i341

Networks and Distributed Applications

DataLink Protocols

Data Link Protocols:

Data Link protocols are the rules which govern the way in which computing/network devices communicate at the data link level.

Several data link protocols commonly used include asynch (asynchronous) protocol, bisynch (binary synchronous) protocol, SDLC (Synchronous Data Link Control) and HDLC (High Level Data Link Control) protocols.

Functions of Data Link Protocols:

Every specific data link protocol performs a set of functions in different ways. There are basic functions that any data link protocol must perform to be considered a true data link protocol. These functions include:

Synchronization: The data link protocol must be capable of establishing and maintaining synchronization between the sender and receiver. This means the receiver must be capable of determining where each bit/character begins and ends.

Framing: The protocol must be capable of marking the beginning and end of each transmission frame.

Control: The protocol must perform a minimum set of control functions. For example, on a multipoint link, the sending station must be capable of identifying the receiving station to which it is transmitting data.

Error Detection: The data link protocol must be able to perform some degree of error detection and implement error recovery.

HDLC (High Level Data Link Control)

HDLC is a bit oriented protocol specification published by ISO (international Standards Organization). HDLC is widely utilized throughout the world, it provides many functions and supports a broad range of applications. HDLC is also the basis for many other widely used protocols (such as SDLC, LAPB and LLC) used in the data communications industry. HDLC Figure-1 illustrates the HDLC family.

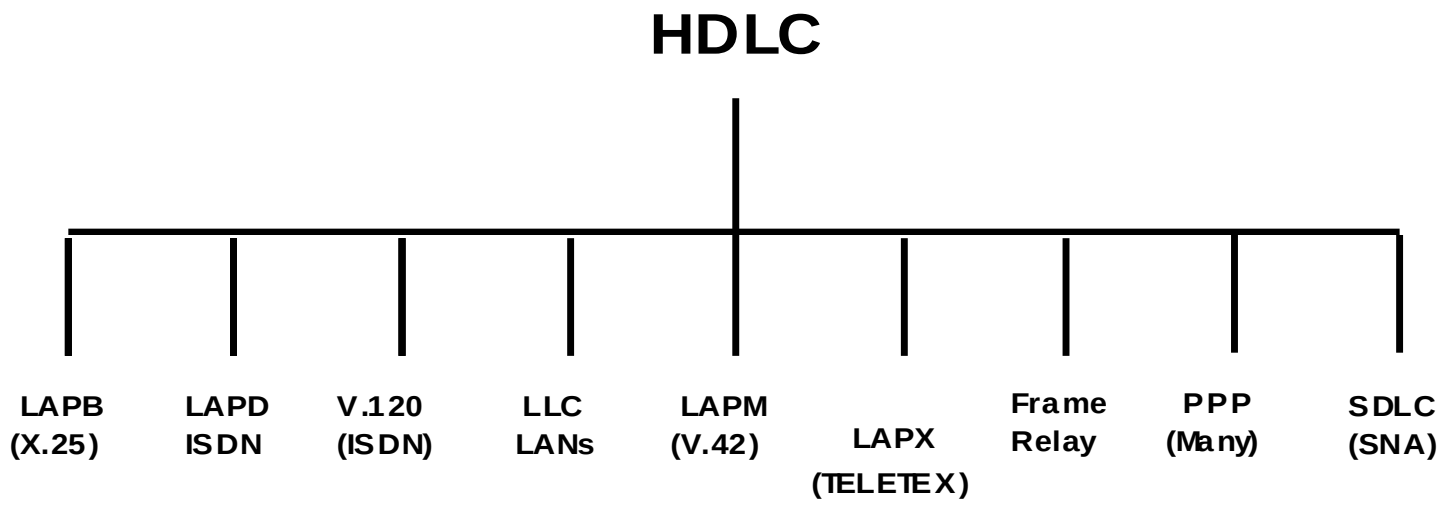
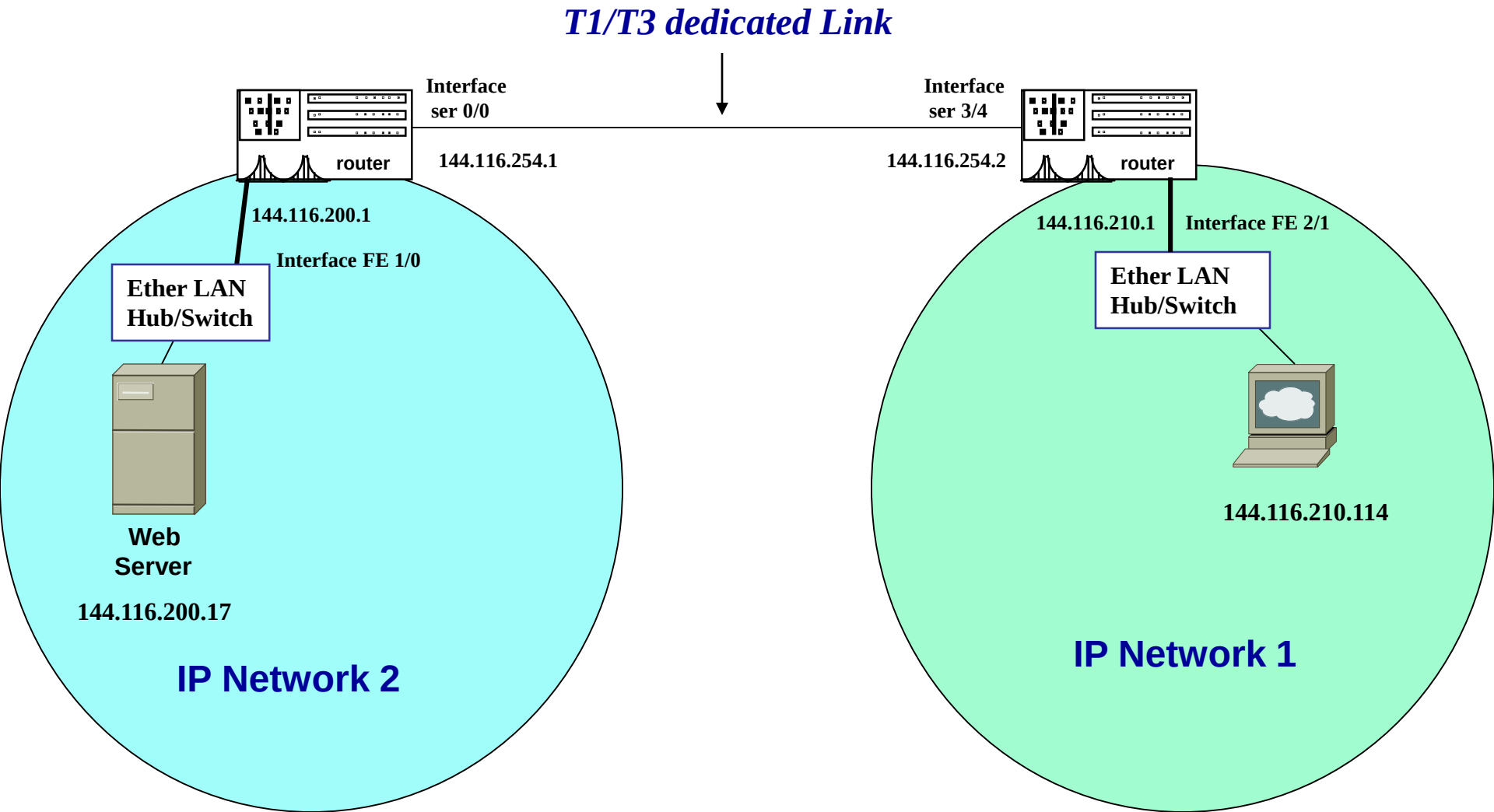


