How to Test:

Layer 3 Switches

Using

340-1004-001 Rev B, 1/99

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How to Test Layer 3 Switches

with ML-7710 SmartCards & SmartWindow

A Guide for Evaluating the Performance of

Layer 3 Devices

using Netcom Systems SmartBits Performance Analyzer and Software

Netcom Systems is pleased to provide a general procedure for testing Layer 3 device performance. The SmartBits chassis, multi-layer ML-7710 SmartCards, and an easy-to-use SmartWindow program are the tools to provide a test methodology which is highly effective in providing critical data to evaluate Layer 3 devices.

Part I: Introduction

What is a Layer 3 Switch?

In most cases, a Layer 3 switch is in fact a fast protocol-based router minus certain router functions. A Layer 3 switch typically works with only one or two protocols, performs at or close to wire speed, is good at keeping streaming packets in order, and makes routing decisions based on ASICs (unlike a router which is software-based).

The 10 Mbps, 100 Mbps and Gigabit Ethernet Layer 3 switches are expected to operate at full line-rate at Layer 2 and wire-speed IP routing at Layer 3 simultaneously on all ports with zero packet loss and extremely low latency.

Test Methodology

SmartWindow is a highly effective front panel GUI designed for developers and QA personnel, who wish to create traditional and custom tests. SmartWindow offers test parameters recommended in the following supported RFCs:

RFC 1242, Benchmarking Terminology for Network Interconnection Devices

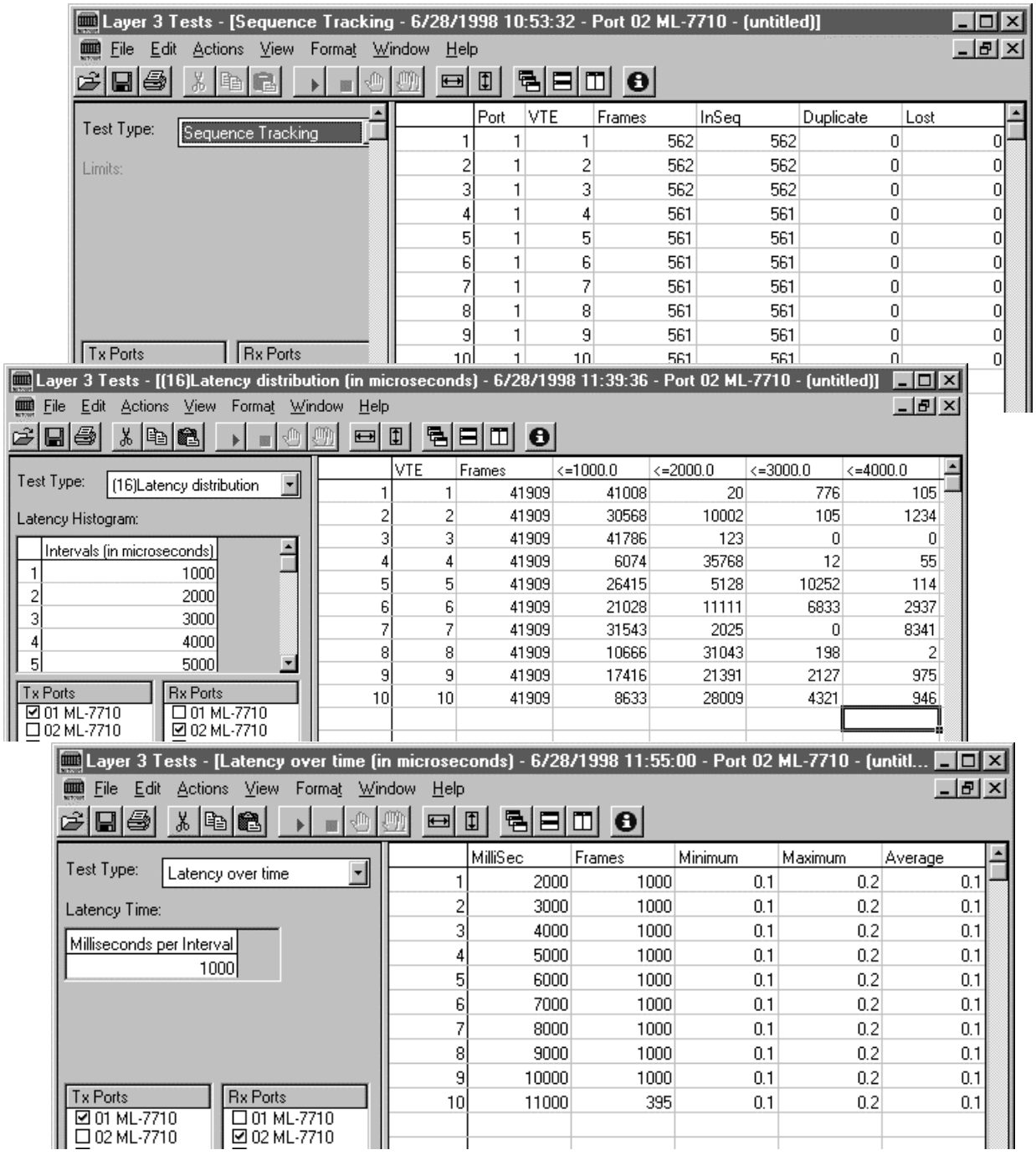
RFC 1944 , Benchmarking Methodology for Network Interconnect Devices

The ML-7710 SmartCard can simulate up to 1000 hosts sending varied or uniform traffic to the layer 3 switch and can fully characterize the switch on both Layer 2 and Layer 3.

The SmartWindow tests and results which demonstrate the performance capability of the switch include the following topics:

- 20 Counters (transmit and receive packets and bytes, packet loss, triggers, tags, collisions, errors, ARP and ping counters)
- Sequence Tracking data
- Latency Distribution data
- Latency over Time data

Sample Layer 3 Test Results



What is a Stream?

It is essential to understand SmartBits streams which provide the basis for using the ML-7710 traffic and test capability. Each stream, generated by its own Virtual Transmit Engine (VTE), represents a repeated packet with the following features:

- Designed to set up traffic for testing layer 2 (switching) or layer 3 (routing) .
- A signature in each packet contains its source and destination location, its sequence in the traffic flow, and when it was sent and received.
- Each stream has its own IP/MAC source and destination addresses, frame length, protocol or custom packet, IP gateway for routing, and statistics/histogram tracking capability.
- With IP, each stream also has ARP request and response ability.
- The stream of one card typically transmits to the stream of another card, simulating transmission from one host computer to a second host computer. Both can be on the same subnet or on different subnets.
- If 10 streams are defined, the 10 packets are transmitted in the order created, then re-cycled to transmit the next 10, until the transmission is stopped. If only one stream is created for a card, then the traffic is comprised of the one packet type.
- Each ML-7710 SmartCard may transmit up to 1000 streams per card, and may track statistics/histogram information on up to approximately 80,000 streams.

Unlike the older SmartCards such as the SX-7410 Ethernet SmartCard which is a packet blaster for hubs and switches, the ML-7710 is equivalent to 1000 IP connections, now condensed into a simple format for creating 1000 streams which closely mimic real world traffic.

Place 20 ML-7710 cards into a SmartBits chassis, then stack 4 chassis; with 80 cards, you can arrange up to 80,000 streams.

Hard Disk Requirements for Streams

If you set up 1000 streams, the setup configuration for each card can take 5 to 7 Mbytes of hard drive (see saved *.msi files).

Multiply by 20 cards = 120Mbytes of hard drive per test setup

Multiply by 4 chassis = 480Mbytes of hard drive per test setup

If you want to make histogram measurements, double your estimated hard drive requirement.

Other Applications Available

More tests are available with the ML-7710. These will be presented in another paper in the near future. The additional applications are:

- ***SmartApplications***
  SmartApplications is a Windows®-based application software program that works with SmartBits systems. These applications automate RFC 1242 testing for determining Throughput, Packet Loss, Latency, Back-to-Back Performance testing under full load, and production Go/No-Go tests for “minimum acceptable” performance levels. Tests are available for Ethernet, Token Ring, ATM, and Frame Relay.
- ***Advanced Switch Tests (AST)***
  AST is an easy to use Windows-based application software program that generates heavy bursts of multidirectional traffic to test 10/100/1000 Mbps Ethernet and 4/16 Mbps Token Ring networks. The application can test requirements described in RFC 2285, and includes tests for head-of-line blocking, filtering illegal frames,

backbone switching, forward rate/IFG, address handling, broadcast frames, and fanout, for Ethernet and Token Ring networks in half or full duplex mode.

- ***VAST***
  VAST is an easy to use Windows-based application that generates heavy bursts of multidirectional stream-based traffic to test switches, routers, and VLANs. The application includes preprogrammed tests for VLAN by port, VLAN by MAC address, VLAN by tag, VLAN by IP subnet, VLAN by protocol, VLAN setup time, filtering illegal frames, many-to-many switching, and routing between VLANs. At least two ML-7710 SmartCards are required to perform these tests.
- ***SmartLib Programming Library***
  SmartLib provides an RFC 1242 API compliant programming library interface for rapid test development. Software developers may also use it to develop programs in Visual Basic, C, or C++ in a Windows 95 environment, and C, C++ or TCL in a UNIX® environment.

PART II:
Setting One Stream per Card & Displaying Counters

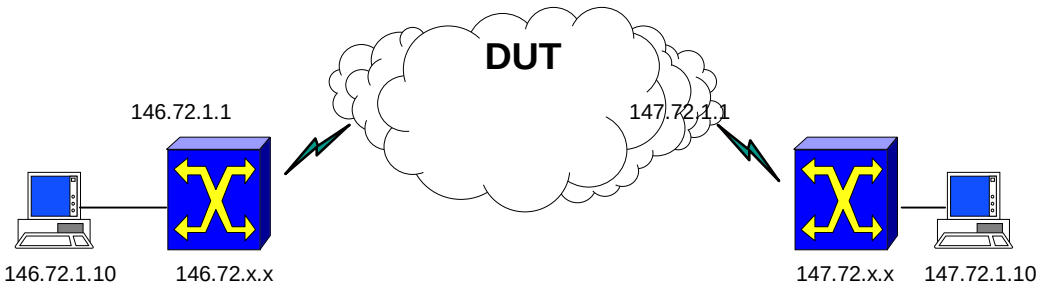
This section presents introductory startup procedures and a basic test scenario based on a single stream from each SmartCard:

Procedure 1: Default Global Settings to Review
Procedure 2: Preferences to Review
Procedure 3: Setting Up One Layer 3 Stream per ML-7710 SmartCard
Procedure 4: Pinging to Check Links
Procedure 5: Transmitting Traffic and Viewing Counters

The test configuration illustrated in the first five procedures has the following connections:

- Two ML-7710 SmartCards are installed in slots 16 and 17 of a SmartBits chassis
- The SmartBits chassis is connected to a PC with SmartWindow via an Ethernet port.
- The two ML-7710 ports of the SmartBits chassis is connected to two gateway ports on the Layer 3 switch/router (Device under Test).

The two subnets and related IP addresses are shown in the illustration below:



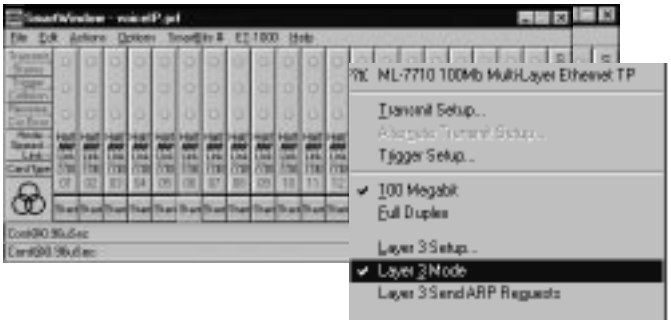
Preparing the Device Under Test (DUT)

IMPORTANT: SNMP functionality, proprietary polling and Spanning Tree frames generated by the DUT will lower the measured performance of the DUT. It is recommended that you turn off all traffic generated by the DUT in order to get actual performance of the switching fabric.

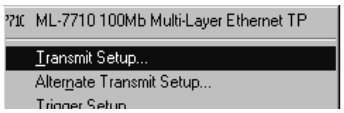
Procedure 1: Default Global Settings to Review

The default settings of each SmartCard should be checked to ensure that they are still appropriate.

