PPP and MLPPP Protocol Overview

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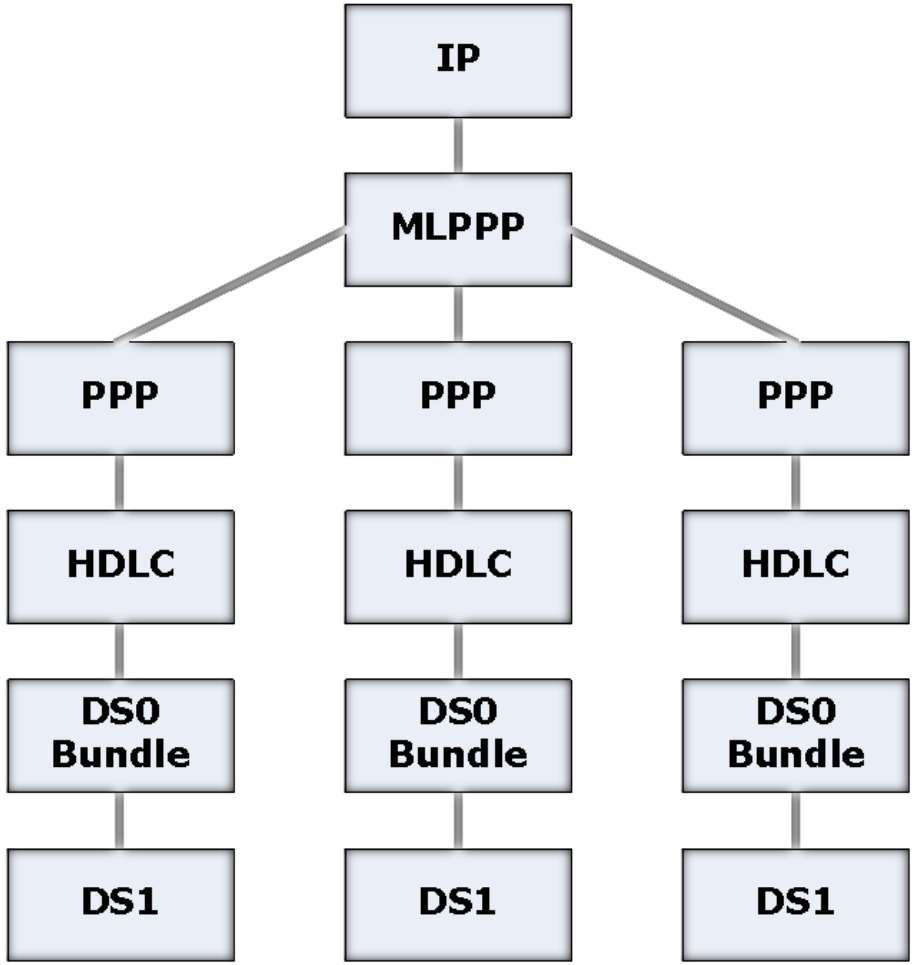
Point-to-Point Protocol (PPP)

- 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)



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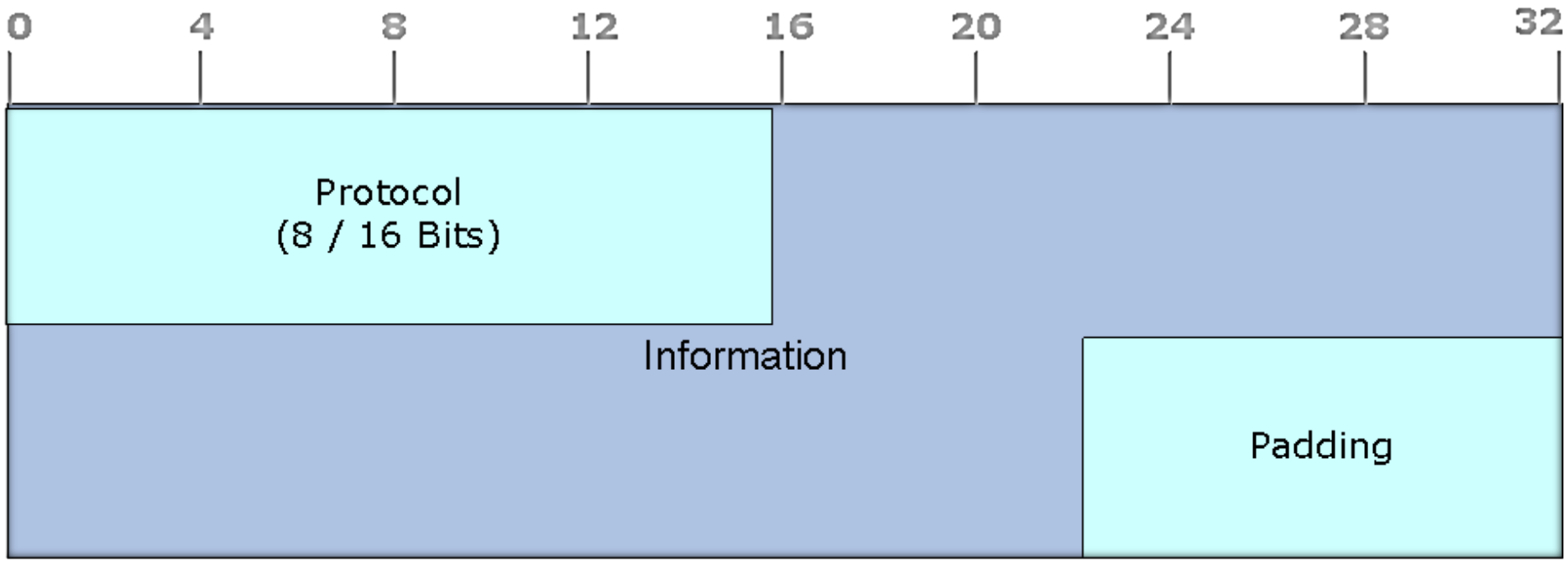
PPP Frame Structure

- **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



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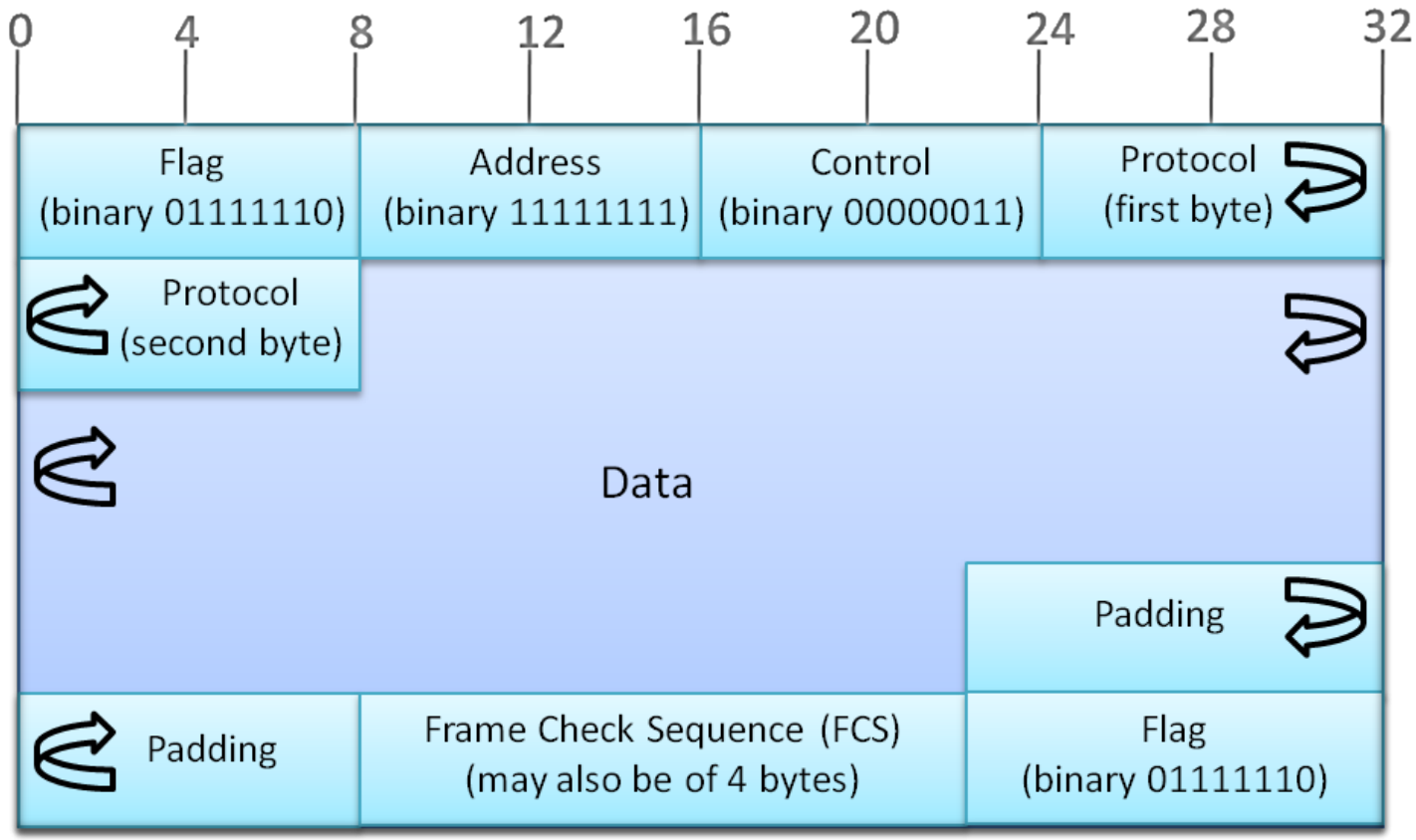
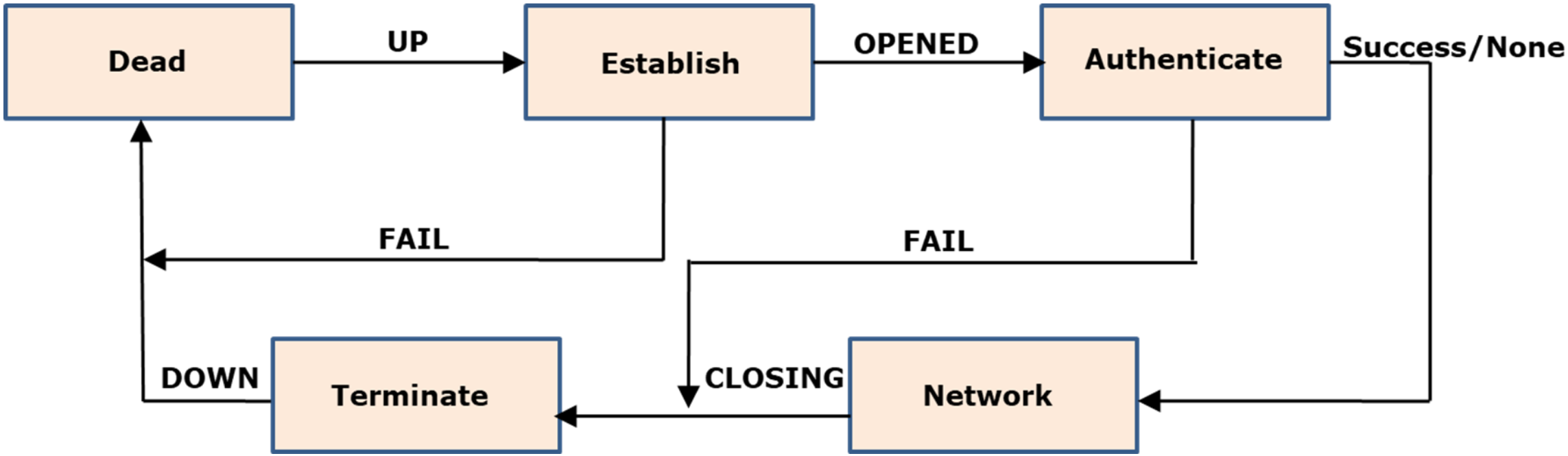
PPP Encapsulation in HDLC Framing

- 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

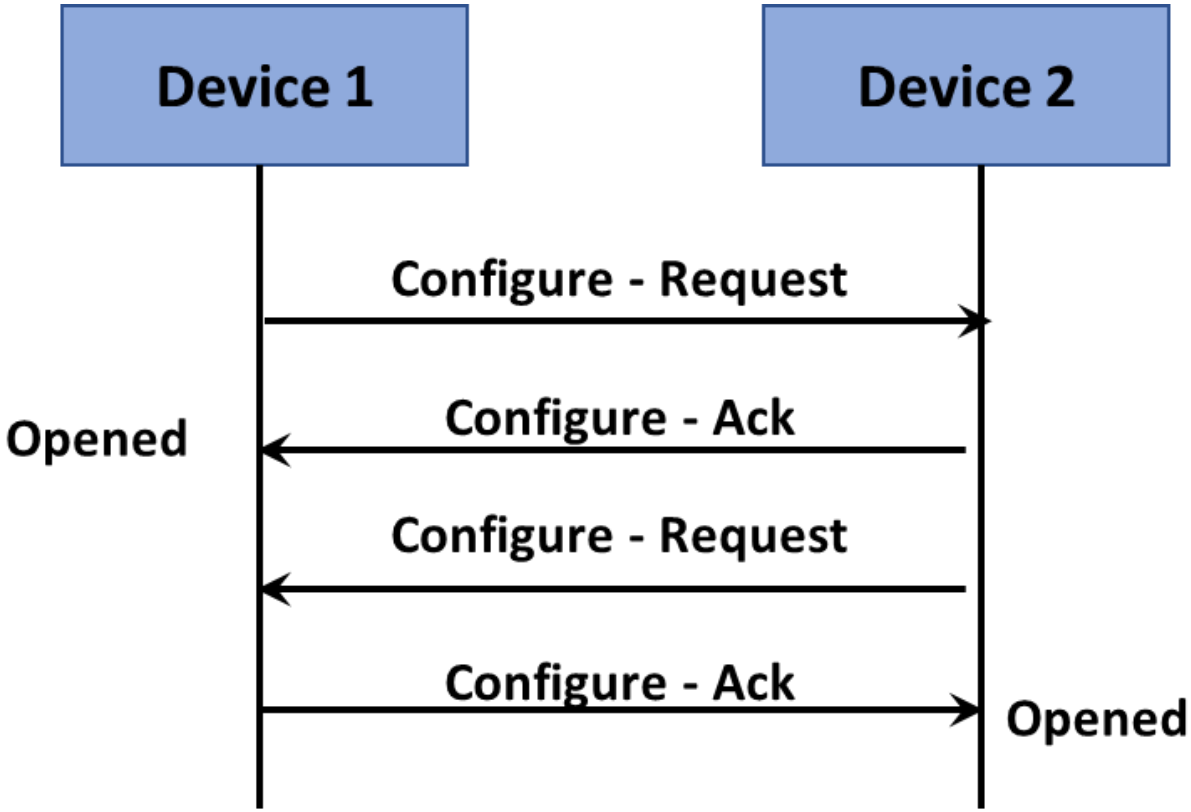


PPP Control Protocols

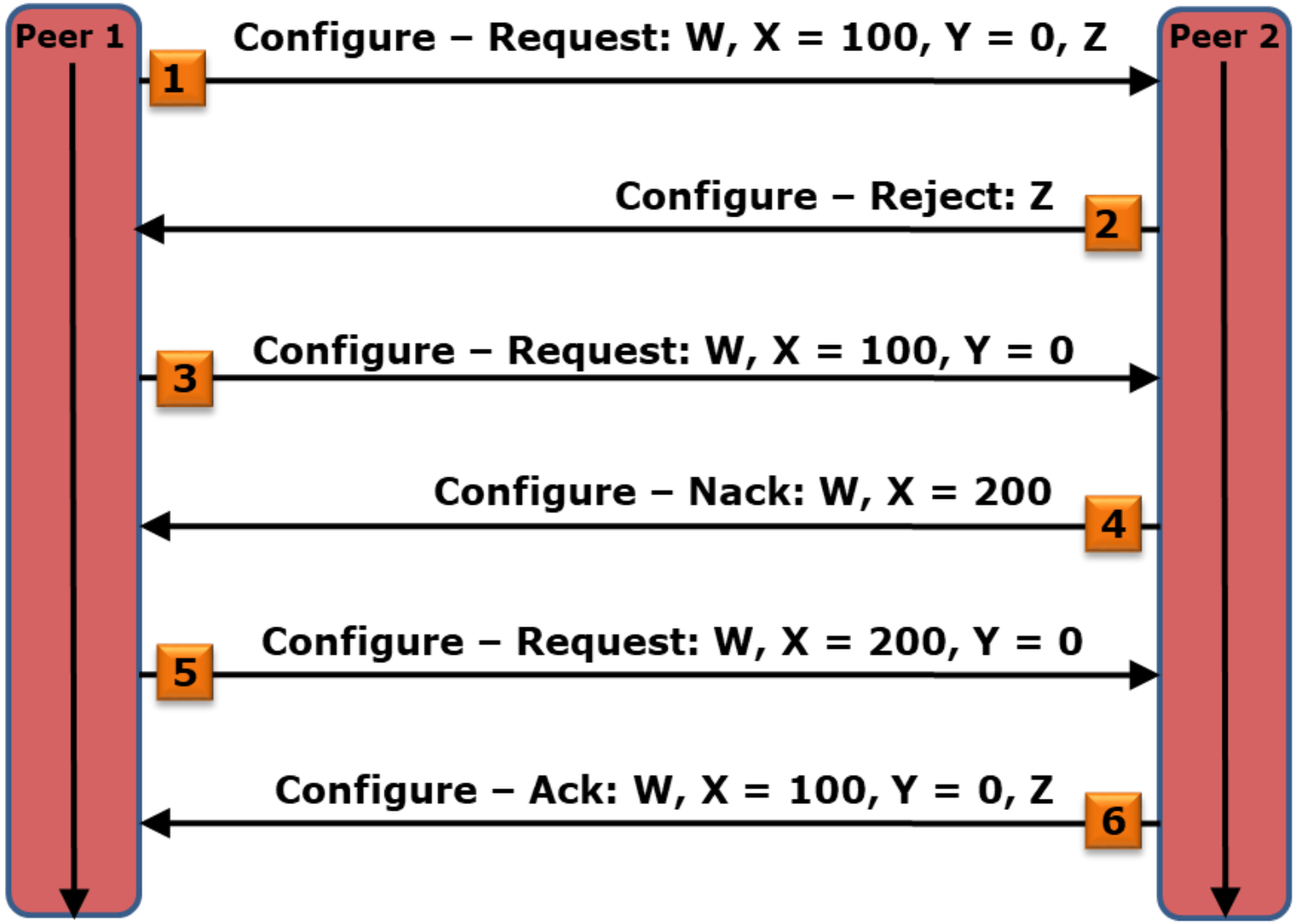
- There are many different PPP control protocols that contain specific information that is used to configure, manage and discontinue PPP links, and to implement the various features that comprise PPP
- Two of such protocols are :-
  - Link Control Protocol (LCP)
  - Network Control Protocols (NCPs)