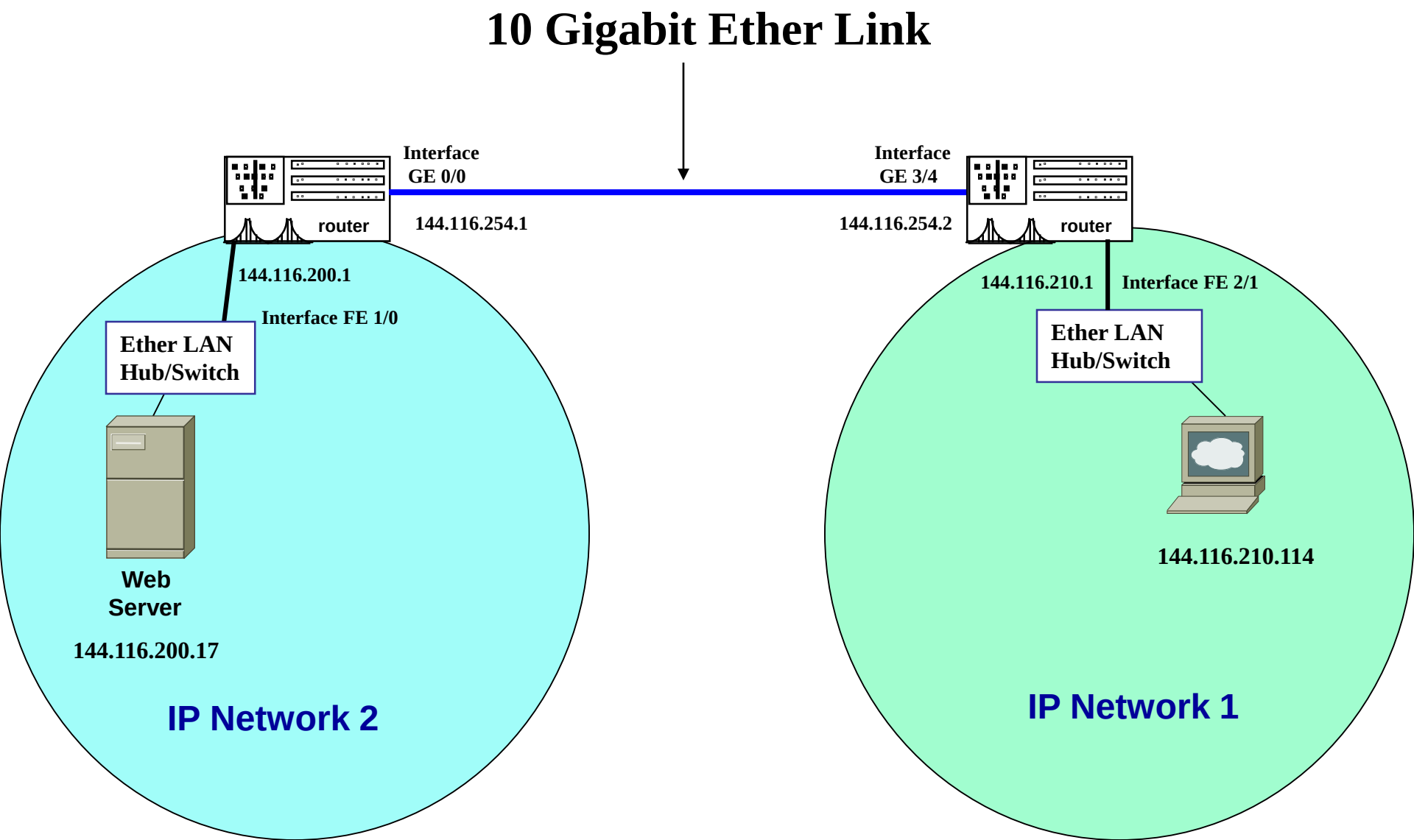
Figure-1 (HDLC Family)

Why would I ever need to know HDLC ?

