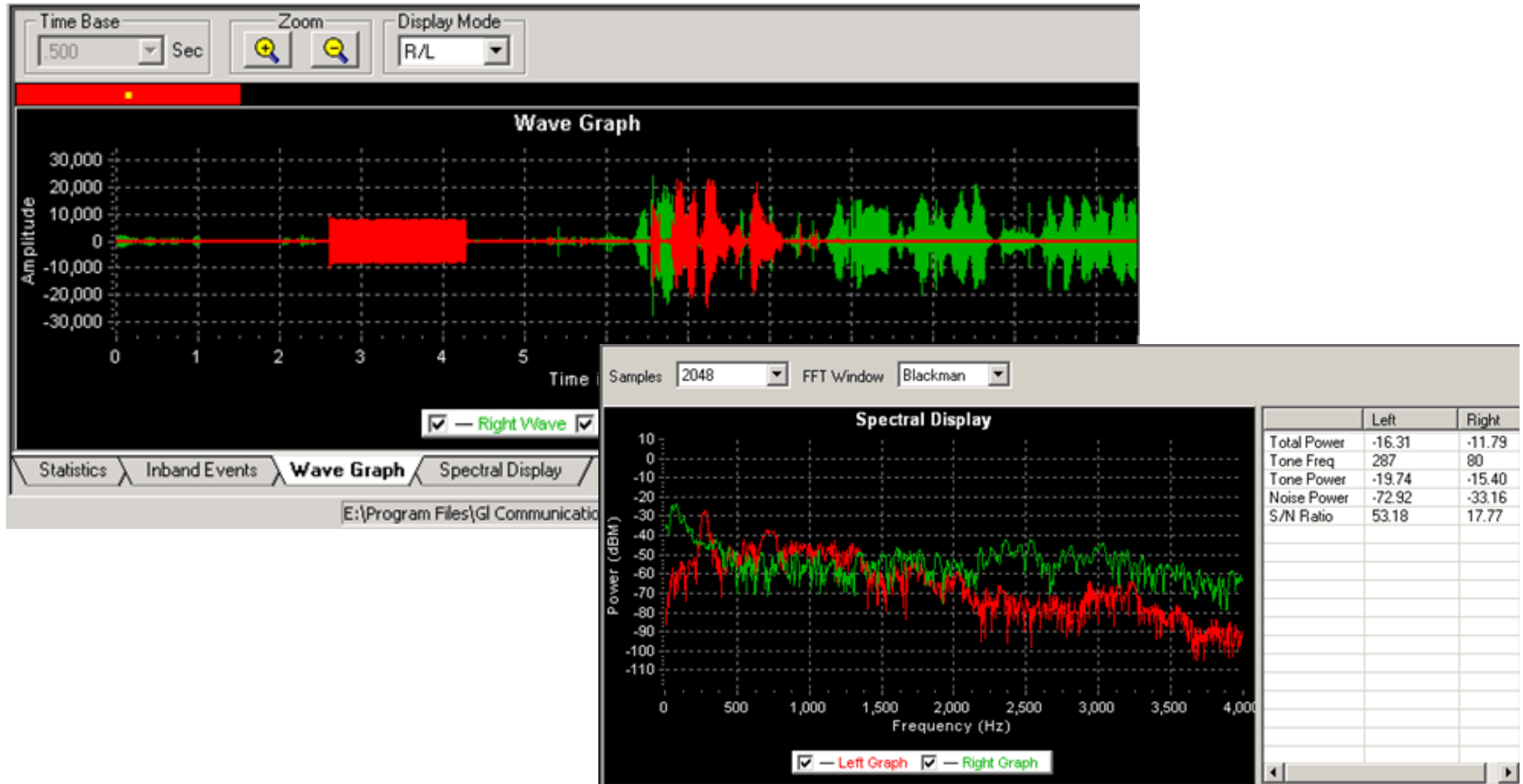
☐ Export Headers

Select All

Export

Exit

Wave Graph and Spectral Display



Statistics and Inband Events

TimeStamp	Type	Event	On	Power	Freq1
00:00:01.881	UNSPEC...	Undefined...	12	-19.57	1647.
00:00:01.892	IDLE		2	0.00	
00:00:01.894	UNSPEC...	Undefined...	52	-19.67	1716.
00:00:01.945	IDLE		0	0.00	
00:00:01.946	UNSPEC...	Undefined...	8	-26.50	1685.
00:00:01.953	IDLE		144	0.00	
00:00:02.097	UNSPEC...	Undefined...	35	-21.49	335/-
00:00:02.133	IDLE		72	0.00	
00:00:02.205	UNSPEC...	Undefined...	43	-20.90	374/-
00:00:02.248	IDLE		87	0.00	
00:00:02.335	UNSPEC...	Undefined...	112	-17.25	0/0.0
00:00:02.446	IDLE		99	0.00	
00:00:02.545	UNSPEC...	Undefined...	4	-23.70	0/0.0
00:00:02.549	IDLE		4	0.00	
00:00:02.553	UNSPEC...	Undefined...	4	-21.81	573/-
00:00:02.556	IDLE		4	0.00	
00:00:02.561	UNSPEC...	Undefined...	4	-24.18	0/0.0
00:00:02.565	IDLE		117	0.00	

Heading	Value
Total Trau packets	14852
Codec Type	GSM610
CRC Error Frames Count	0
Bad Frames Count	0

Statistics
Inband Events
Wave Graph
Spectral Display

Online...

Trigger and Action Settings

- Sets the triggers based on TRAU codec type, CRC errors, and bad frames
- Action criteria for the respective triggers includes saving to *.hdl file, record the call to a file

