

# Understanding and Troubleshooting ATM UNI Signaling

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## Introduction

ATM end systems and network switches use signaling protocols to establish dynamic user connections, known as switched virtual circuits (SVCs). An ATM switch and an ATM end system, such as an ATM-attached router, exchange user to network interface (UNI) signaling messages across UNI links. ATM switches exchange Network to Network Interface (NNI) signaling across NNI links. NNI signaling is part of the Private Network-Network Interface (PNNI) specification, which includes both signaling and routing.

In rare circumstances, SVC connection requests fail or are torn down unexpectedly. This document helps you to troubleshoot SVC connection failures across UNI links.

See also the ATM Signaling and Addressing chapter in the Guide to ATM Technology.

**Note:** PNNI is outside the scope of this document. Refer to the Configuring ATM Routing and PNNI chapter in the ATM Switch Router Software Configuration Guide for more information.

## Prerequisites

### Requirements

There are no specific requirements for this document.

### Components Used

This document is not restricted to specific software and hardware versions.

## Conventions

For more information on document conventions, refer to the Cisco Technical Tips Conventions.

## Understanding the QSAAL PVC

The simplest way to view signaling messages is as control packets that carry important information between ATM switches and end-systems. ATM devices transmit signaling messages over a dedicated PVC configured with a special QSAAL (Quasi Signaling Application Adaptation Layer) ATM adaptation layer encapsulation. By default, the dedicated signaling VC uses virtual path identifier (VPI)=0 and virtual channel identifier (VCI)=5. Cisco Campus ATM switches such as the LightStream 1010 and Catalyst 8500 series create the signaling VC and other well-known (reserved) VCs like ILMI automatically during startup.

Use the **show atm vc** command to confirm that each interface supports a QSAAL PVC. Note how this VC cross-connects to interface ATM 2/0/0, which identifies the switch's internal management port. Since signaling messages are control messages, they must be sent to and processed by the CPU.

```
Switch#show atm vc
Interface VPI VCI Type X-Interface X-VPI X-VCI Encap Status
atm0/0/0 0 5 PVC atm2/0/0 0 39 QSAAL UP
atm0/0/0 0 16 PVC atm2/0/0 0 35 ILMI UP
atm0/0/1 0 5 PVC atm2/0/0 0 40 QSAAL UP
atm0/0/1 0 16 PVC atm2/0/0 0 36 ILMI UP
atm0/0/1 4 50 PVC atm2/0/0 0 230 SNAP UP
```

If you need to use a VPI or VCI value other than the default of 0/5 for the QSAAL VC, use the **atm manual-well-known-vc** command, as shown in the following example:

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm manual-well-known-vc delete
Okay to delete well-known VCS for this interface? [no]: y
Switch(config-if)# atm pvc 1 35 interface atm0 any-vci encap qsaal
```

Confirm your settings with the **show atm vc interface atm** command.

```
Switch# show atm vc interface atm 0/0/0
Interface VPI VCI Type X-Interface X-VPI X-VCI Encap Status
atm0/0/0 1 35 PVC atm0 0 150 QSAAL UP
```

## UNI 3.0, 3.1 and 4.0 Versions

Most Cisco ATM interfaces support versions 3.0, 3.1 and 4.0 of the ATM Forum's UNI signaling recommendations. Use the **atm uni-version** command to manually change the UNI version on an ATM interface.

