
PPP and MLPPP Protocol Overview



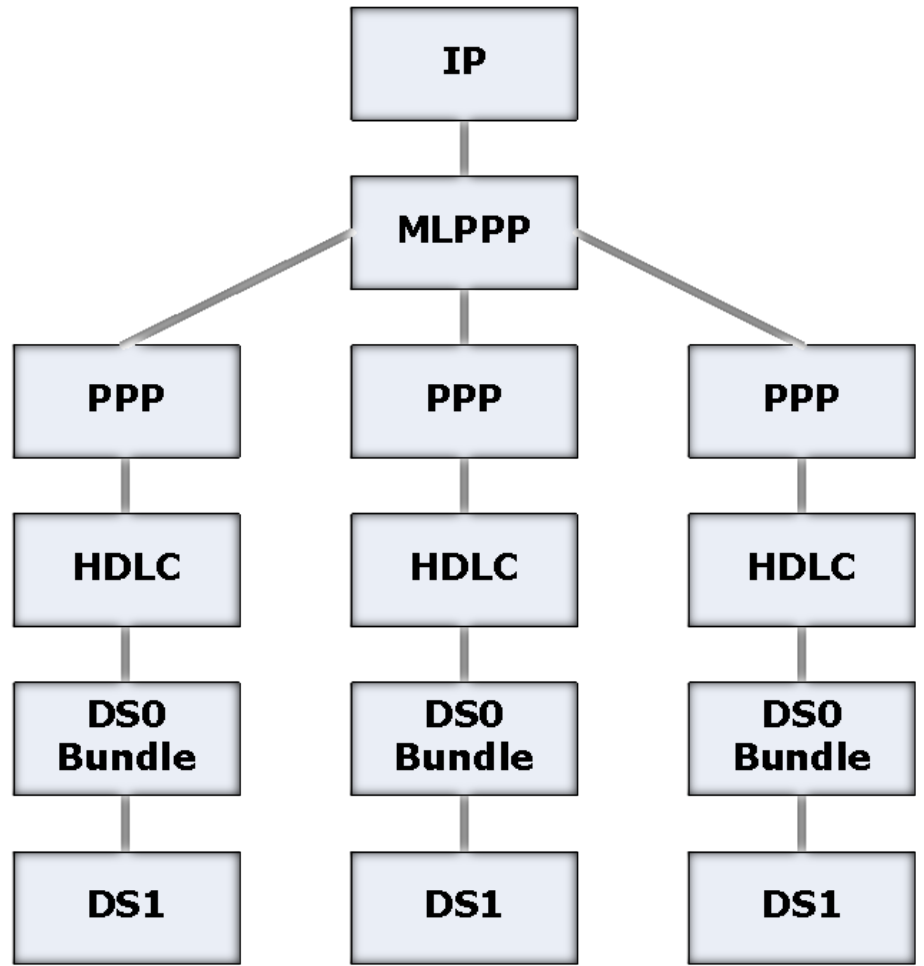
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Point-to-Point Protocol (PPP)

- Point to Point (PPP) networks are used in Ethernet, POS, and in some T1 E1 and T3 E3 dedicated circuits
- Designed to work with numerous network layer protocols (such as Internet Protocol (IP), Internetwork Packet Exchange (IPX), AppleTalk, etc.) and transport packets between two peers
- Encapsulates other network layer protocols like IP for transmission on synchronous and asynchronous communications lines
- Two encapsulated forms of PPP, Point-to-Point Protocol over Ethernet (PPPoE) and Point-to-Point Protocol over ATM (PPPoA), are used mostly by Internet Service Providers
- PPP links provide full-duplex simultaneous bi-directional operation, and deliver packets in order
- Widely used in synchronous connections between LANs, bridges, routers and other intermediate devices
- Major Features of PPP Protocol are:
 - Authentication
 - Encapsulation of higher layer protocols

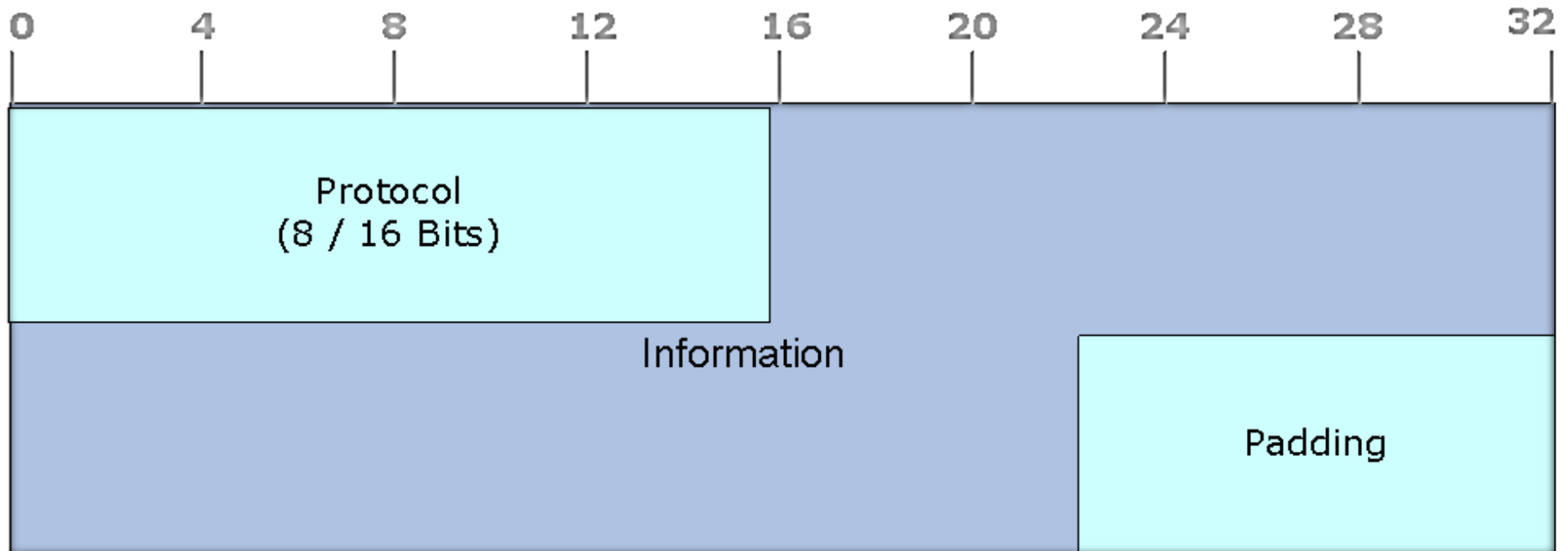
Protocol Information

- The Point-to-Point Protocol (PPP), as described in RFC 1661, provides an encapsulation protocol for transporting network layer traffic over point-to-point links, such as synchronous serial or Integrated Services Digital Network (ISDN)



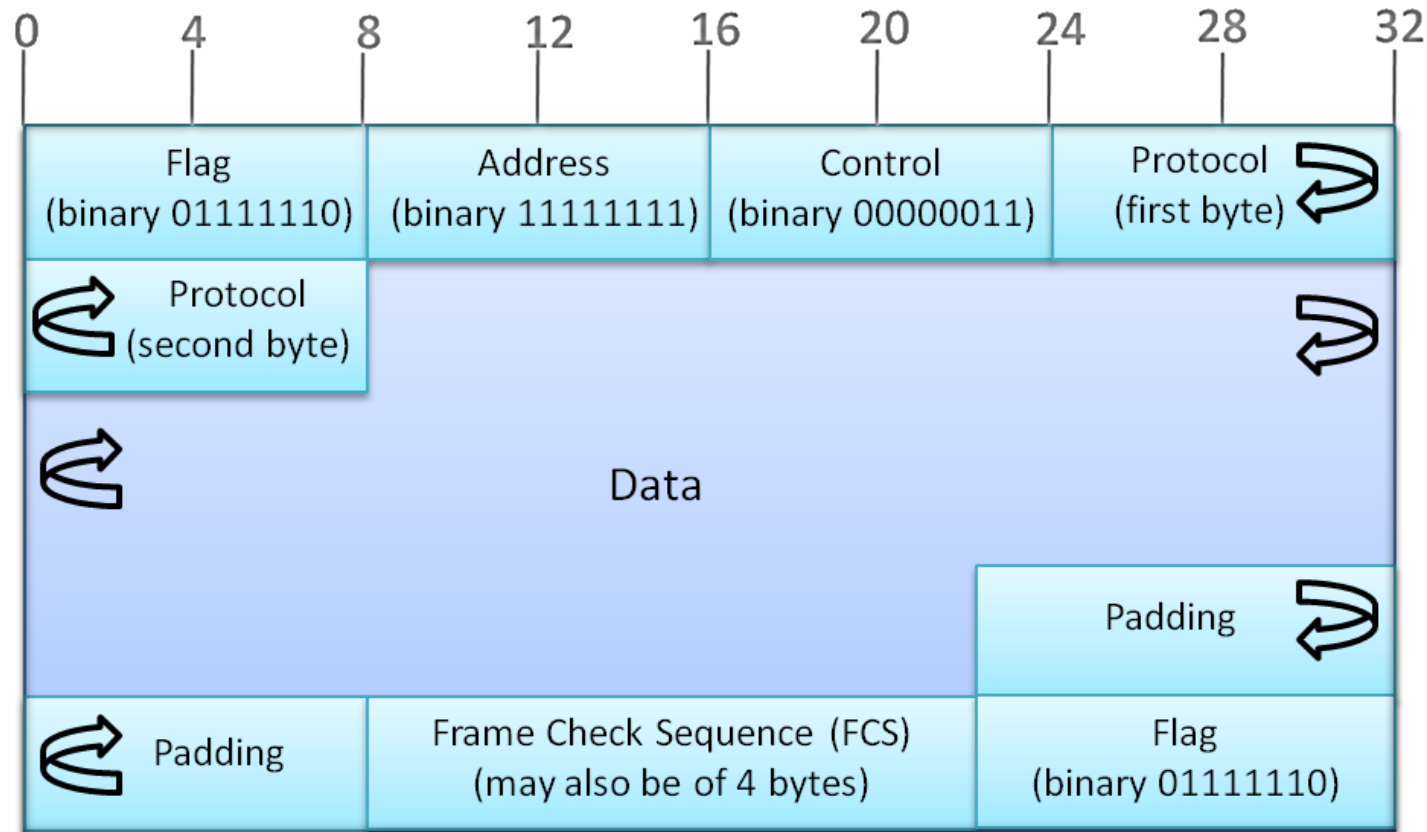
PPP Frame Structure

- **Protocol field:** Identifies the datagram encapsulated in the information field of the packet
- **Information field:** Contains the datagram for the protocol specified in the Protocol field
- **Padding:** On transmission, the Information field may be padded with an arbitrary number of octets



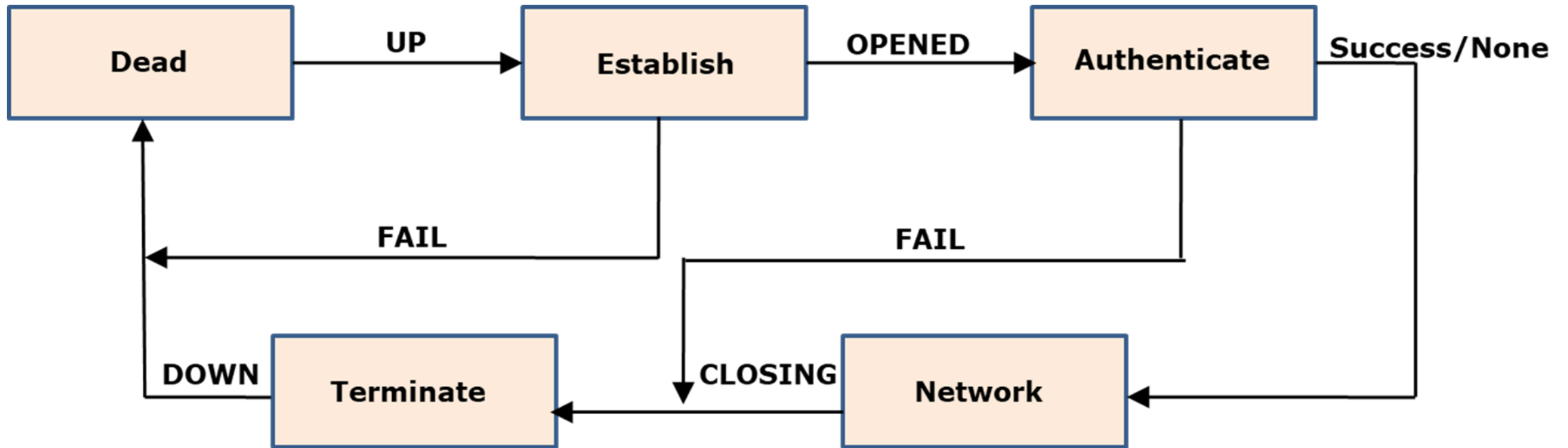
PPP Encapsulation in HDLC Framing

- The basic operation of the PPP is based on the ISO High-Level Data Link Control (HDLC) protocol
- The PPP Frame Format uses the same basic format as HDLC



PPP Link Operation

- To establish communications over a point-to-point link, each end of the PPP link MUST first send LCP packets to configure and test the data link
- The peer MAY be authenticated when the link is established
- Then, PPP MUST send NCP packets to choose and configure one or more network-layer protocols
- The link will remain configured for communications until explicit LCP or NCP packets close the link down

