

Agilent Technologies

ATM Troubleshooting

Application Note 1327

Basic ATM Troubleshooting with the Agilent Advisor



Agilent Technologies

Innovating the HP Way

Contents

Introduction	page 3
How to Use this Application Note	page 3
Overview of ATM Troubleshooting	page 3
Baseline the Network	page 3
Gather initial Information	page 5
Analyze Integrated Diagnosis Functions:	
Operation Logs and OAM-Statistics	page 6
Perform Basic Functional Tests	page 6
Test the ATM Layer and the Application Protocols	
Above	page 7
Detailed Testing Methods	page 7
Troubleshooting the Physical Layer	page 7
Troubleshooting the ATM Layer	page 10
Examine ATM Layer OAM Flows (F4 and F5)	page 10
Verify PVCs, SVC and Addressing	page 12
Monitor to verify existing connections	page 12
Use PINGs to verify PVCs	page 13
Use signaling testing to verify SVCs	page 14
Verify ATM Performance Parameters (QoS)	page 16
Setting up for QoS measurements	page 17
Loopback QoS testing	page 17
End-to-End QoS testing	page 18
QoS results	page 19
Verify Policing Functions and Traffic Contract	
Conformance	page 19
Setting Up a Policing Measurement	page 20
Policing Results	page 20
Troubleshooting Higher Layer Operation	page 21
Test LAN Emulation Functions	page 21
Setting up and running LAN emulation tests	page 21
Monitor PNNI Traffic	page 22
Examine LAN or WAN traffic carried by ATM cells	page 23
ATM Networks; Problem Causes	page 24
Further Information	page 25
Appendix: Select Technical Topics	page 25

Introduction

Asynchronous Transfer Mode's strength lies in its ability to handle virtually any kind of digital traffic (voice, video/images, data) in both a LAN or WAN environment. In addition, ATM provides permanent virtual circuit (PVC) and switched virtual circuit (SVC) capabilities and Quality of Service (QoS) guarantees. But because of these advantages, troubleshooting ATM networks involves unique challenges. While the traditional 'test the layers of the stack' approach can be used, ATM also requires specific test applications in order to adequately examine all aspects of its operation. These include basic network traffic decoding and statistical analysis, SVC signaling tests, LAN Emulation tests, and QoS tests to evaluate cell loss / cell delay and policing functions. This Application Note covers the basics of ATM troubleshooting using the Advisor, and is intended for those who are familiar with ATM technologies but are new to ATM testing.

How to Use this Application Note

The way to get the most benefit from this Application Note is to use it along with the Advisor's online Help. These documents compliment each other in that the high level troubleshooting process is described here, and the low level operational information is presented in the online Help. Other sources of information that can be used in tandem with this Application Note are the ATM Basics online document (found in the Advisor's Help menu), the Agilent Advisor ATM User's Guide, and other Agilent Application Notes and white papers. Please ask your Agilent representative for this additional information.

Overview of ATM Troubleshooting

This section provides a high level overview of the kinds of testing typically required when troubleshooting ATM networks. Testing strategies differ depending upon network symptoms and measurement goals, and the strategies presented here can be tailored to meet specific needs. More detailed and focused testing methods are presented later in this Application Note.

Baseline the Network

Troubleshooting ATM networks should start - as with any network troubleshooting process - before actual network problems occur. This involves gathering the description of all ATM components in the network including their software and hardware configurations, and the protocols and applications that are in use. In addition, important operation statistics (sorted according to users and applications, and measured over time) such as line utilization, error rates, protocol distributions, and response times should be created on a regular basis. A comparison of this data with data gathered when network problems are detected usually provides valuable hints to the source of the problems.

The comprehensive statistic functions of the Agilent Advisor ATM in combination with Agilent’s Advisor Reporter software provide a unique toolset for this task. To gather baseline data, you can use the Advisor’s statistics log functionality. You set up statistics logs in the Log folder in the Configuration view (Figure 1). You can select the type of statistics you want logged, determine the log interval and period, and set up the log file where the statistical data will be saved.

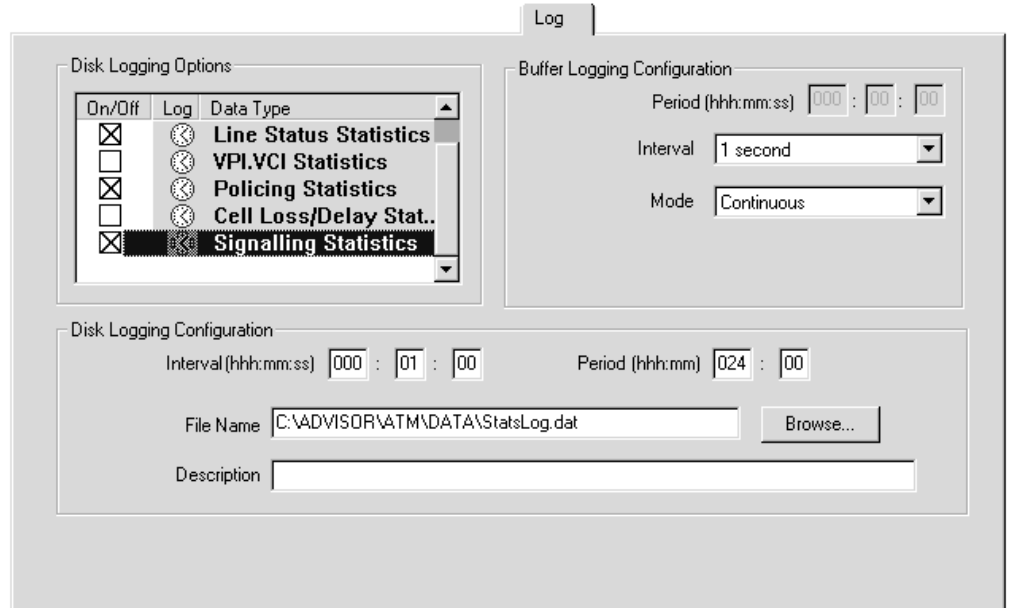


Figure 1. Configuring the Agilent Advisor ATM for long term measurements

Once the measurement is complete, you can open the log file using the Open option in the File menu, and save the file as a comma separated variable (.csv format) file. You can then process this file using the Advisor Reporter software and display it in an easy to understand diagram (see Figure 2). A separate Application Note, Advisor Reporter, is available. Please contact your Agilent representative for more information.

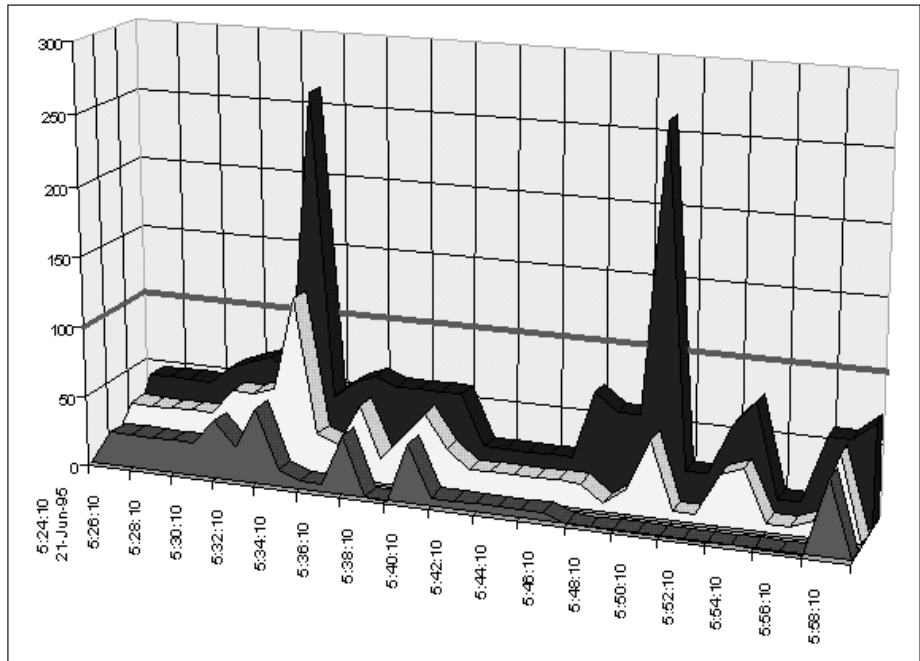


Figure 2. Long term measurement results represented with the Advisor Reporter

Gather Initial Information

At the beginning of any troubleshooting process, and independent of actual protocol analysis or network testing, you need to gather information about problem symptoms and when they occurred, configuration/topology changes, and recent network administrative actions. The more information of this type that you can gather, the probability of solving the problem in a fast and efficient manner is increased. You can also consult the extensive Advisor online Help which contains basic troubleshooting guidelines not only for ATM but for WAN and LAN technologies as well.

Typical questions you ask at this stage are:

- Are the problem symptoms periodic or intermittent?
- Are the symptoms related to certain applications or do they effect any operation on the network?
- Do the symptoms correlate to other activities in the network?
- When was the first occurrence of the symptom?
- Was there any hardware or software change on any component in the network?
- Did anyone connect (disconnect) a PC (laptop or desktop) or any other component to (from) the network? Have there been other changes to any connected workstations?
- Have cables been disconnected or damaged by routine building maintenance or cleaning activities?
- Was there any disruption to the power supply (electrical storms, building maintenance, etc.)?