```
3640-2.2(config-if)#atm uni-version ?
3.0 UNI Version 3.0
3.1 UNI Version 3.1
4.0 UNI Version 4.0
```

By default, ILMI autoconfiguration is enabled on ATM switch interfaces and negotiates the UNI version to the highest version in common between the devices at both ends of the physical link. Avoid manually setting the UNI version unless the attached device does not support autoconfiguration. When manually setting the UNI version, ensure that you also disable autoconfiguration with the **no atm auto-configuration** command.

# Signaling Messages

The ATM Forum UNI specifications are based on the Q.2931 public network signaling protocol developed by the ITU-T. The Q.2931 protocol specifies a call control message format that carries information such as message type (setup, call proceeding, release, and so on) and information elements (IEs), which include addresses and quality of service (QoS).

When troubleshooting signaling issues, the message type and information elements of ATM signaling messages must be understood. We'll look at these in more detail later.

## Message Format

The following table describes the fields in a standard Q.2931 message.

Field	Description
Protocol discriminator	Identifies the message as using either Q.93B or Q.2931 or it identifies another layer-3 signaling protocol, such as that used with X.25.
Call reference value	Identifies each call and is assigned by the originating side of the call (that is, the user at the local side and the network at the remote side). Contains a one-bit call reference flag to identify which end of the signaling VC originated the call.
Message type	Identifies the specific type of message, such as a SETUP or CALL PROCEEDING. (See the Messages section below.)
Message length	Identifies the length of the contents of a message. The value does not count the octets used for the protocol discriminator, call reference, and message type fields.
Variable length information elements	See the Information Elements section below.

## Messages

UNI signaling messages have a name which normally appears in documentation in all capital letters. Let's look at the two most common sets of signaling messages.

Message	Function
<b>Call Establishment</b>	
SETUP	Call establishment has been initiated.
CALL PROCEEDING	Call establishment has begun.
CONNECT	Call has been accepted.

CONNECT ACKNOWLEDGE	Call acceptance has been acknowledged.
<b>Call Clearing</b>	
RELEASE	Call clearing has been initiated.
RELEASE COMPLETE	Call has been cleared.

The UNI protocol also supports three other sets of messages: miscellaneous, global call reference, and point-to-multipoint connections. Since these messages typically are not seen in Cisco ATM debugs, we will not discuss them here.

## Information Elements

IEs form the body of a signaling message. Each message contains one or more IEs. The SETUP message contains numerous IEs, which are listed below.

Information Element	Function
AAL parameters	Indicates the requested ATM adaptation layer (AAL) parameter, which has end-to-end significance. Supported values include AAL1, AAL 3, AAL 4, and AAL5. Each AAL adds more parameters. For example, AAL1 adds constant bit rate (CBR) Rate Identifier and Clock Recovery Type Identifier.
ATM user cell rate	Specifies several traffic parameters, such as the forward and backward peak cell rate.
Broadband bearer capability	Indicates several network bearer services, such as end-to-end timing requirements and whether the traffic type is CBR or variable bit rate (VBR).
Broadband high layer information	Identifies upper layer protocols or a vendor-specific application (that is, the protocol in use at layer 3).
Broadband repeat indicator	Allows repeated information elements to be interpreted correctly.
Broadband low layer information	Identifies lower layer protocols or configurations (that is, the protocol in use at layer 2).
Called party number	Identifies the E.164 or private ATM end-system address of the called party or the destination of the call.
Called party subaddress	Conveys an ATM address in the OSI NSAP format across a public network which supports only E.164 addresses.
Calling party number	Identifies the E.164 or private ATM end-system address of the calling party or the origin of the

	call.
Calling party subaddress	Conveys an ATM address in the OSI NSAP format across a public network which supports only E.164 addresses.
Call state	Specifies one of twelve values describing status of a call. See section below on Call States.
Cause	Describes the reason for generating certain messages, provides diagnostic information in the event of procedural errors, and indicates the location of the cause originator.
Connection identifier	Identifies the VPI and VCI for the call.
QoS parameter	Requests and indicates the quality of service class for a connection.
Broadband sending complete	Indicates the completion of the called party number. Optional for ATM end stations to send and is ignored by network equipment when received.
Transit network selection	Identifies a transit network.
Endpoint reference	Identifies endpoints in a point-to-multipoint connection.
Endpoint state	Indicates each endpoint's state, such as add party initiated, received or active.
Restart indicator	Identifies which virtual channels are to be restarted.

## Call States

Networking protocols frequently use state machines that take a device or interface through several stages to normal operation. UNI recommendations specify ATM call control states for both the user side and the network side. Understanding these states is another important piece of information for troubleshooting ATM signaling issues.

The following table lists the call states that may exist on the user side of the UNI link.

ATM Call States for the User Side	
Null (U0)	No call exists.
Call Initiated (U1)	This state exists for an outgoing call when the user requests call establishment from the network.
Outgoing Call Proceeding (U3)	This state exists for an outgoing call when the user has received acknowledgment that the network has received all call information to effect call establishment.

Call Present (U6)	This state exists for an incoming call when the user has received a call establishment request <del>but has not yet responded.</del>
Connect Request (U8)	This state exists for an incoming call when the user has answered the call and is waiting to be <del>awarded the call.</del>
Incoming Call Proceeding (U9)	This state exists for an incoming call when the user has sent acknowledgment that the user has received all call information necessary to effect
Active (U10)	<del>call establishment.</del> This state exists for an incoming call when the user has received an acknowledgment from the network that the user has been awarded the call. This state exists for an outgoing call when the user has received an indication that the remote user has answered the call.
Release Request (U11)	This state exists when the user has requested the <del>network to clear the end-to-end connection (if</del>
Release Indication (U12)	<del>any) and is waiting for a response.</del> This state exists when the user has received an invitation to disconnect because the network has disconnected the end-to-end connection (if any).

The following table lists the call states that may exist on the network side of the UNI link.

ATM Call States for the Network Side	
Null (N0)	<del>No call exists.</del>
Call Initiated (N1)	This state exists for an outgoing call when the network has received a call establishment request <del>but has not yet responded.</del>
Outgoing Call Proceeding (N3)	This state exists for an outgoing call when the network has sent acknowledgment that the network has received the call information to
Call Present (N6)	<del>effect call establishment.</del> This state exists for an incoming call when the network has sent a call establishment request <del>but not yet received a satisfactory response.</del>
Connect Request (N8)	This state exists for an incoming call when the network has received an answer but the network <del>has not yet awarded the call.</del>
Incoming Call Proceeding (N9)	This state exists for an incoming call when the network has received acknowledgment that the user has received all call information necessary
Active (N10)	<del>to effect call establishment.</del> This state exists for an incoming call when the network has awarded the call to the call user.

	This state exists for an outgoing call when the network has indicated that the remote user has answered the call.
Release Request (N11)	This state exists when the network has received a request from the user to clear the end-to-end connection (if any).
Release Indication (N12)	This state exists when the network has disconnected end-to-end connection (if any) and has sent an invitation to disconnect the user-network connection.

## Sample Debug Output

Let's now look at some sample debug output in order to understand the information presented so far. In the following output, we can see that ATM interface 12/1/1 receives a SETUP message containing the AAL5 parameters, ATM traffic descriptor, and broadband bearer capability IEs. The user-side state changes from Null (U0) for no call exists to Call Present (U6) to indicate that the interface received an incoming call establishment request but has not yet responded. The reports by the LightStream 1010 of a change in call state are highlighted in bold below.

