
Frame Relay Analysis and Emulation



818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878
Phone: (301) 670-4784 Fax: (301) 670-9187 Email: info@gl.com
Website: <https://www.gl.com>

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FrameRelay Analysis and Emulation over T1 E1

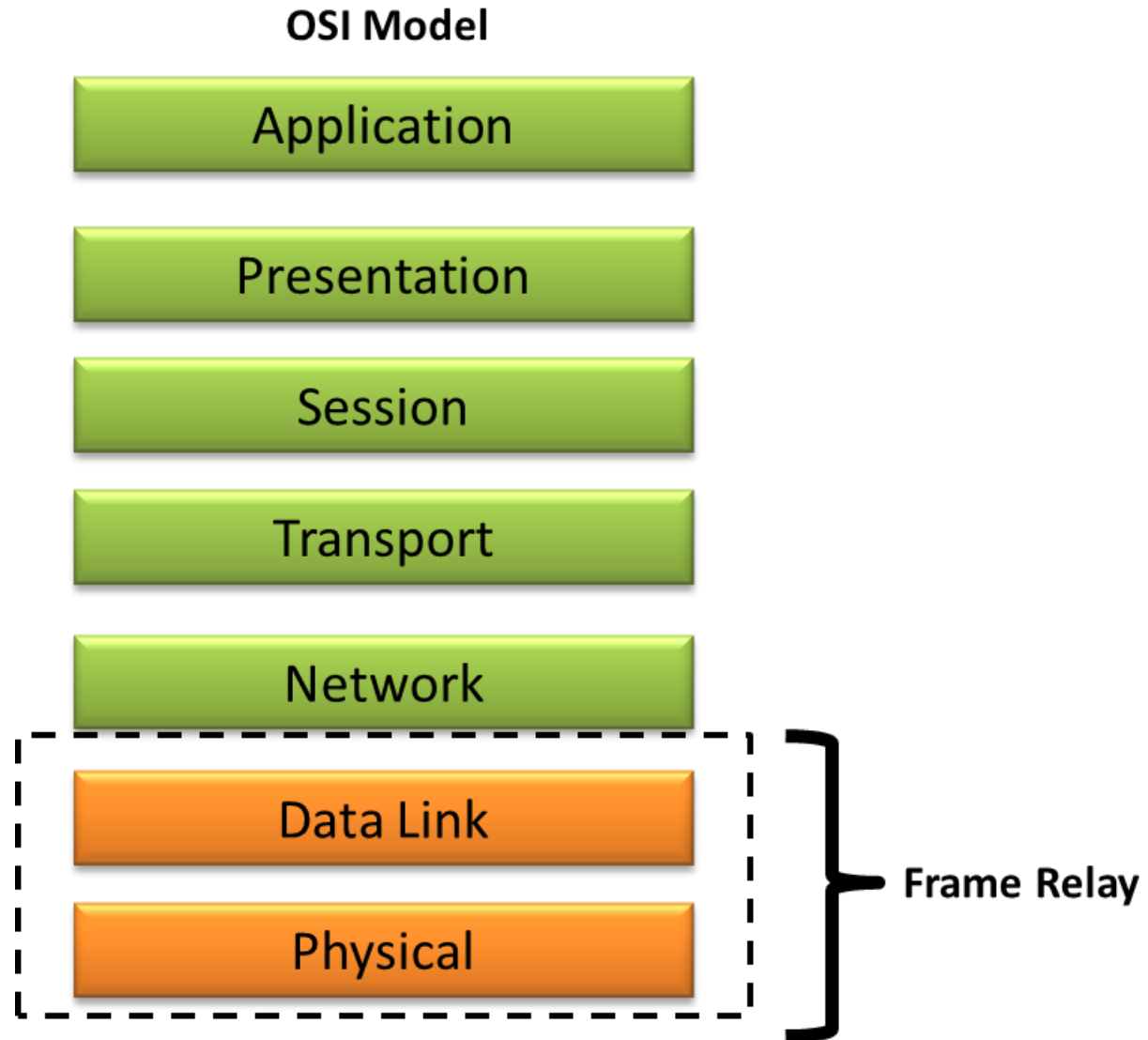
Why use Frame Relay?

- Reduced Overhead –
 - Much faster
 - Lower delays
 - Requires reliable links
- Outband signaling
- Good for bursty and variable traffic
- Cost effective multiplexed communications interface
- Congestion control

Protocol Features

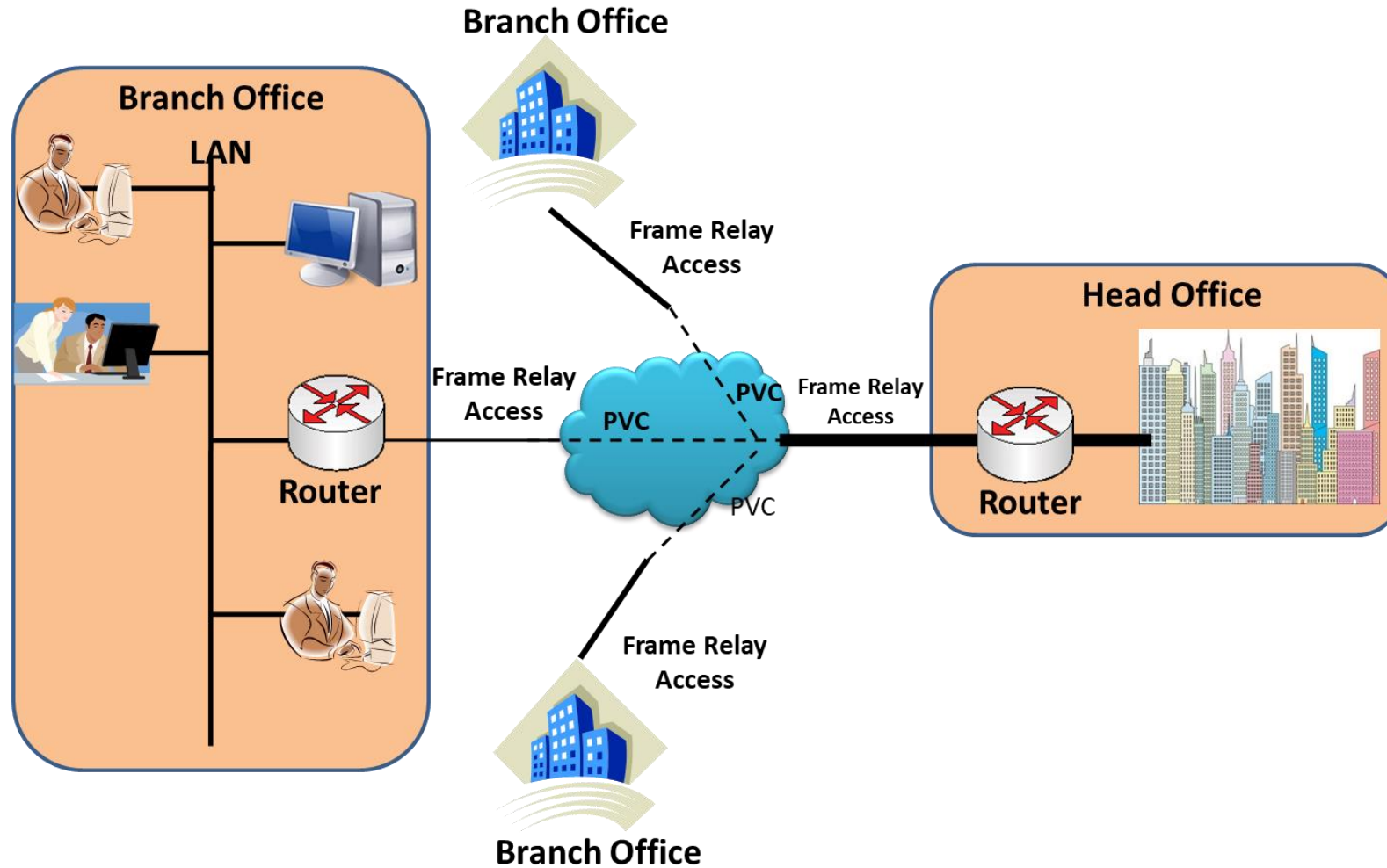
- Connection –oriented WAN technology based on packet (frame) switching
- Frames of variable length (up to 4096 bytes, typically 1600 bytes)
- High data rates at user-network interfaces (2Mbps, ultimately up to 45 Mbps)
- Bandwidth on demand
- No flow control mechanisms (nearly)
- No error control (but FCS) or retransmission mechanisms
- All protocol functions implemented at 2nd level (data link) of OSI model
- No standards for physical interface: can be X.21, V.35, G.703, G.704
- Option to create multiple aggregate column groups and prioritize the groups as per the requirement to display the summary results efficiently
- Allows the user to create search/filter criteria automatically from the current screen selection

Frame Relay in OSI Layer



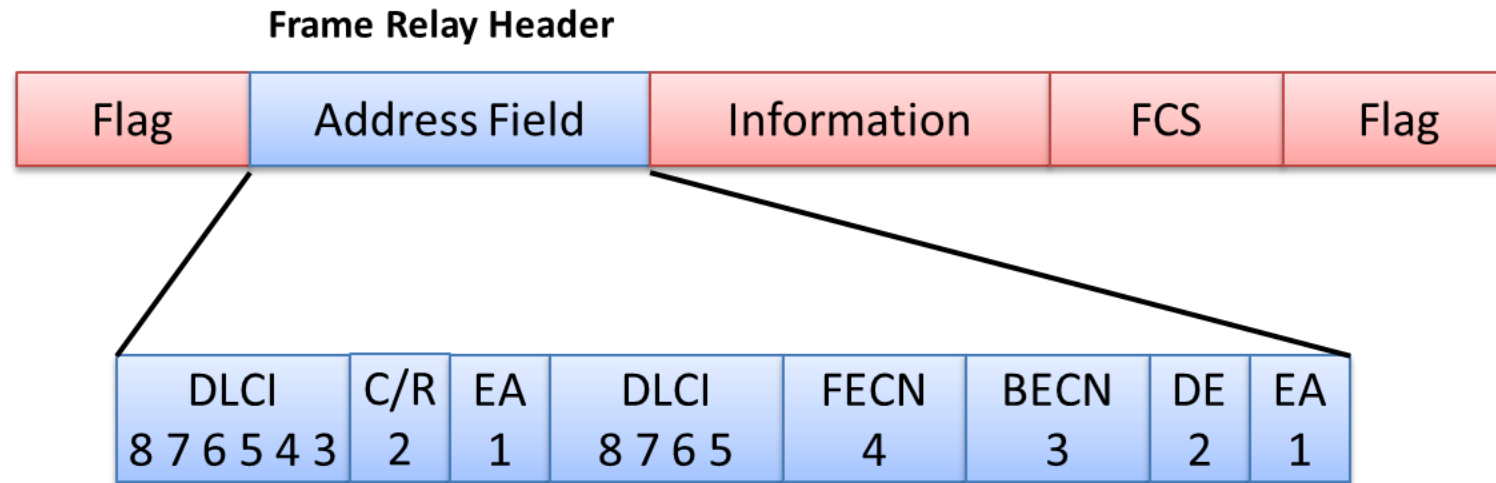
Frame Relay Network

- Data Terminal Equipment (DTE) – User device and the logical frame relay end-system
- Data Communication Equipment (DCE) – Comprises of modems and packet switches



Frame Relay Structure

- Frame Relay structure is based on the LAPD protocol
- Frame Relay header consists of DLCI, C/R, EA, FECN, BECN, and DE



Frame Relay Header Structure

DLCI – Datalink Connection Identifier

C/R – Command/Response

EA – Extended Address field

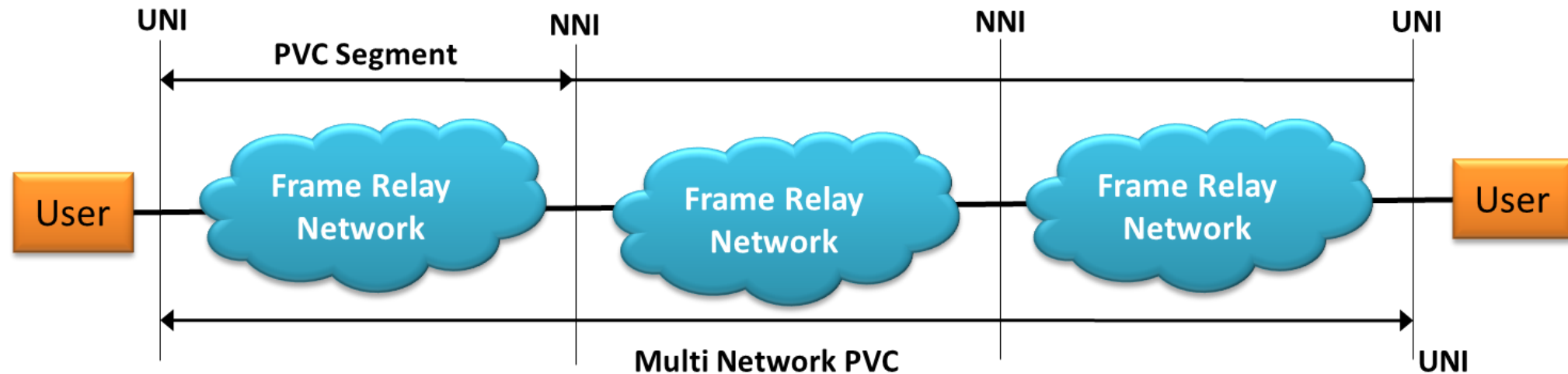
FECN – Forward Explicit Congestion Notification

BECN – Backward Explicit Congestion Notification

DE – Discard Eligibility

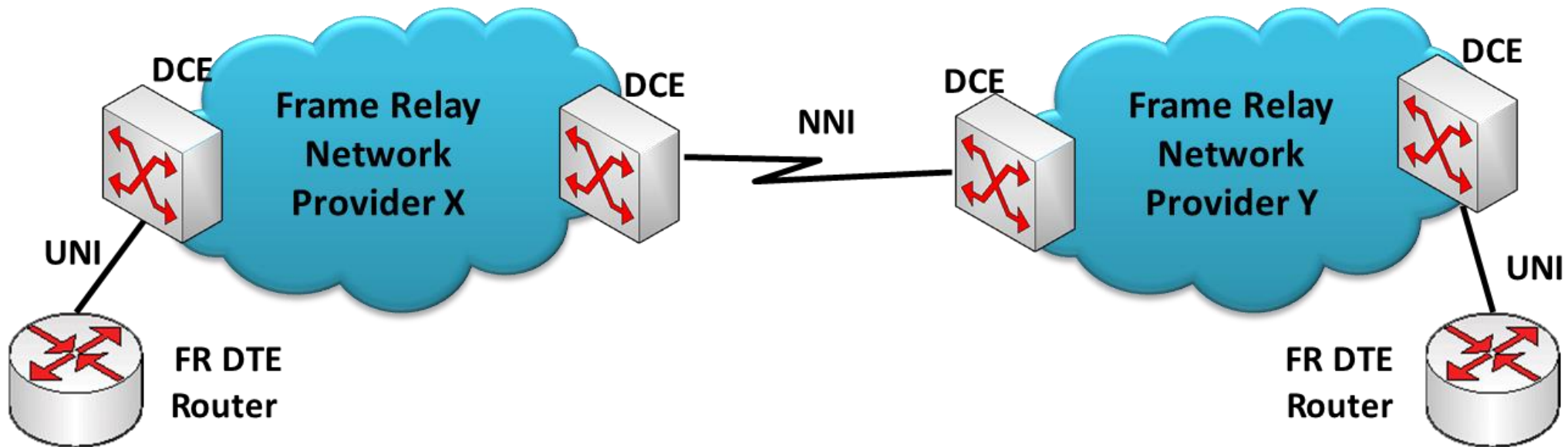
Frame Relay Interface Types

- User-to-Network Interface (UNI)
 - The DTE and DCE interfaces act as fragmentation and reassembly peers; UNI (DTE-DCE) fragmentation is used in order to allow real-time and data frames to share the same UNI interface between a DTE and the Frame Relay Network
- Network-to-Network Interface (NNI)
 - NNI connects different Frame Relay networks together
 - NNI interface standardizes DCE to DCE communication