Analyze Integrated Diagnosis Functions: Operation Logs and OAM-statistics

ATM contains a number of powerful operation and maintenance (OAM) functions. Since ATM is based on a switched architecture and is connection oriented, these integrated monitoring functions are very important because it is no longer possible - as in traditional networks technologies like Ethernet, Token-Ring or FDDI - to monitor an entire network's activity from a single point. Monitoring a single ATM connection delivers information only about the traffic between the two connection endpoints (e.g. an ATM switch port and an ATM computer system). Monitoring and analyzing the data delivered through operation logs and OAM statistics is therefore a necessary step in diagnosing a problem in an ATM network. However, many of today's ATM components support, interpret, or display only a small portion of these diagnosis functions. But with the help of the Advisor's state of the art ATM statistical and decode analysis capabilities, you can look at all five OAM-flows (F1 - F5 OAM - Operation and Maintenance) to see whether they indicate a problem. Physical layer OAM (F1 through F3) and ATM layer OAM (F4 and F5) are discussed in the appropriate sections later in this Note.

Perform Basic Functional Tests

After the analysis of integrated network diagnosis functions and OAM flows, typically you are able to isolate the systems that are affected by the problem. Now you should start the troubleshooting process with basic functional tests. This involves physical layer loopback-tests on the ATM-interfaces, firmware tests (is the firmware active?), and hardware self-tests. The next step is to check cabling and connectors by running bit error rate tests and performing OTDR and LED/laser power spectrum measurements. OTDRs (Optical Time Domain Reflectometers) are test instruments used for physical layer verification of fiber connections. They send defined light pulses over the fiber and measure amplitude and response time of the reflections that return. As a result, fiber length and all attenuation components (splices, connectors, fiber attenuation) along the fiber can be characterized.

Test the ATM Layer and the Application Protocols Above

If the systems pass basic functional tests, you need to start analyzing the ATM layer and the application protocols above it. Typically, you begin by checking whether required PVCs and SVCs are active and correctly operating, and whether ATM routing tables (VPI, VCI) are correct. Then you measure the characteristic ATM layer traffic parameters such as:

- User Cell Rate
- Cell Loss, Cell Loss Ratio
- Cell Delay, Cell Delay Variation
- Cell Misinsertion
- Cell HEC Corrections, Cell HEC Error

This helps you determine whether the traffic contract parameters for the connections or application in question are met. If the ATM layer seems to work properly, you need to check application layer protocols such as Classical IP over ATM, LAN Emulation, or PNNI.

Detailed Testing Methods

This part of the Application Note provides specific testing methods for the topics introduced in the previous sections. Although these methods can be modified to suit your testing requirements, it is a generally a good idea to adhere to the following process:

- Troubleshoot the physical layer
- Troubleshoot the ATM layer
- Troubleshoot higher layers (LAN emulation, PNNI, and non-ATM traffic that has been segmented into cells)

Troubleshooting the Physical Layer

In the vast majority of cases, network troubleshooting begins at the physical layer. If connections are interrupted or network nodes are down, no amount of protocol analysis will solve your problem. To begin, you usually start with basic functional tests of the systems. One method is to loopback the ATM interfaces at the physical layer where you suspect problems might exist and run a basic loopback test. If the test fails, you need to check whether the interface firmware is loaded and the loopback cable is connected correctly. In addition, you can watch the interface's activity LEDs. If these tests are successful, then the ATM interface/firmware is probably operating correctly. You now need to test whether the physical layer between the network interfaces is functional. To perform basic physical layer testing, you can use the Advisor. Connect the Advisor between two nodes such that you can monitor the traffic passing between them. An example is shown in Figure 3, and other connection diagrams are provided in the Advisor's online Help. You have the choice of inserting the analyzer directly into the ATM connection (active monitoring) or connecting it in a passive mode via optical power splitters. Note that the Advisor's OC-3c transmit ports are equipped with single mode lasers. Therefore, if you monitor in a multimode environment, you need to use 10dB attenuators on the transmitters so as to not overdrive the receive electronic of the multimode systems. Overdriving a multimode receiver will not damage it. However, the light from laser transmitters is not completely extinguished for a "0", so sensitive multimode receivers see this as a "1" if an attenuator is not used (resulting in no transitions from "1" to "0" – i.e. effectively no signal).

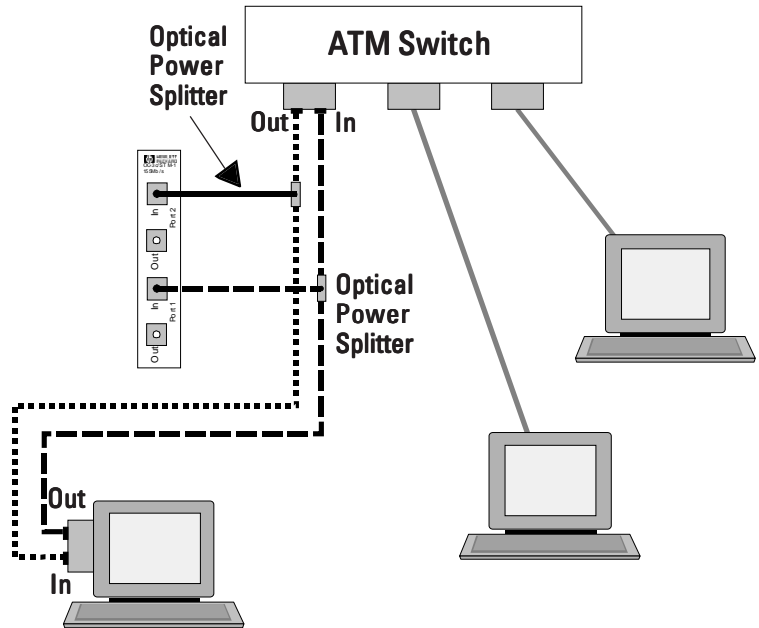
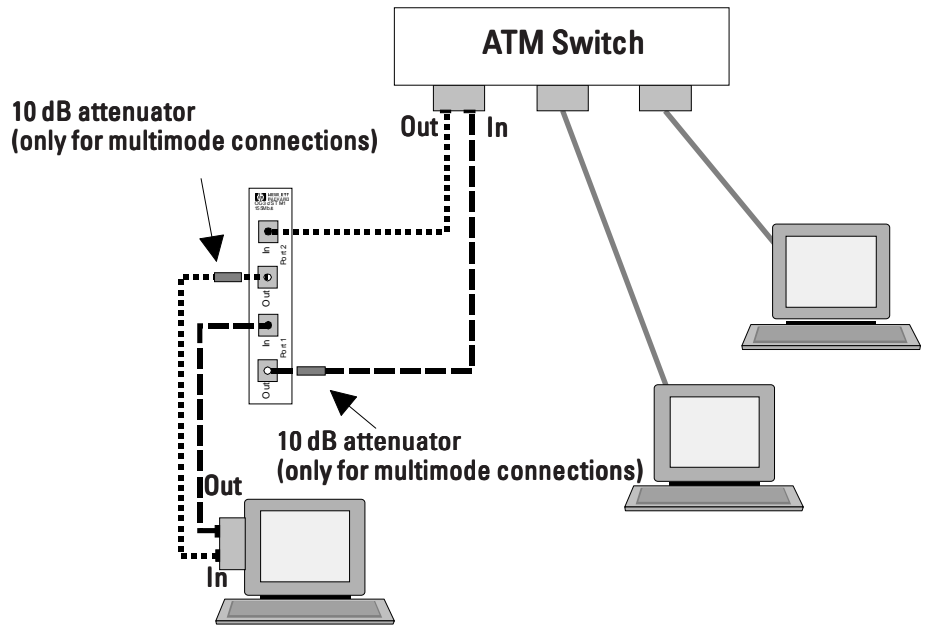


Figure 3. Connecting the Advisor in active and passive monitor mode

To configure the Advisor to monitor, go to the Interface/Protocols folder in the Configuration view, click the Configure button, and set the Run Mode in the physical interface Configuration dialog to Monitor. Start the measurement by clicking the Start tool bar button, and go to the Line Status view (shown in Figure 4) by clicking the appropriate tool bar button. This will give information related to the status of the physical layer. In case of OC-3c/STM-1, the on-screen LEDs Signal, Frame Sync, Cell Sync, AIS, BIP, and Yellow are displayed. If all of these LEDs are green, the physical layer is operating correctly and you can go on to other types of protocol analysis. If one or more LEDs is red, a problem on the physical layer exists. If the Signal LED is red, either no signal or a signal with not enough power is received. You need to check the connections to and from the Advisor, whether you are using the correct cables (single-mode vs. multi-mode), whether the cables are broken, and whether the interfaces of the network nodes are active. If the Signal LED is green, but one or more of the others remain red, the Advisor is not synchronized to the OC-3c/STM-1-frames or the ATM cells. In this case, you need to check the framing and scrambling parameters on your network nodes and on the Advisor. While in the Line Status view, press F1 for online Help related directly to physical measurement parameters.

