IRIS® ATM API Programmer's Guide
SG–2235 2.3

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New Features

IRIS® ATM API Programmer's Guide SG–2235 2.3

This rewrite of the IRIS ATM API Programmer's Guide documents ATM release 2.3 and supports the 6.5 release of the IRIX operating system.

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About This Guide

This publication documents IRIS Asynchronous Transfer Mode (ATM) release 2.3 and supports the IRIX 6.5 operating system running on the Origin Series and the Onyx2, CHALLENGE, and Onyx platforms. It explains the design philosophy and usage of the application programming interface (API) to IRIS ATM. The document assumes familiarity with the IRIX networking environment (which is based on UNIX) and basic programming in the C language.

The IRIS ATM product is hardware and software that together allow applications to transmit and receive data over an ATM connection. IRIS ATM is an excellent data communication or networking solution for applications that require high-speed, constant, or nearly constant data rates.

Related Publications

The following documents contain additional information that might be helpful:

- *IRIS ATM-OC3 Board for CHALLENGE and Onyx Installation Instructions*, publication 108–0113–*xxx*
- *IRIS ATM-OC3c 4Port XIO Board Installation Instructions for Origin2000 and Onyx2*, publication 108–0159–*xxx*
- *IRIS ATM Configuration Guide*, publication 007–2333–*xxx*

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Acronyms Used in This Guide

The following acronyms are used throughout this guide:

AAL	ATM Adaptation Layer
ARP	address resolution protocol
ATM	Asynchronous Transfer Mode
BLLI	broadband low-layer information
CSPDU	AAL5 convergence sublayer protocol data unit
ILMI	interim local management interface
IP	Internet Protocol
LLC/SNAP	logical link control/sub-network access protocol
PVC	permanent virtual circuit
QoS	Quality of Service
SVC	switched virtual circuit
VC	virtual channel
VCC	virtual channel connection

Conventions

This guide uses the following stylistic conventions:

`command`	This fixed-space font denotes literal items such as commands, files, routines, path names, signals, messages, and programming language structures.

variable	Italic typeface denotes variable entries and words or concepts being defined.
`user input`	This bold, fixed-space font denotes literal items that the user enters in interactive sessions. Output is shown in nonbold, fixed-space font.
[ ]	Brackets enclose optional portions of a command or directive line.

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API Specification [1]

This document describes the Silicon Graphics application programming interface (API) for IRIS Asynchronous Transfer Mode (ATM) products. This first chapter provides a general overview of the API and its use. Subsequent chapters contain detailed descriptions of API commands. The product includes a C-language coding example for an application that uses the switched virtual circuit API in the following location: `/usr/lib/atm/examples/sigtest.c`.

Each chapter describes the commands relevant for one of the following types of implementations:

- Permanent virtual circuits, Chapter 2, page 25.
- Switched virtual circuits, Chapter 3, page 51.
- Interim local management interface (ILMI) modules that are not supported on IRIS, Chapter 4, page 95.
- Hardware management programs that are not supported on IRIS, Chapter 5, page 111.

1.1 Features

The IRIS ATM API is based on the following features of the IRIS ATM product:

- ATM adaptation layer 5 (AAL5) protocol mapping (RFC 1483, *Multiprotocol Encapsulation over ATM Adaptation Layer 5* and RFC 1626, *Default IP MTU for Use over ATM AAL5*).
- ATM signaling (ATM Forum UNI 3.0/3.1) (RFC 1755, *ATM Signaling Support for IP over ATM* and RFC 1932, *IP over ATM: A Framework Document*).
- Network and address management via ILMI and the ATM management information database (MIB) for multiple ATM user-network interfaces (UNIs) (ATM ILMI management information base, simple network management protocol (SNMP) based ATM Forum MIB implementation).
- RFC 1577 compliant (classical IP) as well as noncompliant configurations, such as the Simple Protocol for ATM Network Signaling (SPANS). IRIS ATM has the ability to function as the address resolution (ATMARP) server or as a client for each IP subnetwork.

The IRIS ATM API supports the following ATM services:

- Permanent virtual circuits (PVC) for point-to-point, bidirectional or unidirectional connections with constant bit rate (CBR), variable bit rate (VBR), or best-effort service. The traffic can be IP (with or without logical link control/subnetwork access point (LLC/SNAP) encapsulation) or non-IP.
- Switched virtual circuits (SVC) for bidirectional point-to-point and unidirectional point-to-multipoint connections via ATM signaling with CBR, VBR, or best-effort service. Supports non-IP traffic only, with or without LLC/SNAP encapsulation. (IP-over-SVC traffic is handled by the IRIS ATM driver via the standard BSD socket interface.)
- Connections with symmetric or asymmetric bandwidth requirements.
- ATM quality of services (QoS) for classes unspecified, A, B, and D.
- Strict VCI-based packet multiplexing.

1.2 Driver Architecture and Theory of Operations

The services of the IRIS ATM subsystem can be accessed using PVCs or SVCs, for IP or non-IP traffic. These four access scenarios are briefly described in the following list, and are discussed in more detail in the paragraphs that follow:

- Non-IP traffic over PVCs

  The character device interface (IRIS ATM API) allows traffic to be sent constant bit rate, variable bit rate, or best-effort, as requested.

- IP traffic over PVCs

  The character device interface (IRIS ATM API) is used to establish PVCs (using constant bit rate, variable bit rate, or best-effort, as requested) and associate them with IP addresses. LLC/SNAP encapsulation is the default, but can be disabled. The standard BSD socket interface is used for transmit or receive once the PVC is established. IP-to-VC address resolution is handled via a lookup table.

- Non-IP traffic over SVCs

  The character device interface (IRIS ATM API) allows traffic to be sent constant bit rate, variable bit rate, or best-effort service, as requested.

- IP traffic over SVCs

The standard IRIX BSD socket interface to the IP protocol stack allows traffic to be sent best-effort service over SVCs. LLC/SNAP encapsulation is done on all packets.

Note: To use the standard IP socket interface, simply configure the IRIS ATM software for IP-over-ATM, as described in the *IRIS ATM Configuration Guide*, publication 007–2333–*xxx*. Once the software is configured, the services of the IRIS ATM subsystem are available to upper-layer IP applications.

Access to the IRIS ATM subsystem is described in the following list and illustrated in Figure 1, page 5:

- Non-IP data through PVCs

  For each VC, this interface consists of opening a file descriptor (`open()`), using the `ATMIOC_CREATEPVC ioctl()` command to create the VC, and then exchanging data, using the `read()`, `write()`, or `writev()` command.

- IP-over-ATM traffic through PVCs

  For each VC, this interface consists of opening a file descriptor (`open()`), using the `ATMIOC_CREATEPVC` command to create the VC with a tag for IP, and using the `ATMIOC_SETARP` command to create an address resolution mapping. Or, instead, you can configure and run the `atmarp` utility. When `atmarp` is running, customer applications can simply use the BSD socket interface, as described in the next paragraph. (For more information about `atmarp`, see Section 1.4.3.1, page 16.)

  In either case, once the PVCs are established, the BSD socket interface is used to exchange data. Commands used for this exchange are `socket()`, `connect()`, `bind()`, `accept()`, `read()`, `write()`, or `writev()`. Address resolution is provided by RFC 1577 software that responds to InverseARP requests and ILMI software, as described in Section 1.4.1, page 14.

- Non-IP data through SVCs

  For each VC, this interface consists of opening a file descriptor (`open()`), using IRIS ATM `ioctl()` commands, such as `ATMIOC_SETUP` or `ATMIOC_REGISTER`, `ATMIOC_LISTEN`, and `ATMIOC_ACCEPT`, to create the VC , and then exchanging data by using `read()`, `write()`, or `writev()` commands.

- IP-over-ATM traffic over SVCs through the BSD socket interface

Applications that use the standard IRIX BSD socket interface for the IP suite of protocols access the services of the IRIS ATM subsystem like other IRIX network subsystems. This interface consists of standard functions (for example, `socket()`, `bind()`, `listen()`, `connect()`, `read()`, `write()`, `writev()`, and standard, non-ATM `ioctl()` calls). This interface is not described in this document. Address resolution is provided by software based on RFC 1577 that communicates with the subnetwork's ATM address resolution server and ILMI software, both of which are included in the IRIS ATM software.

Note: For more information on the socket interface, see the following man pages: `accept`(2), `bind`(2), `connect`(2), `fcntl`(2), `getsockname`(2), `getsockopt`(2), `ioctl`(2), `listen`(2), `read`(2), `recv`(2), `select`(2), `send`(2), `socket`(2), `socketpair`(2), `write`(2), and `writev`(2).

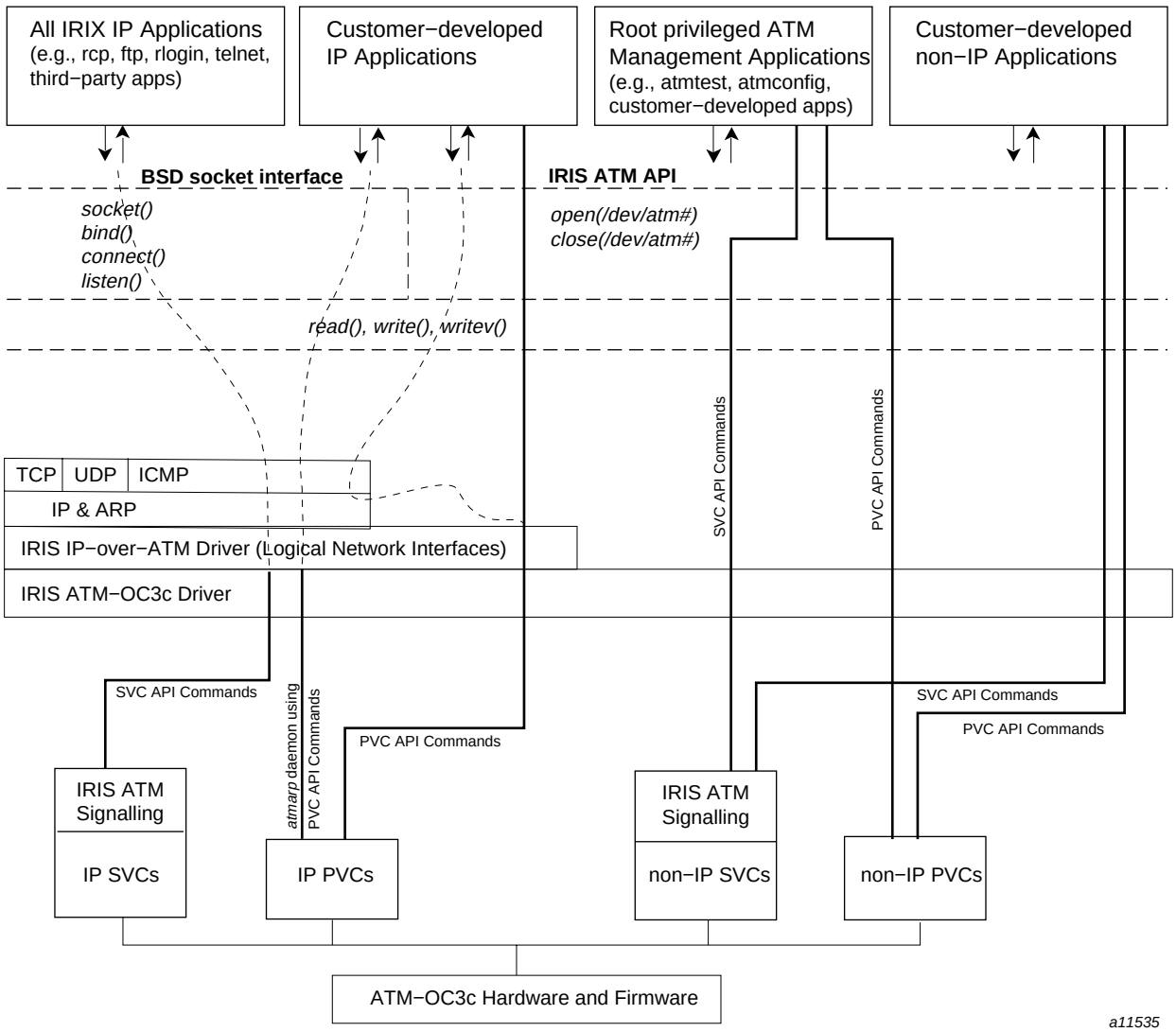


Figure 1. IRIS ATM driver architecture

1.3 Character Device Interface

The character device interface for IRIS ATM supports applications (sending IP or non-IP traffic) that require CBR, VBR, or best-effort service, as well as applications that manage, configure, or control the ATM subsystem. Through

the character device interface, applications can use any combination of PVCs and SVCs. Standard IP applications that can tolerate best-effort service are encouraged to use the IP-over-SVC support that is built into the IRIS ATM driver via IP logical network interfaces (`atm0`, `atm1`, `atm2`, and so on) and the BSD socket interface.

Within the ATM subsystem, there is no implicit binding between a VC and an ATM port. Because of this design, each hardware device (ATM port) simultaneously supports multiple VCs. There is, however, a one-to-one binding between each file descriptor and its associated VC; that is, each open file descriptor supports only one VC. These relationships are portrayed in Figure 2.

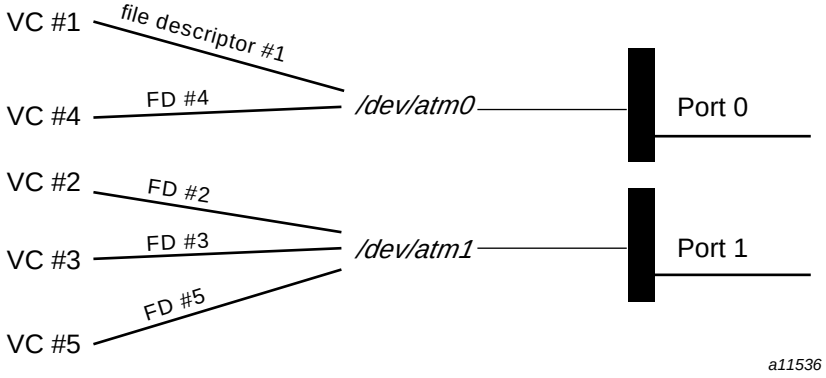


Figure 2. Relationship of VCs, file descriptors, and ATM hardware

The following sections provide the following character device information:

- Include files
- `open` () function
- `close` () function
- `read` () function
- `write` () function
- Command format
- ATM-OC3c management and configuration

1.3.1 Include Files

The following files define structures and constants that must be used with the ATM character device interface:

- ‘‘sys/atm.h’’
- ‘‘sys/atm_user.h’’
- ‘‘sys/if_atm.h’’ (required only for IP-over-PVCs)

1.3.2 open( ) Function

When the `open()`function is invoked on an IRIS ATM device file, the returned file descriptor has established a kernel-level connection to the selected ATM board. There can be multiple character device interfaces active for each installed IRIS ATM port. Each open file descriptor services one VC.