```

LS1010-1#
1d03h: ATMSIG(12/1/1:0 0,0 - 0056/00): (vcnum:0) Input event : Rcvd Setup in Null(U0)
1d03h: ATMSIG(12/1/1:0 0,0 - 0056/00): (vcnum:0) AAL5 Parameters IE (type 5)
1d03h: ATMSIG(12/1/1:0 0,0 - 0056/00): (vcnum:0)
ATM Traffic Descriptor IE: Forward PCR01 ID = 58600 Backward PCR01 ID = 58600 Best1
1d03h: ATMSIG(12/1/1:0 0,117 - 0056/00): (vcnum:0)
Broadband Bearer Capability IE: Bearer class = 0x10 ATC = 0x80 User plane = 0x80
1d03h: ATMSIG(12/1/1:0 0,117 - 0056/00): (vcnum:0) Null(U0) -> Call Present(U6)
1d03h: SIG->CC: Svc Event Rcvd Setup,
State Call Present(U6)atmsig_set_e2e_extqos_def:serv_category 4 extQos 0,
end2enddelayIe 0
1d03h: ATMSIG(12/1/1:0 0,117 - 0056/00): (vcnum:0) sending next port req
1d03h: ATMSIG: ROUTING INTERFACE : call ref = 56(0x800038); call end pt ref = 0(0x0);
calling port : (12/1/1) : 0 ;
1d03h: Port List : no of ports = 0
1d03h: dtl_node : 0:0:00.0000000000000000000000000000.000000000000.00
1d03h: output_port : (0x0)0/0/0:0
1d03h: next_hop.type = addr(0x2);
next_hop addr = 47.000018036680057000000000.00A0B10716B2.0B
1d03h: ATMSIG: processing port_rsp message from routing
1d03h: ATMSIG: ROUTING INTERFACE : err_code = PNNI_SUCCESS
(0x1)call ref = 56(0x800038);
call end pt ref = 0(0x0);
calling port : (12/1/1) : 0 ;
1d03h: Port List : no of ports = 1
Port ID 1 : (12/0/0) : 0
1d03h: dtl_node : 0:0:00.0000000000000000000000000000.000000000000.00
1d03h: output_port : (0x0)0/0/0:0
1d03h: next_hop.type = addr(0x2);
next_hop addr = 47.000018088770005500000000.00A0B10716B2.0B
1d03h: No Received DTLs
1d03h: ATMSIG(12/1/1:0 0,117 - 0056/00): (vcnum:0)Call Control nodetype : uni_node
1d03h: CC->SIG: Svc Event Req Call Proceeding, State Call Present(U6)
1d03h: ATMSIG(12/1/1:0 0,117 - 0056/00): (vcnum:0)
Input event : Req Call Proceeding in Call Present(U6)
1d03h: ATMSIG(12/1/1:0 0,117 - 0056/00): (vcnum:0)
Output Call Proc msg, Call Present(U6) state
1d03h: ATMSIG(12/1/1:0 0,117 - 0056/00): (vcnum:0)
Call Present(U6) -> Incoming Call Proceeding(U9)

```

## Choosing a Debug Command

Debug commands are a powerful tool to troubleshoot ATM signaling issues. Since using debug commands also can interrupt operation of your Cisco device as well as produce a large amount of output, it is important to choose the correct debug command.



**Caution:** Before issuing debug commands, please see Important Information on Debug Commands.