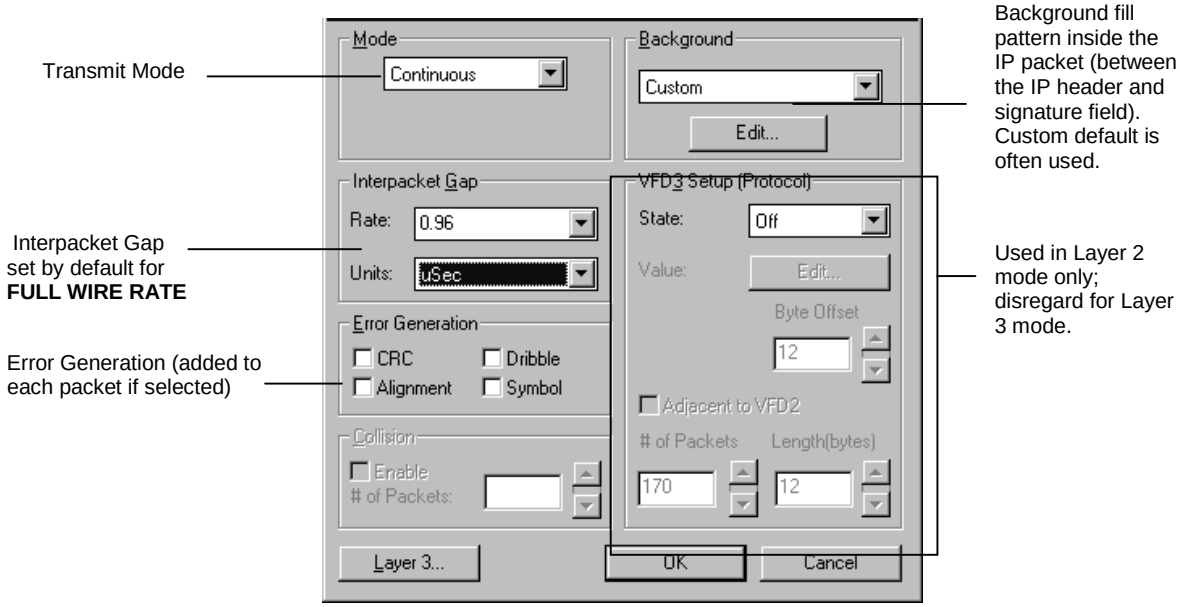
1. Open **SmartWindow**.
2. In SmartWindow, click on each ML-7710 SmartCard, and select the **Layer 3 Mode**.



3. Click on each ML-7710 SmartCard, and select the **Transmit Setup** command.



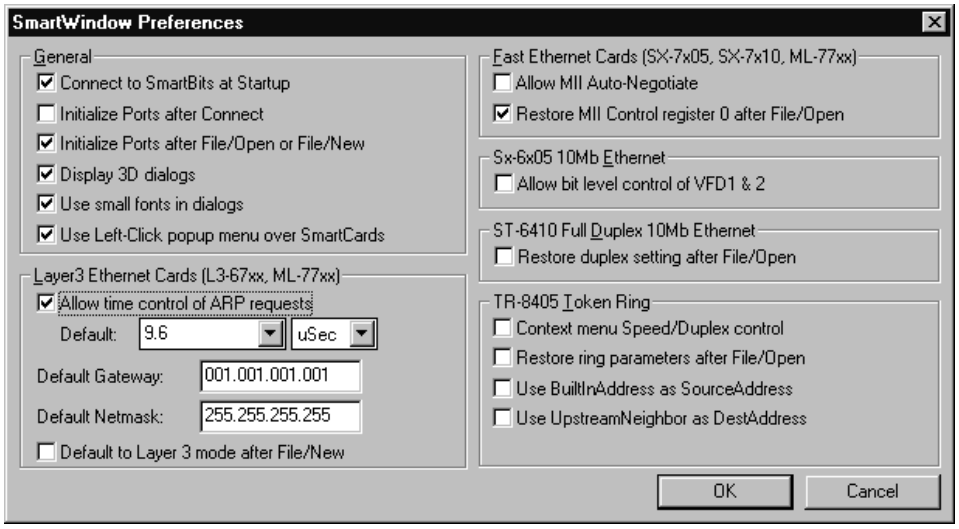
4. In the Transmit Setup window, click the **This Port** button to view the default global settings for the card. Most fields are optional.



Procedure 2: Preferences to Review

There are three preferences which merit quick consideration. Click the Options menu **Preferences** command.

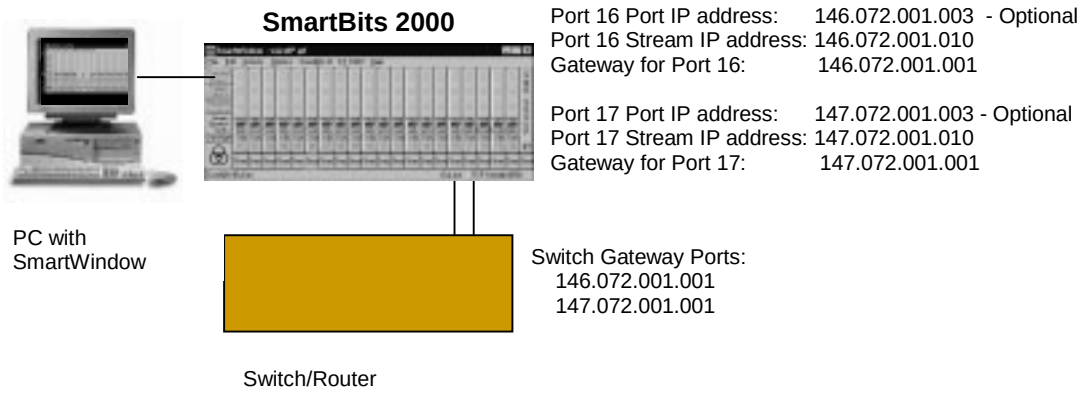
- The default inter ARP gap is set to 9.6 usec as a standard specification and by default cannot be changed for a SmartCard. However, if you wish to change this gap (for instance, a switch cannot process ARP requests at full wire speed), you must turn on the Preference checkbox for **Allow time control of ARP requests**. Then you can re-set the inter ARP gap for each port as needed (click the SmartCard and select **Layer 3 Setup**).
- To automatically update (with speeds, duplex mode, and autonegotiation settings) the Fast Ethernet cards with the last saved configuration or a newly opened configuration file, click the checkbox for **Restore MII Control register 0 after File/Open**.



- To allow MII auto-negotiation for all the Fast Ethernet SmartCards, check the checkbox for **Allow MII Auto-Negotiation**. Then to selectively enable auto-negotiation for each or any SmartCard, click the SmartCard, select **MII Registers**, and click the checkbox for **Enable Auto-Negotiate**.

Procedure 3: Setting Up One Layer 3 Stream per ML-7710 SmartCard

This procedure shows how to configure a single stream in each of two ML-7710 SmartCards (ports 16 and 17 of an SMB-2000 chassis) with SmartWindow 6.25. The SmartBits chassis is connected to a layer 3 switch. It is helpful to set up address assignments in patterns that are easy to remember and interconnect.



IMPORTANT The MAC and IP addresses of streams must be ***unique*** to the streams and cannot be used for ports. The IP address of a stream or a port should be on the same subnet of the associated gateway.

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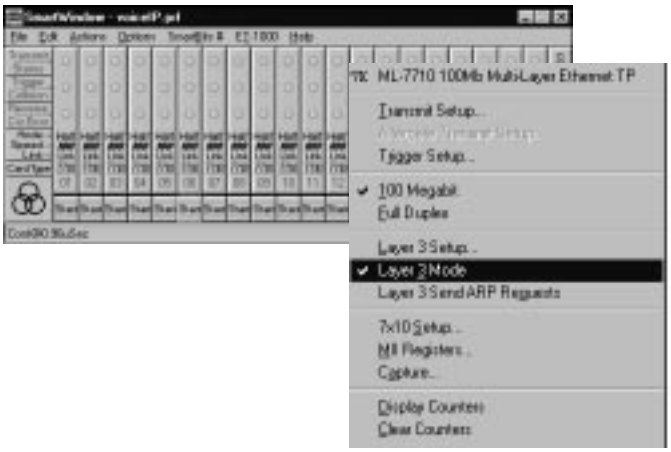
1. In SmartWindow, click on the ML-7710 port 16 SmartCard, and confirm that the **Layer 3 Mode** is selected.

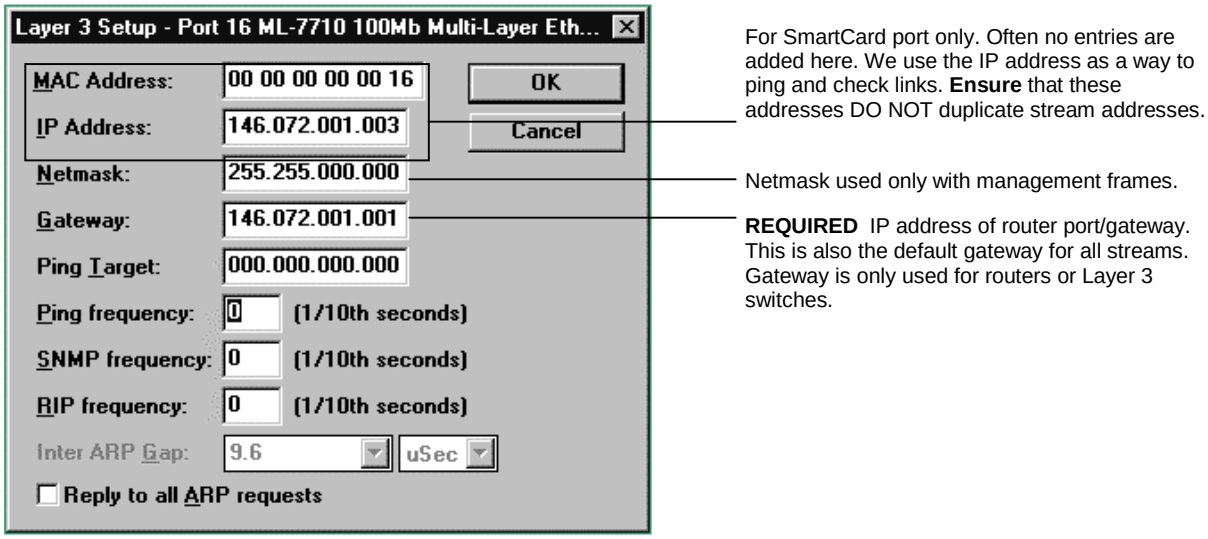


2. Click the SmartCard again, then select **Layer 3 Setup** command.

   The **Layer 3 Setup** window describes the local stack and is optional for most testing requirements. This window is edited for the following purposes:

   -- to set the gateway IP address of the router port (DUT) -- **REQUIRED for Layer 3 switches**
   -- to change MAC and IP addresses (if needed) so that they do not duplicate stream addresses
   -- to set the netmask for management frames if needed (optional; ignored by streams)
   -- to specify a Ping IP address for pings and SNMP frames if needed (optional)
   -- to specify frequency for Ping, SNMP, or RIP (optional)

Port 16 Layer 3 Setup: Set the MAC and IP addresses and gateway address as shown below. Gateway is the IP address of router port. MAC address is for the card (not stream). The IP address must be in the same subnet as the router port/gateway. Once addresses are entered, click **OK**.



IMPORTANT FOR ARP EXCHANGE : The gateway IP address is the target address for ARP frames. If the gateway IP address is zero, the ARP frames will target the destination IP addresses of the streams.

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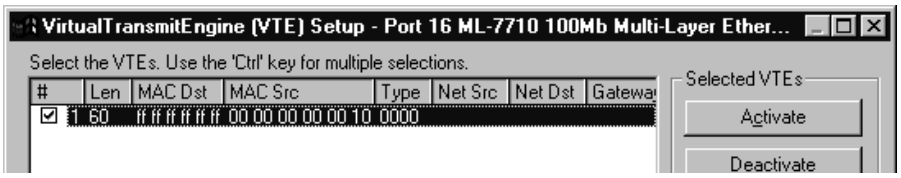
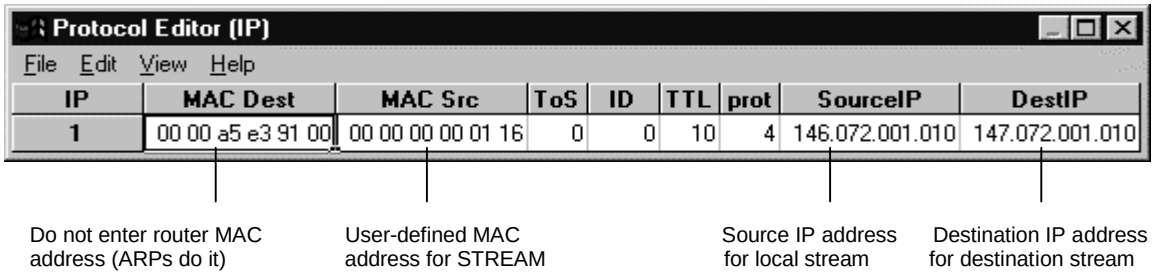
3. In the Transmit Setup window, highlight the default stream and click the **Delete** button. The default stream will be replaced with new fully defined streams.



4. Click the **Add VTEs** button to add a stream onto port 16. Select **IP** from the Protocol pulldown menu, and click **OK**. In the Protocol Editor, toggle the View menu **Concise/Detail** command to see more fields. Enter the necessary addresses.

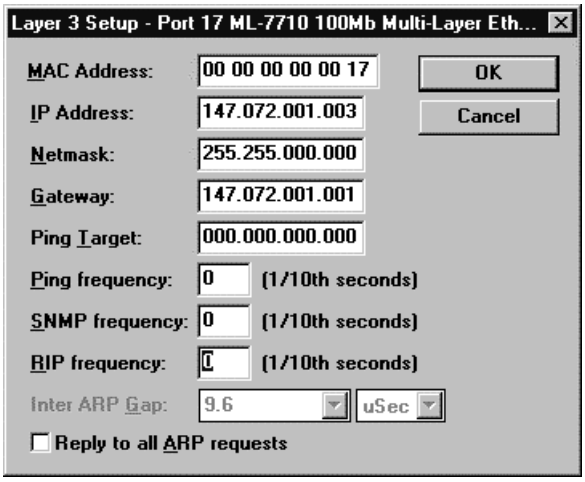
Stream on Port 16

The MAC Dest is the MAC address of router port; it is automatically updated via ARPs; note that when the ARP response is received, the ARPs are handled internally and not updated here. The MAC Src is the MAC address of the stream. The Source IP is the IP address of the stream. The Dest IP is the destination or target IP address.