During startup, a symbolic link is created in the `/dev` directory for each IRIS ATM port listed in the hardware graph (for example, `/hw/atm/0`). By standard convention, the assigned port number is reflected in the device file name. For example, an IRIS ATM port that has been assigned port number 2 has an entry of `/dev/atm2`.

The following example illustrates proper usage where the ATM-OC3c device is identified as port 0 (`/dev/atm0`):

```
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>

int fd_atm;

if ((fd_atm = open("/dev/atm0", O_RDWR)) < 0) {
      perror("open");
      exit(-1);
}
```

Note: At this point, no VC is created; no `read()` or `write()` calls can be made. To create the desired VC, the `ATMIOC_CREATEPVC`, `ATMIOC_REGISTER`, or `ATMIOC_SETUP` `ioctl()` call must be used on the returned file descriptor. These `ioctl()` calls are described in Chapter 2, page 25, and Chapter 3, page 51.

1.3.3 `close()` Function

The `close()` function tears down the bound VC after all the buffered data for the VC has been transmitted. The `close()` results in closing the kernel-level link to the ATM-OC3c port, removing the associated VC from the ATM subsystem, and freeing the port and driver resources. The following example illustrates proper usage:

```
#include <unistd.h>

if (close(fd_atm) < 0) {
      perror("close");
}
```

1.3.4 `read()` Function

The default behavior for `read()` commands on an ATM device is blocking; that is, `read()` calls return only after data has been read or made available. However, you can open the file descriptor in nonblocking mode by using the `O_NDELAY` flag (defined in the `fcntl.h` file).

Note: Do not use the `O_NONBLOCK`, `FNONBLOCK`, or `FNONBLK` flags. They do not work with ATM file descriptors and they destroy the `O_NDELAY` flag, having the effect of a `NULL` flag if used in combination with `O_NDELAY`.

The following example shows the use of the `O_NDELAY` flag:

```
#include <fcntl.h> ...

main() { int fd;
fd=open("/dev/atm0",O_WRONLY|O_NDELAY);

/*Set the nonblocking mode*/

if(ioctl(fd,FIONBIO,O_NDELAY)<0
perror("Couldn't set no delay!\n");
```

With the default blocking mode, `read()` calls wait for data to become available. With the nonblocking mode, `read()` calls return with an `EAGAIN` failure whenever no data is available.

For each ATM read-access interface, it is the responsibility of the application to perform enough `read()` calls to consume the data. There is one receive queue

for each VC; each queue is 50 ATM Adaptation Layer (AAL) convergence sublayer protocol data units (CSPDUs) deep. If an application fails to consume incoming data fast enough and the receive queue in the kernel overflows, CSPDUs are dropped.

The examples in the following sections illustrate correct usage for large- and small-sized data in the current implementation.

1.3.4.1 Small-Sized Data

For data that occupies less than one page of system memory, the following usage is correct:

```
#include <sys/types.h>
#include <sys/uio.h>
#include <unistd.h>
#include <sys/atm_user.h>

buf = (char*) malloc(size);
retvalue = read(fd_atm, buf, MAX_USER_BYTES_PDU);
```

1.3.4.2 Large-Sized Data

For data that is greater than or equal to an operating system page of memory, it is recommended that page-aligned buffers be used in order to optimize performance. This optimization is optional. If page-aligned buffers are not provided, the driver retrieves the data by copying it, as in the following example:

```
#include <sys/types.h>
#include <sys/uio.h>
#include <unistd.h>
#include <sys/atm_user.h>

buf = (char*) valloc(size);
retvalue = read(fd_atm, buf, MAX_USER_BYTES_PDU);
```

1.3.5 `write()` Function

The default behavior for `write()` commands on an ATM device is blocking. However, after opening the file descriptor, nonblocking behavior can be specified (using the standard `ioctl() FIONBIO` command). In the default blocking mode, `write()` commands wait for the direct memory access (DMA)

to the board to complete before returning. In nonblocking mode, `write()` commands return immediately, before the DMA is complete; however, if the previous DMA is not complete, a nonblocking `write()` fails and returns the `EAGAIN` error.

The following list summarizes two methods for transmitting over the ATM-OC3c subsystem with the ATM character device interface:

- Invoking the `write()` call, using one buffer of any size and resulting in one or more AAL CSPDUs. The ATM subsystem divides the data into fully filled CSPDUs, and when necessary, pads the final CSPDU.
- Invoking the `writev()` call, using 1 to `IOV_MAX` buffers (also known as `iovecs`), and resulting in one or more PDUs (that is, as many PDUs as necessary). The data is concatenated and divided into PDUs. When necessary, incomplete PDUs are padded.

The following rules apply to transmissions:

- All buffers must begin on 8-byte boundaries.
- All buffers must be pinned down.
- In the default blocking mode, calls block until the very last byte of data for the call has accessed the board via DMA.
- The buffer (or iovec) size can end at any byte position (odd or even). For the `writev()` call, any buffer that is not a multiple of 8 causes the ATM subsystem to pad out the current CSPDU and transmit it. The data from the next iovec, if one is present, is placed into a new CSPDU.
- As long as buffers are multiples of 8 bytes, but not of `MAX_USER_BYTES_PDU` in size, there is no correlation between the iovec boundaries and the CSPDU boundaries. That is, the driver does not force new CSPDUs to start on iovec boundaries.

  Note: If a buffer is not pinned down, an `EFAULT` error may occur and it is possible that useless data will be sent.

Most audio and video applications have one very large buffer (multiple megabytes) in user virtual address space. By starting the first `write()` on an 8-byte boundary, and making every `write()` a multiple of 8 bytes, all subsequent writes will be automatically properly aligned.

1.3.5.1 General `write()` Example

The example below demonstrates correct usage of the `write()` call:

```
#include <unistd.h>
#include <stdlib.h>
#include <sys/lock.h>

while (needed) {
      buf = (char*) memalign(8, size);  /* any size */
      mpin (buf, size);
      retvalue = write(fd_atm, buf, size);
}
```

1.3.5.2 Sending Multiple Buffers of Data

To send a number of buffers of data, use a `writev()` call, as shown in the following example.

```
struct iovec iov[IOV_MAX];

for (vec=0; vec<vec_count, vec++) {
      iov.iov[vec].iov_base = (caddr_t) memalign( 8, size );
      iov.iov[vec].iov_len = size;
      mpin( iov.iov[vec].iov_base, size );
}

retvalue = writev( fd_atm, iov, vec_count );
```

This method can result in many CSPDUs. For best performance, the size of each of the buffers, except the last one, should be a multiple of 8 bytes. As long as each buffer size is a multiple of 8, the ATM subsystem concatenates the data, divides it into chunks that completely fill CSPDUs, and transmits it. When the ATM subsystem gathers data that is not a multiple of 8, it places that data into the current CSPDU, pads out the CSPDU and transmits it; the next buffer, if there is one, is contained in a new CSPDU.

1.3.5.3 Gathering Data into One Packet

A number of buffers can be gathered into a single CSPDU by using a `writev()` call, as shown in the following example. The size (length) of each buffer, except the last one, must be a multiple of 8 bytes, and the total data for all the buffers must be less than or equal to `MAX_USER_BYTES_PDU`.

```
struct iovec iov[IOV_MAX];

for (vec=0; vec < (vec_count), vec++) {
      /* size = multiple of 8*/
      iov.iov[vec].iov_base = (caddr_t) memalign( 8, size );
      iov.iov[vec].iov_len = size;
      mpin( iov.iov[vec].iov_base, size );
}

/* total size ≤ MAX_USER_BYTES_PDU */
      retvalue = writev( fd_atm, iov, vec_count );
```

1.3.5.4 Sending One Buffer of Data

To send a single buffer, use the `write()` call. The ATM subsystem divides the data into chunks that completely fill CSPDUs, and transmits the CSPDUs, as in the following example. If the final chunk of data does not completely fill a CSPDU, the ATM subsystem pads it and transmits it. Amounts of data smaller than `MAX_USER_BYTES_PDU` can be written, and the ATM subsystem does all appropriate padding; however, throughput is adversely affected.

```
char *buf = memalign(8, size);
mpin (buf, size)
retvalue = write(fd_atm, buf, size);
```

1.3.6 IRIS ATM API Command Format

All the IRIS ATM API commands are available through the IRIS character device interface in the following format:

`ioctl(`*fd_atm*`,` *COMMAND*`,` *arg*`);`

1.3.7 Managing and Configuring the ATM-OC3c Subsystem

Before an application can use the IRIS ATM API to utilize the services of an ATM subsystem, one or more control programs (also called management programs) must take care of the tasks listed in Table 1, page 13. The IRIS ATM driver performs these tasks at startup, thus making available a default configuration of the subsystem. For environments using this default configuration, no additional control program is necessary. For environments requiring a nondefault configuration, a customer-developed control program must reconfigure the subsystem after the IRIS ATM driver has completed its tasks.

Table 1, page 13, indicates which ATM `ioctl()` command is used to carry out each task. It is not important if one or multiple programs are created to perform these tasks; however, the following restrictions apply:

- For any single ATM-OC3c port, each specific task listed in the Task column should be performed by only one control program. Chaos can occur if a number of programs are doing the same task to the same port.
- The tasks must be performed in the order shown in the Task column.
- A program doing the tasks described in the table can (if desired) also do user-data transfers.
- Each task assumes an open file descriptor to the port it is configuring. The file descriptor can be closed whenever the program has finished its tasks.

Table 1. Configuration Tasks That Must Be Done for Each ATM-OC3c Board

Task (in order)	Calls	Comment	More Info
Configure operational modes	`ATMIOC_GETCONF` `ATMIOC_SETCONF`	Retrieve the current configuration. If changes are needed, set new configuration parameters.	Section 5.2.2, page 116 Section 5.2.8, page 132
For IRIS ATM HIO boards only, configure one or more rate queues, if not correctly configured. [1]	`ATMIOC_SETRATEQ` `ATMIOC_SETRATEQ` `ATMIOC_SETRATEQ` `ATMIOC_SETRATEQ`	Rate queue ## Rate queue ## Rate queue ## Rate queue ##	Section 5.2.10, page 138
Monitor status (optional)	`ATMIOC_GETSTAT` `ATMIOC_GETIOSTAT`	Retrieve board statistics. Retrieve driver-internal statistics.	Section 5.2.7, page 126 Section 5.2.3, page 120

Each application that wants to transfer data through the ATM subsystem must wait until the control program has completed its tasks, then it must obtain a file descriptor and create a VC before reading or writing data. When the data

1 See Section 1.5, page 18 for a description of how IRIS ATM configures and manages transmission rates.

transfer is finished, the application simply closes its file descriptor. The ATM subsystem clears the VC, cleans up, and releases resources.

Note: When IP applications are going to use the ATM subsystem, there are additional management requirements, as described in Section 1.4, page 14.

1.4 IP Support for PVCs

The following sections describe IRIS ATM support for IP-over-ATM using PVCs.

1.4.1 Address Resolution for IP-Over-PVCs

IRIS ATM address resolution for IP-over-PVC traffic can be divided into two parts: IP-to-ATM address resolution and IP-to-VC address resolution, described as follows:

- IP-to-ATM address resolution consists of obtaining (registering) an ATM address from the adjacent switch or self-assigning this address, and responding to InverseARP requests[2] in order to verify or provide the IP address that is mapped to the ATM address. The first process is handled automatically by ILMI software modules on both the adjacent switch and the local system, and InverseARP is handled automatically by RFC 1577 software on both the local system and the other endpoint.

  Note: On PVCs, IRIS ATM address resolution software responds to received InverseARP requests when LLC/SNAP encapsulation is enabled; however, it does not generate InverseARP requests.

- IP-to-VC address resolution consists of mapping an IP address to a PVC that is identified by a local hardware address made from a virtual path identifier or virtual channel identifier (VPI or VCI) value and an ATM port identification number. All of the mappings are stored in the kernel-resident ATM address resolution (AR) table. The `atmarp` utility (or equivalently the `ATMIOC_SETARP` command) loads PVC address resolution information into the AR table. The `ATMIOC_GETARPTAB` command retrieves the contents of the table.

The VC address is defined by the `atm_laddr_t` structure, illustrated in Figure 3. The `atm_laddr_t` structure fits conveniently into the standard hardware address, `arp_ha` structure, that the `arpreq` request uses.

2 An InverseARP request is a request for an IP address given a hardware address.

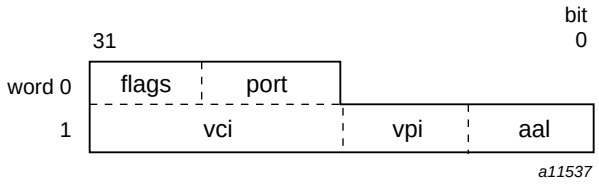


Figure 3. ATM Address Resolution Table Entry: the `atm_laddr_t` Structure

The ATM-specific `ioctl()` calls that are available for address resolution are as follows. These calls are described in Chapter 2, page 25.

- `ATMIOC_SETARP` (adds an entry to the AR table)
- `ATMIOC_GETARP` (retrieves one entry from the table)
- `ATMIOC_DELARP` (deletes an entry from the AR table)
- `ATMIOC_GETARPTAB` (retrieves the entire table)

Address resolution and internal routing of IP packets is handled in the following manner: the `ATMIOC_CREATEPVC` command with the IP flag set to on and the `ATMIOC_SETARP` command create the links between the IP interface and the PVC that allow incoming and outgoing IP packets to be routed correctly.