```
ls1010-2#debug atm sig-?  
sig-all sig-error sig-events sig-hog sig-ie  
sig-mibs sig-mp2p sig-nni sig-packets
```

Command	Description
<b>sig-all</b>	Turns on the debug output for all of the above conditions.
<b>sig-error</b>	Turns on the debug output for the ATM signaling error conditions.
<b>sig-events</b>	Turns on the debug output for the ATM signaling state machine events.
<b>sig-ie</b>	Turns on the debug output for the ATM signaling messages information element encoding.
<b>sig-nni</b>	Turns on the debug output for the ATM signaling NNI state machine events.
<b>sig-packets</b>	Turns on the debug output for the ATM signaling packets.
<i>card/subcard/ port</i>	Specifies the card, subcard, and port number for the ATM interface.

Note the following when enabling signaling debug commands:

- **debug atm sig-all** command does not enable debug atm sig-packet, which must be enabled with a separate configuration command.

```
LS1010-1#debug atm sig-all int atm 0/0/0  
ATM Signaling Events debugging is on  
ATM Signaling Error debugging is on  
ATM Signaling IE debugging is on  
ATM Signaling NNI debugging is on  
ATM Soft vc/vp Events debugging is on  
ATM Signaling CALLFAIL debugging is on  
ATM Signaling Api debugging is on
```

- Perform the following steps to limit the impact of the debug output on the operation of the ATM switch:
  1. Define a specific interface on which to run the debugs.
  2. Disable logging to the console with the **no logging console** command.
  3. Enable logging to the buffer, and configure a large buffer size to store the output.
- **debug sscop error** helps to troubleshoot link up or down events at the logical level. Such events are often due to the service-specific connection-oriented protocol (SSCOP) at the signaling plane that resets all signaling. Use the **show atm sig statistics** command to see the number of resets.

- Note in particular the location code in the cause IE of a RELEASE message and use the value to isolate your troubleshooting to a problem with an endpoint or a switch in the ATM network.

```

Protocol Discriminator:  Q.2931 user-network call control message
Call Reference Length:  3 bytes
  Direction Flag:       Message sent from the side originating call
  Value:                 0x02c858
Message Type:           Release (0x4d)
  Message AI Flag:      Ignore Action Indicator Field
  Action Indicator Field: Not significant
  Message Length:       7 bytes
Information Element Name: Cause (0x08)
  Coding Standard:      ITU-T standardized
  Instruction Flag:      Ignore Instruction Field
  Instruction Field:     Not significant
  Element Length:       3 bytes
Location: User
Cause: Invalid information element contents (100)
Diagnostics:           Present (listed below)
Information Element:    ATM Traffic Descriptor

```

Frame 10:

```

Protocol Discriminator:  Q.2931 user-network call control message
Call Reference Length:  3 bytes
  Direction Flag:       Message sent to the side originating call
  Value:                 0x00096e
Message Type:           Release (0x4d)
  Message AI Flag:      Ignore Action Indicator Field
  Action Indicator Field: Not significant
  Message Length:       6 bytes
Information Element Name: Cause (0x08)
  Coding Standard:      ITU-T standardized
  Instruction Flag:      Ignore Instruction Field
  Instruction Field:     Not significant
  Element Length:       2 bytes
Location: Private network serving the local user
Cause: Message not compatible with call state (101)

```

```

Protocol Discriminator:  Q.2931 user-network call control message
Call Reference Length:  3 bytes
  Direction Flag:       Message sent from the side originating call
  Value:                 0x00096e
Message Type:           Release Complete (0x5a)
  Message AI Flag:      Ignore Action Indicator Field
  Action Indicator Field: Not significant
  Message Length:       6 bytes
Information Element Name: Cause (0x08)
  Coding Standard:      ITU-T standardized
  Instruction Flag:      Ignore Instruction Field
  Instruction Field:     Not significant
  Element Length:       2 bytes
Location: User
Cause: Destination out of order (27)

```

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## Related Information

- [ATM Technology Support Pages](#)
- [ATM Signaling and Addressing](#)
- [ATM Routing with IISP and PNNI](#)
- [Troubleshooting Switch Router ATM Network Connections](#)
- [Technical Support – Cisco Systems](#)

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