TRAU Emulation and Analysis

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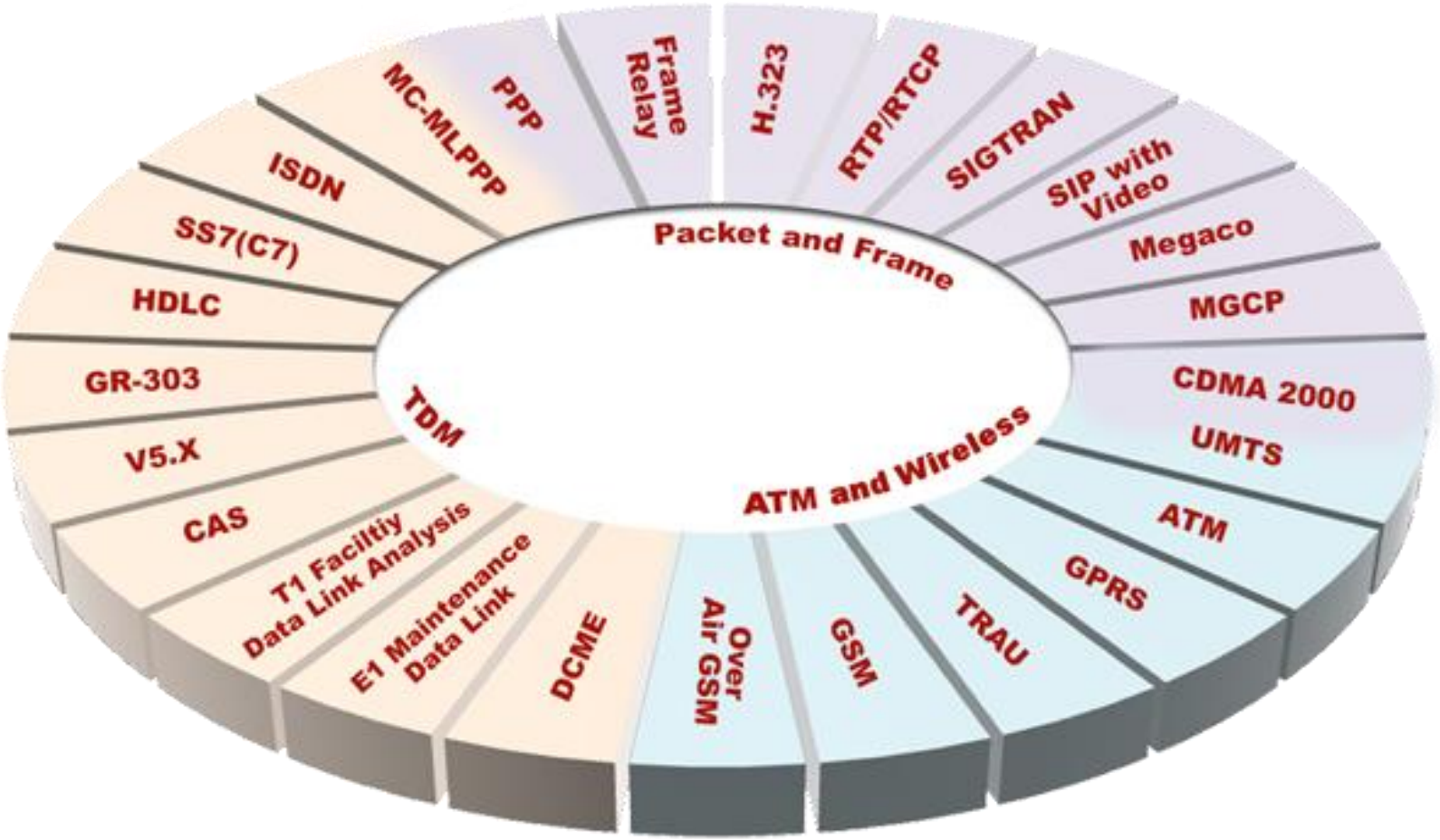
TDM, Wireless, and VoIP Protocol Analysis

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



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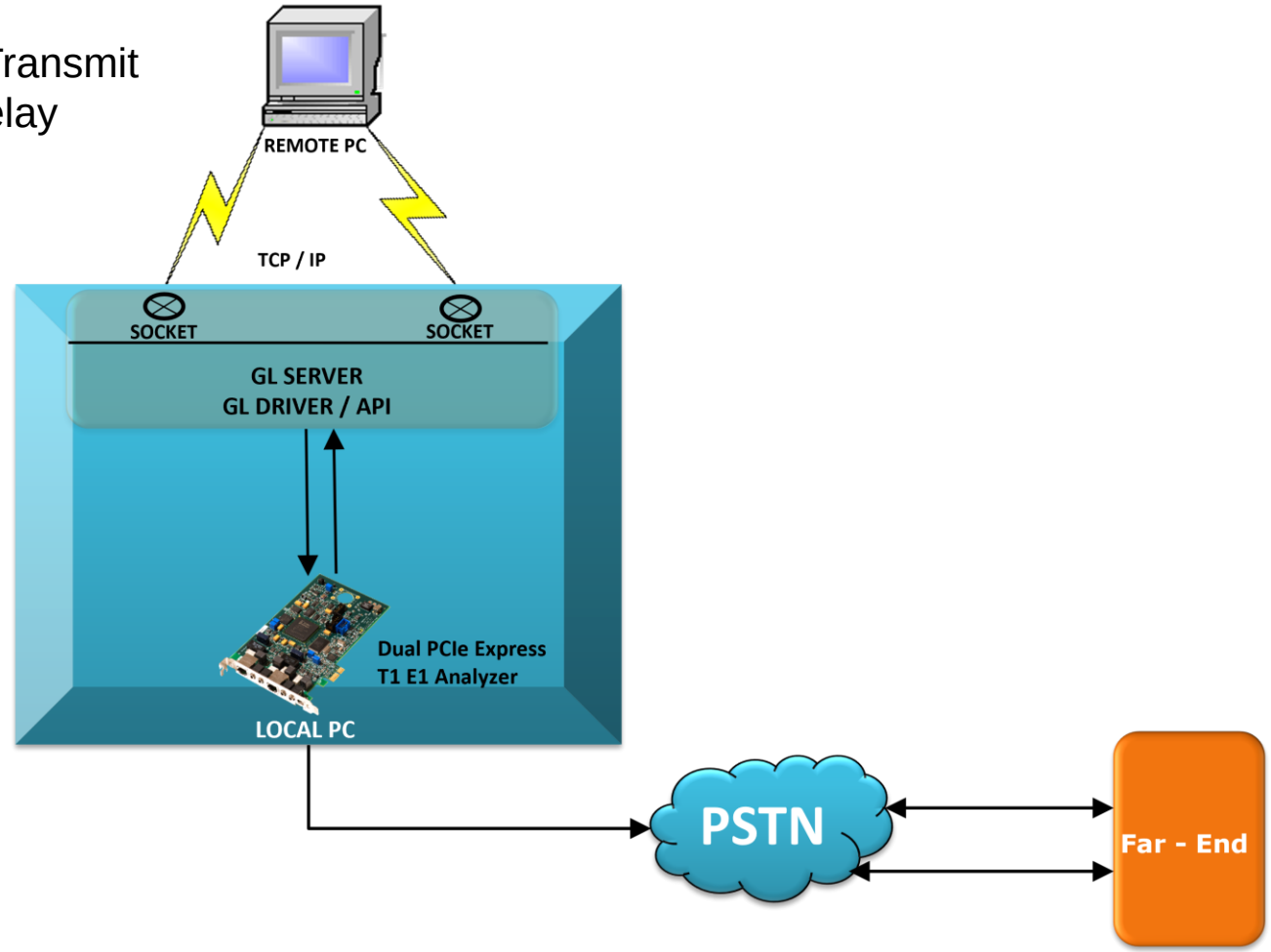
Types of Testing
Intrusive and Non-Intrusive

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

Intrusive Testing



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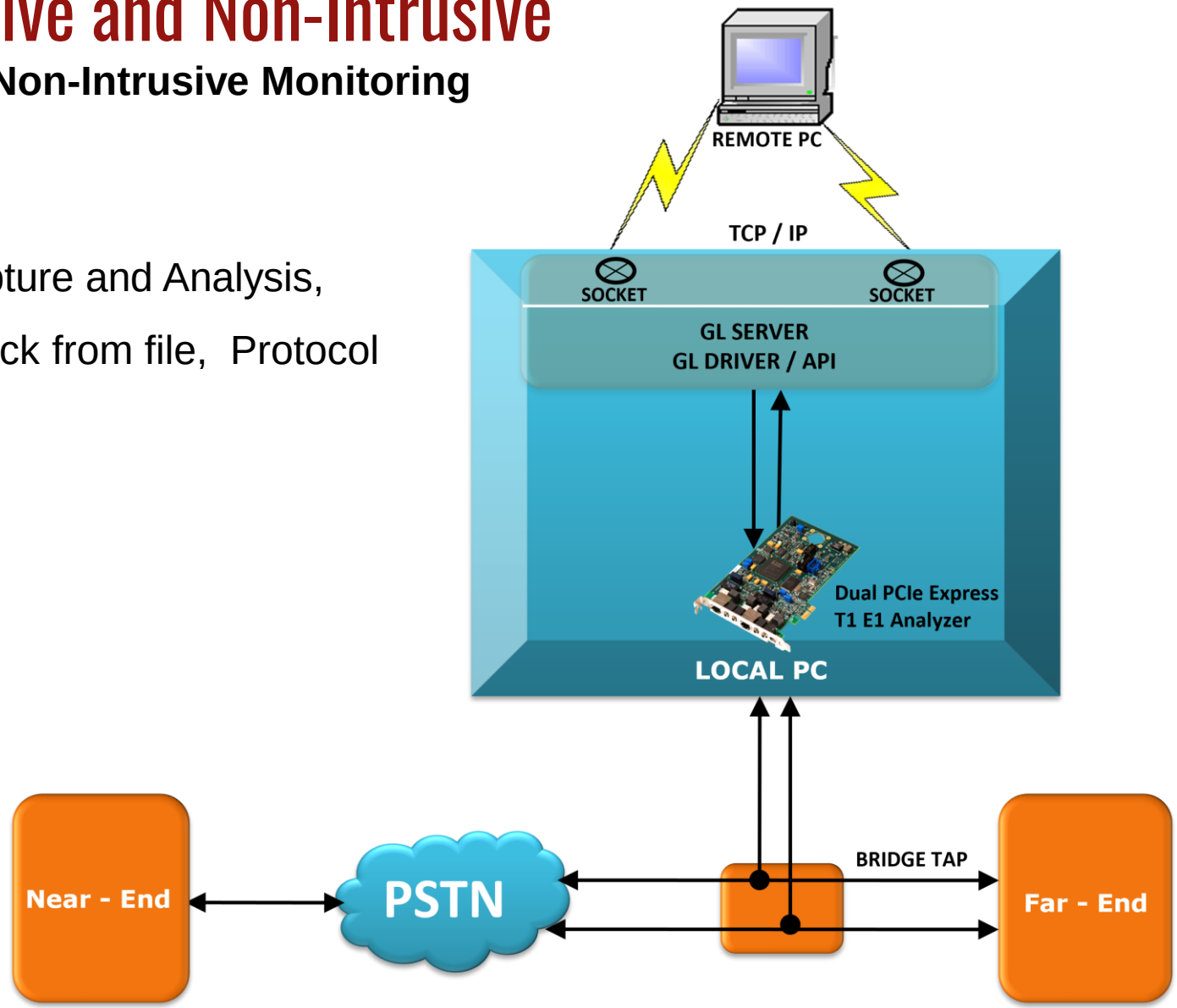
Types of Testing
Intrusive and Non-Intrusive

Non-Intrusive Monitoring

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



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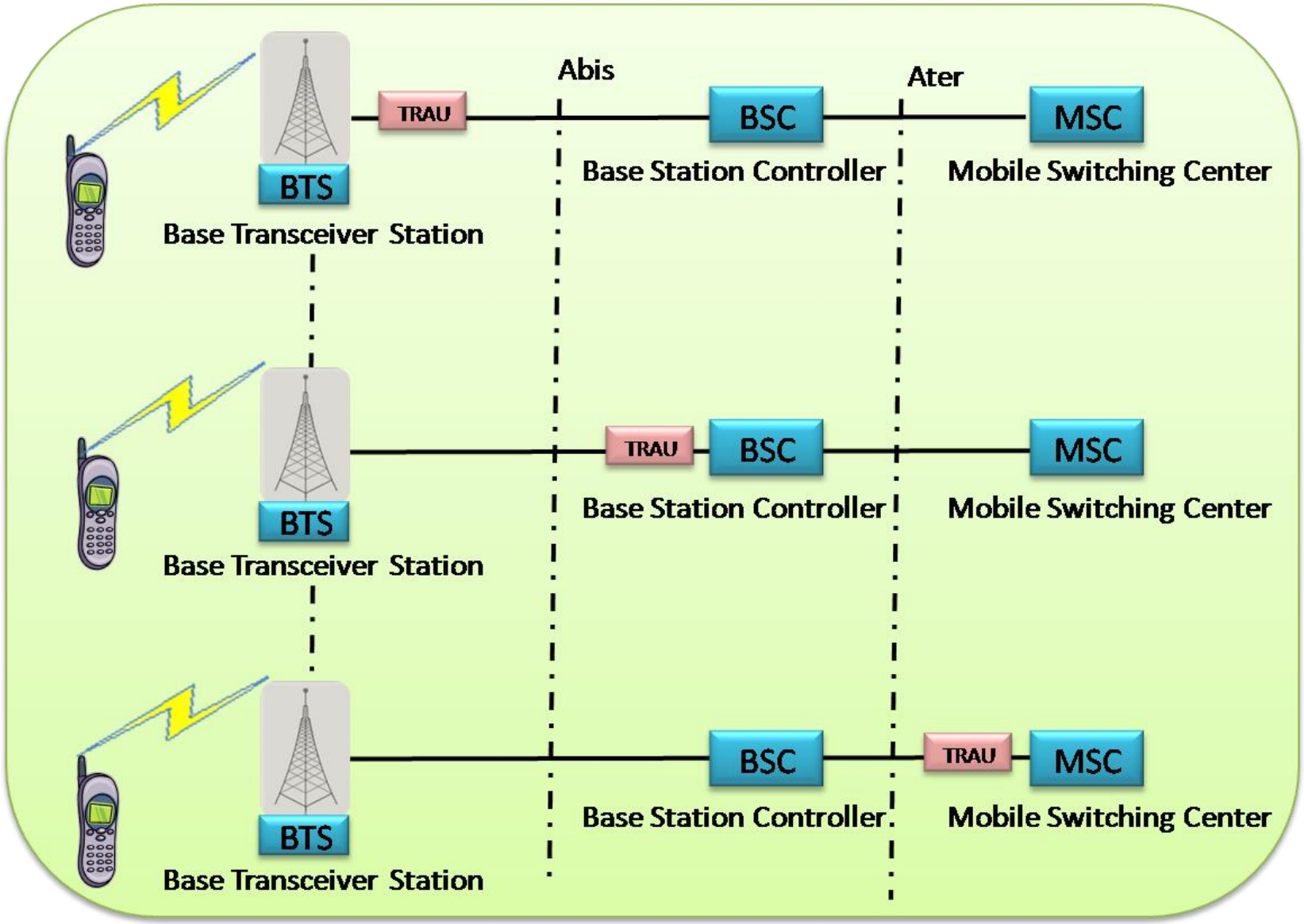
Overview TRAU in Cellular Network



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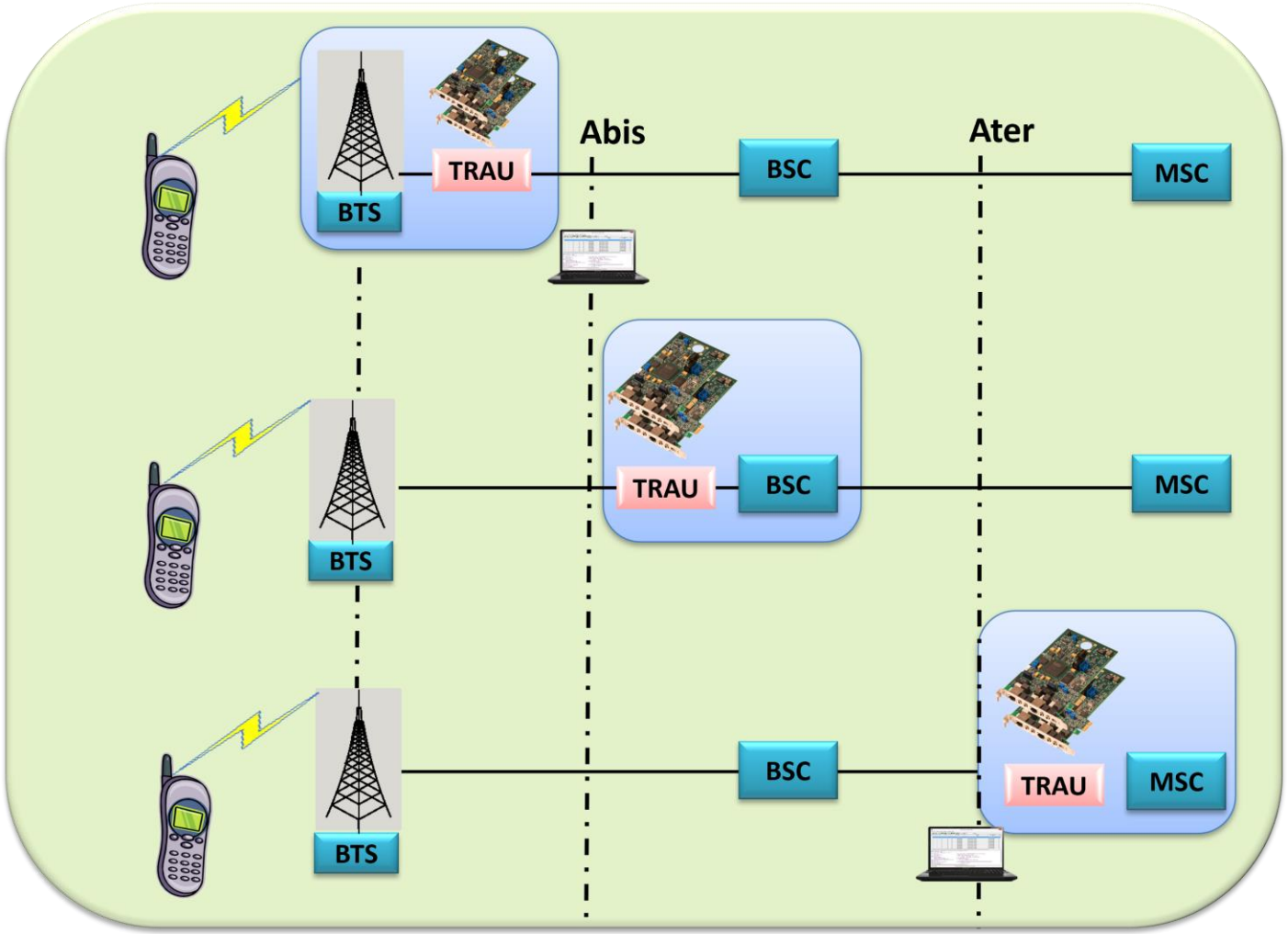
- TRAU (Transcoder/Rate Adaptor Unit) placed between the BTS and BSC/MSC perform compression/decompression of speech channels within the radio cellular network
- TRAU carries speech, data, O&M frames at Full Rate (16Kbps) or Half Rate (8kbps), and control information in a GSM network
- TRAU may be positioned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