1.4.2 LLC/SNAP Encapsulation for PVCs

Each PVC can be configured to perform or not to perform subnetwork access protocol encapsulation (802.2 LLC/SNAP) for packets on VCs associated with an IP logical network interface. When LLC/SNAP encapsulation is enabled for a VC, the LLC and SNAP headers are attached to every packet on that VC, thus allowing ATM subsystems to differentiate among upper-layer protocol stacks (for example, IP and ARP). When LLC/SNAP is enabled on a VC, the IRIS ATM subsystem responds to InverseARP requests. When LLC/SNAP encapsulation is disabled, IP packets on that VC are not encapsulated and InverseARP requests are not answered. The default behavior is to enable LLC/SNAP encapsulation.

Configuration of LLC/SNAP encapsulation for each PVC can be done by either of the following methods:

- Edit the IP-to-PVC address resolution table and let the VCs be opened and configured by the IRIS ATM `atmarp` utility.

- Set the configuration for each PVC when it is created with the `ATMIOC_CREATEPVC` command.

1.4.3 IRIS ATM Subsystem Management for IP-Over-PVCs

Before any IP applications can use IP-over-PVC services, one or more control programs (also called management programs) must take care of the tasks listed in Table 2, page 17. For most implementations, the default control provided by the IRIS ATM utility `atmarp` (which is invoked during startup) is sufficient.

1.4.3.1 PVC Management by `atmarp`

During system startup, the `/etc/init.d/network.atm` script starts the `atmarp` PVC management application if the `/var/atm/pvc.conf` file exists. This user-configurable file maps IP addresses to local ports and VPI or VCI addresses. For each entry in the table, `atmarp` opens a file descriptor for the indicated port, and makes an `ATMIOC_CREATEPVC` and an `ATMIOC_SETARP` `ioctl()` call in order to establish a best-effort PVC and associate it with an IP address. The `atmarp` utility then goes to sleep, leaving the VCs open and ready for use. (If the file descriptors were to be closed, the PVCs would be torn down.) At this point, an IP application that opens a socket to any of the IP addresses in the table transmits or receives over the associated PVC. If `atmarp` is interrupted with a `SIGHUP` signal (for example, `killall -HUP atmarp`) it wakes up, reloads the lookup table from the `pvc.conf` file, makes any changes necessary by closing file descriptors (for deleted entries) or establishing new PVCs (for new entries), then goes back to sleep.

1.4.3.2 PVC Management by a Customer-Developed Application

For implementations that do not use `atmarp` to manage their PVCs, the following guidelines should be adhered to when designing the management application. It is not important if one or multiple programs are created to perform these tasks; however, the following restrictions apply:

- The tasks must be performed in the order shown in the "Task" column of Table 2, page 17.
- Before doing any of the tasks listed in Table 2, page 17, the tasks in Table 1, page 13, must be performed, either by another control program or by the same program doing the tasks listed in Table 2, page 17.
- The management program doing these tasks can (if desired) also read or write over these VCs.

- The management program must keep the file descriptor open for the entire duration of the PVC's use.

Table 2. Configuration Tasks That Must Be Done for Each ATM Network Interface Servicing IP if `atmarp` Is Not Running

Task (in order)	Calls	Comment	More Info

Open as many file descriptors for the port as there will be PVCs.	`fd1=open("/dev/atm0")`
	`fd2=open("/dev/atm0")`
	`fd3=open("/dev/atm0")`
	`fd4=open("/dev/atm0")`
	etc.
		The control program must keep each file descriptor open as long as the associated PVC is being used.	Section 1.3.2, page 7

Create one virtual channel for each file descriptor.	`ATMIOC_CREATEPVC` `ATMIOC_CREATEPVC` etc.	Each `ioctl()` call creates one virtual channel with a cellrate that is as close as possible to the requested rate. Tag each VC for IP.	Section 2.4.1, page 30
Manage ATM address resolution.	`ATMIOC_SETARP` `ATMIOC_SETARP` etc.	Create an IP-to-VC mapping in the ATM subsystem's address resolution table for each IP endpoint. Each `SETARP ioctl()` call creates one entry.	Section 2.4.7, page 47
Tear down a PVC.	close (*fd#*)		Section 1.3.3, page 8
Monitor the AR table (optional).	`ATMIOC_GETARPTAB`		Section 2.4.4, page 39

When the control program closes a file descriptor, the ATM subsystem automatically tears down the associated VC, cleans up the address resolution table, and releases the associated resources.

Each IP application that wants to transfer data through the ATM subsystem simply does what all IP applications do (use `socket()`, `bind()`, `connect()`, `accept()`, and so on) before reading or writing data. When the data transfer is finished, the application closes its socket. The ATM subsystem does not tear down the VC; only closing the file descriptor tears down the VC.

1.5 Characteristics of the ATM-OC3c Hardware

The following sections describe aspects of IRIS ATM hardware design that might be of interest to users of the IRIS ATM API. There is a separate section for each IRIS ATM board.

1.5.1 IRIS ATM-OC3c HIO Board for CHALLENGE and Onyx Platforms

The IRIS ATM-OC3c for CHALLENGE and Onyx HIO board manages transmission rates with rate queues and divisors. The board has eight rate queues organized as two banks: a0–a3 and b0–b3. Each queue can support one peak rate and 63 different sustainable rates. The "a" bank consists of four high-priority queues that are designed for constant bit rate traffic (CBR and VBR channels). The other bank ("b") contains four low-priority queues and are only used for best-effort traffic.

High-priority queues are serviced before low-priority ones. As long as there is data awaiting transfer on any high-priority queue, low-priority data is not transmitted. This means that, for applications with a constant flow of data, only queues a0–a3 will ever operate.

During startup, the IRIS ATM driver configures each rate queue, as follows:

- Queues that are mentioned in the `/var/atm/atmhw.conf` file are configured to a fixed rate, as specified in the file. The IRIS ATM driver never changes the rates for these queues; this ensures that site-specified rates are always available, even when the queues are not actively being used. Table 3, page 19, lists the supported rates, which range from 0 to 135,991,460 bits per second.
- Queues that are not mentioned (or are commented out) in the file are left unconfigured. The driver configures these during operation.

During operation, as VCs are created, the driver associates each newly created VC with the queue whose transmission rate best matches the peak rate requested for that VC. For each `ATMIOC_CREATEPVC` or `ATMIOC_SETUP` command, the driver looks for a queue whose transmission rate best matches the rate requested in the API call, as follows:

- For VCs carrying best-effort traffic, the driver uses the low-priority queue whose rate is closest to, but slower than, the requested peak rate.
- For VCs carrying CBR and VBR traffic, the driver uses the high-priority queue whose configured rate exactly matches the requested peak rate. If the requested rate does not exist, the driver searches for a high-priority queue

with the following characteristics and reconfigures it to the requested peak rate:

– A queue that does not currently have a VC associated with it.

– A queue that was not configured from the `atmhw.conf` file during startup.

Note: There can be dozens of CBR and VBR virtual channels active on a board, but the peak rate for each one must be one of the four rates that are configured on the high-priority queues.

To set the sustainable transmission rate for a particular VC, one of the board's configured rates is divided by a divisor (ranging between 1 and 64). The IRIS ATM driver sets all divisors. Peak rates for CBR, VBR, or best-effort traffic use divisors of 1. Sustainable (average) rates for VBR traffic use divisors from 2 through 64 (inclusive).

To summarize, the IRIS ATM-OC3c HIO board simultaneously makes available for selection up to 8 different peak rates and up to 504 (8x63) sustainable rates. Four of these peak rates are available for use by CBR and VBR VCs. Not all of these available selections can be actively used simultaneously, since this exceeds the board's bandwidth. Rates that are not currently associated with an open VC can be reconfigured to a newly requested rates.

Table 3 summarizes the default settings configured for the IRIS ATM-OC3c HIO board's rates.

Table 3. Default Transmission Rates on ATM-OC3c HIO Board's Queues

Rate Number Id	Queue String Id	Default Cellrate (in ATM Cells Per Second)	Default Bit Rate (in User Payload Bits Per Second)	Priority / Use
0	a0	unconfigured	none	High / CBR, VBR[3]
1	a1	unconfigured	none	High / CBR, VBR
2	a2	unconfigured	none	High / CBR, VBR
3	a3	unconfigured	none	High / CBR, VBR
4	b0	26,041	10,000,000	Low / BE

Rate Number Id	Queue String Id	Default Cellrate (in ATM Cells Per Second)	Default Bit Rate (in User Payload Bits Per Second)	Priority / Use
5	b1	78,125	30,000,000	Low / BE
6	b2	178,571	68,000,000	Low / BE
7	b3	357,142	135,991,460	Low / BE

A board is oversubscribed when the sum of all the open VCs multiplied by their average transmission rates is greater than the board's total payload bandwidth.[4] The IRIS ATM software contains a number of features that prevent performance degradation due to oversubscription. Whenever there is even one VC open for a CBR or VBR traffic contract, the IRIS ATM software refuses to create new VCs once the board's total payload bandwidth is allocated to open VCs (including best-effort ones).[5]

If all the VCs on a board are best-effort (regardless of which queues they are using), the IRIS ATM software allows the board to become oversubscribed and handles the transmission in the best manner possible.

Note: The default Transmission Control Protocol/Internet protocol (TCP/IP) configuration uses the maximum bandwidth for any connection. Therefore, a single TCP/IP connection can oversubscribe the port it uses and prevent CBR traffic. To prevent this, there are two options: (1) reduce the default TCP/IP bandwidth (for example, by editing the `/var/atm/ifatm.conf` file) or (2) use `ifconfig` to disable the TCP/IP logical network interfaces.

1.5.2 IRIS ATM-OC3c XIO Board for Origin2000 and Onyx2 Platforms

The IRIS ATM-OC3c XIO board for Origin2000 and Onyx2 platforms manages transmission rates with a cell-slot table that is controlled by firmware. There is one table for each port. The table has one entry for every cell-slot in the data stream going to the transmit SONET section of the board (illustrated in Figure 4, page 22). Due to this design, this board supports a virtually unlimited number of peak rates and there is no configuration required for the rates. In addition, a VC's sustainable rate is identical to its peak rate.

3 CBR = constant bit rate; VBR = variable bit rate; BE = best-effort

4 When a VC does not specify a sustainable rate, the average rate that is used for this calculation is the peak rate.

5 Total OC3c bandwidth is 155.52 megabits per second; however, of this, about 87.2% (135,631,698 bits) is available for user data. This is referred to as the payload bandwidth.

When an API call is made to create a VC, the software automatically creates enough entries in the cell-slot table to generate the transmission rate. If the request cannot be granted, an error is returned, as explained below. The driver for the IRIS ATM-OC3c 4Port XIO board does not allow oversubscription of any port. Whenever a requested rate cannot be provided, the request is denied. A denial can be due to either of these reasons:

- Not enough table entries are free to create the requested transmission rate, that is, the request is denied when filling it would oversubscribe the line rate.
- The spacing possible with the currently available table entries is not even enough to create a steady data flow for the VC. For example, if the table entries for a requested rate need to be spaced at intervals of 50 (table entries 8, 58, 108, 158, etc. or table entries 3, 53, 103, 153, etc.), the request is denied when one or more of the needed table entries are already filled and a nearby alternate cannot be found. This denial can occur even though the requested rate does not oversubscribe the connection's line rate.

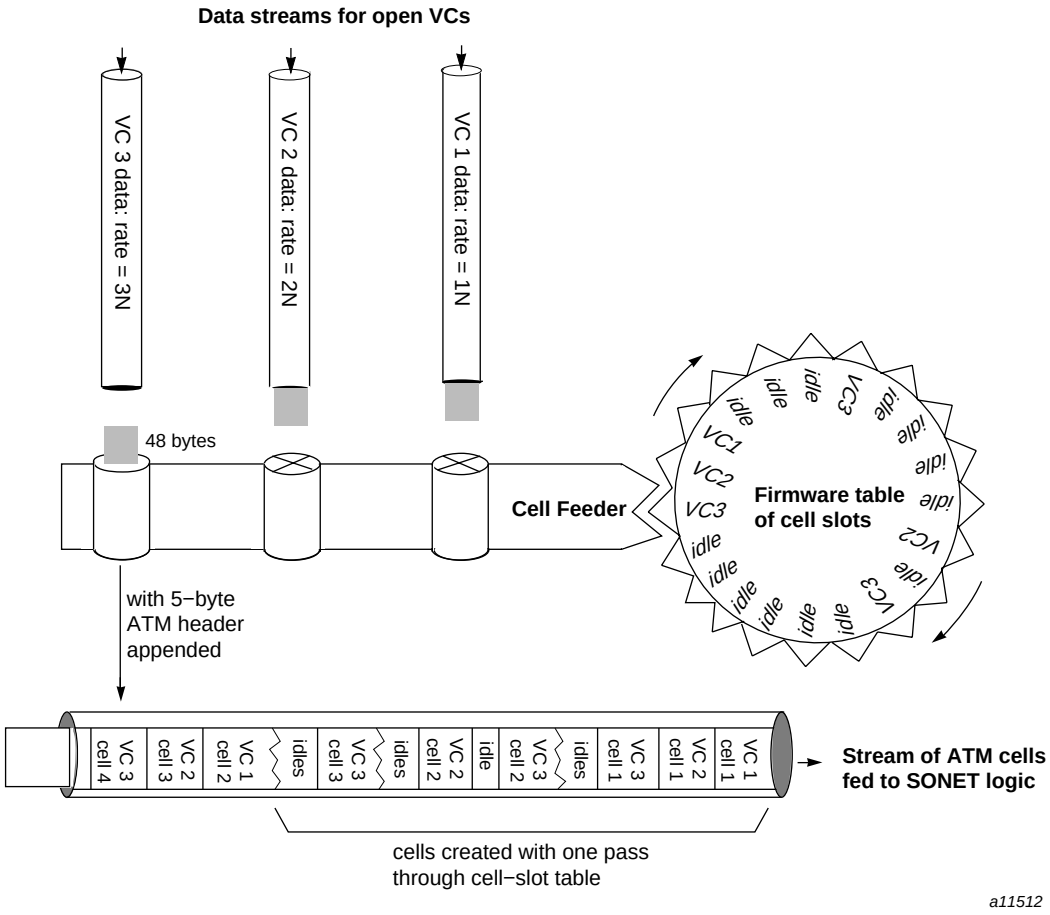


Figure 4. Generation of Transmission Rates in Origin2000 and Onyx2 Platforms

1.6 User-Level Commands

The IRIS ATM software includes utilities in the `/usr/etc` directory (`atmarp`, `atmconfig`, `ifatmconfig`,`atmstat`, and `atmtest`) and the `/usr/lib/atm/bin` directory (`sigtest`). Each utility is briefly described in the following sections. Complete details are provided in the online man pages.