Protocol Illustration Scenario #1



Protocol Illustration Scenario #2



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Data Link Protocols

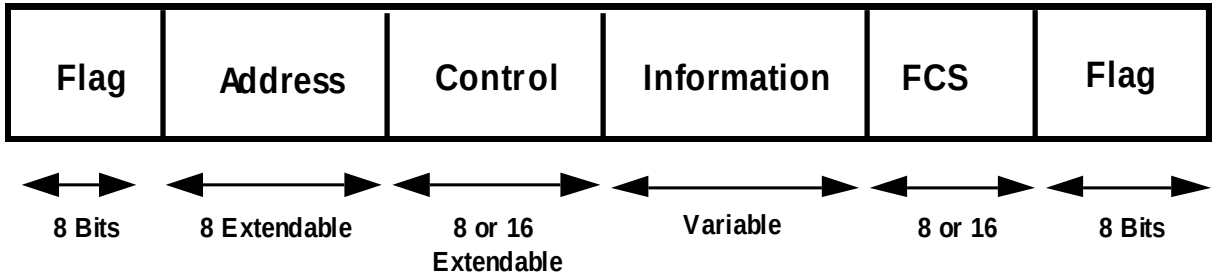


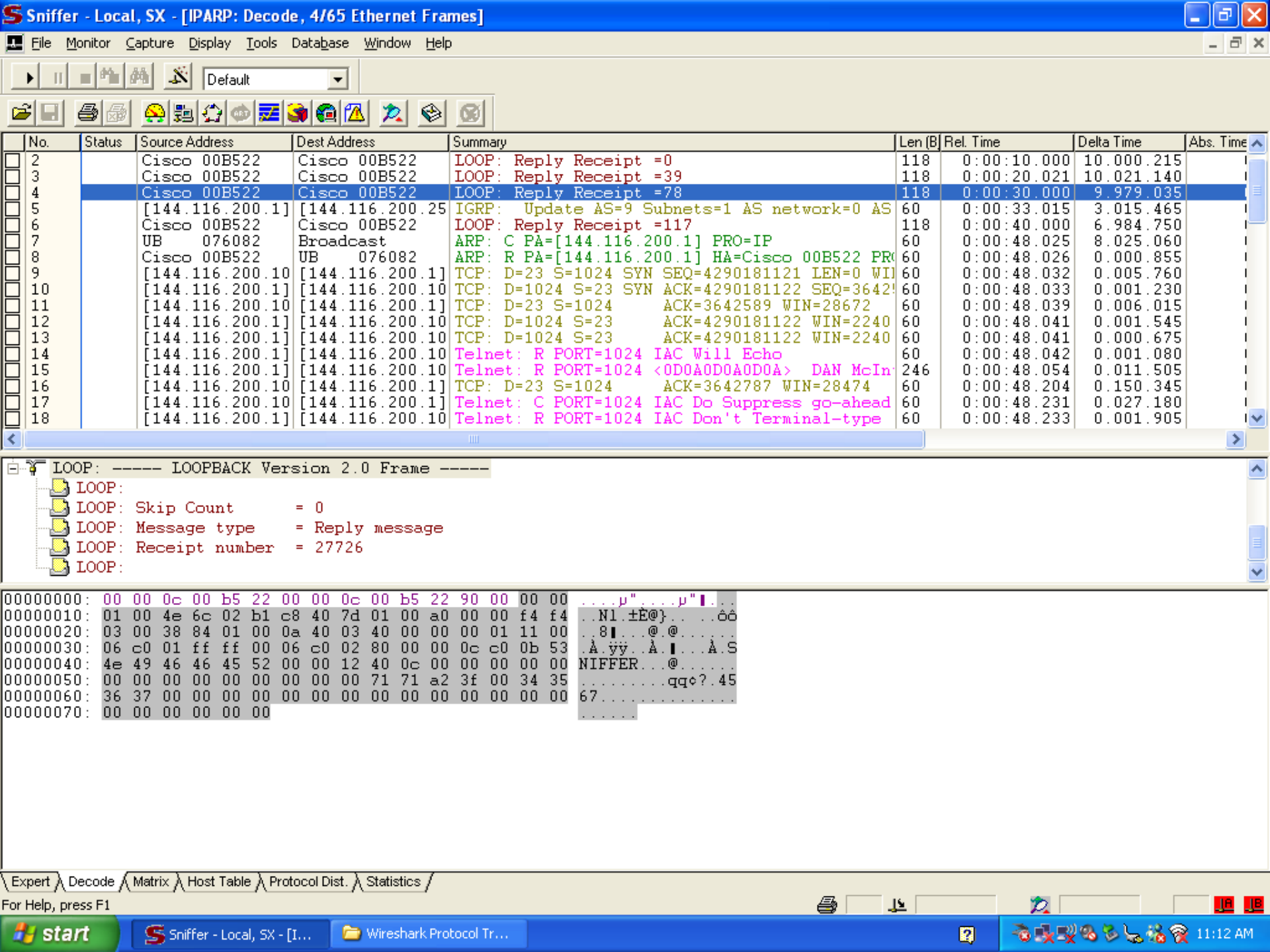
Figure-2 HDLC Frame Format

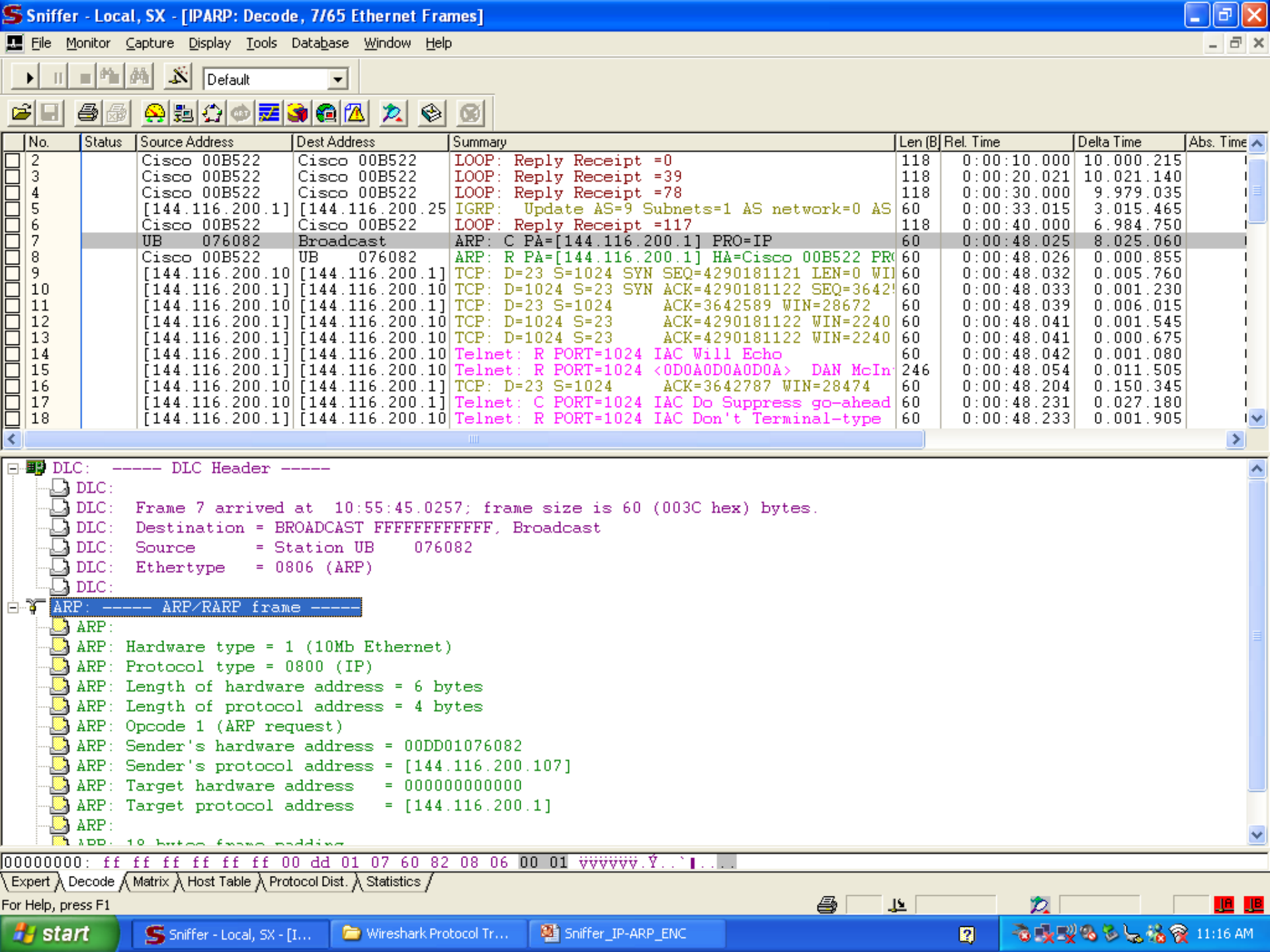
	1	2	3	4	5	6	7	8
I: Information	0	N(S)			P/F	N(R)		
S: Supervisory	1	0	S		P/F	N(R)		
U: Unnumbered	1	1	M		P/F	M		