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

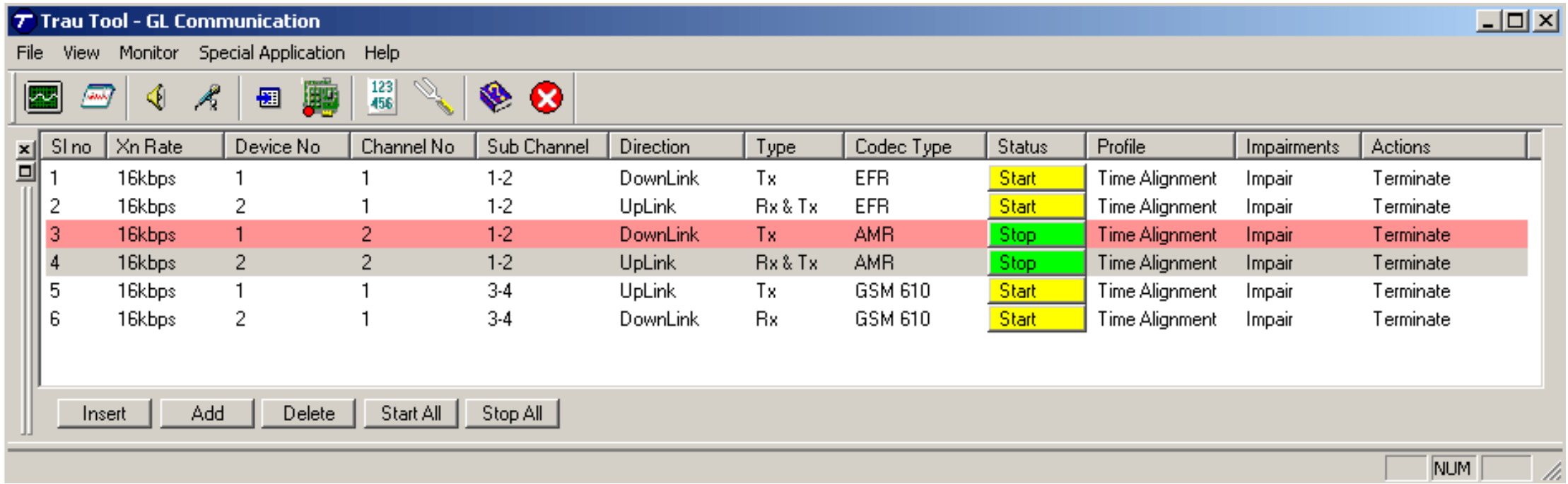
- TRAU ToolBox™: Allows to create, monitor, and terminate multiple TRAU / GSM traffic (TRAU sessions)
- TRAU Traffic Playback : Allows to playback the recorded TRAU file(s) on selected channels
- Automated TRAU Emulation & Analysis (using client-server)
  - File based Record/Playback is a command line-based 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 simulateTRAU / 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™

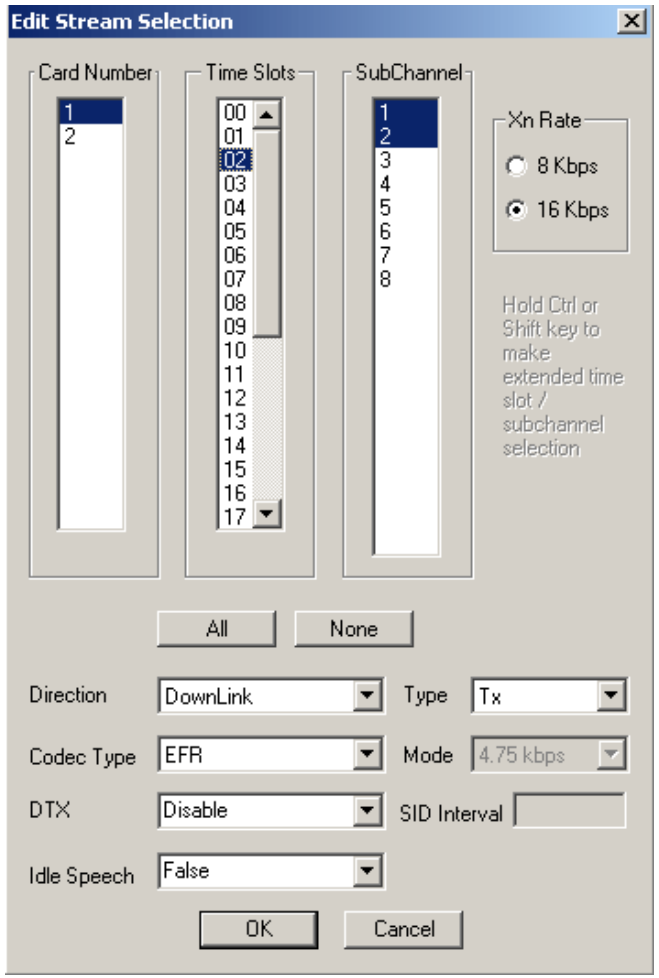
Key Features

- 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)

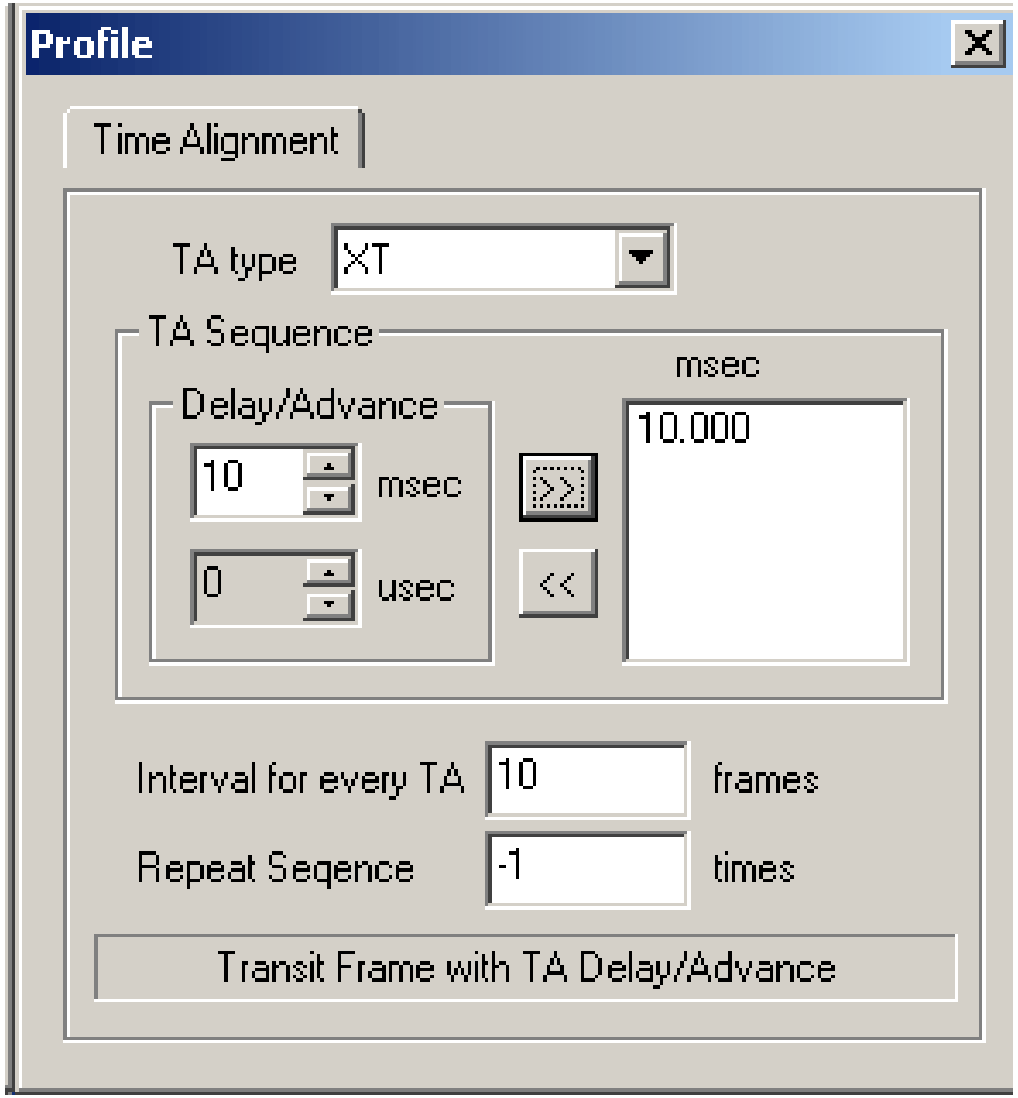


- Selection of contiguous and non-contiguous channels is possible for both 16kbps and 8kbps transmission rates
- Sub-channel selection depending upon the Xn rate
- Work on Transmission (Tx) mode, only Receiving (Rx) mode, or on both Rx & Tx modes



