Aurora Forte ATM OAM Testing

This application note is provided in addition to Application Note 8a and provides additional information concerning the technical operation of ATM OAM functions.

Application Note ANFORTE 08B

Testing the World's Digital Networks

TrendCommunications

ATM Network Operation, Administration Maintenance

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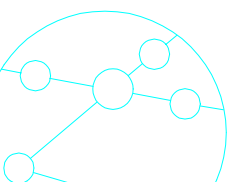
Principles of OAM

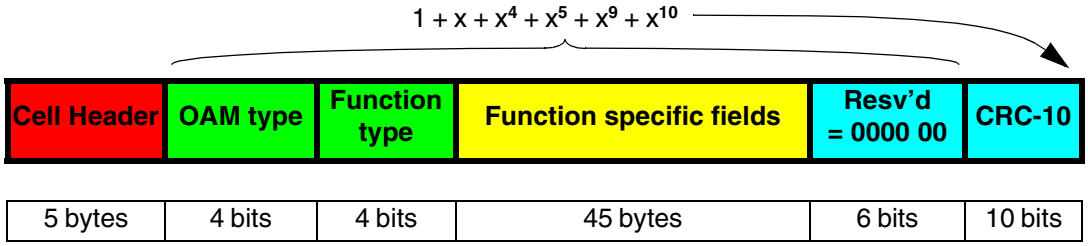
ATM networks provided by public data carriers or large corporations are characterised by multiple switches in different locations with many users connected. It should be considered that the ATM network also includes DSL access networks that are using ATM encapsulation of user data. The ATM cloud will contain many switches that can be connected with multiple possible routes so that protection is provided in the event of link or switch failure. The OAM functions of the network provide the necessary monitoring capability so that the network manager can be informed of the presence of faults and identify the location of both faulty routes and equipment. OAM cells on the ATM layer are an extension of the fault management functions of the physical layer so that on top of physical route protection there is monitoring of the ATM circuits through the network.

The Fault Management layers are summarised in the following table:

OAM Layer	Function	ATM Cell Encoding
F5 end to end	Virtual Channel Connection protection between end points	VCC as user PTI = 101
F5 segment	VCC section between ATM nodes	VCC as user PTI = 100
F4 end to end	Virtual Path Connection protection between terminating switches	VPI as user VCI = 4
F4 segment	VPC section between ATM nodes	VPI as user VCI = 3
F3 Path	End to end transmission path protection	SDH Path overhead
F2 Line	Transmission section protection between switching equipment	SDH Line overhead
F1 Section	Transmission protection of physical links	SDH Section overhead



OAM Format



The OAM cell definition allows a number of functions to be performed:

OAM Type	Coding	Function Type	Coding	Application
Fault Management	0001	AIS	0000	Alarm Indication Signal. Forward indication of faults.
	0001	RDI	0001	Remote Defect Indication. Backward indication of faults.
	0001	Continuity Check	0100	Connection integrity check.
	0001	Loopback	1000	Route tracing and fault location.
Performance Management	0010	Forward performance monitoring	0000	Measurement of the round trip delay on the cellstream. Critical for real time voice or video connections.
	0010	Backward performance monitoring	0001	Measurement of cell arrival jitter. Critical for optimising buffer size so that cell loss and Transfer Delay are acceptable.
ATM Protection Switching Co-ordination Protocol	0101	Group Protection	0000	See ITU-T recommendation I.630
		Individual Protection	0001	See ITU-T recommendation I.630
Activation/De-activation	1000	Control of OAM signals	0000	Performance Monitoring act/de-act
	1000		0001	Continuity Check act/de-act
			0010	Forward Performance Monitoring
System Management	1111			Not standardised