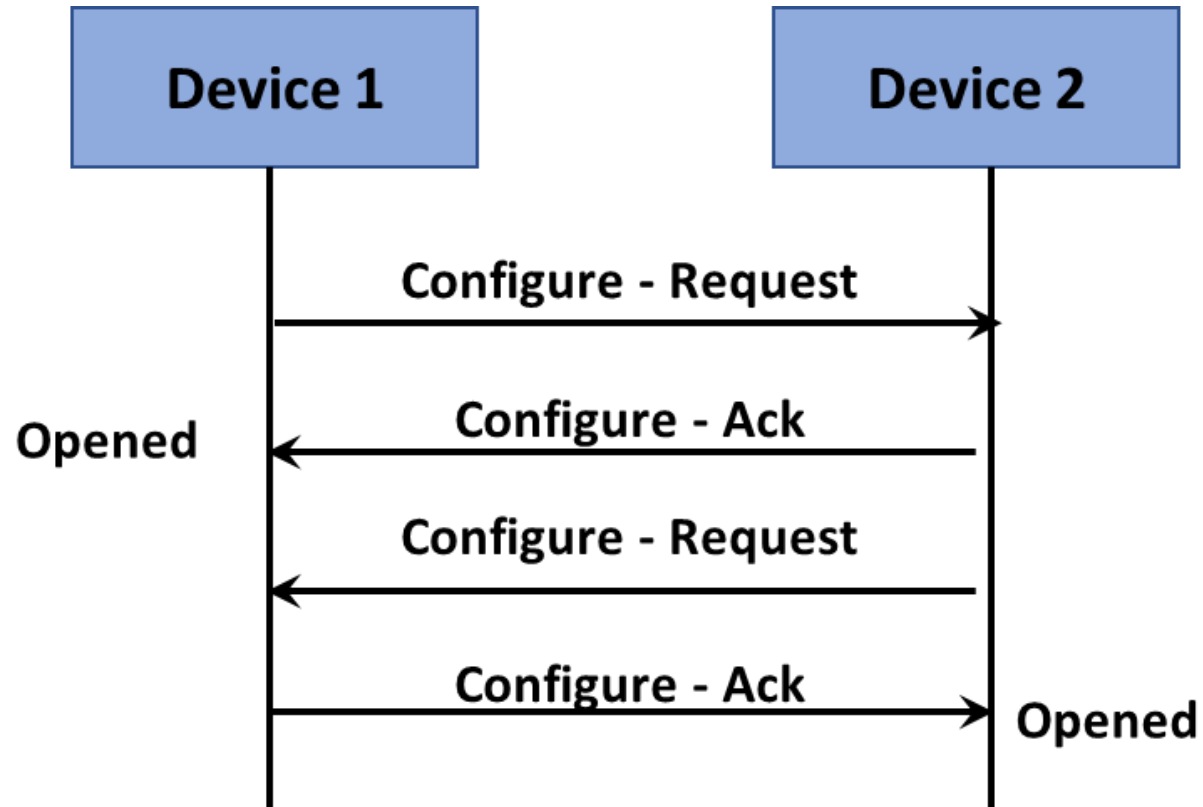


PPP Control Protocols

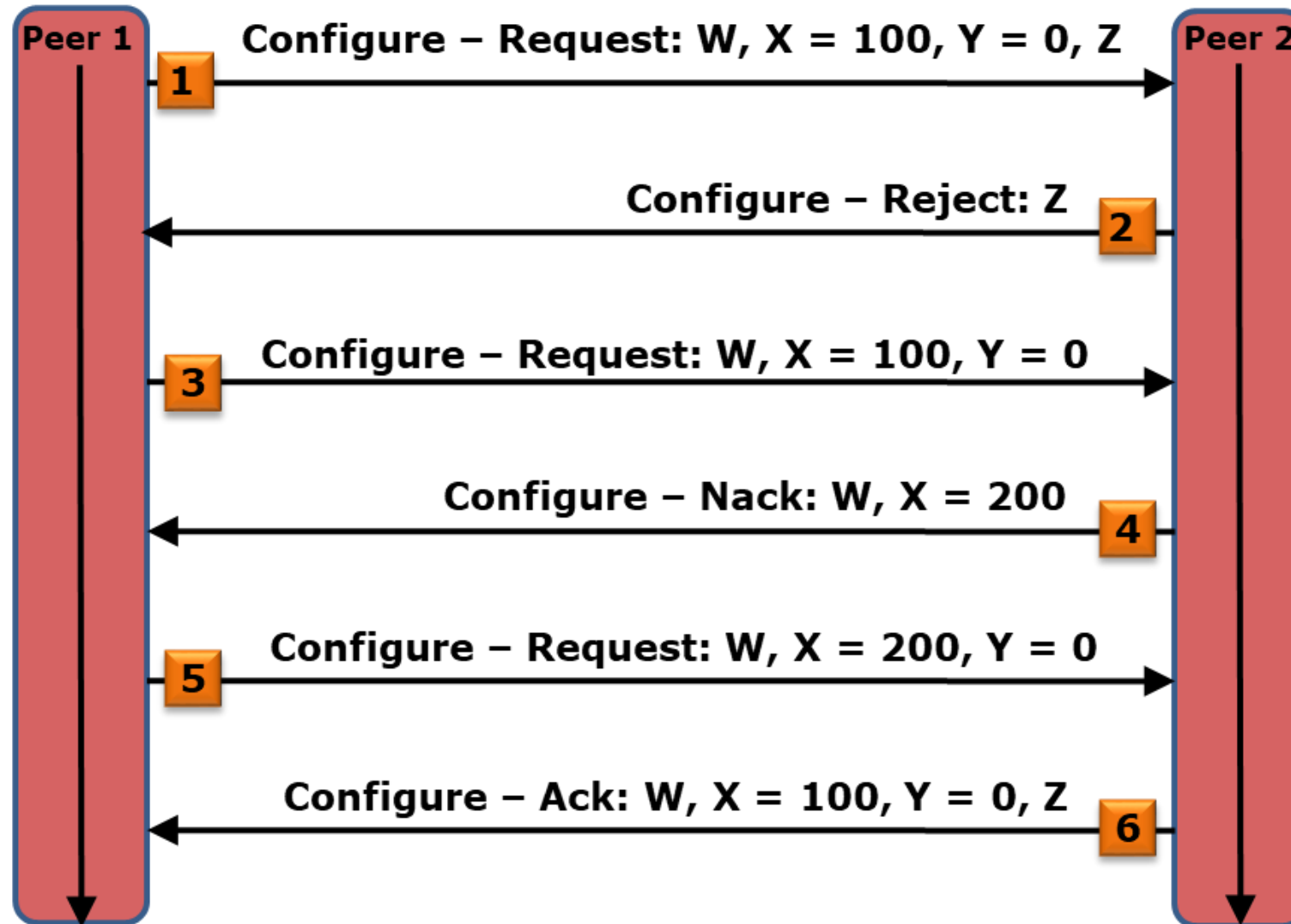
- There are many different PPP control protocols that contain specific information that is used to configure, manage and discontinue PPP links, and to implement the various features that comprise PPP
- Two of such protocols are :-
 - Link Control Protocol (LCP)
 - Network Control Protocols (NCPs)

Link Configuration Protocol (LCP)

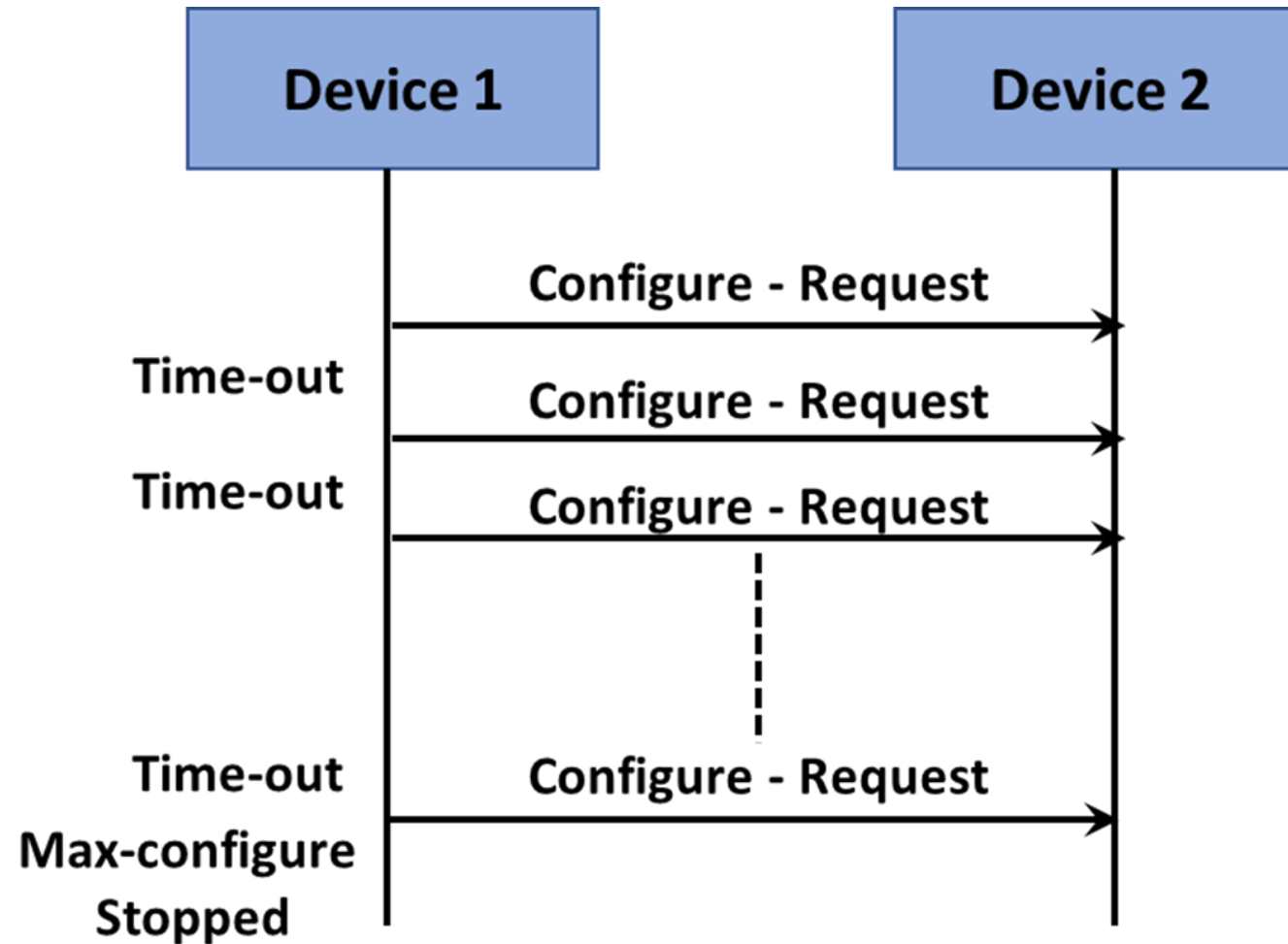
- The LCP is responsible for configuring, maintenance, and termination of links



LCP Negotiation Options

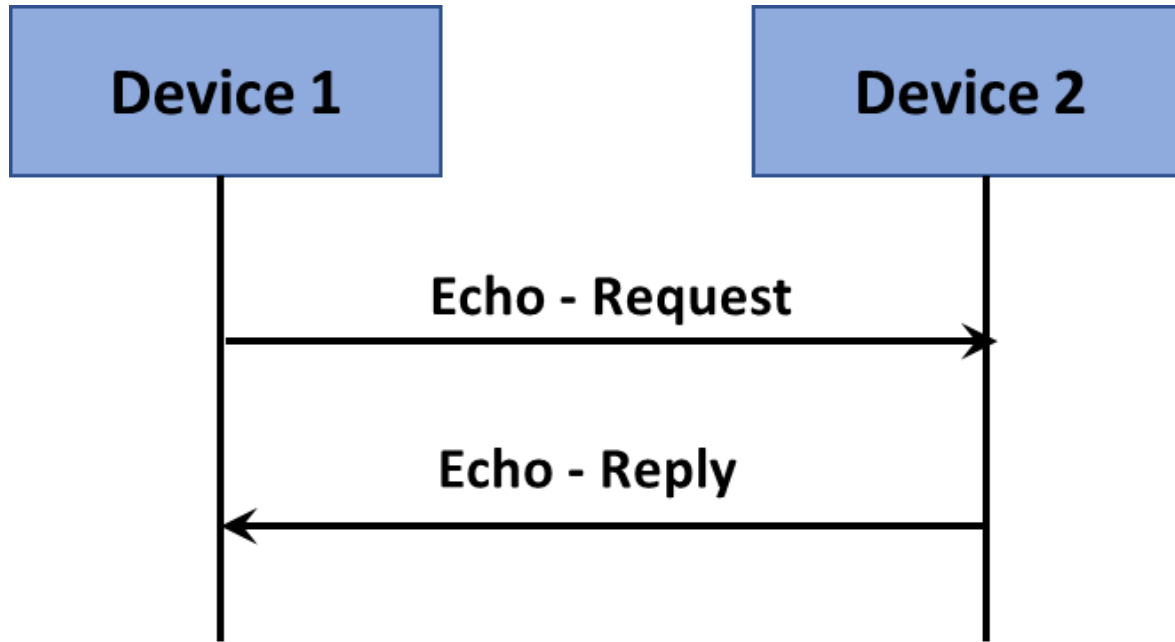


LCP Retransmission

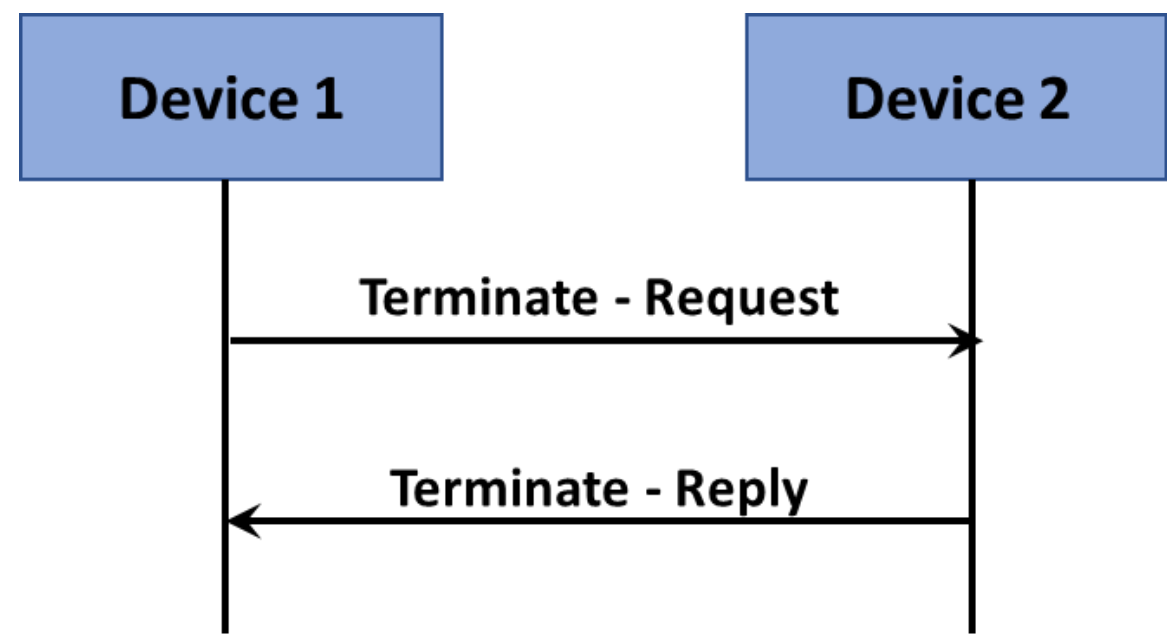


Link Maintenance and Link Termination

Link Maintenance



Link Termination



Network Control Protocols IPCP (NCP for IP)

- Allows PPP to support multiple network layer protocols by negotiating parameters that are unique to the network layer protocol
- Responsible for configuring, enabling, and disabling the IP protocol modules on both ends of the point-to-point link
- Supported IPCP standards:
 - RFC 1332 - The PPP Internet Protocol Control Protocol
 - RFC 1877 - PPP Internet Protocol Control Protocol Extensions for Name Server Addresses
- Supported IPCP negotiation options:
 - IP Address
 - IP Address Compression
 - RFC 1144 - Van Jacobson Compression
 - RFC 3544 – IP Header Compression over PPP
 - RFC 2508 - CRTP
 - RFC 2507 - IP Header Compression
 - Primary and Secondary DNS Server Address
 - Primary and Secondary NBNS Server Address