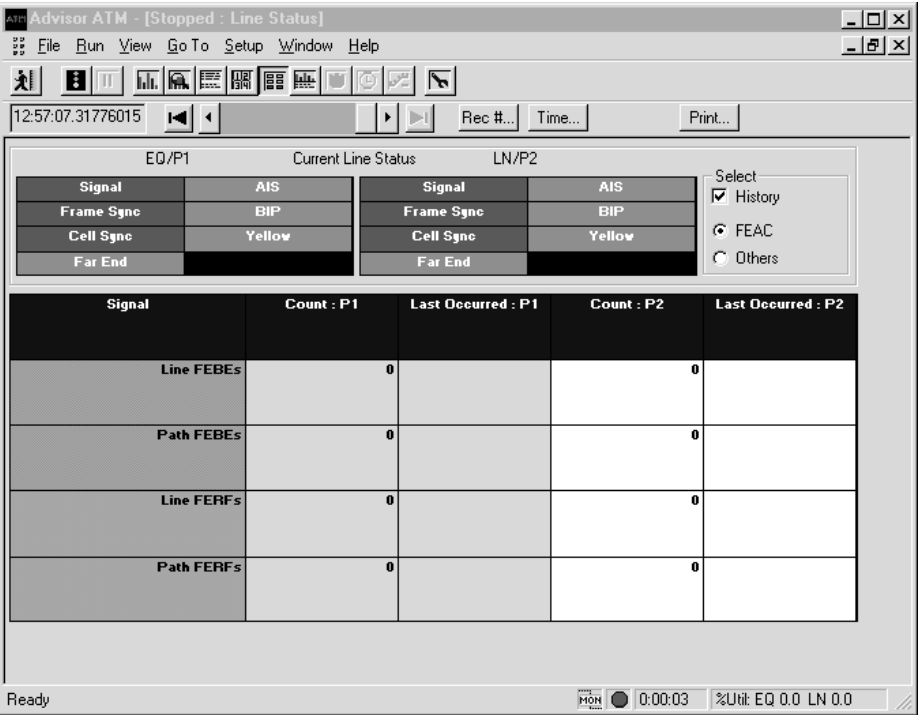


Figure 4. Physical layer alarms and F1-F3 OAM flow statistics in the Line Status view

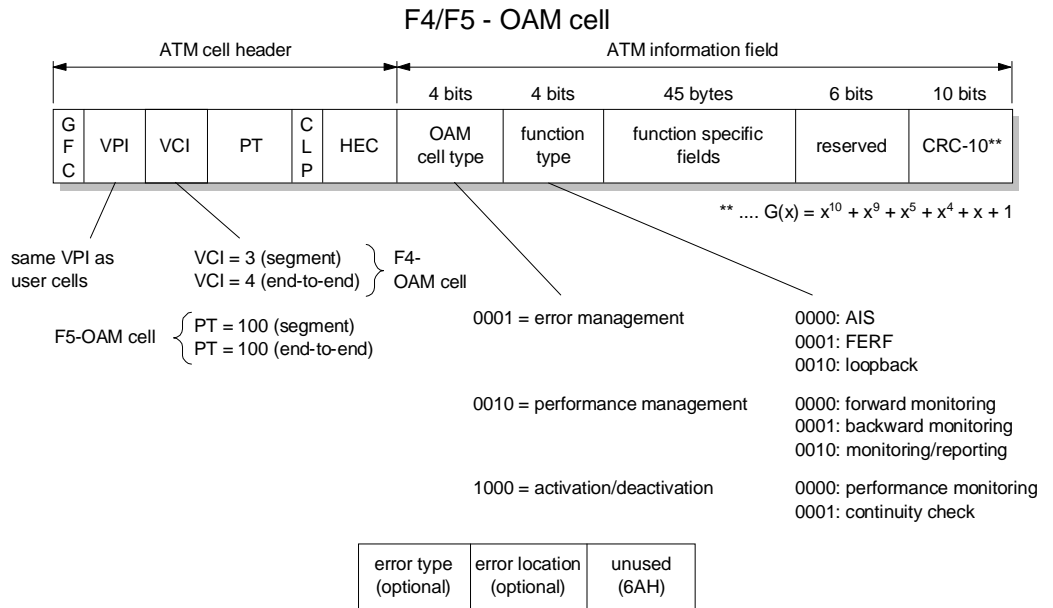
Another important aspect of physical layer testing is the OAM flows (F1-F3) in the transmission layer (SDH, PDH). Again, you can begin by looking at the Line Status view. Figure 4 shows F1-F3 OAM flow statistics such as Far End Block Errors (FEBE) and Far End Receive Failure (FERF) indications for both the line and path levels.

Troubleshooting the ATM Layer

Once correct operation of the physical layer has been verified you can focus your troubleshooting efforts on the ATM layer. Because the ATM layer handles a number of operations and controls some important performance characteristics, this is where protocol analysis really begins. ATM layer troubleshooting is covered in the following sections.

Examine ATM Layer OAM Flows (F4 and F5)

When beginning to troubleshoot the ATM layer, it often makes sense to first examine the OAM cells that handle error and performance management, activation/deactivation, and system management. These F4 and F5 cells (shown in Figure 5) can provide valuable information about the operation status of the network. Error management cells monitor transmission errors, localize them if possible, and report their occurrence to the affected network nodes; ATM layer loop-back cells can also be sent (only these cells are looped back, user cells are unaffected). Performance management cells measure parameters like cell block rate, cell loss rate, or cell misinsertion rate and thus can help you determine the performance of a connection. Activation and deactivation OAM cells are used to start and stop the measurement intervals during which error management and performance management cells are being transmitted. And, finally, system management cells transmit vendor dependent system information between the ATM components in the network.



function specific field of an AIS/RDI error management cell

MCSN	TUC ₀₊₁	BEDC ₀₊₁	TUC ₀	TSTP (optional)	unused	TRCC ₀	BLER ₀₊₁	TRCC ₀₊₁
8 bits	16 bits	16 bits	16 bits	32 bits	29 octets	16 bits	8 bits	16 bits

function specific fields of a performance management cell

BEDC₀₊₁ only used for forward monitoring cellst

TRCC₀, BLER₀₊₁ und TRCC₀₊₁ only used for backward reporting cells

MCSN, TUC₀, TSTP und TUC₀₊₁ used for both types of PL-OAM cells

Figure 5. Format of F4 and F5 OAM cells

To use the Advisor to analyze the ATM layer F4 and F5 OAM flows, you can set up custom filters/counters that will cause the Advisor to capture and gather statistics on only those cells. Go to the Filters/Counters folder in the Configuration view, and click the Add button to add a new filter/counter. When prompted, click No to whether this is to be an AAL-5 PDU filter. When the Filter/Counter Properties dialog is displayed, set the necessary parameters (press F1 for online Help). To configure the filter/counter for OAM flows, go to the ATM folder and set values that correspond to F4 and F5 cells. For example, F4 segment cells are always transmitted on VCI 3, F4 end-to-end cells on VCI 4. F5 cells, on the other hand, are identified through the Payload Type field (PT). PT 100 identifies F5 segment cells, PT 101 F5 end-to-end cells. This set up is shown in Figure 6. When you start the monitor run, statistics related to the filters/counters you set up will be displayed in the Filters/Counters Statistics view.

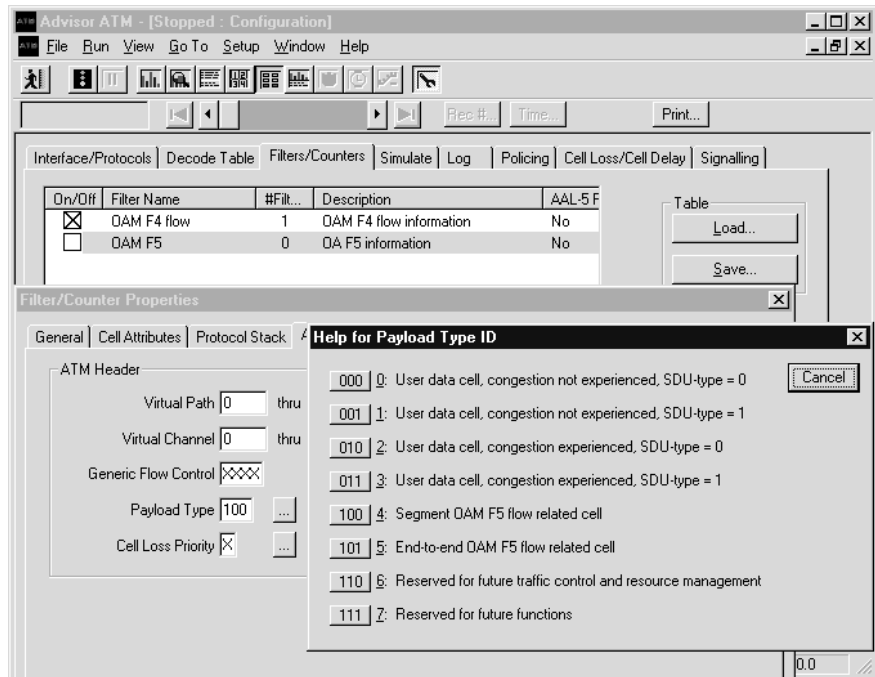


Figure 6. Setup of OAM-F4 and OAM-F5 filters with the Agilent Advisor ATM

Verify PVCs, SVCs and Addressing

The first step to take when troubleshooting the ATM layer is to verify whether ATM connections exist and are functioning correctly. There are a number of ways to do this.