Fragmentation

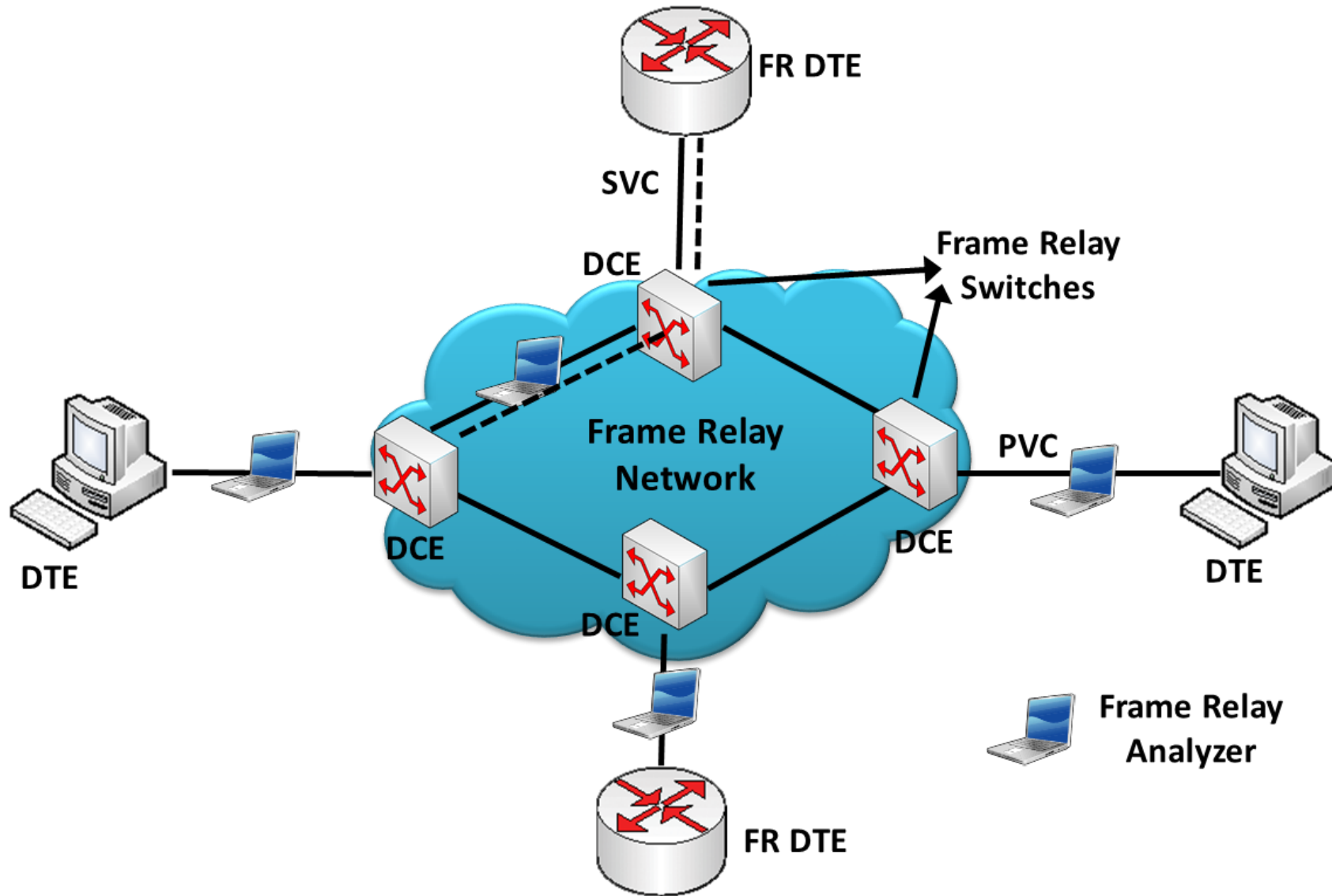
- Fragmentation allows to fragment long data frames into a sequence of shorter frames that are then reassembled into the original frame by the receiving peer DTE or DCE
- FRF.12 supports three fragmentation applications:
 - Locally across a Frame Relay UNI interface between the DTE/DCE peers
 - Locally across a Frame Relay NNI interface between DCE peers
 - End-to-End between two Frame Relay DTEs interconnected by one or more Frame Relay networks



Advantages

- Multiple virtual circuits can exist simultaneously across a given transmission line since virtual circuits consume bandwidth only when they transport data
- Each device can use more of the bandwidth as necessary, and thus operate at higher speeds
- Discard erroneous frames and eliminate time-consuming error-handling processing

GL's Frame Relay Analyzer



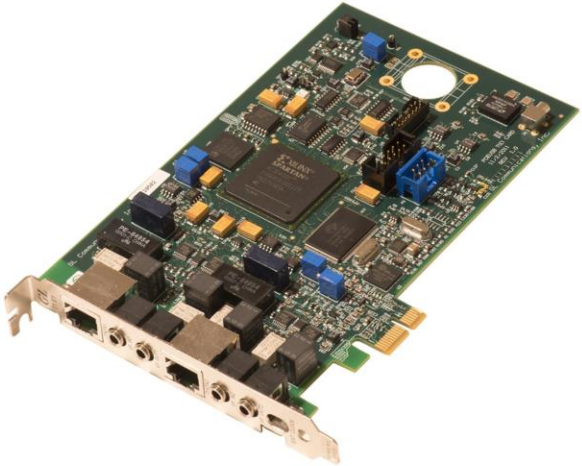
Supported Platforms



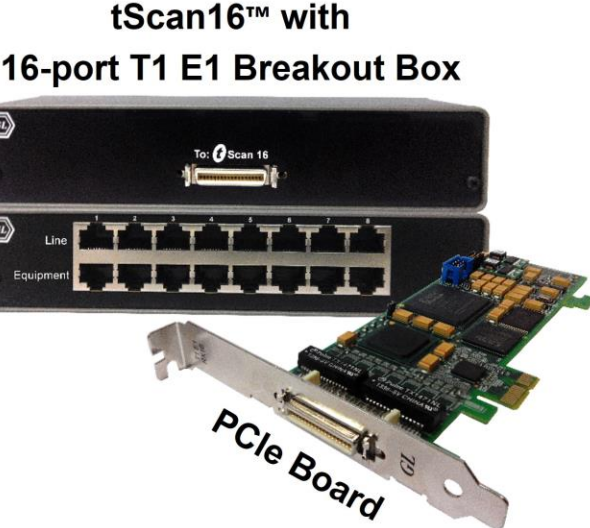
tProbe™ - Portable USB based T1 E1 VF FXO FXS and Serial Datacom Analyzer



Quad / Octal T1 E1 PCIe Card



Dual T1 E1 Express (PCIe) Board

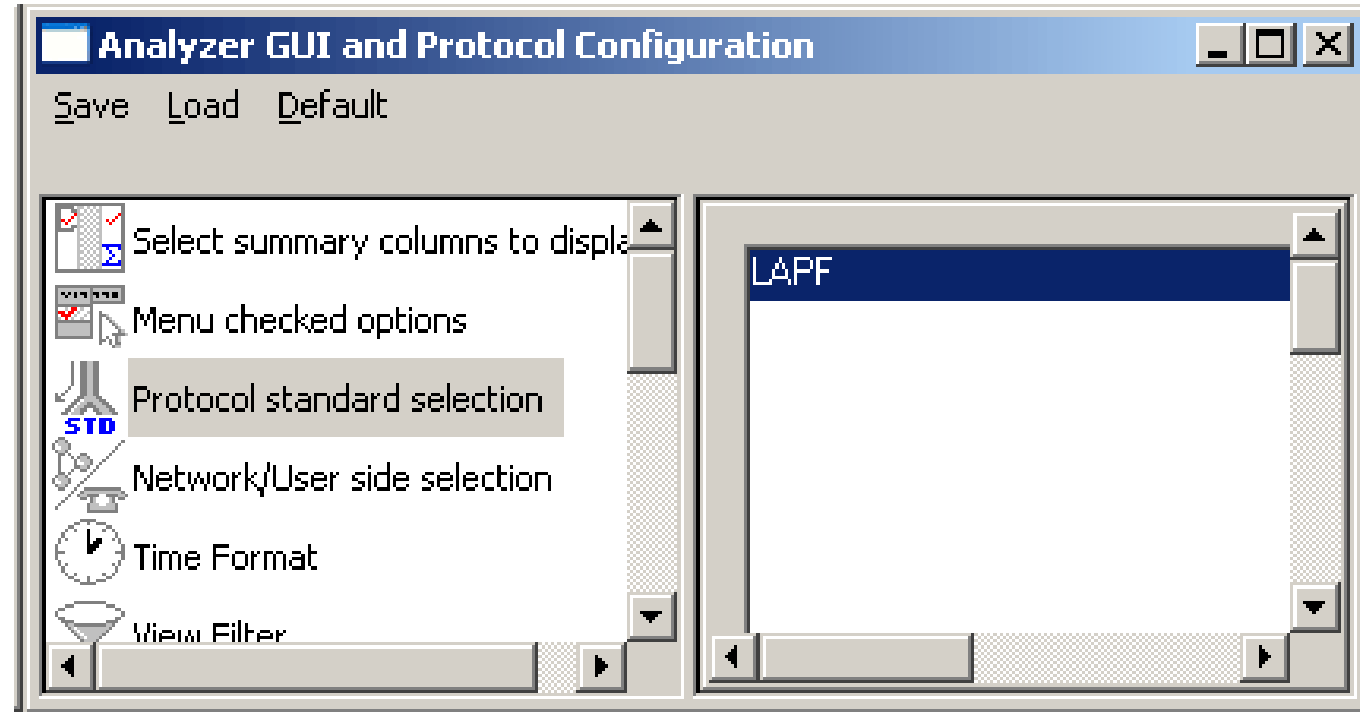
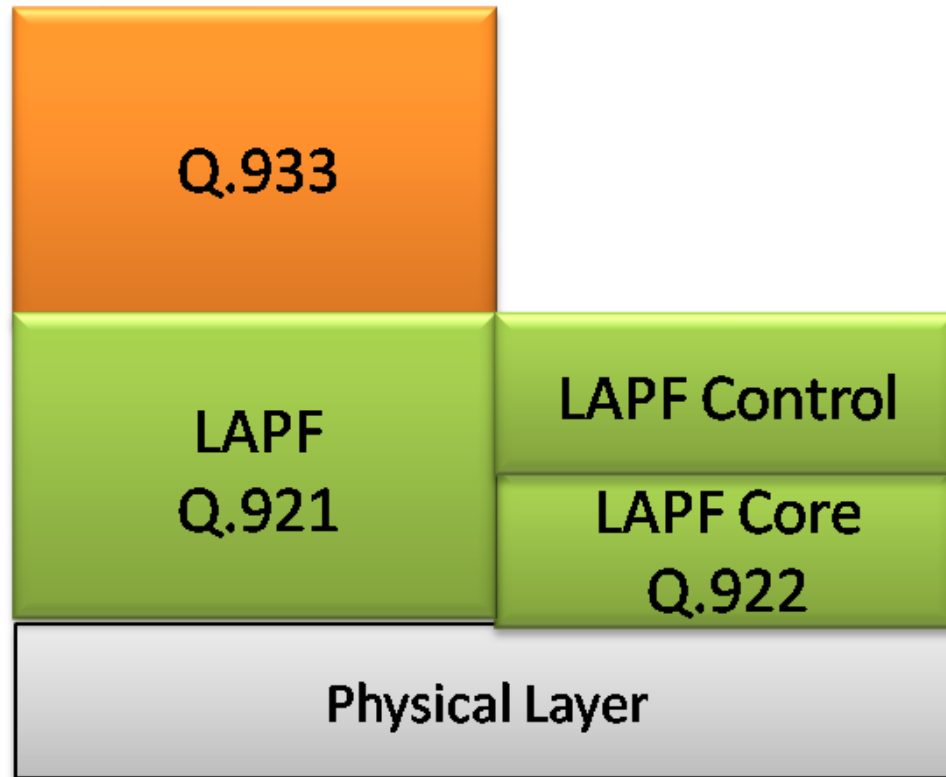


tScan16™ with 16-port T1 E1 Breakout Box

PCIe Board

Supported Protocols

- **LAPF** – Enhanced version of LAPD (Q.921) and decodes Layer 2 as Link Access Procedure/Protocol (LAPF) as defined in the ITU Q.922



Frame Relay Analysis

Frame Relay Protocol Analysis LAPF 64-bit

File View Capture Statistics Database Call Detail Records Configure Help

0 GoTo

Dev	TSlot	SubCh	Frame#	TIME (Relative)	Len	Error	NLPID Multiprotocol Encapsulation	Sequence Number FRF 12.1 Fragment	Destination IP Address IP	Source IP Address IP
✓ 2	1-31		0	00:00:00.000000	76		SNAP		74.125.135.100	192.168.1.56
✓ 2	1-31		1	00:00:00.000000	74		SNAP		74.125.135.100	192.168.1.56
✓ 2	1-31		2	00:00:00.000713	76		SNAP		74.125.128.103	192.168.1.56
✓ 2	1-31		3	00:00:00.000713	74		SNAP		74.125.128.103	192.168.1.56
✓ 2	1-31		4	00:00:00.055750	76		SNAP		192.168.1.56	74.125.135.100

Card2 TimeSlots=1-31 Frame=0 at 00:00:00.000000 OK Len=76 *** Right click to SHOW/HIDE layers

HDLC Frame Data + FCS

```

===== LAPF Layer =====
0000 Control bit           = ..0..... (0)
0000 Ending Fragment      = .1..... Yes
0000 Beginning Fragment   = 1..... Yes
0000 Sequence Number      = 291 (...0001. 00100011)
0002 EA                   = .....0 (0)
    
```

Hex Dump of the Frame Data

```

+-----+-----+-----+-----+-----+-----+
C3 23 00 D1 03 00 80 00 80 C2 00 07 00 17 C5 74   Å# N e eÅ Åt
EA 94 00 1C C0 1C EA 67 08 00 45 00 00 30 8D 14   ê! Å êg E 0
40 00 80 06 D9 F1 C0 A8 01 38 4A 7D 87 64 09 88   @ e ÜñÅ 8J}ld |
00 50 F5 50 2B D4 00 00 00 00 70 02 FF FF C4 60   P&P+Ô p yyÅ
00 00 02 04 05 R4 01 01 04 02 66 38               fR
    
```

Device #	Frame Count(Device #)
2	52
total 2	52

C:\Program Files\GL Communications Inc\U: 52 Frames

Summary view

Detail view

Hex dump view

Statistics view

Different Views

- **Summary View:** This pane displays the columns that contain Card Number, Timeslots, Frame Number, Time, Frame Error Status, Command/Response, Length, Error, C/R, SAPI, CTL, P/F, FUNC, and more in a tabular format
- **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

The screenshot displays a software interface for configuring a real-time analysis bundle. The main window is titled "Bundle 1" and contains several sections:

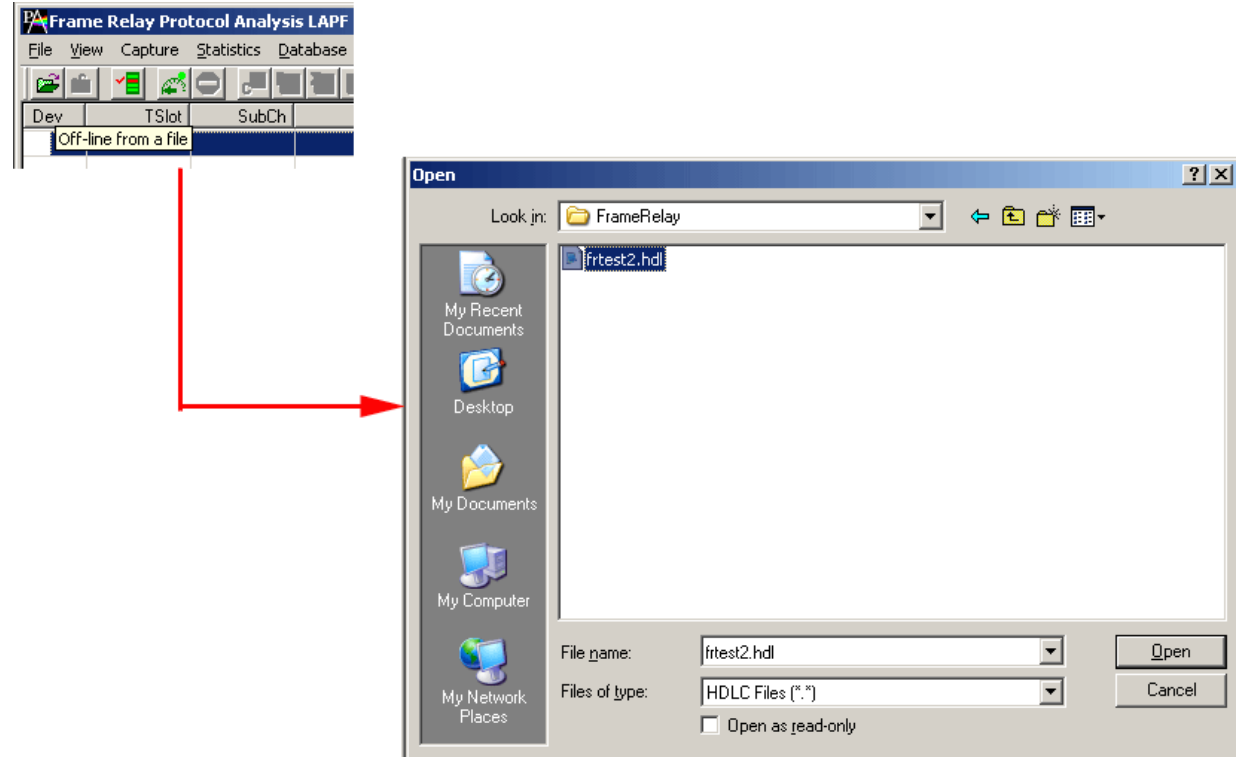
- Bundle 1:** Contains "Add Bundle" and "Delete Bundle" buttons.
- Card 1:** Contains "Add Link" and "Delete Link" buttons.
- Timeslot Selection:** A list of timeslots (TS) from 1 to 12. Below the list are "All TS" and "Clear TS" buttons.
- Data Transmission Rate:** Includes "Single Channel" (64 kbps selected, 56 kbps), "Hyper-Channel" (Nx64 kbps), and "Subchannels 8-56 kbps" (DS0 bits: 8, 16, 24, 32, 40, 48, 56). "All" and "None" buttons are present.
- Card and Timeslot Selection (Modal Dialog):** A dialog box with "Card Selection" (Cards 1, 2), "Timeslot Selection" (TS 1-12), "Data Transmission Rate" (64 kbps selected, 56 kbps), "Hyper-Channel" (Nx64 kbps, Nx56 Kbps (bits 1-7), Nx56 Kbps (Bits 2-8)), "Subchannels 8-56 kbps" (DS0 bits: 1-8), and "CRC" (CRC16). It has "All TS", "Clear TS", and "OK" buttons.
- Bit Inversion [1]:** A checkbox that is unchecked.
- Octet Bit Rever:** A checkbox that is unchecked.
- Selected Links:** A text field containing "TS 1:1..31".

Real-time Analysis

- Streams can be captured on the selected time slots (contiguous or non-contiguous), sub-channels (fractional DS0 to DS1) or full bandwidth
- Frames may also be contained in either one, n x 64 kbps, or n x 56 kbps data channels
- Capture frames based on Frame Relay options such as fragments and maximum differential delay
- Frames may also be captured based on their FCS (16 bits, 32 bits, none), bit inversion, octet bit reversion, user/network side options
- Recorded trace file can then be analyzed offline, exported to ASCII file, or printed

Offline Analysis

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



Offline Analysis using CLI

Off-line Frame Relay Protocol Analysis LAPF

File View Capture Statistics Database Call Detail Records Configure Help

0 GoTo

Dev	TS...	Su...	Frame#	TIME (Relative)	Len	Error	DLCI	DE	BECN	FECN	C
✓ 1	2		0	00:00:00.000000	40		256	0	0	0	L
✓ 1	2		1	00:00:00.000817	10		256	0	0	0	L
✓ 1	2		2	00:00:00.314571	10		256	0	0	0	L

Card1 T HDLC Fr
EA
C/R
DLCI

```

D:\>cd D:\Program Files\Gl Communications Inc\Fram Relay Analyzer
D:\Program Files\Gl Communications Inc\Fram Relay Analyzer>Frelprot framerelay\frtest2.hdl
D:\Program Files\Gl Communications Inc\Fram Relay Analyzer>_
  
```

Hex Dum
+-----
40 01 03 08 02 06 02 05 04 03 80 90 C3 18 03 A9 @ @
83 86 6C 08 80 35 35 35 36 30 30 30 70 08 80 36 ||1 |5556000p |6
37 30 34 37 38 34 C0 70 704784Ap

Call ID	Call Status	Calling Num	Called Num	Call Start Date & Time	Call Duration
0	completed	5556000	6704784	1601-01-01 00:00:00.000001	00:01:47.374180

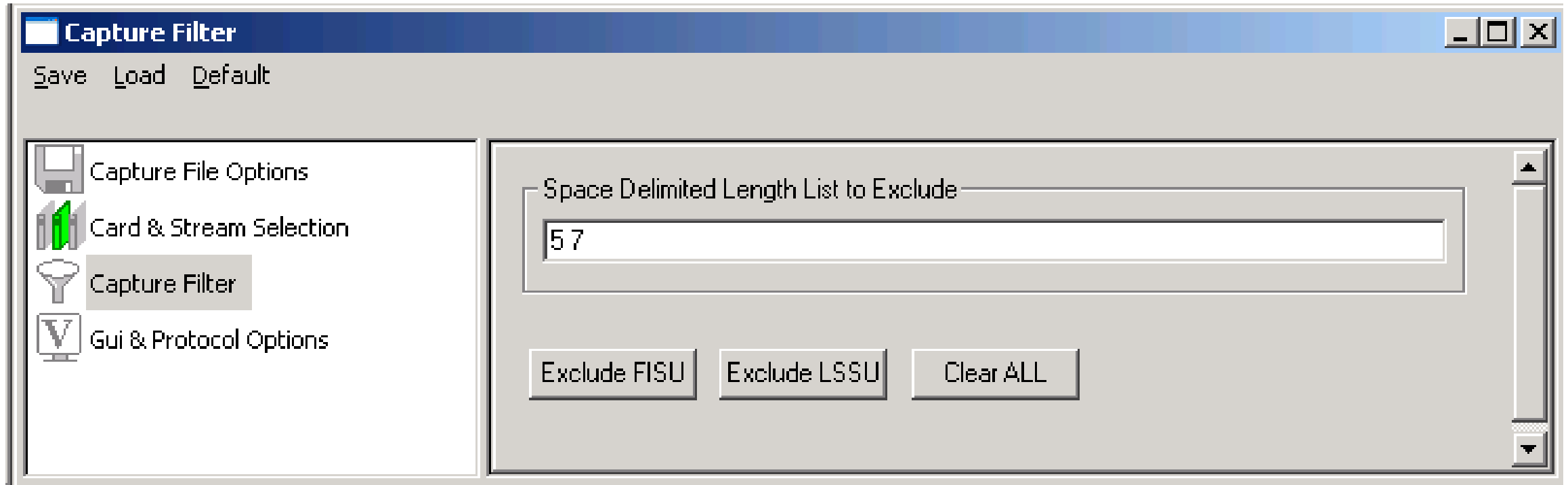
C:\Documents and Settings\root 4 Frames

Other Features

- Call trace defining important call specific parameters such as call ID, status (active or completed), duration, calling number, called number, release complete cause etc. are displayed
- Filter Frames (Real-time): Isolate certain specific frames from all frames in real-time as well as offline
- Filter Frames (Offline): The frames can be filtered after completion of capture based on BECN, FECN, DLCI, DE, NLPID, IP source and destination address, TCP & UDP source and destination port.
- Search features helps users to search for a particular frame based on specific search criteria
- 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

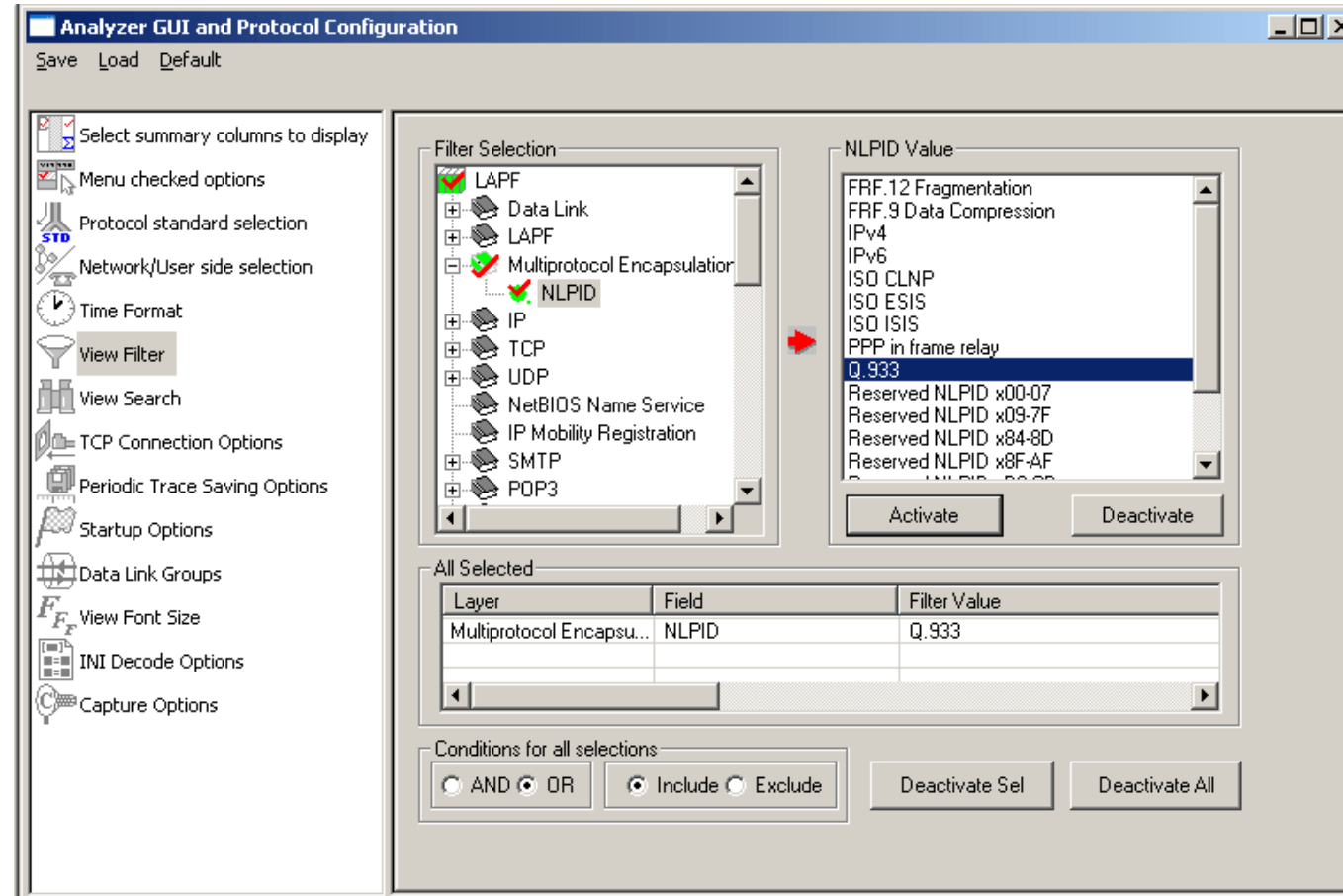
Filter Frames (Real-time)

- Isolate certain specific frames from all frames in real-time as well as offline
- Real-time Filter applies to the frames being captured and is based on the frame length



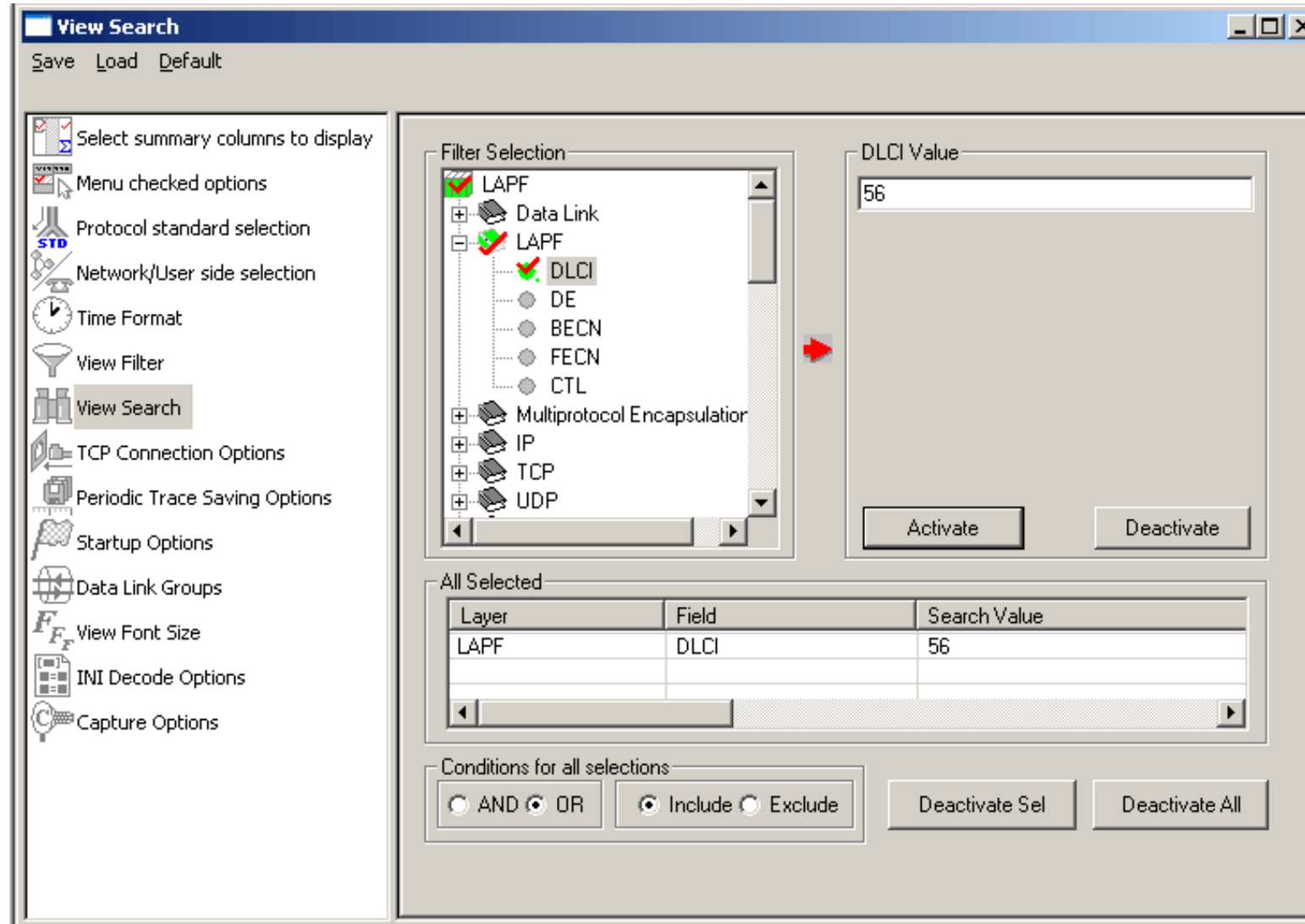
Filter Frames (Offline)