Network Control Protocols

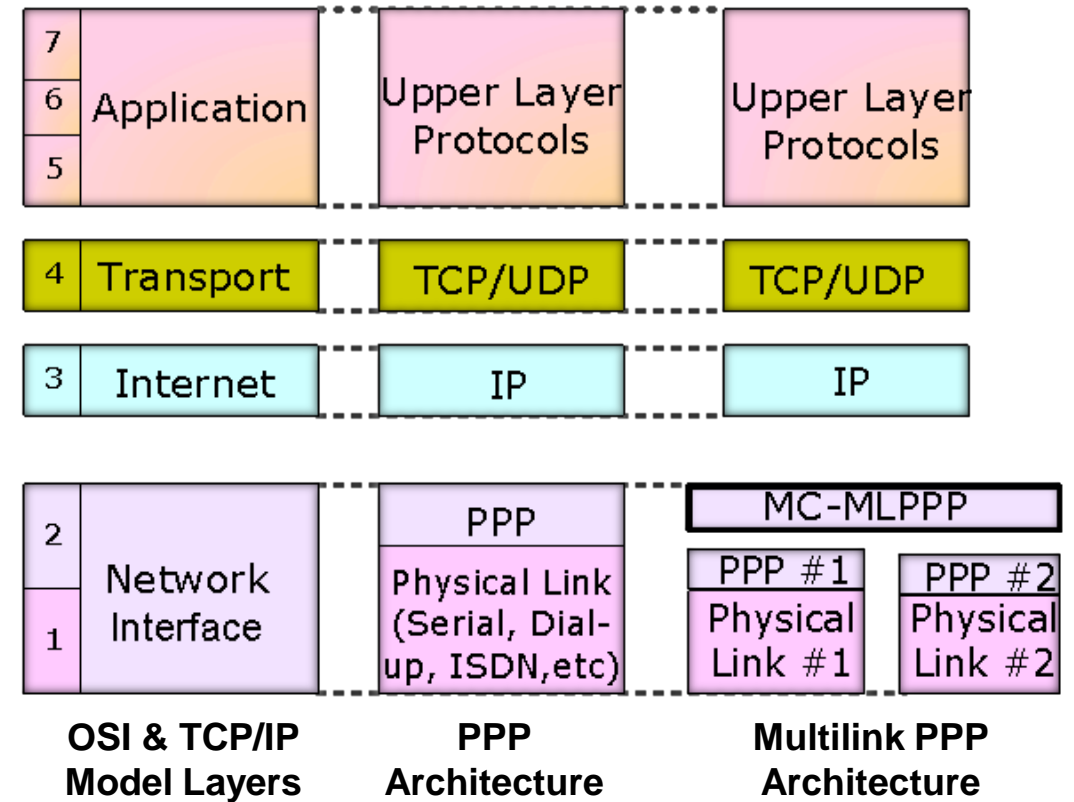
- Bridge Control Protocol (BCP) is responsible for establishing and configuring Remote Bridging for PPP links
- Supported standard – RFC 3518
- Supported BCP negotiation options:
 - Bridge Identification
 - Line Identification
 - MAC Support
 - Tinygram Compression
 - MAC Address
 - Spanning Tree Protocol
 - IEEE 802 Tagged Frame
 - Management Inline
 - Bridge Control Protocol Indicator

PPP Authentication Protocols

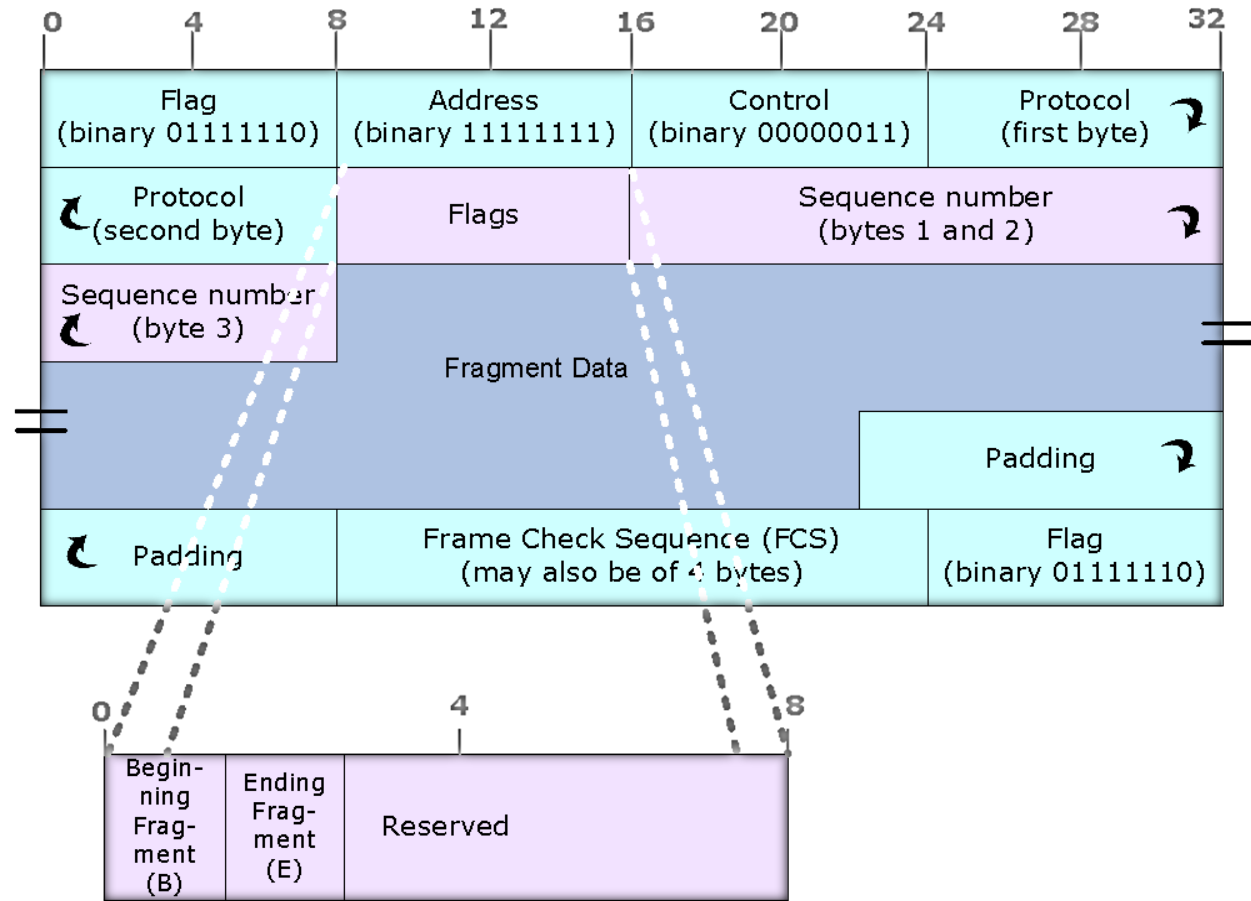
- After the LCP link is set up a series of authentication messages are sent to verify the identity of the device initiating the link
- Only if authentication is successful can the link configuration proceed
 - Password Authentication Protocol (PAP)
 - Challenge Handshake Authentication Protocol (CHAP)

Multilink PPP Protocol

- Multilink PPP (MLP), as defined in RFC 1990, is a variant of PPP
- Allows to bundle multiple low-speed PPP links into a single high-speed logical channel for the transport of traffic
- MLPPP bundles multiple link-layer channels into a single network-layer channel

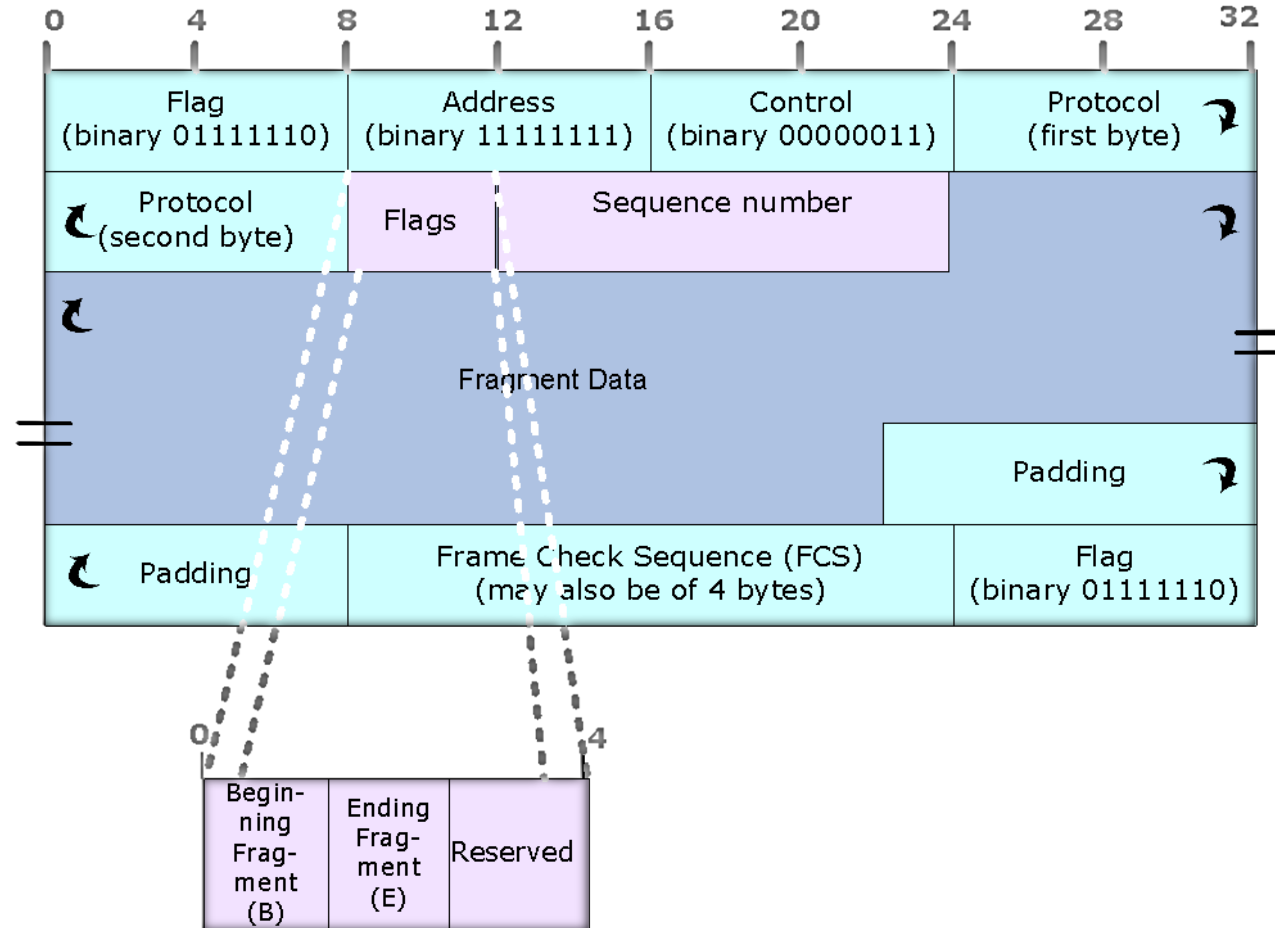


Multilink PPP Long Fragment Frame Format

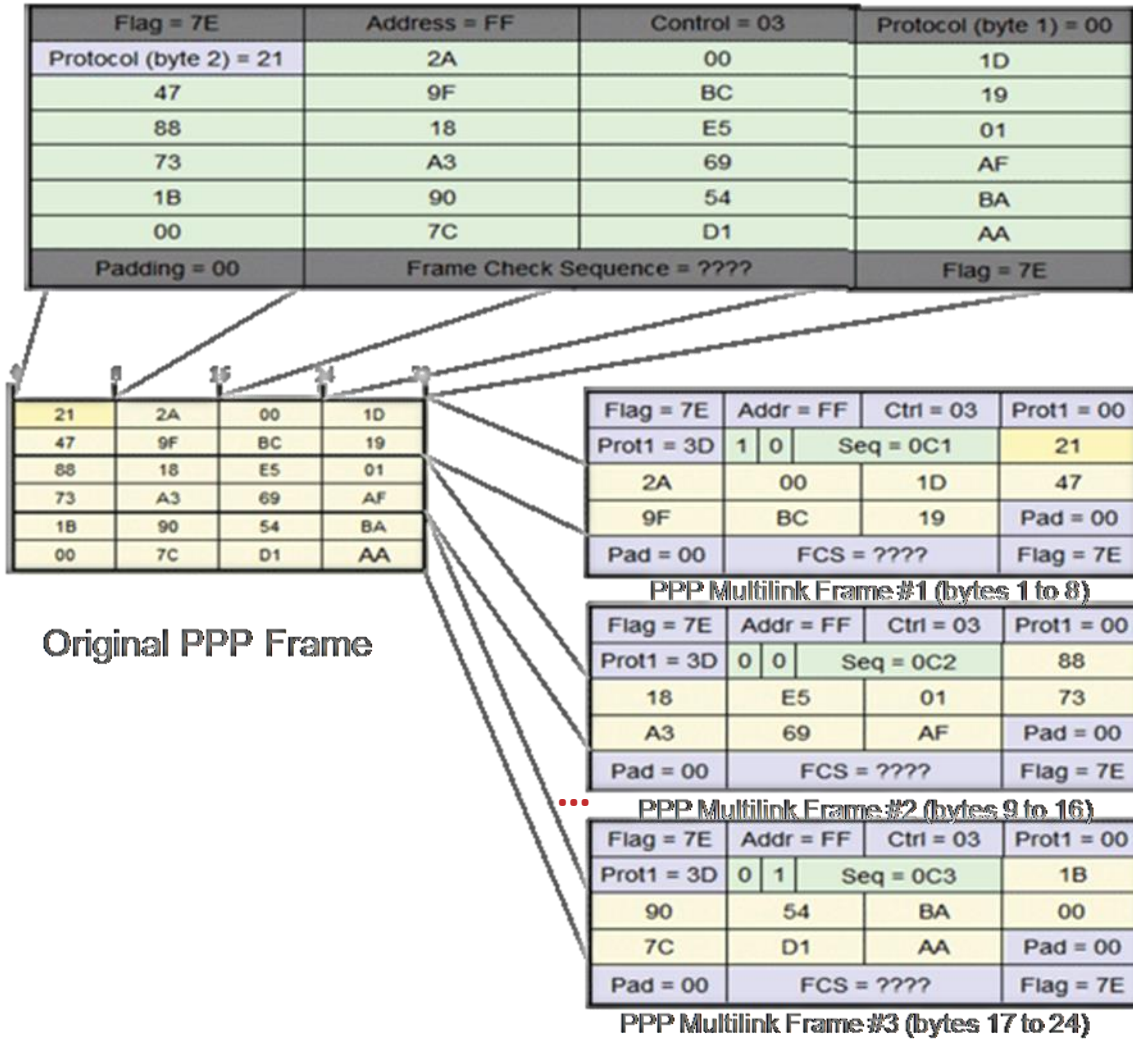


Multilink PPP Short Fragment Frame Format

- Short Sequence Number Format uses 2 octets ML PPP header with 12 bit Sequence number, 1 bit B flag, 1 bit E flag and 2 reserved bits