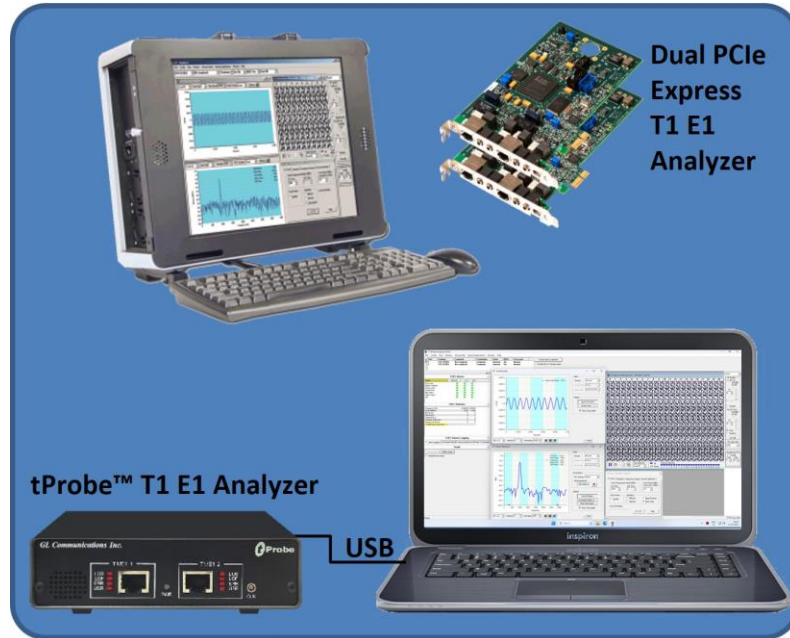
The screenshot shows the 'Triggers and Action Settings' dialog box. It is organized into several functional areas:

- Trigger List:** A list box containing 'Test1' with a checked checkbox.
- Filter Selection:** A tree view where 'TRAU' is expanded, showing sub-items: 'Codec Type' (checked with a red checkmark), '% of CRC Errors', and '% of Bad Frames'.
- Enter Trigger Name:** A text input field containing 'Test1'.
- Enter String Value:** A text input field containing 'GSM610'.
- Conditions:** Radio buttons for 'And' and 'Or', with 'Or' selected.
- Action:** Checkboxes for 'Save Call to HDL' and 'Audio Recording', both of which are checked.
- Audio Recording Options:**
 - Audio File Name Mask:** A text field with the mask '%l_%Y_%M_%D_%h-%m-%s.wav'.
 - Audio Files Destination Directory:** A text field showing 'D:\Program Files\GI Communications I' with a folder selection icon.
- Audio Mixing Options:** Radio buttons for 'Mix' (selected), 'Stereo', and 'To Separate Wave File'.
- Create File Options -- If File Exists:** Radio buttons for 'Overwrite' (selected), 'Skip Operation', and 'Append Sequence Number'.

At the bottom of the dialog are 'Ok' and 'Cancel' buttons.