- Isolates required frames from all frames in real-time, as well as offline
- The frames can be filtered after completion of capture based on BECN, FECN, DLCI, DE, NLPID, IP source and destination address, TCP & UDP source and destination



Search Frames

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



Filtering Criteria From Screen Selection

- Allows the user to create filter criteria automatically from the current screen selection

The screenshot shows the 'Frame Relay Protocol Analysis LAPP 64-bit' application window. The main data table is as follows:

Dev	TSlot	SubCh	Frame#	TIME (Relative)	Len	Error	NLPID Multiprotocol Encapsulation	Sequence Number FRF 12.1 Fragment	Source IP A IP
✓ 2	1-31		0	00:00:00.000000	76		SNAP		192.168.1.56
✓ 2	1-31		1	00:00:00.000000	74		SNAP		192.168.1.56
✓ 2	1-31		2	00:00:00.000713	76		SNAP		
✓ 2	1-31		3	00:00:00.000713	74		SNAP		
✓ 2	1-31		4	00:00:00.055750	76		SNAP		
✓ 2	1-31		5	00:00:00.055750	74		SNAP		

A context menu is open over the second row, with 'Set Filter Criteria as Sel Values' selected. A dialog box titled 'Use Ctrl, Shift for Extended Selection' is open, showing a list of filter criteria: 'Multiprotocol Encapsulation::NLPID', 'IP::Destination IP Address', 'IP::Source IP Address', 'TCP::Destination Port', and 'TCP::Source Port'. The 'IP::Destination IP Address' option is selected. The dialog has 'OK', 'Select All', and 'Cancel' buttons.

The screenshot shows the 'Analyzer GUI and Protocol Configuration' window. The 'Filter Selection' pane is active, showing a tree view of protocol layers. The 'IP' layer is selected. The 'Value Selection' pane is empty. The 'All Selected' table is highlighted with a red box and contains the following data:

Layer	Field	Filter Value
Multiprotocol Encapsu...	NLPID	SNAP
IP	Destination IP Address	74.125.135.100

Below the table, there are radio buttons for 'AND' and 'OR' conditions, and radio buttons for 'Include' and 'Exclude' options. There are also 'Deactivate Sel' and 'Deactivate All' buttons.

Search Criteria From Screen Selection

- Allows the user to create search criteria automatically from the current screen selection

Frame Relay Protocol Analysis LAPP 64-bit

Dev	TSlot	SubCh	Frame#	TIME (Relative)	Len	Error	NLPID	Sequence Number	Source IP Ad
							Multiprotocol Encapsulation	FRF 12.1 Fragment	IP
✓ 2	1-31		0	00:00:00.000000	76		SNAP		192.168.1.56
✓ 2	1-31		1	00:00:00.000000	74		SNAP		
✓ 2	1-31		2	00:00:00.000713	76		SNAP		
✓ 2	1-31		3	00:00:00.000713	74		SNAP		
✓ 2	1-31		4	00:00:00.055750	76		SNAP		
✓ 2	1-31		5	00:00:00.055750	74		SNAP		

Context Menu:

- Search Selected Value
- Set Search Criteria as Sel Values
- Set Filter Criteria as Sel Values

Dialog Box: Use Ctrl, Shift for Extended Selection

- Multiprotocol Encapsulation::NLPID
- IP::Destination IP Address
- IP::Source IP Address
- TCP::Destination Port
- TCP::Source Port

Buttons: OK, Select All, Cancel

Analyzer GUI and Protocol Configuration

Save Load Default

- Select summary columns to di...
- 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
- Define Summary Columns
- Aggregate Summary Columns
- Capture Options

Filter Selection:

- ✓ LAPP
 - Data Link
 - LAPP
 - ✓ Multiprotocol Encapsulation
 - Q.933 Layer 3
 - SNAP
 - MAC
 - ARP
 - PPP over frame relay
 - Link Control Protocol RFC1
 - FRF 12.1 Fragment
 - IP

Value Selection:

Buttons: Activate, Deactivate

All Selected:

Layer	Field	Search Value
Multiprotocol Encapsu...	NLPID	SNAP
IP	Source IP Address	192.168.1.56

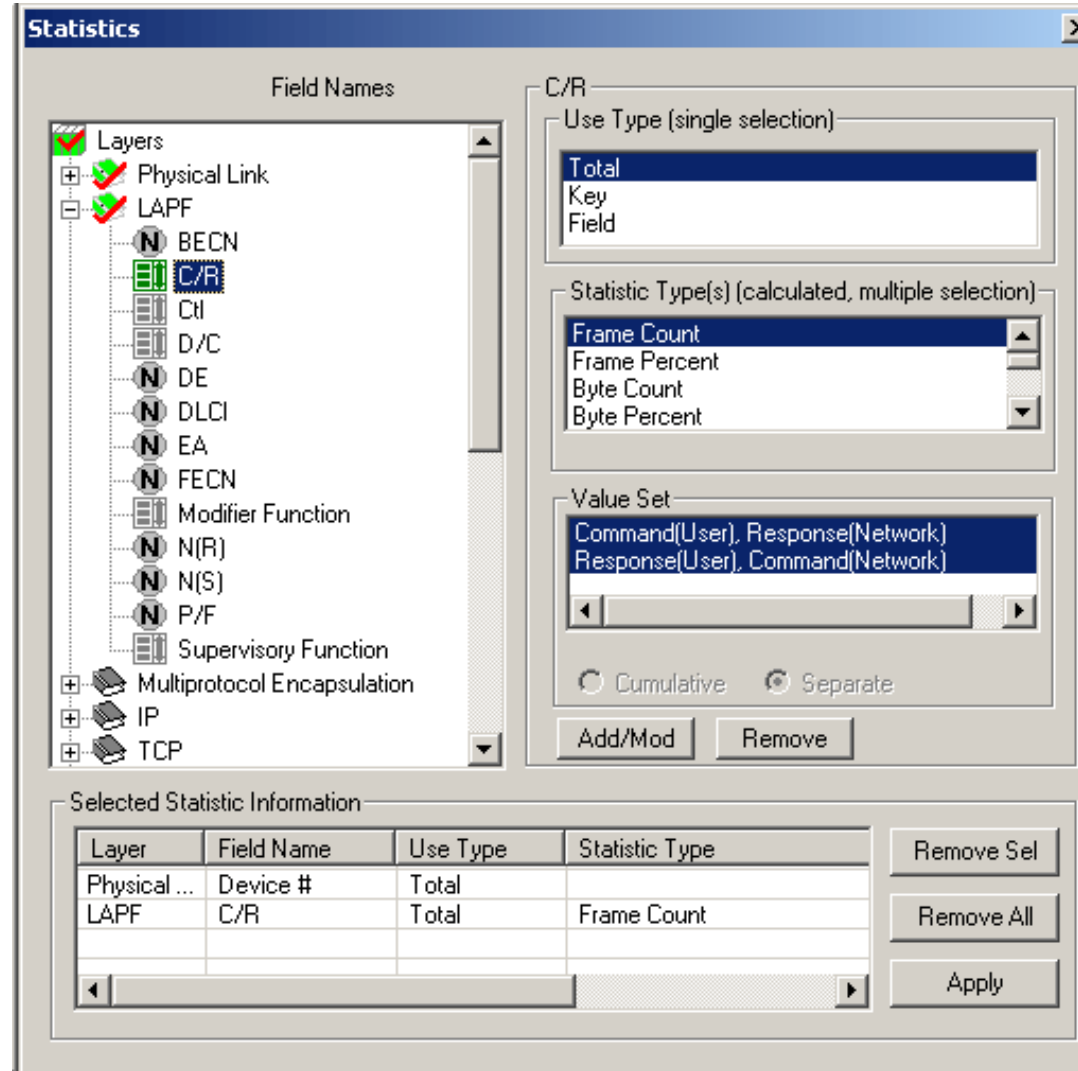
Conditions for all selections:

AND OR Include Exclude

Buttons: Deactivate Sel, Deactivate All

Statistics

- Numerous statistics can be obtained to study the performance and trend in the network



Call Detail Records View

- Call trace defining important call specific parameters such as call ID, status (active or completed), duration, calling number, called number, release complete cause etc. are displayed

The screenshot shows the 'Call Detail Records' view in the 'Frame Relay Protocol Analysis LAPP' application. The main window displays a table of frames with the following columns: Dev, TS..., Su..., Frame#, TIME (Relative), Len, DLCI, DE, BECN, FECN, CTL, NLPID. The data rows are as follows:

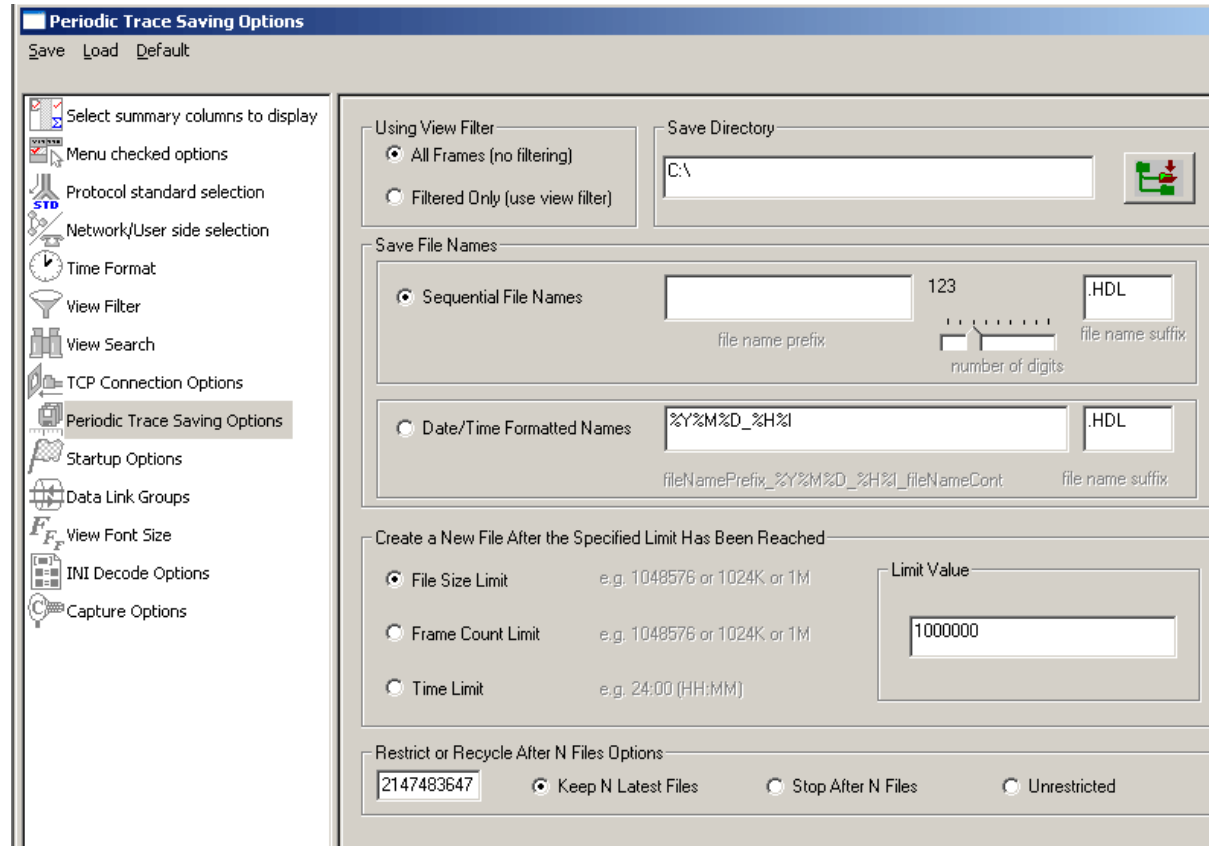
Dev	TS...	Su...	Frame#	TIME (Relative)	Len	DLCI	DE	BECN	FECN	CTL	NLPID
2	0		0	00:00:00.000000	45	416	0	0	0	Unnu...	PPP in fra
2	0		1	00:00:00.296748	45	416	0	0	0	Unnu...	PPP in fra
1	0		2	00:00:00.443543	20	56	0	0	0	Unnu...	PPP in fra
1	0		3	00:00:00.561277	16	0	0	0	0	Unnu...	Q.933
1	0		4	00:00:00.573712	20	40	0	0	0	Unnu...	PPP in fra
2	0		5	00:00:00.596578	45	416	0	0	0	Unnu...	PPP in fra
2	0		6	00:00:00.896409	45	416	0	0	0	Unnu...	PPP in fra
2	0		7	00:00:01.299238	45	416	0	0	0	Unnu...	PPP in fra

Below the main table is a summary table with the following columns: Call ID, Call Status, Calling Num, Called Num, Call Start Date & Time, Call Duration. The data row is as follows:

Call ID	Call Status	Calling Num	Called Num	Call Start Date & Time	Call Duration
0	completed	5556000	6704784	1601-01-01 00:00:00.000001	00:01:47.374180

Saving a File

- Captured trace files can be controlled by saving the trace using different conventions such as –
 - Trace files with user-defined prefixes
 - Trace file with date-time prefixes
 - Slider control to indicate the total number of files, file size, frame count, or time limit



Define Summary Columns

- Add or remove any protocol fields through Define Summary Column option

Selection of Summary Column ←

Output display in analyzer ←

Dev	TSlot	SubCh	Frame#	TIME	Len	Error	DLCI	EA	DE	BECCN	FECCN	CTL	Sequence Number
✓ 2	1-31		0	00:00...	182		3	1	0	1	1	Infor...	
✓ 2	1-31		1	25:21...	410		3	1	0	1	1	Infor...	
✓ 2	1-31		2	00:00...	244		3	1	0	1	1	Infor...	
✓ 2	1-31		3	00:00...	76		3	1	0	1	1	Infor...	
✓ 2	1-31		4	00:00...	76		3	1	0	1	1	Infor...	
✓ 2	1-31		5	00:00...	76		3	1	0	1	1	Infor...	
✓ 2	1-31		6	00:00...	76		3	1	0	1	1	Infor...	
✓ 2	1-31		7	00:00...	76		3	1	0	1	1	Infor...	

```
Card2 TimeSlots=1-31 Frame=0 at 13:52:45.690524 OK Len=182
HDLC Frame Data + FCS
***** LAPF Layer *****
Control bit                = .1..... (1)
Ending Fragment            = .1..... Yes
Beginning Fragment        = 1..... Yes
Sequence Number           = 3843 (...1111. 00000011)
EA                         = .....0 (0)
C/R                       = .....0. Command(User). Response(Network)
DLCI                      = 3 (000000... 0011....)
FCS
```