N (S) = Send Sequence Number
N (R) = Receive Sequence Number
S = Supervisory Function bits
M = Unnumbered function bits
P/F = Poll/Final Bit

Figure-3 HDLC Control Field Format

Remember the OSI Layers ?


Sniffer - Local, SX - [IPARP: Decode, 4/65 Ethernet Frames]
File Monitor Capture Display Tools Database Window Help
Default
No. Status Source Address Dest Address Summary Len (B Rel. Time Delta Time Abs. Time
2 Cisco 00B522 Cisco 00B522 LOOP: Reply Receipt =0 118 0:00:10.000 10.000.215
3 Cisco 00B522 Cisco 00B522 LOOP: Reply Receipt =39 118 0:00:20.021 10.021.140
4 Cisco 00B522 Cisco 00B522 LOOP: Reply Receipt =78 118 0:00:30.000 9.979.035
5 [144.116.200.1] [144.116.200.25 IGRP: Update AS=9 Subnets=1 AS network=0 AS 60 0:00:33.015 3.015.465
6 Cisco 00B522 Cisco 00B522 LOOP: Reply Receipt =117 118 0:00:40.000 6.984.750
7 UB 076082 Broadcast ARP: C PA=[144.116.200.1] PRO=IP 60 0:00:48.025 8.025.060
8 Cisco 00B522 UB 076082 ARP: R PA=[144.116.200.1] HA=Cisco 00B522 PR 60 0:00:48.026 0.000.855
9 [144.116.200.10 [144.116.200.1] TCP: D=23 S=1024 SYN SEQ=4290181121 LEN=0 WI 60 0:00:48.032 0.005.760
10 [144.116.200.1] [144.116.200.10 TCP: D=1024 S=23 SYN ACK=4290181122 SEQ=3642 60 0:00:48.033 0.001.230
11 [144.116.200.10 [144.116.200.1] TCP: D=23 S=1024 ACK=3642589 WIN=28672 60 0:00:48.039 0.006.015
12 [144.116.200.1] [144.116.200.10 TCP: D=1024 S=23 ACK=4290181122 WIN=2240 60 0:00:48.041 0.001.545
13 [144.116.200.1] [144.116.200.10 TCP: D=1024 S=23 ACK=4290181122 WIN=2240 60 0:00:48.041 0.000.675
14 [144.116.200.1] [144.116.200.10 Telnet: R PORT=1024 IAC Will Echo 60 0:00:48.042 0.001.080
15 [144.116.200.1] [144.116.200.10 Telnet: R PORT=1024 <0D0A0D0A0D0A> DAN McIn 246 0:00:48.054 0.011.505
16 [144.116.200.10 [144.116.200.1] TCP: D=23 S=1024 ACK=3642787 WIN=28474 60 0:00:48.204 0.150.345
17 [144.116.200.10 [144.116.200.1] Telnet: C PORT=1024 IAC Do Suppress go-ahead 60 0:00:48.231 0.027.180
18 [144.116.200.1] [144.116.200.10 Telnet: R PORT=1024 IAC Don't Terminal-type 60 0:00:48.233 0.001.905
LOOP: ----- LOOPBACK Version 2.0 Frame -----
LOOP:
LOOP: Skip Count = 0
LOOP: Message type = Reply message
LOOP: Receipt number = 27726
LOOP:
00000000: 00 00 0c 00 b5 22 00 00 0c 00 b5 22 90 00 00 00 ....µ"....µ"▌...
00000010: 01 00 4e 6c 02 b1 c8 40 7d 01 00 a0 00 00 f4 f4 ..Nl.±È@}.. ..ôô
00000020: 03 00 38 84 01 00 0a 40 03 40 00 00 00 01 11 00 ..8▌...@.@......
00000030: 06 c0 01 ff ff 00 06 c0 02 80 00 00 0c c0 0b 53 .À.ÿÿ..À.▌...À.S
00000040: 4e 49 46 46 45 52 00 00 12 40 0c 00 00 00 00 00 NIFFER...@......
00000050: 00 00 00 00 00 00 00 00 00 71 71 a2 3f 00 34 35 ....qq¢?.45
00000060: 36 37 00 00 00 00 00 00 00 00 00 00 00 00 00 00 67..............
00000070: 00 00 00 00 00 00 ......
Expert Decode Matrix Host Table Protocol Dist. Statistics
For Help, press F1
start
Sniffer - Local, SX - [I...
Wireshark Protocol Tr...
11:12 AM