Fault Monitoring Operation

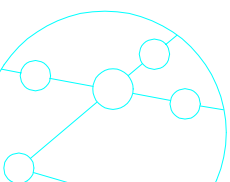
The purpose of OAM functions is to provide indication of user data being interrupted, and of network equipment failing. The most important data path is the F5/VCC end to end (e-t-e) transmission flow of user data, and operators may want a process that provides continuous, real-time monitoring for transmission defects in this path. It is possible that the user application may legitimately halt transmission, in which case the Continuity Check process will provide a 'keep alive' function. The CC process is first activated by a protocol that requests either or both ends of the link to transmit and receive CC cells. The CC cells are sent on the same VCC as the user data at a rate of one per second either continuously, or when there is no user data present. The OAM control function at each node will monitor the user VCC and if there is no data or CC cell for a period (~3 seconds) then a Loss of Continuity (LOC) alarm is issued and e-t-e VC-AIS cells will be sent towards the VCC destination. Each ATM node that receives e-t-e VC-AIS cells will send e-t-e VC-RDI cells in the backward direction. If the network makes use of Location IDs then the AIS and RDI cells can inform the network operator of the ATM node that has originated the fault. This process provides the critical functions of:

- Continuous monitoring of link availability
- Notification to the far end of downstream link failure
- Notification to the near end of upstream link failure
- Indication of the fault location

There is a practical limitation on the number of VCC circuits that may be monitored simultaneously and this limit is determined by each network operator according to the capabilities of the equipment installed in the network.

Segment VC OAM cells allow a network operator to monitor links between ATM nodes, the use of these is determined by each operator. Loopback cells of the Segment type are to be used when discovering the LIDs of ATM nodes along the VCC route; the end to end loopback cell is only used when sending to a F5/VCC termination.

F4/VPC OAM cells are used in a similar way. For instance if the network operator is providing only VP switching for a customer application then the F4/VPC OAM cells may be used to monitor the circuit within the responsibility of the operator. The customer may also use F5/VCC OAM cells to monitor the circuit end to end across their own terminating networks, but the network carrier would not be concerned with this particular flow.



AIS & RDI OAM Cell Format

Additional information may be carried within the cell payload:

Defect type (optional) or = 6Ah	Defect location (optional) or = 6Ah	Not used = 6Ah
1 byte	16 bytes	28 bytes	= 45 bytes

The use of these fields is not standardised.

Loopback Cell Format

Loopback Indication		Correlation tag	Loopback Location ID	Source Location ID (optional)	Source VPI/VCI* (Not used = 6Ah)			Destination VPI/VCI* (Not used = 6Ah)		
0000 000	0/1				0000	VPI(1-12)	VCI(1-16)	0000	VPI(1-12)	VCI(1-16)
1 bytes	4 bytes	16 bytes	16 bytes	4 bytes	4 bytes	= 45 bytes				

Loopback Indication: forward direction = 0000 0001, backward direction = 0000 0000. This field provides explicit indication that loopback has occurred at the requested destination.

Correlation tag: Consecutive numeric value that allows received loopback cells to be matched to the sent cell.

LLID: Indicates the ATM node where the loopback is to occur (LI=1), or the ID of the ATM node at which the loopback occurred (LI=0).

SLID: Indicates ID of the originating ATM node.

* The **Not used** field is encoded by Aurora Forte for route tracing. The originating tester will encode the VPI & VCI that it is used in the first 4 bytes, the responding tester will add the VPI & VCI that it is connected to in the latter 4 bytes of the loopback response. This is of value for confirming that as well as the correct destination being reached that the correct VCC routing has been used.