Multilink Protocol (MP) Fragmentation

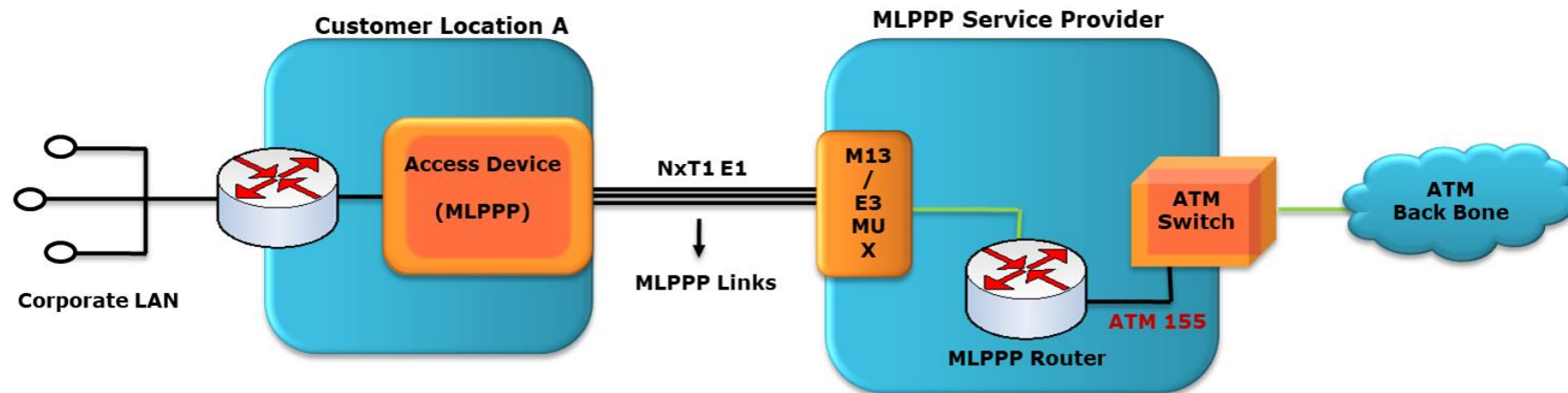


Multilink PPP Long Fragment Frame Format

- Long Sequence Number Format uses 4 octets ML PPP header with 24-bit sequence number, 1 bit B flag, 1 bit E flag and 6 reserved bits
- Flags:
 - Begin (B) Flag - One bit field; 1 on the first fragment and 0 for all other fragments
 - End (E) Flag - One bit field; 1 on the last fragment and 0 for all other fragments

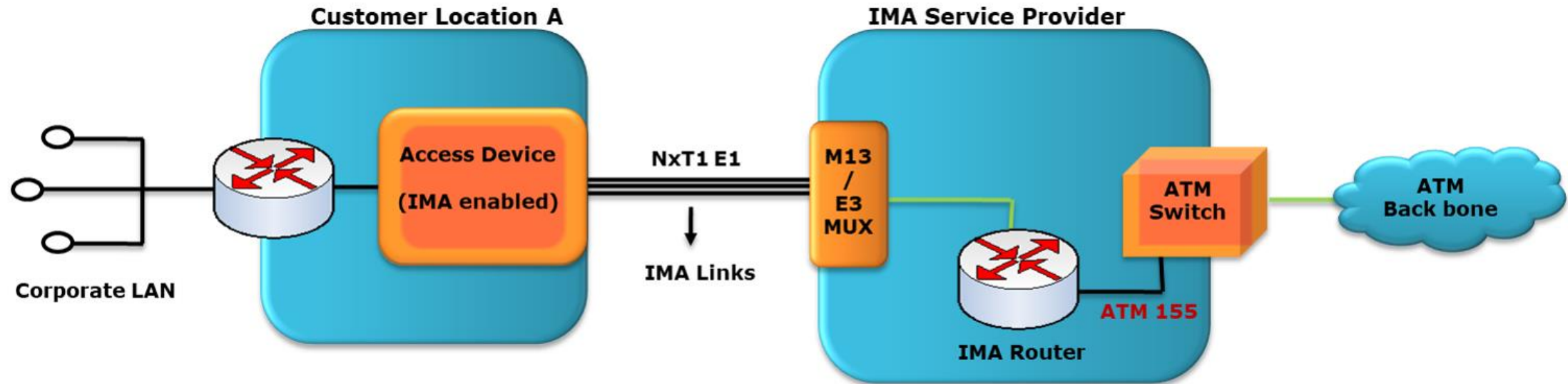
Multilink Point-to-Point Protocol (MLPPP)

- More efficient mapping of Ethernet frames into MLPPP frames equals less processing overhead
- Facilitates traffic delivery to the WAN by application type or IP source/destination address
- Supports an all IP connectionless environment for VPNs
- Uses an average overhead of only 2-3% of the customer's access bandwidth



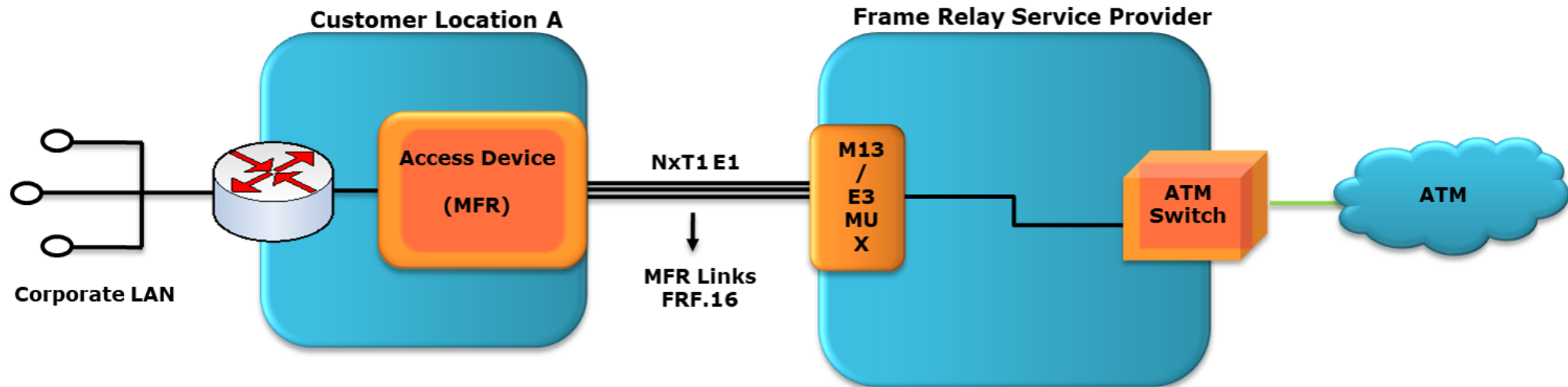
Inverse Multiplexing over ATM (IMA)

- IMA allows some Quality of Service (QoS) capability Contains some considerable overhead



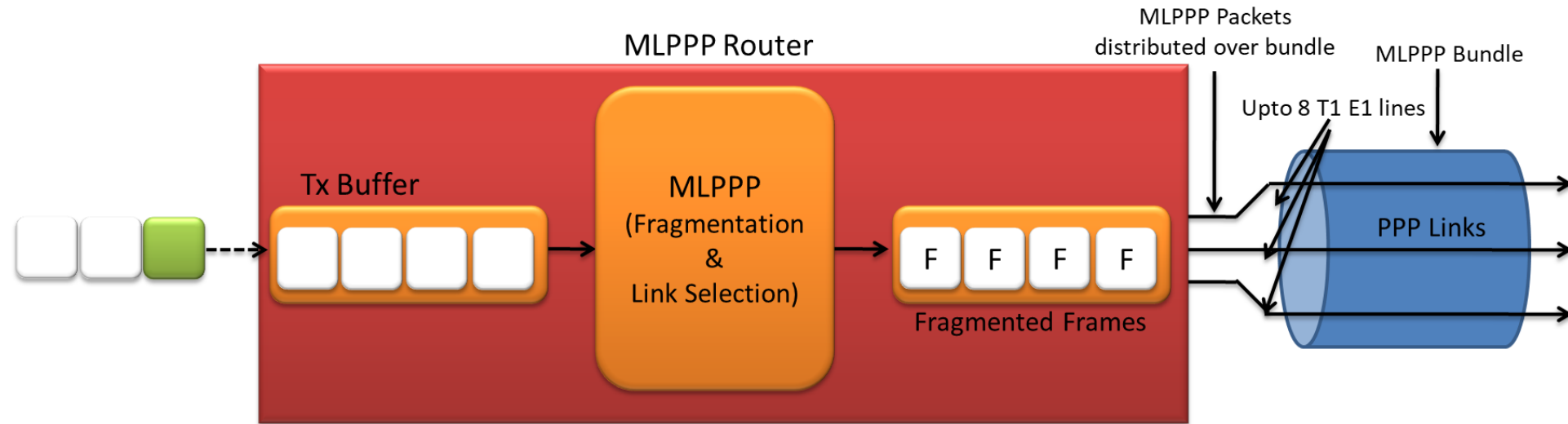
Multilink Frame Relay (MFR)

- Supports variable frame sizes and fragmentation
- Low latency
- Minimal management bandwidth overhead of 2-3%
- Provides for standards-based Service Level Agreements using FRF.13

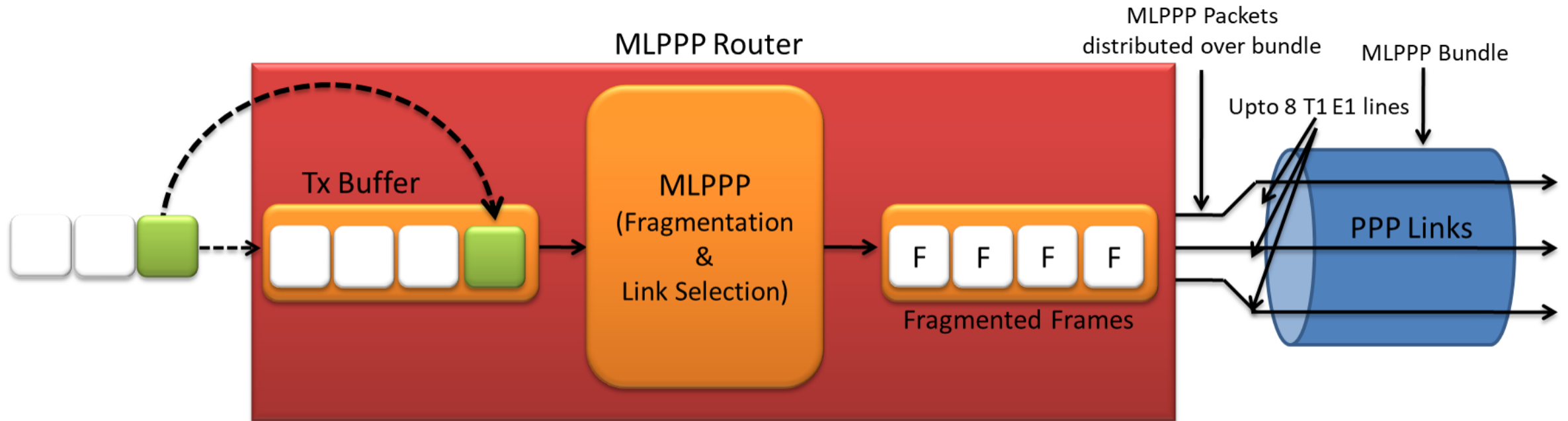


Need for Multi-Class

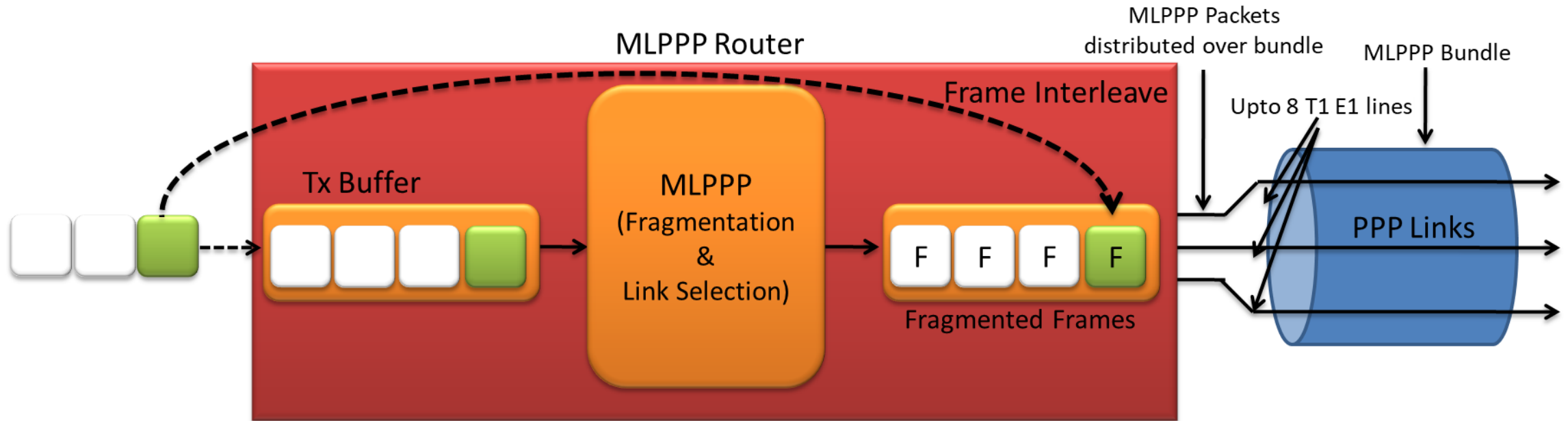
- MLPPP's uses contiguous sequence numbering (for all fragments of a packet) does not allow suspension of the sending of a sequence of fragments of one packet in order to send another higher-priority packet
- This limitation is overcome by Multi-Class MLPPP where each "class" of traffic uses a separate sequence number space and reassembly buffer