Sniffer - Local, SX - [IPARP: Decode, 7/65 Ethernet Frames]
File Monitor Capture Display Tools Database Window Help
Default
No. Status Source Address Dest Address Summary Len (B Rel. Time Delta Time Abs. Time
2 Cisco 00B522 Cisco 00B522 LOOP: Reply Receipt =0 118 0:00:10.000 10.000.215
3 Cisco 00B522 Cisco 00B522 LOOP: Reply Receipt =39 118 0:00:20.021 10.021.140
4 Cisco 00B522 Cisco 00B522 LOOP: Reply Receipt =78 118 0:00:30.000 9.979.035
5 [144.116.200.1] [144.116.200.25 IGRP: Update AS=9 Subnets=1 AS network=0 AS 60 0:00:33.015 3.015.465
6 Cisco 00B522 Cisco 00B522 LOOP: Reply Receipt =117 118 0:00:40.000 6.984.750
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10 [144.116.200.1] [144.116.200.10 TCP: D=1024 S=23 SYN ACK=4290181122 SEQ=3642 60 0:00:48.033 0.001.230
11 [144.116.200.10 [144.116.200.1] TCP: D=23 S=1024 ACK=3642589 WIN=28672 60 0:00:48.039 0.006.015
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13 [144.116.200.1] [144.116.200.10 TCP: D=1024 S=23 ACK=4290181122 WIN=2240 60 0:00:48.041 0.000.675
14 [144.116.200.1] [144.116.200.10 Telnet: R PORT=1024 IAC Will Echo 60 0:00:48.042 0.001.080
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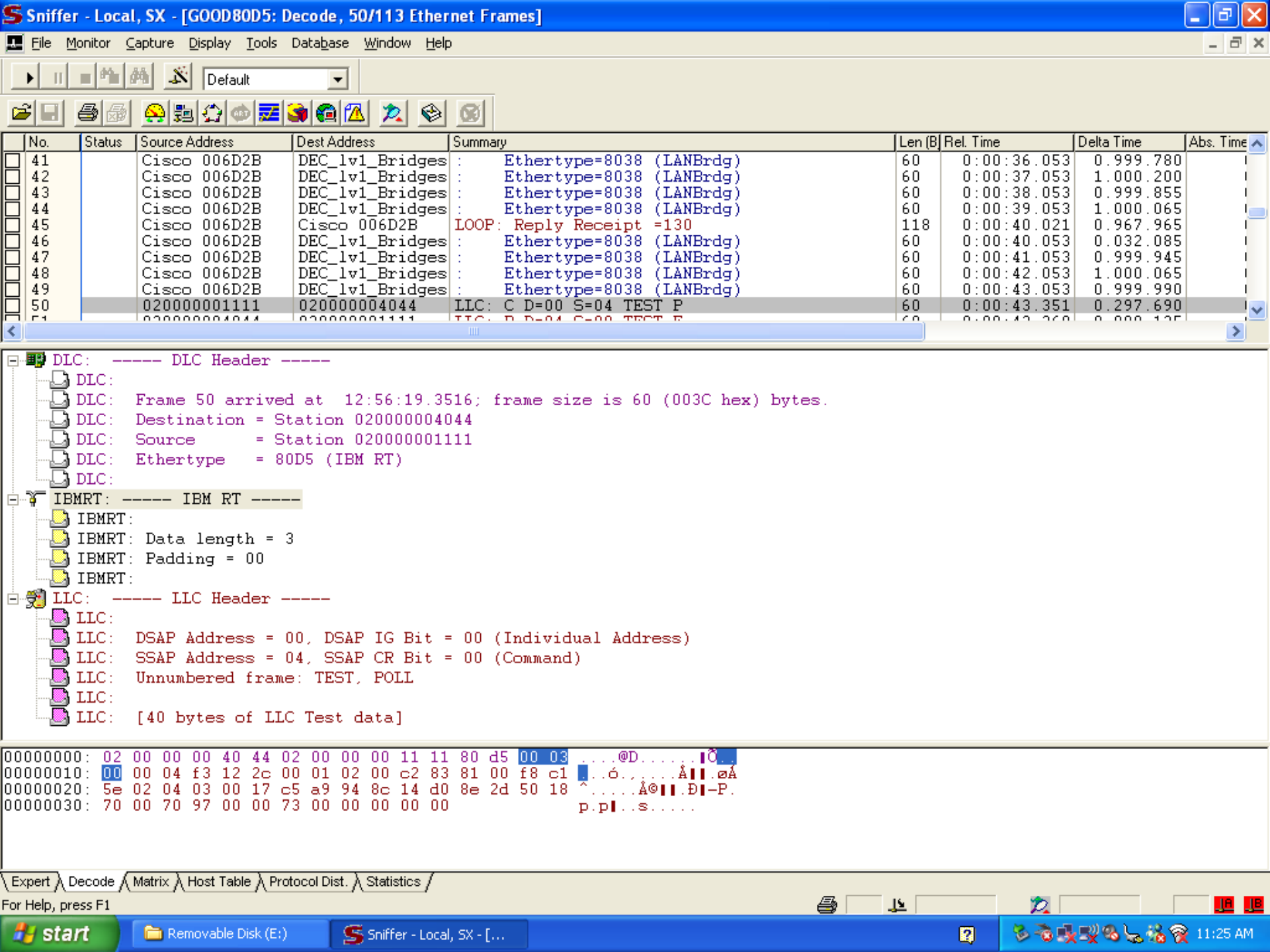
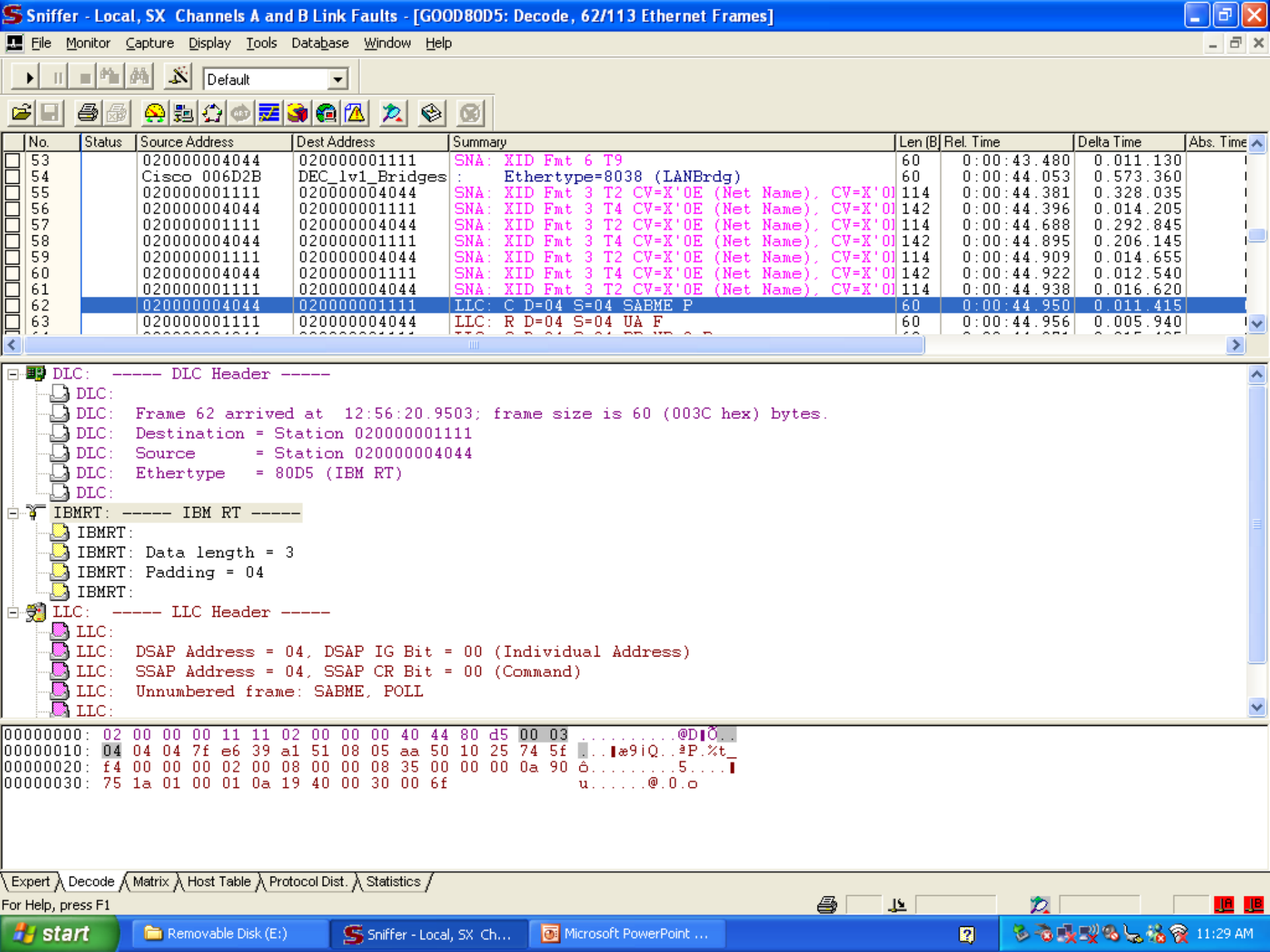
18 [144.116.200.1] [144.116.200.10 Telnet: R PORT=1024 IAC Don't Terminal-type 60 0:00:48.233 0.001.905
DLC: ----- DLC Header -----
DLC:
DLC: Frame 7 arrived at 10:55:45.0257; frame size is 60 (003C hex) bytes.
DLC: Destination = BROADCAST FFFFFFFFFFFF, Broadcast
DLC: Source = Station UB 076082
DLC: Ethertype = 0806 (ARP)
DLC:
ARP: ----- ARP/RARP frame -----
ARP:
ARP: Hardware type = 1 (10Mb Ethernet)
ARP: Protocol type = 0800 (IP)
ARP: Length of hardware address = 6 bytes
ARP: Length of protocol address = 4 bytes
ARP: Opcode 1 (ARP request)
ARP: Sender's hardware address = 00DD01076082
ARP: Sender's protocol address = [144.116.200.107]
ARP: Target hardware address = 000000000000
ARP: Target protocol address = [144.116.200.1]
ARP:
00000000: ff ff ff ff ff ff 00 dd 01 07 60 82 08 06 00 01
Expert Decode Matrix Host Table Protocol Dist. Statistics
For Help, press F1
start
Sniffer - Local, SX - [I...
Wireshark Protocol Tr...
Sniffer_IP-ARP_ENC
11:16 AM