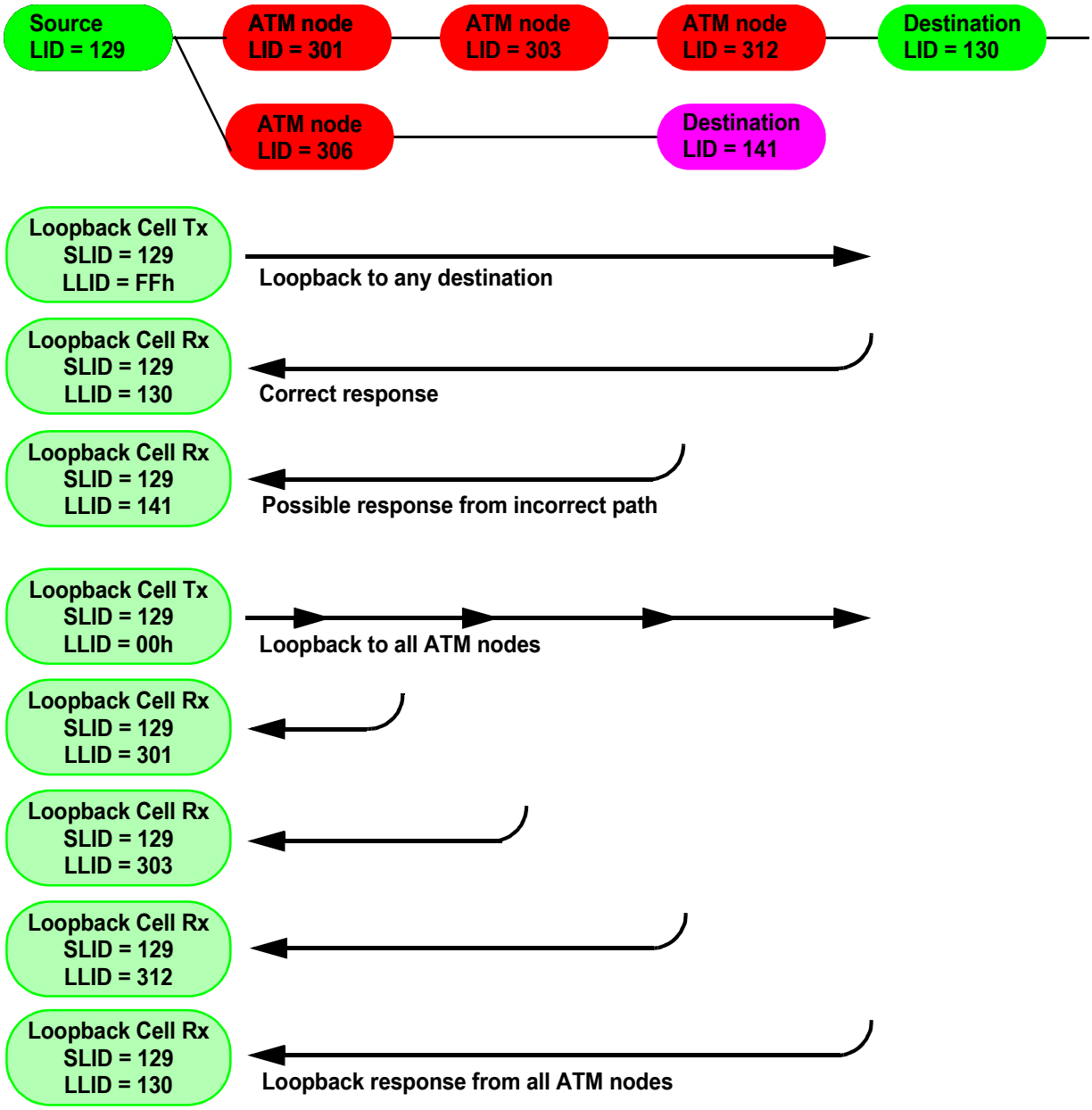
Coding structure of Location ID field:_

Byte 1	Bytes 2 to 16
0000 0000 *	All bytes = 00, for the LLID represents all points where LLID is enabled.
0000 0001	i) Country code (according to E.164) + network ID in bytes 2 to 5 BCD codes ii) Operator specific information in remaining 11 bytes using BCD codes
0000 0010	i) Country code (according to E.164) + network ID in bytes 2 to 5 BCD codes ii) Remaining 11 bytes coded as 6Ah
0000 0011	Not standardised.
1111 1111	No specific coding defined, all bytes coded as FFh *, for the LLID represents the endpoint of the segment or connection.

6Ah	No specific coding defined, all bytes coded as 6Ah *, for the LLID does not represent any connection point and no loopback shall be performed.
Other values	Not standardised.

* Provides backwards compatibility with I.610 (1995), in which Location IDs were not used.

The use of the E.164 coding structure is intended to encourage network operators to use ID values that are globally unique for all ATM nodes. It is the network operators responsibility to assign unique Location IDs to each ATM device in the network.



The simplest method of using loopback cells is to encode the cell payload with all 1s, which will represent that the endpoint (wherever that is) is to provide the loopback response. A response received at the tester will prove that a route through the network exists, and whether it is to the correct endpoint. It is also possible to connect a tester at each end of the circuit, with the far end unit being used to provide the necessary responses, and thus prove that the route is to the intended destination.