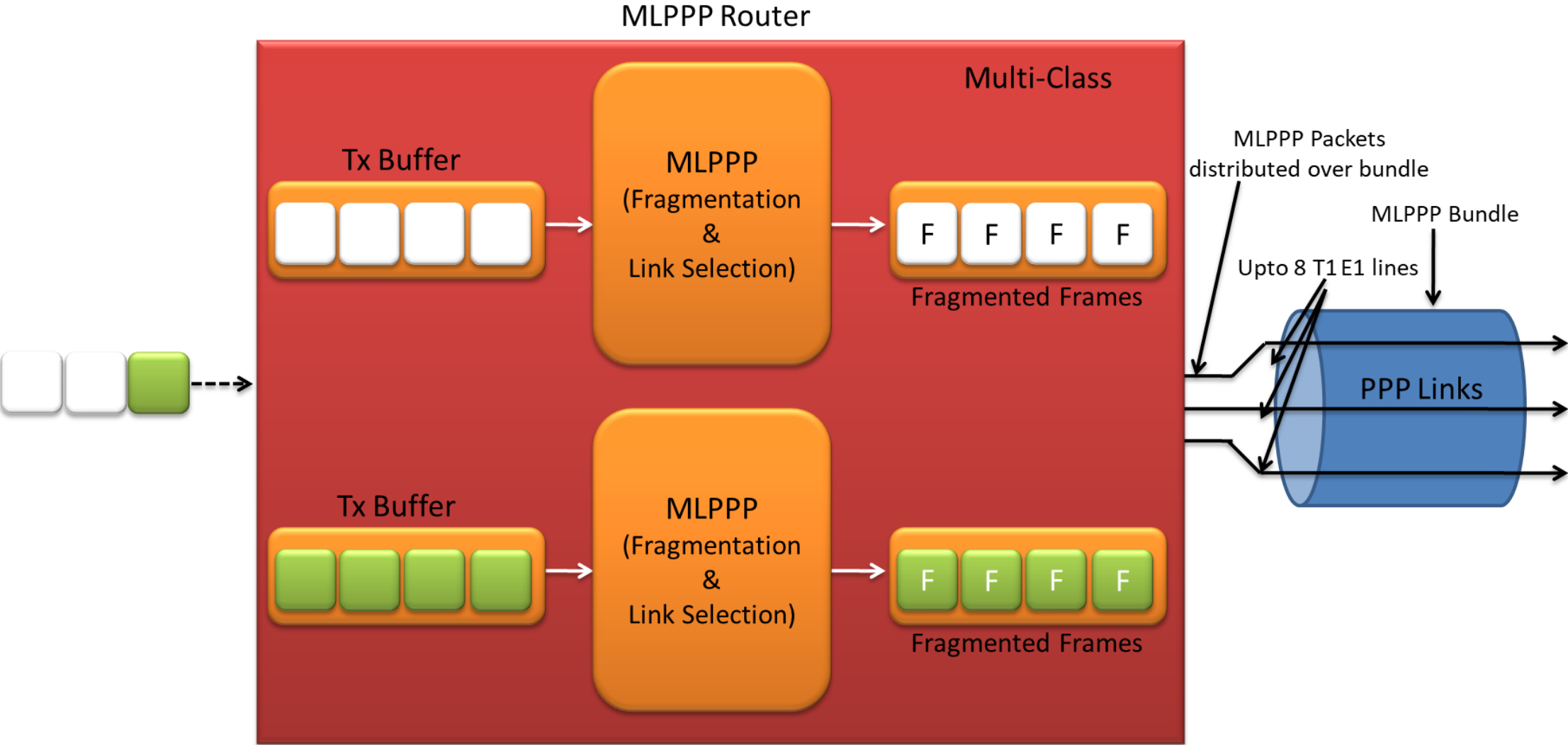
Alternative Methods: 1. Priority Queue



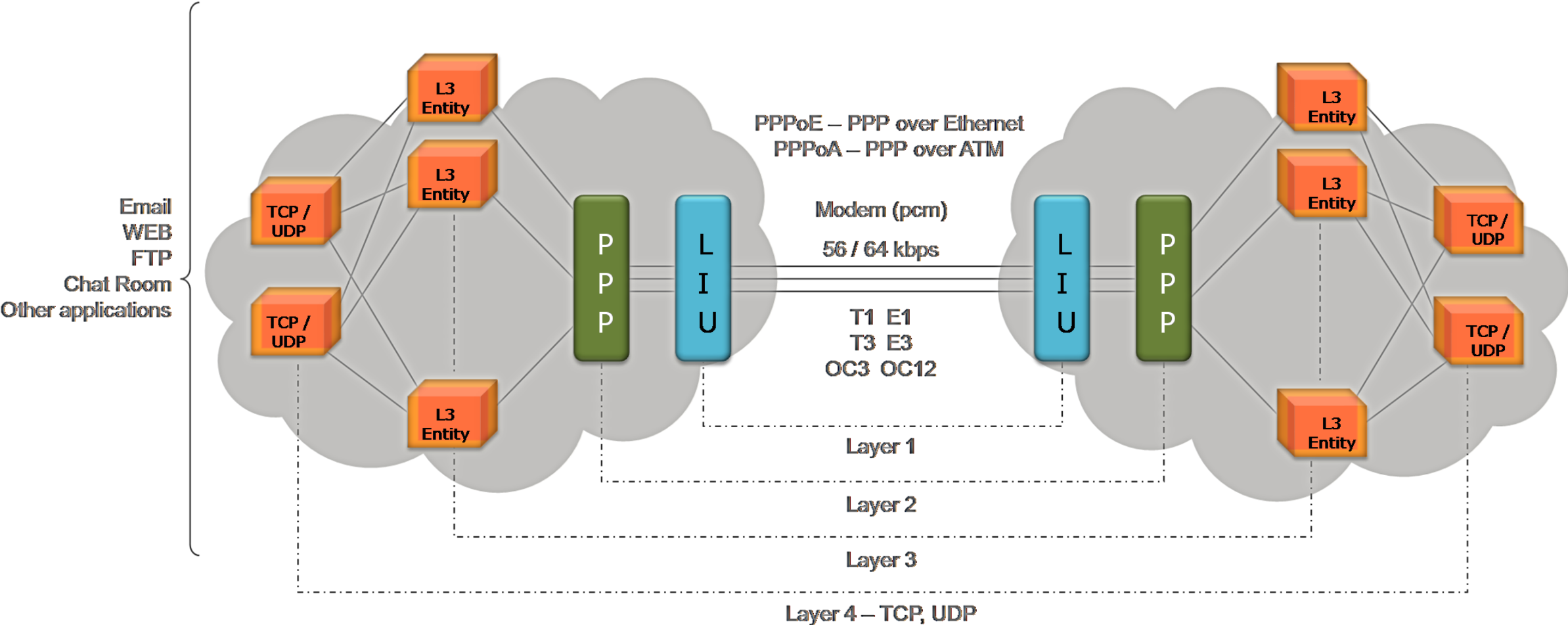
Alternative Methods: 2. Frame Inter-Leaving



Multi-Class MLPPP Explained

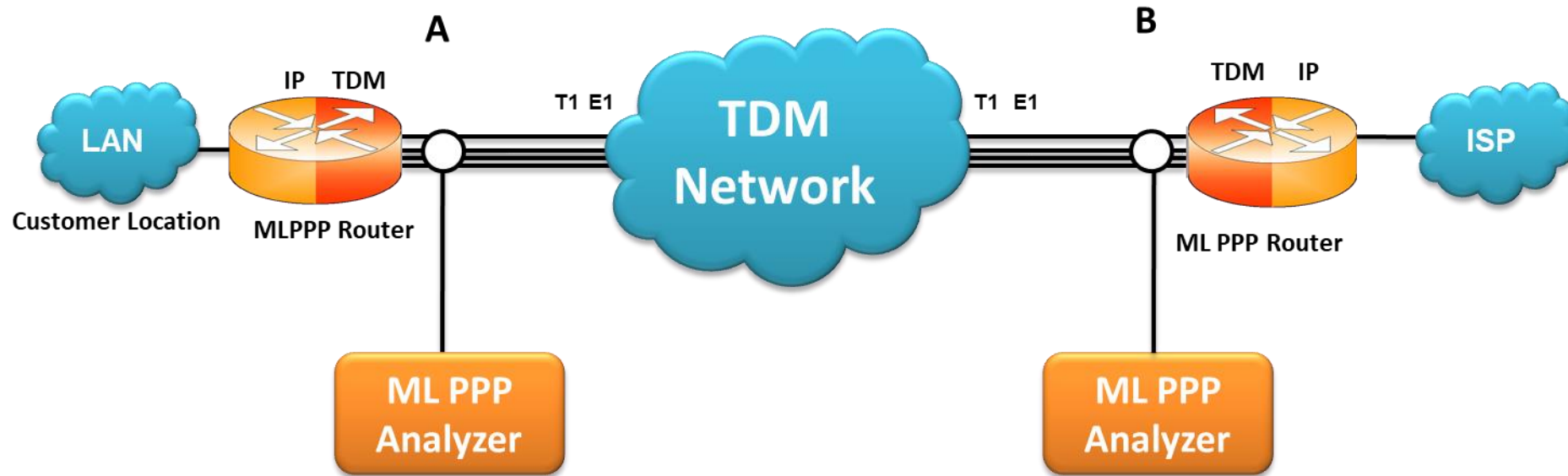


Applications

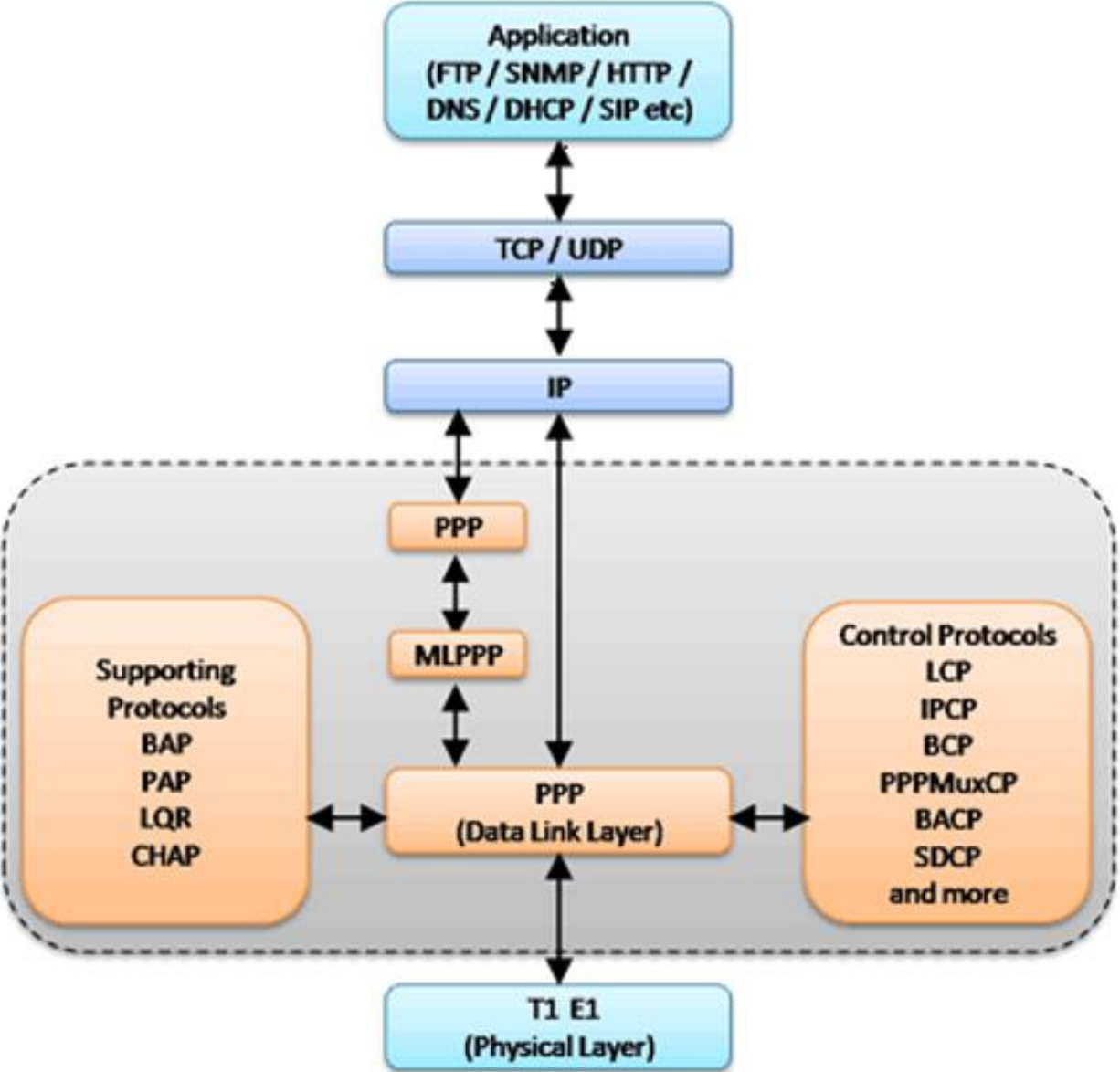


GL's MLPPP Analyzer

- Ability to decode and analyze PPP, MLPPP, and MC-MLPPP packets exchanged between the two nodes over T1 or E1 link
- MLPPP analyzer also supports Packet Data Analysis module (requires additional license) to perform detail analysis of MLPPP packets over IP and segregates them into SIP / H323 / MEGACO / MGCP / T.38 Fax calls



Supported Protocol Stack



Real Time Analysis

TimeSlot Selection

Card and Timeslot Selection

Card Selection: Cards 1, 2

Timeslot Selection: TS 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

Data Transmission Rate: Single Channel (64 kbps, 56 kbps), Hyper-Channel (Nx64 kbps, Nx56 Kbps (bits 1-7), Nx56 Kbps (Bits 2-8))

Subchannels 8-56 kbps: DS0 bits 1, 2, 3, 4, 5, 6, 7, 8

CRC: CRC16

Bit Inversion (1 <-> 0):

Octet Bit Reversion (MSB <-> LSB):

Mlpp Options: Fragment Format: Long Sequence, Maximum Differential Delay: 250 ms

Selected Links:

Real Time Analysis

PPP Protocol Analysis PPP

Dev	TS...	Su...	Frame#	TIME (Relative)	Len	PPP Layer3Prot...	M...	M...	LCP Code	IF
✓ 2	1-2		88	00:03:51.552562	21	Link Control			Echo-Reply	
✓ 1	1-2		89	00:03:52.471625	21	Link Control			Echo-Reply	
✓ 1	1-2		90	00:03:59.839500	21	Link Control			Echo-Request	
✓ 2	1-2		91	00:04:00.791687	21	Link Control			Echo-Request	
✓ 2	1-2		92	00:04:01.547750	21	Link Control			Echo-Reply	
✓ 1	1-2		93	00:04:02.498000	21	Link Control			Echo-Reply	
✓ 1	1-2		94	00:04:09.865812	21	Link Control			Echo-Request	

Card2 TimeSlots=1-2 Frame=88 at 00:03:51.552562 OK Len=21

HDLC Frame Data + FCS

```
===== PPP Link Layer =====
Address          = 11111111 (255)
Ctl              = 00000011 (3)
Protocol         = 11000000 00100001 Link Control
===== Link Control Layer =====
Code            = 00001010 Echo-Reply
Identifier      = 20 (x14)
Length         = 15 (x000F)
```

Hex Dump of the Frame Data

```
+-----+-----+-----+-----+-----+-----+-----+-----+
FF 03 C0 21 0A 14 00 0F 00 00 00 00 47 4C 20 43   y A!      GL C
4F 4D 4D A0 28                                     OMM (
```

Running. Utilization 0.02% UnderRuns=1 Captured 96 frames Errors 0 CRC, 0 Frame

Filter Options

The screenshot displays the PPP Protocol Analysis application interface. The main window shows a table of captured frames:

Dev	TS...	Su...	Frame#	TIME (Relative)	Len	PPP Layer3Prot...	M...	M...	LCP Code	IF
✓ 2	1-2		0	00:00:41.146687	21	Link Control			Echo-Reply	
	1-2		1	00:00:42.089687	21	Link Control			Echo-Reply	
	1-2		2	00:00:51.148687	21	Link Control			Echo-Reply	
	1-2		3	00:00:52.122675	21	Link Control			Echo-Reply	
	1-2		4	00:01:01.162375	21	Link Control			Echo-Reply	
	1-2		5	00:01:02.132687	21	Link Control			Echo-Reply	
	1-2		6	00:01:11.188687	21	Link Control			Echo-Reply	

The detailed view of the selected frame (Frame 0) shows the following structure:

```
12 TimeSlots=1-2 Frame=0 at 00:00:41.146687 OK Len=21
C Frame Data + FCS
===== PPP Link Layer =====
Address = 11111111 (255)
Protocol = 00000011 (3)
Code = 11000000 00100001 Link Control
===== Link Control Layer =====
Code = 00001010 Echo-Reply
Identifier = 1 (x01)
Length = 15 (x000F)
```

The Hex Dump of the Frame Data is as follows:

```
+-----+-----+-----+-----+-----+-----+-----+-----+
FF 03 C0 21 0A 01 00 0F 00 00 00 00 47 4C 20 43      y A!      GL C
4F 4D 4D 24 73      OMM$S
```

The status bar at the bottom indicates: Filter is active. UnderRuns=1 Idle fltr 288 of 586 frames Errors 0 CRC, 0 Frame

Decode View - MLPPP

The screenshot displays the PPP Protocol Analysis application. The top window shows a table of captured packets. The second packet is selected, and the main pane shows its detailed decode view.