Sniffer - Local, SX - [GOOD80D5: Decode, 50/113 Ethernet Frames]
File Monitor Capture Display Tools Database Window Help
Default
No. Status Source Address Dest Address Summary Len (B Rel. Time Delta Time Abs. Time
41 Cisco 006D2B DEC_lv1_Bridges : Ethertype=8038 (LANBrdg) 60 0:00:36.053 0.999.780
42 Cisco 006D2B DEC_lv1_Bridges : Ethertype=8038 (LANBrdg) 60 0:00:37.053 1.000.200
43 Cisco 006D2B DEC_lv1_Bridges : Ethertype=8038 (LANBrdg) 60 0:00:38.053 0.999.855
44 Cisco 006D2B DEC_lv1_Bridges : Ethertype=8038 (LANBrdg) 60 0:00:39.053 1.000.065
45 Cisco 006D2B Cisco 006D2B LOOP: Reply Receipt =130 118 0:00:40.021 0.967.965
46 Cisco 006D2B DEC_lv1_Bridges : Ethertype=8038 (LANBrdg) 60 0:00:40.053 0.032.085
47 Cisco 006D2B DEC_lv1_Bridges : Ethertype=8038 (LANBrdg) 60 0:00:41.053 0.999.945
48 Cisco 006D2B DEC_lv1_Bridges : Ethertype=8038 (LANBrdg) 60 0:00:42.053 1.000.065
49 Cisco 006D2B DEC_lv1_Bridges : Ethertype=8038 (LANBrdg) 60 0:00:43.053 0.999.990
50 020000001111 020000004044 LLC: C D=00 S=04 TEST P 60 0:00:43.351 0.297.690
DLC: ----- DLC Header -----
DLC:
DLC: Frame 50 arrived at 12:56:19.3516; frame size is 60 (003C hex) bytes.
DLC: Destination = Station 020000004044
DLC: Source = Station 020000001111
DLC: Ethertype = 80D5 (IBM RT)
DLC:
IBMRT: ----- IBM RT -----
IBMRT:
IBMRT: Data length = 3
IBMRT: Padding = 00
IBMRT:
LLC: ----- LLC Header -----
LLC:
LLC: DSAP Address = 00, DSAP IG Bit = 00 (Individual Address)
LLC: SSAP Address = 04, SSAP CR Bit = 00 (Command)
LLC: Unnumbered frame: TEST, POLL
LLC:
LLC: [40 bytes of LLC Test data]
00000000: 02 00 00 00 40 44 02 00 00 00 11 11 80 d5 00 03 ....@D..... Õ..
00000010: 00 00 04 f3 12 2c 00 01 02 00 c2 83 81 00 f8 c1 ..ó.,....Å.. øÁ
00000020: 5e 02 04 03 00 17 c5 a9 94 8c 14 d0 8e 2d 50 18 ^.....Å©.. Ð.-P.
00000030: 70 00 70 97 00 00 73 00 00 00 00 00 p.p..s.....
Expert Decode Matrix Host Table Protocol Dist. Statistics
For Help, press F1
start
Removable Disk (E:)
Sniffer - Local, SX - [...
11:25 AM