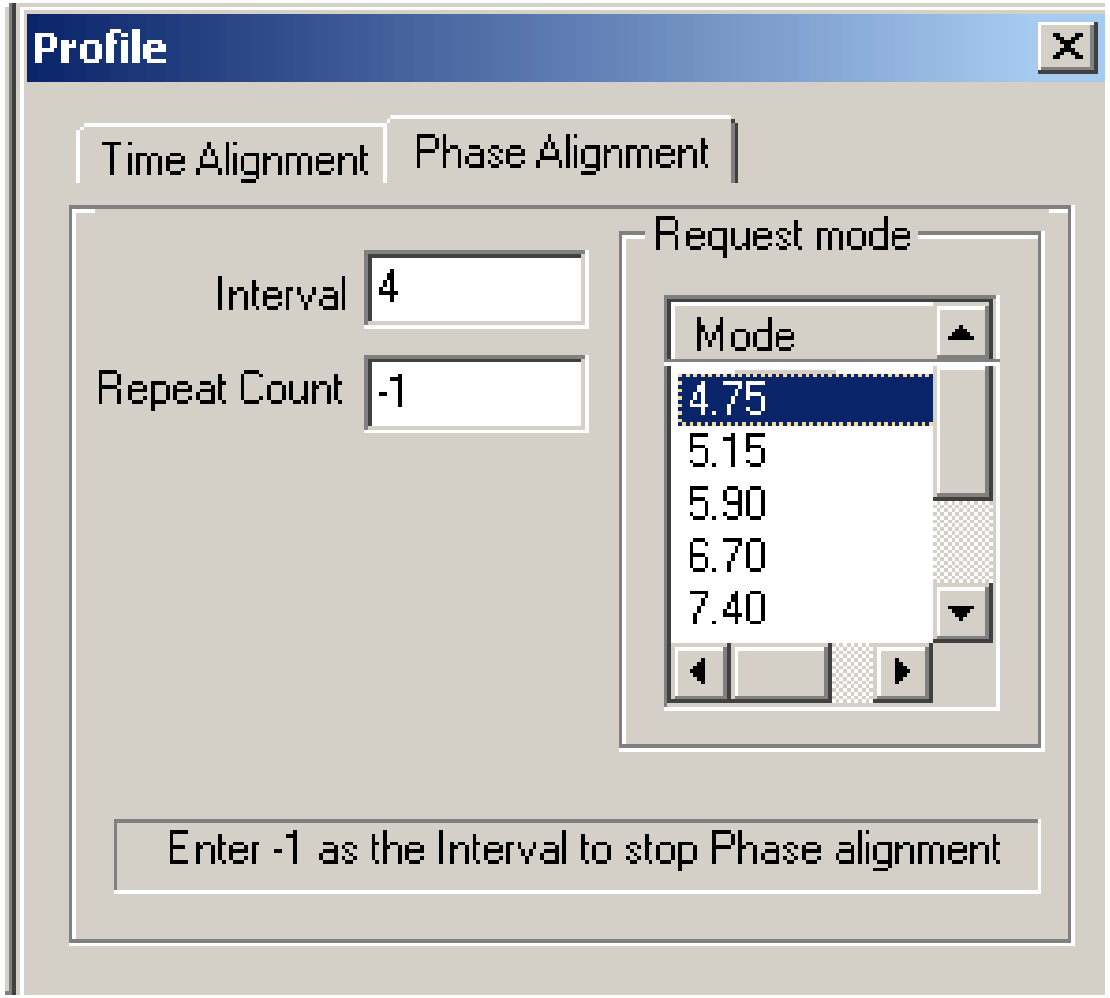
Time Alignment Feature

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



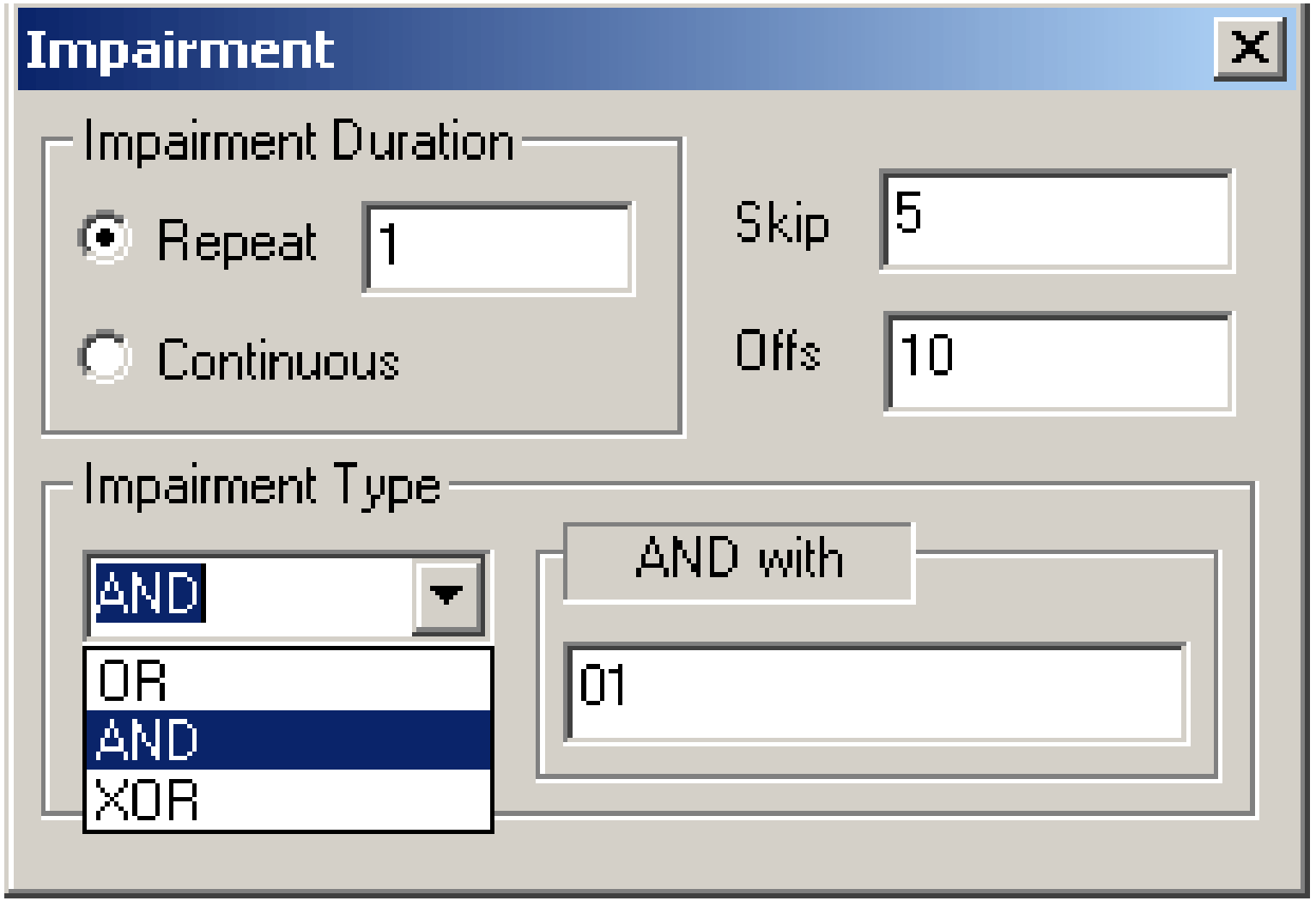
Phase Alignment Feature

- 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



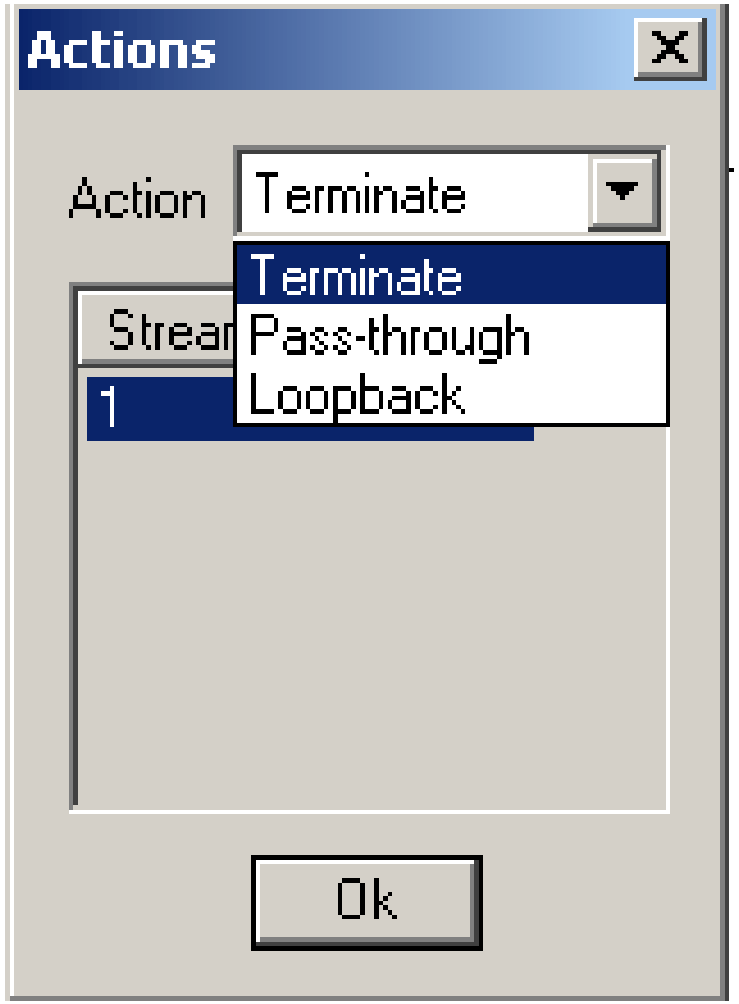
Impairment

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



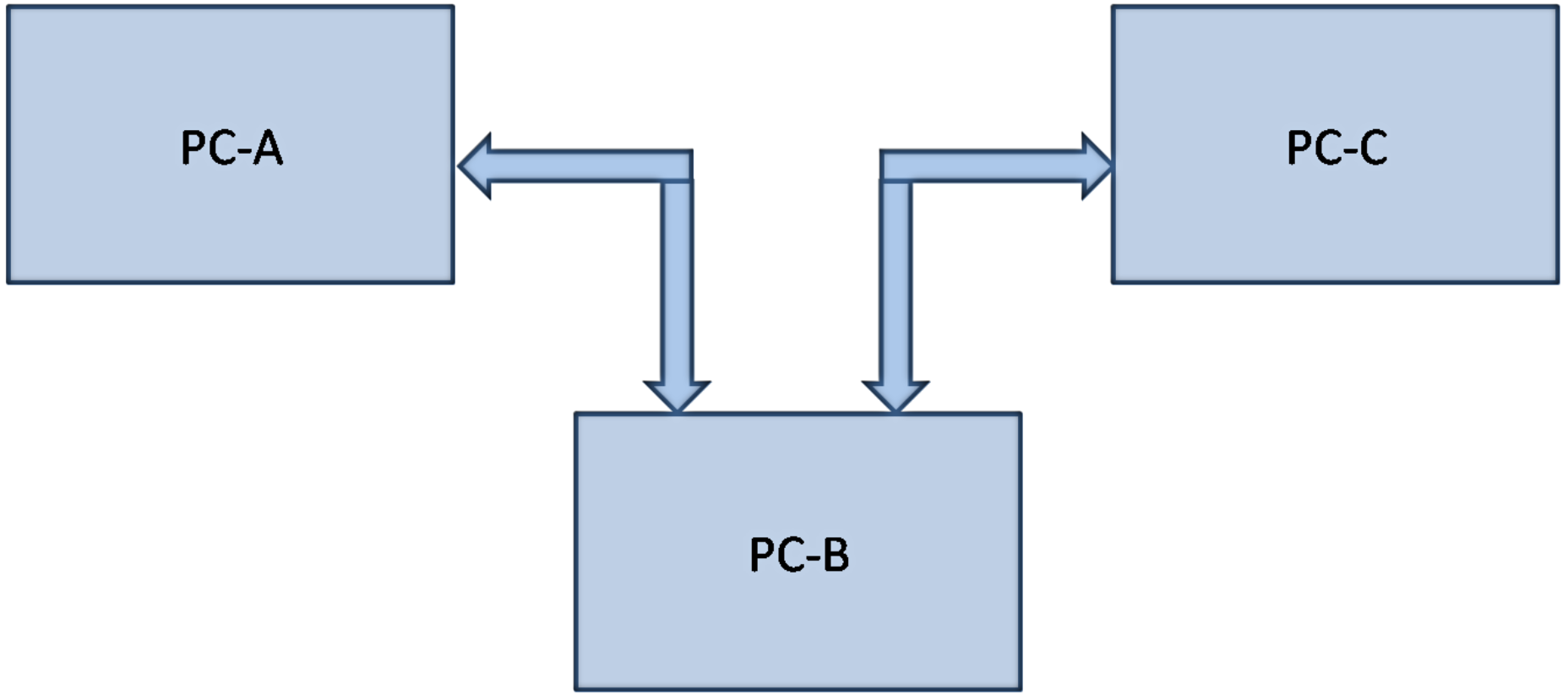
Actions

- Supports Loopback and Pass Through modes



Pass-through Mode

- Sends the received data through some other added stream

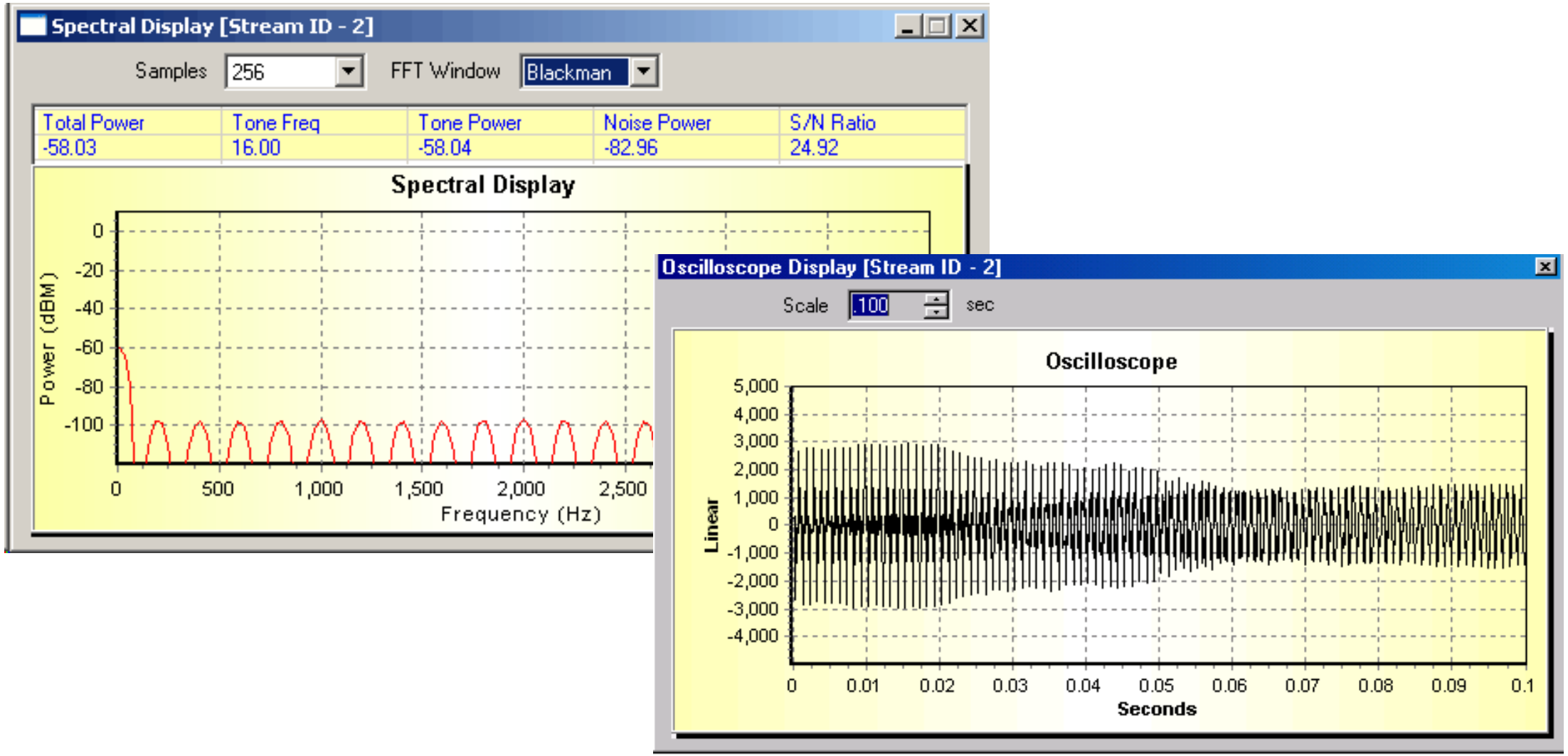


Loopback Mode

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

Monitoring Applications

- Monitor TRAU stream contents using an oscilloscope and spectrum analyzer



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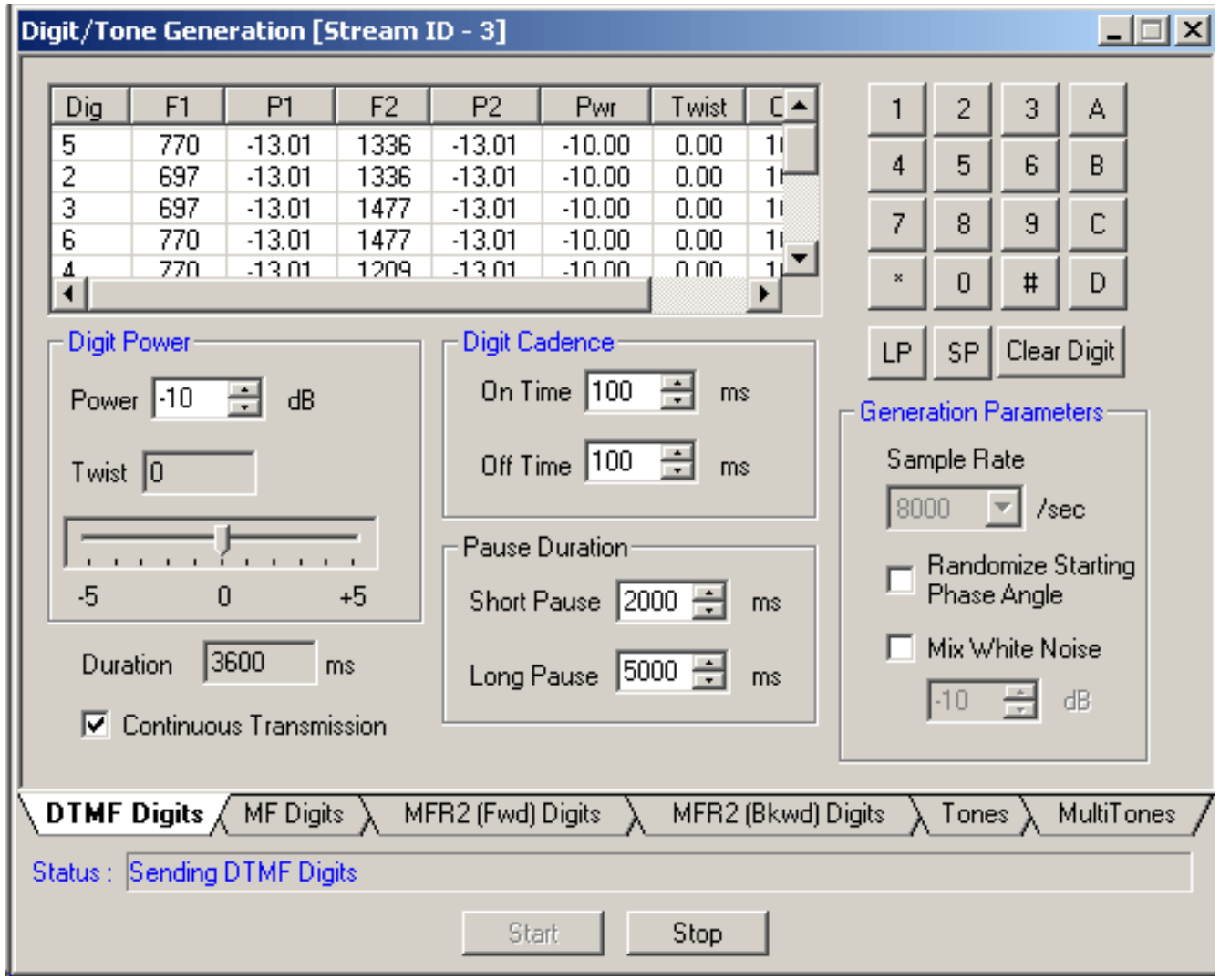
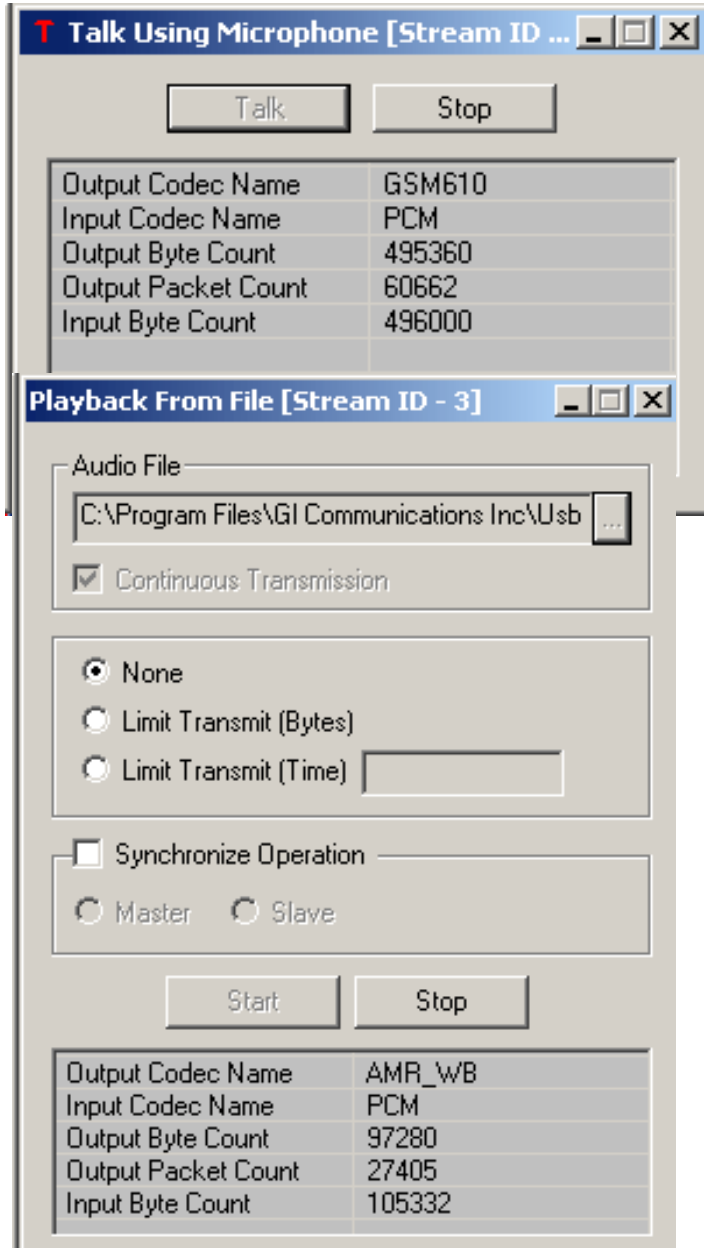
TRAU Traffic Generation

- 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





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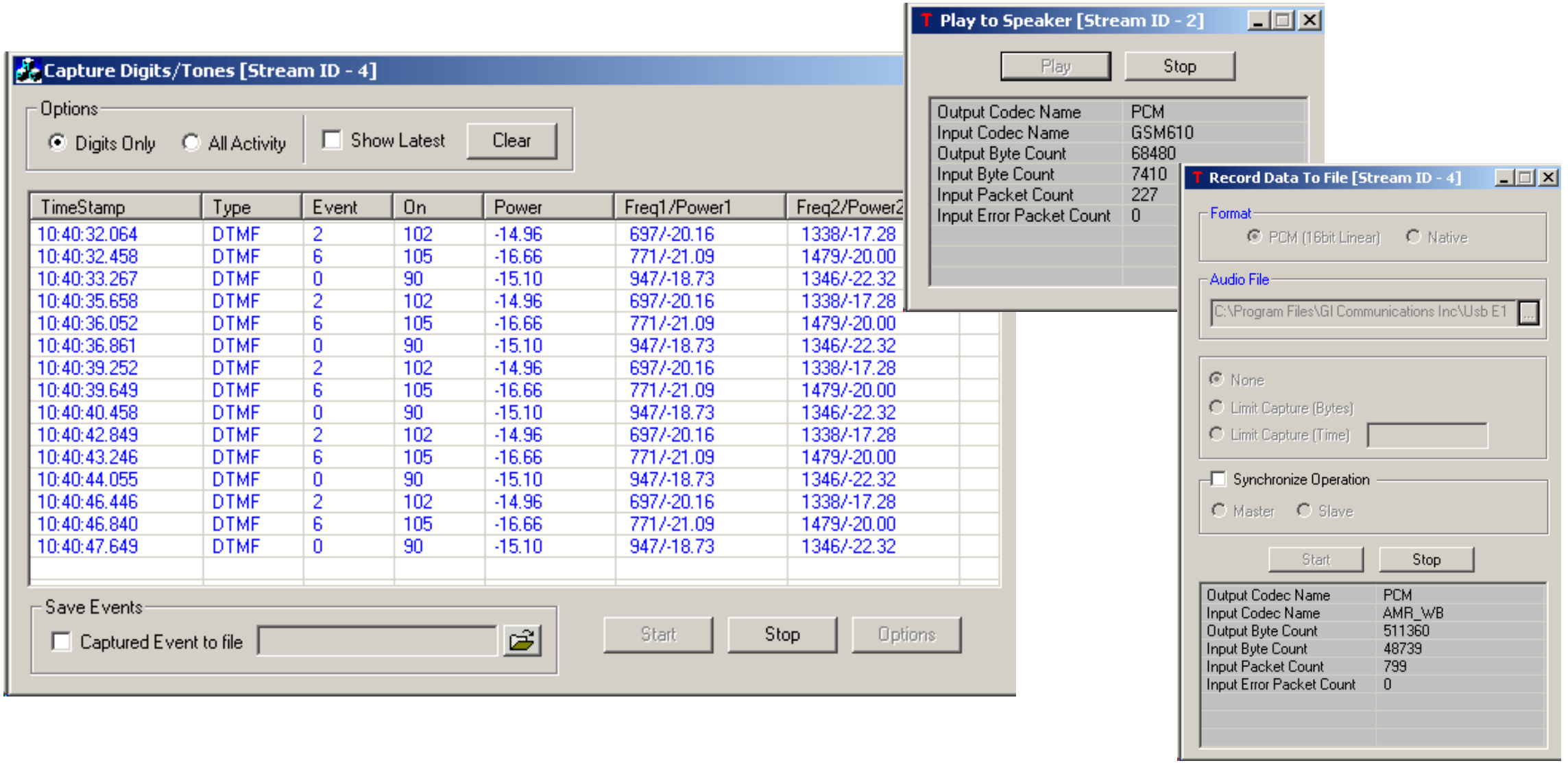
TRAU Traffic Detection

- 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



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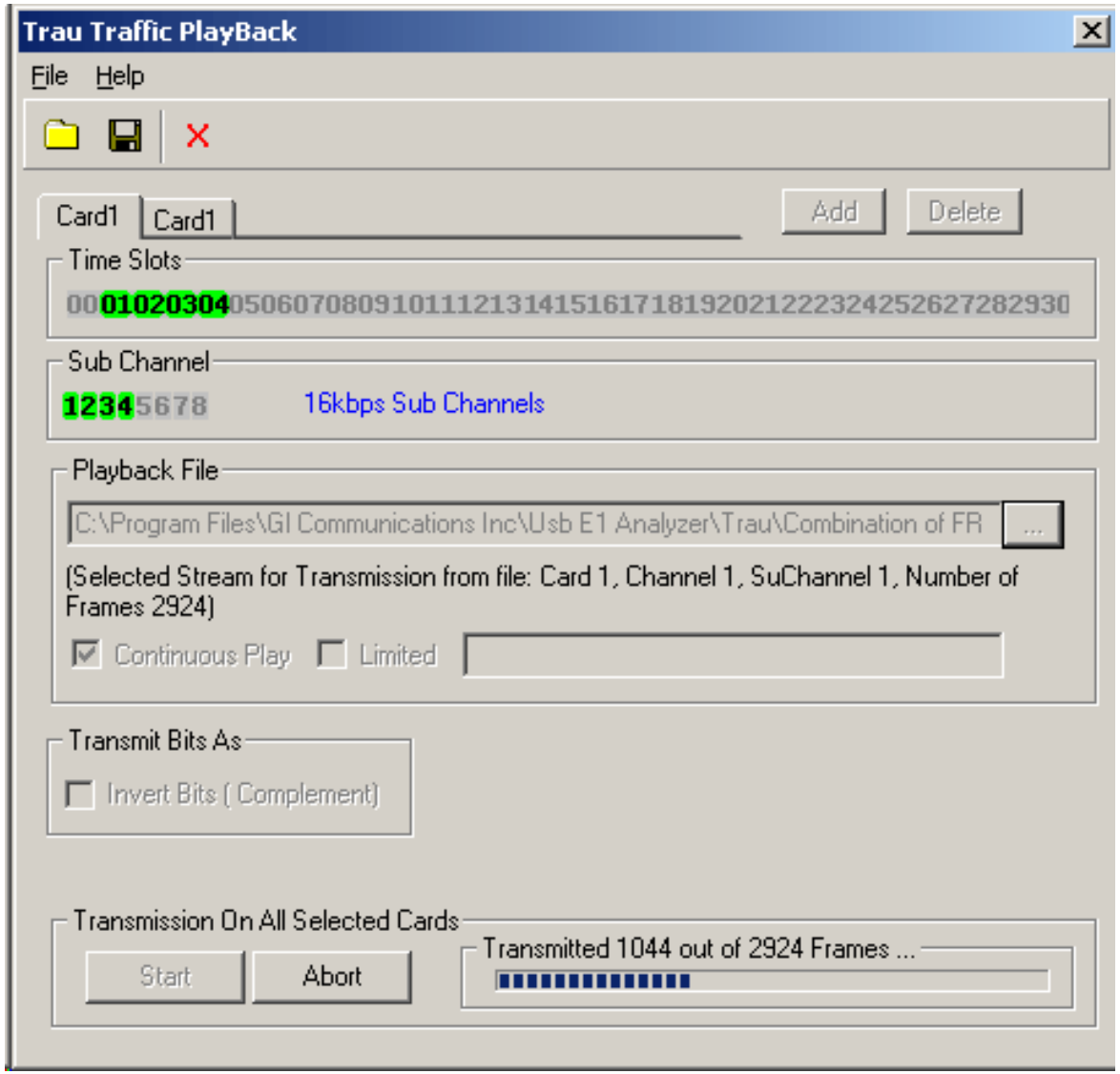
TRAU Traffic Playback

TRAU Traffic Playback

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



Key Features

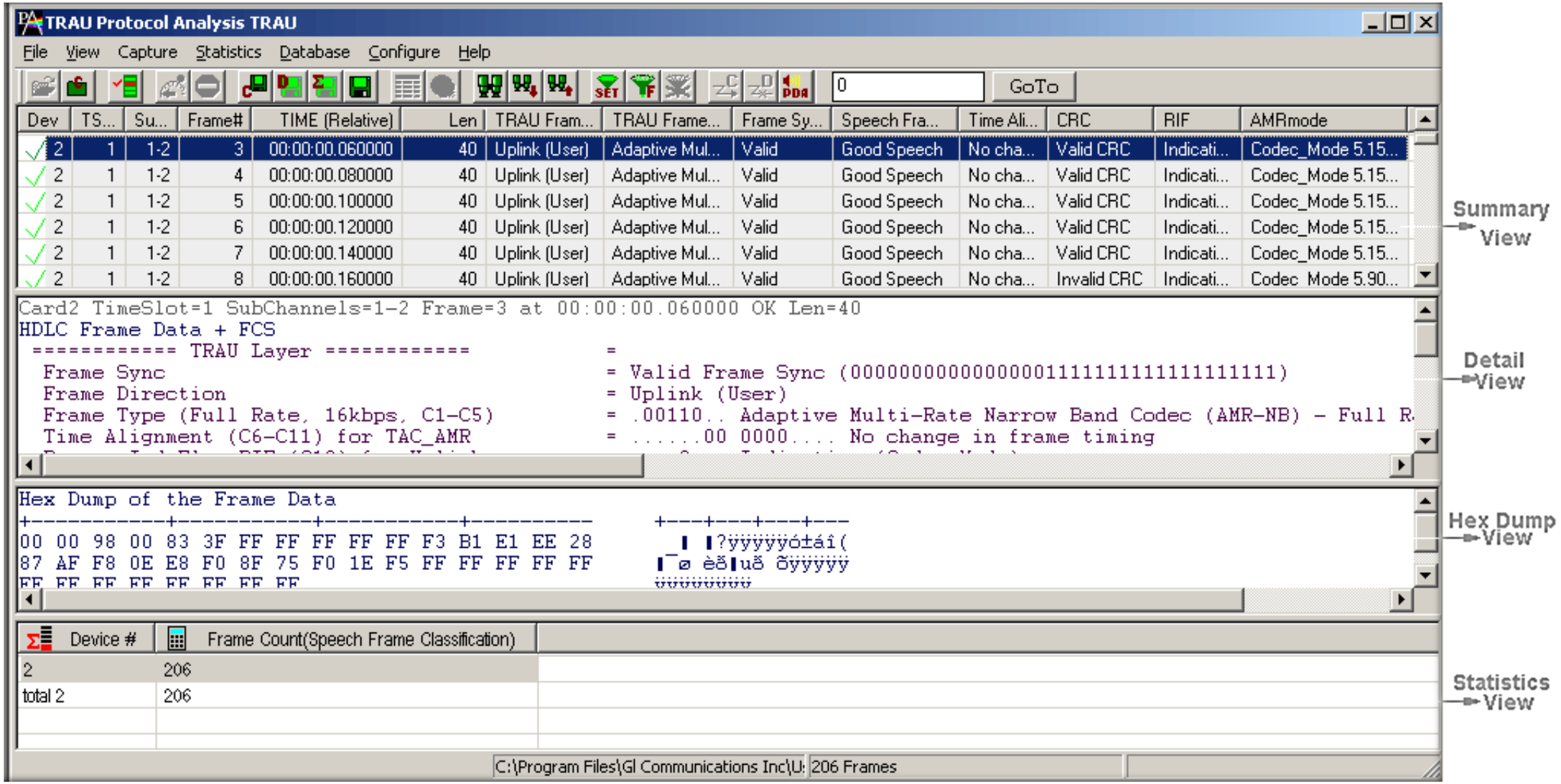
- Data transmission rates supported includes 16kbps and 8 kbps
- Trace files can include TRAU frame types such as EFR, FR (GSM 6.10), HR, AMR-WB, AMR, O&M, Data, Data 14.5 and Idle Speech frame types, which are stored in the recorded TRAU files, can be used for transmission
- Other options include -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