Link Configuration Protocol (LCP)

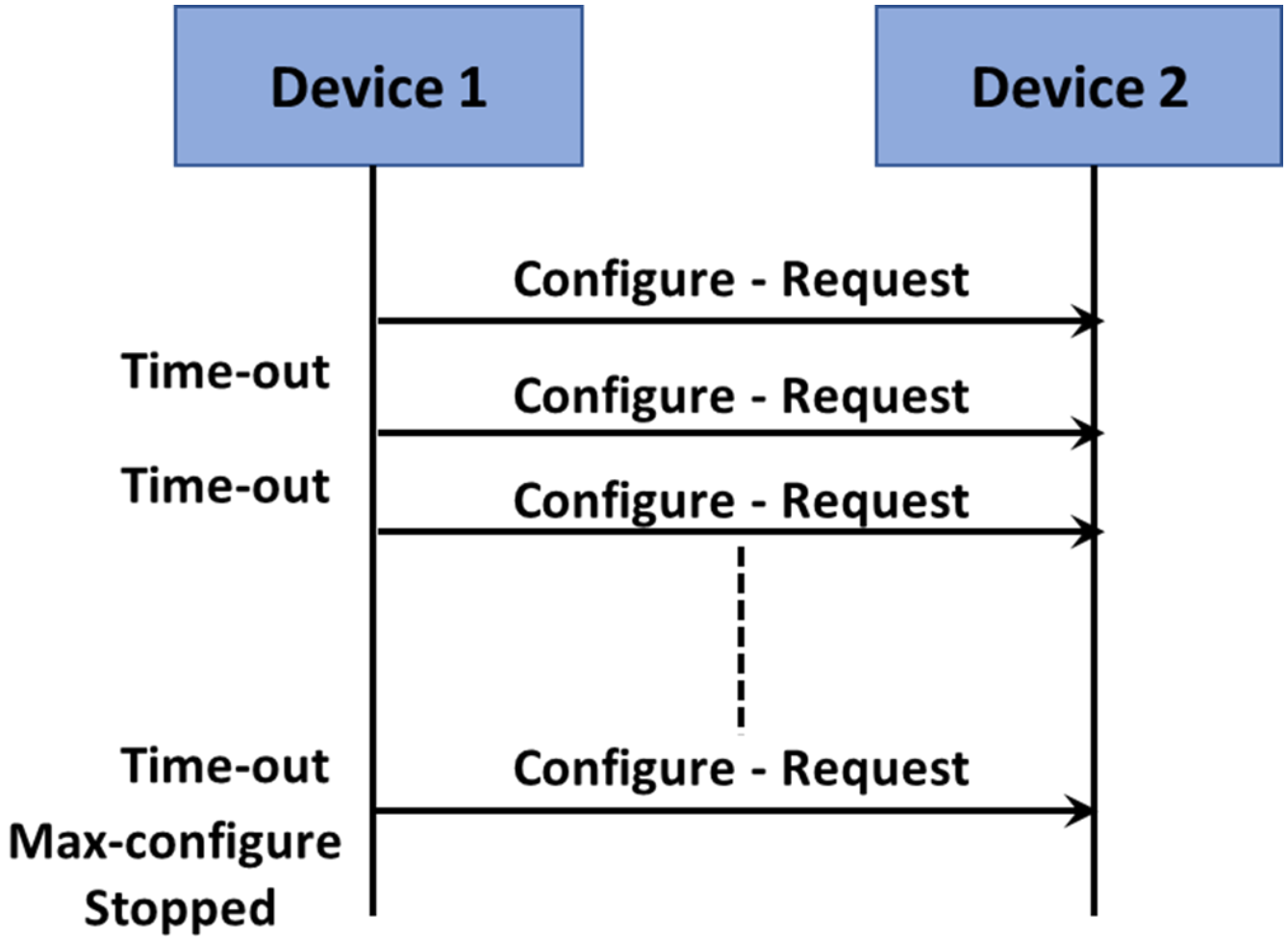
- The LCP is responsible for configuring, maintenance, and termination of links



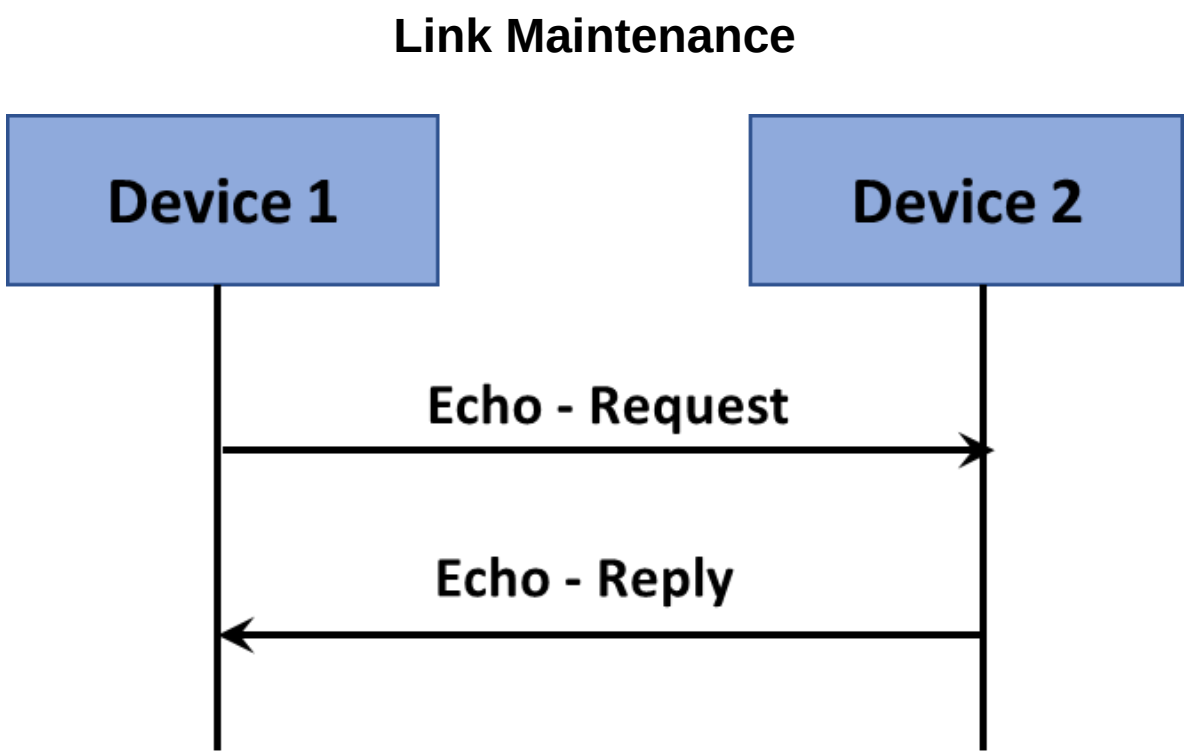
LCP Negotiation Options

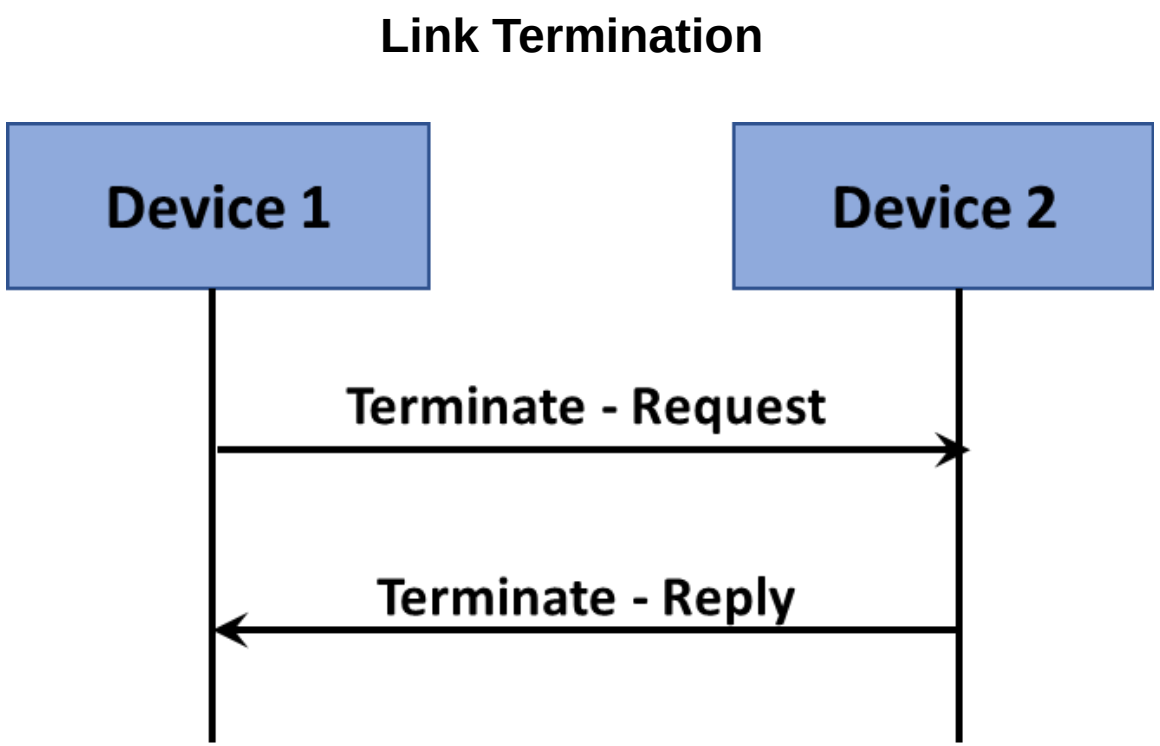


LCP Retransmission



Link Maintenance and Link Termination





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

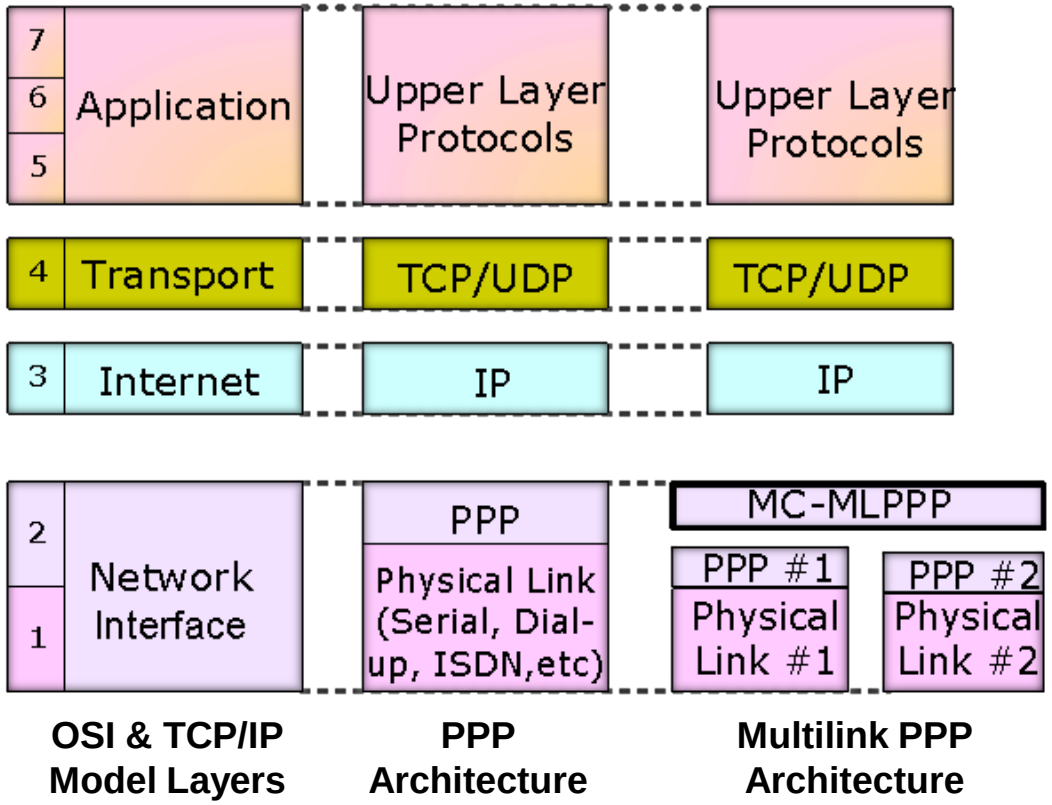
- Bridge Control Protocol (BCP) is responsible for establishing and configuring Remote Bridging for PPP links
- Supported standard – RFC 3518
- Supported BCP negotiation options:
  - Bridge Identification
  - Line Identification
  - MAC Support
  - Tinygram Compression
  - MAC Address
  - Spanning Tree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

PPP Authentication Protocols

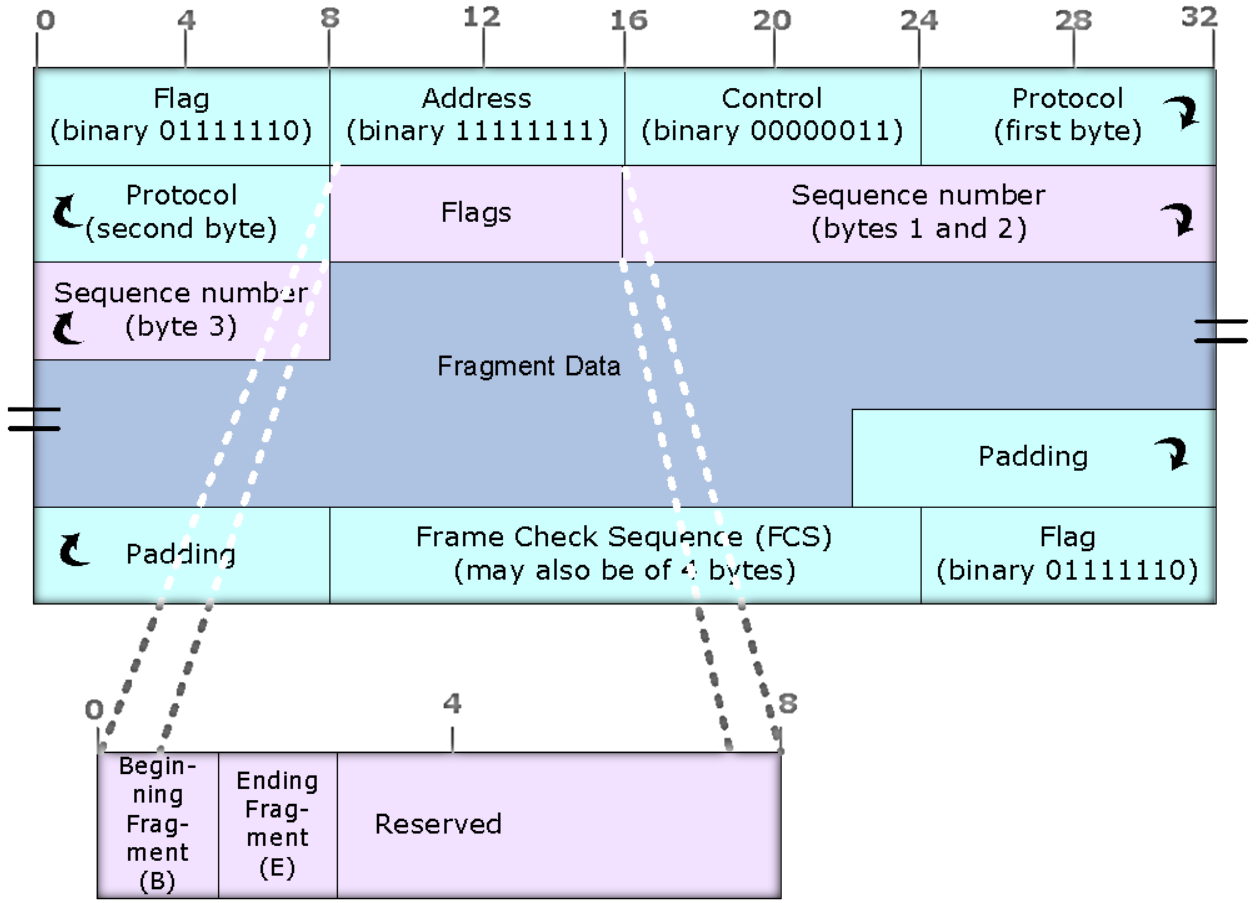
- After the LCP link is set up a series of authentication messages are sent to verify the identity of the device initiating the link
- Only if authentication is successful can the link configuration proceed
  - Password Authentication Protocol (PAP)
  - Challenge Handshake Authentication Protocol (CHAP)