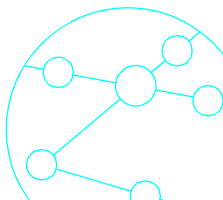
The next use will be to send cells with the Loopback Location ID set to all 0s. This code will command that every ATM node through which the selected VCC is routed is to respond to the loopback cell. Sending the cell will result in a response cell from each ATM node, with each node mapping its own Location ID into the Loopback field. The received cells will make up the route of the VCC through the network. This information can be used to confirm that the route is correct, or if not where the routing mistake has occurred.

Aurora Forte will also use the Loopback cell to calculate the looptime to the far end of the ATM network. This information can be useful for selecting the optimum route for critical traffic types, especially important for voice applications.

Aurora Forte provides an additional ability of recording the VPI/VCI values at each end of the VCC within the 'Unused' part of Loopback cell. With an Aurora Forte connected at each end of the network it is possible to confirm that the VCC at the far end is terminated on the intended VPI/VCI by viewing the VCC information in the OAM trace window.

Typical Faults

- No OAM cells on monitored VCC
  Check that selected VCC is correct. Try other VCCs that are being received in case VCC is routed incorrectly.
- RDI being indicated
  Send user cells on VCC in order that there is real traffic.
  Check and un-check AIS injection on tester.
  ATM fault in network is preventing user data reaching far end.
- No response from loopback cell
  No terminating equipment at far end of VCC.
  Loopback being sent into network on an incorrect VCC that is not terminated.
  VCC routing is incorrect within network and does not reach a termination.

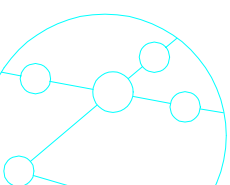


(Use the Loopback trace route to discover the location of the routing error)

- Loopback response is from incorrect destination device (according to LLID)
  Incorrect VCC used for sending Loopback cell
  VCC is routed incorrectly within the network
  (Use the Loopback trace route to discover the location of the routing error)

What Next?

Aurora Forte can also be used to test the bandwidth traffic contract, VCC reliability and QoS characteristics and IP connectivity of the ATM network. Other application notes in this series provide information about these functions.



Aurora Presto

Aurora Presto is an ADSL handheld tester with the key features of providing a choice of ADSL interface cards, ATM25 and Ethernet data interfaces, data statistics are displayed for the ADSL and ATM layers and tests are implemented for ATM BERT and IP Ping. Other options are PPPoA, PPPoE software, and TDR/DMM hardware.

Aurora Forte

Aurora Forte is an ATM handheld tester with the key features of being multi-interface with a graphical user interface and providing physical, ATM and IP layer test routines. File Management System allows test results and configurations to be copied to/from a PC using the testers Ethernet port.

- *Portable, battery powered, handheld unit, rugged design*
- *Large high resolution colour display*
- *Graphical ICON based window applications for easy operation of tests*
- *Interfaces - combined E1 + E3, combined DS1 + DS3, ATM25,*
- *OC3/STM1 (Single mode, Multi mode, G703, CAT5)*
- *Bi-directional monitoring*
- *Pass / Fail parameters for fast analysis of test results*
- *Physical Frame and Alarm monitoring & Injection*
- *Physical BERT for E1, E3, DS1, DS3*
- *ATM VCC real time Traffic Scanning - up to 1024 VCC*
- *ATM cellstream transmission - up to 256 VCC*
- *ATM BERT*
- *Quality of Service (O.191) measurement*
- *Traffic Policing - to monitor and enforce a committed service level agreement*
- *F4 and F5 OAM testing of ATM fault management layer (AIS, RDI, CC, Loopback), real time and trace history OAM cell capture with English language decode*
- *IP ping over ATM - transmit and respond tests*
- *SVC UNI 3.0, 3.1, 4.0 support with comprehensive Information Element editing*
- *Management of results and configuration files via PC on Ethernet interface for simple operation*
- *Software upgrades available from Trend Communications website, with download to tester via Ethernet port*

Aurora Forte is subject to an ongoing development program with continuous addition of new features - call for more information.

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