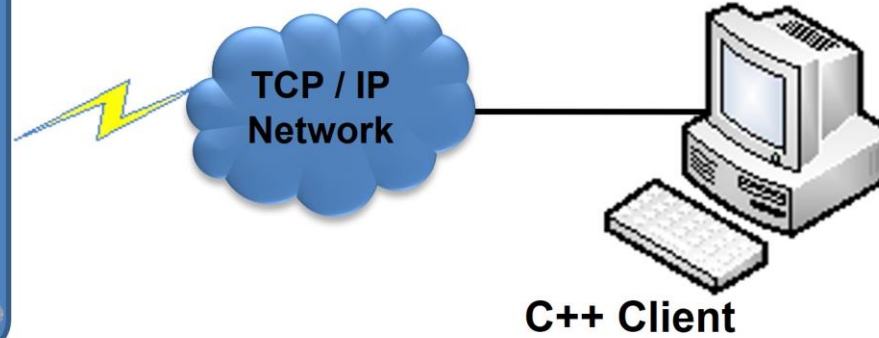
TRAU Emulation and Analysis using Windows Client Server

GL's T1 E1 Server



Supported Platforms-

- Dual T1 E1 Express (PCIe) Cards
- tProbe™ T1 E1 Analyzer



GL's TRAU Tx/Rx
Test Application

Features

Remote operation	✓
Automation	✓
Multi-site connectivity	✓
Simultaneous testing of high capacity T1 E1 systems through a single Client	✓
Integration of T1 E1 testing into more complex testing systems	✓
Intrusive / Non-Intrusive T1 E1 Testing	✓

- Allows traffic generation and verification over TRAU links using client-server technology, which may be accessed through GUI or through command line scripts
- Client-server based TRAU Emulation applications includes -
 - WCS TRAU Tx/Rx Test (GUI as well as Command Line based)
 - Send / Receive TRAU frames with or without impairments using sequential numbers, hex octet pattern, flat binary file data, and *.hdl file formats
 - Time alignment can be applied to the specified TRAU frames with specified interval
 - File based TRAU Record/Playback (Command Line based)
 - Receives and transmits TRAU frames in .HDL file format located on the server

WCS TRAU Tx/Rx Test

WCS TRAU Emulator - AMR_16kbps_4

File Action Help

Icons: Folder, Save, Help, Error

Sl no	Xn Rate	Device No	Channel No	Sub Channel	Direction	Codec Type	Status
0	16kbps	1	1	1-2	UpLink	AMR	Stop
1	16kbps	1	2	1-2	UpLink	AMR	Stop
2	16kbps	2	1	1-2	DownLink	AMR	Stop
3	16kbps	2	2	1-2	DownLink	AMR	Stop