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

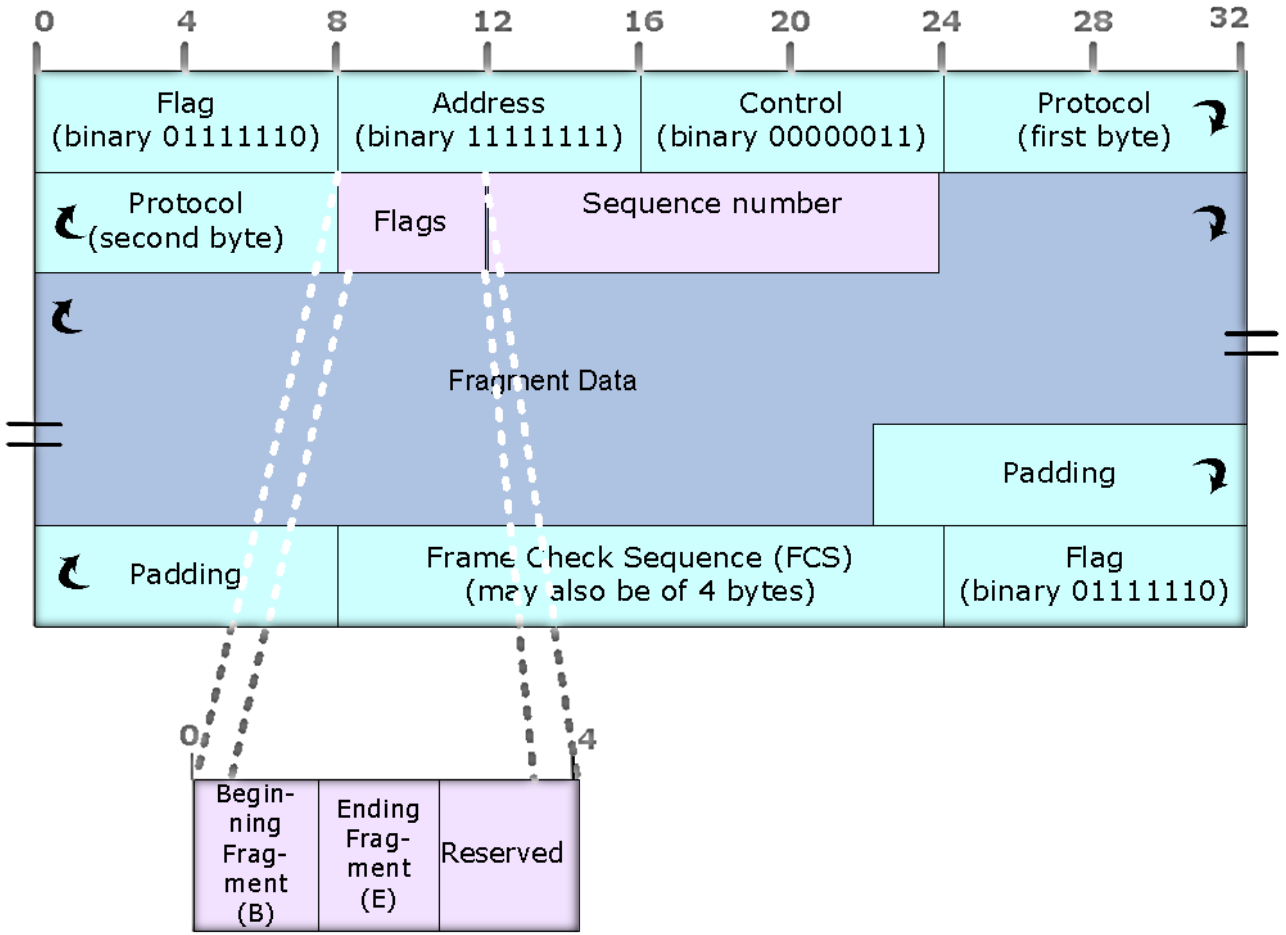


Multilink PPP Long Fragment Frame Format

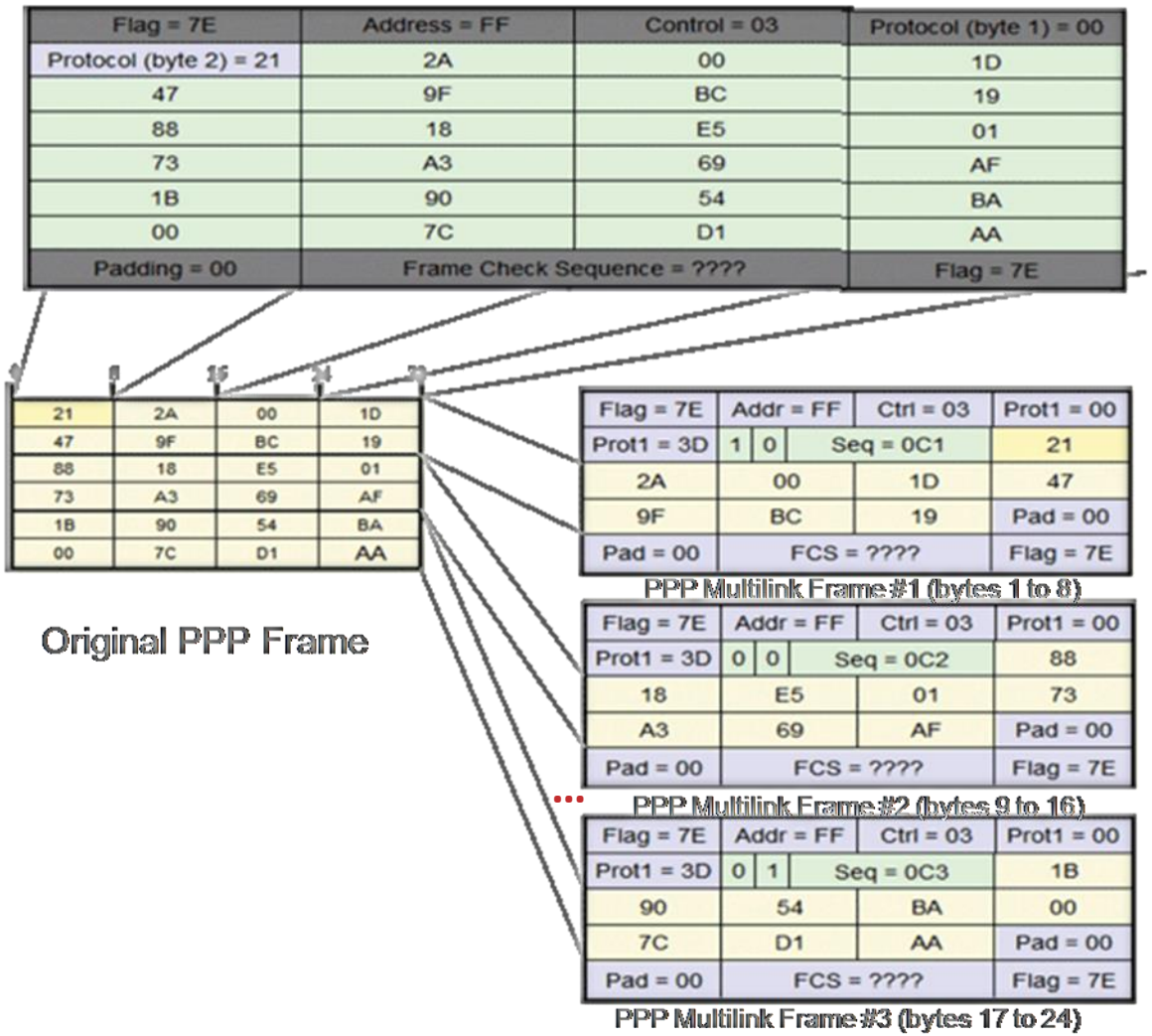


Multilink PPP Short Fragment Frame Format

- 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



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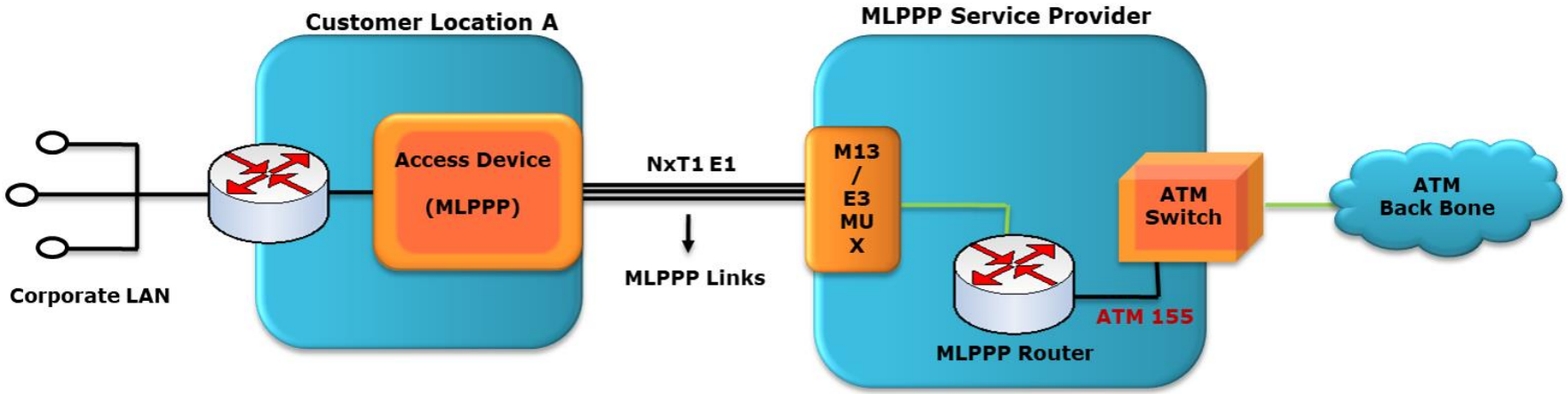
Multilink PPP Long Fragment Frame Format

- 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

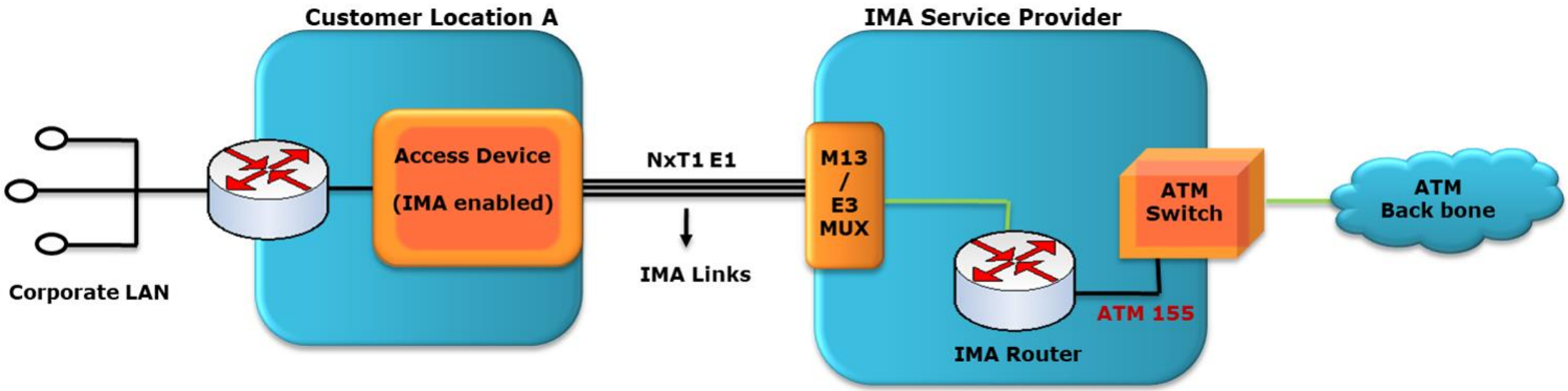
Multilink Point-to-Point Protocol (MLPPP)

- 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



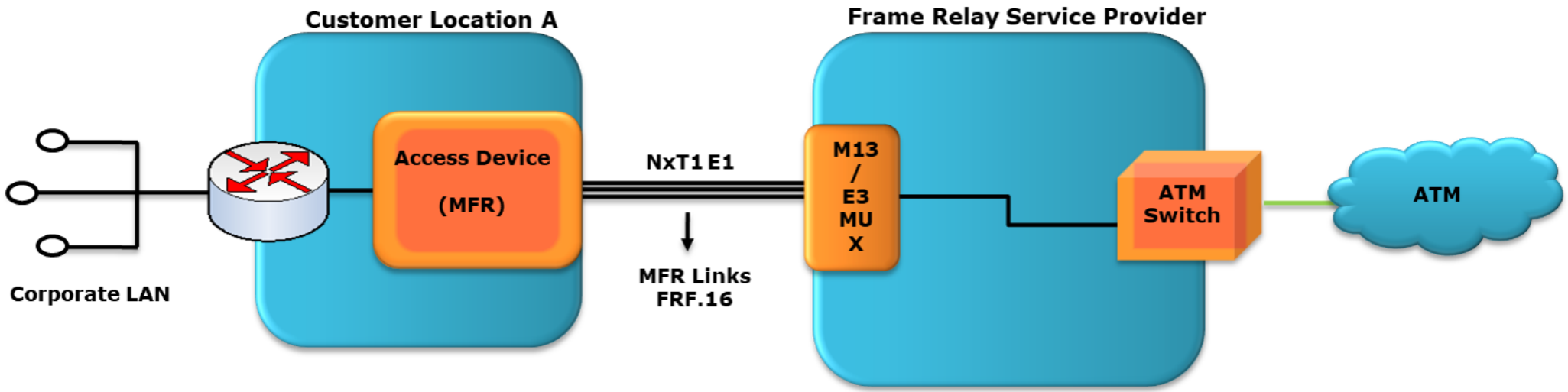
Inverse Multiplexing over ATM (IMA)

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



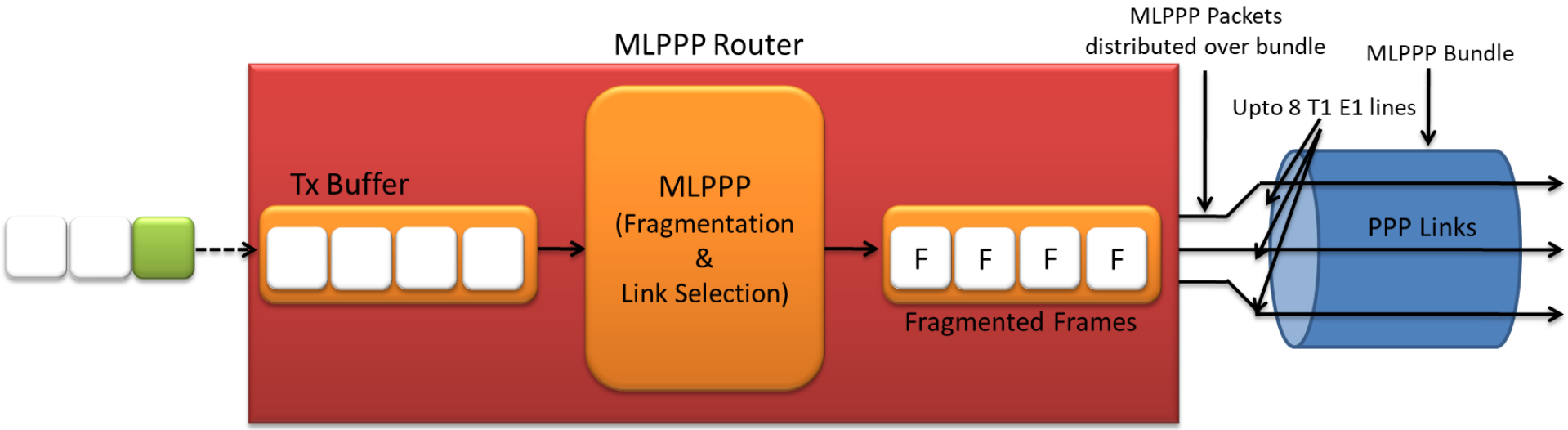
Multilink Frame Relay (MFR)