1.6.1 atmarp

The `atmarp` utility provides command-level support for displaying and reloading the IP-to-ATM address resolution table. Also, it operates as an IP-to-PVC address resolution daemon, managing the mappings between VCs, ATM hardware, and ATM logical network interfaces.

Note: The `/etc/init.d/network.atm` IP startup script invokes this utility during each system startup or each invocation of the script. The command loads the contents of the `/var/atm/pvc.conf` IP-to-VC address mapping file into the kernel-resident address resolution table, maintains the file, and responds to address resolution requests.

1.6.2 atmconfig

The `atmconfig` utility provides command-level support for on-the-fly configuring and controlling of the ATM hardware:

- Configure the state of ATM ports up or down
- Configure a port to operate without an ATM switch
- Configure transmission rates on rate queues
- Configure the size and the number of on-board transmit and receive buffers
- Write firmware onto the Electrically Erasable Programmable Read-Only Memory (EEPROM)
- Reset and reinitialize a port

1.6.3 ifatmconfig

The `ifatmconfig` utility provides command-level support for setting RFC 1577 Logical IP Subnetwork (LIS) parameters for IP-over-ATM. The command allows you to configure the ATM address resolution server, the time out for inactive VCs, the maximum cellrate to use for the VCs, and the ATM physical port to use for each LIS. Each ATM LIS appears as a logical network interface that can be given an IP address and can be enabled or disabled with `ifconfig`, just like other conventional IP network devices.

Note: The IRIS ATM startup script (`/etc/init.d/atm`) invokes this utility during each system startup or each invocation of the script, telling it to read the `/var/atm/ifatm.conf` LIS configuration file for settings of these parameters.

1.6.4 atmstat

The `atmstat` utility provides command-level support for monitoring the status and operational statistics of ATM interfaces and IRIS ATM-OC3c ports.

1.6.5 atmtest

The `atmtest` utility provides command-level support for testing data transmission over the ATM subsystem when it is physically looped back (that is, a port's output is connected to the same port's input). Command line options allow you to control parameters such as the length of the randomly generated data and the speed at which it is sent.

1.6.6 sigtest

The `sigtest` utility provides command-level support for testing data transmission and reception for switched virtual circuits. The program allows you to create the following types of connections:

- A point-to-point loopback connection through the switch: a transmitting VCC to the switch that feeds into a receiving VCC from the switch. The transmitter and receiver are two instances of `sigtest` running on the same system.
- A point-to-point connection between two different systems that are both running `sigtest.`
- A point-to-multipoint connection in which the members of the party (the receivers) can include any combination of the following: one receiving `sigtest` session on the same system that is setting up the call, and one receiving `sigtest` session on each remote system.

Commands for Permanent VCs [2]

This chapter summarizes the IRIS ATM application interface calls that support permanent virtual circuits (PVCs). These commands are described alphabetically in the sections that follow, and are summarized in Table 4.

Note: The IRIS ATM `atmarp` utility handles IP-to-VC address resolution for PVCs that carry IP traffic. When `atmarp` is running, the commands in Table 4 under the heading "Address Resolution for IP-over-ATM when `atmarp` is not running" do not need to be used. These commands are provided for management implementations that do not use the `atmarp` utility. See the `atmarp` man page for further details.

Table 4. Summary of ATM PVC `ioctl()` Calls

Type of Operation	Command (or Function)	Port State	Description	More Info
Getting a link to the ATM-subsystem	`open()`	all	Opens a file descriptor for a device. Must be held open as long as the bound VC is active.	Section 1.3.2, page 7
Tearing down a VC	`close()`	all	Closing the file descriptor causes the VC to be torn down and all resources released.	Section 1.3.3, page 8
Managing transmission rates for HIO mezzanine (CHALLENGE) board				
	`ATMIOC_SETRATEQ`	up or down	Sets rate for one of the 8 rate queues.	Section 5.2.10, page 138
	`ATMIOC_GETRATEQ`	up	Reads rate for the indicated rate queue.	Section 5.2.6, page 124

Type of Operation	Command (or Function)	Port State	Description	More Info
Managing PVCs				
	`ATMIOC_CREATEPVC`	up	Binds one pair of virtual path or virtual channel identifiers to a file descriptor.	Section 2.4.1, page 30
	`ATMIOC_GETVCCTABLEINFO`	up	Retrieves information about all the VCCs currently open on the device.	Section 2.4.5, page 42
Address resolution for IP-over-ATM when `atmarp` is not running				
	`ATMIOC_GETARPTAB`	up or down	Retrieves the entire IP-to-ATM address resolution table.	Section 2.4.4, page 39
	`ATMIOC_GETARP`	up or down	Retrieves one entry from the ATM address resolution table.	Section 2.4.3, page 37
	`ATMIOC_SETARP`	up or down	Sets a static entry in IP-to-ATM address resolution table. AR table maps IP addresses to `atm_laddr_t` structures.	Section 2.4.7, page 47
	`ATMIOC_DELARP`	up or down	Deletes one entry from IP-to-ATM AR table.	Section 2.4.2, page 36
Managing data				
	`write()`	up	Pinned down, 8-byte aligned buffer of any size. If necessary, ATM subsystem divides data into different packets for transmission.	Section 1.3.5, page 9

Type of Operation	Command (or Function)	Port State	Description	More Info
	`writev()`	up	Gathers data from a number of buffers for transmission as one or more packets.	Section 1.3.5, page 9
	`read()`	up	Retrieves incoming data.	Section 1.3.4, page 8

2.1 Include Files for PVCs

The following files must be included in any program using the ATM-specific `ioctl()` calls:

- `''sys/atm.h''`
- `''sys/atm_user.h''`
- `''sys/if_atm.h''` (only for applications doing IP-over-ATM)

2.2 Frequently Used Structures

Some structures are used as arguments for many of the ATM-specific `ioctl()` calls. For reference, these frequently used structures are described in the following section.

2.2.1 The `atm_laddr_t` Structure

The `atm_laddr_t` structure is the ATM subsystem's local hardware address used for IP-to-VC address resolution (that is, the IRIS ATM ARP for PVCs) commands. For IP-over-PVCs, the structure is used within the standard `arpreq` structure. Table 5 and the following paragraphs describe the `atm_laddr_t` structure and its usage.

Table 5. IRIS ATM Local Hardware Address: `atm_laddr_t`

Field of `atm_laddr_t`	Recommended Value	Comments
`port`	0 – 11	Port's number. The number can be determined with the `/sbin/hinv` command. The value must be less than `ATM_MAXBD`.
`flags`	none	Used internally by IRIS ATM software.
`aal`	value of `AALTYPE_5`	Currently, only AAL5 is supported.
`vpi`	0 – 255 (decimal)	Virtual path identifier.
`vci`	0 – 65535 (decimal)	Virtual channel identifier. The VPI/VCI combination must be currently unused, and thus, available, both locally and on the switch.

Following is an example of the `arpreq` structure, as defined in the `if_arp.h` file:

```
struct arpreq {
      struct sockaddr arp_pa; /* protocol address */
      struct sockaddr arp_ha; /* hardware address */
                              /* for ATM = atm_laddr_t*/
      int arp_flags;
};
```

Following is an example of the `sockaddr` structure, as defined in the `socket.h` file:

```
struct sockaddr {
      u_short sa_family; /* address family */
      char sa_data[14];  /* up to 14 bytes of direct address */
};
```

Following is an example of the `atm_laddr` structure, as defined in the `atm_user.h` file:

```
typedef struct atm_laddr {
      u_char port;  /* local port number; brd's unit nmbr*/
      u_char flags; /* flags - local use only */
      u_char aal;   /* aal type - local use only */
      u_char vpi;   /* remote VPI */
      u_short vci;  /* remote VCI */
```

```
} atm_laddr_t;
```

Following are values for the `aal` field of `atm_laddr_t` structure, as defined in the `atm_b2h.h` file (included in the `atm_user.h` file)

```
#define AALTYPE_34 0
#define AALTYPE_5 1
#define AALTYPE_CBR 6
#define AALTYPE_RAW 7
```

2.3 PVC Code Sample

This section provides a simple code example showing creation, use, and tear down of one PVC.

```
/* open a file descriptor */

      fd = open( "/dev/atm0", rw );
      if ( fd < 0 )
          perror( "couldn't open device" ),exit(1);
/* define the VC's parameters */
       vpi = <your value>
       vci = <your value>
       xmitMaxCSDU = <your value>
       recvMaxCSDU = <your value>
       cellrate_type = <your value>
       cellrate_peak_rate = <your bits-per-second/384>
       cellrate_sustainable_rate = <your bits-per-second/384>
       cellrate_maxburst_size = <your value>

/* prepare the argument for ATMIOC_CREATEPVC with VC's */
/* parameters */
      atm_createpvc_t pvcreq;
      bzero( &pvcreq, sizeof(pvcreq) );
      pvcreq.vpi = vpi;
      pvcreq.vci = vci;
      pvcreq.xmitMaxCSDU = xmitMaxCSDU;
      pvcreq.recvMaxCSDU = recvMaxCSDU;
      pvcreq.xmitcellrate.cellrate_type = cellrate_type;

/* then one of these two sets,  */
/* depending on which type was used */
/* this for CRT_PEAK_AGG or CRT_BEST_EFFORT */
```

```
      pvcreq.xmitcellrate.rate.pcr_01.pcr01 = cellrate_peak_rate;

/* or this set for CRT_PSB_AGG */
      pvcreq.xmitcellrate.rate.psb_01.pcr01 = cellrate_peak_rate;
      pvcreq.xmitcellrate.rate.psb_01.scr01 = cellrate_sustainable.rate;
      pvcreq.xmitcellrate.rate.psb_01.mbs01 = cellrate_maxburst_size;

/* create the VC */
      if ( ioctl( fd, ATMIOC_CREATEPVC, &pvcreq ) < 0 )
          perror( ''couldn't ATMIOC_CREATEPVC'' ),exit(
/* the VC can now be written and read
      write(fd, obuf, length); #follow the guidelines in Section 1.3.5, page 9
      read(fd, ibuf, length ); #follow the guidelines in Section 1.3.4, page 8
/* to tear down the VC */
      error = close( fd, rw );
      if ( error != 0 )
          perror( ''couldn't close device'' ),exit(1);
```

2.4 PVC Commands

Thie following sections describe each `ATM PVC ioctl()` command in detail. The commands are organized alphabetically.

2.4.1 `ATMIOC_CREATEPVC`

The `ATMIOC_CREATEPVC ioctl()` command creates a permanent virtual circuit. A successful call binds an open file descriptor to one (a read-only or write-only) or two (a read and a write) virtual channel connections (VCCs), creates entries in the appropriate VC tables, and allocates board resources. Each VCC is identified by a VC address: virtual path identifier (VPI) and virtual channel identifier (VCI). The call creates a single VCC when the open file descriptor is read-only or write-only; it creates two VCCs (one forward and one back, using the same VC address for each) when the file descriptor is read and write. Only one `ATMIOC_CREATEPVC` can be called for each open file descriptor. Only one PVC is allowed for each VPI/VCI pair. The software prevents creation of a second VCC to the same VPI/VCI pair.

For a writable file descriptor, the call fails if the requested cellrate cannot be provided by the IRIS ATM hardware subsystem, as explained in Section 1.5, page 18. To maximize throughput, set the size for the transmitting VC's user protocol data units (CSPDUs) to `MAX_CS_PDU`.

Creating a PVC for a readable file descriptor causes the ATM subsystem to send all incoming PDUs (received on the incoming VCC) up to the application. Received PDUs are buffered in the kernel in per-VC queues. Cells received for a VPI or VCI address that has not been created are discarded by the ATM subsystem.

The port must be in the up state.

Note: To tear down the VC, simply close the file descriptor. The IRIS ATM subsystem tears down the VC, releases resources, and cleans up.

2.4.1.1 Usage

Use the following format:

`ioctl (`*`fd_atm`*`, ATMIOC_CREATEPVC, &`*`createpvc`*`);`

createpvc is an `atm_createpvc_t` structure.

2.4.1.2 Argument Values

The pointer to *createpvc* identifies an instance of an `atm_createpvc_t` structure that is set up as shown in Table 6, page 31.

Table 6. Recommended Values for Arguments of the `ATMIOC_CREATEPVC` Command

Field of `atm_createpvc_t`	Recommended Value	Comments
`vpi`	0 – 0xFF	Virtual path identifier. Value must match the one used by the switch for this VC and, if servicing IP traffic, the one used in any local IP-to-VC address mapping file.
`vci`	0 – 0xFFFF	Virtual channel identifier. Value must match the one used by the switch for this VC.[1]
`xmitMaxCSDU`	8 up to 0x2FF8	Maximum size for user-level packets (PDUs). Value cannot be 0 or larger than `MAX_CS_PDU` and must be divisible by 8. Set to `MAX_CS_PDU` for optimal throughput.

1 VPI/VCI values 0/0–32 are reserved by the ATM standards for use by ATM signaling and ILMI modules.

Field of `atm_createpvc_t`	Recommended Value	Comments
`recvMaxCSDU`	8 up to 0x2FF8	Maximum size for user-level packets (PDUs). Value cannot be 0 or larger than `MAX_CS_PDU` and must be divisible by 8.
`flags`	as desired	0 = no flags; default functionality, or one or more of the following flags: `ATMPVCFL_IP` indicates that the VC is servicing an IP logical network interface. If this flag is set, the `ATMIOC_SETARP` command must be used to bind this VPI or VCI to an IP address. `ATMPVCFL_NOSNAP` indicates that 802.2 LLC/SNAP encapsulation should not be attached on the packets on this VC.
`xmitcellrate`	`cellrate_t`	Set up as described in Table 7, page 32. Upon return, this value equals the out value, which is the actual value for the VC.

The `cellrate_t` structure defines the traffic parameters for the PVC. The supported values are described in Table 7, page 32, where CR stands for cellrate expressed in cells per second. For the call to succeed, the specified peak cellrate must be supported by the hardware; see Section 1.5, page 18, for a description of the transmission rate queues and how they are configured.