Monitor to verify existing connections

The quickest way to initially verify existing connections is to monitor traffic at key points in your network. If, at a specific point in the network, you are aware of the Permanent Virtual Circuits (PVC) that should exist, you can use the VP.VC Statistics view shown in Figure 7. The VP.VC Statistics view shows the first 12 VP.VCs the Advisor detects, and provides utilization, throughput, and cell/byte count information according to each. If this basic monitor activity does not indicate correct operation, more active measures need to be taken such as PINGs, signaling testing, custom cell-based simulation, and so on. **Note:** the Advisor will also detect VP.VCs associated with SVC set up but will not dynamically update the VP.VC Statistics view when these SVCs are disconnected.

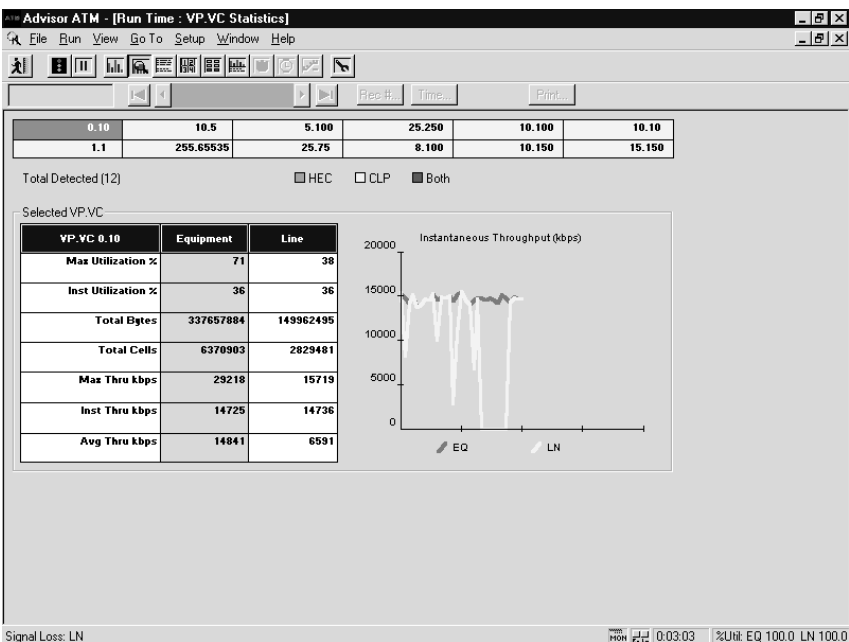


Figure 7. UP.VC. statistics view.

Use PINGs to Verify PVCs

To verify the existence and basic operation of PVCs, you can use PINGs. You can send and receive PINGs from workstations on the network. In addition, you can use the Advisor ATM's PING capability. To do this, go to the Interface/Protocols folder in the Configuration view, click the Configuration button (to open the physical interface Configuration dialog box), and set the Run Mode to Simulation. Then go to the Simulate folder, click the Send Ctrl button to open the Send Control dialog and select Send PINGs in the drop-down list box and define the PING parameters in the ATM PING dialog when it opens (see Figure 8). Press F1 with this dialog open to see online Help related to setting up PING messages. To start the test, click the Start tool bar button in the Advisor's tool bar.

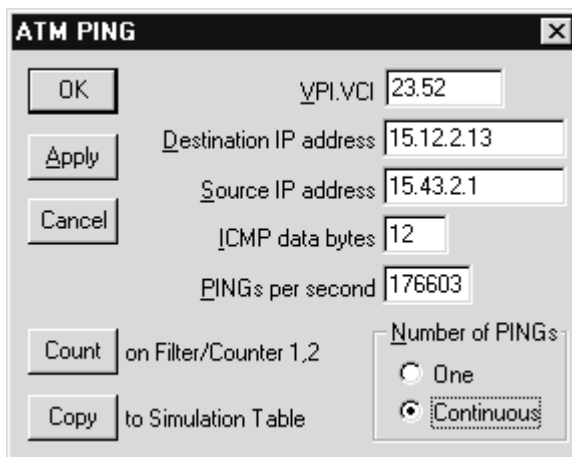


Figure 8. Setup of ATM PINGs for PVC connectivity tests.

If the PING does not get through to its destination, you need to monitor whether the cells leave the switch and arrive at the interface of the destination node. To do this you either watch the port LEDs on the switch and on the destination node, or you monitor and decode the traffic with a second Advisor.

To decode the ATM traffic in order to see whether PING Requests and Replies are being sent and received, you use the Decode view. With an Advisor connected to the network such that you can monitor traffic between sending and receiving nodes, open the Decode view by clicking the appropriate tool bar button. To make it easier to see the ICMP messages, click the Filter button to open the Display Filter Properties dialog. In the Protocols folder, click the Hide All button and then double-click the LAN item. Now when you start the monitor run, the Advisor will display only the reassembled LAN packets sent over the line it is monitoring and you can easily recognize whether the PING packets are present or not. If no PING packets arrive, check the switch to see if the PVC is set up at all, if the VCI values are configured correctly, and if the internal path between the two switch ports is functioning.

Use signaling testing to verify SVCs

If Switched Virtual Circuits (SVCs) are used on the network under test, you need to check if the signaling process that sets up your connections is operating properly. If PINGs between two SVC nodes cannot get through, the first step is again to check the configuration of the switch and the nodes. Are the nodes registered on the ATM ARP server with the correct ATM and IP addresses? Is the correct address of the ARP server registered on the clients? Is the ILMI stack on the switch and on the clients active? Once these questions are answered, and if the problem still remains, you need to monitor and analyze the signaling process itself with the Advisor.

To do this, make sure the Advisor is connected to the network such that you can perform signaling testing (connection diagrams can be found in the Advisor's online Help). Then, go to the Interface/Protocols folder in the Configuration view, click the Configuration button (to open the physical interface Configuration dialog box), and set the Run Mode to Signaling. Go to the Signaling folder (shown in Figure 9) and select the signaling variant (UNI 3.0, UNI 3.1, UNI 4.0) and direction, and the information elements that the Advisor will use in the SETUP message (the Advisor displays the most common set of required information elements as the default - you can usually use those).

Note: ATM Forum UNI 4.0 signaling is, in most respects, equivalent to ITU-T Q.2931 UNI signaling; there are some additional information elements specified in UNI 4.0 and a few missing for Q.2931, but this is not usually a problem.

Now you can start the test, and set up or release SVCs using the buttons in the Signaling Results view as shown in Figure 10. The Layer 2 connection is set up by clicking the Establish button in the SSCOP Link portion of the view. Once the red down arrow turns into a green up arrow the SSCOP connection is active and you can send the SETUP message using the Send SETUP button. If the SSCOP layer does not come up, it is likely that either the Begin PDU (BGN-PDU) did not get through to the destination system, or the Begin

Acknowledged PDU (BGAK-PDU) did not reach the source system. In this case, the Connection Control Timer (CC Timer) of the SSCOP layer times out and the connection cannot be established. If this occurs, you need to verify whether the SSCOP layers of both systems are operating and are compatible to each other. Remember that there are differences in the SSCOP sub-layers of UNI 3.0 and UNI 3.1, and they are therefore not compatible. However, the ATM Forum UNI 3.1, UNI 4.0, and ITU-T Q.2931 all use the same signaling AAL (as specified in ITU-T Q.2110).