- 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

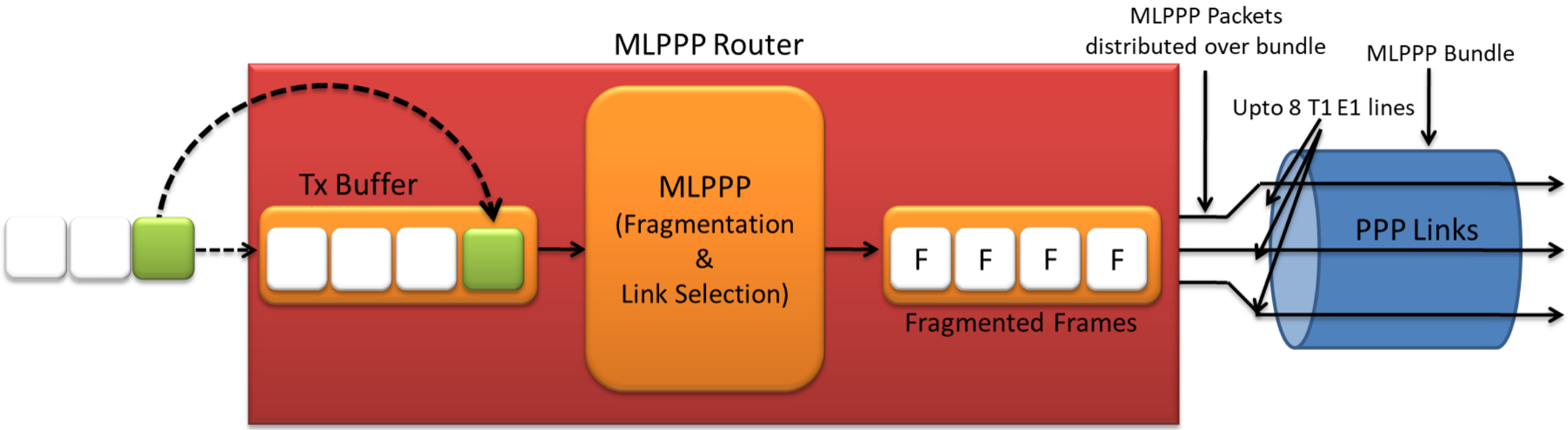


Need for Multi-Class

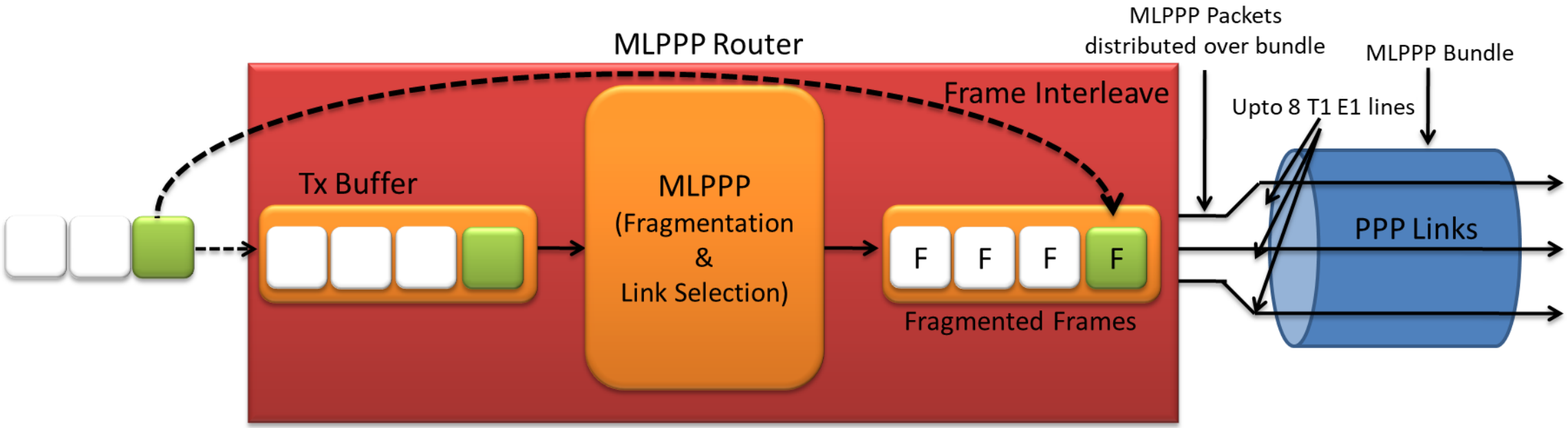
- MLPPP's uses contiguous sequence numbering (for all fragments of a packet) does not allow suspension of the sending of a sequence of fragments of one packet in order to send another higher-priority packet
- This limitation is overcome by Multi-Class MLPPP where each "class" of traffic uses a separate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



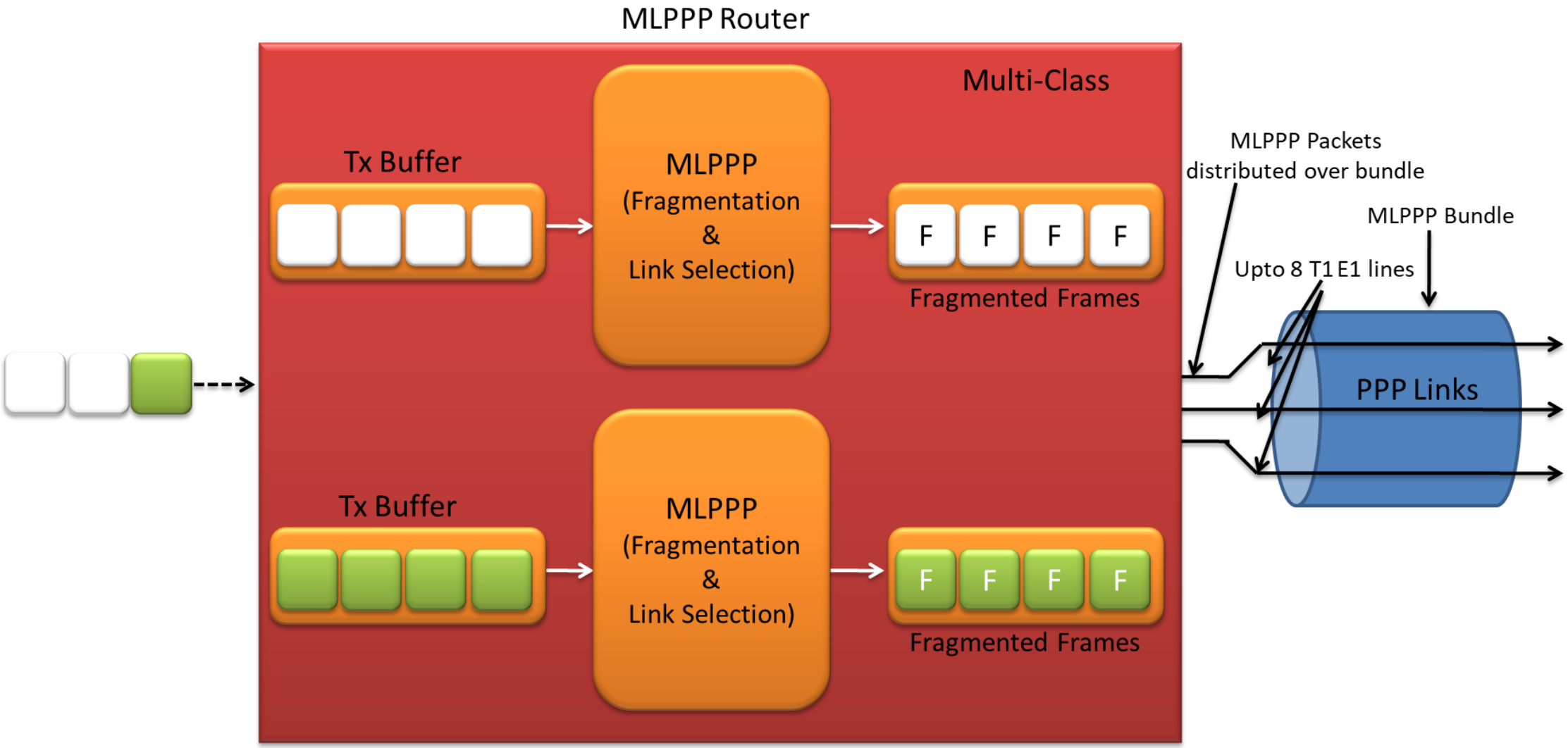
Alternative Methods: 1. Priority Queue



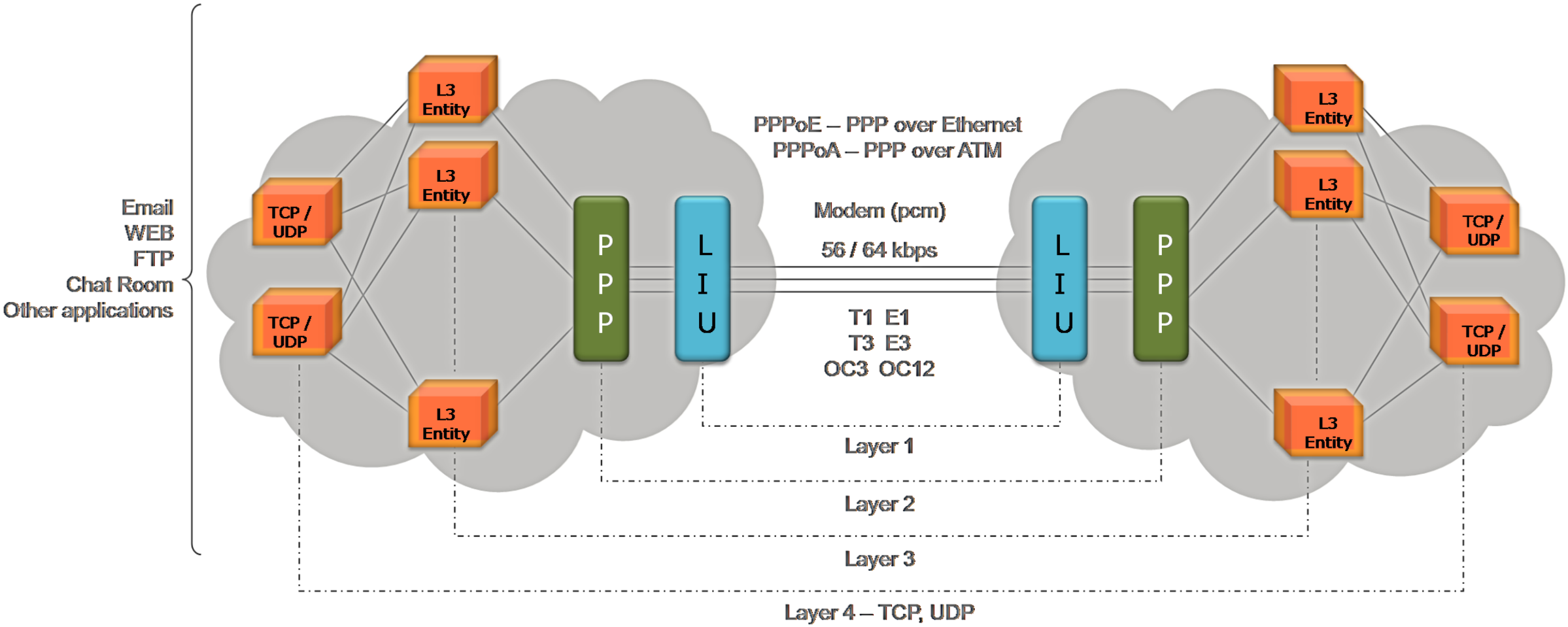
Alternative Methods: 2. Frame Inter-Leaving