Dev	TS...	Su...	Frame#	TIME (Relative)	Len	PPP Layer3Prot...	Mlppp Seq...	Mlppp Class	LCP Code	IPCP Code
✓ 1	1-30		2	00:00:04.986112	19	Link Control			Configure-Request	
✓ 1	1-30		3	00:00:05.002229	28	ML PPP	0	0	Configure-Request	Configure-Request
✓ 1	1-30		4	00:00:07.975691	28	ML PPP	1	0		Configure-Ack
✓ 1	1-30		5	00:00:39.987229	12	Link Control			Echo-Request	
✓ 1	1-30		6	00:00:39.993145	12	Link Control			Echo-Reply	

Card1 TimeSlots=1-30 Frame=3 at 00:00:05.002229 OK Len=28
HDLC Frame Data + FCS

```
***** PPP Link Layer *****
Address                = 11111111 (255)
Ctl                    = 00000011 (3)
Protocol               = 00000000 00111101 ML PPP
***** ML PPP Layer *****
Beginning Fragment    = 1..... Yes
Ending Fragment      = .1..... Yes
Mlppp Class          = ..0000.. (0)
Sequence Number(Long) = 0 (x000000)
***** PPP Link Layer *****
Protocol              = 00000000 00111101 ML PPP
***** ML PPP Layer *****
Beginning Fragment    = 1..... Yes
Ending Fragment      = .1..... Yes
Mlppp Class          = ..0000.. (0)
Sequence Number(Long) = 0 (x000000)
***** PPP Link Layer *****
Protocol              = 10000000 00100001 IPCP
***** IPCP Layer *****
Code                  = 00000001 Configure-Request
Identifier            = 1 (x01)
Length                = 10 (x000A)
```

Off-line Viewing | D:\Program Files\GL Communications II | 489 Frames

Summary, Detail and Hex Dump Views

The screenshot displays the PPP Protocol Analysis software interface, which is divided into three main sections. The top section is a table showing a list of captured frames. The middle section provides a detailed view of the selected frame (Frame 9), and the bottom section shows the raw hex dump of the frame data.

ev	TS...	Su...	Frame#	TIME (Relative)	Len	PPP Layer3Prot...	Mlppp Seq No	Mlppp Class	LCP Code	IPCP Code	BCI
1	2		9	00:00:07.495...	18	Link Control			Configure-Ack		
1	1		10	00:00:07.822...	21	Link Control			Echo-Request		
1	1		11	00:00:07.837...	59	ML PPP	0	0	Echo-Request		
1	1		12	00:00:07.857...	16	ML PPP	1	0		Configure-Request	
1	2		13	00:00:08.196...	21	Link Control			Echo-Request		
2	1		14	00:00:09.275...	21	Link Control			Echo-Request		
2	2		15	00:00:09.276...	21	Link Control			Echo-Request		

Card1 TimeSlot=2 Frame=9 at 00:00:07.495875 OK Len=18
HDLC Frame Data + FCS
===== PPP Link Layer =====
Address = 11111111 (255)
Ctl = 00000011 (3)
Protocol = 11000000 00100001 Link Control
===== Link Control Layer =====
Code = 00000010 Configure-Ack
Identifier = 1 (x01)
Length = 12 (x000C)
MRU =
Type = 00000001 Maximum-Receive-Init

Hex Dump of the Frame Data
+-----+-----+-----+-----+-----+-----+
FF 03 C0 21 02 01 00 0C 01 04 01 00 11 04 05 DC ÿ Å! Û
B7 9B · |

Off-line Viewing D:\Program Files\GL Communicator 50 Frames

Summary View
Detail View
Hex Dump View

Statistics

The screenshot shows the 'PPP Protocol Analysis' window. The main pane displays a list of frames with columns: Dev, TS..., Su..., Frame#, TIME (Relative), Len, PPP Layer3Prot..., Mlppp Seq No, Mlppp Class, LCP Code, and IPCP Code. The summary table below shows frame counts for various codes across two devices.

Device #	Code	Frame Count
1	Configure-Request ...	1
1	Configure-Ack (2)	2
1	Terminate-Request ...	2
1	Terminate-Ack (6)	1
1	Echo-Request (9)	24
1	Echo-Reply (10)	23
total 1	Total	53
2	Configure-Request ...	3
2	Configure-Ack (2)	1
2	Terminate-Ack (6)	2
2	Echo-Request (9)	24
2	Echo-Reply (10)	24
total 2	Total	54

Statistics View

MLPPP Analyzer with Packet Data Analysis

Traffic Analyser - Summary View

File View Call Summary Settings Help

Sip Calls Show All Sessions

Call Summary | Registrar Summary | Alert Summary

Call #	SSRC	Payload	Packet Received	Conversat MOS/R...	Listening MOS/R...	Packets Discard...	Missing Packets...	Duplicate Packets...	Out Of Sequen...	Average Gap(ms)	Average Delay	Average Jitter	Averag Inter Ar
Call#000001 Caller:UA01@192.164.1.64 Callee:UA01@192.168.1.21 CallId:GLPG2310064722738 Call StartTime:2009-03-24 15:01:55.000390 Call Dur													
1	27335...	PCMU...	7632	1.30 / ...	1.33 / ...	114 / ...	2595 / ...	0 / 0.00	0 / 0.00	26.75	0.00	8.00	3
1	27317...	PCMU...	10250	4.01 / ...	4.04 / ...	158 / ...	0 / 0.00	0 / 0.00	0 / 0.00	20.01	0.00	1.00	8
Call#000002 Caller:UA02@192.164.1.64 Callee:UA02@192.168.1.21 CallId:GLPG2313494722741 Call StartTime:2009-03-24 15:01:55.000642 Call Dur													
2	27387...	PCM...											
2	27351...	PCM...											
Call#000003 Caller:UA0...													

Traffic Analyser - Detail View

File View Detail View Settings Help

Sip Calls Show All Sessions

Call Summary | Registrar Summary | Alert Summary

Packet...	Sequ...	RT...	Payload...	Pay...	Packet S...	Gap[...	G...	Packet...	Sequ...	RT...	Payload...	Pay...	Packet S...	Gap[...	G...
M 272	61850	497...	PCMU/8...	160	Session I...	0.00	0...	M 27	58264	597...	PCMU/8...	160	Session I...	0.00	0...
280	61851	497...	PCMU/8...	160	Session I...	29.08	2...	29	58265	597...	PCMU/8...	160	Session I...	0.28	2...
294	61853	497...	PCMU/8...	160	Jump Wit...	22.44	4...	31	58266	597...	PCMU/8...	160	In Seque...	8.47	2...
316	61856	497...	PCMU/8...	160	Jump Wit...	32.10	6...	35	58267	597...	PCMU/8...	160	In Seque...	21.20	2...
329	61858	497...	PCMU/8...	160	Jump Wit...	21.91	4...	47	58268	597...	PCMU/8...	160	In Seque...	18.91	2...
339	61859	497...	PCMU/8...	160	In Seque...	21.23	2...	52	58269	597...	PCMU/8...	160	In Seque...	20.41	2...
350	61860	497...	PCMU/8...	160	In Seque...	10.98	2...	57	58270	597...	PCMU/8...	160	In Seque...	19.54	2...
356	61861	497...	PCMU/8...	160	In Seque...	10.41	2...	62	58271	597...	PCMU/8...	160	In Seque...	20.52	2...
366	61862	497...	PCMU/8...	160	In Seque...	11.12	2...	67	58272	597...	PCMU/8...	160	In Seque...	19.46	2...

No of Calls

15:01:55 15:02:22 15:

Active Calls G

Heading	Value	Heading	Value
SSRC	2733575681	SSRC	2731721729
Source IP Address	192.168.1.64	Source IP Address	192.168.1.21
Destination IP Address	192.168.1.21	Destination IP Address	192.168.1.64
Source Port	1024	Source Port	1024
Destination Port	1024	Destination Port	1024
RTP Packets Count	7620	RTP Packets Count	10237

RTP Statistics | RTCP | Gap Graph | Jitter Graph | Gap Distribution Graph | Jitter Distribution Graph | MOS Graph | Quality Factors

Offline Protocol Analyzer

The screenshot displays the 'Off-line PPP Protocol Analysis' application window. The main window title is 'Off-line PPP Protocol Analysis PPP'. The menu bar includes 'File', 'View', 'Capture', 'Statistics', 'Database', 'Configure', and 'Help'. The toolbar contains various icons for file operations, capture, and protocol analysis. Below the toolbar is a table with the following columns: Dev, TS..., Su..., Frame#, TIME (Relative), Len, Error, PPP Layer3Prot..., and Mlppp Seq No. The table shows seven frames, all with a length of 1442 and identified as 'Bridging PDU'. Below the table, there are three sections: 'Card2 TimeSlots=0-23 Frame=0 at 00:00:00.000000 OK Len=1442', 'HDLC Frame Data + FCS' which details the PPP Link Layer and Bridging PDU Layer fields, and 'Hex Dump of the Frame Data' showing the raw hexadecimal and ASCII data of the frame.

Dev	TS...	Su...	Frame#	TIME (Relative)	Len	Error	PPP Layer3Prot...	Mlppp Seq No
✓ 2	0-23		0	00:00:00.000000	1442		Bridging PDU	
✓ 2	0-23		1	00:00:00.016885	1442		Bridging PDU	
✓ 2	0-23		2	00:00:00.033718	1442		Bridging PDU	
✓ 2	0-23		3	00:00:00.050625	1442		Bridging PDU	
✓ 2	0-23		4	00:00:00.071244	1442		Bridging PDU	
✓ 2	0-23		5	00:00:00.084479	1442		Bridging PDU	
✓ 2	0-23		6	00:00:00.101218	1442		Bridging PDU	
✓ 2	0-23		7	00:00:00.118135	1442		Bridging PDU	

Card2 TimeSlots=0-23 Frame=0 at 00:00:00.000000 OK Len=1442

HDLC Frame Data + FCS

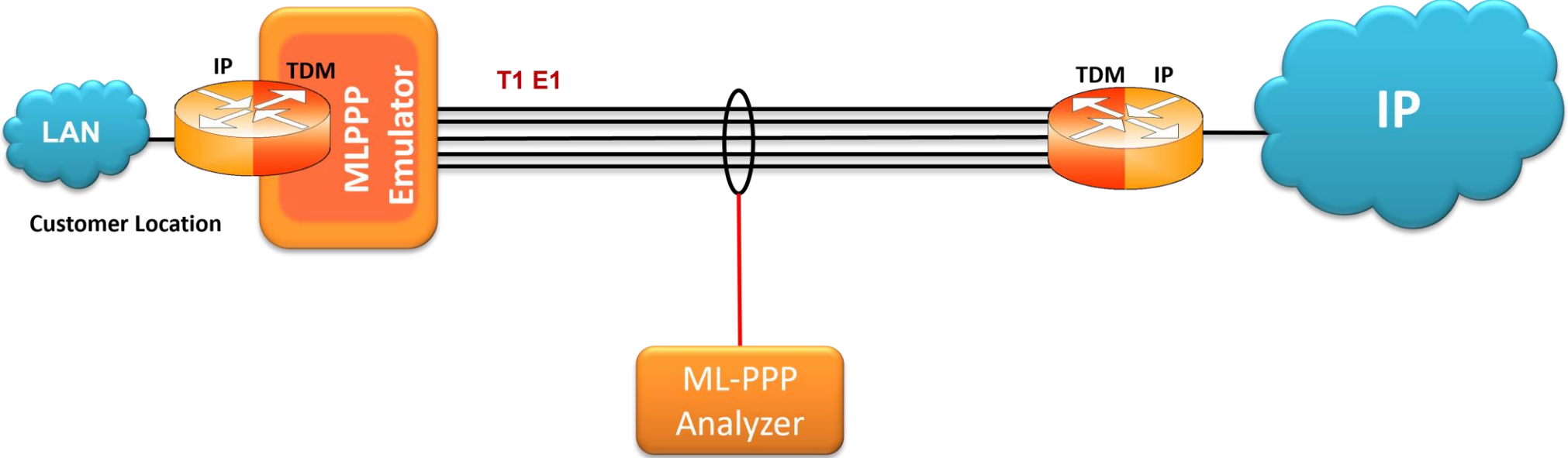
```
===== PPP Link Layer =====
Address                = 11111111 (255)
Ctl                    = 00000011 (3)
Protocol               = 00000000 00110001 Bridging
===== Bridging PDU Layer =====
Bit F:                 = 0..... LAN FCS Field is no
Bit I:                 = .0..... LAN ID Field is no
Bit Z:                 = ..0..... Reserved
Count                  = 0000 (0)
```