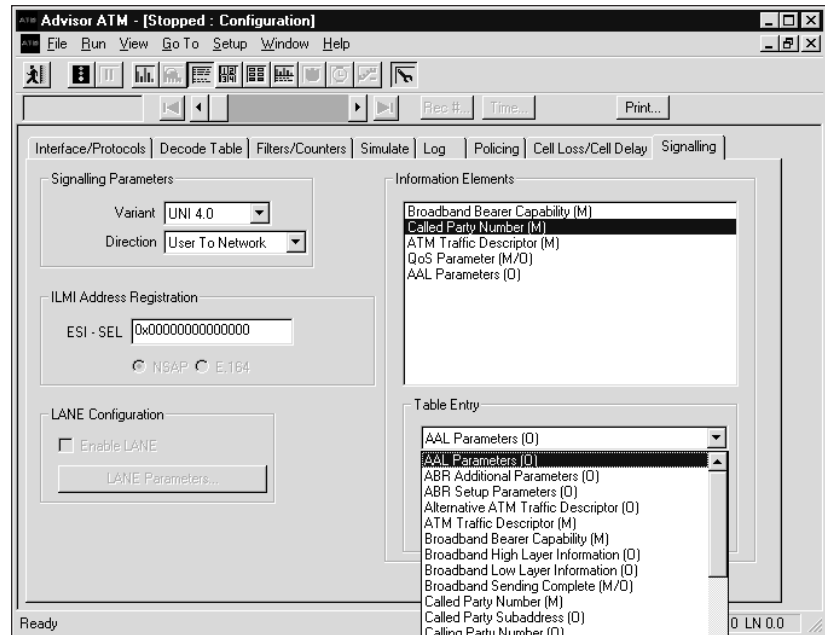


Figure 9. Configuring the Advisor for UNI signalling

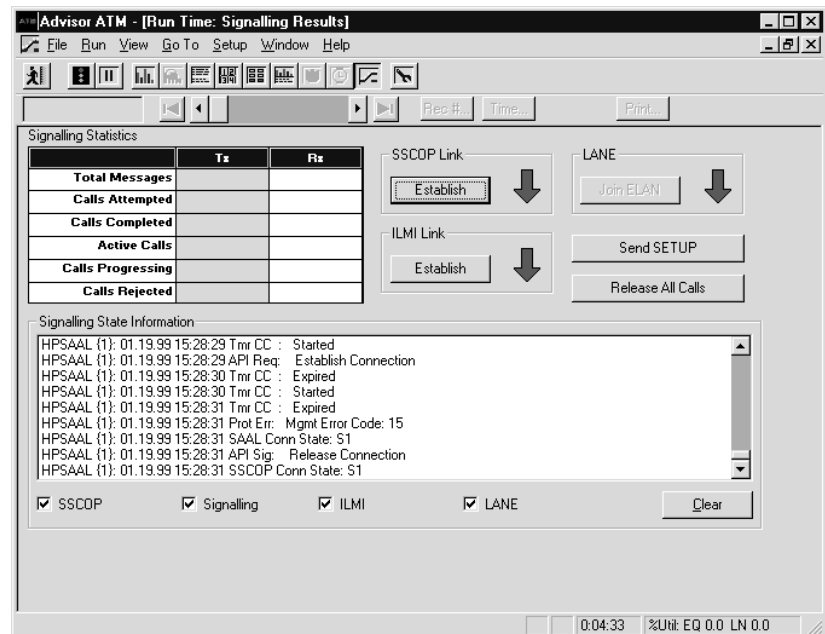


Figure 10. Setting up and releasing SVCs with the Advisor

Once the SSCOP layer is established successfully and the SETUP message is sent, you can watch the signaling states of the connections between the Advisor and the switch in the Signalling State Information portion of the view. In addition, a full decode of signaling messages can be monitored and analyzed in the Decode view.

Verify ATM performance parameters (QoS)

If tests of ATM connections (that is, sending PING messages between two nodes, establishing and disconnecting SVCs, and so on) seem to prove that everything is operating correctly, but problems arise when application data with higher traffic loads is being transmitted, excessive cell loss or cell delay may exist. This could be caused by traffic contracts that provide inadequate bandwidth or by an overloaded switch. Measurements that determine these types of ATM performance parameters - that is, Quality of Service (QoS) measurements - can be made either in-service or out-of-service. Out-of-service measurements are performed with special out-of-service test cells as defined in the ITU O.191 specification and shown in Figure 11.

5 bytes	4 bytes	4 bytes	37 bytes	1 byte	2 bytes
ATM header	sequence number	time stamp	unused	TCPT	CRC-10

TCPT - Test Cell Payload Type

Figure 11. Format of the O.191 test cell

These test cells use standard ATM cell headers, and can be sent using any VPI/VCI address. In the payload they carry a 32-bit sequence number for measuring cell loss and cell misinsertions, and a 32-bit timestamp for measuring cell delay and cell delay variation with a resolution of 10ns. You can use the Advisor to perform these important QoS measurements for permanent virtual circuits relatively quickly.

Setting up for QoS measurements

To test QoS, go to the Interface/Protocols folder in the Configuration view, click the Configuration button, and set the Run Mode in the physical interface Configuration dialog box to Cell Loss / Cell Delay. Now go to the Cell Loss / Cell Delay folder (as shown in Figure 12) and set the Connection parameter to either Loop back or End-to-End (the difference between the two settings is discussed in the two sub-sections that follow). Also set the parameters in the Test Cell Traffic Setup, Background Traffic Setup, and Traffic Contract Parameters portions of the folder. The Advisor's online Help provides more detail on how to set up QoS measurements.

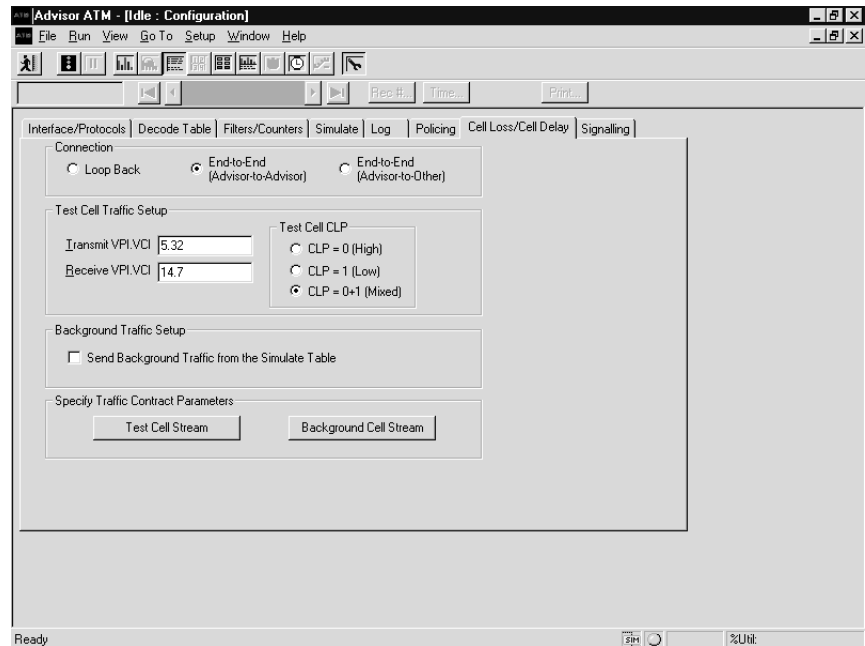


Figure 12. Setting up for cell loss and cell delay measurements

Loopback QoS testing

To perform QoS loopback tests, you connect the Advisor to the transmit and receive points of a switch port (say, port P1). After a PVC between port P1 and another port (for example, P2) is configured, you connect the transmit point of P2 to the receive point of P2. This loops back all traffic sent from switch port P1 to switch port P2 back to port P1. If you want to load all ports of a switch with traffic, you need to set up the loopback connections as shown in Figure 13, but you must be careful to specify the traffic contracts for each connection to allow for the CDV which may be added by each transition of the switching fabric.

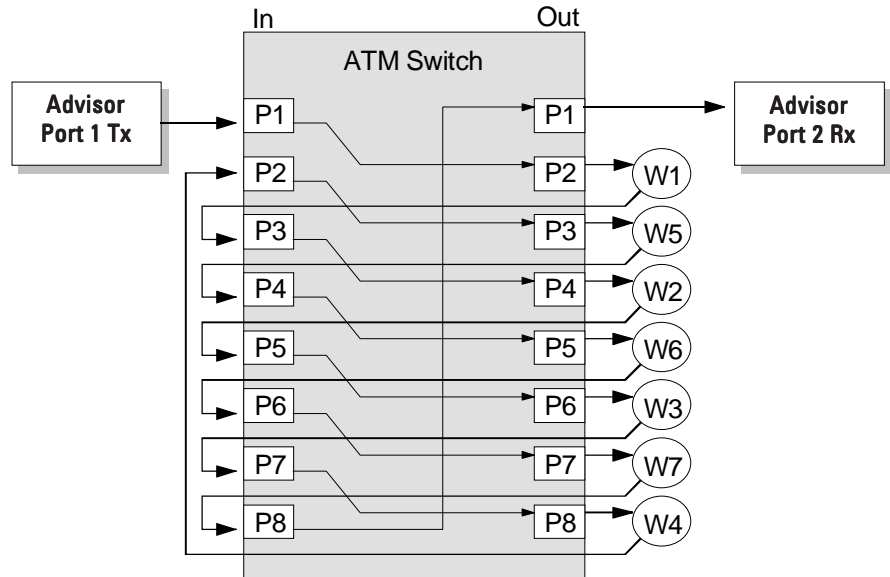


Figure 13. Loadtest-setup for a 8-port ATM switch

End-to-End QoS testing

To test QoS end-to-end (that is, the one-way switching performance of an ATM switch between two different ports without loopbacks), you need to use a second Advisor or another comparable test device.

Note: the Advisor always needs to be connected to both connectors (Tx and Rx) of a switch port, otherwise layer 1 would not become activated. Figure 14 shows an end-to-end connection using two Advisors.