Multi-Class MLPPP Explained

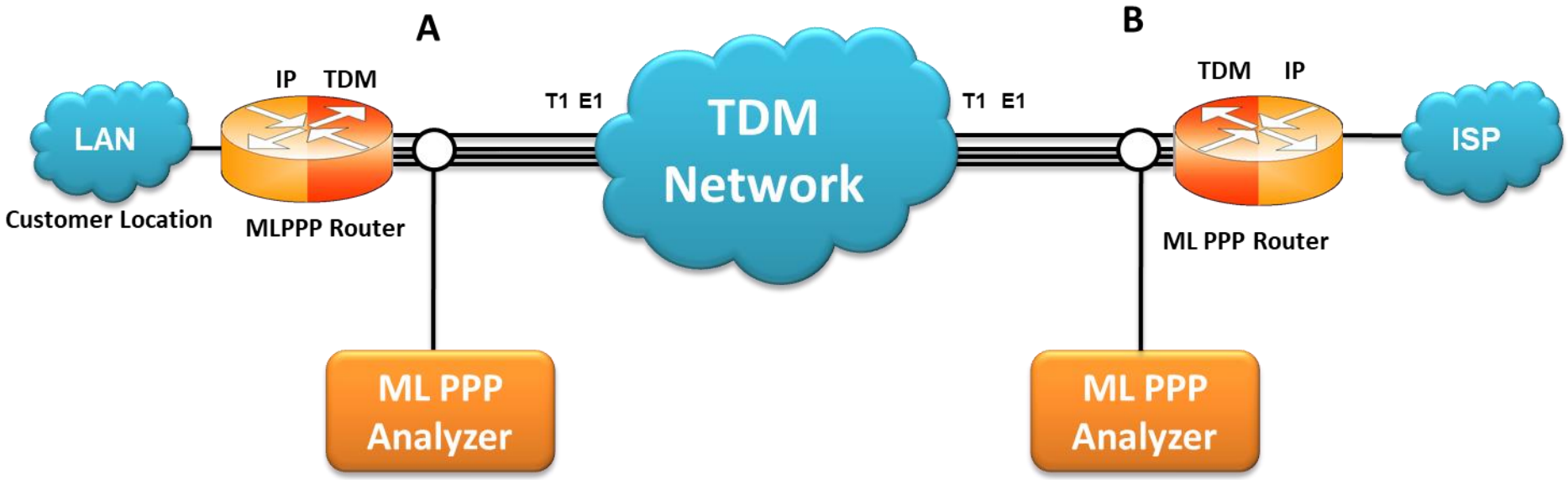


Applications

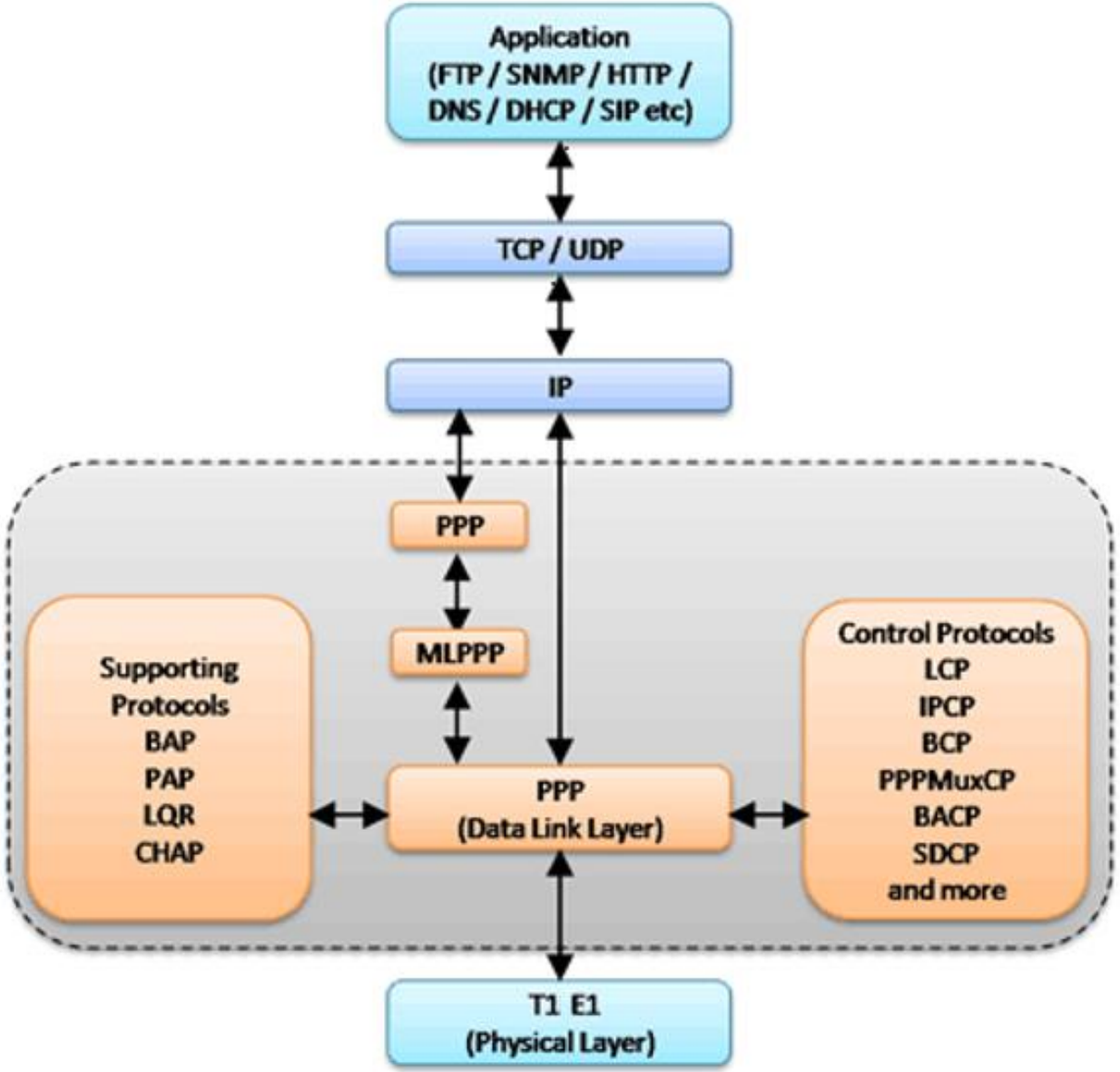


GL's MLPPP Analyzer

- 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

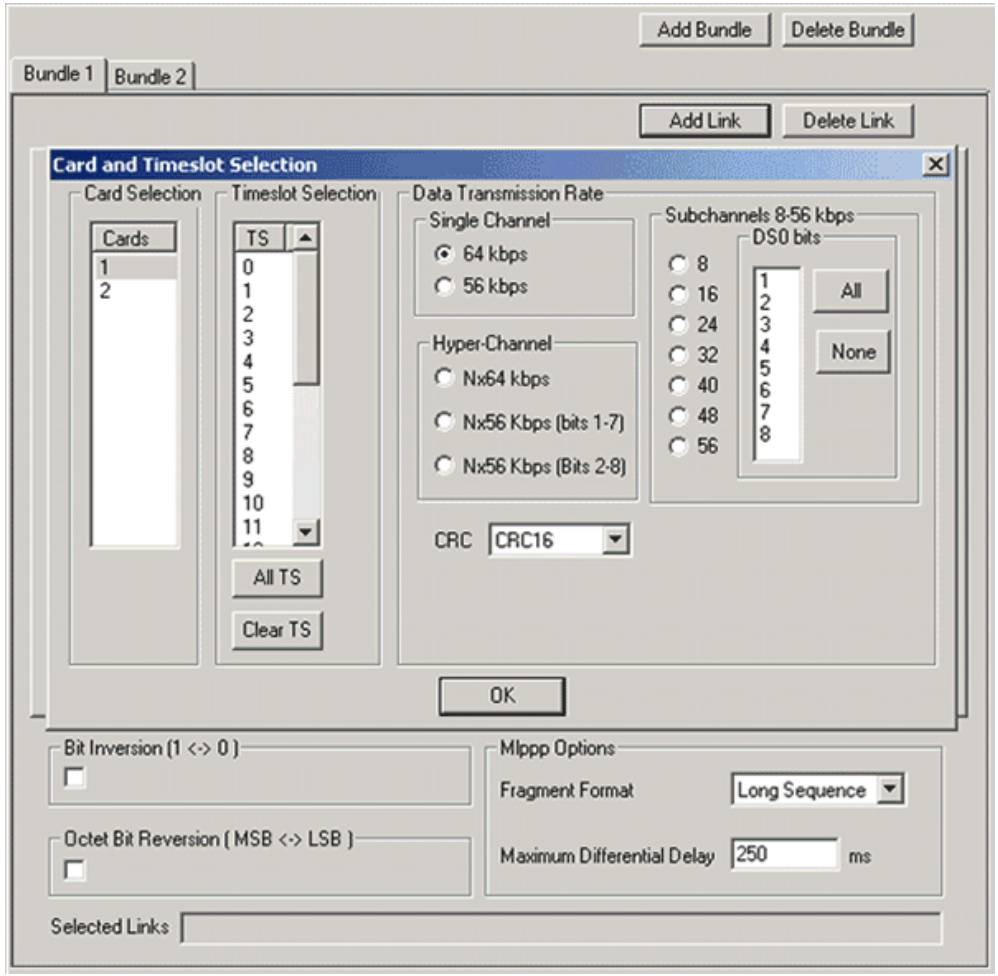


Supported Protocol Stack

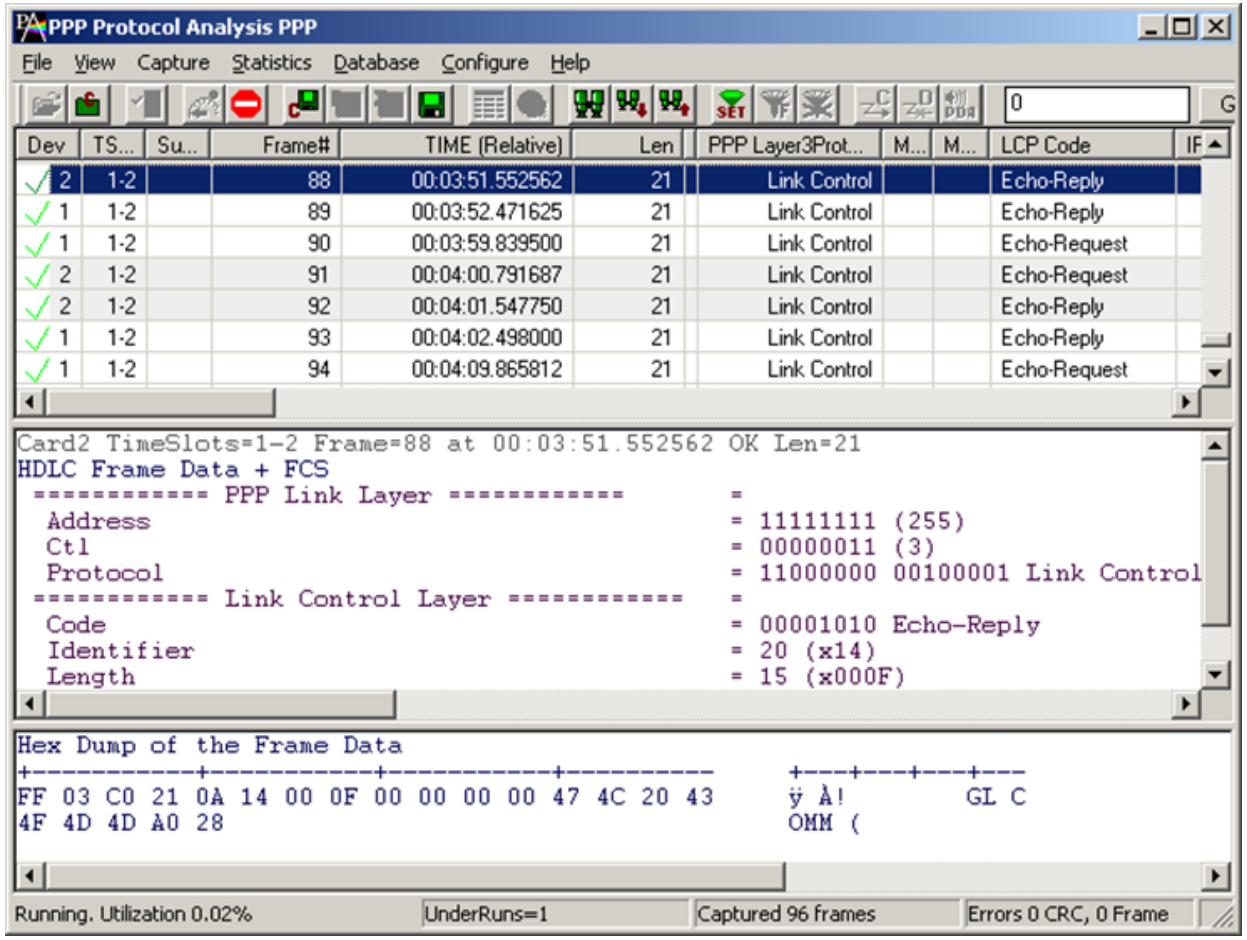


Real Time Analysis

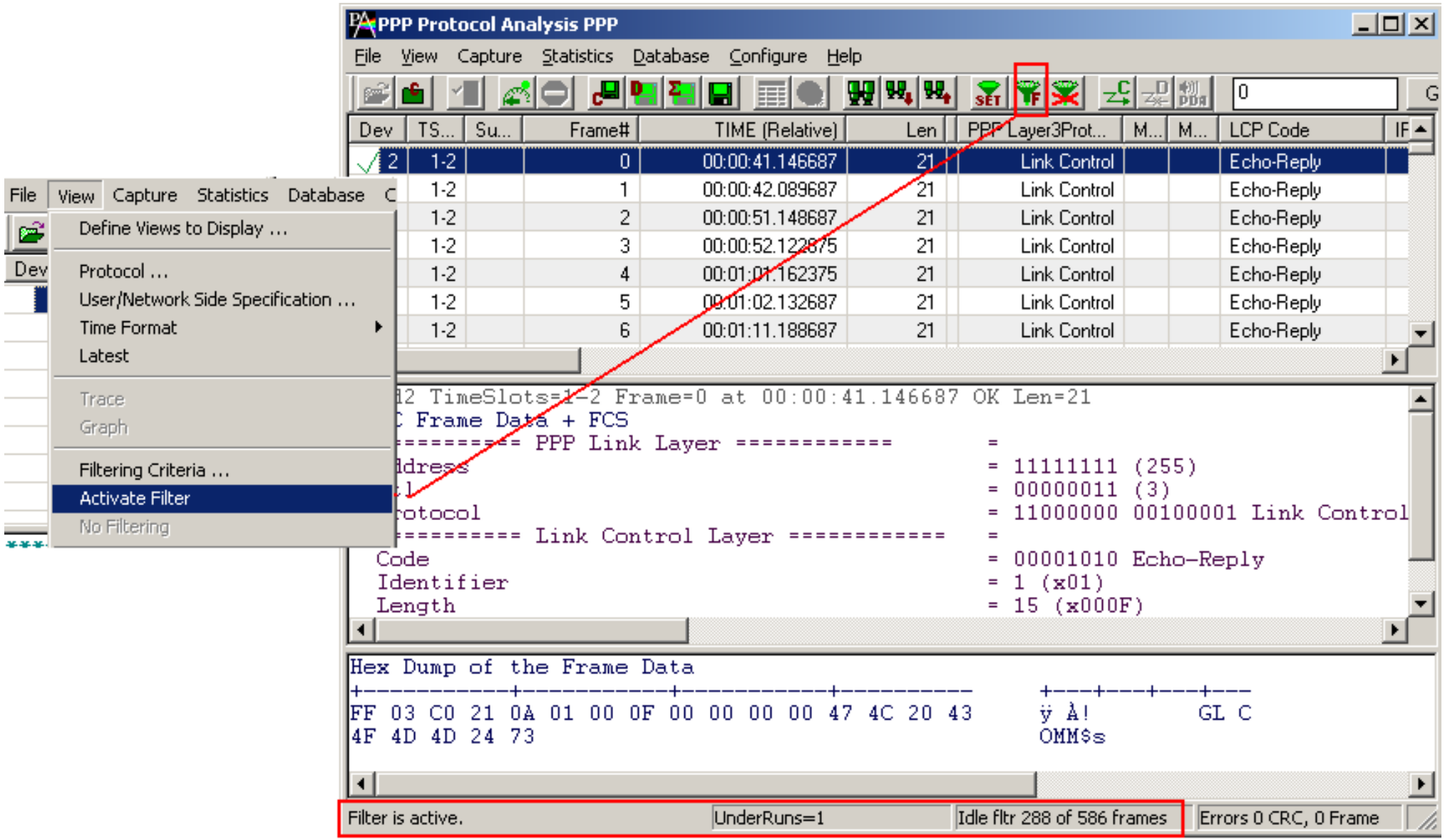
TimeSlot Selection



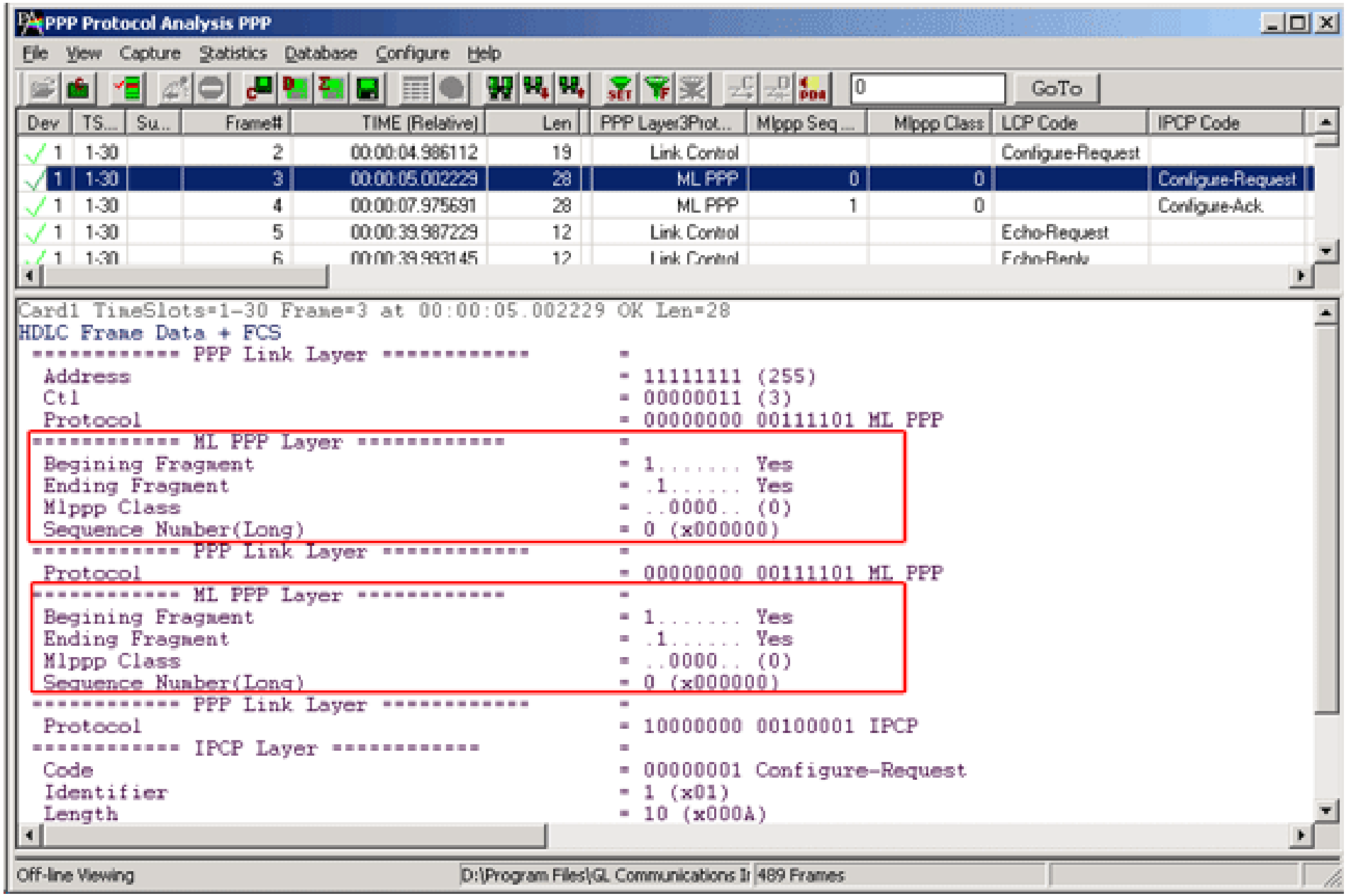
Real Time Analysis



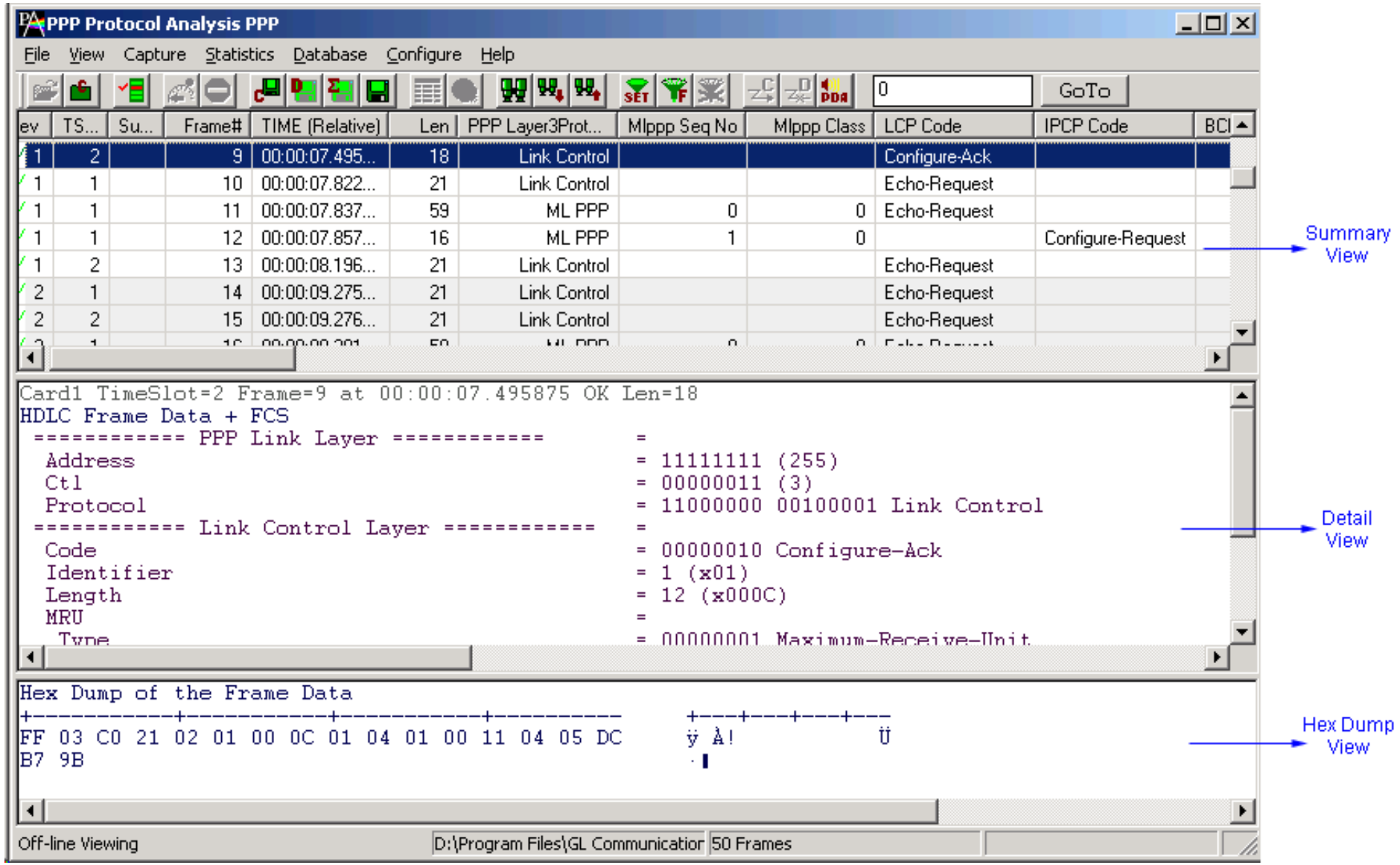
Filter Options



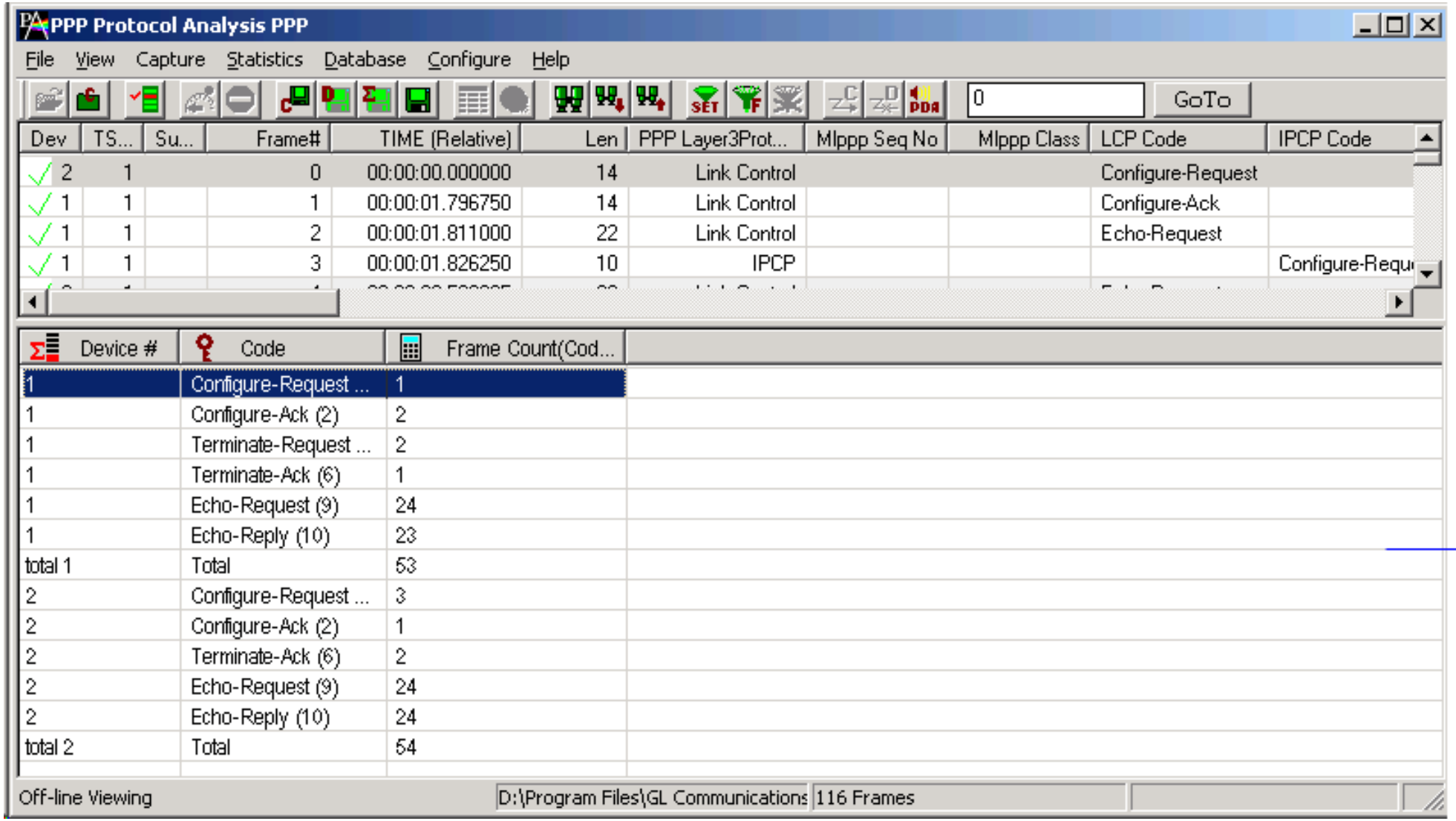
Decode View - MLPPP



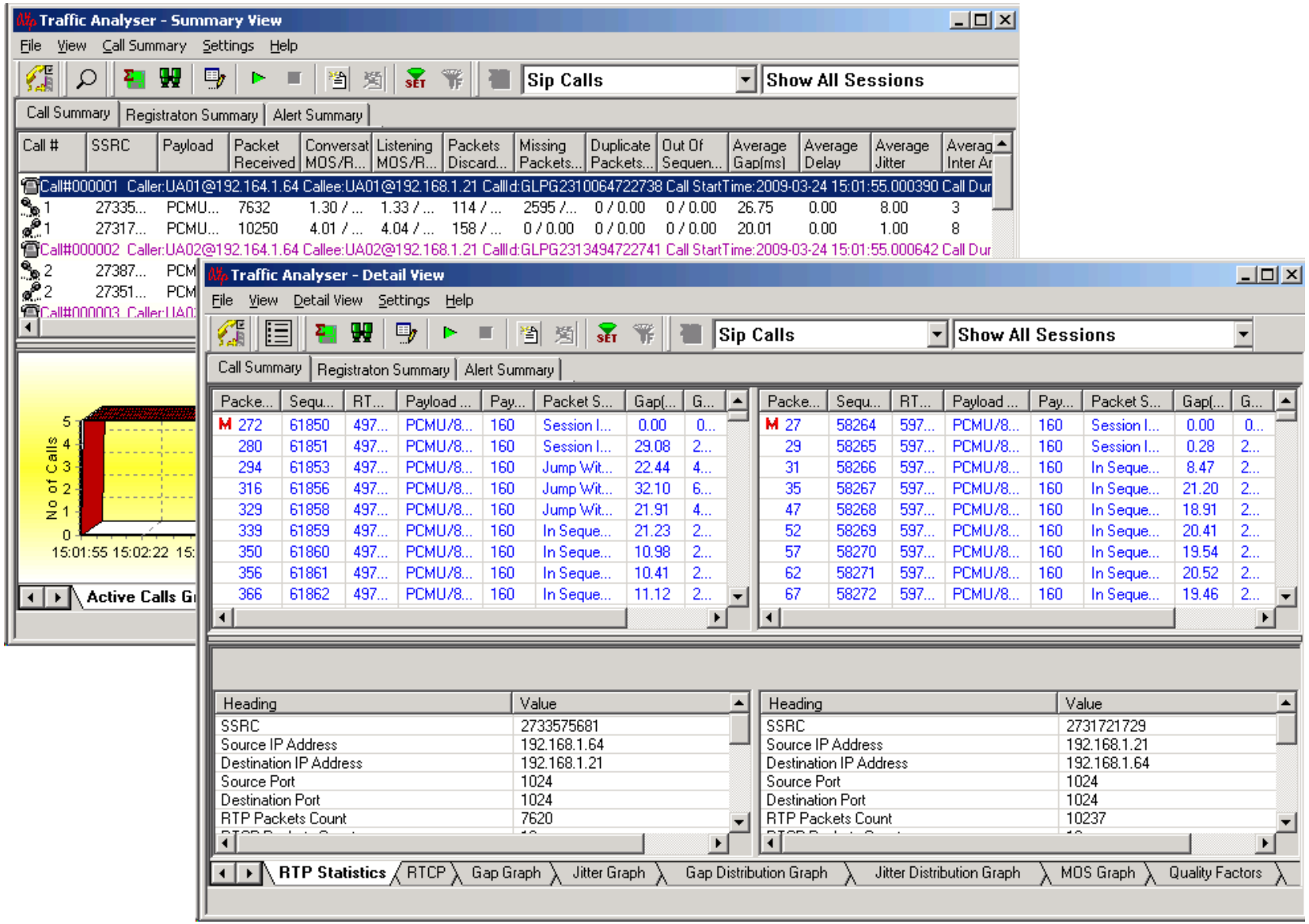
Summary, Detail and Hex Dump Views



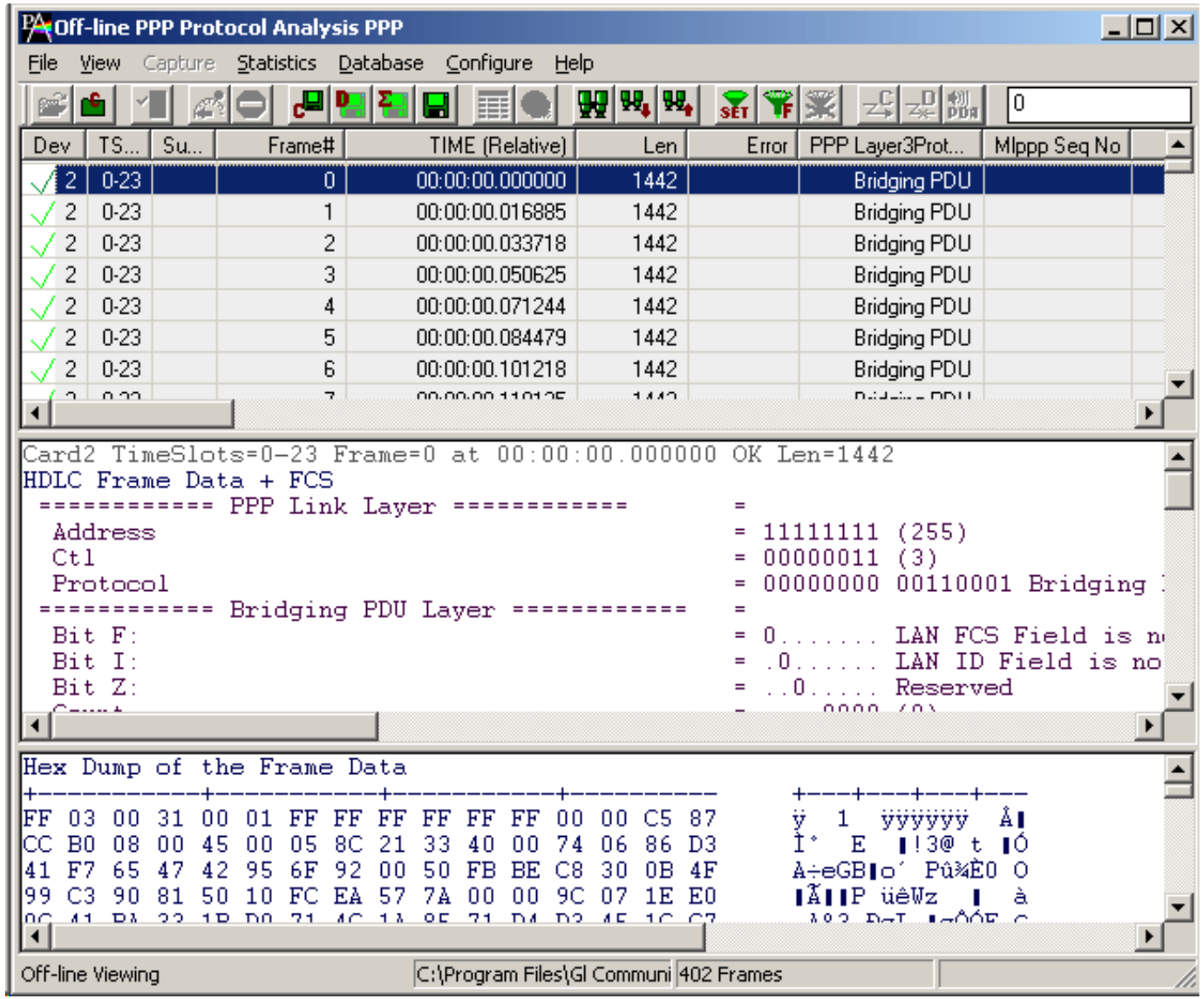
Statistics


PPP Protocol Analysis PPP