Hex Dump of the Frame Data

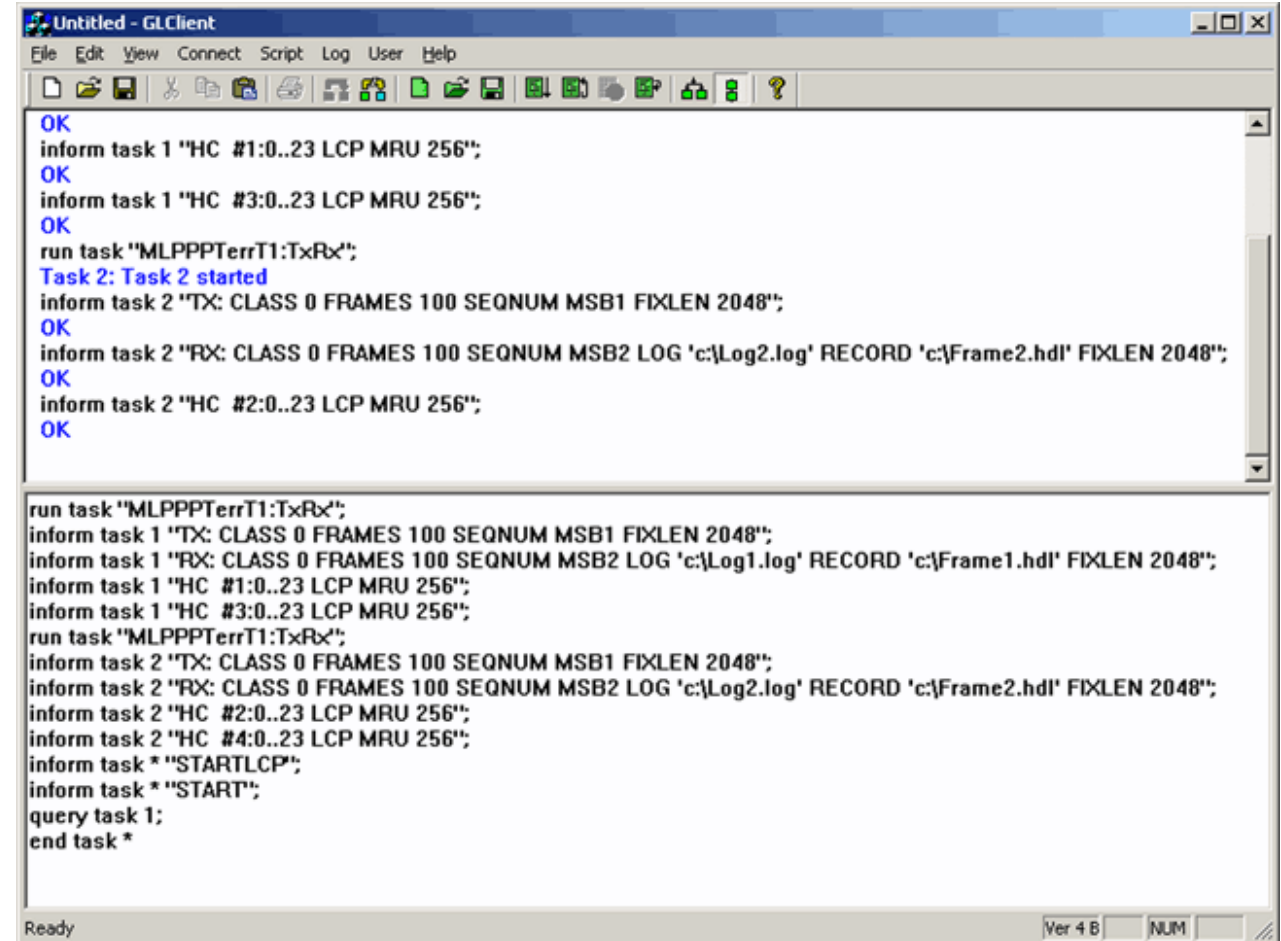
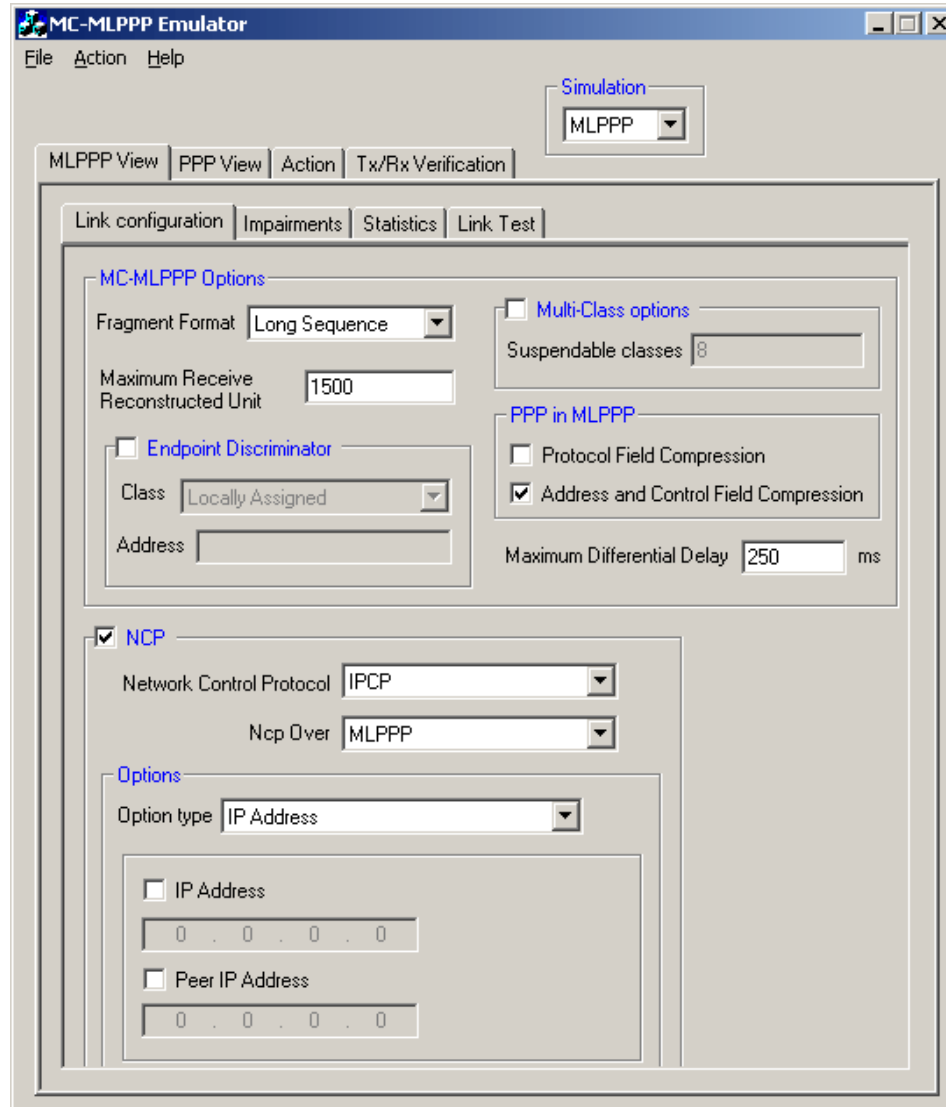
```
+-----+-----+-----+-----+-----+-----+-----+-----+
FF 03 00 31 00 01 FF FF FF FF FF FF 00 00 C5 87   y 1 yyyyyyy A|
CC B0 08 00 45 00 05 8C 21 33 40 00 74 06 86 D3   I* E !!3@ t |O
41 F7 65 47 42 95 6F 92 00 50 FB BE C8 30 0B 4F   A-eGB|o' Pû&E0 O
99 C3 90 81 50 10 FC EA 57 7A 00 00 9C 07 1E E0   |Ã|P uêWz | à
0C 41 BA 22 1B D0 31 4C 1A 8E 31 D4 D3 4E 1C C7   102 DeT |eÔ6E C
```

Off-line Viewing C:\Program Files\Gl Communi 402 Frames

MC-MLPPP Emulator

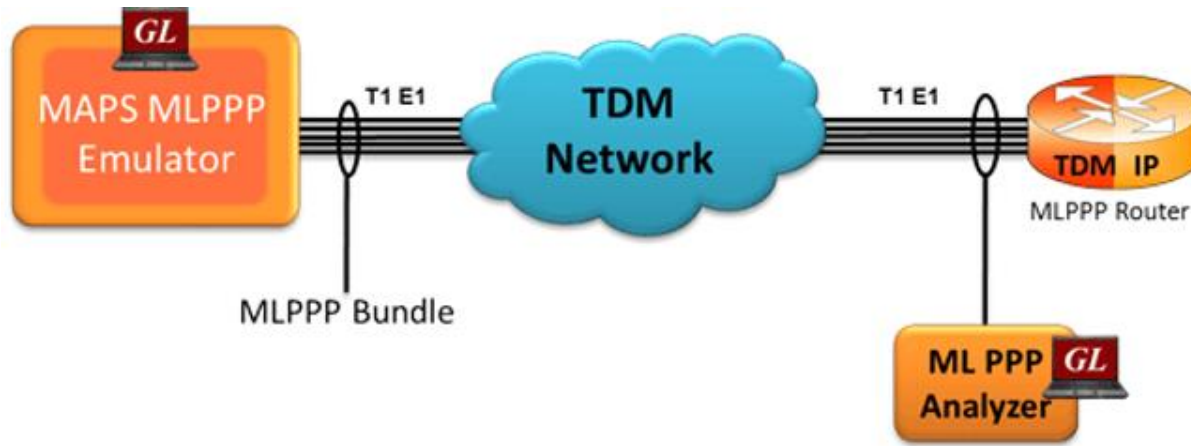


Automated Testing of PPP, MLPPP, and MC-MLPPP using Client Server



Scripted MLPPP Conformance Testing using MAPS™

- MAPS™ MLPPP is an advanced protocol simulator/tester for MC-MLPPP/MLPPP/PPP protocols over TDM (T1 E1)
- The tester can simulate a complete PPP/MLPPP link between two peers (Router or a Switch), with MLPPP signaling conforming to IETF specifications



The image shows two screenshots of the MAPS software interface. The top screenshot, titled 'Call Generation - Untitled', displays a table of call execution results. The bottom screenshot, titled 'Call Reception', shows a detailed message sequence between MAPS and the DUT (Device Under Test).

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Result	Total Iterati...	Completed Iterations
1	OpenStateTest.g...	Profile_openState.xml		Start	Opened	None		Pass	1	1

Sr No	Script Name	Call Info	Script Execution	Status	Events	Events Profile	Results
1	TestLoopBackUsingPeerMagicNumber.gls		Completed		None		Fail
2	TestLoopBackUsingPeerMagicNumber.gls		Completed		None		Pass
3	TestLoopBackUsingPeerMagicNumber.gls		Completed		None		Pass
4	TestLoopBackUsingPeerMagicNumber.gls		Completed		None		Unknown
5	TestLoopBackUsingPeerMagicNumber.gls		Completed		None		Unknown
6	TestLoopBackUsingPeerMagicNumber.gls		Completed		None		Fail

The 'Call Reception' window shows a message sequence between MAPS and DUT:

- MAPS → DUT: Configure-Request (4:16:34.828000)
- DUT → MAPS: Configure-Request (4:16:40.734000)
- DUT → MAPS: Configure-Ack (4:16:40.7340)
- MAPS → DUT: Configure-Request (4:16:40.8900)
- DUT → MAPS: Configure-Ack (4:16:44.3750)

The right pane of the 'Call Reception' window displays protocol details for the PPP Link Layer:

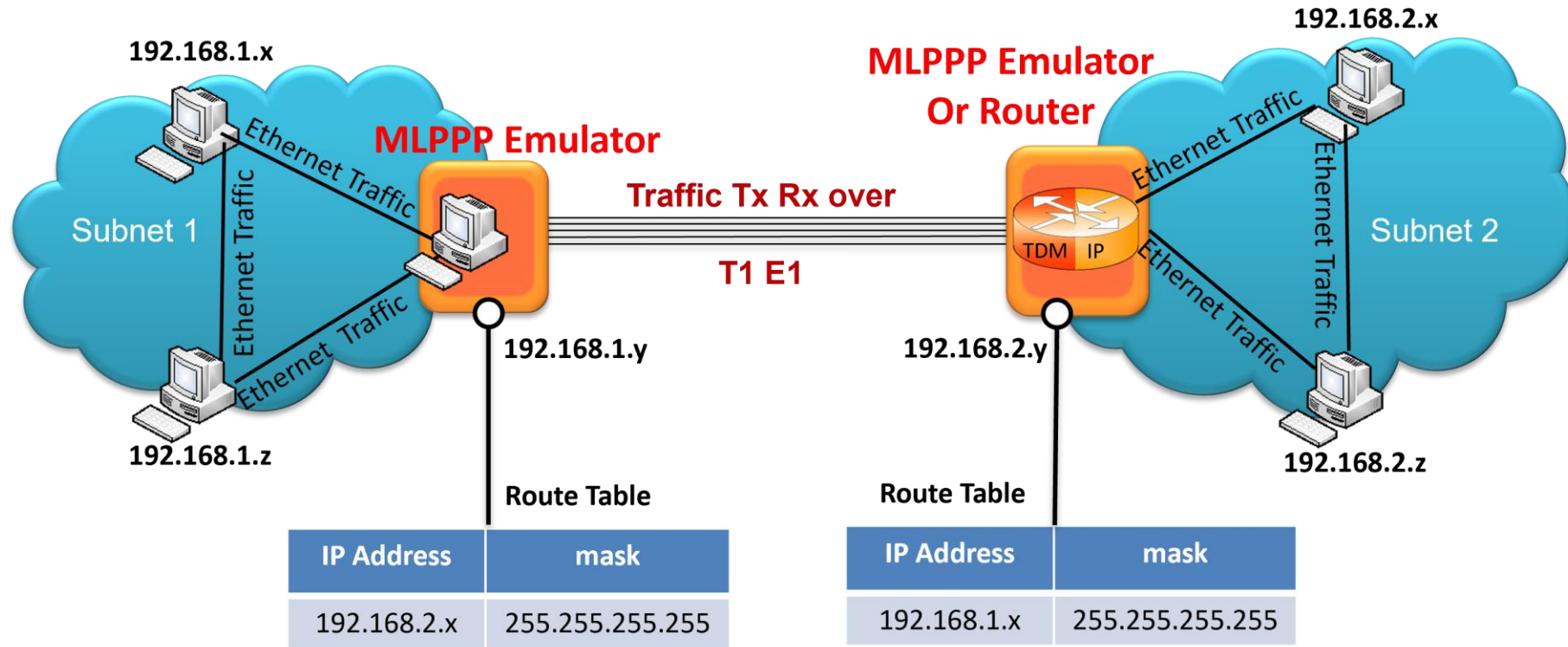
```
===== PPP Link Layer =====
Address Compression Choice = 1111... No Address Com
Address = 11111111 Broadcast Add
Ctl = 00000011 UnSequenced Fr
Protocol Field Selection = .....0 ProtocolField
Protocol = 11000000 00100001 Link
```

The bottom pane shows details for the Link Control Layer:

```
===== Link Control Layer =====
Code Type =
Code = 00000001 Configure-Re
Identifier = 1 (x011)
Length = 18 (x0012)
Magic-Number =
IE id = 00000101 Magic-Number
Length of Options = 6 (x06)
```

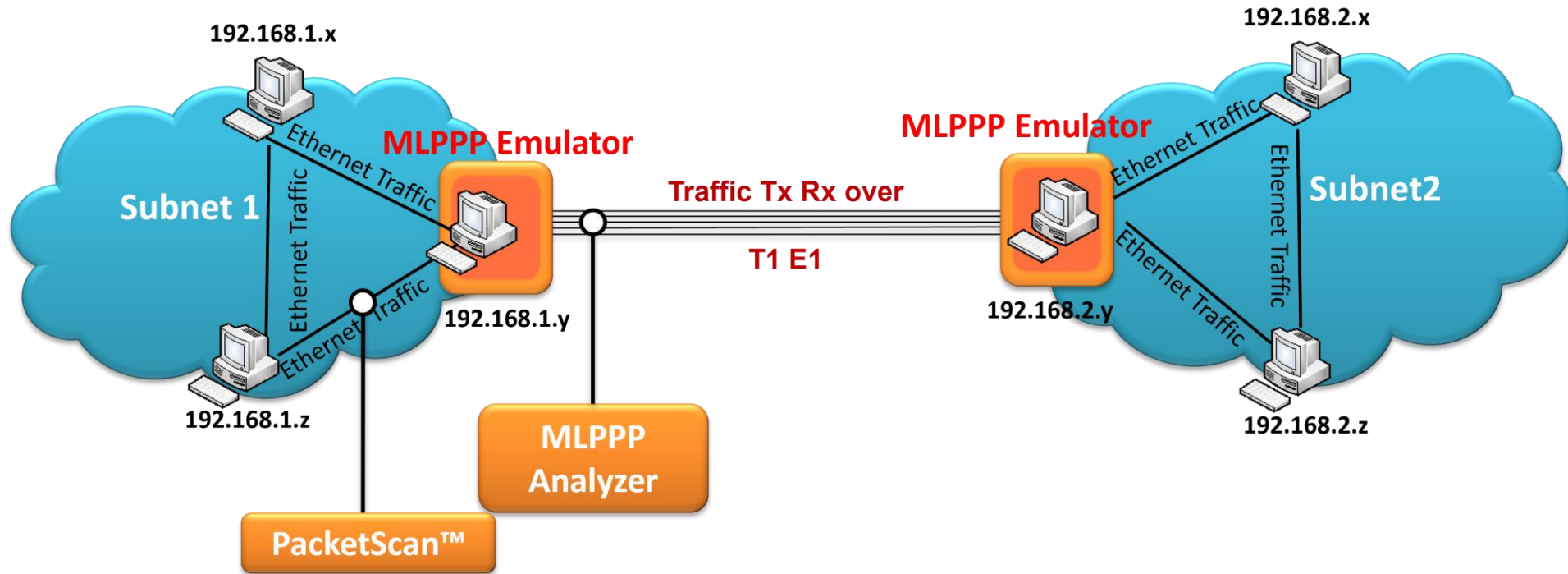

MLPPP Emulator as Router

- MLPPP Emulator is configured as router (using NETWORK TRAFFIC source and sink type) and might be required to maintain the timing while forwarding packets from Ethernet to T1 or E1 and vice versa
- The time difference between the consecutive packets captured from NIC card is maintained while transmitting on T1 or E1 and vice versa



MLPPP Emulator as MLPPP Bridge

- Emulator is configured to act as bridge between two networks, all ARP and traffic (checked against the priority table) received from the network is encapsulated as BPDU (Bridging Protocol Data Unit) and streamed over T1 E1 links
- The Emulator on another network removes BPDU header, converts to Ethernet and streams to the destination



Impairments

- Various impairments can be introduced before frames are transmitted or during traffic generation
- In PPP simulation frames are impaired by applying impairment to a particular PPP link
- One can specify a limited number of impairments or continuous impairment