Table 7. Supported Values for Traffic Parameters of `ATMIOC_CREATEPVC`

Fields of `cellrate_t` Structure	Possible Values	Description
`cellrate_type`	`CRT_NULL`	Zero bandwidth.
	`CRT_PEAK_AGG`	Aggregate peak CR for CLP0+1. CBR traffic.
	`CRT_PSB_AGG`	Aggregate peak CR, sustainable CR, and burst size for CLP 0+1. VBR traffic.
	`CRT_BEST_EFFORT`	Peak CR for CLP0+1 with best-effort indication.

Fields of `cellrate_t` Structure	Possible Values	Description
	`CRT_PEAK`	Not supported in this release. Peak CRs for CLP0 and CLP0+1.[2]
	`CRT_PEAK_TAG`	Not supported in this release. Same as `CRT_PEAK`, with tagging requested.
	`CRT_PSB`	Not supported in this release. Peak CR for CLP0+1, sustainable CR for CLP0, burst size for CLP0.
	`CRT_PSB_TAG`	Not supported in this release. Same as `CRT_PSB`, with tagging requested.
`rate` (for type `CRT_PEAK_AGG`)		
	`struct pcr_01`: `pcr01`	Peak CR for CLP 0+1. Value must be supported by the IRIS ATM hardware, as described in Section 1.5, page 18.
`rate` (for type `CRT_PSB_AGG`)	`struct psb_01`: `pcr01` `scr01` `mbs01`	Peak CR for CLP 0+1. Value must be supported by the IRIS ATM hardware, as described in Section 1.5, page 18. Sustainable CR for CLP 0+1. Maximum burst size for CLP 0+1 in cells per burst. Valid values are multiples of 32 between 1 and 2,048, inclusive. Zero is not valid.
`rate` (for type `CRT_BEST_EFFORT`)	`struct pcr_01`: `pcr01`	Peak CR for CLP 0+1. Value must be supported by the IRIS ATM hardware, as described in Section 1.5, page 18.
`rate` (for types `CRT_PEAK` `CRT_PEAK_TAG` `CRT_PSB` `CRT_PSB_TAG`)	not applicable	Not supported in this release.

2.4.1.3 Success or Failure

If successful, `ATMIOC_CREATEPVC` returns zero. The out values should be read.

[2] CR or cr = cellrate expressed in cells per second. For example, a CR of 100 means that 4,800 bytes of user data (100 cells * 48 bytes of payload for each ATM cell) are transmitted each second.

On failure, the `ioctl()` call returns –1 with an error stored in `errno`. For descriptions of individual errors, see Section 2.4.1.6, page 35.

2.4.1.4 Out Values

When the VC is successfully created, the actual values that were used to create the VC are written to the call's argument. The *xmitcellrate* value should be read and verified because it might be different from the requested value.

When the `ATMIOC_CREATEPVC` fails, the values in the argument do not change and are not meaningful.

2.4.1.5 Relevant Structures

The following code is the `atm_createpvc_t` structure, as defined in the `sys/atm_user.h` file:

```
typedef struct {
      u_short vpi;
      u_short vci;
      u_short xmitMaxCSDU, recvMaxCSDU;
      u_char flags;
      cellrate_t xmitcellrate;
} atm_createpvc_t;

typedef struct {
      char cellrate_type;
      union {
          /* for cellrate_type = CRT_PEAK, CRT_PEAK_TAG */
          struct {
              int pcr0;
              int pcr01;
          } pcr_0_01;

          /* for cellrate_type = CRT_PEAK_AGG, CRT_BEST_EFFORT */
          struct {
              int pcr01;
          } pcr_01;

          /* for cellrate_type = CRT_PSB, CRT_PSB_TAG */
          struct {
              int pcr01;
              int scr0;
```

```
            int mbs0;
        } psb_0_01;

        /* for cellrate_type = CRT_PSB_AGG */
        struct {
             int pcr01;
             int scr01;
             int mbs01;
        } psb_01;

    } rate;
} cellrate_t;
```

2.4.1.6 Errors

Possible errors include:

`EADDRINUSE`	The VCI value is already in use by another VC.
`EFAULT`	An error occurred as the driver was copying in the command's *createpvc* argument.
`EINVAL`	The specified type of cellrate is not supported. Or, the specified cellrate is not valid for the type of cellrate. (For example, for a best-effort type with the IRIS ATM HIO (CHALLENGE) board, the slowest configured low-priority rate is still too fast, or for peak aggregate, all the high-priority queues are in use or are configured at a fixed value and none of their rates matches the value specified for *pcr01*). Or, the specified maximum CSDU size is larger than `MAX_CS_PDU` (that is, 12 kilobytes – 8 bytes). Or, there is no open file descriptor.
`ENODEV`	The port is not up.
`ENOMEM`	The port was unable to allocate enough on-board memory to complete this task.
`ENOSPC`	The maximum number of supported open VCs (`MAX_FWD_VCS` or `MAX_RVS_VCS`) are already created. Or, the port is out of buffers for the PDU size specified in the argument. Or, the port is out

of resources (all the bandwidth is currently occupied by other open VCs).

2.4.2 ATMIOC_DELARP

The ATMIOC_DELARP ioctl() command deletes one static PVC entry from the IP-to-ATM address resolution table.

Note: This command will not be supported in future releases of the IRIS ATM API. The portable method for managing the ATM ARP table is the atmarp utility.

2.4.2.1 Usage

Use the following format:

```
ioctl (fd_atm, ATMIOC_DELARP, &arp);
```

arp is an instance of arpreq.

2.4.2.2 Argument Values

The pointer to *arp* identifies an instance of an arpreq structure that indicates which entry in the ATM address resolution table is to be removed. The arpreq structure must be set up as described in Table 8.

Table 8. Recommended Values for Arguments of the ATMIOC_DELARP Command

Field of arpreq_t	Recommended Value	Comments
arp_pa	IP address	In sa_family field, set the protocol family to AF_INET, and, in sa_data field, provide the IP address of remote system.
arp_ha	none	This field is ignored.
arp_flags	none	

2.4.2.3 Success or Failure

If successful, ATMIOC_DELARP returns zero.

On failure, the `ioctl()` returns –1 with an error stored in `errno`. For descriptions of individual errors, see Section 2.4.2.5.

2.4.2.4 Relevant Structures

The `arpreq` and `atm_laddr_t` structures are described in Section 2.2, page 27.

2.4.2.5 Errors

Possible errors include:

`EAFNOSUPPORT`	The address family specified in the protocol portion of the `arpreq` structure is not `AF_INET`.
`EFAULT`	When attempting to copy the data, an error occurred.
`EINVAL`	An not valid entry occurred during processing of the address resolution. It may be that the requested address was not found in the AR table.
`ENODEV`	The port was not in the up or down state.

2.4.3 `ATMIOC_GETARP`

The `ATMIOC_GETARP` `ioctl()` command retrieves the mapping for one static PVC entry from the IP-to-ATM address resolution table.

Note: This command will not be supported in future releases of the IRIS ATM API. The portable method for managing the ATM ARP table is the `atmarp` utility.

2.4.3.1 Usage

Use the following format:

```
ioctl (fd_atm, ATMIOC_GETARP, &arp);
```

arp is an `arpreq` structure.

2.4.3.2 Argument Values

The pointer to *arp* identifies an instance of a standard `arpreq` structure defining the protocol address half of the IP-to-ATM address resolution entry to be retrieved.

The arpreq structure should be set up as shown in Table 9.

Table 9. Recommended Values for Arguments of the ATMIOC_GETARP Command

Field of arpreq_t	Recommended Value	Comments
arp_pa	AF_INET and IP address	In the sa_family field, set the protocol family to AF_INET, and, in the sa_data field, provide the IP address of the remote system.
arp_ha	none	Out value: retrieved. Upon return, this value equals the out value. atm_laddr_t structure. See Table 5, page 28, for description.
arp_flags	none	

2.4.3.3 Success or Failure

If successful, ATMIOC_GETARP returns zero. The out values should be read.

On failure, the ioctl() returns –1 with an error stored in errno. For descriptions of individual errors, see Section 2.4.3.6, page 38.

2.4.3.4 Out Values

The retrieved PVC hardware address is written as an atm_laddr_t structure within the arp_ha field of the argument.

2.4.3.5 Relevant Structures

The arpreq and atm_laddr_t structures are described in Section 2.2, page 27.

2.4.3.6 Errors

Possible errors include:

EAFNOSUPPORT	The address family specified in arp_pa is not supported.
EFAULT	When attempting to copy the data, an error occurred.

ENODEV	The port was not in the up or down state.
ENXIO	The arp_pa specified in the argument was not found in the ATM address resolution table.

2.4.4 ATMIOC_GETARPTAB

The ATMIOC_GETARPTAB ioctl() command retrieves the entire contents of the IP-to-ATM address resolution table. The retrieved entries include all PVCs that, at creation, were tagged with the ATMPVCFL_IP flag (even those that do not have an IP address assigned).

Note: This command will not be supported in future releases of the IRIS ATM API. The portable method for managing the ATM ARP table is the atmarp utility.

2.4.4.1 Usage

Use the following format:

```
ioctl (fd_atm, ATMIOC_GETARPTAB, &sioc);
```

sioc is an atmsioc_t structure.

2.4.4.2 Argument Values

The pointer to *sioc* identifies an instance of an atmsioc_t structure, set up as shown in Table 10, page 40. Within *sioc*, the **ptr* field must be a pointer to an array of atm_arptab_t structures.

Table 10. Recommended Values for Arguments of the ATMIOC_GETARPTAB Command

Field of atmsioc_t	Recommended Value	Comments
**ptr*	pointer to atm_arptab[ ]	Start address where retrieved ATM address resolution table is written. The out value equals the array of atm_arptab_t structures. Upon return, the out value equals the recommended value.
len	size of (atm_arptab[ATMARP_TABLESZ*2])	Maximum possible size of table. The out value is equal to the length of the retrieved table. Upon return, the out value equals the recommended value.

2.4.4.3 Success or Failure

If successful, ATMIOC_GETARPTAB returns zero. The out values should be read.

On failure, the ioctl() returns –1 with an error stored in errno. For descriptions of individual errors, see Section 2.4.4.6, page 42.

2.4.4.4 Out Values

The *len* field in the argument (*sioc*) is updated to contain the actual length of the retrieved data. The retrieved table is written to the atm_arptab[]. Each table entry is one atm_arptab_t structure, described in Table 11.

Table 11. Values Retrieved by the ATMIOC_GETARPTAB Command

Field in atm_arptab_t	Type	Description
iaddr	structin_addr	The out value is equal to the IP address. Upon return, the out value is equal to the type.
atmaddr	structatm_address_t	The out value is equal to the ATM address, if one exists. Upon return, the out value is equal to the type.

Field in atm_arptab_t	Type	Description
laddr	struct atm_laddr_t	The out value is equal to the local hardware address: VPI, VCI, PT. See Section 2.2.1, page 27. Upon return, the out value is equal to the type.
flags	u_char	The out value is equal to entries from Table 12, page 41. Upon return, the out value is equal to the type.

Table 12. Flags Retrieved by the ATMIOC_GETARPTAB Command

Flag	Description
COMPL	The ATM address for this IP address has been obtained.
CONN	The connection has been established for the VC.
NAK	The ATMARP server has responded that it does not recognize this endpoint.
NOSNAP	The VC is not using LLC/SNAP encapsulation.
PEND	The connection has not yet been established; it is pending setup completion.
PVC	The VC is a permanent virtual circuit, not a switched one.
VALIDATE	The IP address is in the process of being validated with InverseARP.

2.4.4.5 Relevant Structures

The atmsioc_t structure is described in the following example. The atm_arptab_t structure is described in Table 11, page 40, and in Section 2.2.1, page 27.

Following is an example of the atmsioc_t structure, as defined in the sys/atm_user.h file:

```
typedef struct atmsioc {
      void *ptr; /* where data is located */
      u_int len; /* size of structure at *ptr */
} atmsioc_t;
```

Following is an example of the `atm_arptab_t` structure, as defined in the `if_atm.h` file:

```
typedef struct atm_arptab {
      struct in_addr iaddr;
      atm_address_t atmaddr;
      atm_laddr_t laddr;
      u_char flags;
} atm_arptab_t;
```

2.4.4.6 Errors

Possible errors include:

`EFAULT`	When attempting to copy the data, an error occurred.
`ENODEV`	The port was not in the up or down state.

2.4.5 ATMIOC_GETVCCTABLEINFO

The `ATMIOC_GETVCCTABLEINFO` `ioctl()` command retrieves the entire virtual channel table (both transmit and receive VCs) from any IRIS ATM port. The port must be in the up state.

2.4.5.1 Usage

Use the following format:

`ioctl (`*fd_atm*`, ATMIOC_GETVCCTABLEINFO, &`*sioc*`);`

sioc is an `atmsioc_t` structure.

2.4.5.2 Argument Values

The pointer to *sioc* identifies an instance of an `atmsioc_t` structure. The `atmsioc_t` structure should be set up as summarized in Table 13, page 43.

Table 13. Recommended Values for Arguments of the ATMIOC_GETVCTAB Command

Field of atmsioc_t	Recommended Value	Comments
**ptr*	pointer to vcce[]	Pointer to location for retrieved information. The out value is equal to an array of atm_vcce_t structures. Upon return, the out value equals the recommended value
len	size of (vcce[MAX_FWD_VCS++MAX_RVS_VCS]);	Maximum possible size of the table. The out value is equal to the length of the retrieved table. Upon return, the out value equals the recommended value.

2.4.5.3 Success or Failure

If successful, ATMIOC_GETVCCTABLEINFO returns zero. The out values should be read.

On failure, the ioctl() call returns –1 with an error stored in errno. For descriptions of individual errors, see Section 2.4.5.6, page 44.

2.4.5.4 Out Values

The *len* field in the *sioc* argument is updated to contain the actual length of the retrieved data, as described in Table 13, page 43. The retrieved data is written to the array of atm_vcce_t structures. Each table entry is one atm_vcce_t structure, as described in Table 14.