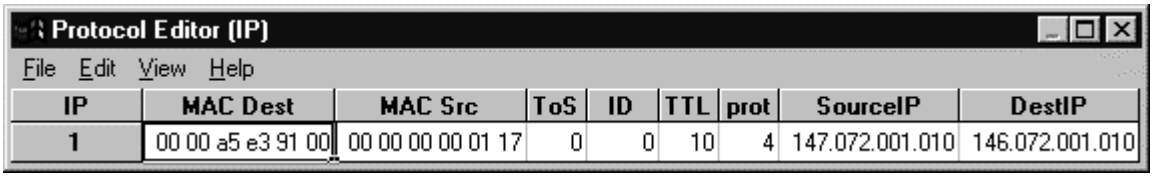
5. Now configure the port and stream for ML-7710 Port 17. Click the port 17 SmartCard and select **Layer 3 Setup** command.

Port 17 Layer 3 Setup: Set the MAC and IP addresses and gateway address as shown below. Remember, the CARD must have a different MAC and IP address than any of the streams. Once addresses are entered, click **OK**.



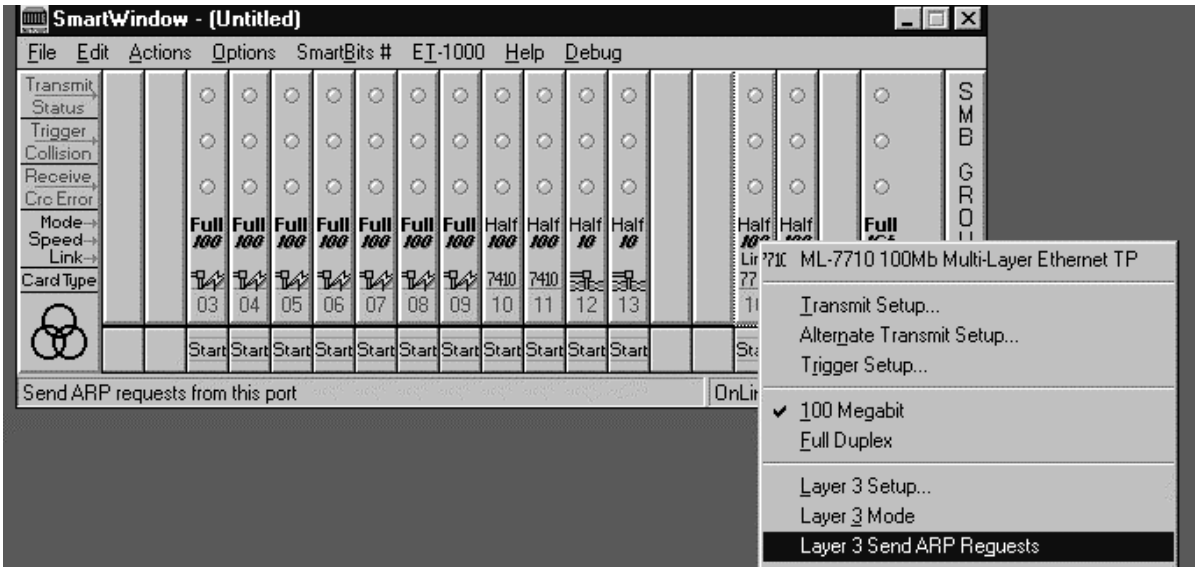
Stream on port 17: Click the port 17 SmartCard and select **Transmit Setup**. Highlight the default stream and **Delete**. Click the **Add VTEs** button to add a stream onto port 16. Select **IP** from the Protocol pulldown menu, and click **OK**. In the Protocol Editor, toggle the View menu **Concise/Detail** command to see more fields. Enter the necessary addresses. Be sure to press the Enter key after each text entry to save it. Click the Close button to exit the window.

Note that Source and Destination IPs are mirrors of the settings on port 16.



IP	MAC Dest	MAC Src	ToS	ID	TTL	prot	SourceIP	DestIP
1	00 00 a5 e3 91 00	00 00 00 00 01 17	0	0	10	4	147.072.001.010	146.072.001.010

6. When complete, send Layer 3 ARPs from each card by clicking on each SmartCard and selecting **Layer 3 Send ARP Requests.** *This is necessary to learn the MAC destination addresses.*



Alternatively, you can select Actions menu **Layer 3 ARP** command to send ARP requests from ALL configured ports at one time.

WATCH THE SMARTBITS HARDWARE or **SmartWindow front panel LEDs**: As each SmartCard transmits an ARP request, look for a brief green LED for transmit and receive. If you do not see a momentary green LED light for receive, the ARP response was not received.

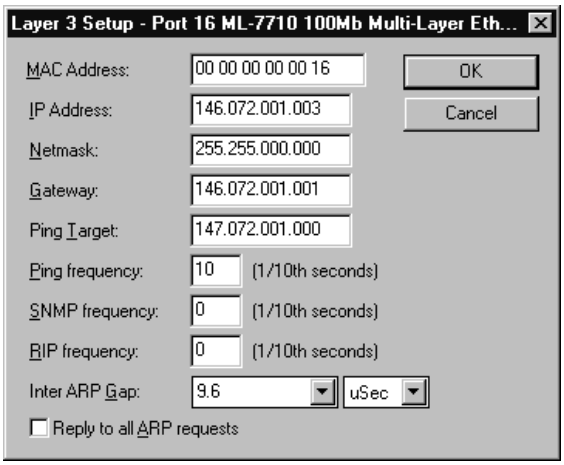
For many streams and ARPs, perform the ARP Exchange Times test (Procedure 10) to ensure that ARPs for all streams were received.

Procedure 4: Pinging to Check Links

Before transmitting traffic, it is worthwhile to ping the SmartCard IP addresses to confirm that the links to the DUT are working properly.

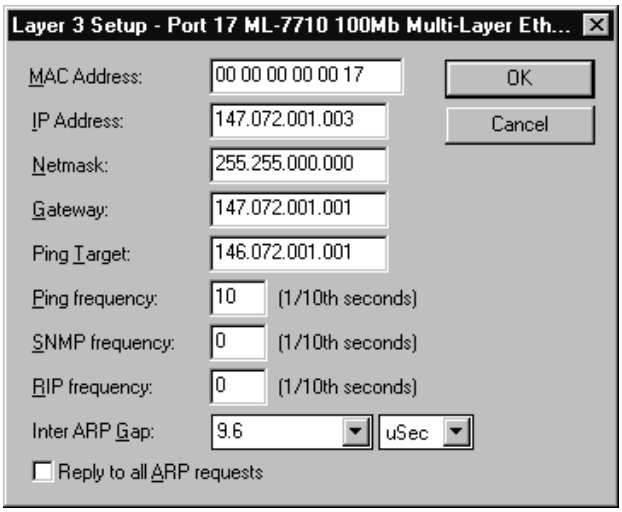
To ping each SmartCard:

1. Click on port 16, select **Layer 3 Setup**, enter the target IP address for port 17, and set the ping frequency to 10:



   Click **OK**.

2. Click on port 17, select **Layer 3 Setup**, enter the target IP address for port 16, and set the ping frequency to 10:



   Click **OK**.

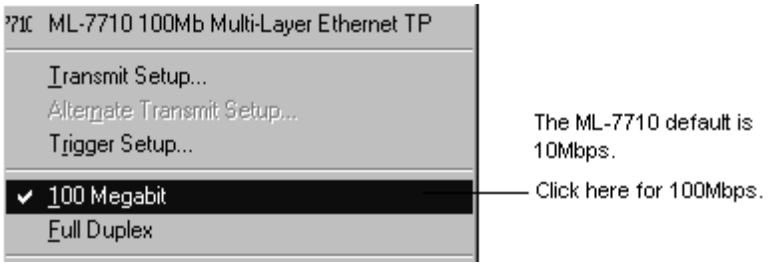
3. To view counters for pings, click Actions menu **SmartCounters** command, then select the File menu **New Counter Window** command. Highlight ports 16 and 17.

4. Click on the **Start** command on each SmartCard and watch SmartCounters for the ping counters.

5. After the pinging is performed, go back to the Layer 3 Setup of each card to turn off pinging by setting the Ping Frequency to **O**. This will keep other traffic results more clearly defined.

Check SmartCard Speed Setting

If the link is still not active, **check that the correct speed** is selected (default is 10Mbps and you may require 100Mbps). To reset the SmartCard speed, click on each card, and select **100Mbps** on the main menu of each SmartCard.



Procedure 5: Transmitting Traffic and Viewing Counters

Now you are ready to transmit traffic and view counters.

1. Click on the port 16 SmartCard, and select **Display Counters** to view results during transmission. Repeat for the port 17 SmartCard.

   Or select Actions menu **SmartCounters** command, then select File menu **New Counter Window** to view all counters. You can save SmartCounters to an excel spreadsheet file with the File menu **Save As** command.

2. Click **Start** on transmitting SmartCard to start transmission. For bidirectional transmission, click **Start** on both SmartCards.

PART III:
Setting Multiple Streams per Card & Displaying Counters

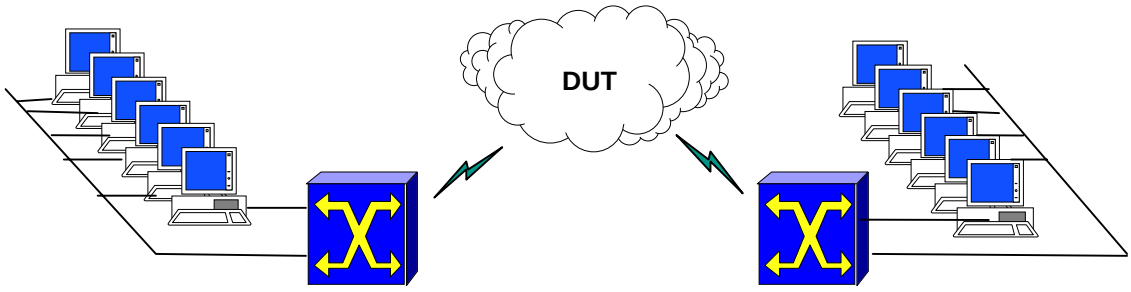
This section presents detailed procedures for creating and using multiple streams on two ML-7710 SmartCards, and then producing counters and test results:

Procedure 6: Setting Up 20 Streams per ML-7710 SmartCard

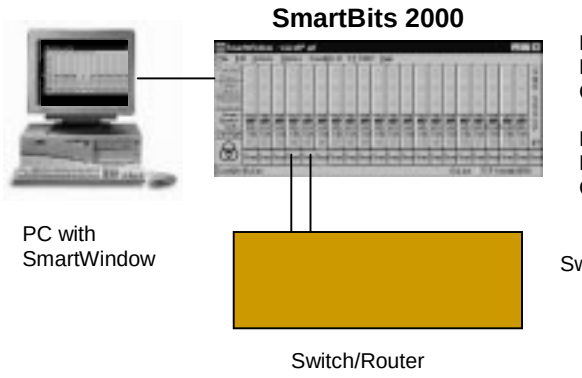
Procedure 7: Creating SMB Group, Transmitting Traffic, and Viewing Counters

Procedure 6: Setting Up 20 Streams per ML-7710 SmartCard

The following procedure describes how to quickly set up 20 consecutive streams from each SmartCard, with varied IP and MAC addresses as well as with varied packet lengths. If desired, you can also assign different protocols and add up to 1000 streams to further mimic real world networks.



Simulation of a network of 40 PC Hosts sending and receiving traffic through the DUT



Port 5 Port IP address: 192.005.001.025
Port 5 Stream IP addresses: 192.005.001.005 - 192.005.001.024
Gateway for Port 5: 192.005.001.254

Port 6 Port IP address: 192.006.001.026
Port 6 Stream IP addresses: 192.006.001.006 - 192.006.001.025
Gateway for Port 6: 192.006.001.254

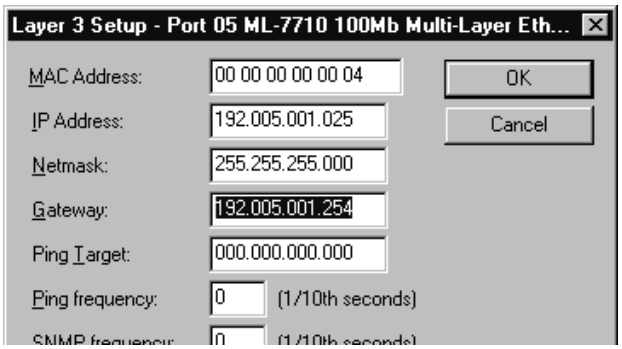
Switch Gateway Ports:
192.005.001.254
192.006.001.254

Test Setup

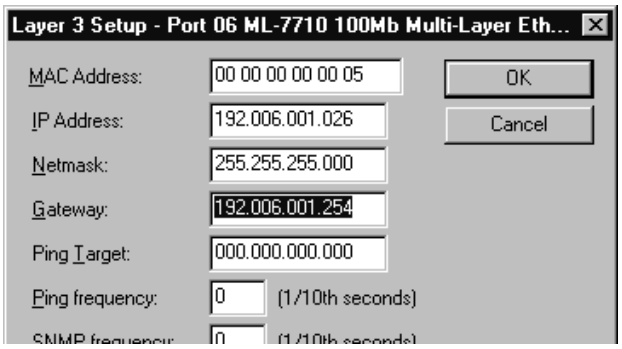
1. Open SmartWindow.