Hex Dump of the Frame Data

```
FF 03 00 3D C0 00 0C 3C 00 21 45 00 00 AA F9 89  y =A < IE #a|
40 00 3F 06 C9 3C CA AE 9C 22 48 25 C9 91 06 B8  @ ? E<E@|HxE'
E8 9F 00 44 EE F3 4C 96 B9 52 80 18 00 D7 08 84  è| DióL|R| x |
00 00 01 01 08 0A 02 73 1B B2 02 53 6A 22 03 00  s | Sj*
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

Aggregate Group Column

- The user can create multiple aggregate column groups and prioritize the groups as per the requirement to display the summary results efficiently

The image shows two overlapping windows from a network analysis application. The top window is the 'Aggregate Summary Columns' dialog, which allows users to define custom summary columns. It features a list of configuration options on the left and a table for defining columns on the right. The bottom window is a network analysis tool displaying a table of captured frames with a custom 'Group~0' column highlighted in red.

Aggregate Summary Columns Dialog Configuration:

Name	Display Format	Summary Columns	Separator
Group~0	Concat	NLPID_Multiprotocol Encapsulation Destination IP Address_IP	&
Group~1	<Col_Alias> Value	POP3 Message_POP3	
Group~2	Overlay	Destination Port_TCP	

Network Analysis Tool Data Table:

TSlot	SubCh	Frame#	TIME (Relative)	Len	Group~0	Error	NLPID Multiprotocol Encapsulation	Sequence Number FRF 12.1 Fragment	Source IP Address IP	Destination IP Address IP
1-31		0	00:00:00.000000	76	SNAP & 74.125.135.100		SNAP		192.168.1.56	74.125.135.100
1-31		1	00:00:00.000000	74	SNAP & 74.125.135.100		SNAP		192.168.1.56	74.125.135.100
1-31		2	00:00:00.000713	76	SNAP & 74.125.128.103		SNAP		192.168.1.56	74.125.128.103
1-31		3	00:00:00.000713	74	SNAP & 74.125.128.103		SNAP		192.168.1.56	74.125.128.103
1-31		4	00:00:00.055750	76	SNAP & 192.168.1.56		SNAP		74.125.135.100	192.168.1.56
1-31		5	00:00:00.055750	74	SNAP & 192.168.1.56		SNAP		74.125.135.100	192.168.1.56
1-31		6	00:00:00.056463	68	SNAP & 74.125.135.100		SNAP		192.168.1.56	74.125.135.100
1-31		7	00:00:00.056463	66	SNAP & 74.125.135.100		SNAP		192.168.1.56	74.125.135.100
1-31		8	00:00:00.057141	76	SNAP & 74.125.128.103		SNAP		192.168.1.56	74.125.128.103
1-31		9	00:00:00.057141	74	SNAP & 74.125.128.103		SNAP		192.168.1.56	74.125.128.103
1-31		10	00:00:00.088036	76	SNAP & 192.168.1.56		SNAP		74.125.128.103	192.168.1.56
1-31		11	00:00:00.088036	74	SNAP & 192.168.1.56		SNAP		74.125.128.103	192.168.1.56

Network Analysis Tool Details:

```
Card2 TimeSlots=1-31 Frame=0 at 00:00:00.000000 OK Len=76
HDLC Frame Data + FCS
----- LAPF Layer -----
0000 Control bit          = ..0.... (0)
0000 Ending Fragment     = .1..... Yes
0000 Beginning Fragment  = 1..... Yes
0000 Sequence Number     = 291 (...0001. 00100011)
0002 EA                  = .....0 (0)
0002 C/R                 = .....0. Command(User). Response(Network)
0002 DLCI                = 13 (000000.. 1101....)
0003 EA                  = .....1 (1)
0003 DE                  = .....0. (0)
0003 BECN               = ....0.. (0)
0003 FECN               = .....0 (0)
```

Data Link Group

- Data link groups that help in defining the direction of the calls in each network and form logical groups comprised of unidirectional (either 'Forward' or 'Backward') data links

Data Link Group Specification

Card	Timeslot	Subch
01	00	0
02	01	1
03	02	2
04	03	3
05	04	4
06	05	5
07	06	6
08	07	7
09	08	
10	09	
11	10	
12	11	
13	12	
14	13	
15	14	
16	15	
17	16	
18	17	
19	18	
20	19	

Data Link Group Name:

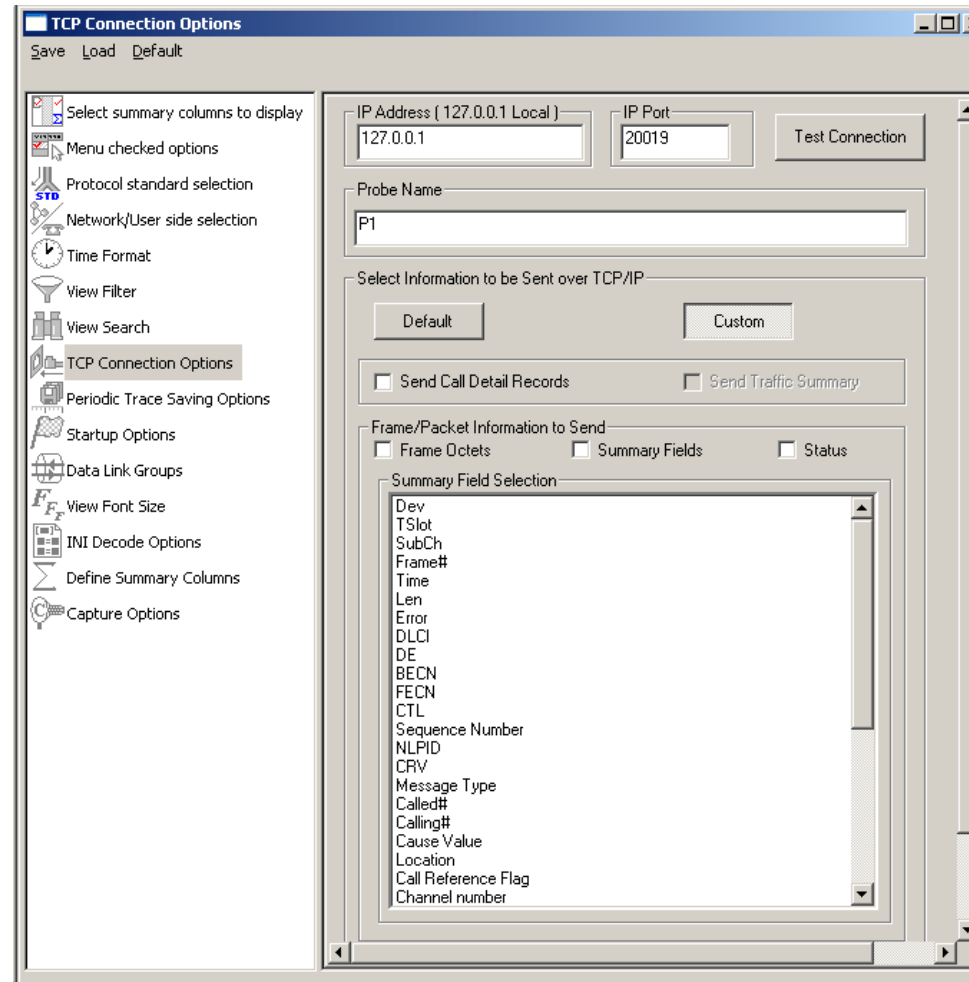
Forward Link Direction

Buttons: Add, Odd Cards, Even Cards, All Cards, None, Delete Sel, Delete All, Default

Card	TS	Sc	Dir	Data Link Group Name
1	0	0	-->	West
2	1	1	<--	West
3	2	0	-->	West
4	3	1	<--	West
5	0	0	-->	East
6	1	1	<--	East
7	2	0	<--	East
8	3	1	-->	East

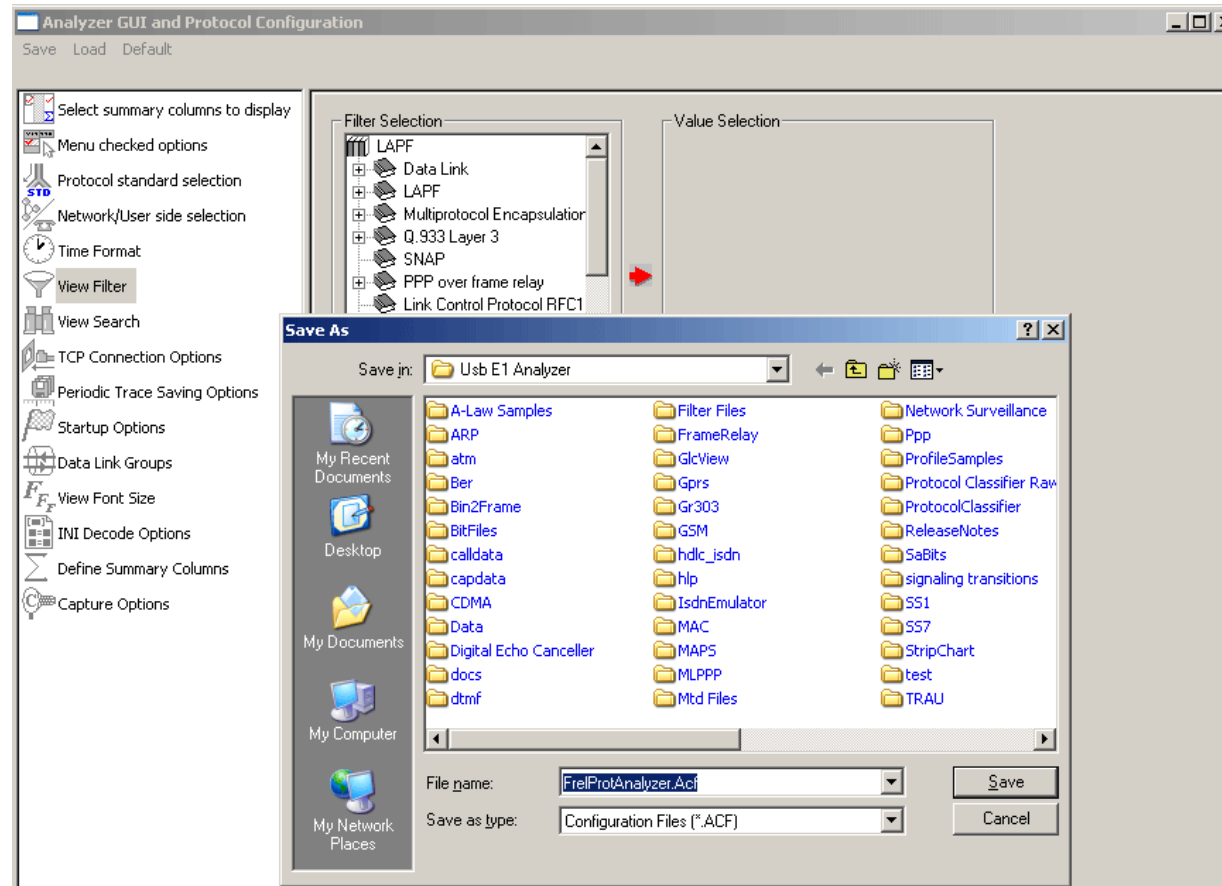
TCP Connection Options

- Used for Network Surveillance and Monitoring
- Designed to send protocol summary information and binary frame data via TCP- IP connection to a Database Loader to load data into a database



Save/Load All Configuration Settings

- Protocol Configuration window provides a consolidated interface for all the settings required in the analyzer such as protocol selection, filter criteria, search criteria, 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



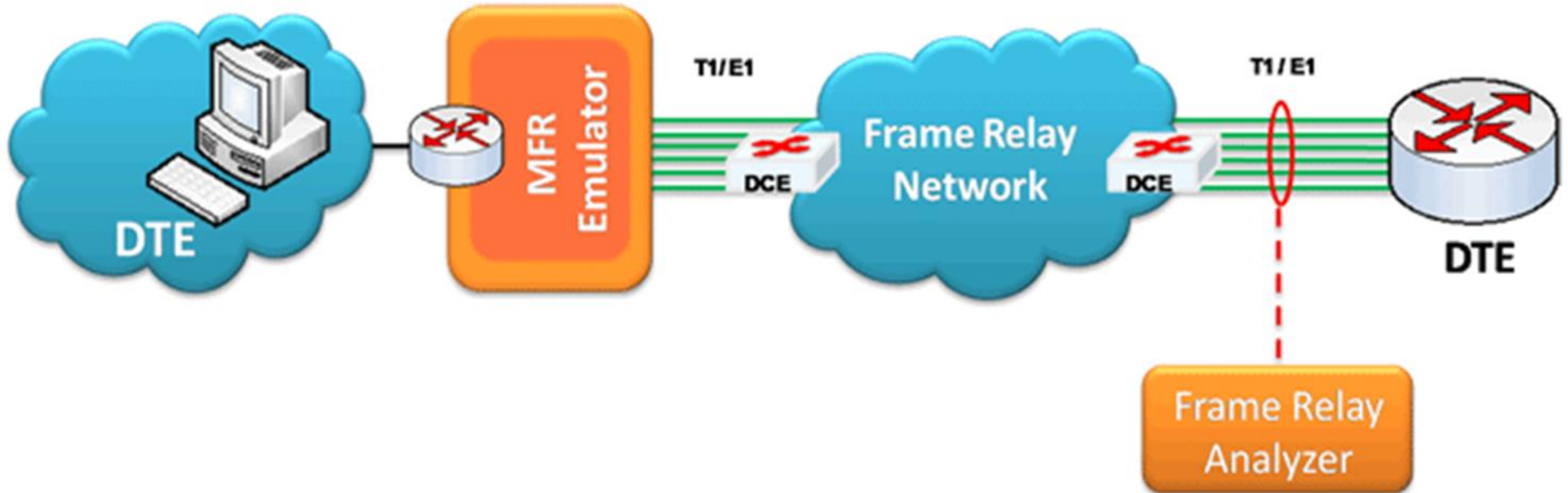
Applications

- Can be used as independent standalone units as "probes" integrated in a network surveillance systems
- Triggering, collecting, and filtering for unique subscriber information and relaying such information to a back-end processor
- Collecting Call Detail Records (CDR) information for billing
- Numerous statistics can be obtained to study the performance and trend in the network

Multi-Link Frame Relay Emulation using Client-Server

MFR Emulator

- GUI based WCS client, which simulates Multi-Link Frame Relay Emulation
- Capable of generating and receiving MFR/FR traffic (with or without impairments)
- Traffic source can be sequence number, HDL files (containing packets/frames), flat binary file, user-defined frames (ASCII HEX file), and Ethernet data



FR Simulation

The screenshot shows the MFR Emulator interface. At the top, the title bar reads "MFR Emulator - FR Simulation - Untitled". Below the title bar is a menu bar with "File", "Action", "Simulation", and "Help". A "Server Connection Status" indicator shows a green light. The main area has a tabbed interface with "Link View", "Action", "VC Statistics", and "Tx/Rx Verification" tabs. The "Link View" tab is active, displaying a table with the following data:

Link Name	Action	Status
#1:1..10	Open	Down
#1:11..20	Open	Down
#1:21..30	Open	Down

Below the table are buttons for "Add", "Delete", "Open", and "Close". At the bottom, there are tabs for "Link Config", "Impairments", "Statistics", and "HDLC Statistics". The "Link Config" tab is active, showing a "Fragmentation" section with a "Fragment Size" input field, radio buttons for "UNI NNI Fragmentation" and "End to End Fragmentation", and a "Flags between Hdlc frames" checkbox with an input field.

MFR Simulation

MFR Emulator - MFR Simulation - Untitled

File Action Simulation Help

Server Connection Status ●

Bundles	Status
1	DOWN
2	No Links

Link View | Action | VC Statistics | Tx/Rx Verification | Bundle Config & Statistics

Link Name	Action	Status
#1:1..5	Open	Down
#1:11..15	Open	Down
#1:6..10	Open	Down

Add Delete Open Close

Link Config | Impairments | Statistics | HDLC Statistics

Fragmentation

Fragment Size

Flags between Hdlc frames

UNI NNI Fragmentation

End to End Fragmentation

Bundle ID

Add Delete

Open Close

Supported Standards

- FRF12 – This supports Frame Relay Fragmentation Implementation Agreement

Features

- Performs MFR as well as FR simulation on up to 16 T1 E1 lines; Group FR links to create a MFR bundle with each bundle/link configured with multiple virtual channels for traffic Tx/Rx
- FR links can be created on Full or Fractional Timeslots
- Supports hyper channels with discontinuous (sparse) timeslots
- Dynamically add/remove (open/close) of Frame Relay links without loss in data
- Multiple MFR Bundles/FR links can be created
- Generate and verify end to end traffic on each Virtual Channel
- User configurable FR/MFR packet and fragment size, bandwidth using flags, and maximum link differential delay
- Payload traffic generation and verification using Sequence number, pre-captured HDL files (containing packets/frames), Flat Binary file, and User defined frame (ASCII HEX file) for each Virtual Channel independently

Features

- Supports both Interface (UNI and NNI) and End-to-End fragmentation
- Transmit and receive Ethernet traffic over T1 E1 links by operating either in bridge or router mode
- Supports various Byte level, Frame level , CRC error, and Frame error impairments at link level
- Supports various Byte level and Frame level impairments at Fragment/Packet level for each Virtual Channel
- Provides detailed statistics for each bundle and virtual channels associated with a bundle
- Provides end to end traffic verification statistics
- Ideal solution for automated testing using command line scripts

FR Simulation

Adding Links

- Supports up to 16 T1 E1 links
- Timeslot of 64 Kbps or a Hyper Channels of n*64 Kbps or sub channels can also be used
- Supports hyper channels with continuous or discontinuous timeslots
- Each link is independent and can be configured with the selected 'Link Config' options

Added Links

The screenshot shows the MFR Emulator interface. The main window has a menu bar (File, Action, Simulation, Help) and a 'Server Connection Status' indicator (green dot). A 'Links' dropdown menu shows '#1:1'. Below this is a table with columns 'Link Name', 'Action', and 'Status'. The table contains three rows: '#1:1', '#1:2', and '#1:3', all with 'Open' in the Action column and 'Down' in the Status column. A 'Port And Timeslot Selection' dialog box is open, showing a 'Port Number' list with 1 and 2 selected, a 'Timeslot' list with 1 through 15, and a 'Subchannels 8-56 kbps' section with radio buttons for 8, 16, 24, 32, 40, 48, 56, and 64. The 'D50 bits' section has a list with 1 through 8, and 'All' and 'None' buttons. An 'Add' button is at the bottom right of the dialog.

Link Name	Action	Status
#1:1	Open	Down
#1:2	Open	Down
#1:3	Open	Down

Link Configuration

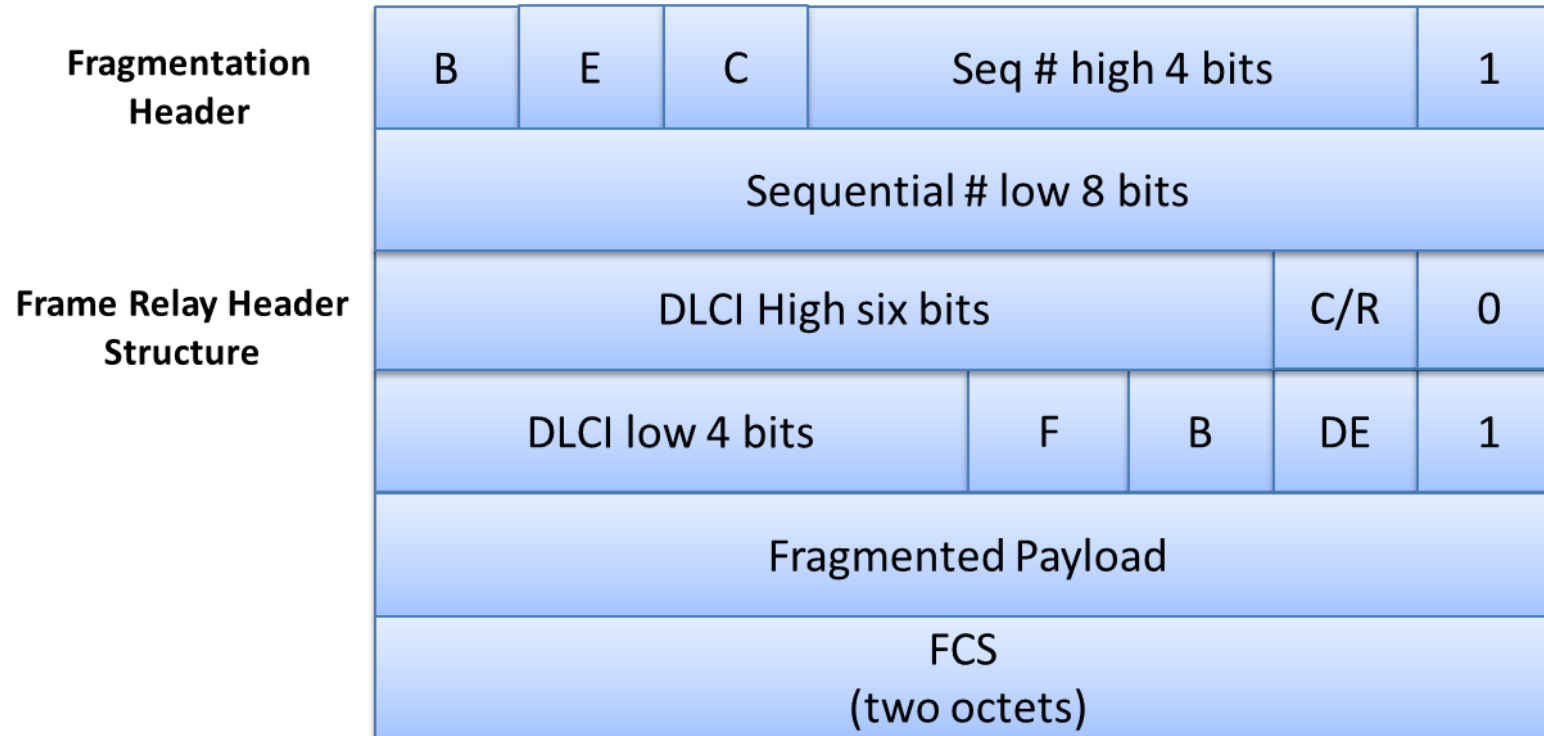
Link configuration is an optional feature, and the following values are negotiated when enabled

- Fragmentation Size: By default, the fragment size is 256. User can specify Fragment Size as required
- UNI NNI Fragmentation
- End to End Fragmentation
- Flags between Hdlc frames: This defines the number of flags to be inserted between HDLC frames the default value is 100

The screenshot displays a configuration window with four tabs: "Link Config", "Impairments", "Statistics", and "HDLC Statistics". The "Link Config" tab is active. It features a "Fragmentation" checkbox which is checked. Below this checkbox is a text input field for "Fragment Size" containing the value "256". To the right of this field is another checked checkbox labeled "Flags between Hdlc frames" with a corresponding text input field containing the value "100". Below the "Fragment Size" field is a sub-panel containing two radio button options: "UNI NNI Fragmentation" (which is selected) and "End to End Fragmentation".

UNI NNI Fragmentation

- UNI NNI Fragmentation: In UNI and NNI fragmentation, the frame starts with the fragmentation header, followed by the Frame Relay header

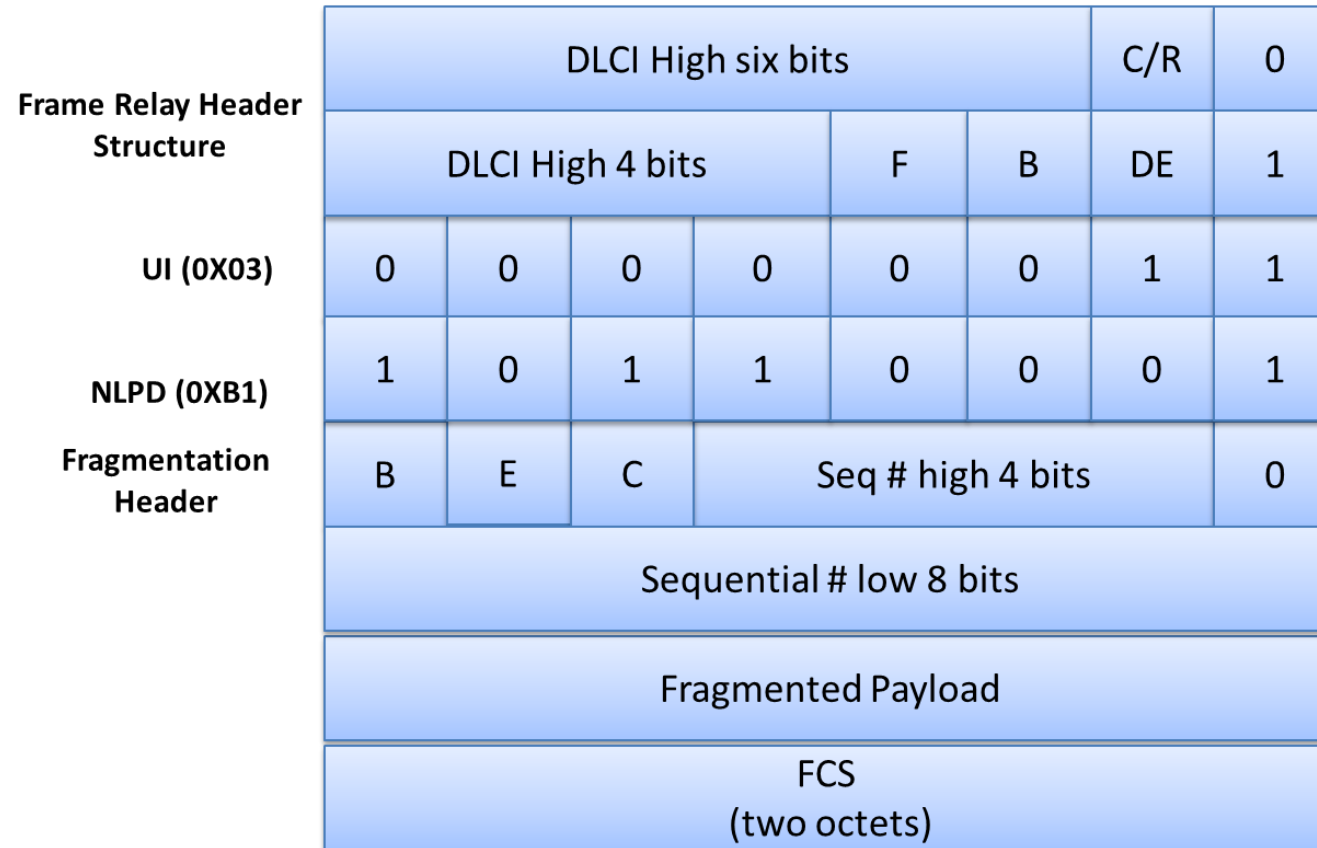


DLCI – Datalink Connection Identifier
 C/R – Command/Response
 DE – Discard Eligibility

B – Beginning Fragment Bit
 E – Ending Fragment Bit
 C – Control Bit

End to End Fragmentation

- End to End Fragmentation: End-to-End fragmentation is used between peer DTEs and is restricted to use on PVCs only. The Network Layer Protocol ID (NLPID) will be set to 0xB1

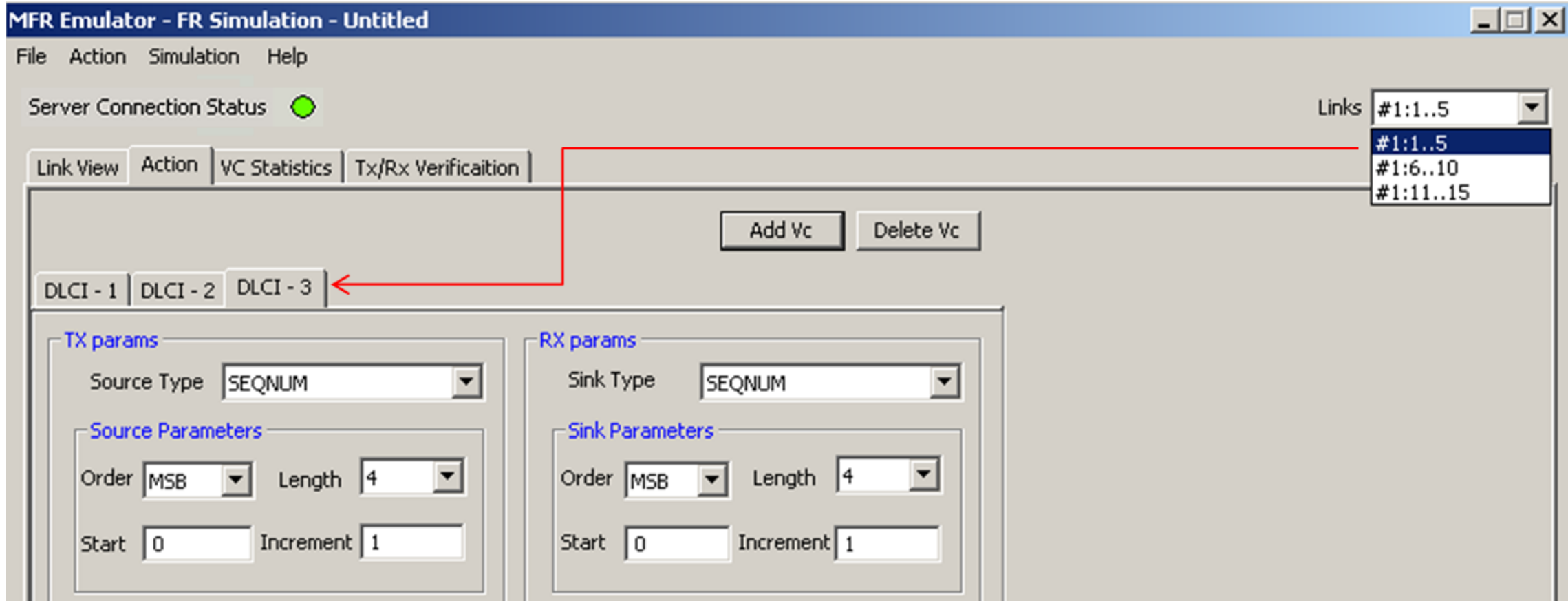


DLCI – Datalink Connection Identifier
 C/R – Command/Response
 DE – Discard Eligibility

B – Beginning Fragment Bit
 E – Ending Fragment Bit
 C – Control Bit

Adding VC in FR Simulation

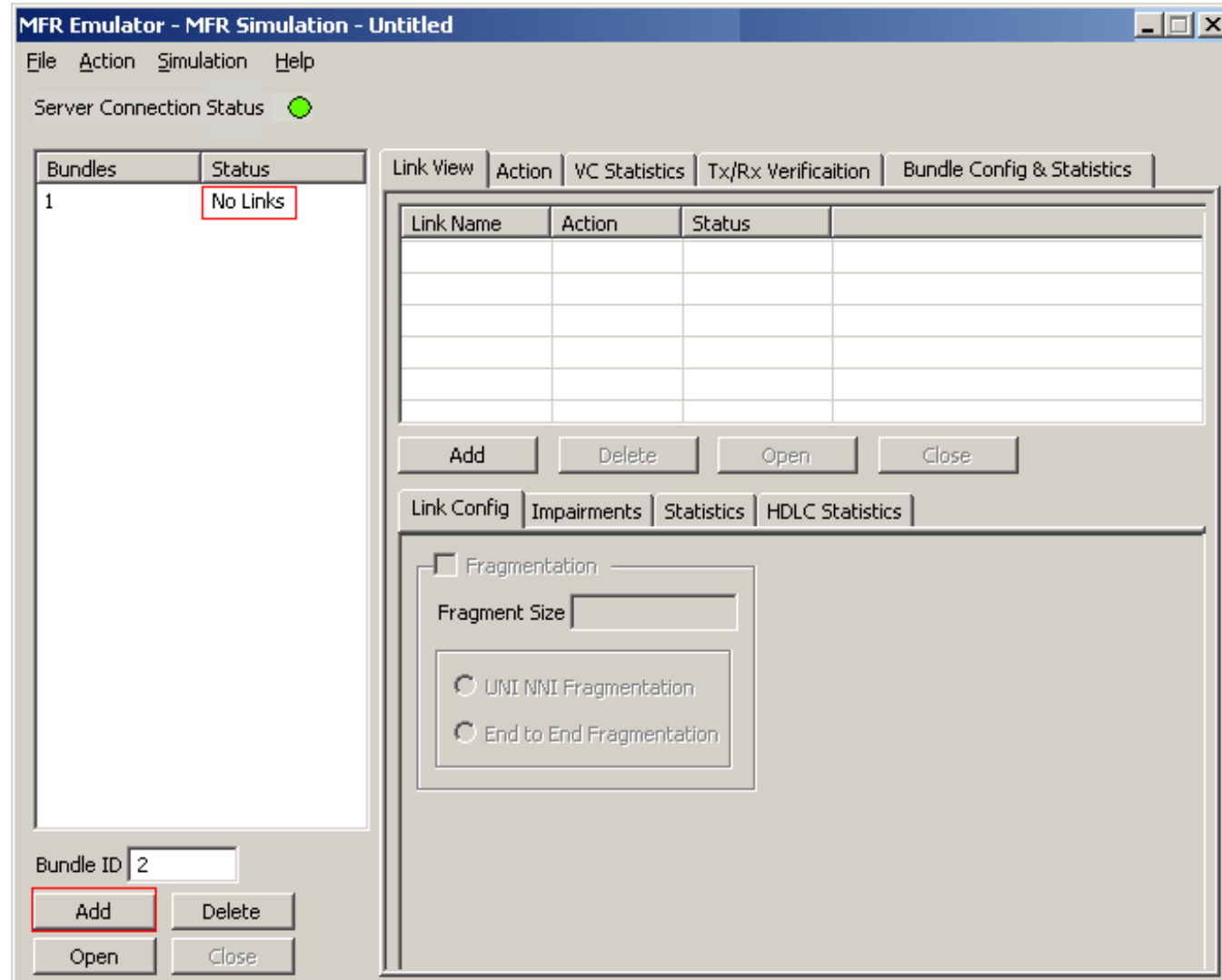
- In FR simulation virtual channels are added on the selected link



MFR Simulation

Adding a Bundle

- User can add a bundle by Clicking on Add button in the bundle pane, number of links constitute a bundle



Adding links to form an MFR bundle

- Various links (of any bandwidth varying from 64Kbps to n*64Kpbs or sub channels) can be added to form the MFR bundle
- MFR bundles multiple link-layer channels into a single network-layer channel

The screenshot displays the 'MFR Emulator - MFR Simulation - Untitled' window. It features a menu bar with 'File', 'Action', 'Simulation', and 'Help'. Below the menu is a 'Server Connection Status' indicator with a green dot. The main interface is divided into several sections:

- Bundles Table:** A table with two columns: 'Bundles' and 'Status'. It lists two bundles: '1' with status 'DOWN' and '2' with status 'No Links'. The 'DOWN' and 'No Links' text is highlighted with a red box.
- Link View Table:** A table with columns 'Link Name', 'Action', and 'Status'. It lists three links: '#1:1..5', '#1:11..15', and '#1:6..10', each with an 'Open' action and a 'Down' status.
- Buttons:** 'Add', 'Delete', 'Open', and 'Close' buttons are present below the Link View table.
- Link Config Section:** Includes tabs for 'Link Config', 'Impairments', 'Statistics', and 'HDLC Statistics'. It contains checkboxes for 'Fragmentation' and 'Flags between Hdlic frames', along with input fields for 'Fragment Size' and 'Flags between Hdlic frames'. Radio buttons are provided for 'UNI NMI Fragmentation' and 'End to End Fragmentation'.
- Bundle ID Input:** A text box labeled 'Bundle ID' containing the value '3', with 'Add', 'Delete', 'Open', and 'Close' buttons below it.

Bundle Config and Statistics

- Bundle Statistics will show statistics of transmitted frames, received frames, transmitted octets, and received octets for a selected bundle

Server Connection Status ●

Bundles	Status
1	UP
2	UP

Link View | Action | VC Statistics | Tx/Rx Verification | **Bundle Config & Statistics**

Bundle Statistics

Number of Frames transmitted:

Number of Frames Received:

Number of Octets transmitted:

Number of Octets received:

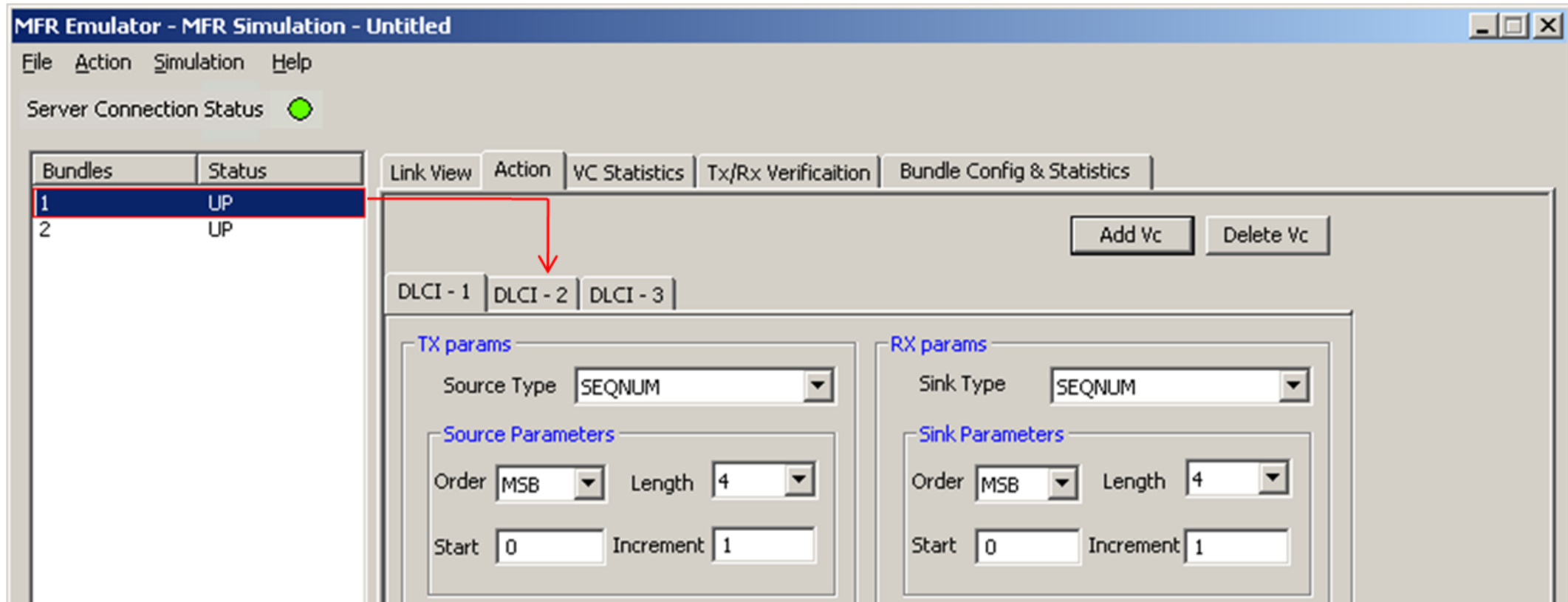
Bundle Config

Fragment Size:

Max Differential Delay:

Adding VC in MFR Simulation

- In MFR Simulation virtual channels are added on the selected bundle

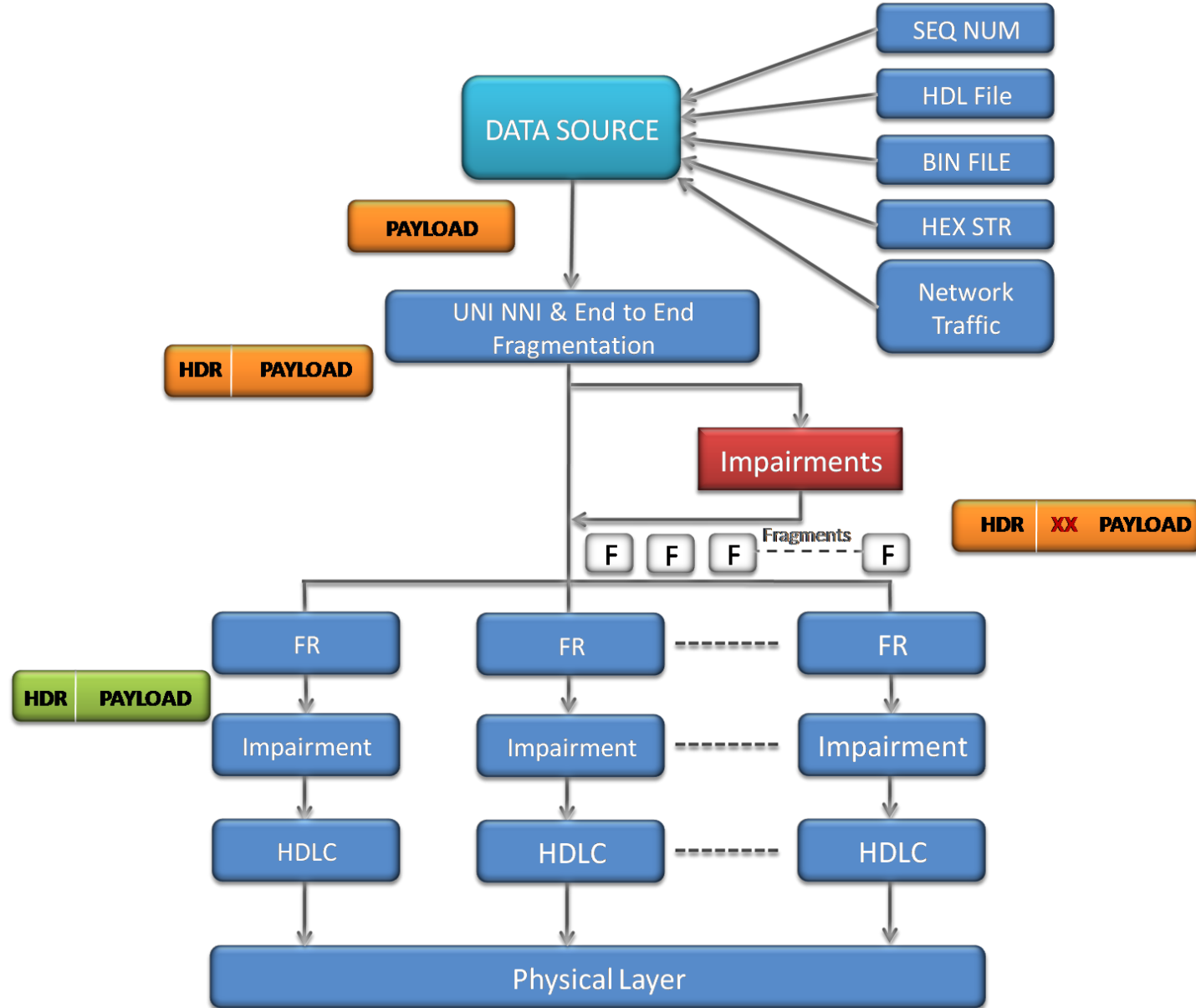


Tx and Rx Parameters

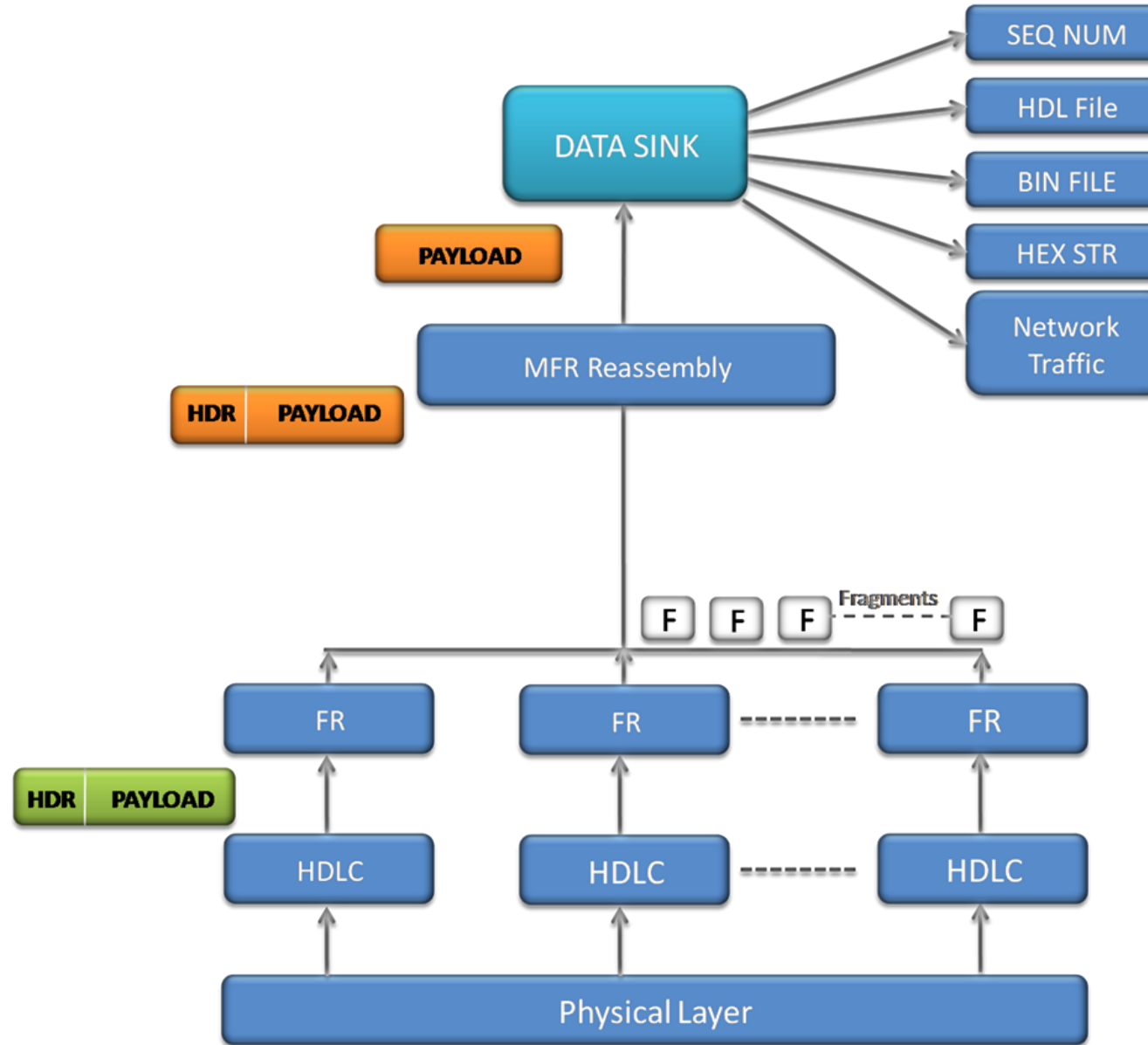
- Tx parameters are used to generate the FR traffic and Rx parameters are used as reference to verify the received frames. The results of the verification are displayed in Tx/Rx Verification tab

The image displays two side-by-side configuration panels for TX and RX parameters. Both panels have a 'Source Type' or 'Sink Type' dropdown menu set to 'SEQNUM'. Below this, a dropdown menu for 'Source Param' or 'Sink Parameter' is open, showing options: 'SEQNUM', 'HDLFILE', 'BINFILE', 'HEXSTR', and 'NETWORK TRAFFIC'. The 'SEQNUM' option is highlighted. In both panels, the 'Order' is set to 'MSB', 'Start' is '0', and 'Increment' is '1'. There is an unchecked checkbox for 'Prefix Header'. The 'Duration Spec' section has three radio buttons: 'Continuous transmission' (selected) and 'Continuous Reception' (selected), 'Limited frames' (with a value of 1000), and 'EOF'. The 'Payload Len' is set to 1500. At the bottom, there are buttons for 'Start Tx', 'Start Rx', 'Start All Tx', and 'Start All Rx', along with an 'Impairments' button.

Transmit Function



Receive Function



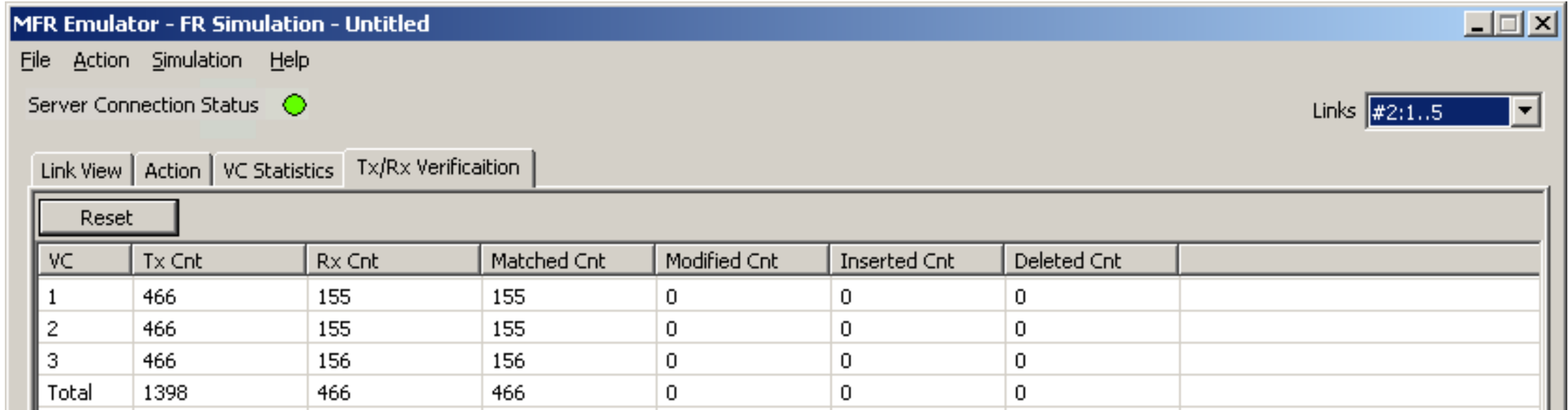
VC Statistics

- The Statistics for each of the added VCs are available in VC Statistics tab
- The statistics include number of Transmitted and received frames, Fragments, Octets, and Lost fragments

VC	Tx Frames	Tx Frags	Tx Octets	Rx Frames	Rx Frags	Rx Octets	Lost Frags
1	427	2562	640500	385	2310	577500	0
2	426	2556	639000	384	2304	576000	0
3	425	2550	637500	383	2298	574500	0
Total	1278	7668	1917000	1152	6912	1728000	0

Tx/Rx Verification

- The results of the verification for each of the added VCs are available in Tx/Rx Verification
- The statistics include number of frames Transmitted, Received, Matched, Modified, Inserted and Deleted



The screenshot shows the MFR Emulator interface with the 'Tx/Rx Verification' tab selected. The window title is 'MFR Emulator - FR Simulation - Untitled'. The menu bar includes 'File', 'Action', 'Simulation', and 'Help'. The 'Server Connection Status' is indicated by a green light. The 'Links' dropdown menu is set to '#2:1..5'. The 'Tx/Rx Verification' tab is active, and a 'Reset' button is visible above the table. The table displays the following statistics:

VC	Tx Cnt	Rx Cnt	Matched Cnt	Modified Cnt	Inserted Cnt	Deleted Cnt
1	466	155	155	0	0	0
2	466	155	155	0	0	0
3	466	156	156	0	0	0
Total	1398	466	466	0	0	0

Impairments

- Supports various Byte level, Frame level , CRC error, and Frame error impairments at link level
- Supports various Byte level and Frame level impairments at Fragment/Packet level for each Virtual Channel
- Impairments that affect an entire frame:
 - Delete Frame
 - Insert Frame
 - CRC error
 - Frame error
 - Duplicate Frame
- Impairments that modify a byte or few bytes in a frame at specified offset :
 - Insert Bytes
 - Delete Bytes
 - Bitwise ANDing octets
 - Bitwise Oring octets
 - Bitwise XORing octets
- Differential link delay insertion during transmission

Link Level Impairments

- Different kinds of impairments are available, namely:
- Impairments that affect an entire FR frame -
 - DELETE FRAME
 - INSERT FRAME
 - CRC
 - FRAME
 - DUPLICATE FRAME

DELETE FRAME
INSERT FRAME
DELETE BYTES
INSERT BYTES
DUPLICATE FRAME
CRC
FRAME
AND
OR
XOR

Link Config | Impairments | Statistics | HDLC Statistics

Enable

Impairment Type: DELETE FRAME

Options

Frame count: 1

Byte Offset: 1

Skip Before Impair: 1

Impairment Duration

Repeat 1

Continuous

Activate

Delay: 250 msec Apply

Sync All Links

Link Level Impairments

Original Frame

00	11	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00

Original Frame

00	11	AB	01	DE	87	46	31
68	AB	01	DE	87	46	31	68
AB	01	DE	87	46	31	68	AB
01	DE	87	46	31	68	AB	01
DE	87	46	31	68	AB	01	DE
87	46	31	68	AB	01	DE	87

Impairment : INS ABCD, OFF 10

00	11	00	00	00	01	00	00
00	01	AB	CD	00	00	00	01
00	00	00	01	00	00	00	01
00	00	00	01	00	00	00	01
00	00	00	01	00	00	00	01
00	00	00	01	00	00	00	01
00	00						

Impairment : DEL 6, OFF 10

00	11	AB	01	DE	87	46	31
68	AB	AB	01	DE	87	46	31
68	AB	01	DE	87	46	31	68
AB	01	DE	87	46	31	68	AB
01	DE	87	46	31	68	AB	01
DE	87						

Link Level Impairments


Original Frame

00	11	AB	01	DE	87	46	31
68	AB	01	DE	87	46	31	68
AB	01	DE	87	46	31	68	AB
01	DE	87	46	31	68	AB	01
DE	87	46	31	68	AB	01	DE
87	46	31	68	AB	01	DE	87

Impairment : AND 0x00, OFF 10

00	11	AB	01	DE	87	46	31
68	AB	00	DE	87	46	31	68
AB	01	DE	87	46	31	68	AB
01	DE	87	46	31	68	AB	01
DE	87	46	31	68	AB	01	DE
87	46	31	68	AB	01	DE	87

Link Level Impairments Verification

Server Connection Status  Links #2:1..31

Link View | Action | VC Statistics | Tx/Rx Verifaiction

Reset

VC	Tx Cnt	Rx Cnt	Matched Cnt	Modified Cnt	Inserted Cnt	Deleted Cnt	
1	1000	1000	667	0	333	0	
Total	1000	1000	667	0	333	0	

VC Impairments

- Impairments in Action layer can be applied for individual VCs

The screenshot displays a configuration window for a Virtual Circuit (VC) with the following elements:

- Navigation Tabs:** Link View, Action, VC Statistics, Tx/Rx Verification.
- Buttons:** Add Vc, Delete Vc.
- VC Identifier:** DLCI - 1.
- TX params (Left Column):**
 - Source Type: SEQNUM
 - Source Parameters:
 - Order: MSB
 - Length: 4
 - Start: 0
 - Increment: 1
 - Prefix Header:
 - Duration Spec:
 - Continuous transmission
 - Limited frames: 1000
 - EOF
 - Payload Len: 1500
- RX params (Right Column):**
 - Sink Type: SEQNUM
 - Sink Parameters:
 - Order: MSB
 - Length: 4
 - Start: 0
 - Increment: 1
 - Prefix Header:
 - Duration Spec:
 - Continuous Reception
 - Limited frames: 1000
 - EOF
 - Payload Len: 1500
- Control Buttons:** Start Tx, **Impairments** (highlighted with a red box), Start Rx, Start All Tx, Start All Rx.

VC Impairments Verification

MFR Emulator - MFR Simulation - Untitled

File Action Simulation Help

Server Connection Status ●

MFR Bundles	Status
1	UP
2	UP

Bundle ID

Add Delete

Open Close

Link View Action VC Statistics Tx/Rx Verification Bundle Config & Statistics

Reset

VC	Tx Cnt	Rx Cnt	Matched Cnt	Modified Cnt	Inserted Cnt	Deleted Cnt
1	0	12927	12927	0	0	10
Total	0	12927	12927	0	0	10

MFR Emulator - MFR Simulation - Untitled

File Action Simulation Help

Server Connection Status ●

MFR Bundles	Status
1	UP
2	UP

Bundle ID

Add Delete

Open Close

Link View Action VC Statistics Tx/Rx Verification Bundle Config & Statistics

Reset

VC	Tx Frames	Tx Frags	Tx Octets	Rx Frames	Rx Frags	Rx Octets	Lost Frags
1	0	0	0	63779	382674	95668500	30
Total	0	0	0	63779	382674	95668500	30

Link Statistics

- Provides important statistics information for the selected link, such as
- Number of frames transmitted
- Received frames
- Number of Octets Transmitted
- Number of Octets Received

Link Config	Impairments	Statistics	HDLC Statistics
Number of Frames Transmitted	893		Reset
Number of Frames Received	967		
Number of Octets Transmitted	1343072		
Number of Octets Received	1454368		

Hdlc Statistics

- The following error statistics are shown in Hdlc tab –
- Tx Under/Over Runs
- Rx Under/Over Runs
- Number of FR packets with bad FCS
- Number of packets with Frame Error

Link Config	Impairments	Statistics	HDLC Statistics
Tx Under/Over Runs	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="button" value="Reset"/>
Rx Under/Over Runs	<input type="text" value="0"/>	<input type="text" value="0"/>	
CRC Error Frames	<input type="text" value="3000"/>	<input type="text" value="3000"/>	
Frame Error Frames	<input type="text" value="0"/>	<input type="text" value="0"/>	

Client-Server MFR Emulation

- Sample script for Transmission & Reception of MFR Frames

FrameRelay_E1.gls - GLClient