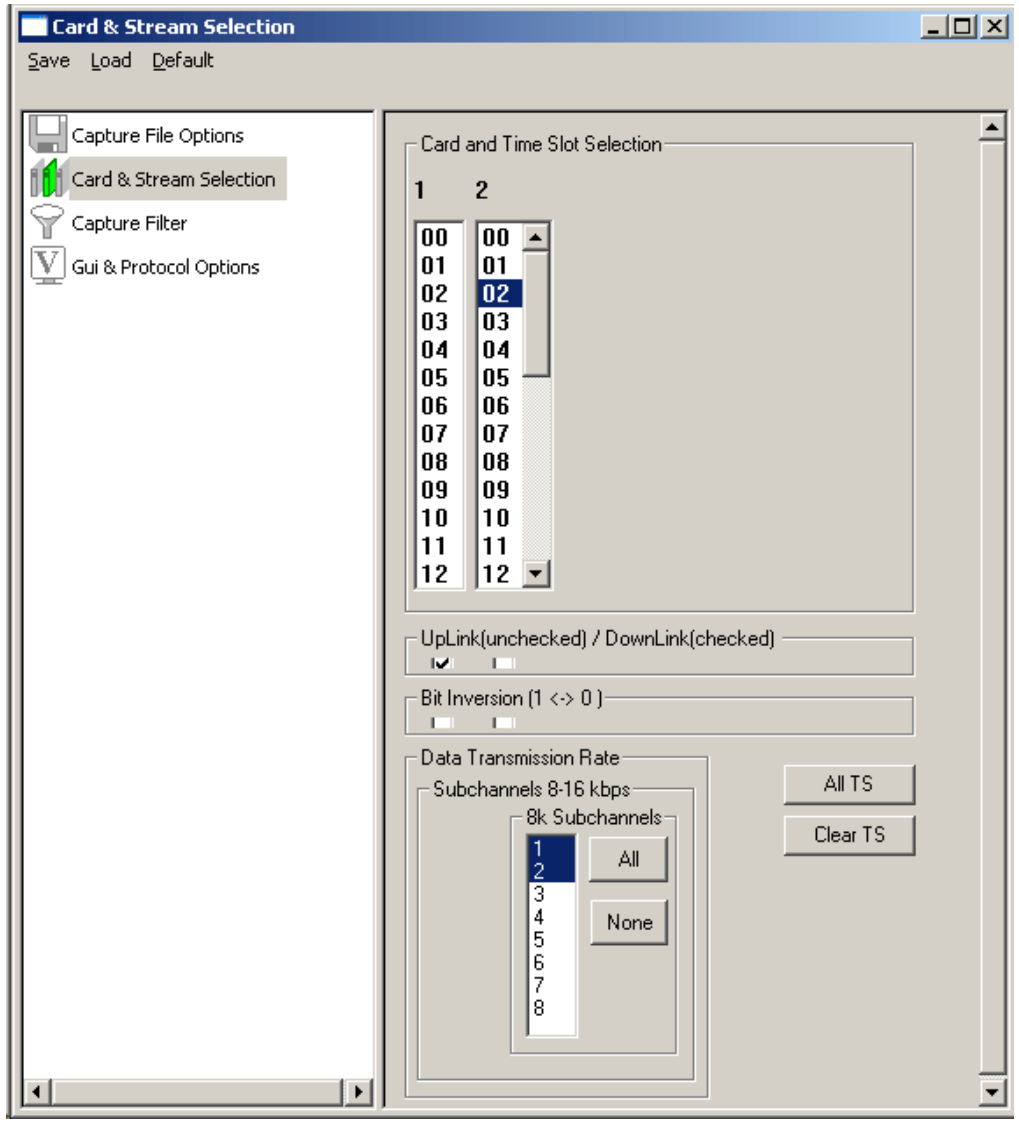
Different Views



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

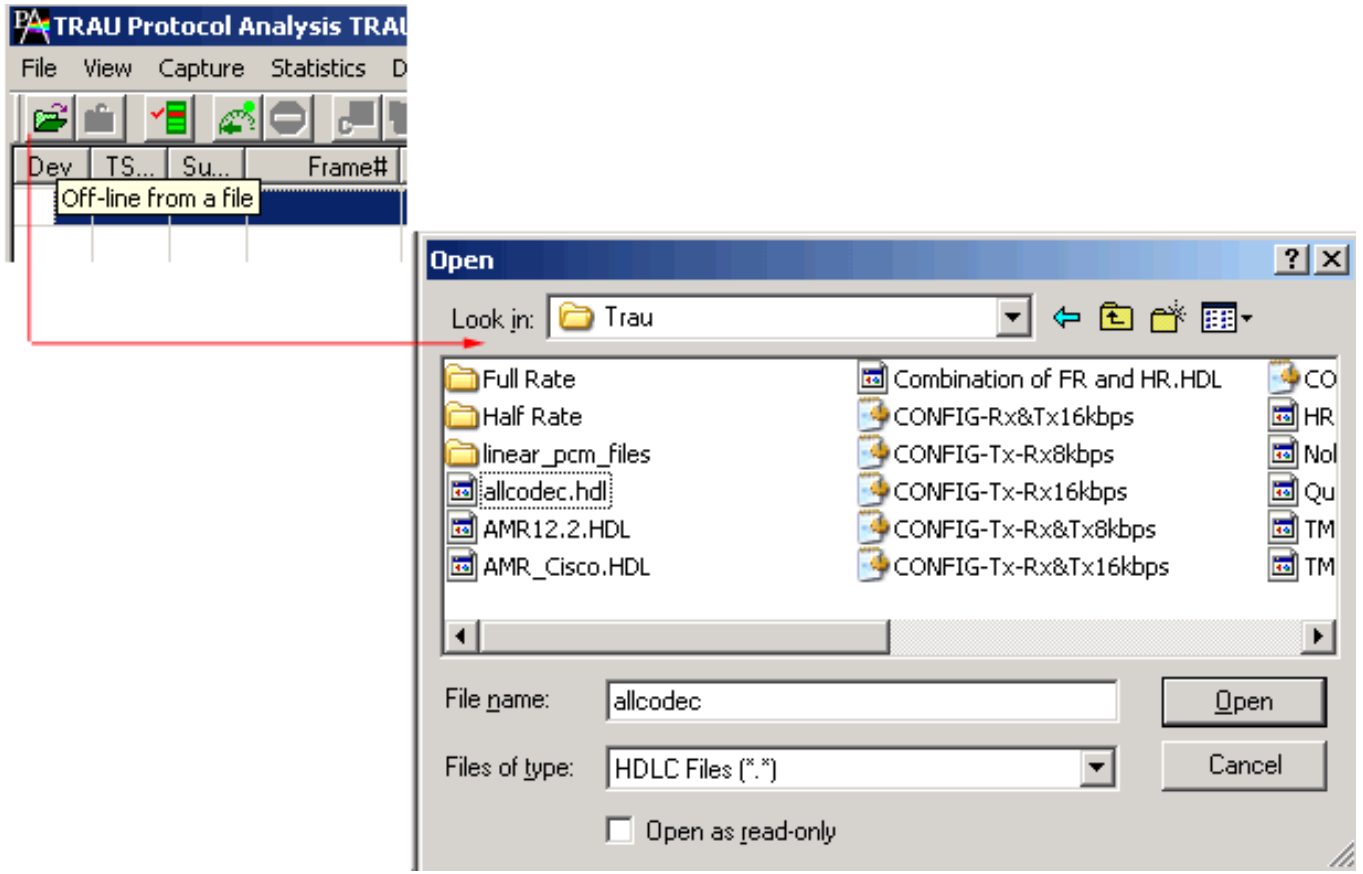


Real-time Analysis

- 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

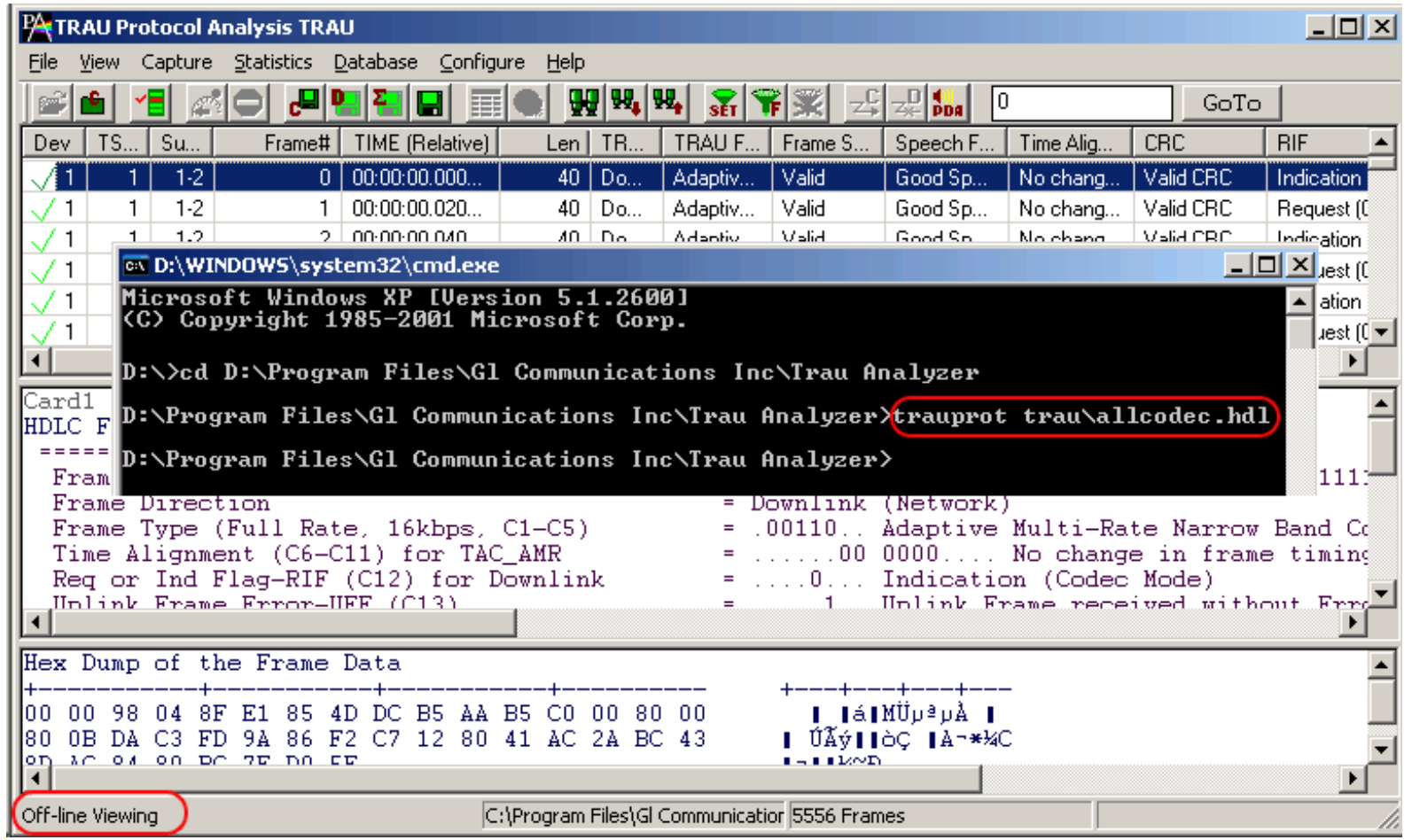
Offline Analysis

- 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



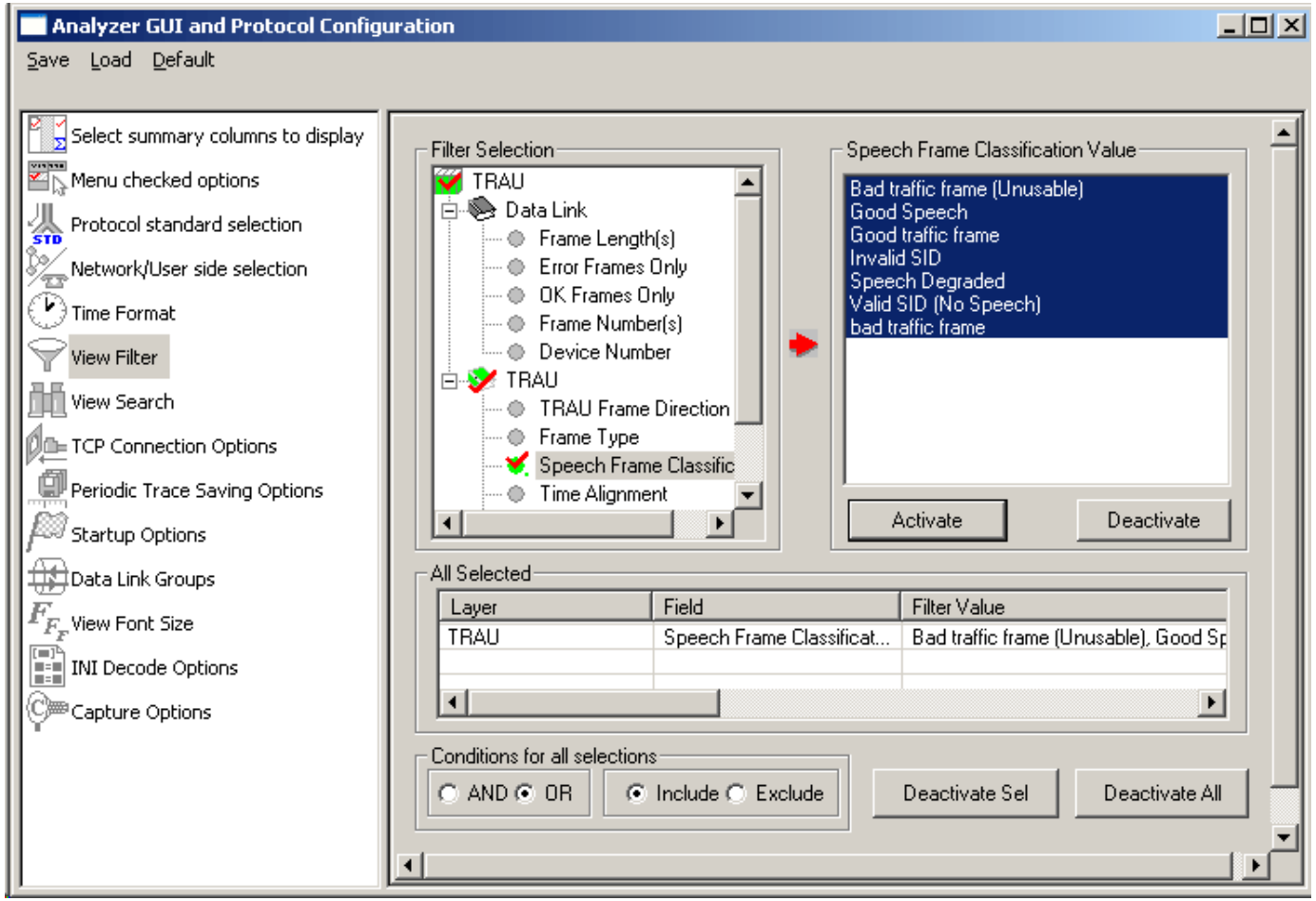
Offline Analysis

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



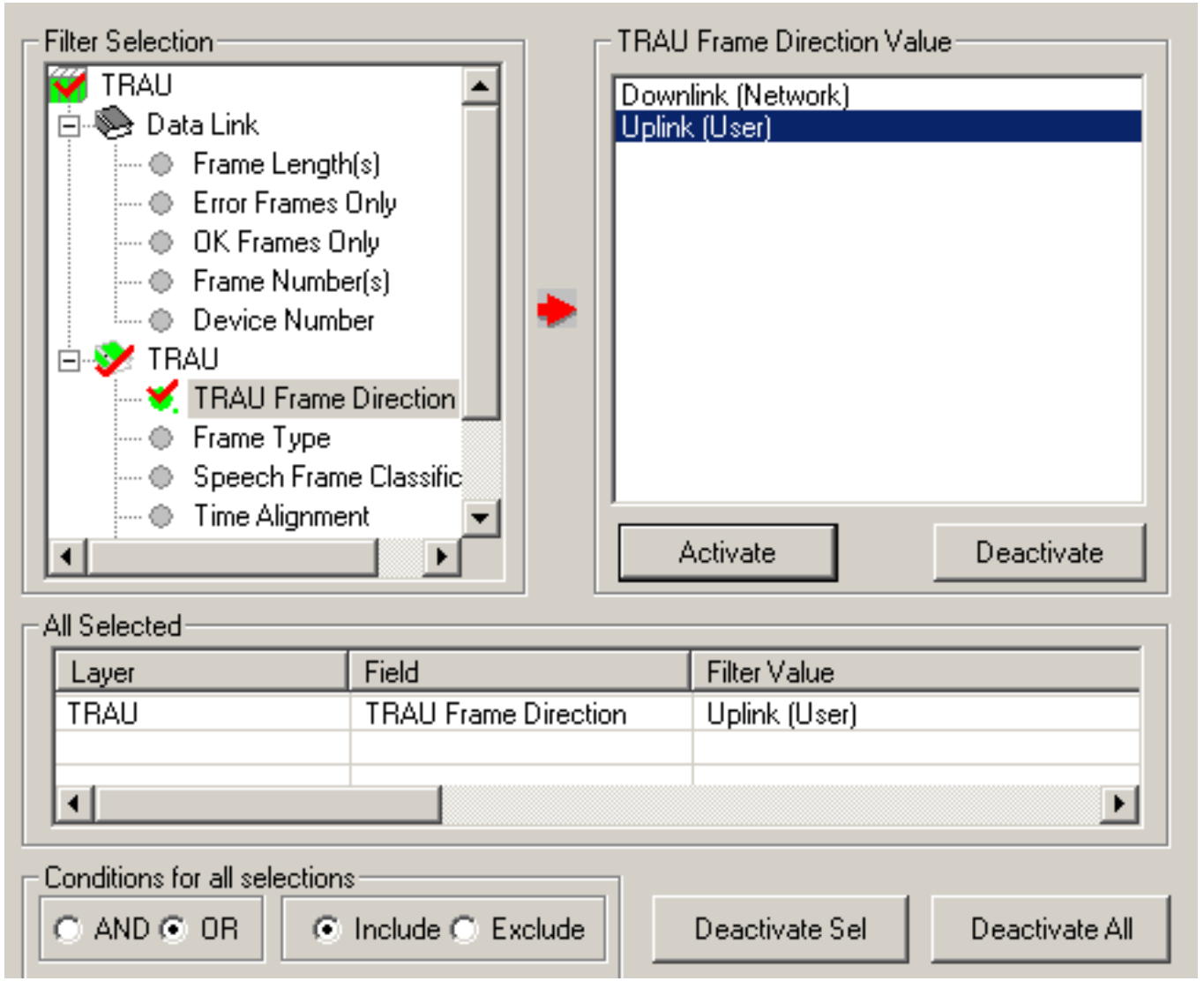
Filters – Offline View Filter

- 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



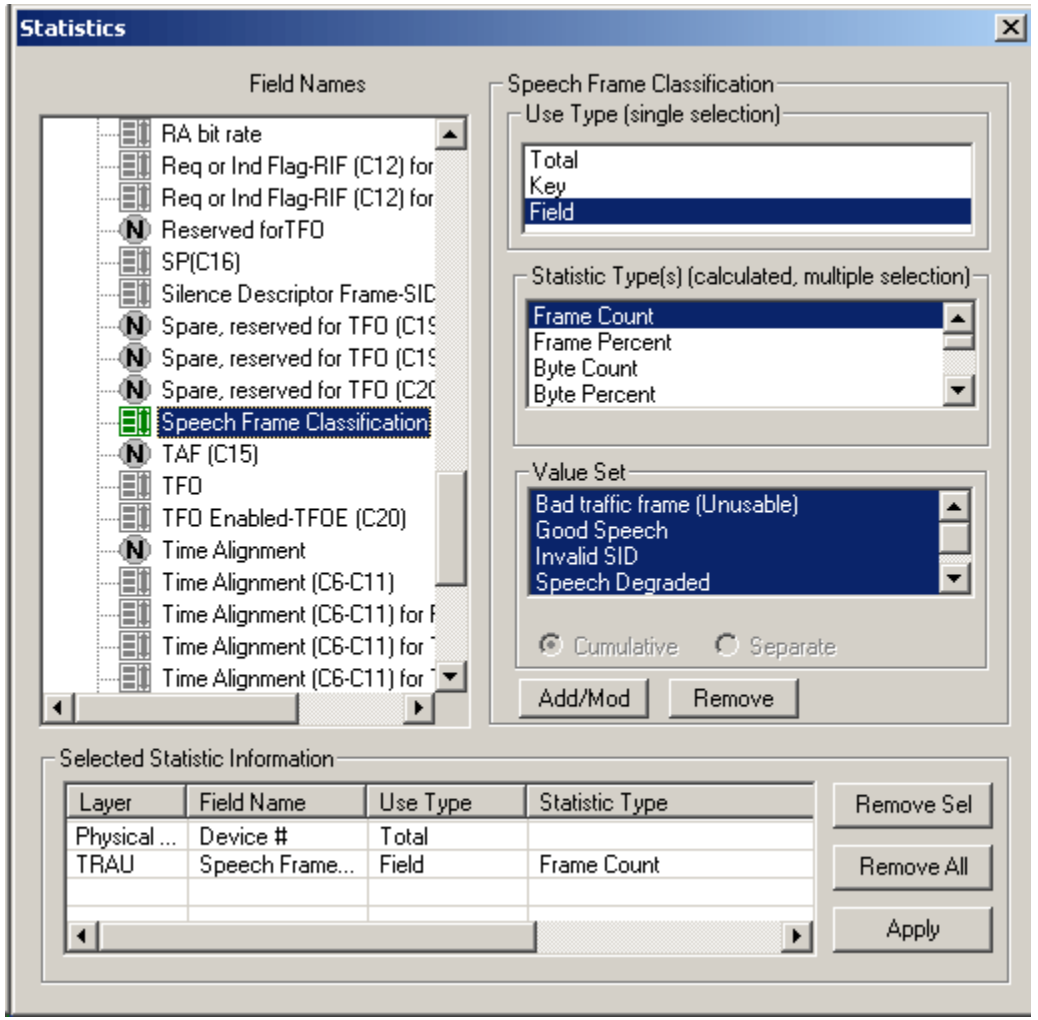
Search Options

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



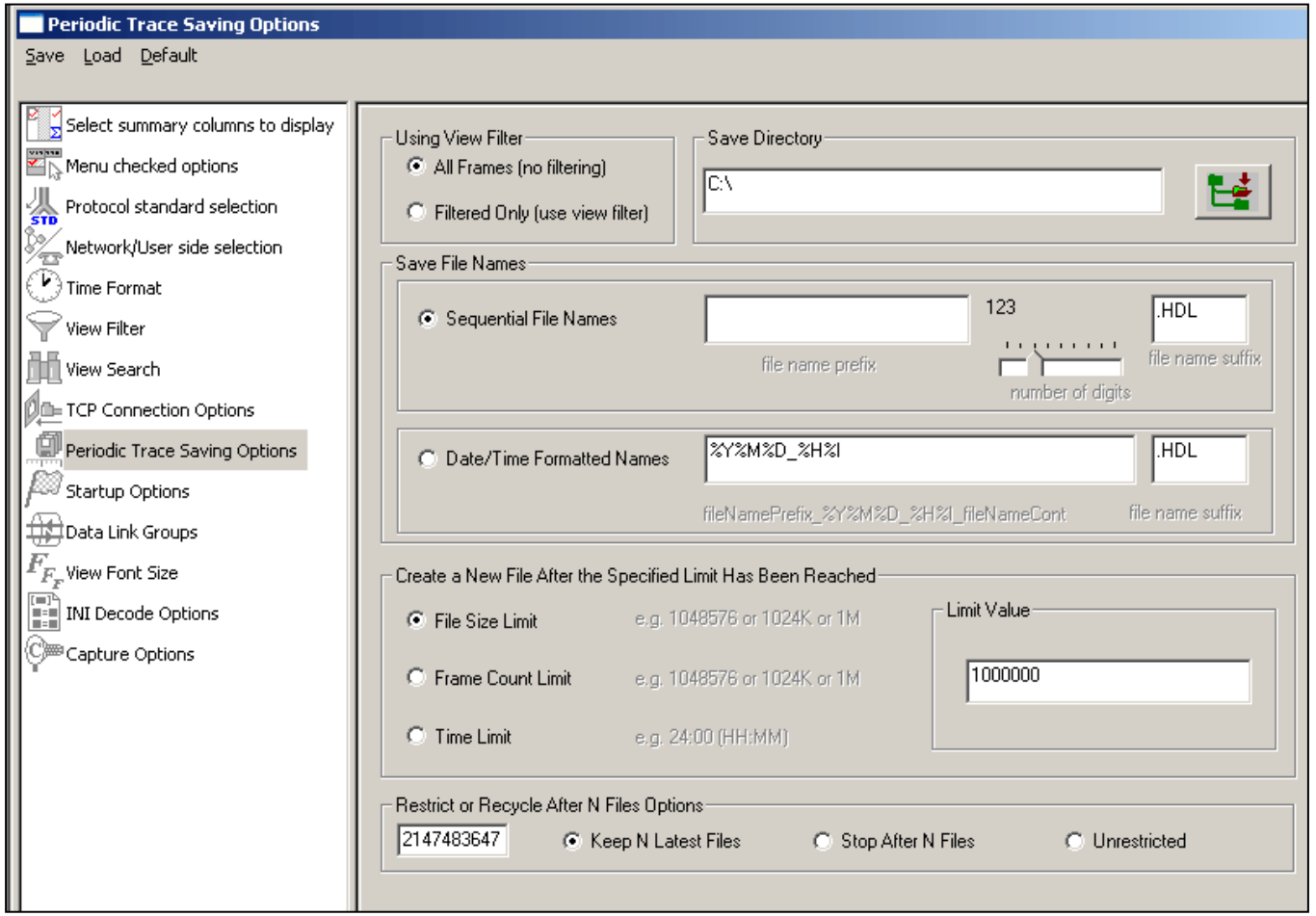