Sniffer - Local, SX Channels A and B Link Faults - [GOOD80D5: Decode, 62/113 Ethernet Frames]
File Monitor Capture Display Tools Database Window Help
Default
No. Status Source Address Dest Address Summary Len (B Rel. Time Delta Time Abs. Time
53 020000004044 020000001111 SNA: XID Fmt 6 T9 60 0:00:43.480 0.011.130
54 Cisco 006D2B DEC_lv1_Bridges : Ethertype=8038 (LANBrdg) 60 0:00:44.053 0.573.360
55 020000001111 020000004044 SNA: XID Fmt 3 T2 CV=X'0E (Net Name), CV=X'0 114 0:00:44.381 0.328.035
56 020000004044 020000001111 SNA: XID Fmt 3 T4 CV=X'0E (Net Name), CV=X'0 142 0:00:44.396 0.014.205
57 020000001111 020000004044 SNA: XID Fmt 3 T2 CV=X'0E (Net Name), CV=X'0 114 0:00:44.688 0.292.845
58 020000004044 020000001111 SNA: XID Fmt 3 T4 CV=X'0E (Net Name), CV=X'0 142 0:00:44.895 0.206.145
59 020000001111 020000004044 SNA: XID Fmt 3 T2 CV=X'0E (Net Name), CV=X'0 114 0:00:44.909 0.014.655
60 020000004044 020000001111 SNA: XID Fmt 3 T4 CV=X'0E (Net Name), CV=X'0 142 0:00:44.922 0.012.540
61 020000001111 020000004044 SNA: XID Fmt 3 T2 CV=X'0E (Net Name), CV=X'0 114 0:00:44.938 0.016.620
62 020000004044 020000001111 LLC: C D=04 S=04 SABME P 60 0:00:44.950 0.011.415
63 020000001111 020000004044 LLC: R D=04 S=04 UA F 60 0:00:44.956 0.005.940
DLC: ----- DLC Header -----
DLC:
DLC: Frame 62 arrived at 12:56:20.9503; frame size is 60 (003C hex) bytes.
DLC: Destination = Station 020000001111
DLC: Source = Station 020000004044
DLC: Ethertype = 80D5 (IBM RT)
DLC:
IBMRT: ----- IBM RT -----
IBMRT:
IBMRT: Data length = 3
IBMRT: Padding = 04
IBMRT:
LLC: ----- LLC Header -----
LLC:
LLC: DSAP Address = 04, DSAP IG Bit = 00 (Individual Address)
LLC: SSAP Address = 04, SSAP CR Bit = 00 (Command)
LLC: Unnumbered frame: SABME, POLL
LLC:
00000000: 02 00 00 00 11 11 02 00 00 00 40 44 80 d5 00 03 .....@D
00000010: 04 04 04 7f e6 39 a1 51 08 05 aa 50 10 25 74 5f .....9.Q...P.%t_
00000020: f4 00 00 00 02 00 08 00 00 08 35 00 00 00 0a 90 .....5.....
00000030: 75 1a 01 00 01 0a 19 40 00 30 00 6f u.....@.0.o
Expert Decode Matrix Host Table Protocol Dist. Statistics
For Help, press F1
start
Removable Disk (E:)
Sniffer - Local, SX Ch...
Microsoft PowerPoint ...
11:29 AM

Data Link Protocols

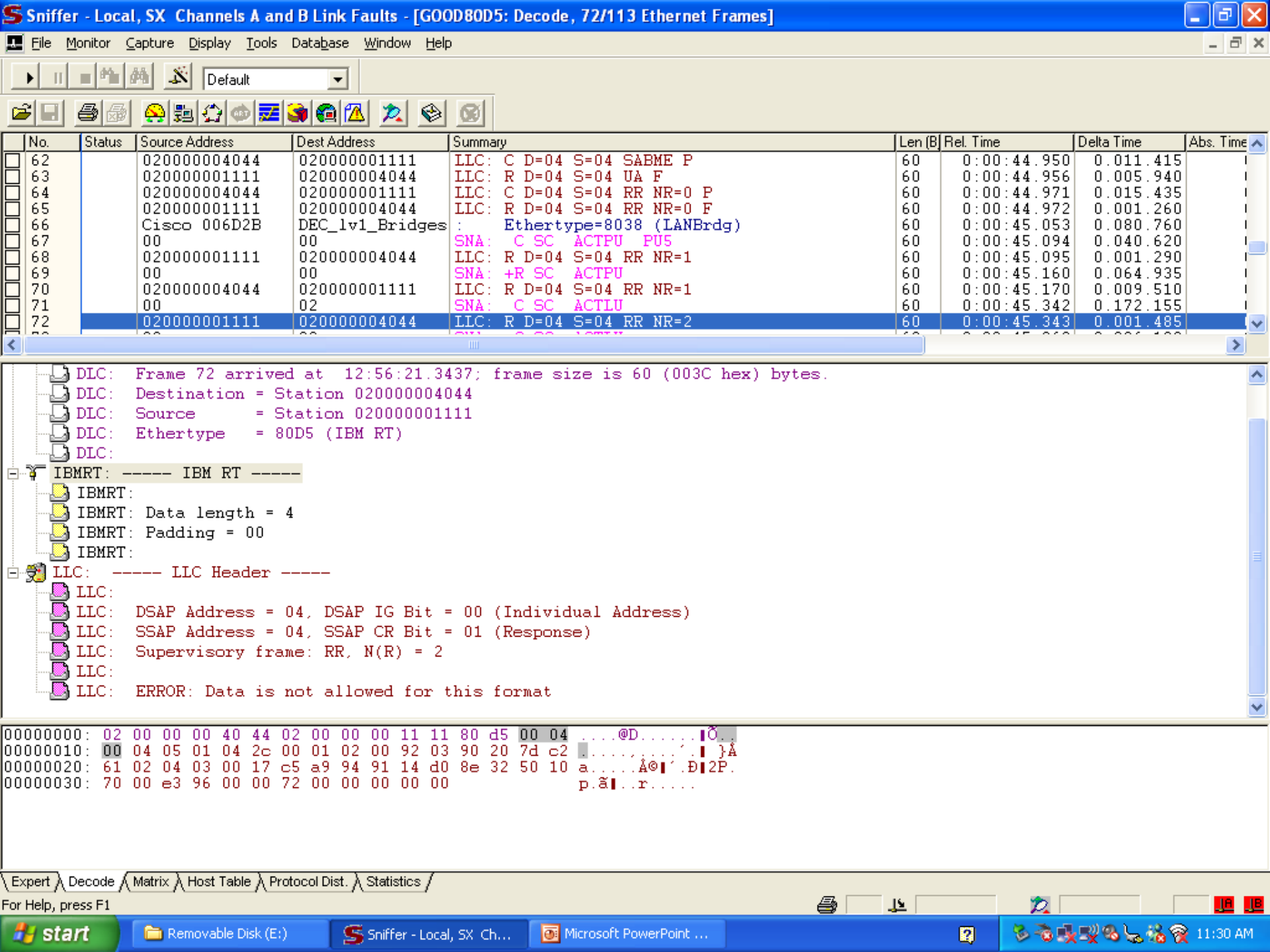
Sequence Counter Definitions:

V(R) Receive-state variable. A counter maintained by a network station. This counter indicates the sequence number of the next-in-sequence I PDU to be received on a connection. It is maintained in the network station and not the frame.

N(S) Sequence number of the frame (called the send sequence number). Located in the transmitted frame, this field will only be set in information (I) packets. Prior to sending an I frame, the value of N(S) is set to the value of V(S), the send-state variable. This is located in the frame and not in the network station.

V(S) Send-state variable. This number indicates the next sequence number expected on the connection. It is incremented by one for each successive I-frame transmission. It is maintained in the network station and not the frame.

N(R) Receive Sequence number. This is an acknowledgment of a previous frame. It is located in the transmitted frame. All information and supervisory frames will contain this. Prior to sending that type of frame, it is set equal to the value of the receive-state V(R) for that connection. N(R) indicates to the receiving station that the station that originated this frame accepts all frames up to the N(R) minus 1.


Sniffer - Local, SX Channels A and B Link Faults - [GOOD80D5: Decode, 72/113 Ethernet Frames]
File Monitor Capture Display Tools Database Window Help
Default
No. Status Source Address Dest Address Summary Len (B Rel. Time Delta Time Abs. Time
62 020000004044 020000001111 LLC: C D=04 S=04 SABME P 60 0:00:44.950 0.011.415
63 020000001111 020000004044 LLC: R D=04 S=04 UA F 60 0:00:44.956 0.005.940
64 020000004044 020000001111 LLC: C D=04 S=04 RR NR=0 P 60 0:00:44.971 0.015.435
65 020000001111 020000004044 LLC: R D=04 S=04 RR NR=0 F 60 0:00:44.972 0.001.260
66 Cisco 006D2B DEC_lv1_Bridges : Ethertype=8038 (LANBrdg) 60 0:00:45.053 0.080.760
67 00 00 SNA: C SC ACTPU PU5 60 0:00:45.094 0.040.620
68 020000001111 020000004044 LLC: R D=04 S=04 RR NR=1 60 0:00:45.095 0.001.290
69 00 00 SNA: +R SC ACTPU 60 0:00:45.160 0.064.935
70 020000004044 020000001111 LLC: R D=04 S=04 RR NR=1 60 0:00:45.170 0.009.510
71 00 02 SNA: C SC ACTLU 60 0:00:45.342 0.172.155
72 020000001111 020000004044 LLC: R D=04 S=04 RR NR=2 60 0:00:45.343 0.001.485
DLC: Frame 72 arrived at 12:56:21.3437; frame size is 60 (003C hex) bytes.
DLC: Destination = Station 020000004044
DLC: Source = Station 020000001111
DLC: Ethertype = 80D5 (IBM RT)
DLC:
IBMRT: ----- IBM RT -----
IBMRT:
IBMRT: Data length = 4
IBMRT: Padding = 00
IBMRT:
LLC: ----- LLC Header -----
LLC:
LLC: DSAP Address = 04, DSAP IG Bit = 00 (Individual Address)
LLC: SSAP Address = 04, SSAP CR Bit = 01 (Response)
LLC: Supervisory frame: RR, N(R) = 2
LLC:
LLC: ERROR: Data is not allowed for this format
00000000: 02 00 00 00 40 44 02 00 00 00 11 11 80 d5 00 04 ....@D.....▌Õ..
00000010: 00 04 05 01 04 2c 00 01 02 00 92 03 90 20 7d c2 .....,....´.▌ }Å
00000020: 61 02 04 03 00 17 c5 a9 94 91 14 d0 8e 32 50 10 a.....Å©▌´.Ð▌2P.
00000030: 70 00 e3 96 00 00 72 00 00 00 00 00 p.ã▌..r.....
Expert Decode Matrix Host Table Protocol Dist. Statistics
For Help, press F1
start
Removable Disk (E:)
Sniffer - Local, SX Ch...
Microsoft PowerPoint ...
11:30 AM

Data Link Protocols

This ability to detect and correct sequence errors is basically characterized by three types of retransmissions: **Go Back to N, Selective Repeat, and Stop and Wait**.

All three types have their merits.

The **Selective Reject** offers better bandwidth utilization in that only the out-of-sequence frame needs to be retransmitted. But the receiving network station must wait for that frame and, when it does arrive, it must reorder the data in the correct sequence before presenting it to the next layer. This consumes memory and CPU utilization.

Go-Back-to-N method specifies not only a specific sequence number is to be retransmitted, but also any frames before that and up to the last acknowledged sequence number. It is a simpler method; however, it uses more network bandwidth and is generally slower that the Selective Reject. HDLC uses the Selective Reject methods. Other network protocols use a variance of the both Go Back to N and Selective Reject.

Stop-and-Wait method has a window size of 1, for only one frame may be outstanding at a time. Stop and Wait means send a packet and do not transmit another until that packet has been acknowledged exchange.