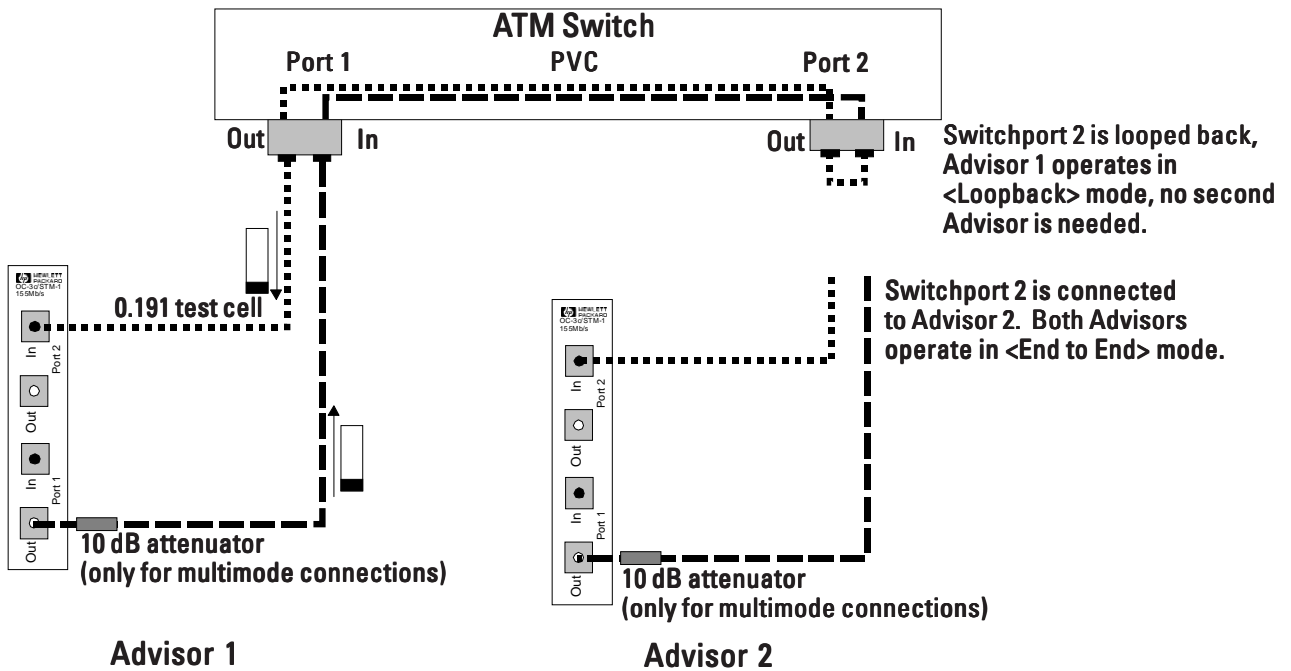


Figure 14. Connecting the Advisor for cell loss and cell delay measurements

QoS results

Once the Advisor is connected and configured, you can start the Cell Loss and Cell Delay measurement. Test results will be shown in the Cell Loss/Delay Statistics view as shown in Figure 15. The most common reasons for lost cells are congestion in the ATM switch or policing action at the user-network interface (UNI). Cell errors are caused by bit errors in the cell payload resulting from physical layer bit errors. The reason for these bit errors is often a higher level of signal jitter than the ATM interface can handle. Cell delays are normally the consequence of non-ATM electronic switching and signal propagation delay, while cell delay variation is caused by the varying fill states of the switch buffers the cells have to pass as they traverse the switch.

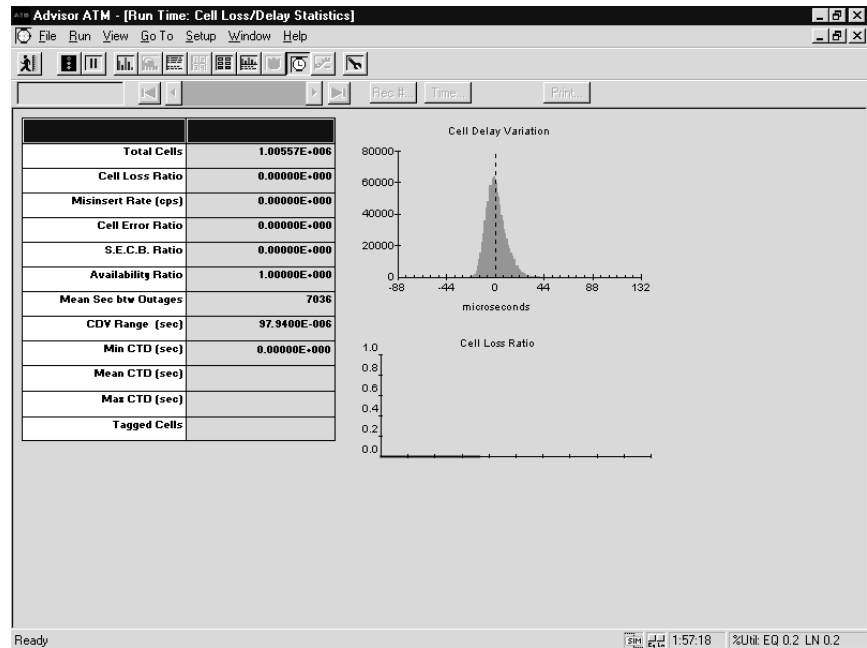


Figure 15. Measuring cell loss and cell delay with the Advisor.

Verify policing functions and traffic contract conformance

Another source of network problems at the ATM layer is the way network traffic is 'policed'. Policing, more formally known as Usage Parameter Control (UPC), takes place when user traffic exceeds the traffic profile (e.g. peak cell rate) defined in the traffic contract. When this occurs, the ATM network, typically via an operation within an edge switch, takes some kind of action to reduce or eliminate the effect of the 'non-conforming' traffic on other 'conforming' traffic. The cells that do not conform to the traffic contract are either marked by setting their cell loss priority field (CLP) from 0 to 1 (the cells are 'tagged'), or are discarded immediately. Systems that support cell tagging will transport tagged cells as long as there is bandwidth available. However, if the link is highly loaded and the bandwidth becomes an issue, tagged cells are the first to be discarded. Because discarded cells contribute to the overall cell loss ratio which, in turn, degrades network performance, it is often necessary to test network traffic to make sure it conforms to the traffic profile.

Setting up a policing measurement

With the help of the Advisor you can easily find out whether the cell stream of a network node or application conforms to the traffic contract. To do this, connect the Advisor such that you can monitor network traffic before it is policed by an edge switch. Then go to the Interface/Protocols folder in the Configuration view, click the Configuration button, and set the Run Mode in the physical interface Configuration dialog to Policing. Now, go to the Policing folder and set the VPI/VCI of the cell stream you want to analyze, and select the Generic Cell Rate Algorithm (GCRA) you want the Advisor to use as it evaluates incoming traffic. There are six: three constant bit rate (CBR/UBR/DBR) profiles and three variable bit rate (VBR/SBR) profiles. You will also need to set specific traffic contract parameters such as Peak Cell Rate (PCR), Sustained Cell Rate (SCR), Cell Delay Variation Tolerance (CDVT), and others. The online Help (F1) contains much more detailed information on these parameters.

Policing results

To start the Policing measurement, click the Start tool bar button. Measurement results will be shown in the Policing Statistics view (shown in Figure 16) - that is, you will see the number of conforming and of non-conforming cells. If one of the traffic profiles which support tagging is selected, the number of cells which would be tagged by the policing function of an ATM switch will also be displayed. Since the Advisor does not actually tag nonconforming cells, the appropriate graph in the measurement window is called Virtual Tagged Cell Count.

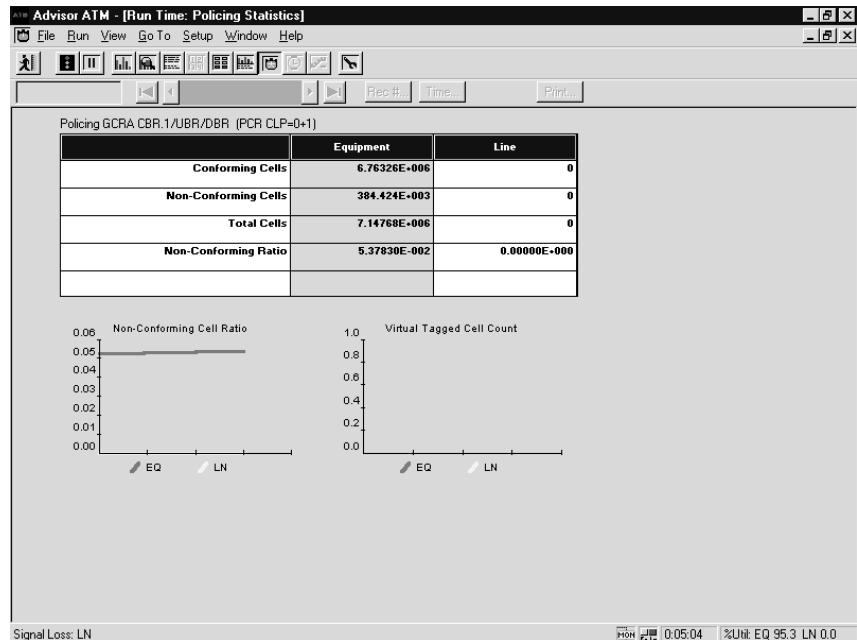


Figure 16. Policing Statistics view.