Statistics

- 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



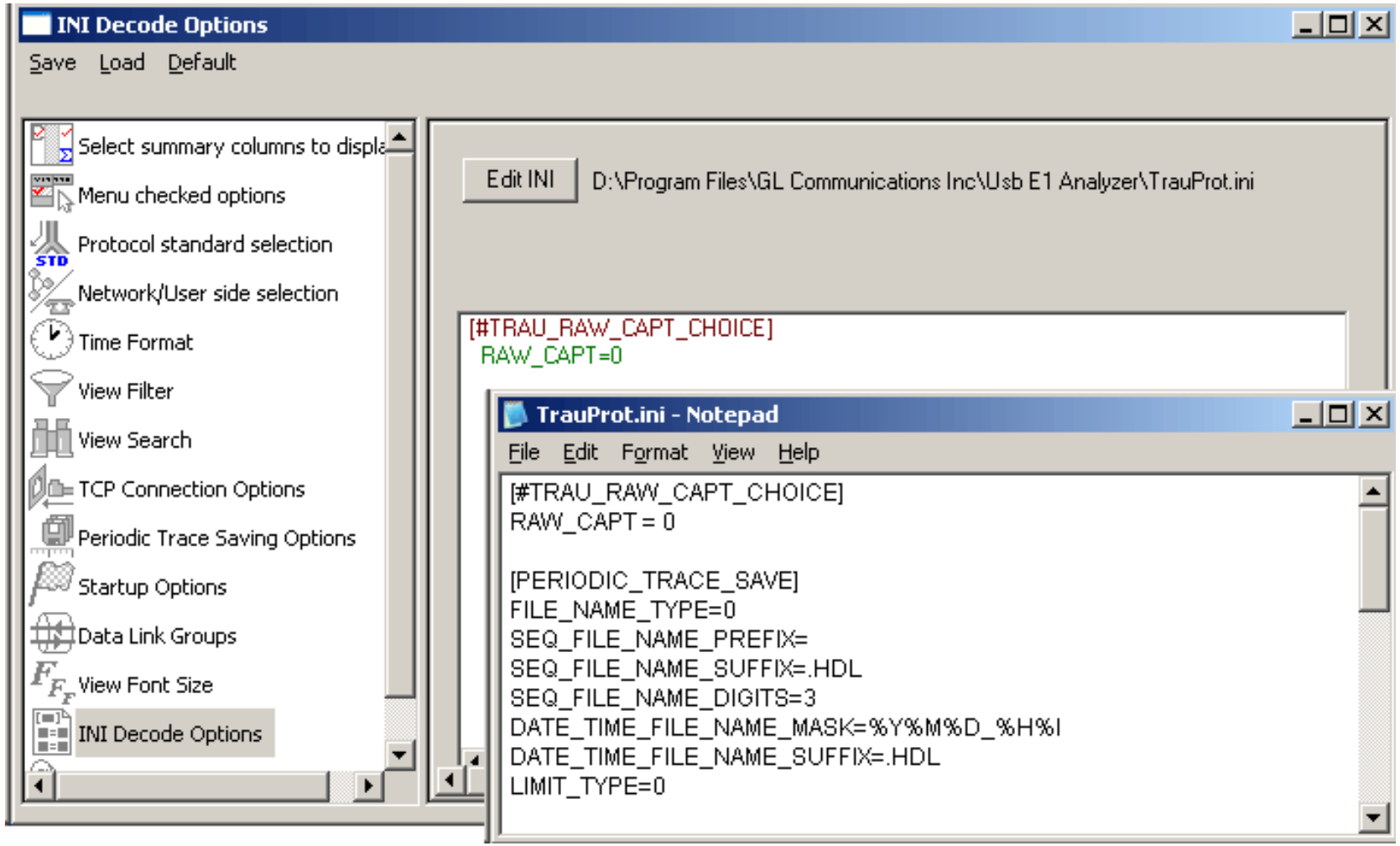
Saving a File

- 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



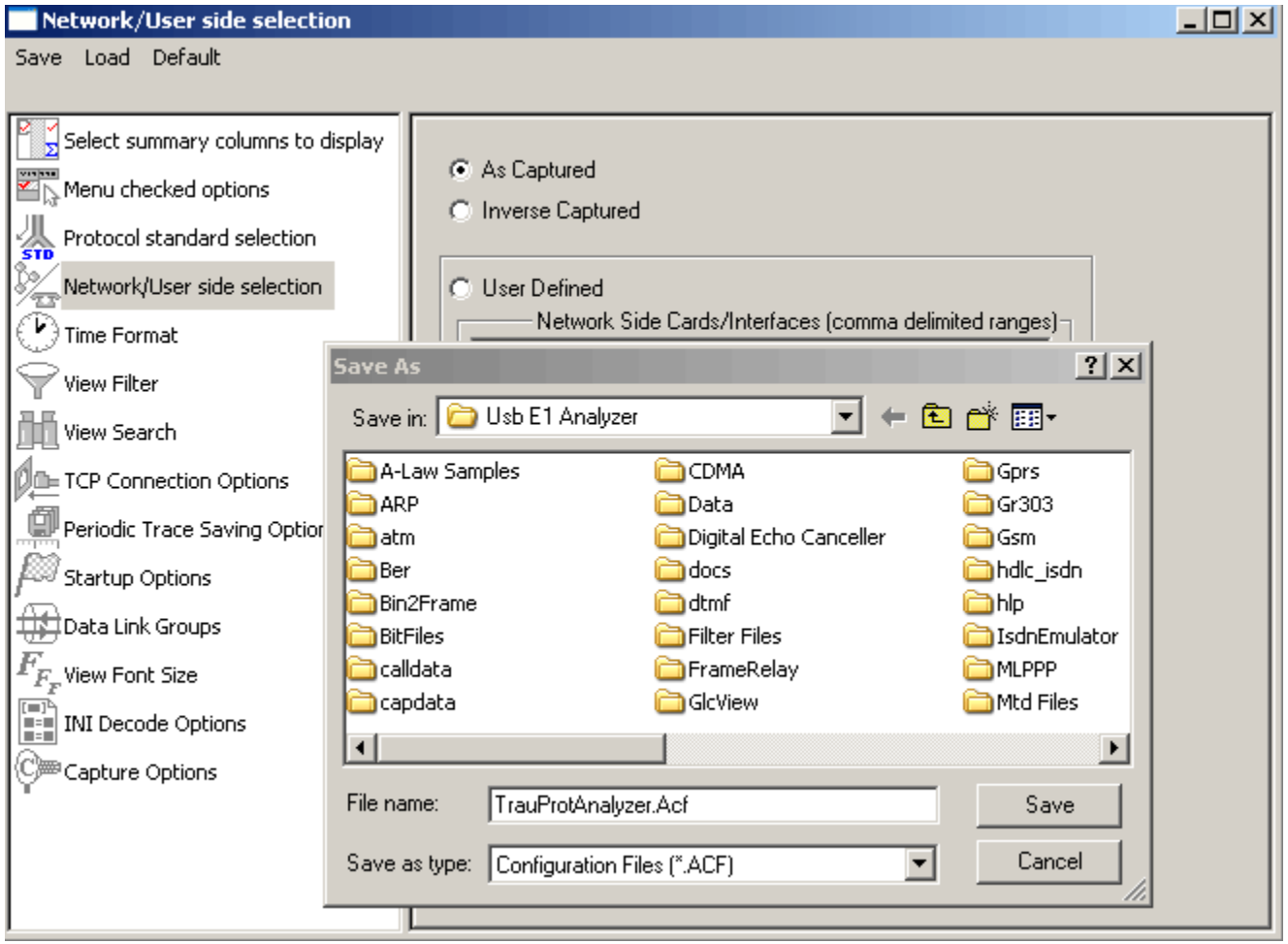
Configuring INI Decode Options

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



Save/Load All Configuration Settings

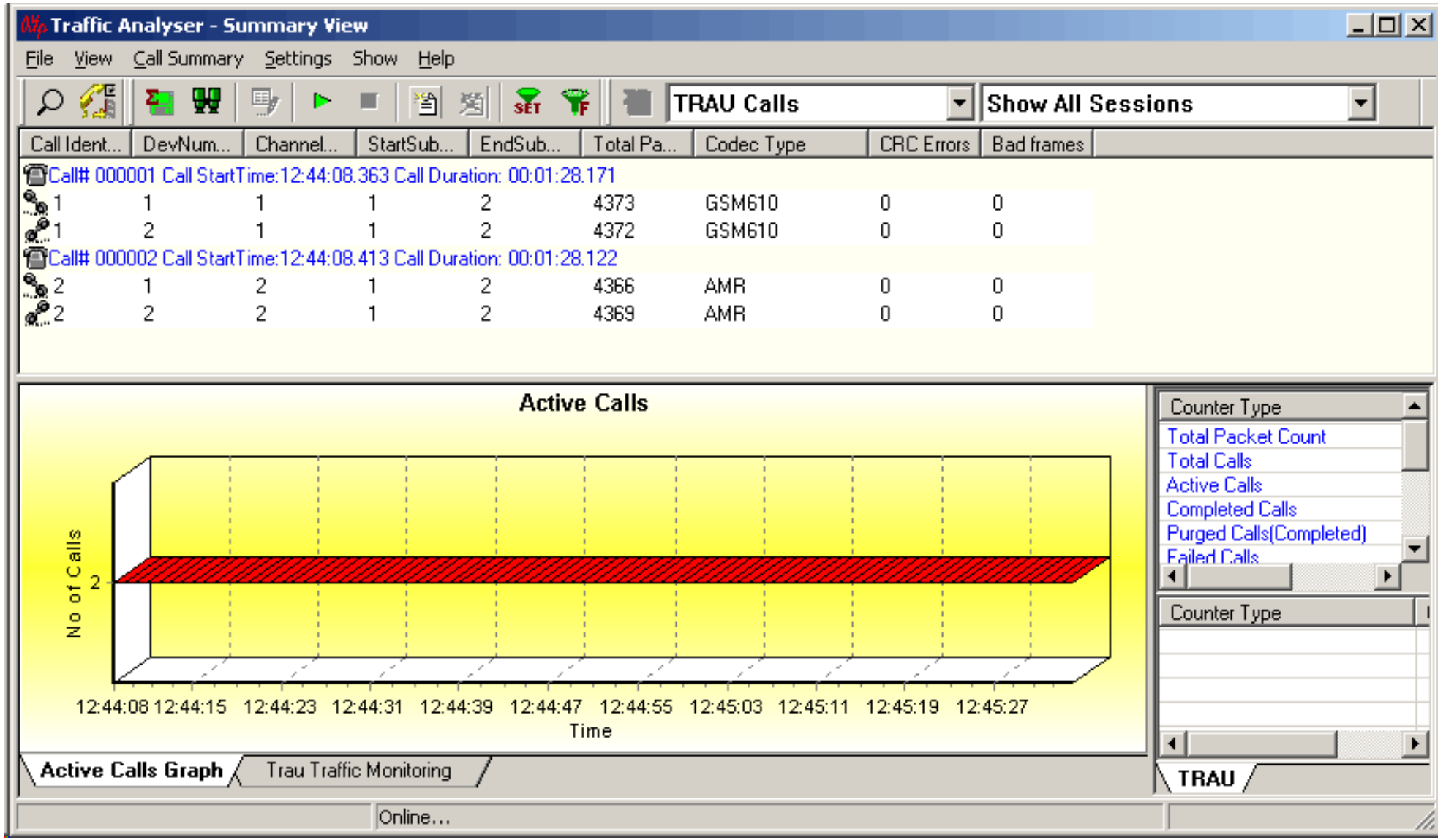
- Protocol configuration window provides a consolidated interface for all the settings required in the analyzer such as protocol selection, stream/interface selection, and so on
- Configuration settings can be saved to a file, loaded from a configuration file, or user may just revert to the default values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