```

OK
inform task 3 "CREATE VC HC #1:1..31 DLCI 1 FRAG FORMAT END TO END FRAGSIZE 256";
OK
inform task 3 "Tx: HC #1:1..31 DLCI 1 CONT FIXLEN 1500 SEQNUM MSB4";
OK
inform task 3 "START TX HC #1:1..31 DLCI 1";
OK
query task 3;
Task 3:
Simulation=Frame Relay, Total FR Links=1, Active FR Links=1, Selected Link=1:1
===== HDLC Stats =====, Tx Octets=9159516, Tx Frames=35502, Rx Octets=0
Runs=0, Rx Over/Under Runs=0, CRC Error Count=0,
===== Virtual Channel Stats =====, Number of VC's on FR Link: '1:1..31'=1,
VC 1, DLCI=1, Tx Frames=5917, Tx Frags=35502, Rx Frames=0, Rx Frags=0, Los
Matched count=0, Modified count=0, Inserted count=0, Deleted count=0
OK

//I here should be fragmentation with B=1,E=U for first fragment,
//B=0,E=0 for in between fragments and B=0, E=1 for last fragment.

run task "MFRemulatorE1:TxRx";
inform task 1 "SIMULATION FR";
inform task 1 "HC #1:1..31 FLAGS 100";
//inform task 1 "TS #1:1..31 FLAGS 100";
//inform task 1 "SC #1:1..31:1..8 FLAGS 100";
inform task 1 "ACTIVATE HC #1:1..31";
//inform task 1 "ACTIVATE TS #1:1..31";
//inform task 1 "ACTIVATE SC #1:1..31:1..8";
inform task 1 "CREATE VC HC #1:1..31 DLCI 1 FRAG FORMAT END TO END FRAGS
//inform task 1 "CREATE VC TS #1:1..31 DLCI 1 FRAG FORMAT END TO END FRAG
//inform task 1 "CREATE VC SC #1:1..31:1..8 DLCI 1 FRAG FORMAT END TO END F
inform task 1 "Tx: HC #1:1..31 DLCI 1 FRAMES 10 FIXLEN 1500 SEQNUM MSB4";
//inform task 1 "Tx: TS #1:1..31 DLCI 1 FRAMES 10 FIXLEN 1500 SEQNUM MSB4";
//inform task 1 "Tx: SC #1:1..31:1..8 DLCI 1 FRAMES 10 FIXLEN 1500 SEQNUM MS
    
```

Frame Relay Protocol Analysis LAPP

Dev	TS...	Su...	Frame#	TIME (Relative)	Len	DLCI	DE	BECN	FECN	CTL	NLPID	Sequenc...
✓ 2	1-31		0	-00:00:00.004403	264	1	0	0	0	Unnu...	FRF.12 Fragme...	0
✓ 2	1-31		1	-00:00:00.002935	264	1	0	0	0	Unnu...	FRF.12 Fragme...	1
✓ 2	1-31		2	-00:00:00.001467	264	1	0	0	0	Unnu...	FRF.12 Fragme...	2
✓ 2	1-31		3	00:00:00.000000	264	1	0	0	0	Unnu...	FRF.12 Fragme...	3
✓ 2	1-31		4	00:00:00.001467	264	1	0	0	0	Unnu...	FRF.12 Fragme...	4
✓ 2	1-31		5	00:00:00.002935	228	1	0	0	0	Unnu...	FRF.12 Fragme...	5
✓ 2	1-31		6	00:00:00.004258	264	1	0	0	0	Unnu...	FRF.12 Fragme...	6

Card2 TimeSlots=1-31 Frame=0 at -00:00:00.004403 OK Len=264
 HDLC Frame Data + FCS
 ===== LAPP Layer =====
 EA =0 (0)
 C/R =0. Command(User), Response(Network)
 DLCI = 1 (000000...0001....)
 EA =1 (1)
 DE =0. (0)
 BECN =0.. (0)
 FECN =0... (0)

Hex Dump of the Frame Data

```

+-----+-----+-----+-----+-----+-----+-----+-----+
00 11 03 B1 80 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
    
```

Running. Utilization 21.39% C:\Temp.Hdl Captured 64186 frames

Features

- WCS Multi-Link Frame Relay is also available as a CLI application. Following functions are supported using simple commands:
- Activate/deactivate the individual bundle links in the MFR bundle
- Create/delete the virtual channels on the links
- Sends MFR frames with or without impairments
- Receives MFR frames
- Generates & receives traffic using source and sink types
 - Sequence numbers
 - Hex string frame
 - Binary flat files
 - HDL trace files (GL's proprietary file format)
- Various impairments can be applied on each individual FR links and virtual channels

Thank You