Add Delete Start Stop

TimeAlignment Impairment TxRx Verification

TX params

Source Type: SEQNUM

Source Parameters

Order: MSB Length: 4

Start: 0 Increment: 1

Duration Spec

☒ Continuous transmission

☐ Limited frames: 100

☐ EOF

Start Tx

RX params

Sink Type: SEQNUM

Sink Parameters

Order: MSB Length: 4

Start: 0 Increment: 1

Duration Spec

☒ Continuous Reception

☐ Limited frames: 100

☐ EOF

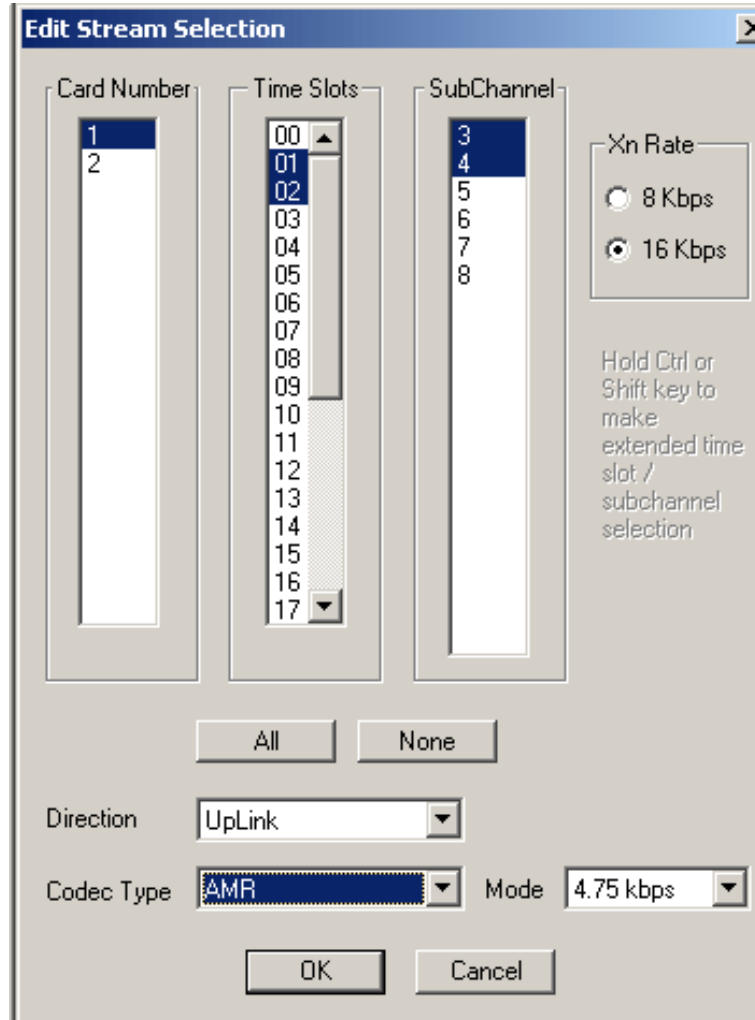
Start Rx

Key Features

- Simulates TRAU traffic over Abis and Ater interfaces
- Can be used to test the backhaul network
- Time Alignment can be applied in the TRAU frames
- Payload traffic generation and verification
- Supports various impairments - CRC error, frame duplication, and more
- Provides detailed test (Tx/Rx) results for each TRAU link
- Ideal solution for automated testing using command line scripts

Adding Sessions

- Various TRAU session of 8 or 16 Kbps transmission rate can be added to a stream
- Streams can be formed with contiguous or non-contiguous timeslots, hyper-channels, various codecs, and uplink or downlink directions



The 'Edit Stream Selection' dialog box is used for configuring stream parameters. It features three vertical list boxes for 'Card Number' (showing 1, 2), 'Time Slots' (showing 00 to 17), and 'SubChannel' (showing 3, 4, 5, 6, 7, 8). To the right, the 'Xn Rate' is set to 16 Kbps (selected) or 8 Kbps. A note indicates that holding Ctrl or Shift allows for extended selections. At the bottom, there are buttons for 'All' and 'None', a 'Direction' dropdown set to 'UpLink', a 'Codec Type' dropdown set to 'AMR', a 'Mode' dropdown set to '4.75 kbps', and 'OK' and 'Cancel' buttons.

Card Number	Time Slots	SubChannel
1	00	3
2	01	4
	02	5
	03	6
	04	7
	05	8
	06	
	07	
	08	
	09	
	10	
	11	
	12	
	13	
	14	
	15	
	16	
	17	

Xn Rate
☐ 8 Kbps
☒ 16 Kbps

Hold Ctrl or Shift key to make extended time slot / subchannel selection

All None

Direction: UpLink

Codec Type: AMR Mode: 4.75 kbps

OK Cancel

Traffic Generation and Reception

Action | TimeAlignment | Impairment | TxRx Verification

TX params

Source Type SEQNUM

Source Parameters

Order MSB Length 4

Start 0 Increment 1

Duration Spec

☒ Continuous transmission

☐ Limited frames 100

☐ EOF

Start Tx

RX params

Sink Type SEQNUM

Sink Parameters

Order MSB Length 4

Start 0 Increment 1

Duration Spec

☒ Continuous Reception

☐ Limited frames 100

☐ EOF

Start Rx

Traffic Generation and Reception

- Traffic is generated and received on the individual TRAU Session
- Tx parameters are used to generate traffic , while Rx parameters are used as reference to verify the received frames
- Permits transmission and reception of following source / sink types:
 - Sequence numbers (1,2,4 or 8 least significant byte first (LSB) or most significant byte first (MSB)) with configurable start sequence numbers and increments
 - User defined HEX string frame, which is ASCII based. Can be edited, loaded and saved
 - Binary flat files that allows user to provide any random data
 - GL *.HDL trace file is GL's packet file format which can be constructed pre-hand or captured using TRAU Analyzer

Impairment

- Various impairments can be introduced to a TRAU stream before frames are transmitted or during traffic generation
- TRAU frames can be impaired either limitedly or continuously
- Impairment types include CRC error, Sync error, Frame duplication, and Bitwise AND/OR/XOR

The screenshot shows a software window for configuring impairments. It features several sections:

- Enable:** A checked checkbox.
- Impairment Duration:** A section containing two radio buttons: "Repeat" (unselected) and "Continuous" (selected). The "Repeat" option has a text box with the value "1".
- Skip:** A text box containing the value "10".
- OFFS:** A checked checkbox followed by a text box containing the value "5".
- Impairment Type:** A dropdown menu currently showing "AND". Below it is an "Apply" button.
- Options:** A sub-section containing a text box labeled "AND with" which contains the value "01".