2. Click on ML-7710 port 5. Click the **Layer 3 Mode** command.
   For **Port 5**: Click the card again and select the **Layer 3 Setup** command.
   Enter the gateway IP address for port 5: 192.005.001.254. Click **OK**.

   NOTE The IP ADDRESS for each port is **OPTIONAL** and is added here only to allow for pinging.



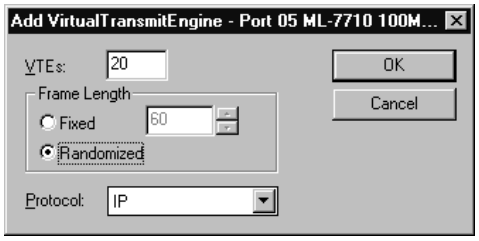
3. Click on ML-7710 port 6. Click the **Layer 3 Mode** command.
   For **Port 6**: Click the card again and select the **Layer 3 Setup** command. Enter the gateway IP address for port 6: 192.006.001.254. Click **OK**.



4. Click on the port 5 SmartCard and select **Transmit Setup**. Highlight the default stream and click the **Delete** button. It is helpful to delete the generic stream and then enter all new streams at one time.

5. Now click **Add VTEs** button to add 20 streams:
   Enter **20** VTEs. Click the **Randomized** radio button for Frame Length. Select **IP** for the Protocol.

   NOTE We recommend that you start with **Fixed** frame lengths to set initial testing benchmarks, then try randomized frame lengths in contrast.



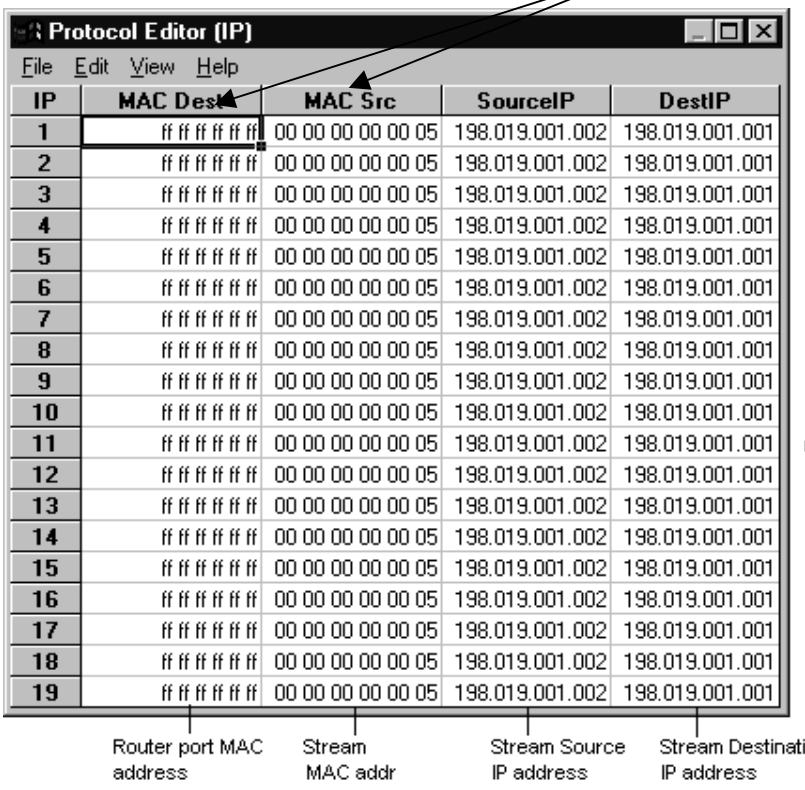
6. Click **OK**. The Protocol Editor appears with default addresses for 20 streams (see next page).

7. Edit the first stream as follows:

   Source IP address for the first stream: 192.005.001.005
   Destination IP address for the stream (which is a port 6 VTE stream): 192.006.001.006

   Then highlight each column (the SourceIP, then DestIP) individually, right-click on the first entry, select the **Copy Down** command, then select the **Fill Increment 0.0.0.x.** The Edited Screen on the next page shows the last column highlighted after these commands have been applied.

Keep MAC address defaults. SmartBits handles MAC addresses internally.

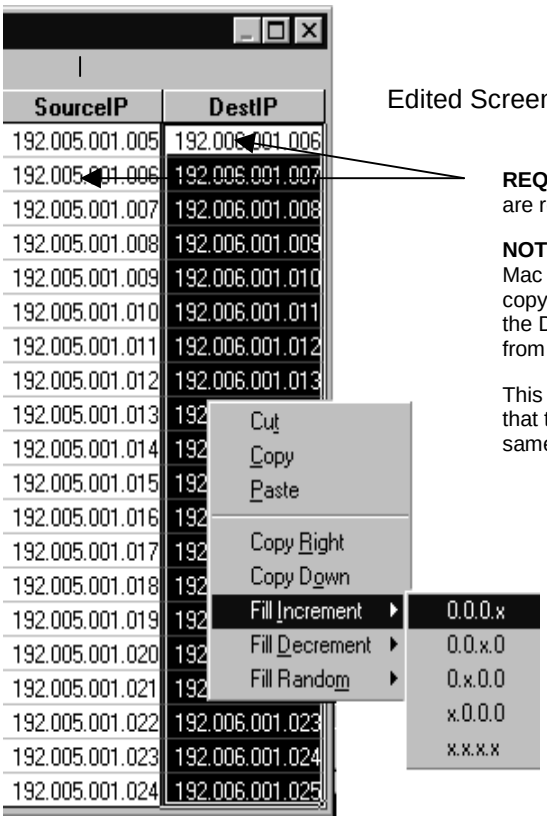


To change defaults:

1. Edit stream 1 SourceIP and DestIP.
2. Highlight SourceIP column, right-click, Copy Down, Fill Increment 0.0.0.x.
3. Highlight DestIP column, right-click, Copy Down, Fill Increment 0.0.0.x.

(MAC destinations are filled by ARP exchange.)

Default Screen



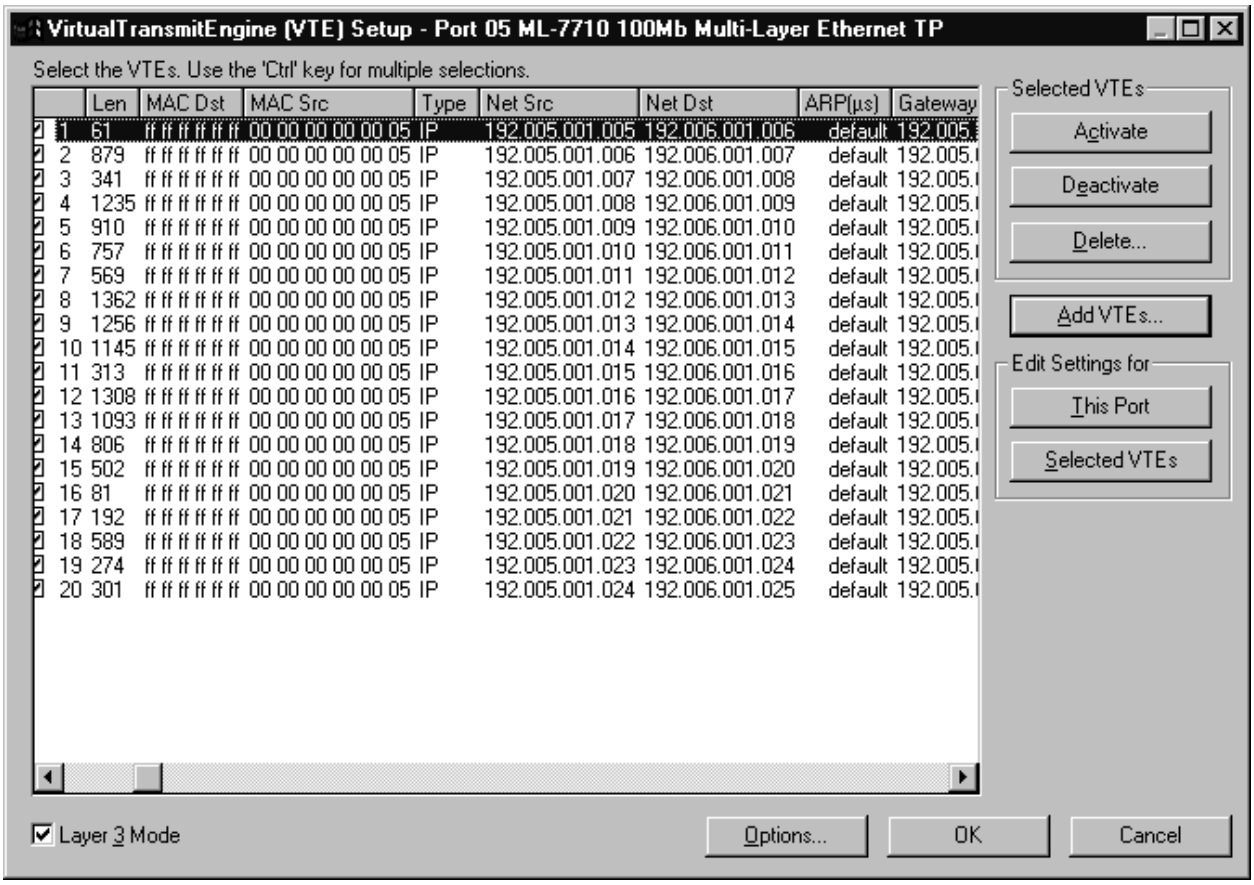
Edited Screen

REQUIRED. User-specified entries are required for SourceIP and DestIP.

NOTE You can optionally change the Mac Src addresses (using the same copy and increment commands) so the DUT thinks that the streams came from 20 different devices.

This minimum configuration indicates that the streams are coming from the same physical device.

8. Click the Close button and view the 20 streams for port 5 in the Transmit Setup window. Click **OK**.



9. Repeat above steps 1 through 7 for **port 6** using the following IP addresses. Use the port 5 addresses for Destination IP addresses.

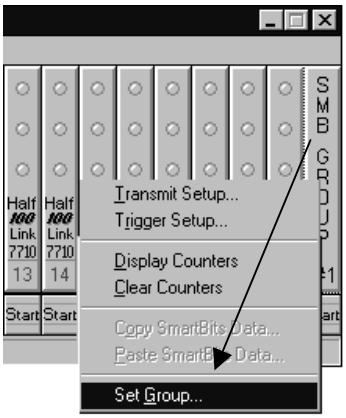
   Port 6 Stream IP addresses: 192.006.001.006 through 192.006.001.025
   Gateway for Port 6: 192.006.001.254

10. Click Actions menu **Layer 3 ARP** to send ARP requests to all configured ports. To check that all ports have sent and received ARPs, you can perform the ARP Exchange Times test (see Procedure 10).

11. To confirm that the SmartBits links to the DUT are working properly, ping the port IP addresses as shown in Procedure 4.

Procedure 7: Creating an SMB Group, Transmitting Traffic, & Viewing Counters

1. It is handy to start all transmissions of multiple SmartCards at the same time. To do this, click on SMB Group and select **Set Group**.



   Click the **None** button to clear all ports, then click on port 5 and port 6 boxes for the group. Then click **OK**.

2. To see results of multiple SmartCards on a single screen, click the Actions menu **SmartCounters** command. Then select the File menu **New Counter Window** command. Highlight the port numbers whose counters you wish to view (here ports 5 and 6). Keep this window open.
3. Click View menu **Show** command and check the boxes for rows and columns.
4. To define a custom indicator, select an empty cell to the right of the cells where data will be entered. Left-click inside this cell, then insert your math equation (press **F2 twice**) using spreadsheet conventions.
5. Now click on the **Start** command on the SMB Group and watch the SmartCounters.

Part IV: Detailed Tracking and Statistical Results

This section provides procedures which demonstrate latency and sequence tracking tests, raw packet results, and data capture.

Procedure 8: Performing Latency and Sequence Tracking Tests

Procedure 9: Inspecting Raw Packets

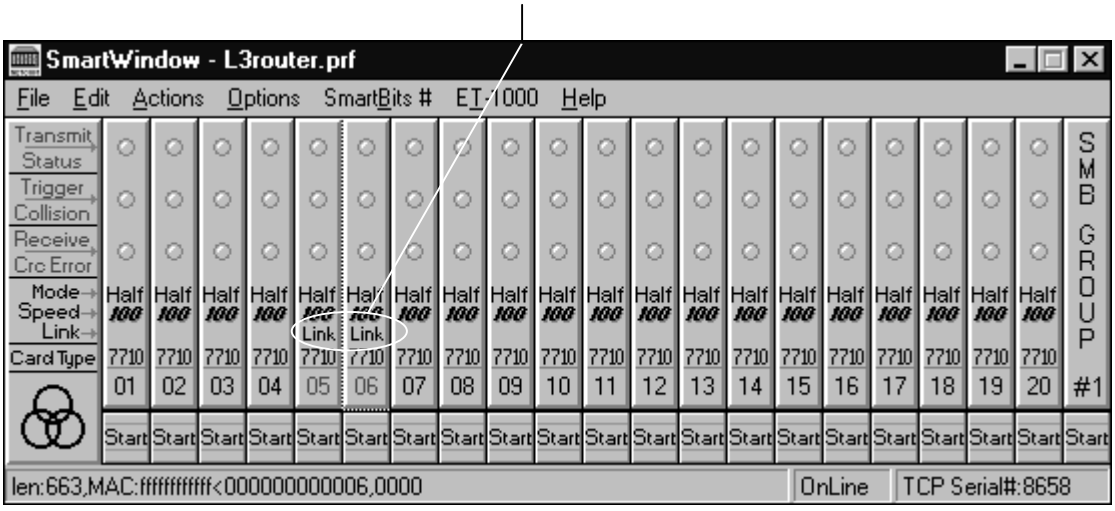
Procedure 10: Using Triggers and Capture

Procedure 8: Performing Latency and Sequence Tracking Tests

The Latency and Sequence Tracking tests provide valuable statistical data for performance analysis of the Layer 3 switch/router.