Troubleshooting Higher Layer Operation

If you have tested the ATM layer and a problem still remains, you need to analyze the higher layer protocols that are in use. Two of the most common higher layer protocols - in addition to UNI signaling which we have already covered - are LAN Emulation (LANE) and the Private Network-to-Network Interface (PNNI).

Test LAN Emulation Functions

If problems in LAN Emulation (LANE) environments occur, the first step is to check whether connected traditional LANs (10/100/1000Mbit/s Ethernet or Token Ring) are operating correctly, as well as the LAN interfaces of your LAN/ATM interworking devices. This includes verifying the various LAN configuration settings and performing basic network statistic measurements with the Advisor's extensive LAN capabilities. Only after the 'pure' LAN portion of your network is shown to be operating correctly, should you start to examine the LAN Emulation components. To examine the network's LANE operations, you first need to send PINGs between two LAN Emulation Clients (LEC) and to see whether a connection can be set up at all. If the PING does not get through, you should check the IP interfaces of the LECs. This involves examining whether IP interfaces are active at all and whether IP-addresses and subnet masks are correct and part of one subnet. The next thing to look at is whether the LANE software on the clients is active, and if both LECs belong to the same ELAN (Emulated LAN). If you do not find an error, you need to systematically check the following configurations via the system management interface of your ATM components:

- Are both LECs registered on the same LES (LAN Emulation Server)/BUS (Broadcast Unknown Server)?
- Is the ATM address of the primary (and, if configured, the secondary) LES correct and are the Configuration-Direct-VCCs setup?
- Is the ATM address of the primary and secondary BUS correct, and are the Multicast-Send-VCCs setup?

Setting up and running LAN emulation tests

The fastest way to find out where the problem originates is to use the Advisor's LAN emulation test capability. Remember, that LANE operation relies on SVC signaling to establish and maintain a number of circuits for the communications between the LAN Emulation Client (LEC) and the LAN Emulation Configuration Server (LECS), LAN Emulation Server (LES), and Broadcast and Unknown Server (BUS). Therefore, to test LANE you need to connect the Advisor such that it can act as a LAN Emulation Client (LEC). Note that for Signaling testing, only Port 1 can be used as the transmitting port. Configure the Advisor for Signaling testing as described in the Verifying PVCs, SVCs, and Addressing section earlier in this Application Note. In the Signaling folder in the Configuration view, set the UNI Variant to UNI 3.0 or 3.1 and the Direction to User-to-Network. Then place a check in the Enable LANE check box, and click the LANE

Parameters button to open the LANE Configuration dialog. Use the online Help (press F1) as a guide to set LANE parameters, and then close the dialog. Go to the Signaling Results view and follow the steps in the online Help to run the Signaling/LANE test to get the Advisor (acting as a LEC) to join the ELAN. During the test, you will be able to see state information in the Signaling State Information portion of the view, and you can see detailed decodes of all signaling messages in the Decode view. **Note:** the Advisor supports LAN emulation active testing for LANE 1.0 (UNI 3.0 or 3.1) only. LANE 2.0 traffic, however, can be fully decoded and displayed in the Decode view.

Monitor PNNI traffic

PNNI (Private Network to Network Interface) is one of the protocols used for SVC connections between two NNI networks (for example, switch-to-switch signaling). It consists of two protocols: the routing protocol, which distributes information about the network topology to network nodes, and the signalling protocol, which is basically an extension of ATM Forum's UNI signaling protocol.

Troubleshooting PNNI problems start with an examination of the UNI signaling functions of the end systems in which the problem might exist. Questions that need to be asked are:

- Are the interfaces of the ATM nodes and switches active?
- Are the signaling versions of all systems compatible (for example, UNI 3.1 vs. 4.0)?
- Are the ILMI and the SSCOP layers active?

If the end systems begin signaling processes that do not finish correctly (That is, result in an established SVC), the next step is to analyze PNNI SVC routing. To do this, you use your ATM equipment vendor's system management interface to read out the PNNI operations log and examine the PNNI routes that are being calculated by the sending node. If the route leads to an incorrect node, an incorrect ATM address is probably the cause. If the switch cannot find a route to the destination at all, you need to check the switch's topology information. If the topology information does not contain the destination node, physical problems in the network or the switch's inability to update its topology database could be the cause. If the sending node finds a route to the destination system, but a connectivity problem remains, it is possible that some traffic parameters are not supported by one of the ATM switches.

Again, the fastest way to determine the problem is to monitor the PNNI messages with the Agilent Advisor. To do this, you insert the Advisor in the transmission path between two switches that use PNNI to communicate between them. Configure the Advisor's Run Mode for Monitor, start the monitor run, and go to the Decode view. To focus on PNNI only, click the Filter button to open the Display Filter Properties dialog. Configure the Display Filter to show only PNNI-Routing and PNNI-Signaling cells. As shown in Figure 17, you can examine the contents of PNNI traffic in Summary, Detailed, or Hexadecimal formats.

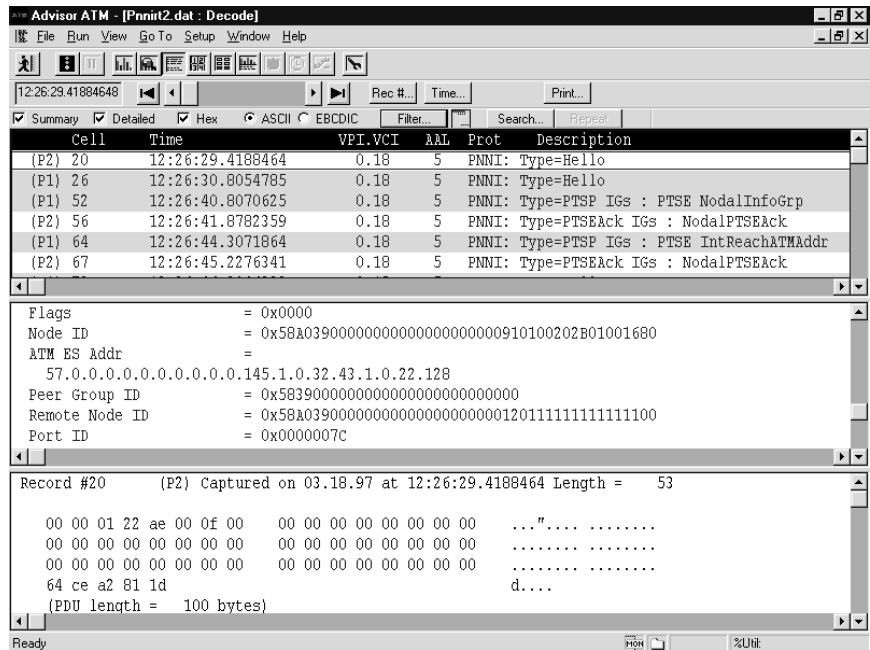


Figure 17. PNNI decode results.

Examine LAN or WAN Traffic Carried by ATM Cells

If all aspects of the ATM network appear to be operating properly, but there still seems to be problems with data transmission or network-based applications, you can examine the LAN or WAN traffic carried by the ATM cells. A comprehensive discussion of troubleshooting at this level in the ATM stack is beyond the scope of this document. However, some useful testing ideas include:

- In most test situations, you can view full LAN and WAN decodes for the traffic segmented into and transported by ATM cells. This traffic is reassembled in the Decode view and can be examined real-time or post-process.
- One of the best ways to examine the details of LAN or WAN traffic is to use the Advisor's AAL-5 search and filter capabilities. Specifically, the Advisor provides support for IP and Frame Relay carried in AAL-5 cells.
- Along with basic LAN and WAN decodes, the Advisor ATM provides for traffic types unique to ATM networks or not normally found on other networks. For example, you may need to decode AAL 1 through AAL 5 traffic, in addition to signaling protocols such as SAAL, Q.SAAL1, and OAM. In addition, network problems might be identified only by examining the details of Multi-Protocol over ATM (MPOA) or MPEG-2 video applications.