The interface is designed with a light gray background and standard Windows-style controls.

Time Alignment

- Time alignment can be applied to the specified TRAU frames with specified interval
- Delays / advances the TRAU frames by specified value in msec/uSec

The screenshot shows a software window titled "TimeAlignment" with four tabs: "Action", "TimeAlignment", "Impairment", and "TxRx Verification". The "TimeAlignment" tab is active. Inside the window, there is a "TA type" dropdown menu set to "XT". Below this is a "TA Sequence" section containing a "Delay/Advance" sub-section with two spinners: "10 msec" and "0 usec". To the right of these are two buttons, ">>" and "<<". Further right is a large text box displaying "10.000 msec". Below the "TA Sequence" section, there are two more input fields: "Interval for every TA" set to "10 frames" and "Repeat Sequence" set to "2 times". At the bottom of the window, there are two buttons: "Transmit Frame with TA Delay/Advance" and "Apply".

Data Verification

- Traffic verification provides the overall statistics for all TRAU sessions
- Displays number of Transmitted, Received, Matched, Modified, and Inserted frames

Action

TimeAlignment

Impairment

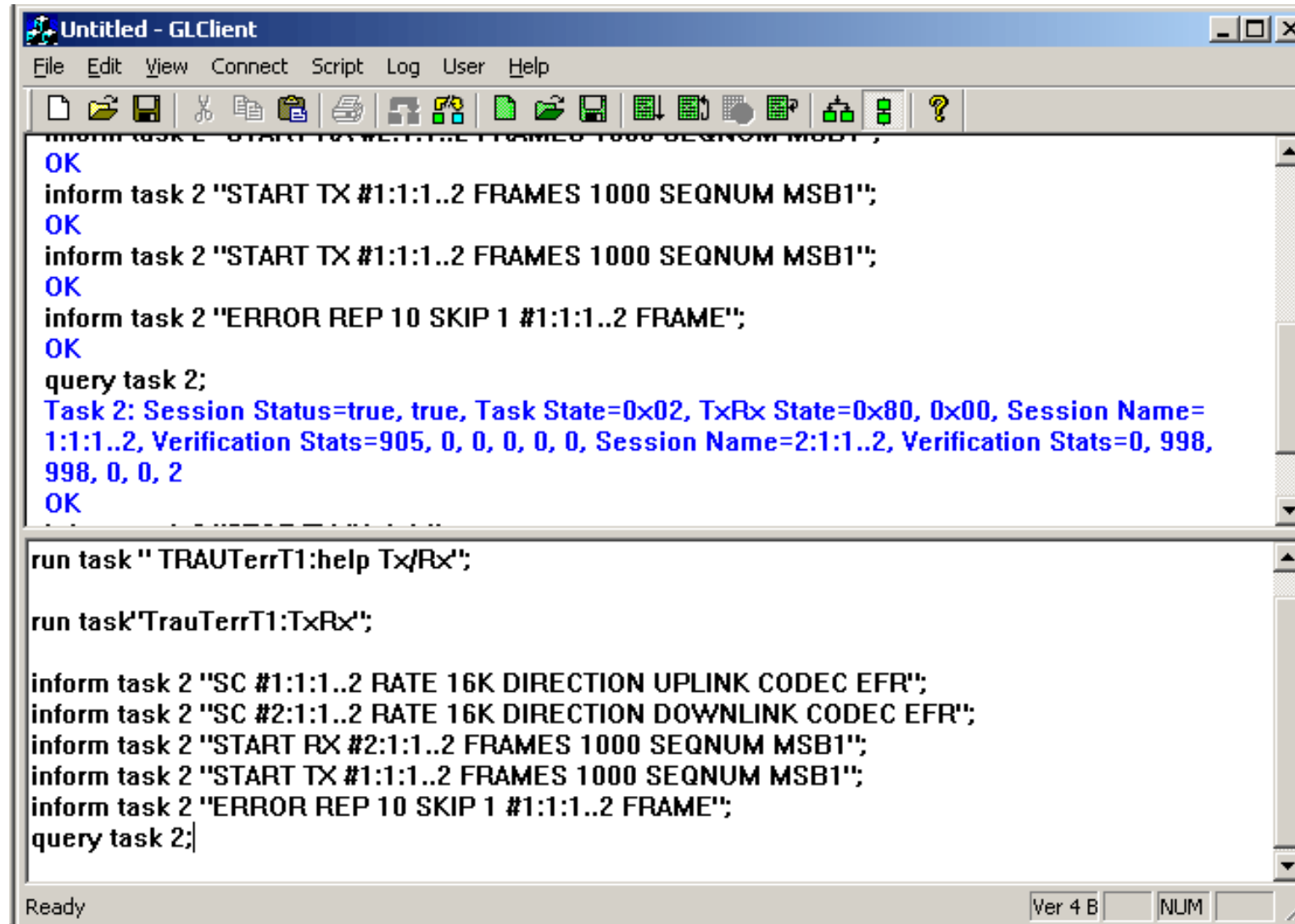
TxRx Verification

Reset

Link Na...	Transmitted Fra...	Received Frame...	Matched Frame ...	Modified Frame ...	Inserted Frame ...	Deleted Frame Cnt
#1:1:1-2	10650	10303	10300	0	0	2
#1:2:1-2	100	98	98	0	0	2
#2:1:1-2	10440	10296	10249	0	0	5
#2:2:1-2	100	98	98	0	0	2
Total	21290	20795	20745	0	0	11

TRAU Tx/Rx Command Line Based

- Sample script performing TRAU emulation using client-server



The screenshot shows a window titled "Untitled - GLClient" with a menu bar (File, Edit, View, Connect, Script, Log, User, Help) and a toolbar. The main text area contains a script for TRAU emulation. The script includes several "OK" responses, "inform task 2" commands for starting transmission (TX) and reception (RX) with specific parameters, and a "query task 2;" command. The status bar at the bottom indicates "Ready" and "Ver 4 B".