Before running these tests, confirm that your links are alive.

Note that the ***Link*** on the SmartCard indicates an active link to the DUT.



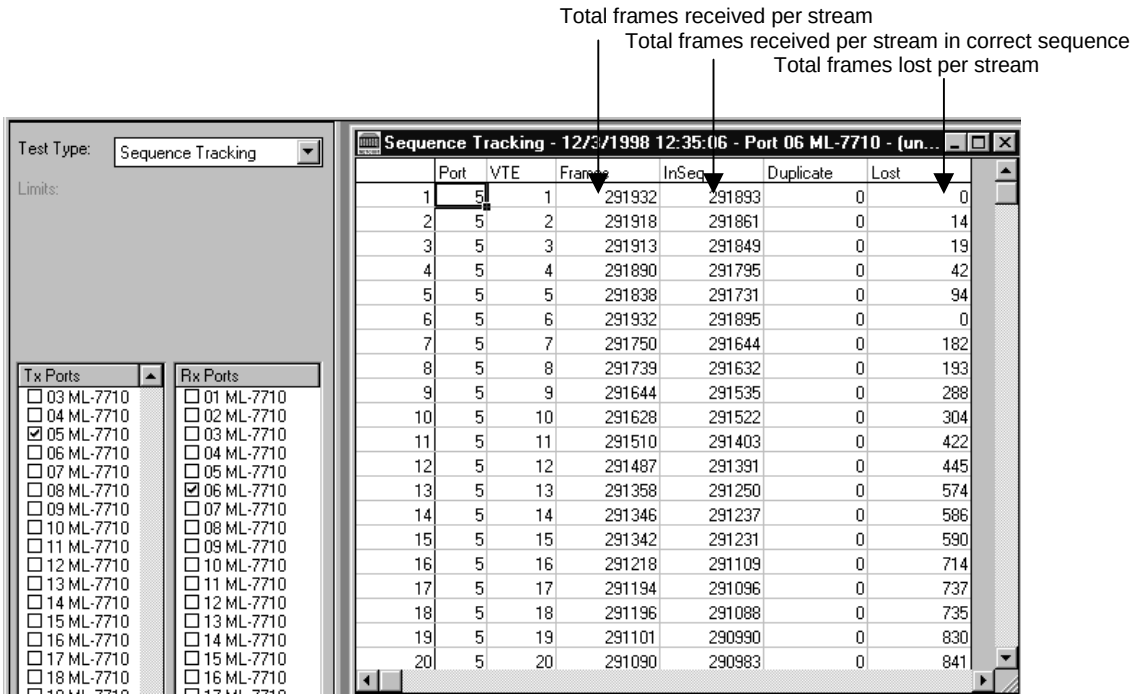
In this example, the following parameters are set up with the 20 streams for ports 5 and 6 set up earlier:

- Transmit Setup: **Continuous** Mode, **9.6** usec interpacket gap for 100% utilization
- Frame length for all streams: **60**

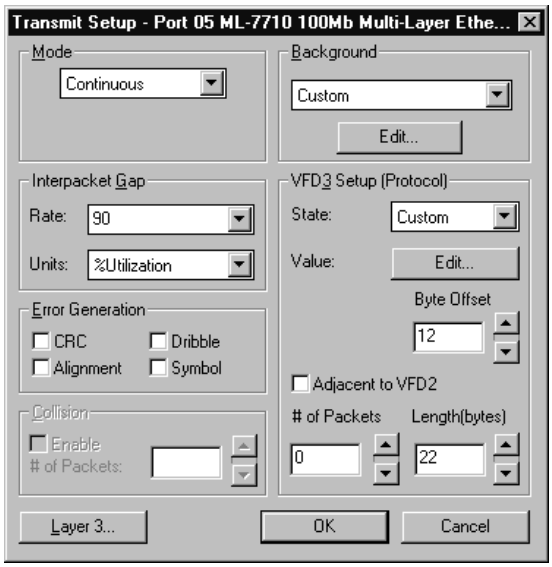
1. Select Actions menu **Layer 3 Send ARP Requests**.
2. Click **Start** on port 5 SmartCard. Note the green transmit LED on port 5 and the green receive LED on port 6.
3. To see data from the transmitted traffic from port 5 to port 6, click Options menu **Layer 3 Tests**.

Sequence Tracking

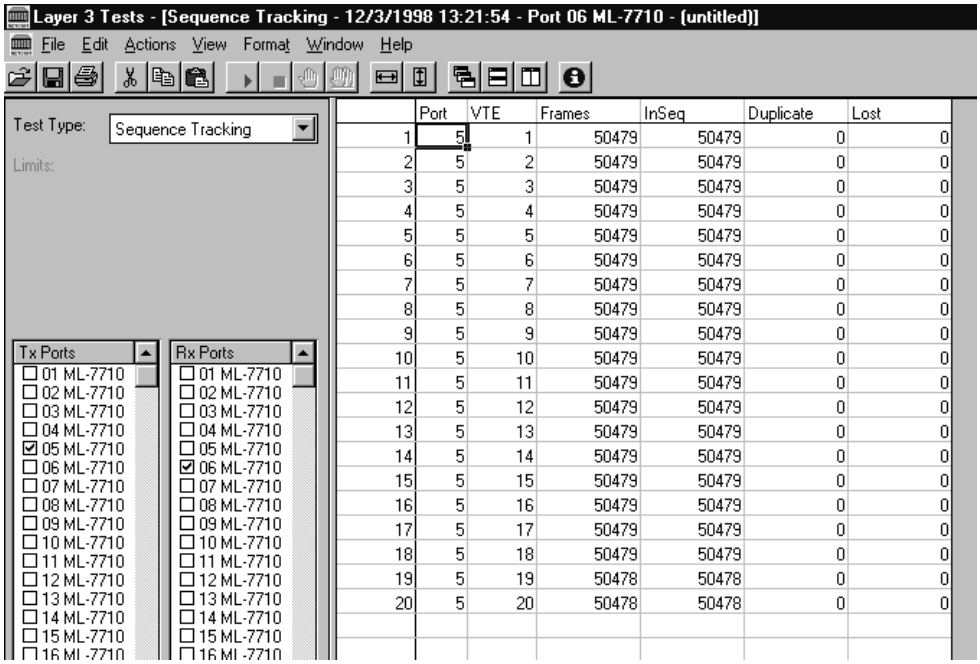
4. Select Test Type S**equence Tracking** test, select checkboxes for Tx Port **05** and Rx Port **06**, then click **Start** button at the bottom of the window. After several seconds, click **Stop** button. Then click **Results** button and select the receive card, port 06.



5. To set a lighter load and determine the rate at which there is little or no packet loss, click the port 5 SmartCard, select **Transmit Setup**, and click **This Port** button. From the pulldown menu for Interpacket Gap, select **% Utilization** and enter **90** in the Rate box. Click **OK**. Click **OK** again and close the Transmit Setup window. Click **Start** on the port 5 SmartCard to transmit traffic and view the Sequence Tracking.



6. After a few more test runs, the 80% load produced the following sequence tracking. You may wish to repeat this test a number of times over a period of time to track the consistency of the router and potential interruptions during the same and different loads, with increased or decreased number of streams, with varied frame lengths (either fixed or random).



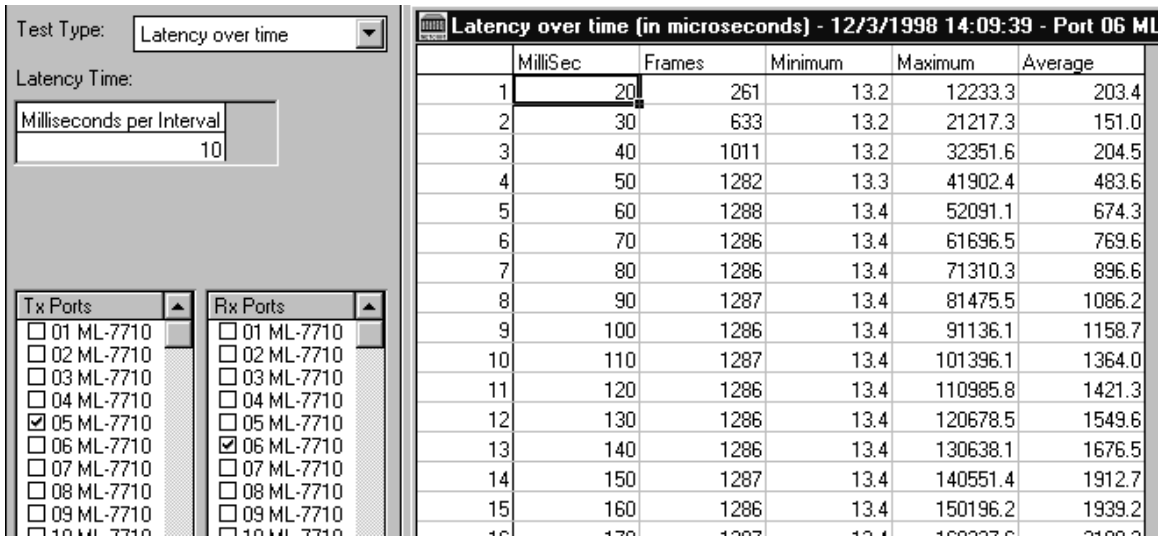
	Port	VTE	Frames	InSeq	Duplicate	Lost
1	5	1	50479	50479	0	0
2	5	2	50479	50479	0	0
3	5	3	50479	50479	0	0
4	5	4	50479	50479	0	0
5	5	5	50479	50479	0	0
6	5	6	50479	50479	0	0
7	5	7	50479	50479	0	0
8	5	8	50479	50479	0	0
9	5	9	50479	50479	0	0
10	5	10	50479	50479	0	0
11	5	11	50479	50479	0	0
12	5	12	50479	50479	0	0
13	5	13	50479	50479	0	0
14	5	14	50479	50479	0	0
15	5	15	50479	50479	0	0
16	5	16	50479	50479	0	0
17	5	17	50479	50479	0	0
18	5	18	50479	50479	0	0
19	5	19	50478	50478	0	0
20	5	20	50478	50478	0	0

After approximately 1 second, the latency dropped to a reasonable level. A possible cause of this change is the use of a Fast Path mechanism.

The remaining tests are run at the 80% utilization rate with the same switch.

Latency Tests

7. Select Test Type **Latency over Time**. Click **Start** button, run for a few seconds, then click the **Stop** bottom. Click **Results** button and select the receive port 06.



Latency over time (in microseconds) - 12/3/1998 14:09:39 - Port 06 ML

	MilliSec	Frames	Minimum	Maximum	Average
1	20	261	13.2	12233.3	203.4
2	30	633	13.2	21217.3	151.0
3	40	1011	13.2	32351.6	204.5
4	50	1282	13.3	41902.4	483.6
5	60	1288	13.4	52091.1	674.3
6	70	1286	13.4	61696.5	769.6
7	80	1286	13.4	71310.3	896.6
8	90	1287	13.4	81475.5	1086.2
9	100	1286	13.4	91136.1	1158.7
10	110	1287	13.4	101396.1	1364.0
11	120	1286	13.4	110985.8	1421.3
12	130	1286	13.4	120678.5	1549.6
13	140	1286	13.4	130638.1	1676.5
14	150	1287	13.4	140551.4	1912.7
15	160	1286	13.4	150196.2	1939.2

An ideal switch would slightly increase latency for a short time; latency would remain constant for most of the test, then decrease as the ML-7710 stops transmitting. An increasing latency from start to finish indicates that the switch cannot handle the load for long sustained periods. As the latency

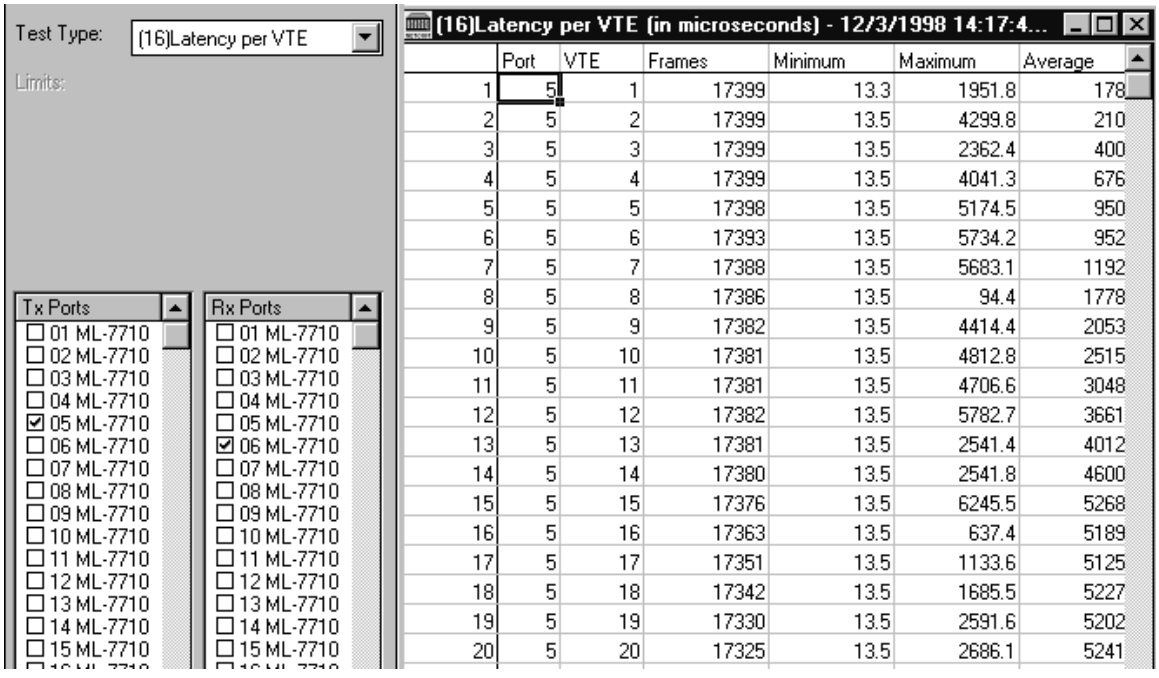
increases, the switch buffers more frames. A spike in the latency indicates a problem with buffer scheduling and warrants more investigation.