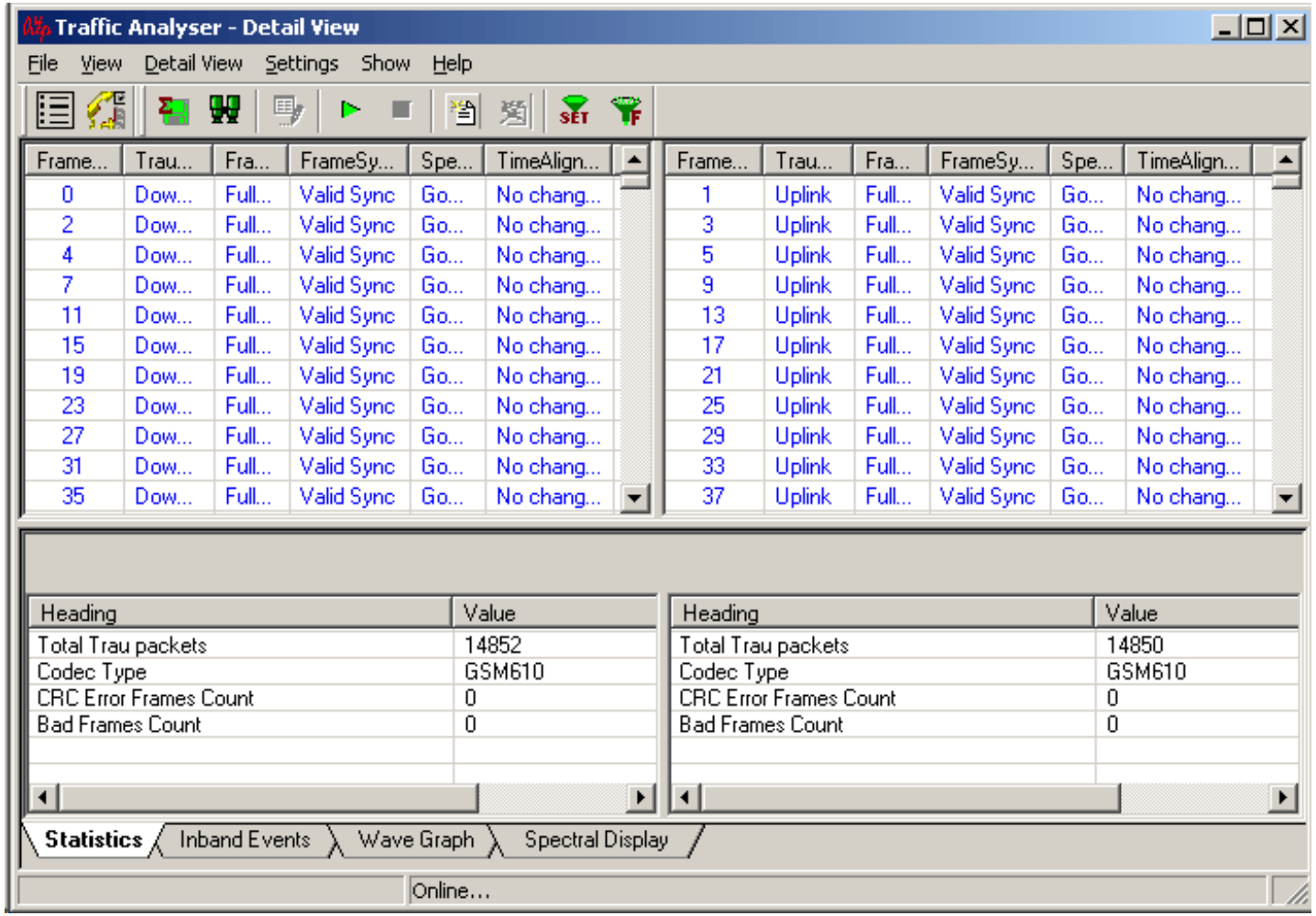


Key Features

- 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

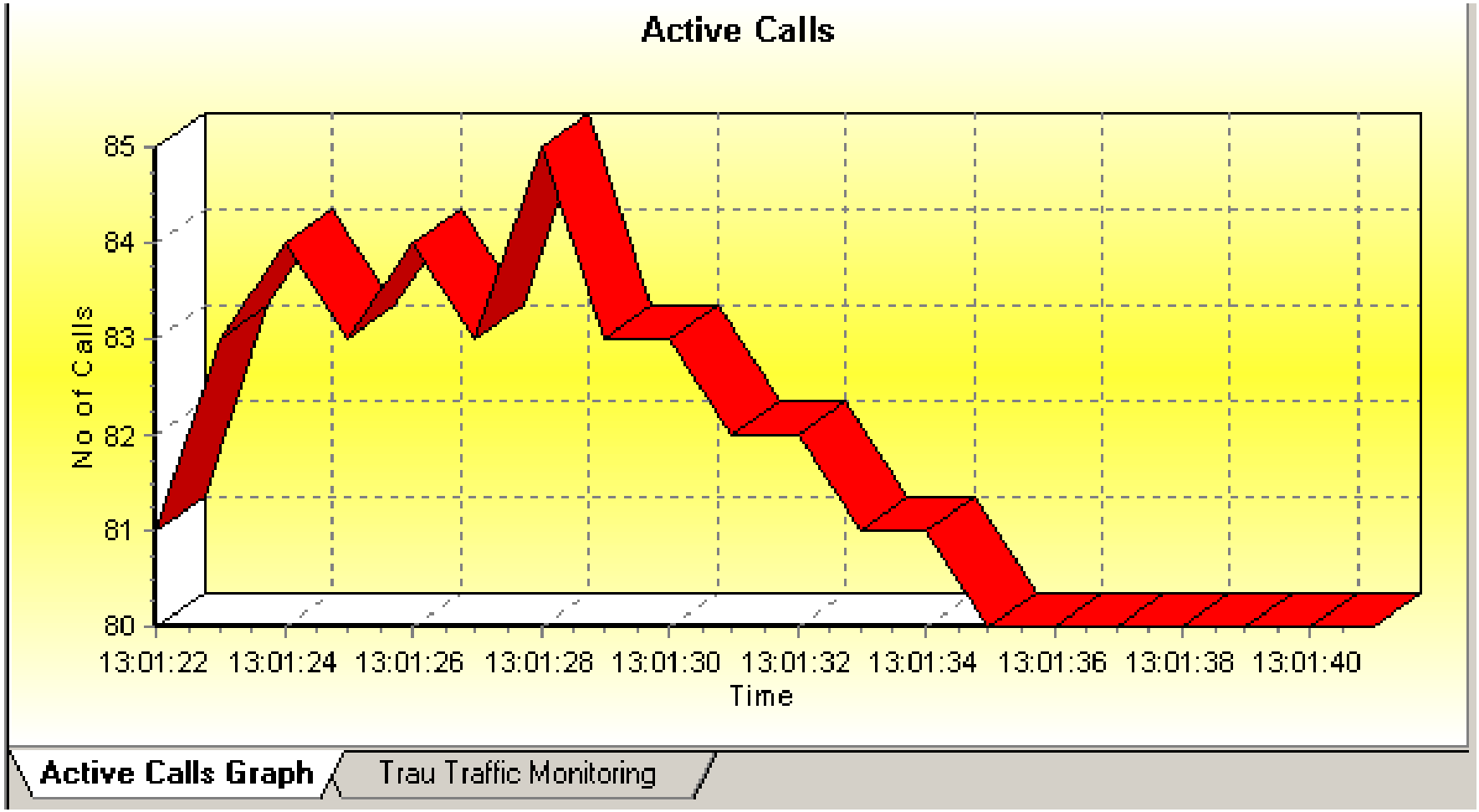
Detail View

- 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

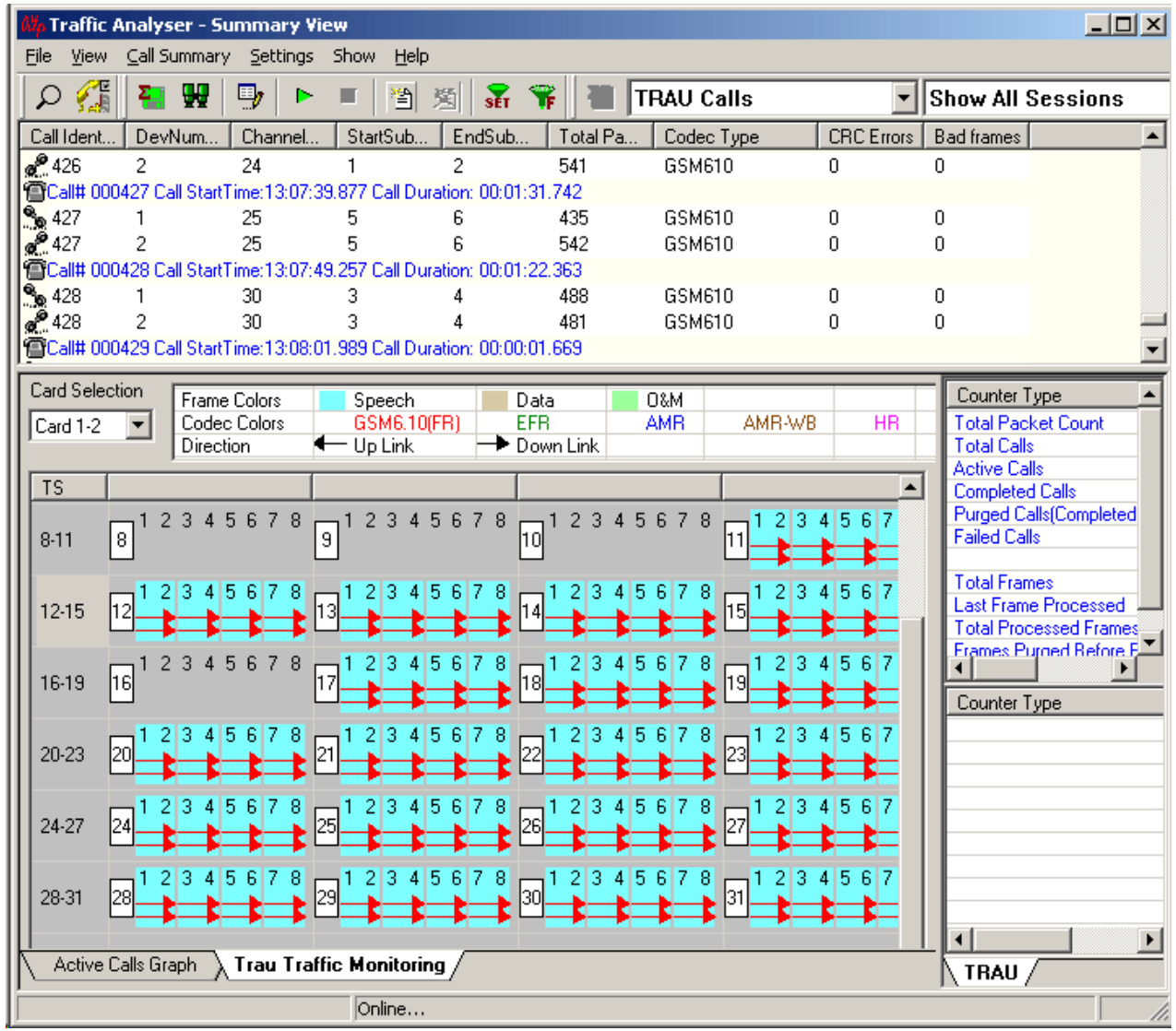


Active Calls Graph – Summary View

- View active calls over the duration of the capture



TRAU Traffic Monitoring – Summary View

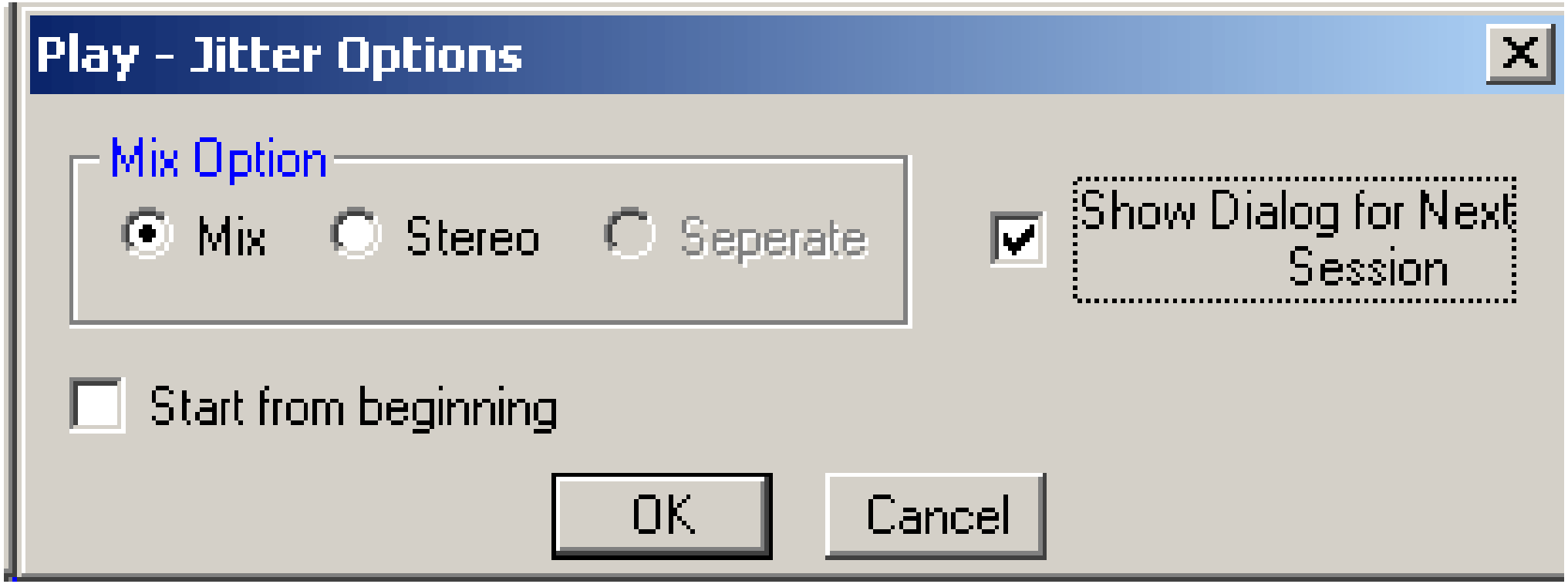


TRAU Traffic Monitoring

- 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

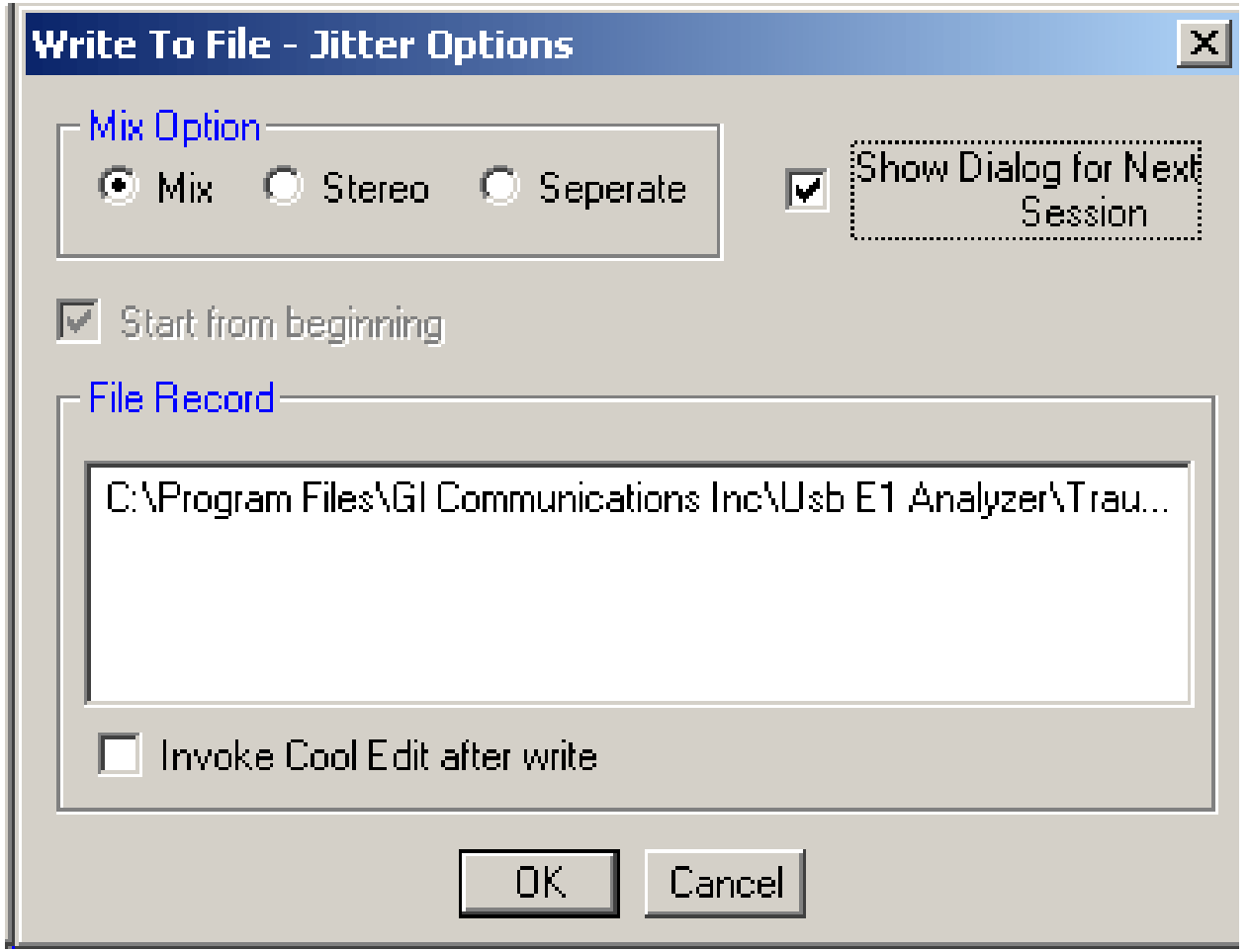
Play Audio

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



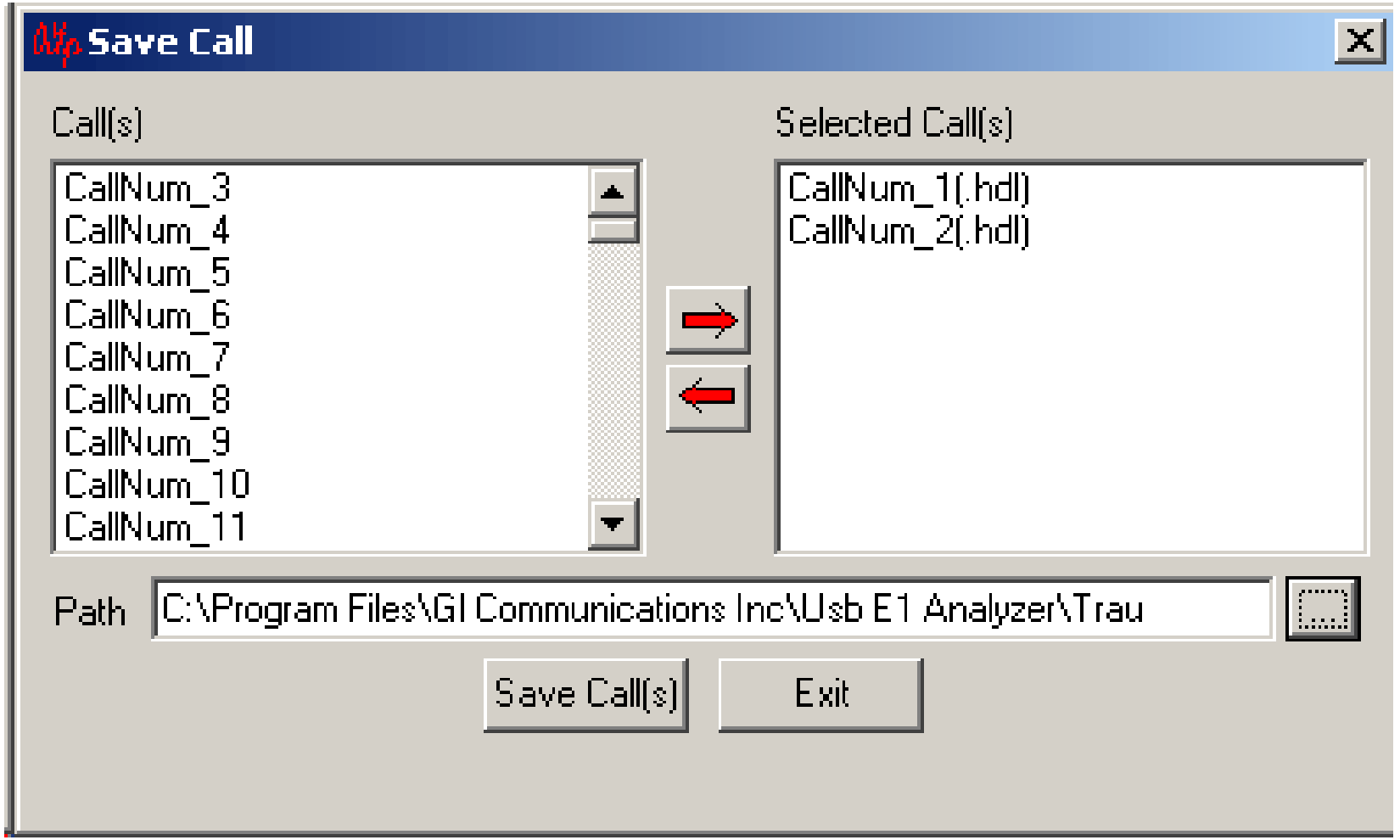
Write to File

- 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



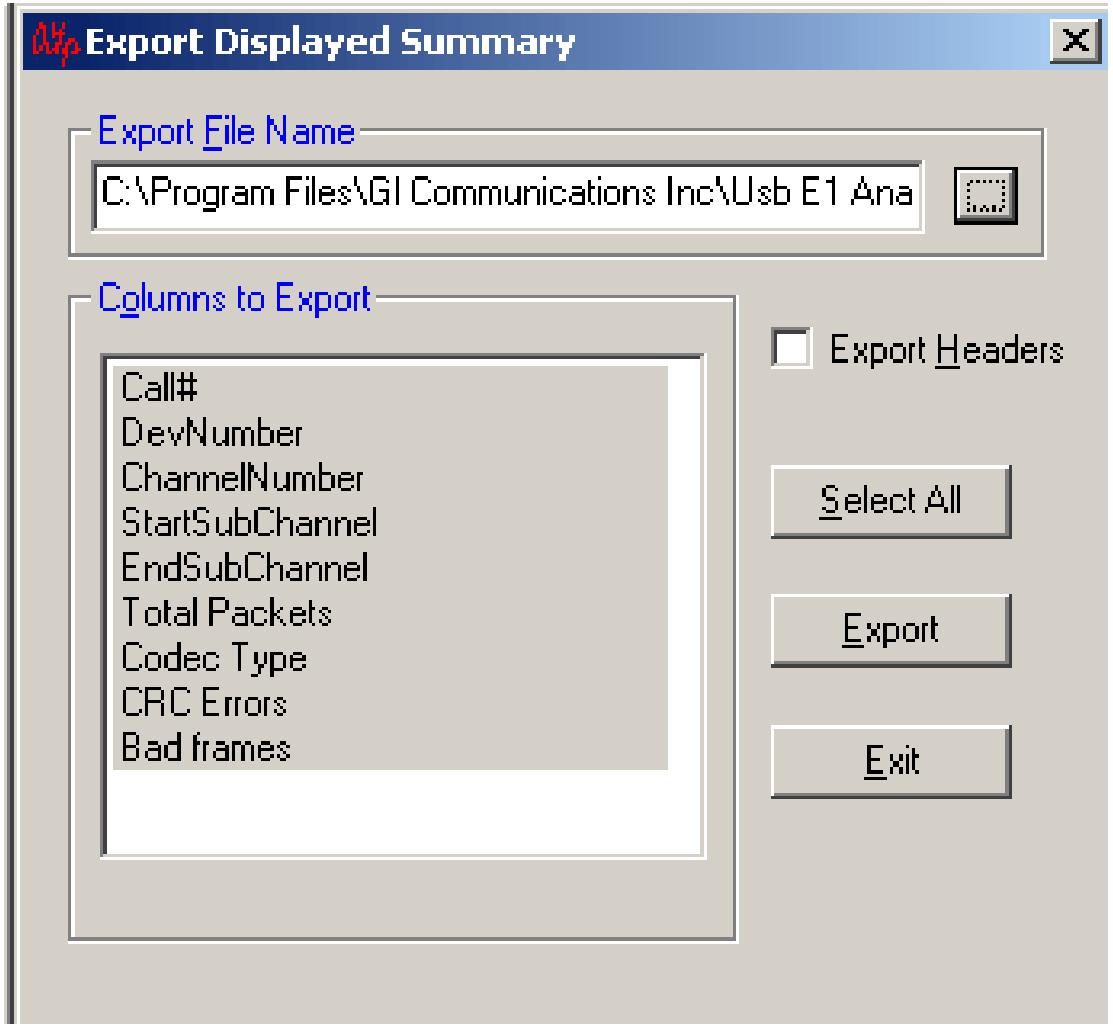
Save Call

- 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



Wave Graph and Spectral Display

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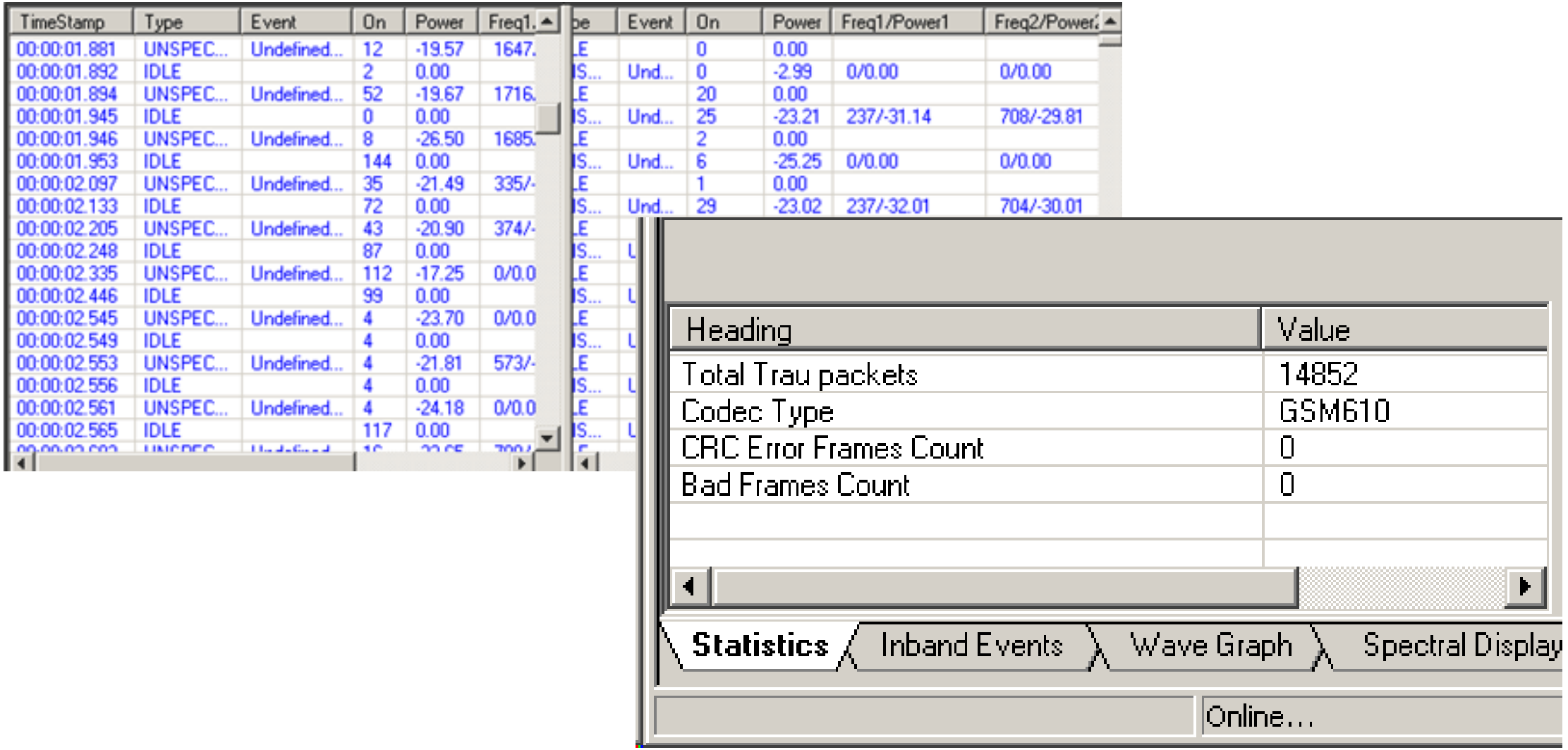
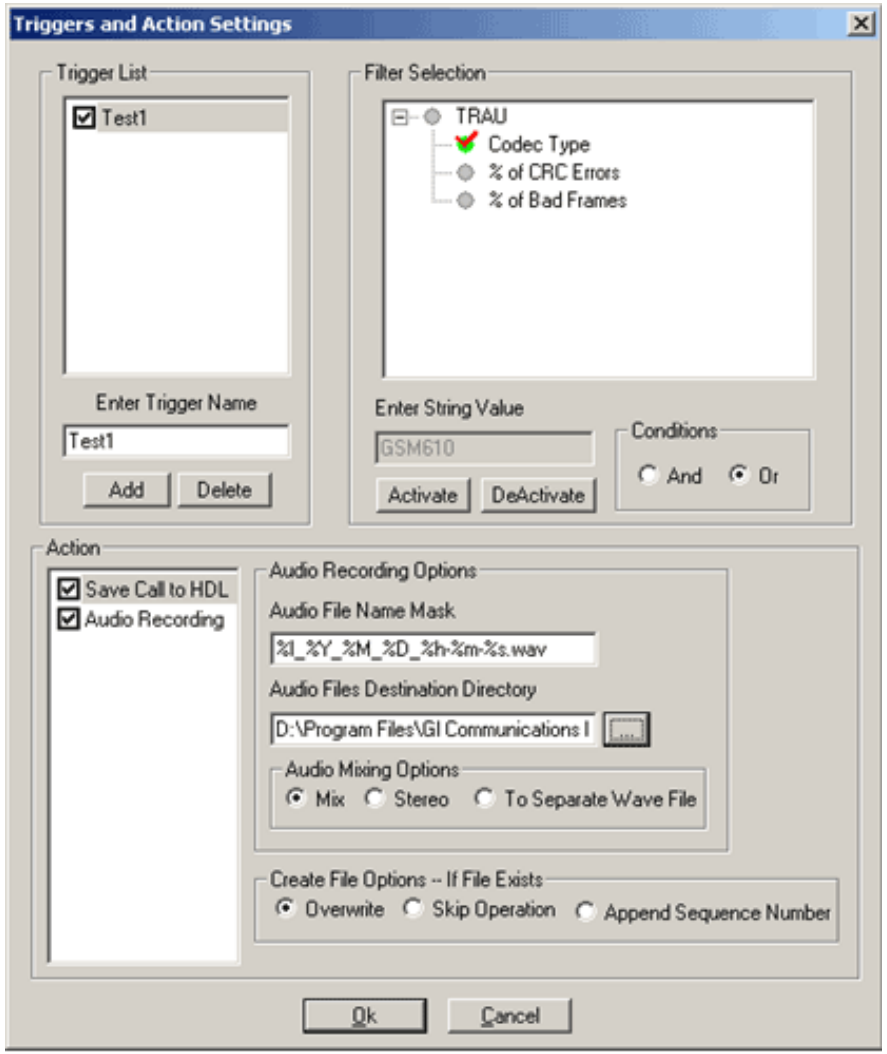