```
OK
inform task 2 "START TX #1:1:1..2 FRAMES 1000 SEQNUM MSB1";
OK
inform task 2 "START TX #1:1:1..2 FRAMES 1000 SEQNUM MSB1";
OK
inform task 2 "ERROR REP 10 SKIP 1 #1:1:1..2 FRAME";
OK
query task 2;
Task 2: Session Status=true, true, Task State=0x02, TxRx State=0x80, 0x00, Session Name=
1:1:1..2, Verification Stats=905, 0, 0, 0, 0, 0, Session Name=2:1:1..2, Verification Stats=0, 998,
998, 0, 0, 2
OK

run task " TRAUTerrT1:help Tx/Rx";

run task "TrauTerrT1:TxRx";

inform task 2 "SC #1:1:1..2 RATE 16K DIRECTION UPLINK CODEC EFR";
inform task 2 "SC #2:1:1..2 RATE 16K DIRECTION DOWNLINK CODEC EFR";
inform task 2 "START RX #2:1:1..2 FRAMES 1000 SEQNUM MSB1";
inform task 2 "START TX #1:1:1..2 FRAMES 1000 SEQNUM MSB1";
inform task 2 "ERROR REP 10 SKIP 1 #1:1:1..2 FRAME";
query task 2;
```

TRAU Tx/Rx Command Line Based

- Sends and receives TRAU frames (with or without impairments) based on the codec type, and time alignment, and logs the events

Example –

```
run task "TRAUTerrE1:TxRx";  
inform task 1 "SC #1:1:1..2 RATE 16K DIRECTION UPLINK CODEC EFR";  
inform task 1 "SC #2:1:1..2 RATE 16K DIRECTION DOWNLINK CODEC EFR";  
inform task 1 "START RX #2:1:1..2 FRAMES 1000 SEQNUM MSB1";  
inform task 1 "START TX #1:1:1..2 FRAMES 1000 SEQNUM MSB1";  
inform task 1 "ERROR REP 8 SKIP 5 #1:1:1..2 DUP 10";  
inform task 1 "TA CONT INTERVAL 10 #1:1:1..2 XT -1";
```

File based TRAU Record/Playback

- Sample Script performing TRAU record / playback and analysis using TRAU analyzer

The screenshot displays two windows from the GL Communications suite. The 'E1_Trau wcs scripts.gls - GLClient' window shows a script being executed, with status messages indicating connection to a GL Server and the start/termination of Task 3. The script includes commands for transmitting and receiving TRAU frames. The 'TRAU Protocol Analysis TRAU' window provides a detailed view of the captured TRAU frames, including a table of frame data and a hex dump of the frame data for frame 192.