Latency over time (in microseconds) - 12/3/1998 14:09:39 - Port 06 ML

	MilliSec	Frames	Minimum	Maximum	Average
107	1080	1286	13.4	1044798.1	14579.9
108	1090	1287	13.4	1053946.6	13878.2
109	1100	1272	13.4	1055081.4	2501.5
110	1110	1269	13.4	14.2	13.7
111	1120	1269	13.4	14.2	13.8
112	1130	1269	13.4	14.1	13.7
113	1140	1269	13.4	14.2	13.8
114	1150	1269	13.4	14.1	13.7
115	1160	1269	13.4	14.2	13.7
116	1170	1269	13.4	14.2	13.8
117	1180	1269	13.4	14.1	13.7
118	1190	1270	13.4	14.2	13.8
119	1200	1268	13.4	14.1	13.7
120	1210	1270	13.4	14.2	13.8
121	1220	1269	13.4	14.2	13.7
122	1230	1269	13.4	14.2	13.8
123	1240	1269	13.4	14.2	13.8
124	1250	1269	13.4	14.2	13.7
125	1260	1269	13.4	14.2	13.8
126	1270	1269	13.4	14.1	13.7

After approximately 1 second, the latency dropped to a reasonable level. A possible cause of this change is the use of a Fast Path mechanism.

8. Here we now take a closer look at the Latency per VTE. Continue to send traffic. Select Test Type **Latency per VTE**. Click **Start** button, run for a few seconds, then click the **Stop** bottom. Click **Results** button and select the receive port 06. Here again the spikes in latency are apparent.



(16)Latency per VTE (in microseconds) - 12/3/1998 14:17:4...

	Port	VTE	Frames	Minimum	Maximum	Average
1	5	1	17399	13.3	1951.8	178
2	5	2	17399	13.5	4299.8	210
3	5	3	17399	13.5	2362.4	400
4	5	4	17399	13.5	4041.3	676
5	5	5	17398	13.5	5174.5	950
6	5	6	17393	13.5	5734.2	952
7	5	7	17388	13.5	5683.1	1192
8	5	8	17386	13.5	94.4	1778
9	5	9	17382	13.5	4414.4	2053
10	5	10	17381	13.5	4812.8	2515
11	5	11	17381	13.5	4706.6	3048
12	5	12	17382	13.5	5782.7	3661
13	5	13	17381	13.5	2541.4	4012
14	5	14	17380	13.5	2541.8	4600
15	5	15	17376	13.5	6245.5	5268
16	5	16	17363	13.5	637.4	5189
17	5	17	17351	13.5	1133.6	5125
18	5	18	17342	13.5	1685.5	5227
19	5	19	17330	13.5	2591.6	5202
20	5	20	17325	13.5	2686.1	5241

The 20 streams are summarized with the minimum, maximum, and average for each stream. The latency range is relatively wide.

9. With the traffic still running, select Test Type **Latency Distribution**. Click **Start** button, run for a few seconds, then click the **Stop** bottom. Click **Results** button and select the receive port 06. Here the latency has dropped dramatically, to the later low level shown in step 7, so that the 13.4 to 14.2 msec shows consistently under the 20 msec time interval.

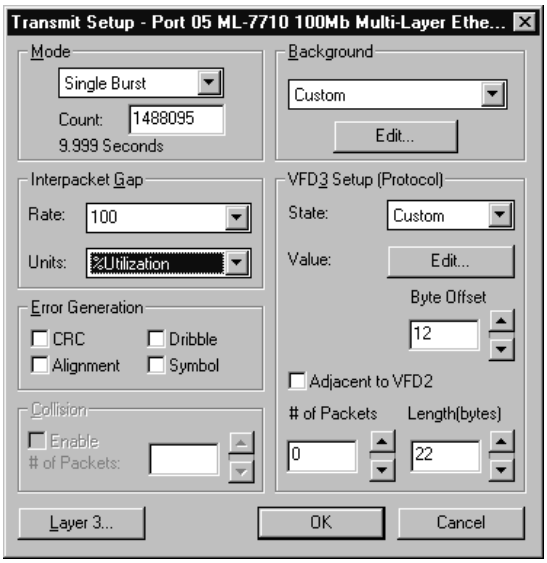
(16)Latency distribution (in microseconds) - 12/3/1998 14:22:54 - Port 06 ML-7710 - LATDIST.XLS

	Frames	<=0.1	<=0.2	<=0.5	<=1.0	<=2.0	<=5.0	<=10.0	<=20.0
1	1309085	0	0	0	0	0	0	0	1309034
2	1309081	0	0	0	0	0	0	0	1309011
3	1309077	0	0	0	0	0	0	0	1308990
4	1309062	0	0	0	0	0	0	0	1308931
5	1309056	0	0	0	0	0	0	0	1308910
6	1309079	0	0	0	0	0	0	0	1308987
7	1308990	0	0	0	0	0	0	0	1308816
8	1308915	0	0	0	0	0	0	0	1308732
9	1308897	0	0	0	0	0	0	0	1308711
10	1308884	0	0	0	0	0	0	0	1308690
11	1308779	0	0	0	0	0	0	0	1308577
12	1308776	0	0	0	0	0	0	0	1308561
13	1308664	0	0	0	0	0	0	0	1308437
14	1308654	0	0	0	0	0	0	0	1308418
15	1308642	0	0	0	0	0	0	0	1308399
16	1308553	0	0	0	0	0	0	0	1308304
17	1308534	0	0	0	0	0	0	0	1308286
18	1308519	0	0	0	0	0	0	0	1308268
19	1308501	0	0	0	0	0	0	0	1308250
20	1308487	0	0	0	0	0	0	0	1308238

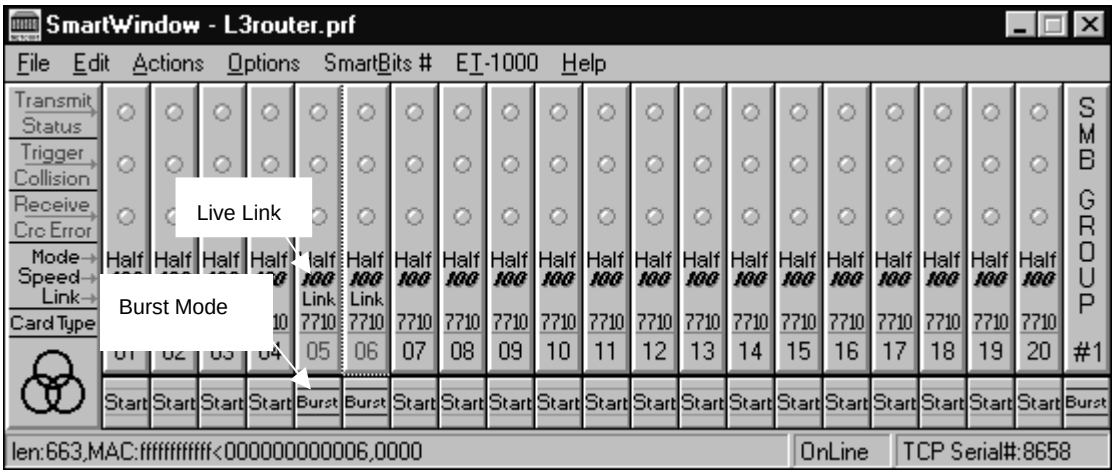
Procedure 9: Inspecting Raw Packets

To look closely at the content of the last 131,000 packets received, you use the Options menu Layer 3 Tests command and the Test Type **Raw Packet Tags**.

1. Here you may wish to try full wire rate in burst mode. To do this, click the port 6 SmartCard, select Transmit Setup, and click **This Port** button. Set mode to Single Burst and Interpacket Gap to 100% utilization which will create a 10-second burst at full wire rate. Click **OK**.



Note that the two active ML-7710 SmartCards show the live Link status and the Burst mode.



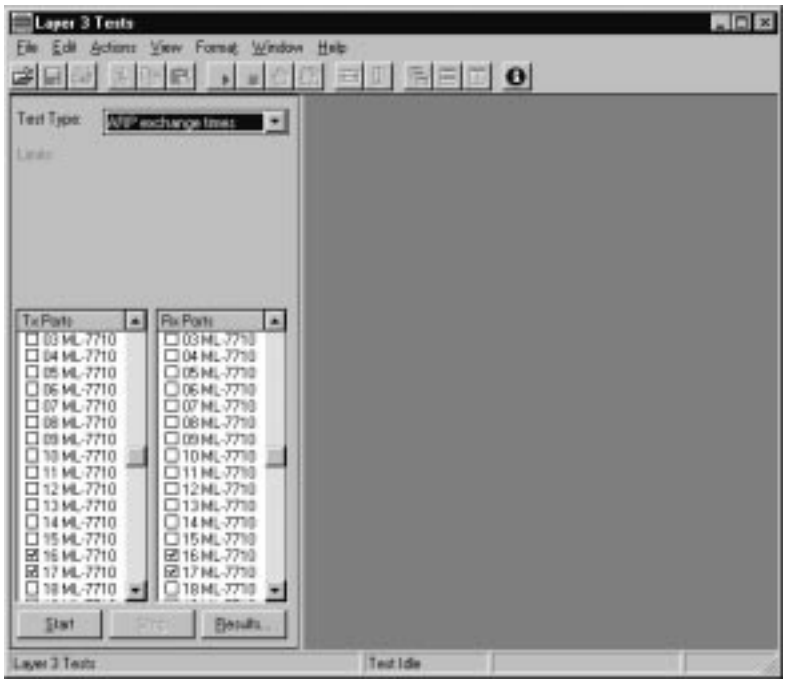
2. Click the **Start** button on the port 5 SmartCard.
3. Now select Options menu **Layer 3 Tests** command and the Test Type **Raw Packet Tags**.
4. Click the **Start**, **Stop**, and **Results** buttons to view raw packets in detail.

Procedure 10: Viewing ARP Response Times

It can be helpful to look at ARP response times which may vary with traffic load, time of day, and the characteristics of each switch. The ARP response times also confirm that all ports are sending and receiving ARPs properly.

To perform an ARP exchange and view the ARP response times:

1. Select the Options menu **Layer 3 Tests** command.
2. From the Test Type pulldown menu, select **ARP exchange times**.
3. Click on ports 16 and 17 for Tx and Rx Ports. Each port will send ARPs to the DUT and receive an response time for each stream.



4. Click the **Start** button. After a few seconds, click the **Stop** button.
5. Click the **Results** button and select port 16 results. Then click port 17 results. A separate results window appears for each port.

Procedure 11: Using Triggers and Capture

A trigger is a pattern counting tool which "triggers" a count of any packets holding a specific pattern located inside any of the packets received by the receive SmartCard. You can track one or two triggers per receiving SmartCard in any combination (singly or together).

The pattern is defined:

- in the transmitting SmartCard
- in the Trigger Setup of the receiving SmartCard

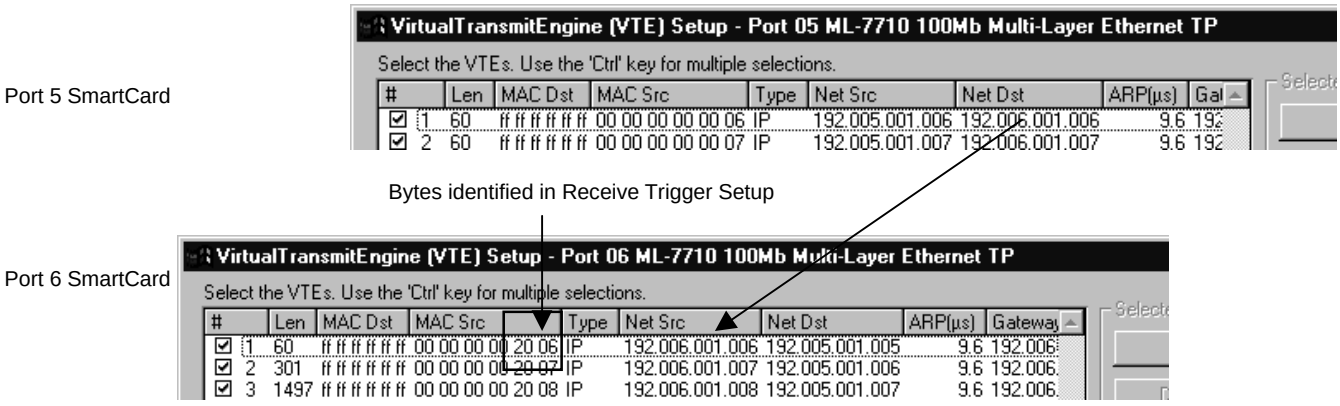
To see the trigger count, you send traffic, click the receive SmartCard, select the **Display Counters** command, and check the Trig counters.