Statistics and Inband Events

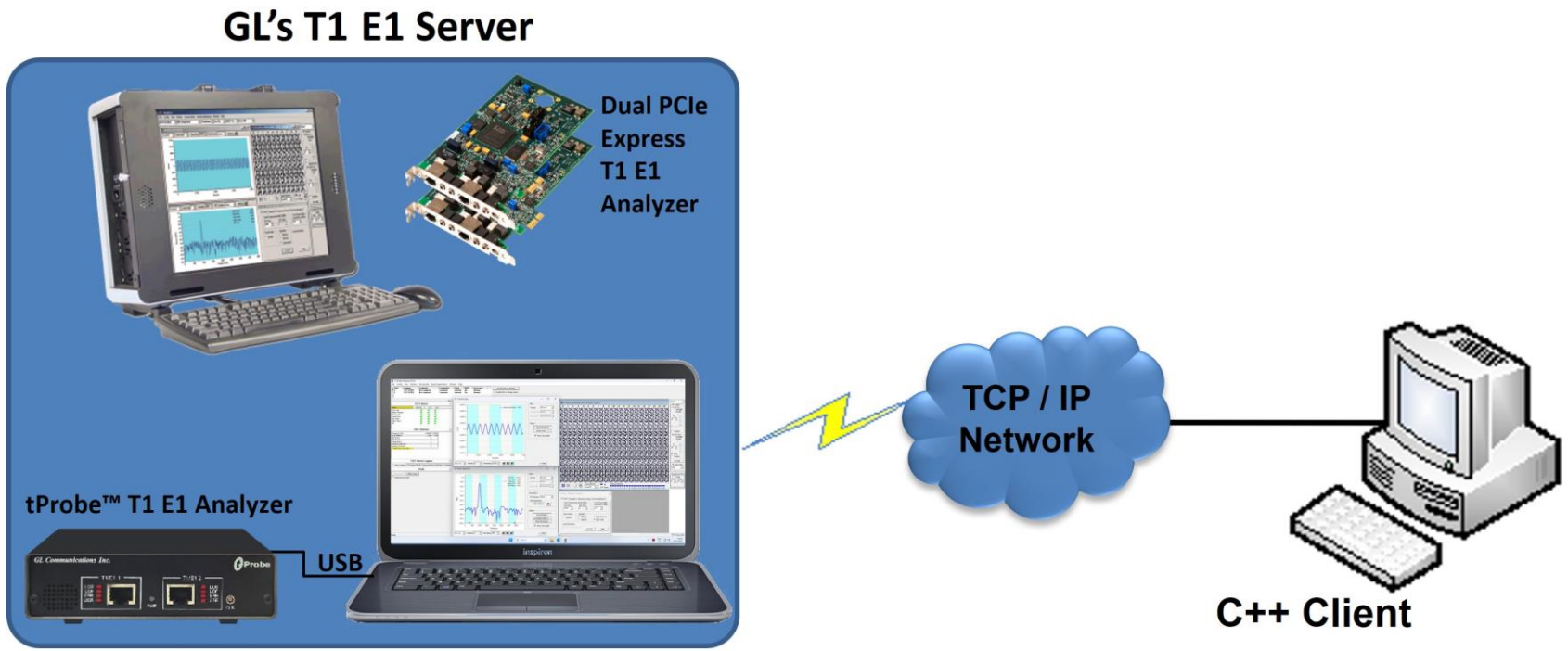


Trigger and Action Settings

- 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



TRAU Emulation and Analysis using Windows Client Server



Supported Platforms-

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

GL's TRAU Tx/Rx Test Application

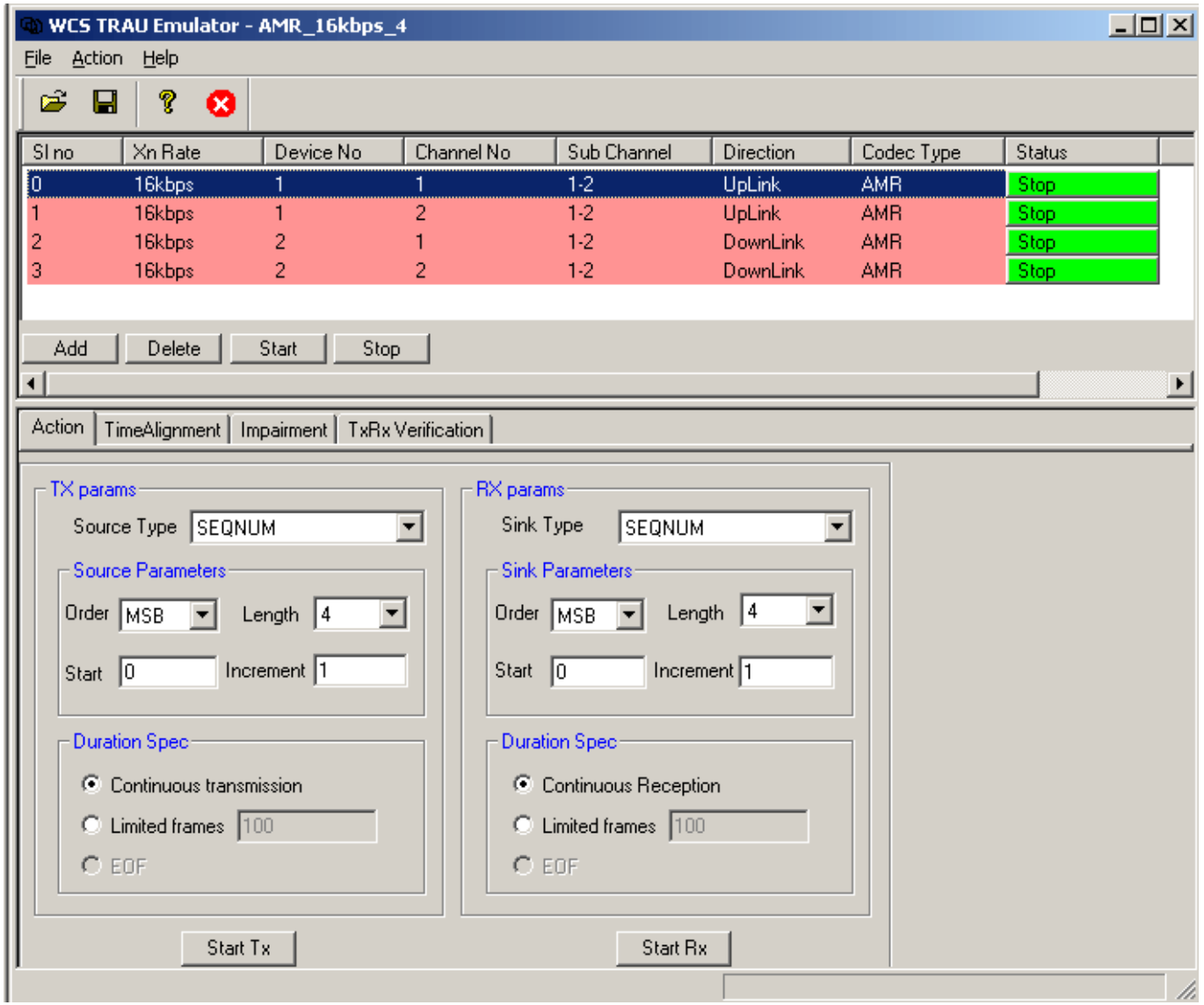
Features

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	✓

GL Communications

- 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



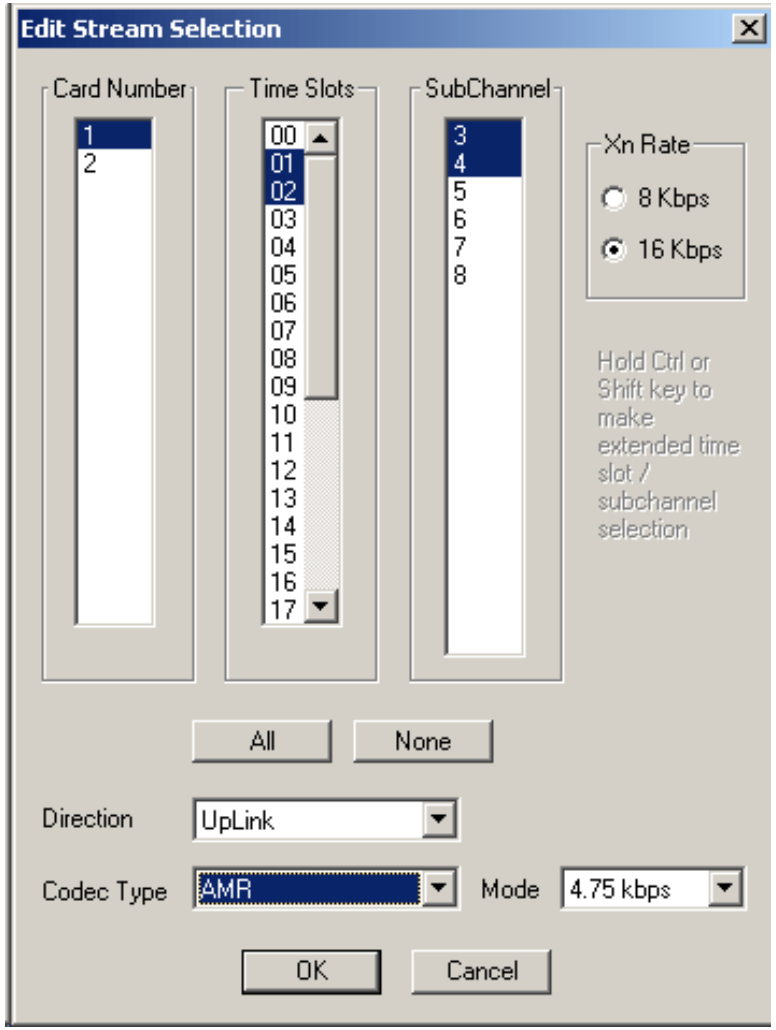
GL Communications

Key Features

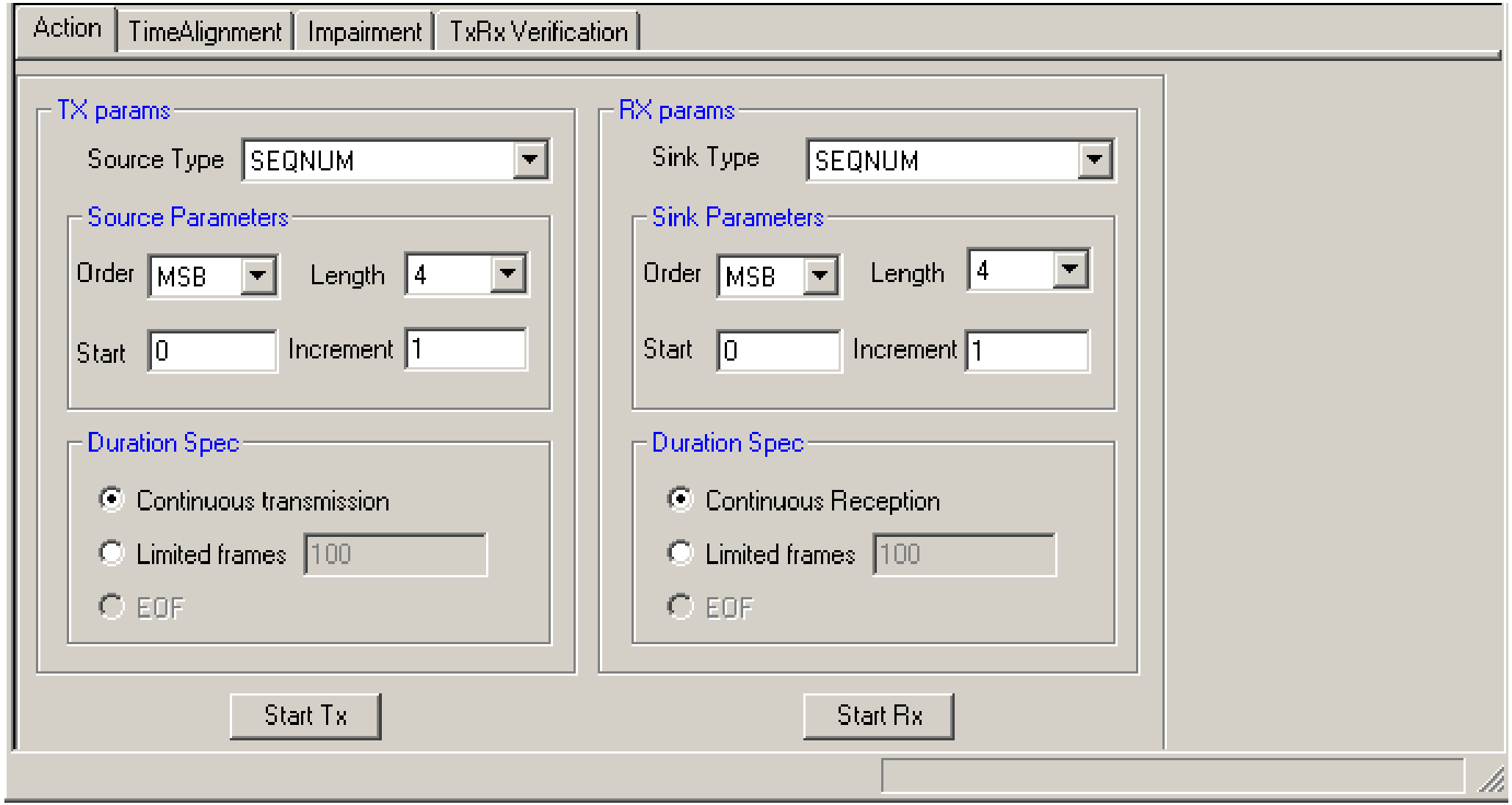
- Simulates TRAU traffic over Abis and Ater interfaces
- Can be used to test the backhaul network
- Time Alignment can be applied in the TRAU frames
- Payload traffic generation and verification
- Supports various impairments - CRC error, frame duplication, and more
- Provides detailed test (Tx/Rx) results 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