Table 14. Values Retrieved by the ATMIOC_GETVCCTABLEINFO Command

Field of atm_vcce_t	Type	Description
vpi	int	Value for VPI
vci	int	Value for VCI
xmit_cellrate	struct cellrate_t	Transmit cellrate

Field of atm_vcce_t	Type	Description
recv_cellrate	struct cellrate_t	Receive (backward) cellrate
xmitQOS	int	Transmit quality of service
recvQOS	int	Receive (backward) quality of service

2.4.5.5 Relevant Structures

The atmsioc_t structure and the atm_vcce_t structure, as defined in the sys/atm_user.h file, are as follows:

```
typedef struct atmsioc {
 void *ptr;
 u_int len;
} atmsioc_t;

typedef struct {
 int         vpi;
 int         vci;
 cellrate_t  xmit_cellrate;
 cellrate_t  recv_cellrate;
 int         xmitQOS;
 int         recvQOS;
} atm_vcce_t;
```

2.4.5.6 Errors

Possible errors include:

EFAULT	An error occurred when the driver was copying the data.
EINVAL	The *len* specified in the argument is too small to contain the information being retrieved.
ENODEV	The port was not in the up state.

2.4.6 ATMIOC_GETVCTAB

The hardware-dependent ATMIOC_GETVCTAB ioctl() command retrieves the entire virtual channel table (both transmit and receive VCs) from an IRIS ATM

HIO (CHALLENGE) board; other boards do not support this call. The board must be in the up state.

Note: This command will not be supported in future releases of the IRIS ATM API. The portable method for managing the VC table is the `ATMIOC_GETVCCTABLEINFO` command.

2.4.6.1 Usage

Use the following format:

`ioctl (`*fd_atm*`, ATMIOC_GETVCTAB, &`*sioc*`);`

sioc is an `atmsioc_t` structure.

2.4.6.2 Argument Values

The pointer to *sioc* identifies an instance of an `atmsioc_t` structure. The `atmsioc_t` structure should be set up as summarized in Table 15.

Table 15. Recommended Values for Arguments of the `ATMIOC_GETVCTAB` Command

Field of `atmsioc_t`	Recommended Value	Comments
**ptr*	pointer to `vct[]`	Pointer to location for retrieved information. The out value equals an array of `atm_vcte_t` structures. Upon return, the out value equals the recommended value.
len	size of (`vct[MAX_FWD_VCS+MAX_RVS_VCS]`);	Maximum possible size of the table. The out value equals the length of retrieved table. Upon return, the out value equals the recommended value.

2.4.6.3 Success or Failure

If successful, `ATMIOC_GETVCTAB` returns zero. The out values should be read.

On failure, the `ioctl()` call returns –1 with an error stored in `errno`. For descriptions of individual errors, see Section 2.4.6.6, page 47.

2.4.6.4 Out Values

The *len* field in the (*sioc*) argument is updated to contain the actual length of the retrieved data, as described in Table 15, page 45. The retrieved data is written to the array of `atm_vcte_t` structures. Each table entry is one `atm_vcte_t` structure, as described in Table 16.

Table 16. Values Retrieved by the `ATMIOC_GETVCTAB` Command

Field of `atm_vcte_t`	Type	Description
`cell_hdr`	`u_int`	VPI=bits 27:20; VCI=bits 19:4; PT=bits 3:0
`max_cs_pdu_size`	`u_int`	Maximum PDU size on this VC.
`burst_size`	`u_short`	Maximum burst allowed. A burst is the maximum number of back-to-back cells transmitted at peak cellrate (CQ). 32 modulo bucket depth.
`rate_queue_number`	`u_char`	Rate queue ID. The configured rate on this queue is the peak cellrate for this VC.
`avg_rate_divisor`	`u_char`	The peak cellrate is divided by this value to give the average or sustainable cellrate for the VC (TIQ).
`read_write`	`u_char`	VCC type description: `VCTE_RW` = read+write `VCTE_RO` = read only `VCTE_WO` = write only
`aal_type`	`u_char`	AAL type: AAL3/4, AAL5, Raw, CBR.
`flags`	`u_char`	Flags: `VCTE_IP` = VC carries IP traffic `VCTE_NOTRAILERS` = no AAL5 trailers or CRCs are used `VCTE_NOSNAP` = packets are not encapsulated with 802.2 LLC/SNAP
`ifunit_in`	`u_char`	Logical network interface number (`if_net`) that is the endpoint. Only for VCs servicing IP traffic.
`vcte`	`u_int`	Local index (number), which was provided by the driver at the time the VC was created.

2.4.6.5 Relevant Structures

The `atmsioc_t` structure, as defined in the `sys/atm_user.h` file and the `atm_vcte_t` structure, as defined in the `sys/atm_b2h.h` file (which is included in the `sys/atm_user.h` file), are shown in the following sample code:

```
typedef struct atmsioc {
      void *ptr;
      u_int len;
} atmsioc_t;

typedef struct atm_vcte {
      u_int cell_hdr;
      u_int max_cs_pdu_size;
      u_short burst_size;
      u_char rate_queue_number;
      u_char avg_rate_divisor;
      u_char read_write;
      u_char aal_type;
      u_char flags;
      u_char ifunit_in;
      u_int vcte;
} atm_vcte_t;
```

2.4.6.6 Errors

Possible errors include:

`EFAULT`	An error occurred when the driver was copying the data.
`EINVAL`	The *len* specified in the argument is too small to contain the information being retrieved.
`ENODEV`	The board was not in the up state.

2.4.7 `ATMIOC_SETARP`

The `ATMIOC_SETARP` `ioctl()` command puts one static mapping for a PVC into the IP-to-ATM address resolution table. This command is required for any VC that had the `ATMPVCFL_IP` flag set when the VC was created (with `ATMIOC_CREATEPVC`). The VC must already have been created with the `ATMIOC_CREATEPVC` call.

Note: This command will not be supported in future releases of the IRIS ATM API. The portable method for managing the ATM ARP table is the `atmarp` utility.

2.4.7.1 Usage

Use the following format:

`ioctl (`*fd_atm*`,ATMIOC_SETARP, &`*arp*`);`

The file descriptor used for *fd_atm* is relatively unimportant (either the file descriptor from the `ATMIOC_CREATEPVC` or an IP socket descriptor can be used), and *arp* is defined as `struct arpreq`.

2.4.7.2 Argument Values

The pointer to an `arpreq` structure, is set up as explained in Table 17.

Table 17. Recommended Values for Arguments of the `ATMIOC_SETARP` Command

Field of `arpreq_t`	Recommended Value	Comments
`arp_pa`	`AF_INET` and IP address	Within `sa_data` field, set the protocol family to `AF_INET` and provide the IP address of the remote system.
`arp_ha`	`atm_laddr_t` structure	The local hardware address for the PVC. For complete details, see Table 6, page 31.
`arp_flags`	none	

2.4.7.3 Success or Failure

If successful, `ATMIOC_SETARP` returns zero.

On failure, the `ioctl()` command returns –1 with an error stored in `errno`. For descriptions of individual errors, see Section 2.4.7.5, page 49.

2.4.7.4 Relevant Structures

The `arpreq` and `atm_laddr_t` structures are described in Section 2.2, page 27.

2.4.7.5 Errors

Possible errors include:

`EADDRINUSE`	The address resolution table is already full. The current entry request was not added.
`EAFNOSUPPORT`	One of the *sa_family* fields within the `arpreq` indicated an address family that is not supported. Only `AF_UNSPEC` is supported for the `arp_ha` information, and only `AF_INET` is supported for the `arp_pa` area.
`EFAULT`	An error occurred as the driver was trying to copy the command's argument.
`EINVAL`	The *port* indicated in the `atm_laddr_t` is not valid, or the *vpi/vci* pair indicated in the `atm_laddr_t` already exists in the table, or the specified VC is not flagged for IP use.
`ENODEV`	The port was not in the up or down state.

Commands for Switched VCs [3]

This chapter summarizes the IRIS ATM signaling application interface calls that support switched virtual circuits (SVCs). The product includes an example of an application coded in C, `/usr/lib/atm/examples/sigtest.c`, that uses this SVC API.

The services of the ATM subsystem are accessed through the IRIX character device interface `ioctl()` calls that specify ATM signaling requests (commands). These calls are described alphabetically in Section 3.5, page 68, and are summarized in Table 18.

Table 18. Summary of SVC `ioctl()` calls

Type of Operation	Command (or Function)	Port State	Description	More Info
Getting a link to the ATM subsystem	`open()`	all	Opens a file descriptor for a device. Must be held open as long as the SVC or the SVC request-queue is active.	Section 1.3.2, page 7
Tearing down a VC	`close()`	all	Closes the file descriptor and causes the VC to be torn down and all resources released, including graceful rejection of any setup requests in the input queue.	Section 1.3.3, page 8
Activating SVCs as the called party				
	`ATMIOC_REGISTER`	up/dn	Creates a request queue for incoming setup requests. Setup requests that match the specified traffic contract are accepted.	Section 3.5.7, page 84

Type of Operation	Command (or Function)	Port State	Description	More Info
	ATMIOC_LISTEN	up/dn	Retrieves one setup request from the SVC's request queue.	Section 3.5.5, page 77
	ATMIOC_ACCEPT	up/dn	Accepts a setup request. This results in a new SVC.	Section 3.5.1, page 68
	ATMIOC_REJECT	up/dn	Refuses to accept a setup request.	Section 3.5.8, page 87
Activating SVCs as the calling party				
	ATMIOC_SETUP	up/dn	Requests a point-to-point SVC.	Section 3.5.9, page 89
	ATMIOC_MPSETUP	up/dn	Requests a point-to-multipoint SVC and adds the first party.	Section 3.5.6, page 80
Maintaining a multipoint SVC				
	ATMIOC_ADDPARTY	up/dn	Each call adds one more destination address to a point-to-multipoint SVC.	Section 3.5.2, page 71
	ATMIOC_DROPPARTY	up/dn	Drops one destination address from a point-to-multipoint SVC.	Section 3.5.3, page 73
Retrieving VC Information				
	ATMIOC_GETVCCTABLEINFO	up	Retrieves information about all the VCCs currently open on the device.	Section 3.5.4, page 75
Managing data				

Type of Operation	Command (or Function)	Port State	Description	More Info
	`write()`	up	Pinned down, 8-byte aligned buffer of any size. If necessary, ATM subsystem divides data into different packets for transmission.	Section 1.3.5, page 9
	`writev()`	up	Gathers data from a number of buffers for transmission as one or more packets.	Section 1.3.5, page 9
	`read()`	up	Retrieves incoming data.	Section 1.3.4, page 8

3.1 Include Files for SVCs

The following files must be included in any program using the ATM-specific `ioctl()` calls:

- `''sys/atm.h''`
- `''sys/atm_user.h''`
- `''sys/if_atm.h''` (only for applications doing IP-over-ATM)

3.2 Overview

The IRIS ATM signaling software makes it possible for applications to dynamically set up and tear down switched virtual circuits (SVCs) in accordance with the ATM User-Network Interface (ATM UNI) standard. The software consists of the following components that work together to transparently provide support for SVCs:

- Driver for the IRIS ATM network controller hardware
- Signaling daemon (`atmsigd`) that implements the ATM User-Network Interface signaling standard for setting up and tearing down SVCs
- Interim local management interface daemon (`atmilmid`) that implements the ATM User-Network Interface local management standard for exchange

of status, configuration, and control information, including obtaining ATM addressing information from an adjacent switch

The IRIS ATM driver is the access point for applications using IRIS ATM services, as illustrated in Figure 5, page 55, to Figure 8, page 58. Applications use the IRIS ATM application programming interface (API) to place their requests for creating and tearing down SVCs. The driver communicates these requests to the `atmsigd` and `atmilmid` modules, as appropriate. The `atmsigd` and `atmilmid` modules process requests in compliance with the ATM protocols as specified in the *ATM User-Network Interface Specification*.

The `atmsigd` module interfaces with other modules that handle the ATM signaling protocols and communication with the adjacent ATM switch. The ATM signaling protocol stack consists of three protocols: Q.2931, QSAAL, and AAL5. The software can be configured so that multiple UNIs are created, each with a different possible configuration.

The `atmilmid` module uses the simple network management protocol (SNMP, RFC 1157) to maintain a management information database (MIB) for each physical ATM connection and to communicate with adjacent interim local management interface (ILMI) programs. The objects within this MIB are defined in the ILMI section of the ATM User-Network Interface standard. See Chapter 4, page 95, for the API calls that retrieve ILMI information.