To view details of each triggered packet, you can use one or both of the following methods:

- Select the Options menu **Layer 3 Tests** command, select the Test Type **Raw Packets Tags**, send traffic, and run the test (click **Start, Stop**, and **Results** buttons).
- Click the receive SmartCard, select the **Capture** command, select the **Capture Packets with Rx Triggers**, and send traffic to be captured.

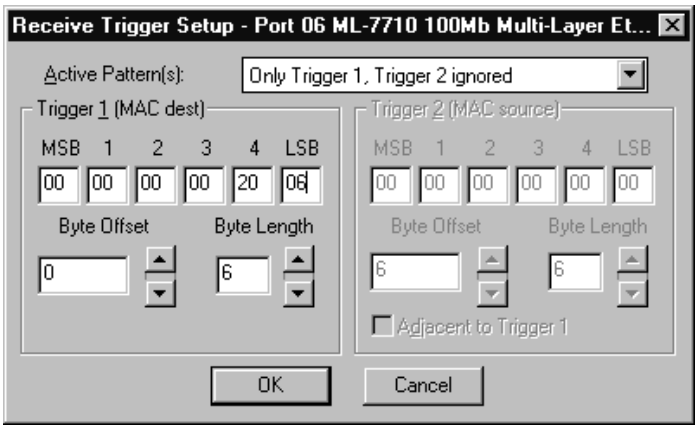
Setting Triggers and Displaying Counters

In the following example, the first stream of port 5 targets the first stream of port 6 (IP address 192.006.001.006 which has the MAC source address 000000002016). In this case, no custom transmit setup is necessary.

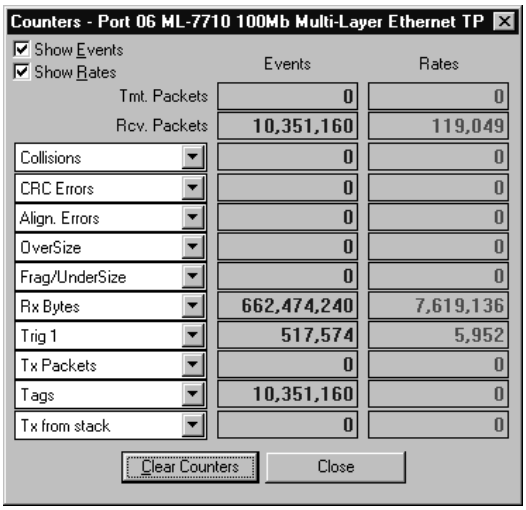


1. Click on the port 6 SmartCard and select the **Trigger Setup** command.
2. Keep the Offset of 0 (for the MAC Destination Address) and the Byte Length of 6.

3. Enter the last 2 bytes of trigger 1: **20 06**



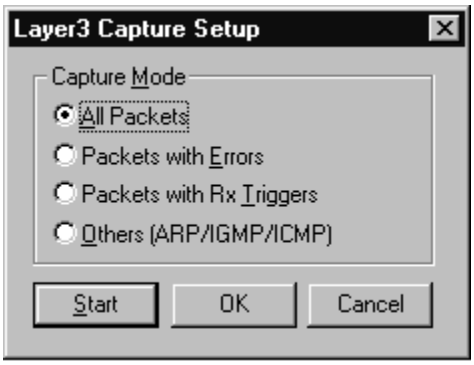
4. Click **OK.**
5. Click the port 6 SmartCard and select the **Display Counters** command.
6. Click **Start** on the port 5 SmartCard to send traffic. Watch the **Trig 1** counters.



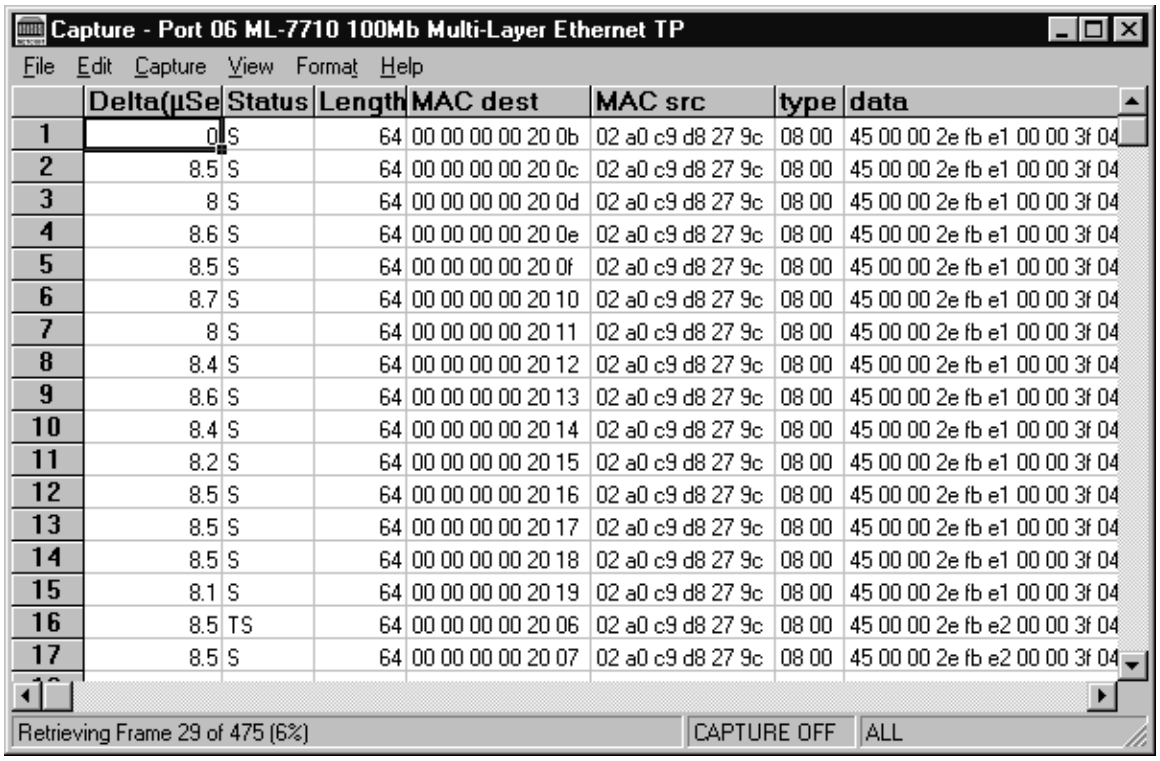
Since Trigger 1 represents stream 1 which is 1/20th of the total traffic sent, the Trig 1 count of **517,574** is close to the expected count of 517,558. The extra triggers may result from a number of causes, including duplicate packets sent, management packets, or counters not cleared.

Capturing Packets

1. To capture packets (up to a maximum of approximately 500 packets) and look at the packet content, click the receive SmartCard, and select the **Capture** command. Keep the setting for **All Packets**.



2. Click the **Start** button on the transmitting SmartCard, and watch the Capture window. Note that all triggers contain the Netcom Systems signature symbol S but that the stream trigger (T) packets are distinguished from all other stream packets.

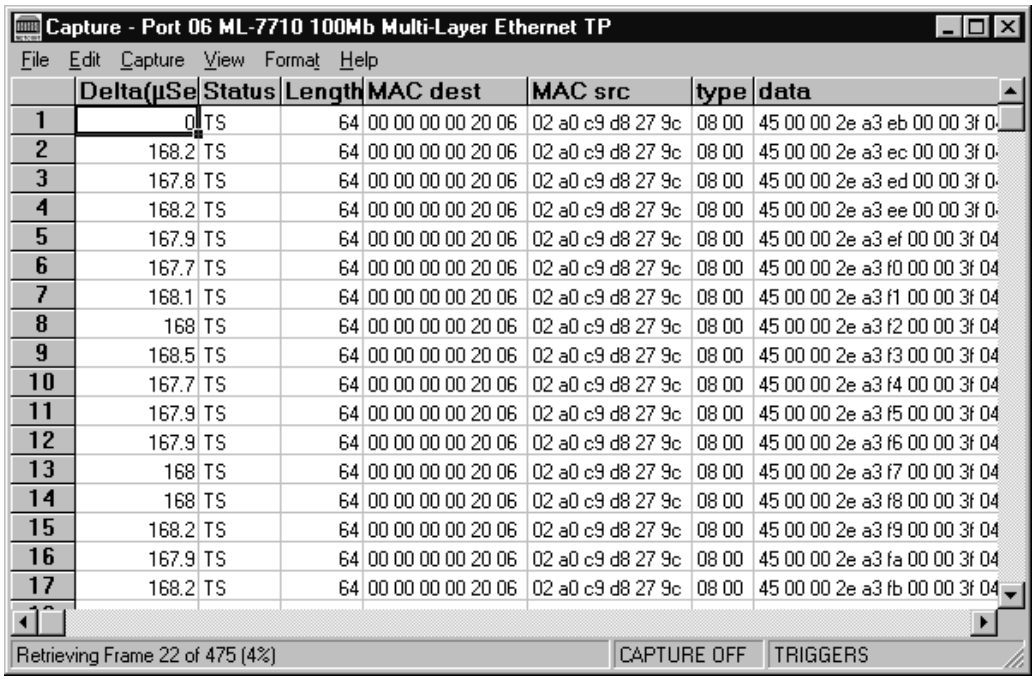


	Delta(µSe	Status	Length	MAC dest	MAC src	type	data
1	0	S	64	00 00 00 00 20 0b	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e1 00 00 3f 04
2	8.5	S	64	00 00 00 00 20 0c	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e1 00 00 3f 04
3	8	S	64	00 00 00 00 20 0d	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e1 00 00 3f 04
4	8.6	S	64	00 00 00 00 20 0e	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e1 00 00 3f 04
5	8.5	S	64	00 00 00 00 20 0f	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e1 00 00 3f 04
6	8.7	S	64	00 00 00 00 20 10	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e1 00 00 3f 04
7	8	S	64	00 00 00 00 20 11	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e1 00 00 3f 04
8	8.4	S	64	00 00 00 00 20 12	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e1 00 00 3f 04
9	8.6	S	64	00 00 00 00 20 13	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e1 00 00 3f 04
10	8.4	S	64	00 00 00 00 20 14	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e1 00 00 3f 04
11	8.2	S	64	00 00 00 00 20 15	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e1 00 00 3f 04
12	8.5	S	64	00 00 00 00 20 16	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e1 00 00 3f 04
13	8.5	S	64	00 00 00 00 20 17	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e1 00 00 3f 04
14	8.5	S	64	00 00 00 00 20 18	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e1 00 00 3f 04
15	8.1	S	64	00 00 00 00 20 19	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e1 00 00 3f 04
16	8.5	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e2 00 00 3f 04
17	8.5	S	64	00 00 00 00 20 07	02 a0 c9 d8 27 9c	08 00	45 00 00 2e fb e2 00 00 3f 04

Packet Status codes are:

A	Alignment	T	Trigger
C	CRC	U	Undersize
I	Interframe gap subminimum	V	VLAN tag
S	Signature		

3. Repeat previous steps 1 and 2 but select the Capture **Packets with Rx Triggers** button.



	Delta(µSe	Status	Length	MAC dest	MAC src	type	data
1	0	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 eb 00 00 3f 0
2	168.2	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 ec 00 00 3f 0
3	167.8	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 ed 00 00 3f 0
4	168.2	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 ee 00 00 3f 0
5	167.9	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 ef 00 00 3f 04
6	167.7	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 f0 00 00 3f 04
7	168.1	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 f1 00 00 3f 04
8	168	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 f2 00 00 3f 04
9	168.5	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 f3 00 00 3f 04
10	167.7	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 f4 00 00 3f 04
11	167.9	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 f5 00 00 3f 04
12	167.9	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 f6 00 00 3f 04
13	168	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 f7 00 00 3f 04
14	168	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 f8 00 00 3f 04
15	168.2	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 f9 00 00 3f 04
16	167.9	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 fa 00 00 3f 04
17	168.2	TS	64	00 00 00 00 20 06	02 a0 c9 d8 27 9c	08 00	45 00 00 2e a3 fb 00 00 3f 04

Appendix A
Sending PING, SNMP, and RIP Frames

In the Layer 3 Setup window (see Procedure 3), you can select Ping, SNMP, and RIP traffic to send. The SNMP and RIP frames are static frames based on RFC 1944 and which can be counted in the SmartWindows **Tx from stack** or **Rx to stack** counters.

Typical values are: Ping frequency 10, SNMP frequency 100, and RIP frequency 200.

To set and send a ping, refer to *Procedure 4, Pinging to Check Links*, on page 14.

Appendix B
Editing Frames

In Layer 3 mode, you can edit the packet content *for each byte of a custom VTE* stream or you can edit the valid parameters of a packet set up with a specific protocol.