Traffic Generation and Reception

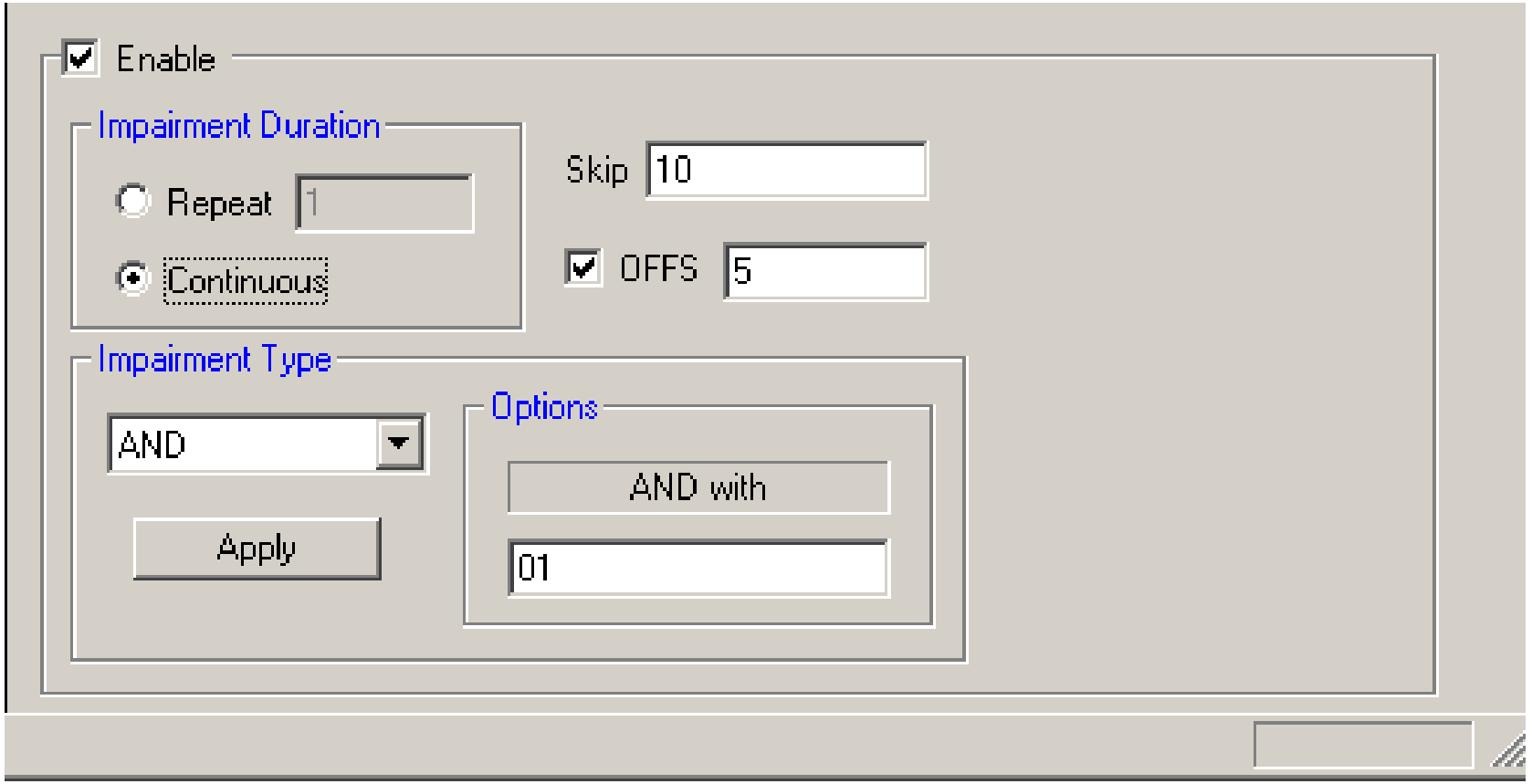


Traffic Generation and Reception

- 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

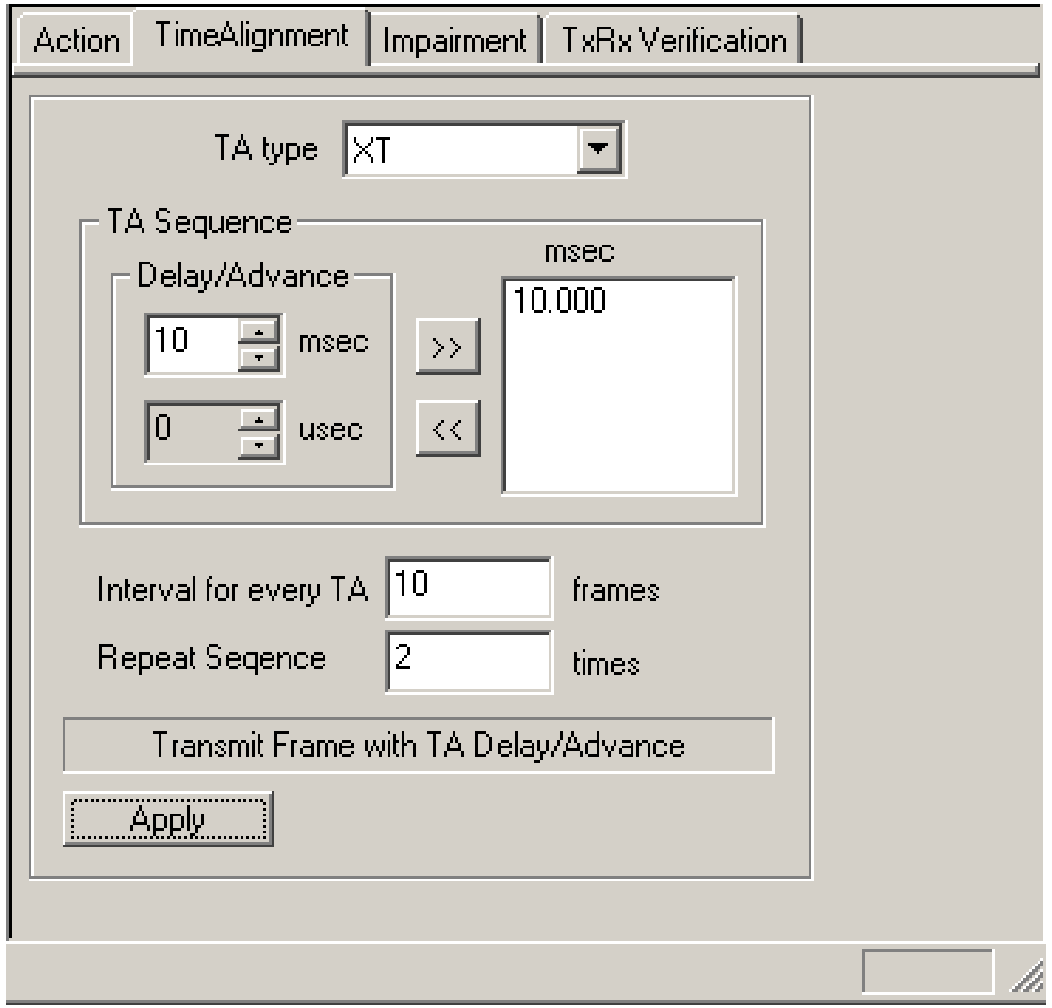
Impairment

- 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 includes CRC error, Sync error, Frame duplication, and Bitwise AND/OR/XOR



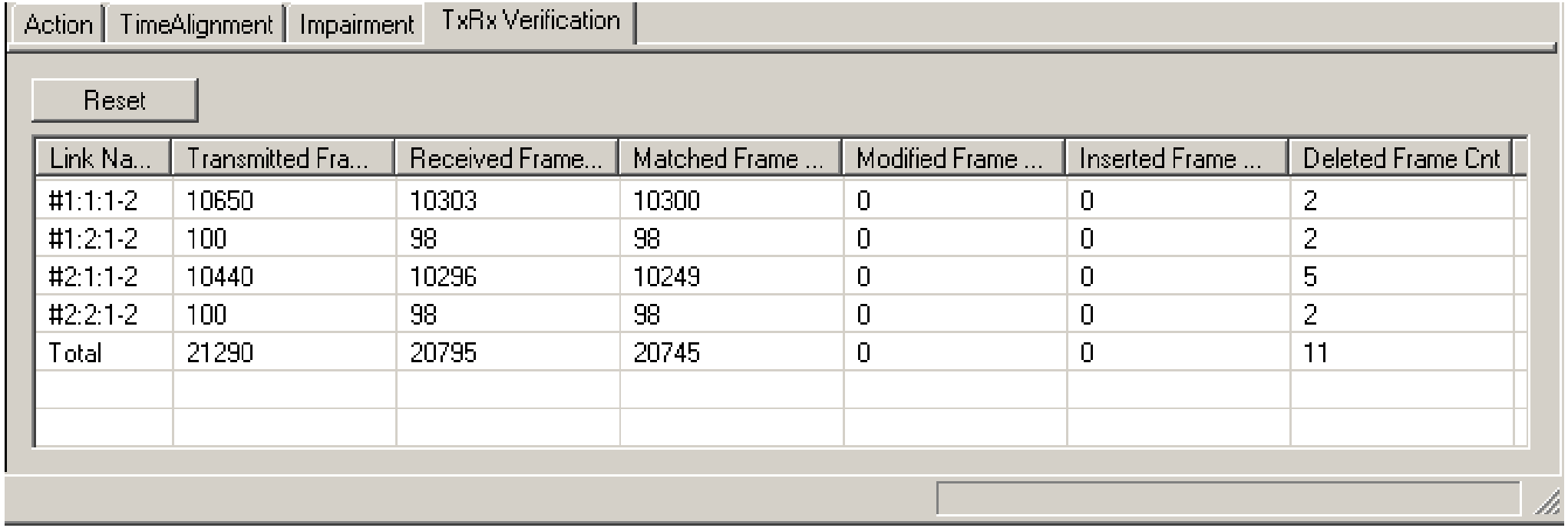
Time Alignment

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



Data Verification

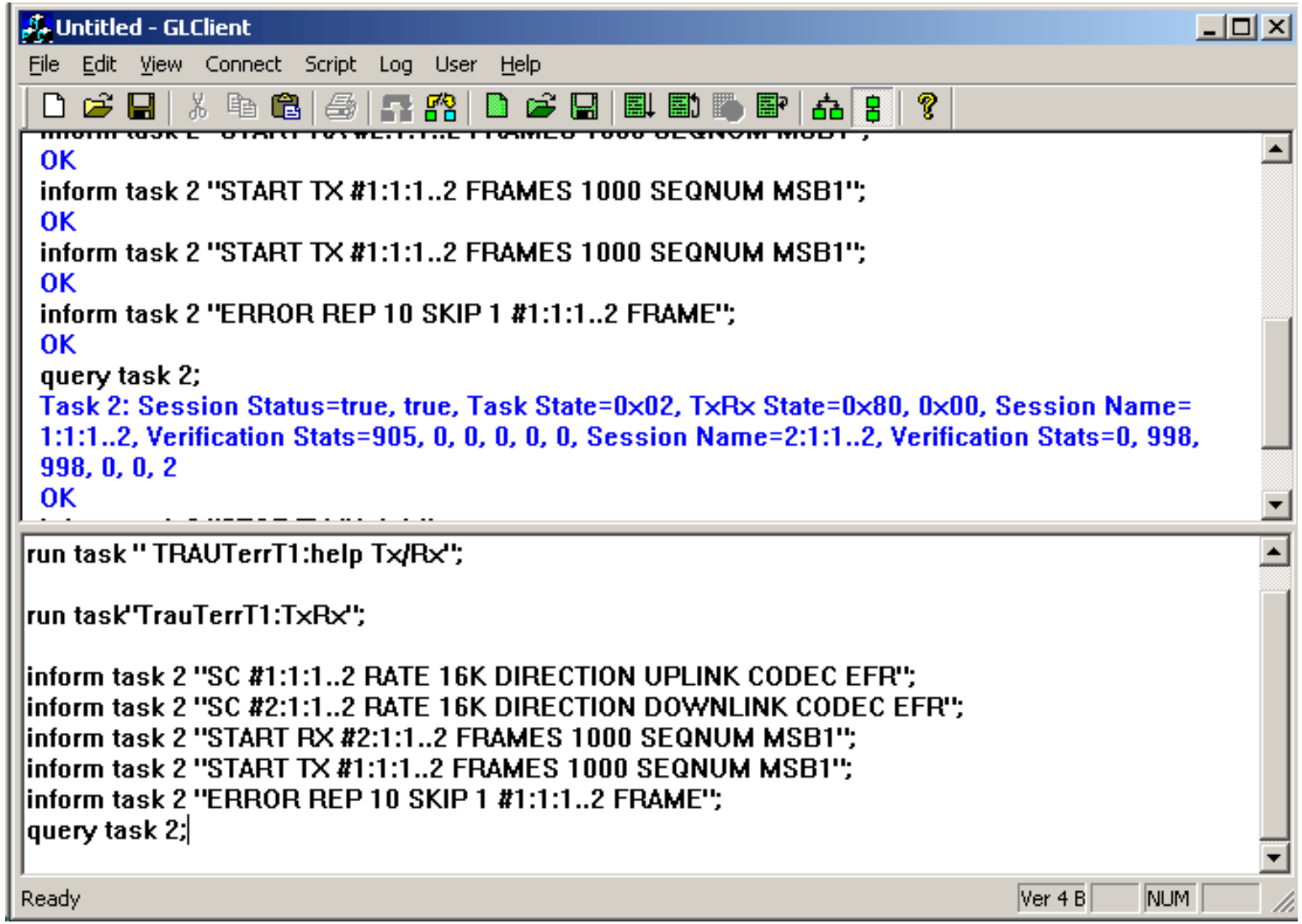
- Traffic verification provides the overall statistics for all TRAU sessions
- Displays number of Transmitted, Received, Matched, Modified, and Inserted frames



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



TRAU Tx/Rx Command Line Based

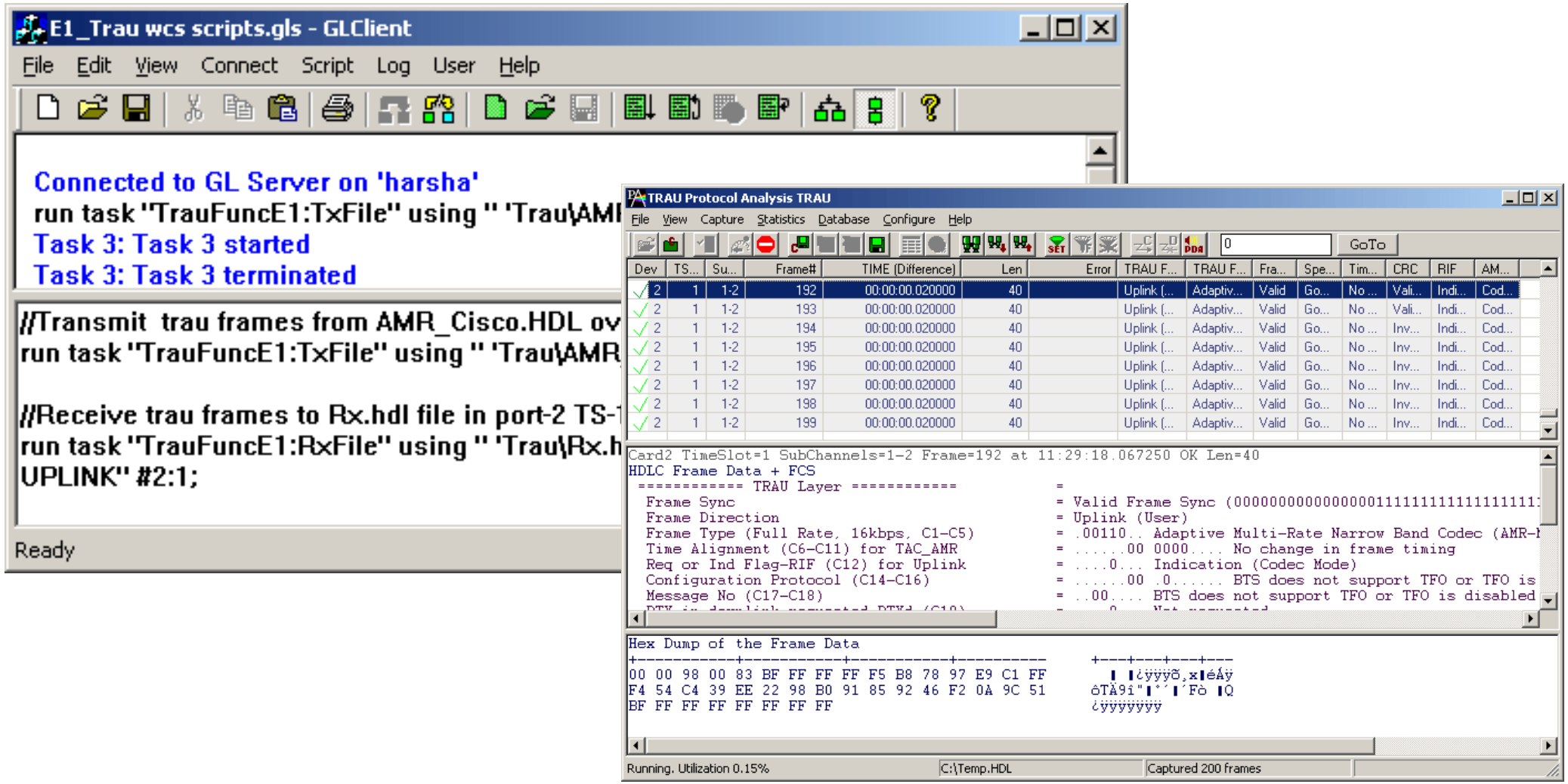
- Sends and receives TRAU frames (with or without impairments) based on the codec type, and time alignment, and logs the events

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



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!