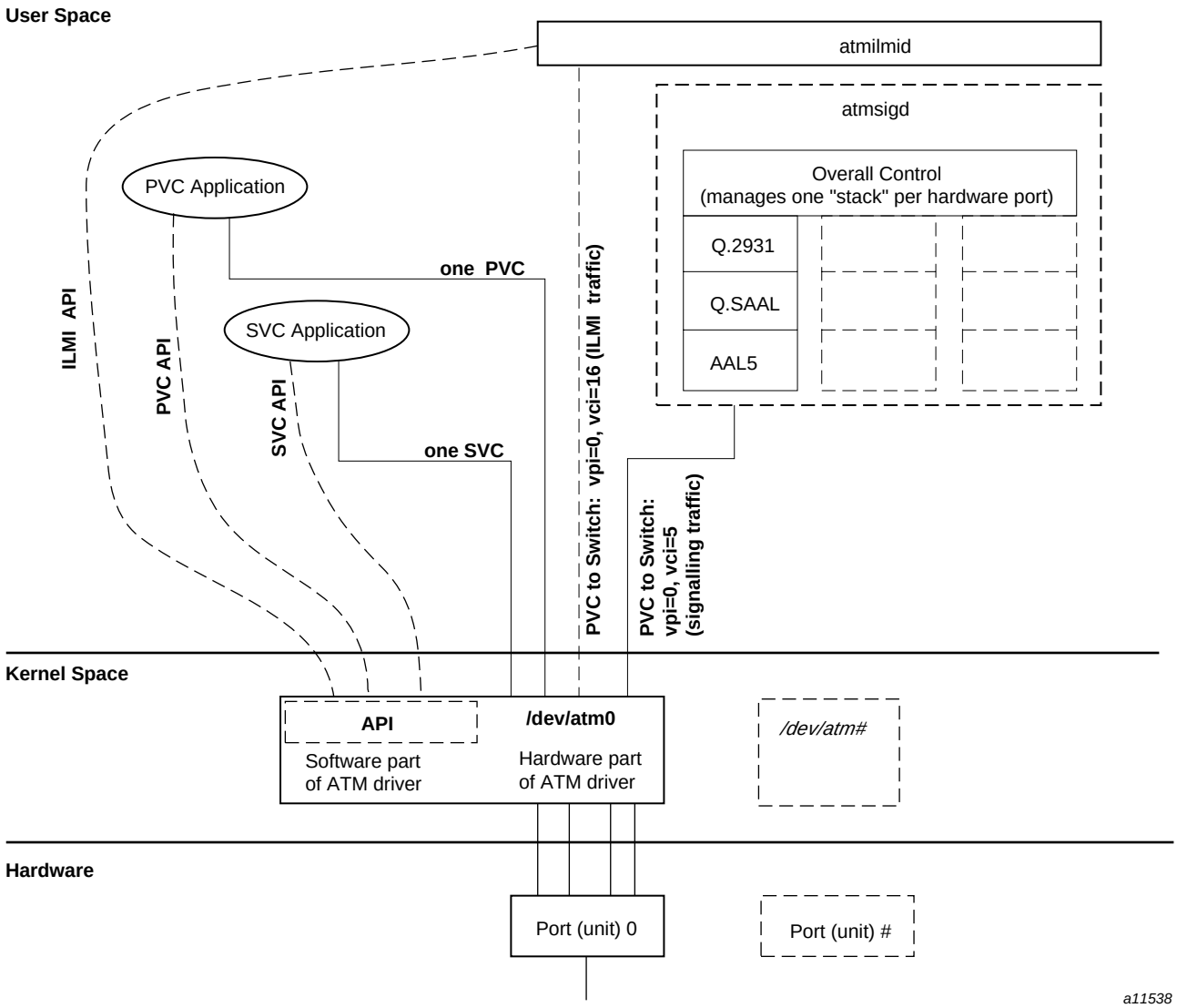


Figure 5. Overview of IRIS ATM Software Modules

Note: SVCs are created using `ATMIOC_SETUP` or `ATMIOC_REGISTER`, `ATMIOC_LISTEN`, and `ATMIOC_ACCEPT`. PVCs are created using `ATMIOC_CREATEPVC`.

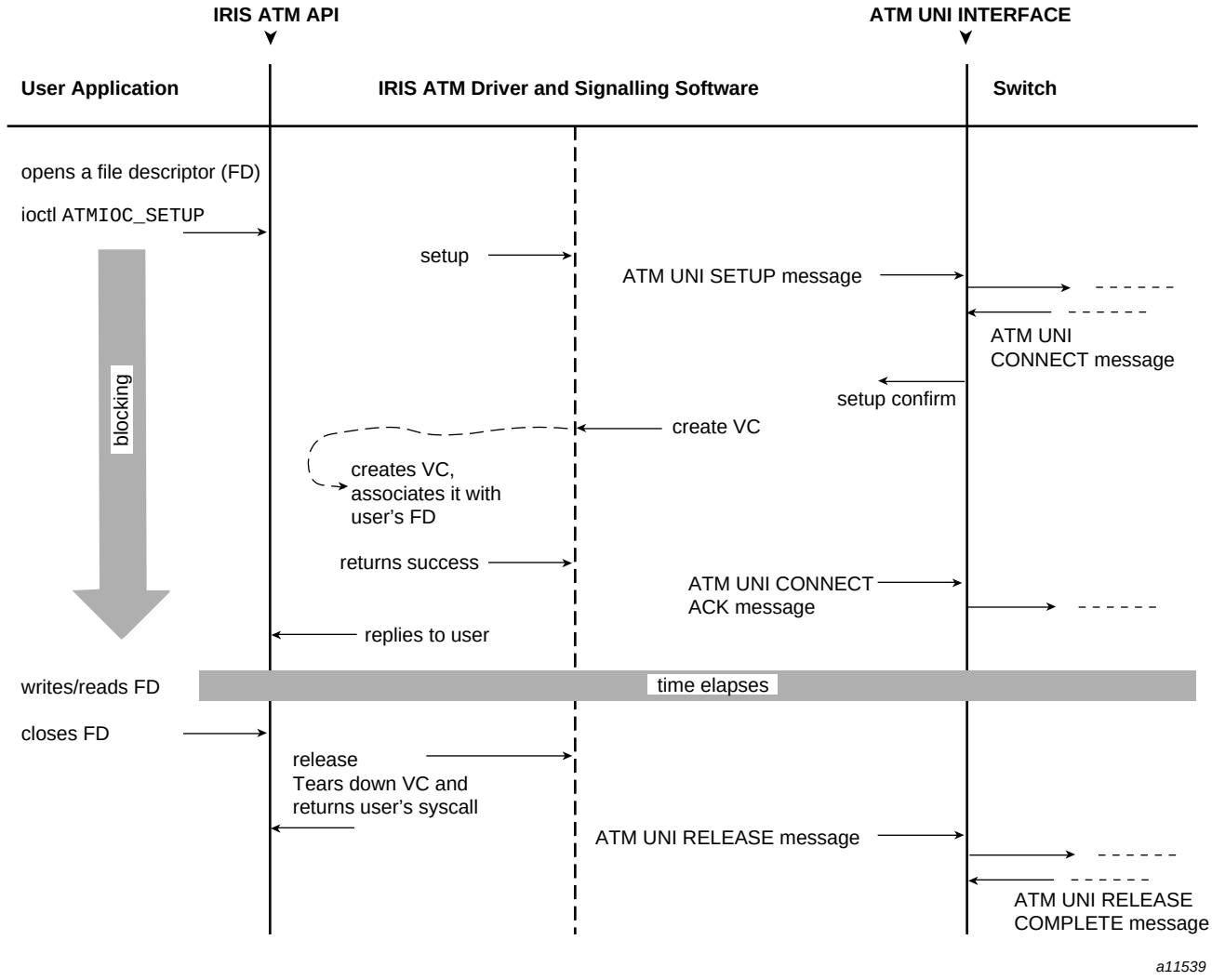


Figure 6. Successful Call Setup by Calling User

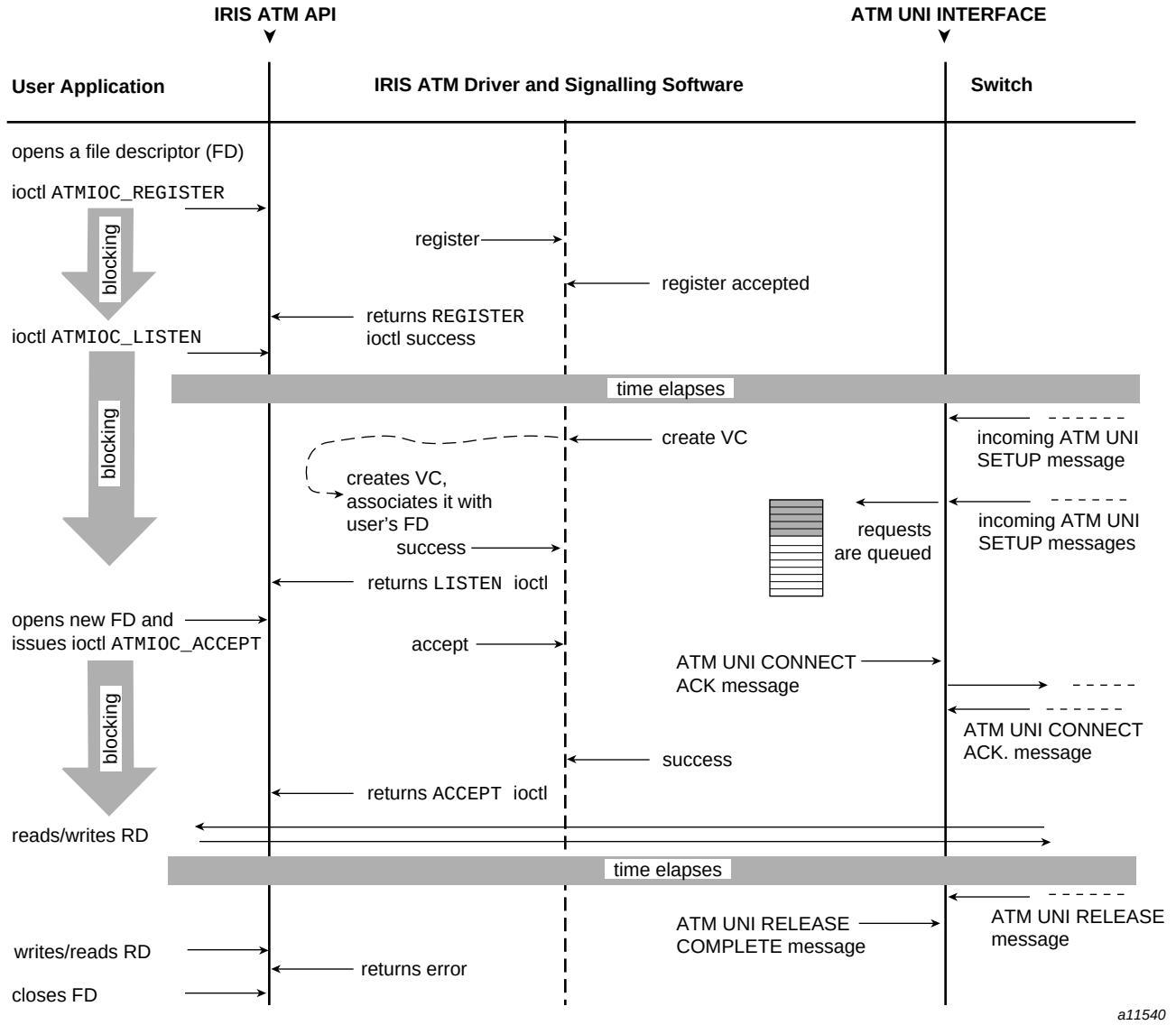


Figure 7. Successful Call Setup by Called User

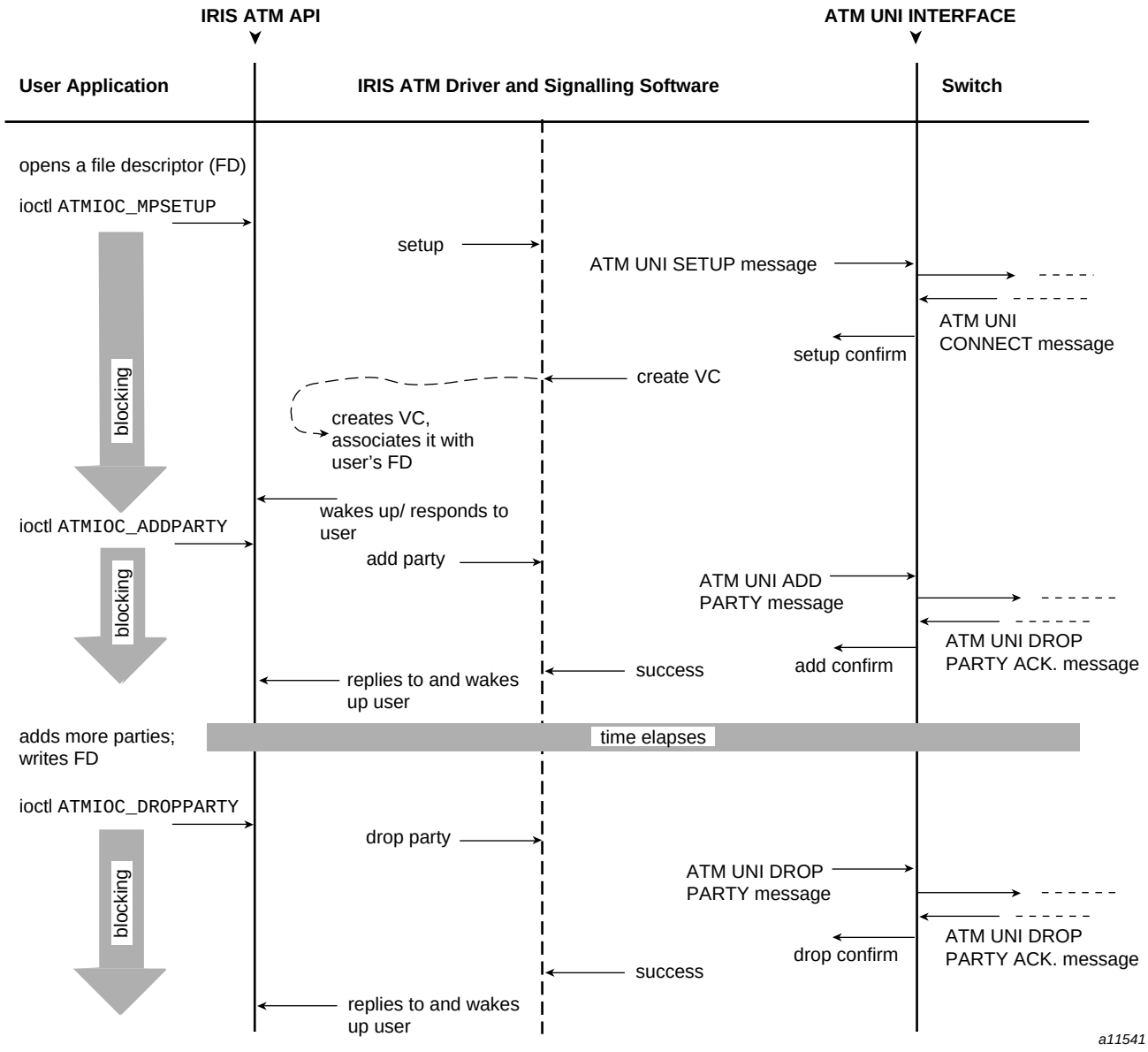


Figure 8. Successful Call Setup for Multicast SVC

3.3 Frequently Used Structures

The data structures described in this section are used as arguments for many of the ATM signaling `ioctl()` calls.

3.3.1 The `atm_address_t` Structure

The `atm_address_t` structure contains an ATM subsystem's network layer address, used for identifying users (the two endpoints) of a VC. Separate addresses are used for the called and the calling ATM subsystems. All fields of this address, except the `ESI` and `SEL` fields of the ATM network service access point (NSAP), are assigned by an endpoint's switch.