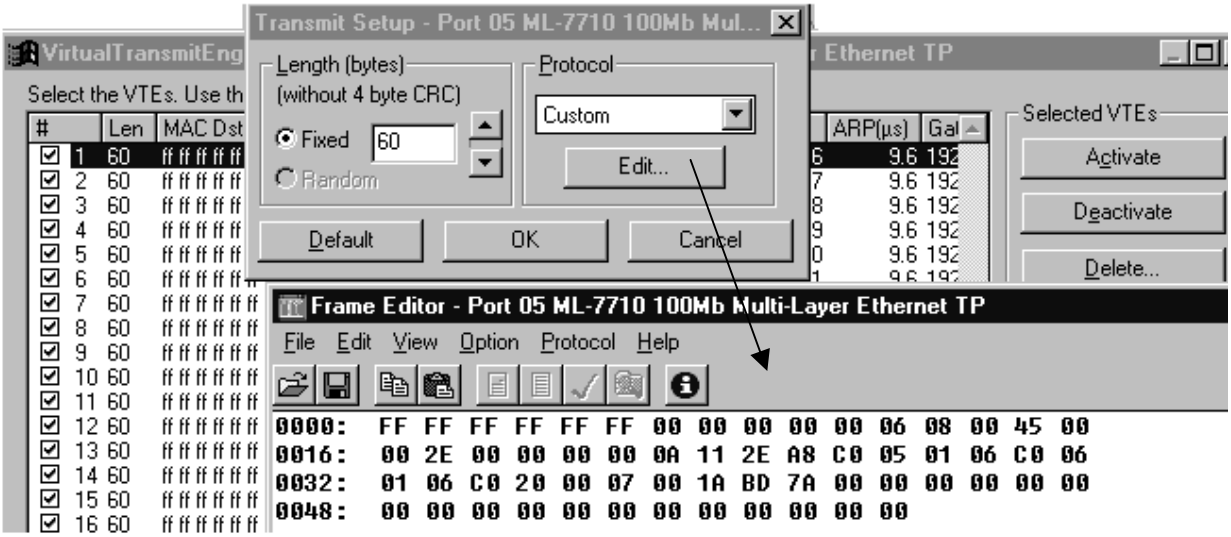
WARNINGS **For a specific protocol such as IP or UDP**, you should only edit the valid protocol parameters.

The last 18 bytes of EACH layer 3 mode stream is RESERVED FOR SMARTBITS usage. Any values inserted into a custom packet in the last 18 bytes will be overwritten.

The Custom packet view-window also allows you to see the byte location of protocol parameters; however, it is important to edit ONLY the parameters specifically set up for that protocol.

Creating Custom Packets

1. Click on the ML-7710 SmartCard and select **Transmit Setup**.
2. Double-click on the VTE stream, set the Protocol type to **Custom**. Click the **Edit** button. Note that there are no parameters assigned to the custom packet bytes.



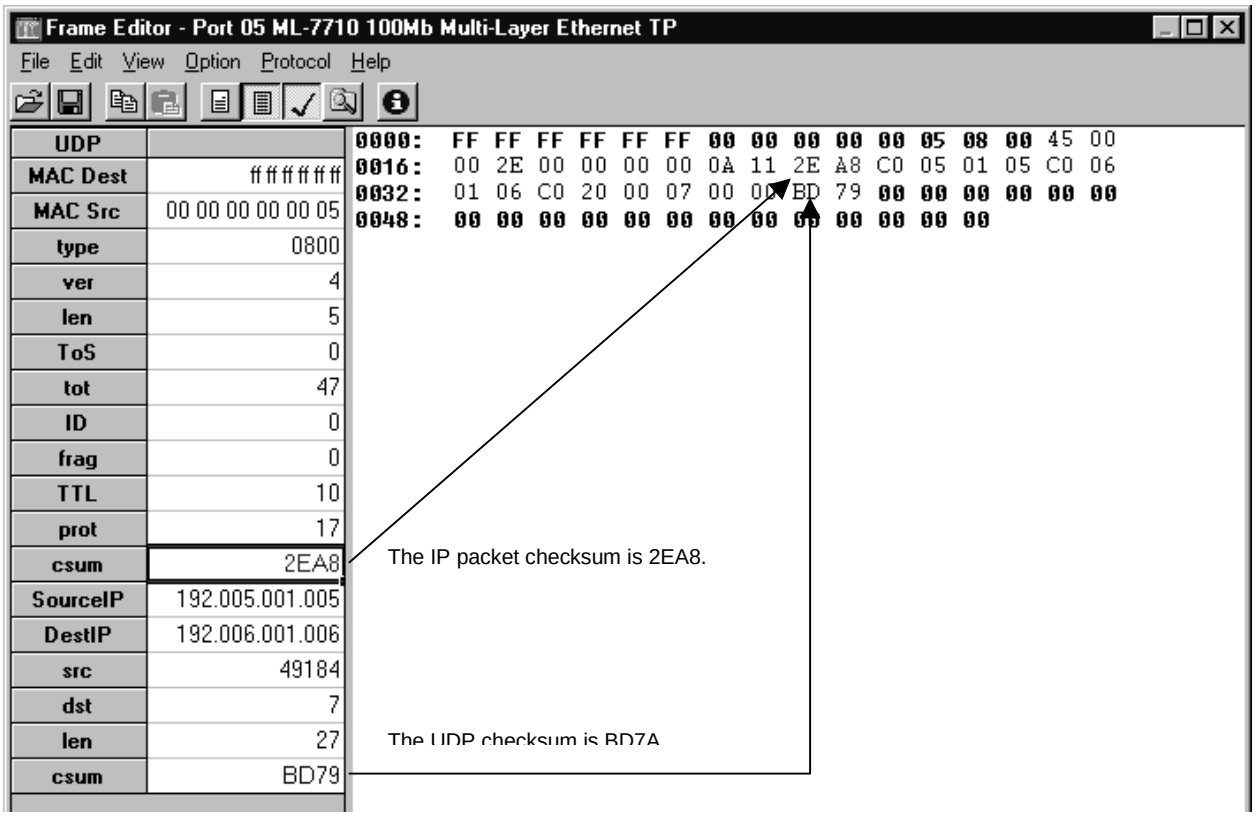
3. Here you can edit the packet contents according to the custom packet you wish to create.
4. Use the File menu **Save As** command to save your parameters to a **.s** (S-Record) file for repeated use. Then click the close-X button. Then **OK**.

Viewing Byte Location of a Protocol Parameter

5. In the Frame Editor window, now select the Protocol menu **IP-UDP** command. The first packet checksum (csum) is for IP and listed first; the second checksum is for the UDP packet.

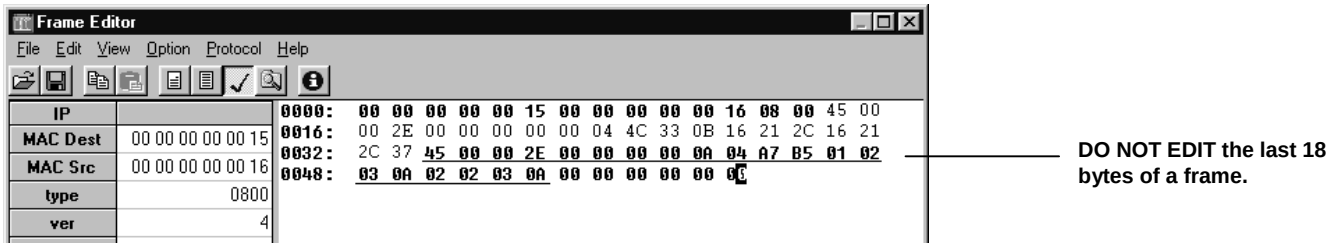
   If you click inside a parameter such as TTL, the number 10 value turns *blue* inside the byte editor area -- so the exact location of specific parameters appears quickly and easily.

UDP Example



Example of what not to do

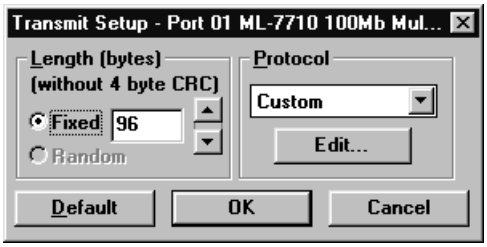
This is an IP packet which has been edited in the underlined section**; SmartBits will overwrite the last 18 bytes of the packet.** This packet should be a custom packet, not an IP packet. To be usable as a custom packet, the frame length would have to be extended to 72 bytes.



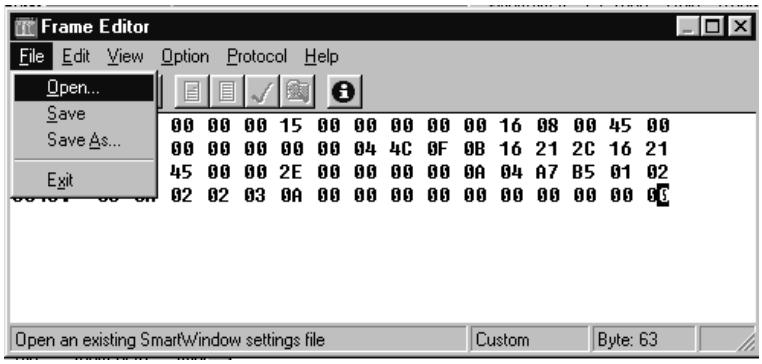
Repeating a custom frame in another stream or card

To insert the protocol data in layer 3 mode (or on another card):

1. Set the length to the same value as the saved file. Select CUSTOM from the protocol field. Click the Edit button.



2. Select **Open** from the Custom frame editor File menu.



3. Select a previously saved file such as **cb_pkt.s**.

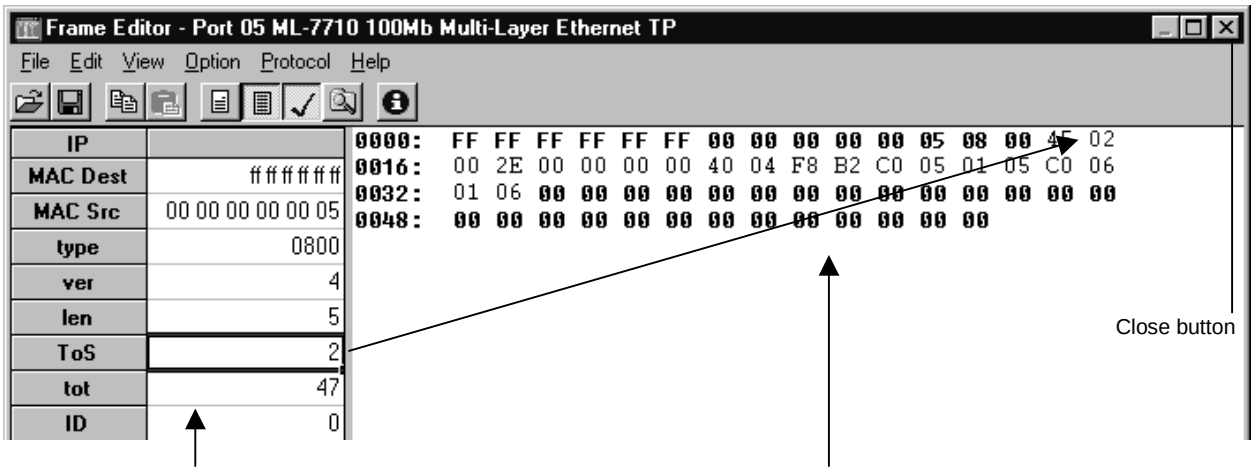
4. Save (File menu **Save As** command), update (Actions menu **Update** command), and transmit (click **Start** command on transmitting SmartCard), as required.

Appendix C
Tips for Testing a Specific Parameter

For example, to test the ToS (Type of Service) parameter, you can set the ToS parameter in the IP packet as a trigger. Then view the SmartCounters for the trigger and/or capture the trigger packets. Note the following sequence.

1. Click on the port 5 SmartCard, select Transmit Setup, and double-click on a VTE IP stream.

2. Select **Custom** as the Protocol, then in the Frame Editor, select **IP** from the Protocol menu. This allows you to VIEW the parameter byte locations on the right side and EDIT valid parameters on the left side.



Parameter Sidebar for editing **Byte Location Area for View-Only**

WARNINGS **For a specific protocol such as IP or UDP**, you should edit ONLY the parameters which appear in the Parameter Sidebar or which appear when you click the Edit button below the protocol entry.

The last 18 bytes of EACH layer 3 mode stream is RESERVED FOR SMARTBITS usage. Any values inserted into a custom packet in the last 18 bytes will be overwritten.

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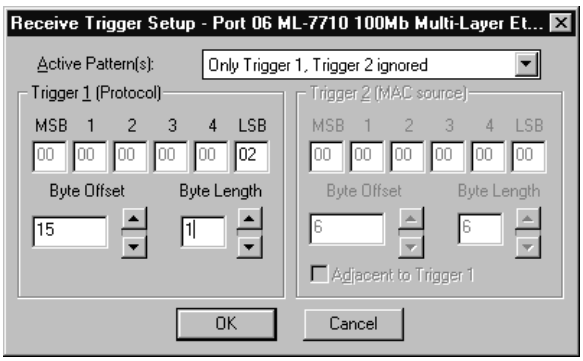
3. Here we edited the ToS field to be type 2, which appears at byte 16 (therefore the offset is 15). Select File menu **Save** command. Click the Close X button. Click **OK**.

4. To set the receive trigger on the port 6 receive card, set the offset to 15 bytes, and enter 02 as the value to set the trigger. Click **OK**.



Then click on the port 6 SmartCard and select the **Capture** command. In the Layer3 Capture Setup window, click on the selection:

- Packets with Rx Triggers

5. Click the **Start** button on the transmitting SmartCard and watch the Capture window.