ATM Networks: Problem Causes

The following table lists the most common problems in ATM networks in alphabetical order:

ATM interface card broken
ATM interface card misconfigured (interrupts, driver, timer)
ATM port configuration incorrect (bit-rate, scrambling, interface type, frame type - PLCP, G.804, SDH, SONET)
ATM switch port out of order
Cabling problems
Cell streams with low and high priority cells: tagged cells (CLP=1) are discarded
Classical IP: No or wrong ATM-ARP-server address configured on the client system
Electromagnetic interference (ATM over UTP)
Faulty installation (router, switch): cables, connectors, or interfaces are loose, tip-switches are not set, cable-connections on the backplane are missing or not connected right
High signal propagation delay over very long distances
ILMI not active on the client system
ILMI software is incompatible (different software versions)
LANE: ARP entries are wrong (MAC-ATM address mapping is incorrect)
LANE: BUS-VCC (Multicast-Send-VCC) inactive, ATM-BUS-address wrong
LANE: LAN Emulation clients are not part of the same ELAN
LANE: LECs are not registered on the same BUS/LES
LANE: LES-VCC (Configuration-Direct-VCC) is inactive, ATM-LES-address is incorrect
LANE: primary LANE is out of order, secondary LANE is not activated
LANE: requested traffic profiles of the LECs are incompatible
Loose or broken connectors on interface cards, wallplugs, routers, switches
Misconfigured filter settings on the router
Misconfigured protocol settings on the router (address tables, mapping tables, subnetmasks, default gateways, routing tables, timer)
Misconfigured router or ATM-switch (port not active, wrong operation mode, protocol is not active)
PNNI: faulty route selection because of misconfigured ATM addresses
PNNI: Hello-Protocol on the PNNI-interface is inactive or not functioning
PNNI: Peer-Group-Leader configuration error (PGL not active, has no parent LGN)
PNNI: PNNI-address prefixes or short PNNI-addresses (summary-addresses) are incorrect
PNNI: PNNI-port parameter (cell rate , cell transfer delay, bit-rate) are incorrect
PNNI: PNNI-Routing Control Channel (SVCC-RCC) is inactive
PNNI: topology information in the switchport is incomplete
PNNI: Uplinks to Neighbor-Peer-Groups are not configured inactive
PVC not configured, wrong VCIs
Switch buffer capacity too small
Switch is overloaded
Too many switching-nodes within a VCI cause high cell error rate
Traffic contract is exceeded, policing takes place

Further Information

For further information on network troubleshooting, ATM standards, or the Agilent Advisor, please go to the following Web pages:

www.itu.ch

www.atmforum.com

agilent.com/comms/onenetworks

Appendix: Select Technical Topics

This appendix contains a number of brief technical overviews, each related to some aspect of the ATM capabilities mentioned earlier in this Application Note. To learn about basic ATM concepts and its cell structure, or to get more detailed information related to the topics covered in this appendix, please refer to the online ATM Basics (found in the Advisor ATM Help menu), to ATM text books, or to other Agilent Application Note.

Your Agilent representative should be able to help.

Policing, Traffic Shaping, and the Traffic Contract

To make sure traffic entering an ATM network does not exceed traffic contract parameters (ensuring QoS for all users), ATM networks/devices employ two mechanisms, traffic shaping and policing. These operations are defined and agreed upon between network operators and subscribers in the traffic contract. These concepts are briefly discussed next.

Traffic Shaping

Traffic shaping is the method end user ATM devices use to control the traffic that is transmitted onto the network. In return for ensuring that a given user receives the QoS for which they contracted, the network expects end user devices to control the sequence of cells that are sent. Network devices 'shape' traffic by buffering cells, reducing Peak Cell Rates (PCR), limiting burst lengths, queueing cells based on their priority or traffic type, and framing to introduce a more controlled delay variation.

Policing (Usage Parameter Control)

Another method used to ensure QoS is Usage Parameter Control (UPC) also known as 'policing'. Instead of controlling the traffic before it gets to the network (shaping), policing deals with it as it arrives. It does this by evaluating incoming cells to see whether they conform to the traffic contract parameters the user/subscriber has arranged with the service provider. If cells are conforming, they are transmitted onto the network. If they are not, however, they are either discarded or their Cell Loss Priority (CLP) bits are set to 'low priority' which means the cells may still be discarded if they encounter congestion at another point in the network.

The Traffic Contract

The agreement made between subscribers/end-users and network service providers is often called the 'traffic contract'. This term is also used to describe the defining characteristics of ATM traffic that must adhere to certain policing and shaping requirements. Broadly speaking, the traffic contract is defined by traffic profiles (also known as ATM Transfer Capabilities - ATC). These are:

- The ITU-T's Deterministic Bit Rate Transfer Capability (DBR); equivalent to the ATM Forum's Constant Bit Rate (CBR).
- The ITU-T's Statistical Bit Rate Transfer Capability (SBR); equivalent to the ATM Forum's Variable Bit Rate (VBR).
- The ITU-T's ATM Block Transfer Capability (ABT); no ATM Forum equivalent.
- Available Bit Rate Transfer Capability (ABR); supported by both the ITU-T and the ATM Forum.

Depending on the transfer capability type, different traffic parameters are used to define the traffic contract. A DBR/CBR connection, which guarantees a fixed bandwidth, is characterized by the two parameters peak cell rate (PCR) and cell delay variation tolerance (CDVT). The traffic profile SBR/VBR uses Sustainable Cell Rate (SCR) and Maximum Burst Size (MBS). The Sustainable Cell Rate is an upper limit for the average cell transfer rate, which can be exceeded for a short time with traffic bursts up to the Intrinsic Burst Tolerance. In this case the network only has to make bandwidth reservations for the SCR, and not the much higher Peak Cell Rate (PCR), while still being able to guarantee the negotiated cell loss rate. The measurement of the SCR and the MBS is achieved via the Generic Cell Rate Algorithm (GCRA) also known as the 'leaky bucket' algorithm. Finally ATM Block Transfer Capability traffic (ABT) uses the parameter Block Cell Rate (BCR), and ABR uses Minimum Cell Rate (MCR) and Peak Cell rate (PCR). As long as user traffic conforms to the agreed parameters, the network guarantees quality of service (QoS) in terms of cell loss and cell transfer delay (and therefore CDV).

Quality of Service (QoS)

ATM provides a way to guarantee a specific level of service based on the type of traffic a subscriber/user needs to have transported - this is called Quality of Service (QoS). For example, because video or voice traffic is very time sensitive, the cells carrying this traffic must be delivered with a relatively small amount of delay and within a narrow window relative of each other so they can be reassembled in the correct sequence. However, because human perception is somewhat forgiving in terms of quality, some cell loss or excessive cell delay can be tolerated up to a certain threshold. On the other hand, email and file transfers cannot tolerate lost or errored data, but can tolerate a varying amount of transfer delay. These different service needs are the reason for the Classes of Service mentioned in the previous section and for the different segmentation methods used by the Adaptation layers.

To ensure a specific level of service, users/subscribers contract with service providers for a specific QoS. These traffic contracts consist of a number of parameters that define the transmission characteristics of a given cell stream. In general, QoS is defined by:

- Peak Cell Rate (PCR) and Sustained Cell Rate (SCR)
- Cell Delay Variation (CDV) and Cell Delay Variation Tolerance (CDVT)
- Cell Transfer Delay (CTD)
- Cell Loss Ratio (CLR)

Cell streams that adhere to the traffic contract parameters are said to 'conform', while cell streams that exceed these parameters are 'nonconforming' resulting in discarded or tagged cells.

SVC Signaling

Another feature that adds to ATM's flexibility and power is the ability to set up and control switched virtual circuits (SVC) dynamically. To accomplish this, ATM devices must send and respond to signaling messages that request calls, negotiate services, and define QoS parameters. Although many (if not most) ATM networks use permanent virtual circuits (PVC), a significant number are setting up calls and circuits as needed. This signaling process can occur at the User-Network Interface (UNI) or at the Network-Network Interface (NNI). For the most part, ATM's signaling capabilities are defined by the ATM Forum. Signaling uses a number of protocols at the AAL (more specifically, SAAL) and above to control the various aspects of the process. For UNI, these include SSCOP (Service Specific Connection Oriented Protocol), SSCF (Service Specific Coordination Function), and ILMI (Integrated Local Management Interface).

LAN Emulation

One important ATM function that is enabled by SVC signaling is LAN emulation (LANE). LANE allows portions of an ATM network to operate as a virtual LAN so that ATM devices can interact with LAN devices transparently. It also allows LAN-to-LAN bridged connectivity over an ATM network. LANE protocols and processes are defined by the ATM Forum. LANE emulation works by having a LAN Emulation Client (LEC) set up the necessary Switched Virtual Circuits (SVCs) so that communication between it and the emulated LAN can take place. In general (and very briefly), LAN emulation occurs as follows:

- An SVC is set up so that the configuration request and response interchange between the LEC the LAN Emulation Configuration Server (LECS) can occur.
- Another SVC is set up so that join requests can be sent from the LEC to the LAN Emulation Server (LES).
- The Broadcast and Unknown Server (BUS) address is determined, after which an SVC is set up between the LEC and the BUS.
- The emulated LAN (ELAN) is then 'joined' and communication between the LEC and other LECs or LAN nodes can occur.

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- Yes
 No
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What is your time frame to implement this product?

- 30 days 180 days
 90 days Other – (please define) _____

Product(s) of Interest

- The Agilent Advisor** – Integrated, High-Performance Troubleshooting for:
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 ____ Advisor WAN
 ____ Advisor ATM
- The LAN Analyzer** – Scaleable Ethernet and Token Ring Test Solutions
- Telegra Fax Test** – Fax Protocol and Low Generation Analysis
- Telegra Voice Quality Tester** – Detailed Voice Analysis for Clarity, Echo and Delay using
 PSQM and PAMS
- Telegra Voice and Fax over IP** – Protocol Analysis
- FASTest** – Automated Service Verification for PSTN and IP Networks

**What is the main problem you
need to solve on your network?**



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