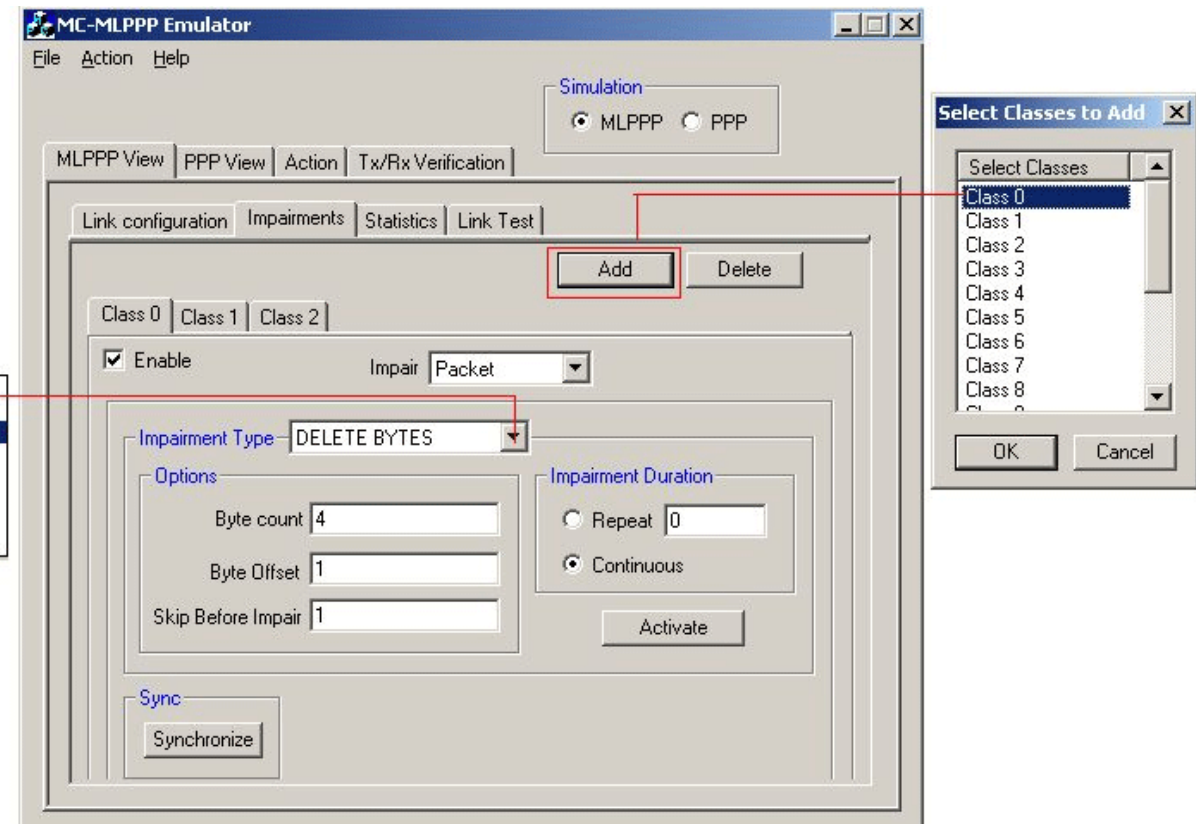
Impairments that affect an entire frame:

- CRC Error
- Insert and delete frame
- Frame Error
- Frame duplication

Impairments that affect a frame by impairing frame data:

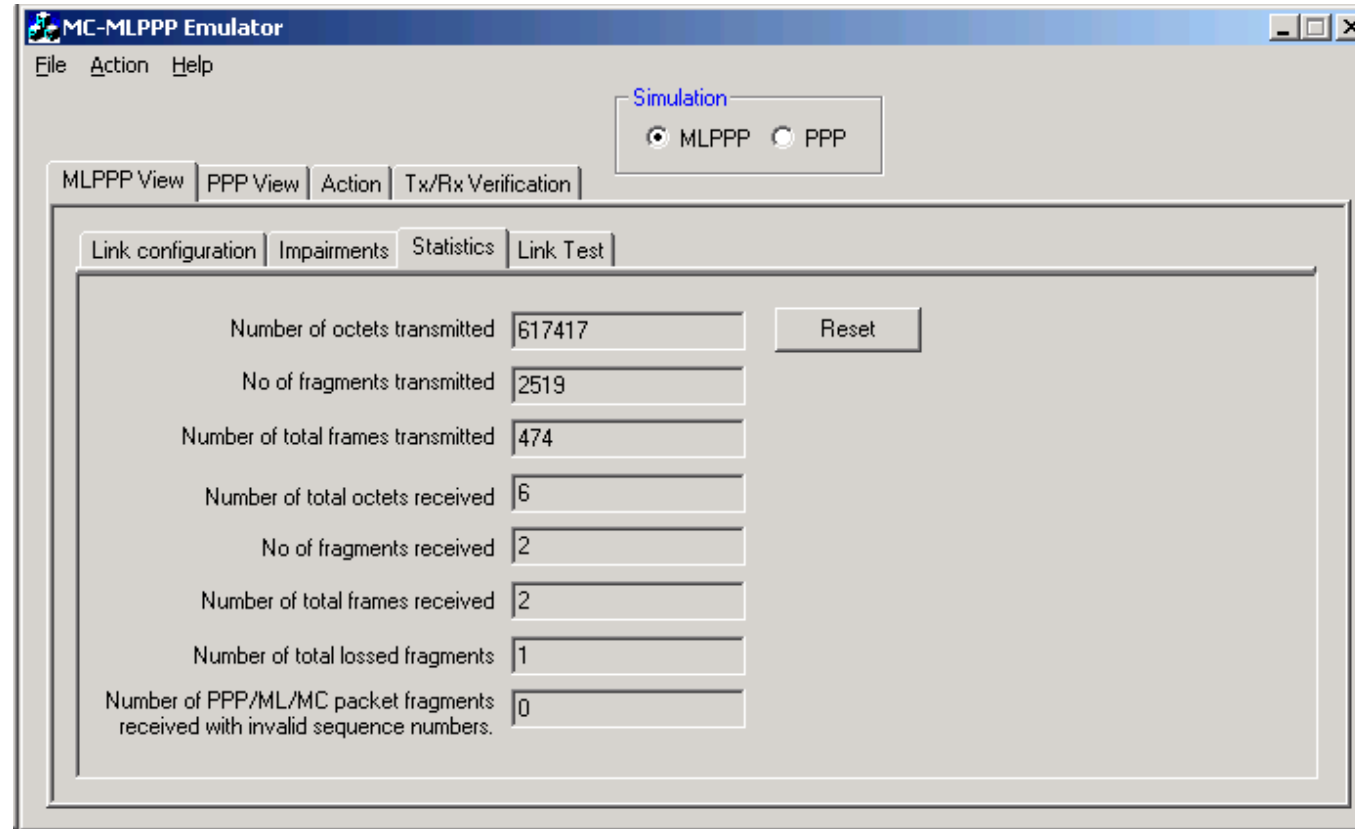
- Inserting bytes
- Deleting bytes
- Bitwise ANDing octets
- Bitwise Oring octets
- Bitwise XORing octets

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



Data Verification using Statistics

MLPPP Statistics



The screenshot shows the 'MC-MLPPP Emulator' window with the 'Statistics' tab selected. The 'Simulation' section has 'MLPPP' selected. The 'Statistics' section displays the following data:

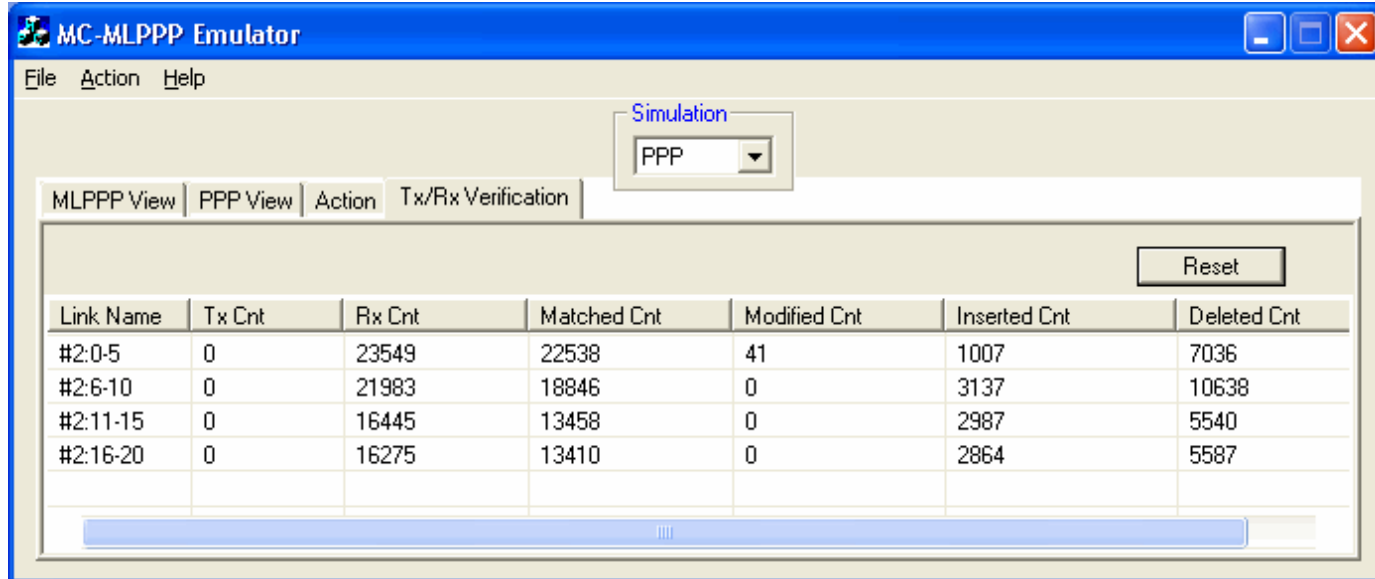
Metric	Value
Number of octets transmitted	617417
No of fragments transmitted	2519
Number of total frames transmitted	474
Number of total octets received	6
No of fragments received	2
Number of total frames received	2
Number of total lossed fragments	1
Number of PPP/ML/MC packet fragments received with invalid sequence numbers.	0

A 'Reset' button is located to the right of the first input field.

- MLPPP statistics provides important information about the MLPPP bundle such as Number of transmitted/received octets, frames, fragments, lost fragments, and PPP/ML/MC packet fragments received with invalid sequence numbers

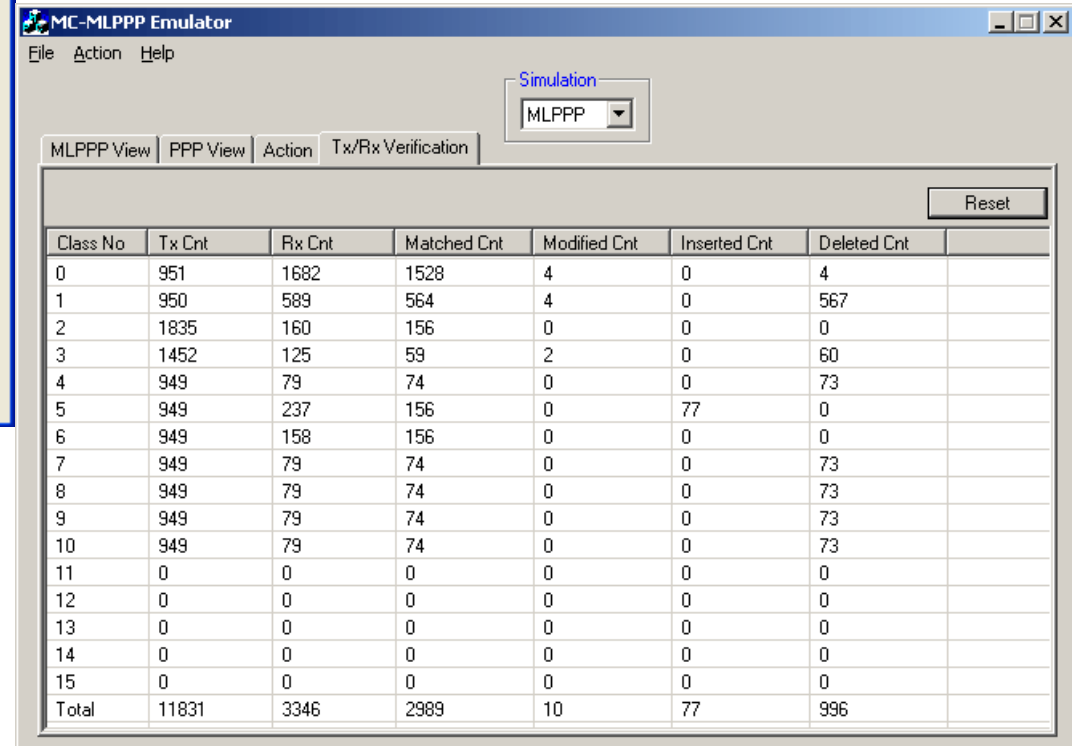
Tx/Rx Verification

- Traffic verification results provide the overall statistics for all classes (MLPPP Simulation) or links (PPP Simulation)
- The statistics include number of Transmitted, Received, Matched, Modified, Inserted and Deleted frames



The screenshot shows the 'MC-MLPPP Emulator' window with the 'Simulation' dropdown set to 'PPP'. The 'Tx/Rx Verification' tab is active, displaying a table with the following data:

Link Name	Tx Cnt	Rx Cnt	Matched Cnt	Modified Cnt	Inserted Cnt	Deleted Cnt
#2:0-5	0	23549	22538	41	1007	7036
#2:6-10	0	21983	18846	0	3137	10638
#2:11-15	0	16445	13458	0	2987	5540
#2:16-20	0	16275	13410	0	2864	5587



The screenshot shows the 'MC-MLPPP Emulator' window with the 'Simulation' dropdown set to 'MLPPP'. The 'Tx/Rx Verification' tab is active, displaying a table with the following data:

Class No	Tx Cnt	Rx Cnt	Matched Cnt	Modified Cnt	Inserted Cnt	Deleted Cnt
0	951	1682	1528	4	0	4
1	950	589	564	4	0	567
2	1835	160	156	0	0	0
3	1452	125	59	2	0	60
4	949	79	74	0	0	73
5	949	237	156	0	77	0
6	949	158	156	0	0	0
7	949	79	74	0	0	73
8	949	79	74	0	0	73
9	949	79	74	0	0	73
10	949	79	74	0	0	73
11	0	0	0	0	0	0
12	0	0	0	0	0	0
13	0	0	0	0	0	0
14	0	0	0	0	0	0
15	0	0	0	0	0	0
Total	11831	3346	2989	10	77	996

PPP Statistics

- PPP Statistics provides important statistics information for the selected PPP link, such as the Number of transmitted/received octets, frames, PPP packets with bad addresses, PPP packets with bad control bytes, and PPP packets exceeding the MRU

LCP Configuration	NCP Configuration	Link Test	Statistics	HDLC Statistics	Impairments
Number of octets transmitted				<input type="text" value="3212"/>	<input type="button" value="Reset"/>
Number of total frames transmitted				<input type="text" value="206"/>	
Number of total octets received				<input type="text" value="3184"/>	
Number of total frames received				<input type="text" value="202"/>	
Number of PPP packets with bad addresses				<input type="text" value="0"/>	
Number of PPP packets with bad control bytes				<input type="text" value="0"/>	
Number of PPP packets too long exceeding the MRU				<input type="text" value="0"/>	

Thank you