File View Capture Statistics Database Configure Help
GoTo
Dev | TS... | Su... | Frame# | TIME (Relative) | Len | PPP Layer3Prot... | Mlppp Seq No | Mlppp Class | LCP Code | IPCP Code
2 | 1 | | 0 | 00:00:00.000000 | 14 | Link Control | | | Configure-Request |
1 | 1 | | 1 | 00:00:01.796750 | 14 | Link Control | | | Configure-Ack |
1 | 1 | | 2 | 00:00:01.811000 | 22 | Link Control | | | Echo-Request |
1 | 1 | | 3 | 00:00:01.826250 | 10 | IPCP | | | | Configure-Requ
Device # | Code | Frame Count(Cod...
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
Off-line Viewing
D:\Program Files\GL Communications
116 Frames
Statistics View

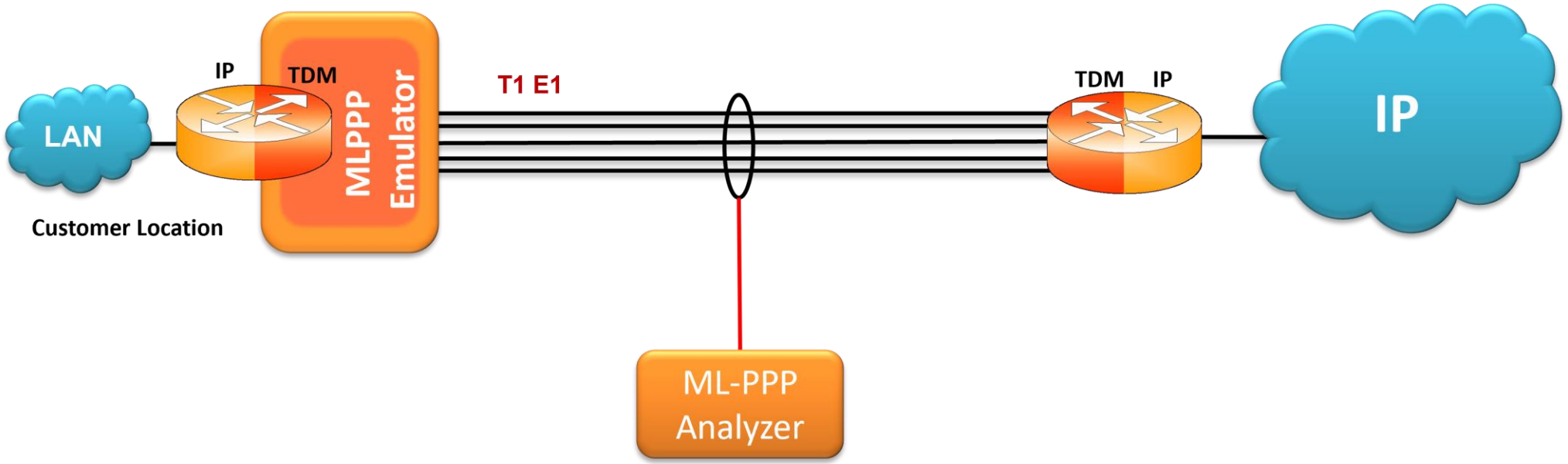
MLPPP Analyzer with Packet Data Analysis