E1_Trau wcs scripts.gls - GLClient

File Edit View Connect Script Log User Help

Connected to GL Server on 'harsha'

run task "TrauFuncE1:TxFFile" using " 'Trau\AMR

Task 3: Task 3 started

Task 3: Task 3 terminated

//Transmit trau frames from AMR_Cisco.HDL ov

run task "TrauFuncE1:TxFFile" using " 'Trau\AMR

//Receive trau frames to Rx.hdl file in port-2 TS-1

run task "TrauFuncE1:RxFile" using " 'Trau\Rx.h

UPLINK" #2:1;

Ready

TRAU Protocol Analysis TRAU

File View Capture Statistics Database Configure Help

Dev	TS...	Su...	Frame#	TIME (Difference)	Len	Error	TRAU F...	TRAU F...	Fra...	Spe...	Tim...	CRC	RIF	AM...
✓ 2	1	1-2	192	00:00:00.020000	40		Uplink (...)	Adaptiv...	Valid	Go...	No...	Vali...	Indi...	Cod...
✓ 2	1	1-2	193	00:00:00.020000	40		Uplink (...)	Adaptiv...	Valid	Go...	No...	Vali...	Indi...	Cod...
✓ 2	1	1-2	194	00:00:00.020000	40		Uplink (...)	Adaptiv...	Valid	Go...	No...	Inv...	Indi...	Cod...
✓ 2	1	1-2	195	00:00:00.020000	40		Uplink (...)	Adaptiv...	Valid	Go...	No...	Inv...	Indi...	Cod...
✓ 2	1	1-2	196	00:00:00.020000	40		Uplink (...)	Adaptiv...	Valid	Go...	No...	Inv...	Indi...	Cod...
✓ 2	1	1-2	197	00:00:00.020000	40		Uplink (...)	Adaptiv...	Valid	Go...	No...	Inv...	Indi...	Cod...
✓ 2	1	1-2	198	00:00:00.020000	40		Uplink (...)	Adaptiv...	Valid	Go...	No...	Inv...	Indi...	Cod...
✓ 2	1	1-2	199	00:00:00.020000	40		Uplink (...)	Adaptiv...	Valid	Go...	No...	Inv...	Indi...	Cod...

Card2 TimeSlot=1 SubChannels=1-2 Frame=192 at 11:29:18.067250 OK Len=40

HDLC Frame Data + FCS

===== TRAU Layer =====

Frame Sync = Valid Frame Sync (00000000000000011111111111111111)

Frame Direction = Uplink (User)

Frame Type (Full Rate, 16kbps, C1-C5) = .00110... Adaptive Multi-Rate Narrow Band Codec (AMR-I)

Time Alignment (C6-C11) for TAC_AMR =00 0000.... No change in frame timing

Req or Ind Flag-RIF (C12) for Uplink =0... Indication (Codec Mode)

Configuration Protocol (C14-C16) =00 .0..... BTS does not support TFO or TFO is

Message No (C17-C18) = ..00.... BTS does not support TFO or TFO is disabled

RTW (in downlink) requested RTW (C19) = ..0... Not requested

Hex Dump of the Frame Data

00 00 98 00 83 BF FF FF FF F5 B8 78 97 E9 C1 FF | |ÿÿÿÿ8,x1éÁÿ

F4 54 C4 39 EE 22 98 B0 91 85 92 46 F2 0A 9C 51 | ðTÀ9i" | Fò IQ

BF FF FF FF FF FF FF FF | ÿÿÿÿÿÿÿÿ

Running. Utilization 0.15% C:\Temp.HDL Captured 200 frames

File Based TRAU Record / Playback

- File based TRAU Record / Playback (Traufunc) module is an command-line based client application used to capture / playback TRAU traffic
- Allows transmission / reception of TRAU frames in *.hdl file format
- Example
 - run task "TrauFuncT(E)1:help" #*;
 - run task "TrauFuncE1:TxFile" using " file.hdl CONT 8K SC:80 " #1:10;
 - run task "TrauFuncE1:RxFile" using "trau.hdl 10000000 CONT 16K SC:FF UPLINK " #1:23;

Thank You!