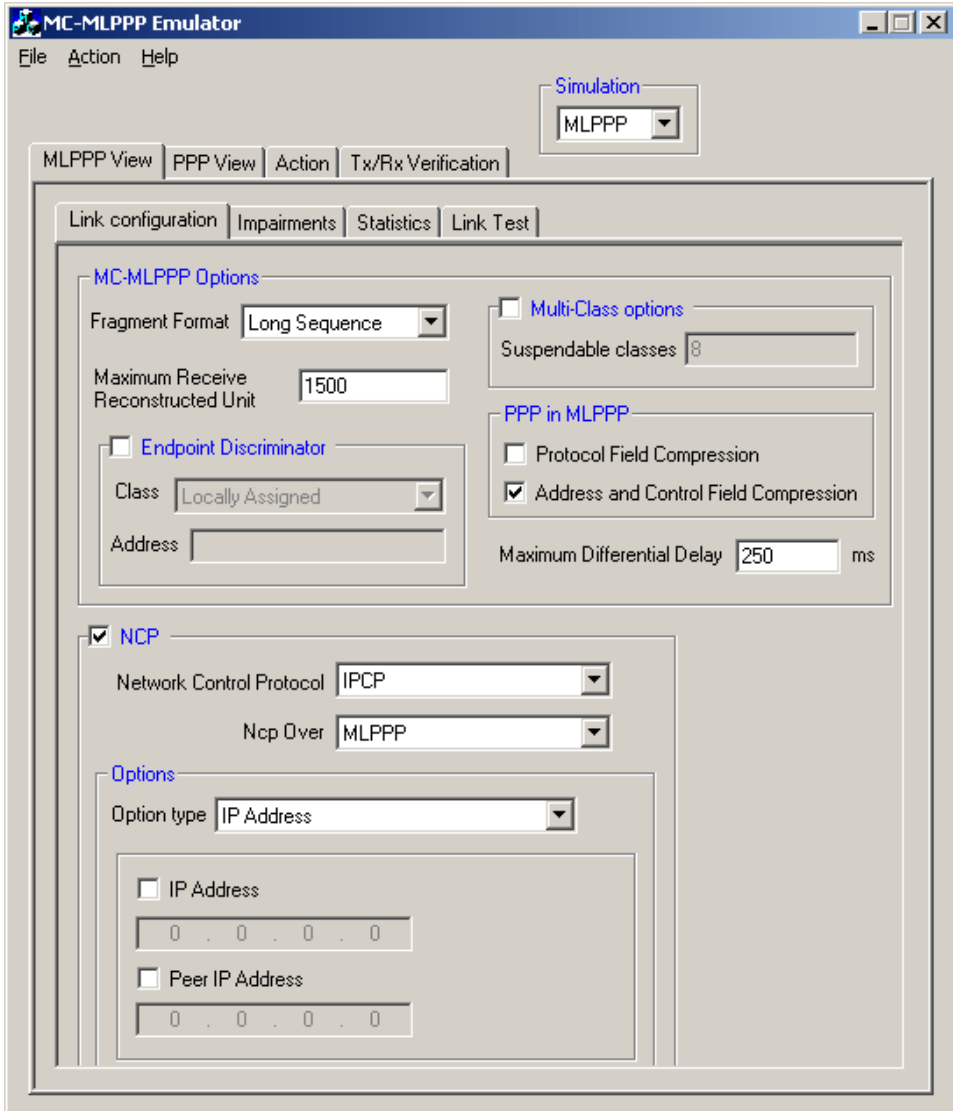
Offline Protocol Analyzer

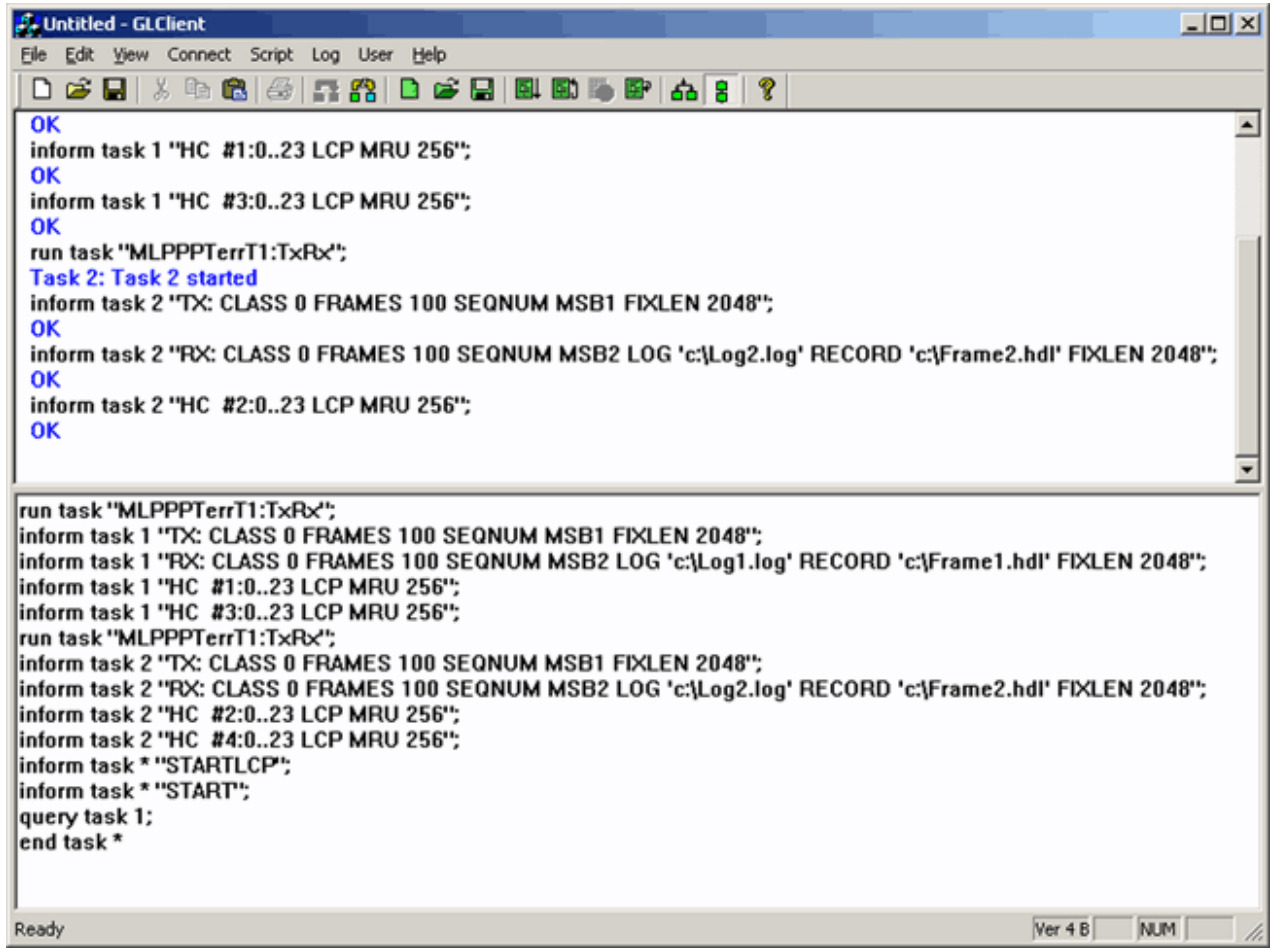


MC-MLPPP Emulator



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





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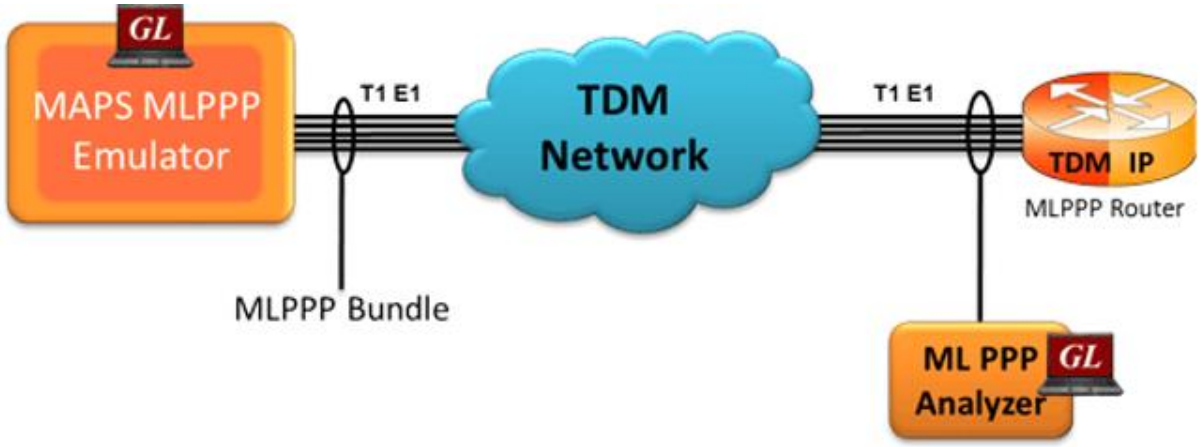
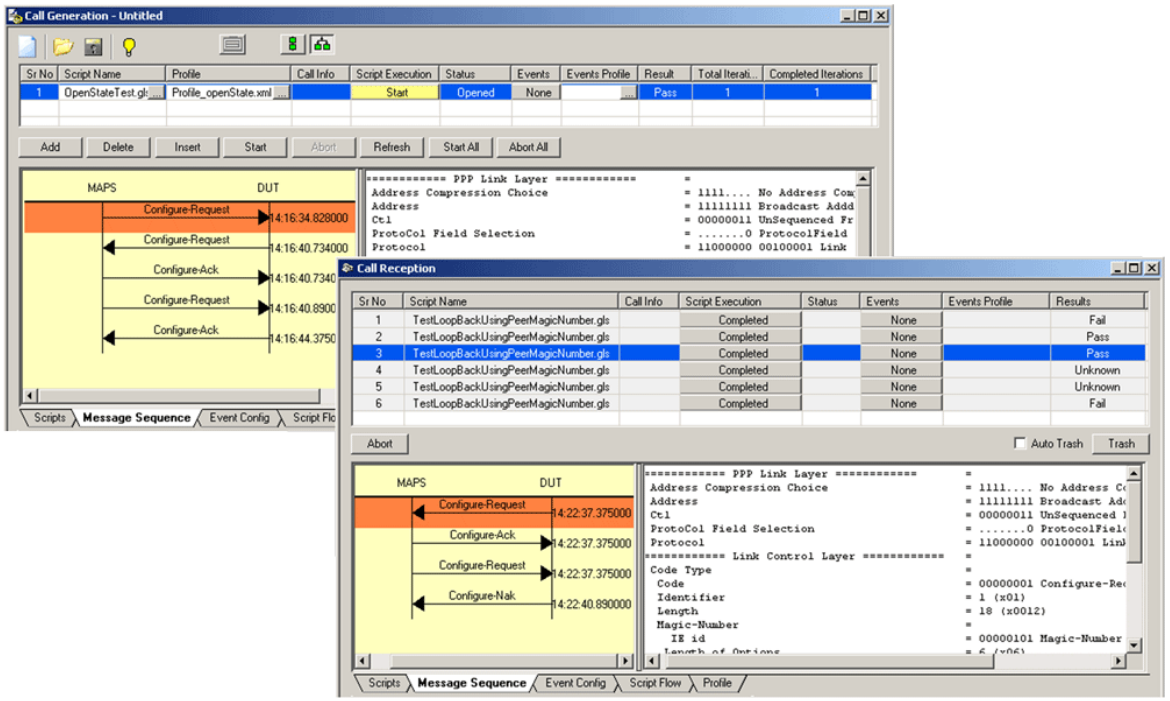
Scripted MLPPP Conformance Testing using MAPS™

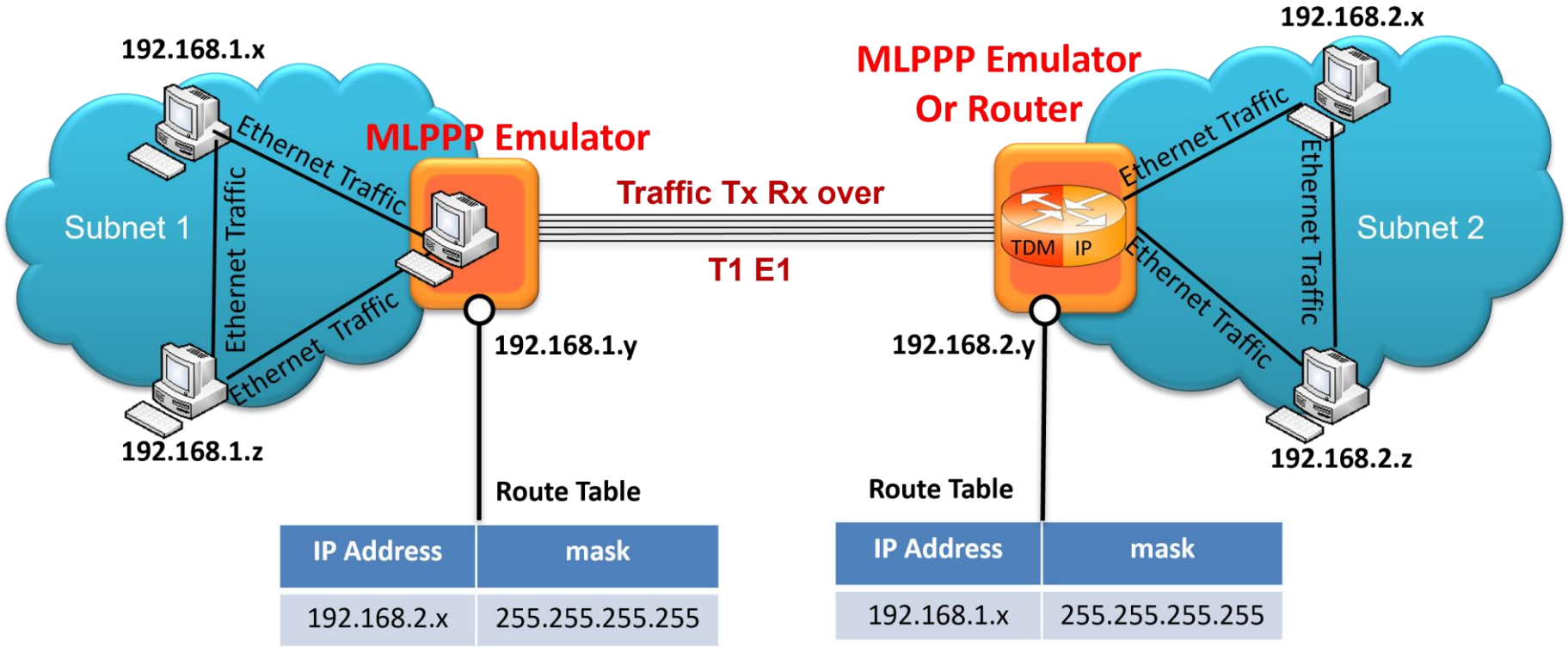
- MAPS™ MLPPP is an advanced protocol simulator/tester for MC-MLPPP/MLPPP/PPP protocols over TDM (T1 E1)
- The tester can simulate a complete PPP/MLPPP link between two peers (Router or a Switch), with MLPPP signaling conforming to IETF specifications





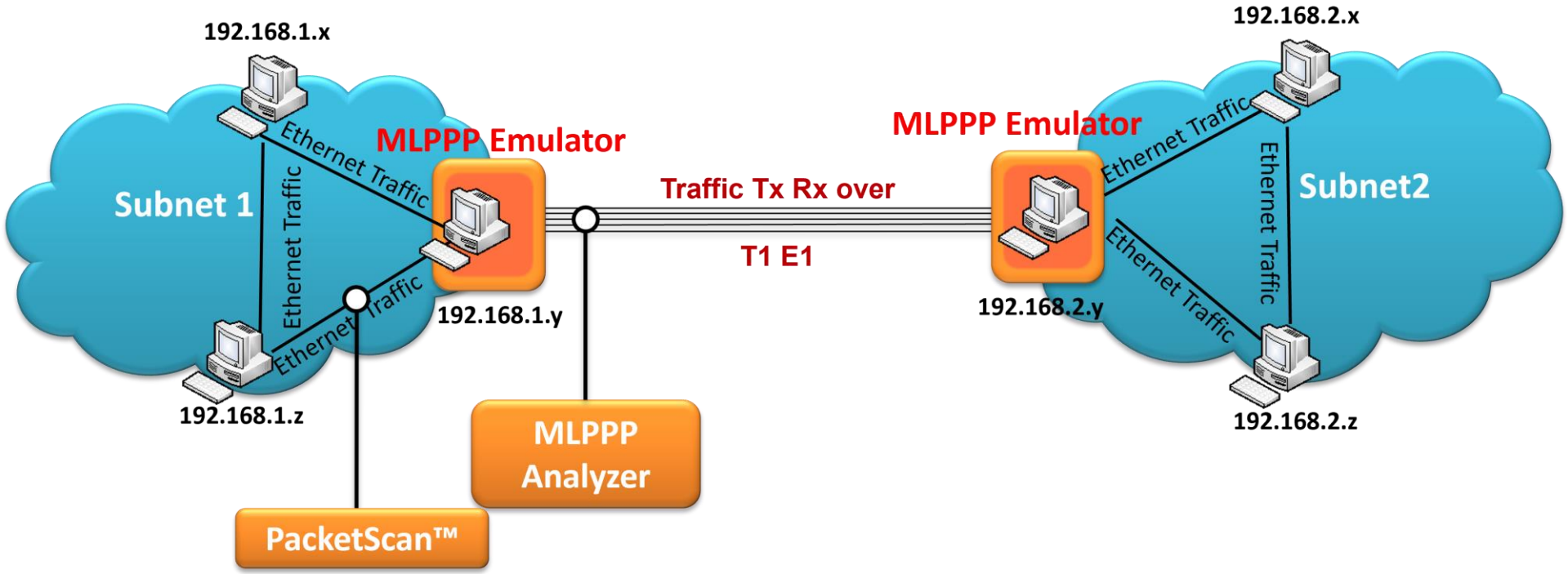
MLPPP Emulator as Router

- 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

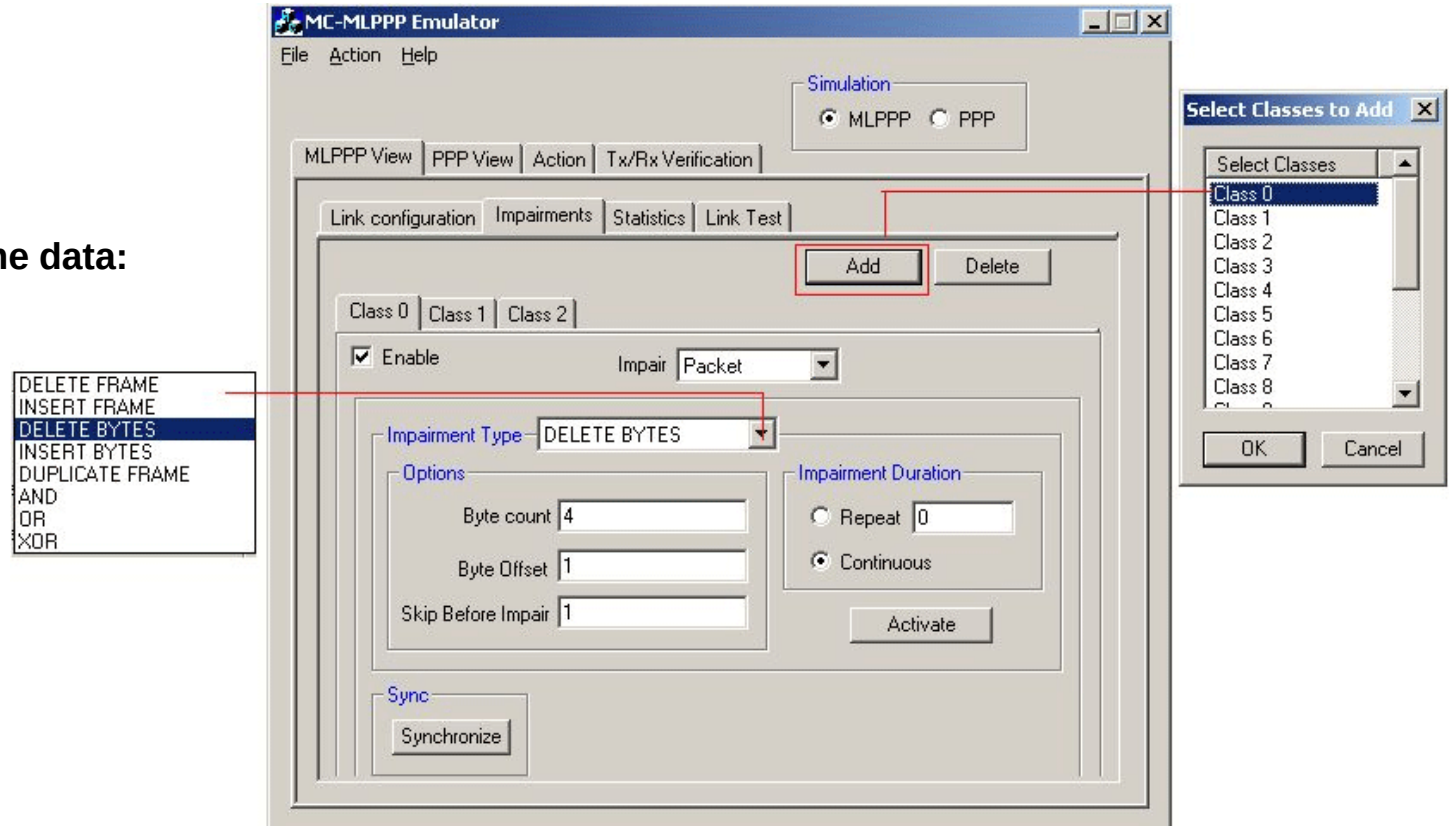
- Various impairments can be introduced before frames are transmitted or during traffic generation
- In PPP simulation frames are impaired by applying impairment to a particular PPP link
- One can specify a limited number of impairments or continuous impairment

Impairments that affect an entire frame:

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

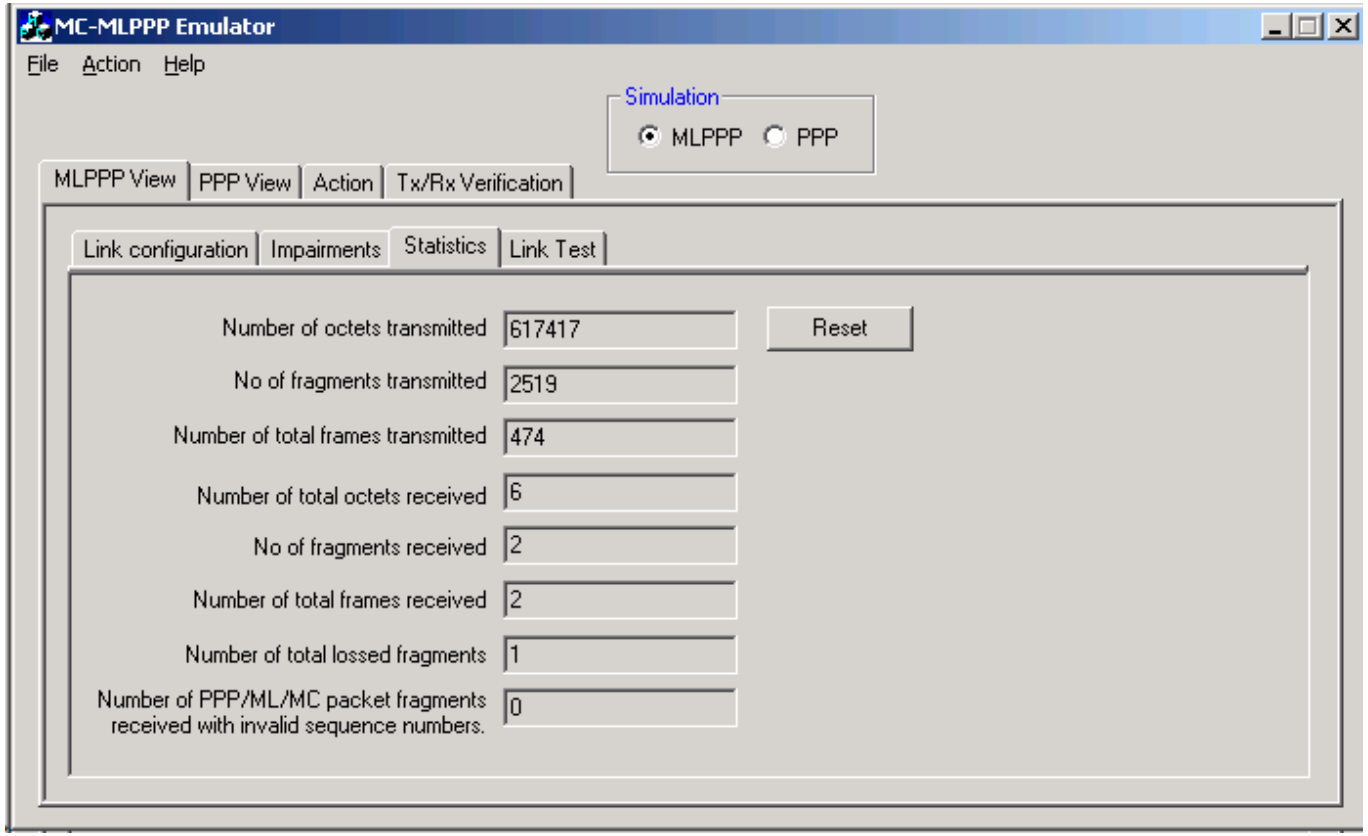
Impairments that affect a frame by impairing frame data:

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



Data Verification using Statistics

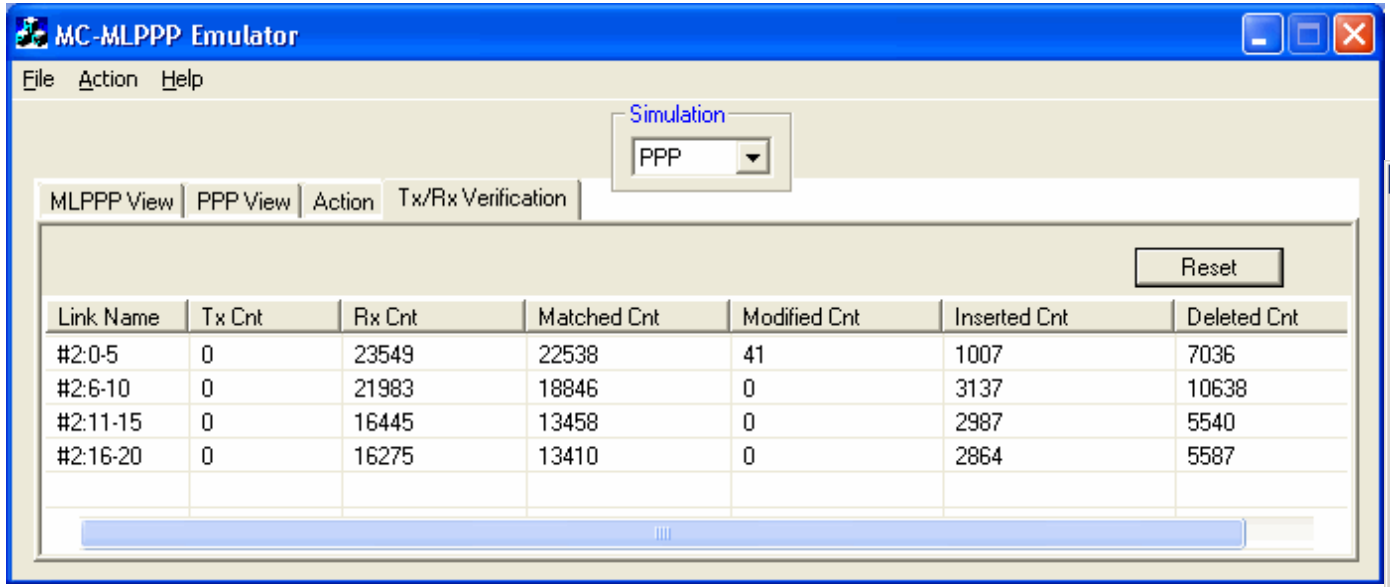
MLPPP Statistics



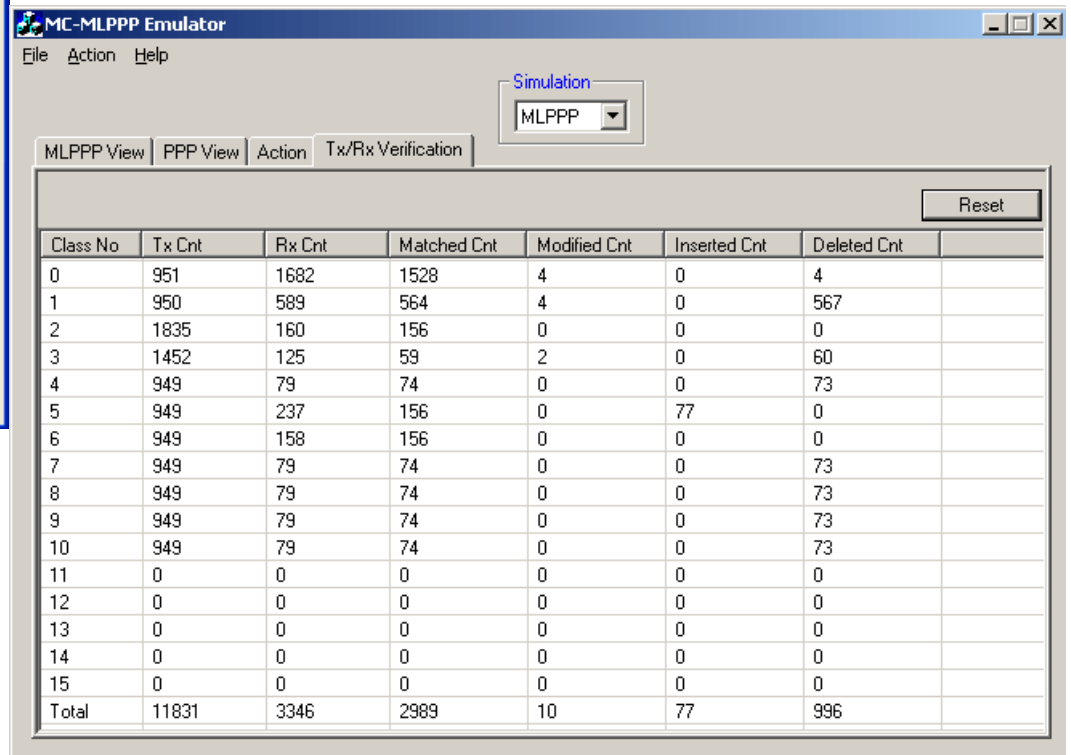
- MLPPP statistics provides important information about the MLPPP bundle such as Number of transmitted/received octets, frames, fragments, lost fragments, and PPP/ML/MC packet fragments received with invalid sequence numbers

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



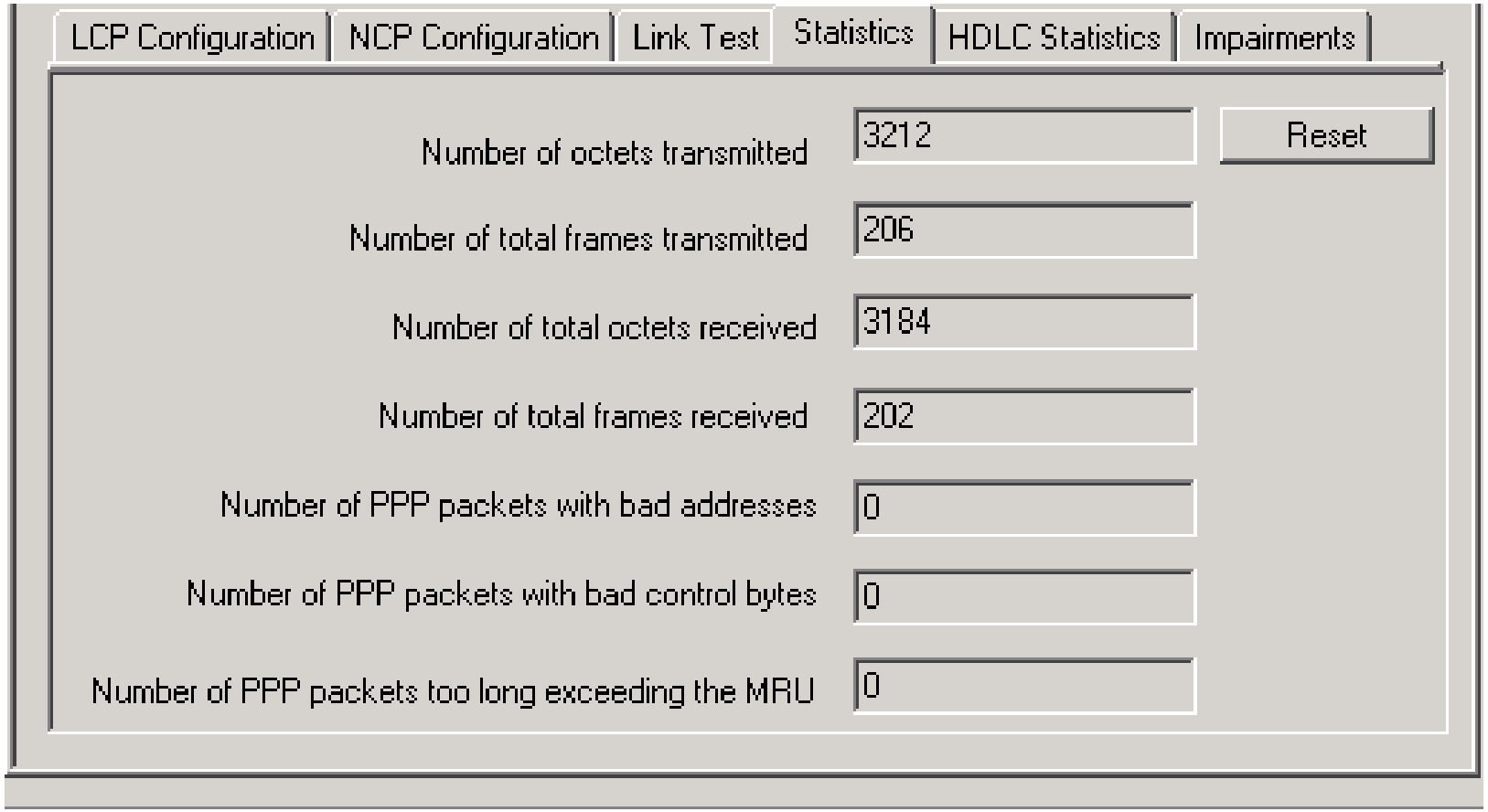
Link Name	Tx Cnt	Rx Cnt	Matched Cnt	Modified Cnt	Inserted Cnt	Deleted Cnt
#2:0-5	0	23549	22538	41	1007	7036
#2:6-10	0	21983	18846	0	3137	10638
#2:11-15	0	16445	13458	0	2987	5540
#2:16-20	0	16275	13410	0	2864	5587



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



Thank you