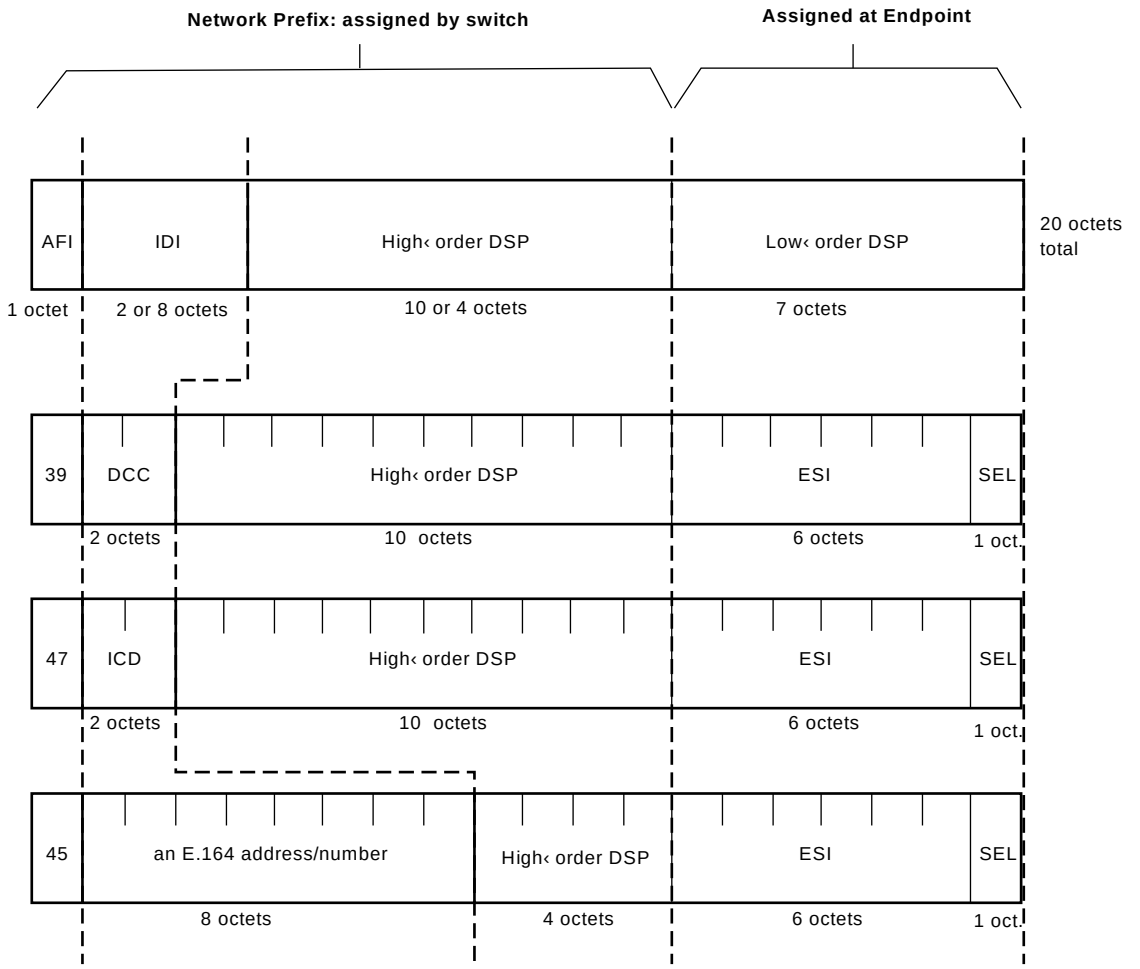
Table 19, page 59, describes the `atm_address_t` structure. The first byte (`addrType` field) of the structure indicates the type of address: null, ATM NSAP, or native-E.164. The remaining field, `addr`, contains either a 20-byte ATM NSAP address (array of characters) or a variable-length E.164 address structure.

Table 19. The `atm_address_t` structure

Field	Type	Values

`addrType`	`char`	`NULLADDR_TYPE`: no address is specified.
		`NSAP_TYPE`
		`E164_TYPE`

`addr`	`union`	One of the following structures:
`nsap`	`array of char`	`atm_nsap_t[20]`: an array of 20 numerals. Table 20, page 61, and Figure 9, page 60, provide more details.
`e164`	`struct`	`atm_e164_t`: variable length structure (as described in next 2 rows).
`len`	`char`	Number of valid digits in `addr[]` array.
`addr[15]`	array of `char`	Up to 15 digits encoded in IA5 characters. Table 65, page 171 describes the IA5 character set.



AFI = authority and format identifier (8 bits)
IDI = initial domain identifier (16 or 64 bits)
DSP = domain specific part (136 or 88 bits)

DCC = data country code (16 bits)
ICD = international code designator (16 bits)
ESI = end system identifier; can be a MAC address (48 bits)
IRIS ATM registers port's MAC address for this field.
SEL = end system selector; defined by local system, not by ATM standard (8 bits)
IRIS ATM software makes this field match the logical network interface number, so *atm1* uses SEL=0x01 and *atm47* uses SEL=0x2F.

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Figure 9. ATM NSAP Format

Table 20. Contents for fields of ATM NSAP

Field	AFI Value[1]	IDI Content (Data Size, Field Length)	DSP Length	Total Length of NSAP When in This Format
AFI_DCC	39	An ISO DCC value, which is a data country code from ISO 3166 (3-digit code, represented by 2 octets in which the unused least-significant 4 bits are set to ones).	17 octets	20 octets
AFI_E164	45	An E.164 address or number (up to 15 digits, represented by 8 octets in which the least significant 4 bits are ones, and any unused most-significant bits are set to zeros)	11 octets	20 octets
AFI_ICD	47	An ISO ICD value, which is an international code designator from ISO 6523 (4-digit code, represented by 2 octets)	17 octets	20 octets

Following is an example of the `atm_address` structure, as defined in the `sys/atm_user.h` file:

```
typedef struct atm_address {
      #define NULLADDR_TYPE 0 /* No address specified */
      #define NSAP_TYPE 0x02
      #define E164_TYPE 0x11

char addrType; /* one of the above types */
union {
          nsap_address_t nsap;
          e164_address_t e164;
      } addr;
} atm_address_t;

#define AFI_DCC 0x39
#define AFI_ICD 0x47
#define AFI_E164 0x45

typedef char nsap_address_t[20];
```

1 Encoded in binary-coded decimal (BCD) format, where each 4 bits encodes one decimal numeral. For example, 0001 0010 (binary) represents 12 decimal. Binary values 0xA to 0xF are not valid for BCD encoding.

```
typedef struct e164_address {
      unsigned char len;
      char addr[15];
} e164_address_t;
```

3.3.2 The `cellrate_t` Structure

The `cellrate_t` structure (described in Table 22, page 63) is used to specify an SVC's transmission rate and other traffic contract parameters. The user selects one of the cellrate types listed in Table 21, page 62, and specifies that selection in the first byte of the `cellrate_t` structure. The format for the remaining portions of the `cellrate_t` structure depends on the content of the `cellrate_type` field. The various formats are described in Table 22, page 63. The specified peak cellrate must be supported by the hardware subsystem, as described in the Section 1.5, page 18; each IRIS ATM board handles transmission rates differently.

Table 21. Values for `cellrate` Type

Value for `cellrate` Type Field	Description
`CRT_NULL`	Zero bandwidth.
`CRT_PEAK_AGG`	Aggregate peak cellrate for CLP0+1.
`CRT_PSB_AGG`	Aggregate peak cellrate, sustainable cellrate, and maximum burst size for CLP 0+1.
`CRT_BEST_EFFORT`	Peak cellrate for CLP0+1 with best-effort indication.
`CRT_PEAK`	Not supported in this release. Peak cellrates for CLP0 and CLP0+1.
`CRT_PEAK_TAG`	Not supported in this release. Same as `CRT_PEAK`, with tagging requested.
`CRT_PSB`	Not supported in this release. Peak cellrate for CLP0+1, sustainable cellrate for CLP0, maximum burst size for CLP0.
`CRT_PSB_TAG`	Not supported in this release. Same as `CRT_PSB`, with tagging requested.

Table 22. The `cellrate_t` structure

Field	Type	Values
`cellrate_type`	`char`	From Table 21, page 62.
`rate`	`union`	One of the following formats or structures:
`pcr_01`	`struct`	Use with `CRT_PEAK_AGG` and `CRT_BEST_EFFORT`
`pcr01`	`int`	Peak cellrate for CLP 0+1, in cells per second. Value must be supported by the IRIS ATM hardware, as described in Section 1.5, page 18.
`psb_01`	`struct`	Use with `CRT_PSB_AGG`.
`pcr01`	`int`	Peak cellrate for CLP 0+1, in cells per second. Value must be supported by the IRIS ATM hardware, as described in Section 1.5, page 18.
`scr01`	`int`	Sustainable cellrate for CLP 0+1, in cells per second. Value must be supported by the IRIS ATM hardware, as described in Section 1.5, page 18.
`mbs01`	`int`	Maximum burst size for CLP 0+1, in cells per burst. Valid values are multiples of 32 between 1 and 2,048, inclusive. Zero is not valid.

Following is an example of the `cellrate_type` structure, as defined in the `sys/atm_user.h` file:

```
typedef struct {
      char cellrate_type; /* a value from Table 21, page 62 */

      union {
          /* for cellrate_type = CRT_PEAK, CRT_PEAK_TAG */
          struct {
              int pcr0;
              int pcr01;
          } pcr_0_01;

          /* for cellrate_type = CRT_PEAK_AGG, CRT_BEST_EFFORT */
          struct {
              int pcr01;
          } pcr_01;

          /* for cellrate_type = CRT_PSB, CRT_PSB_TAG */
          struct {
              int pcr01;
              int scr0;
```

```
            int mbs0;
        } psb_0_01;

        /* for cellrate_type = CRT_PSB_AGG */
        struct {
            int pcr01;
            int scr01;
            int mbs01;
        } psb_01;

    } rate;
} cellrate_t;
```

3.3.3 The `reject_reason_t` Structure

Many of the `ioctl()` SVC commands provide information returned from the ATM network that indicates the cause when a signaling message fails or is rejected. The structure used for this information is `reject_reason_t`, summarized in Table 23, page 64.

Table 23. The `reject_reason_t` structure

Field	Type	Values
location	`char`	Identifies where along the VCC the failure or rejection occurred. Table 24, page 64, lists the values for this field.
cause	`char`	Describes the reason for the failure. Table 66, page 177, lists the values for this field.
diags[4]	array of `char`	Reserved for future use. Does not contain valid data.

Table 24. Values for *location* Field in the `reject_reason_t` Structure

Text	Value for *location* Field
User	0x00
Private network serving the local user	0x01

Text	Value for *location* Field
Public network serving the local user	0x02
Transit network	0x03
Public network serving the remote user	0x04
Private network serving the remote user	0x05
International network	0x07
Network beyond interworking point	0x0A

Following is an example of the `reject_reason_t` structure, as defined in the `sys/atm_user.h` file:

```
typedef struct {
      char cause;/* value from Table 66, page 177 or Table 67, page 180 */
      char location;/* value from Table 24, page 64 */
      char diags[4];/* reserved for future use */
} reject_reason_t;
```

3.3.4 The QoS Variables

The 1-byte quality of service variables (fwdQOS and bwdQOS) are used in a number of ATM signaling commands to specify the forward and backward ATM service classes. Table 25, page 65, summarizes the valid values.

Table 25. Values for QoS Variables

Text	Value for QoS Variable	Description
`QOS_CLASS_0`	0	Use with best-effort traffic.
`QOS_CLASS_1`	1	Use with constant bit rate (CBR).
`QOS_CLASS_2`	2	Use with variable bit rate (VBR).
`QOS_CLASS_3`	3	Use for connection-oriented data.
`QOS_CLASS_4`	4	Use for connectionless data.

3.3.5 The BLLI Variable

The broadband low layer information (BLLI) variable is used in a number of ATM signaling commands to specify or communicate the ATM user network interface (UNI) BLLI for a virtual channel connection (VCC). Calling parties can specify one to three BLLI options in their setup requests; after the request succeeds, the single negotiated BLLI option is returned in the first element of the array. Called parties register for one option. Each BLLI value can be registered (with `ATMIOC_REGISTER`) by only one process at a time. (This does not mean one VC, since by forking, the registered process can support multiple VCs, as explained in Section 3.5.1, page 68.) Table 26, page 66, summarizes the supported BLLI values.

When the `BLLI_ANY` value is specified in an `ATMIOC_REGISTER` call, any incoming BLLI value from the other party is accepted (including a null BLLI). Use of all other values requires that the other party's specified BLLI selection match exactly; if there is no match, the IRIS ATM software rejects the connection request and does not place it on a reception queue.

Table 26. Values for BLLI Variable

Text	Value for BLLI Variable	Description
`BLLI_NULL`	0	Null low layers. When used with `ATMIOC_SETUP`, always results in a negotiated BLLI of null. When used with `ATMIOC_REGISTER`, matches only to an incoming null BLLI.
`BLLI_ANY`	1	Any BLLI. Not valid for `ATMIOC_SETUP`. With `ATMIOC_REGISTER`, matches any BLLI, including null, on incoming setup requests.
`BLLI_LLC2`	2	Level 2 LLI = LLC. Whenever IP-over-ATM is enabled, this BLLI is registered (occupied) by the IP stack (the input queues for logical IP network interfaces), so other processes cannot receive on it. Additional `ATMIOC_REGISTER` commands fail.
`BLLI_LE_C`	3	LAN Emulation control.
`BLLI_LE_ENET`	4	LAN Emulation 802.3 data.
`BLLI_LE_ENET_MC`	5	LAN Emulation 802.3 multicast.

Text	Value for BLLI Variable	Description
BLLI_LE_TR	6	LAN Emulation 802.5 data.
BLLI_LE_TR_MC	7	LAN Emulation 802.5 multicast.

3.3.6 The BearerClass Variable

The 1-byte BearerClass variable is used in a number of ATM signaling commands to specify the broadband bearer (also called transport or network) capability. Table 27, page 67, summarizes the valid values. See ATM UNI 3.1, Appendix F, for usage guidelines.

Table 27. Values for BearerClass Variables

Text	Value for BearerClass Variable	Description
BCOB_A	1	For use with non-ATM endpoints. Intermediate network nodes may map the data to another format.
BCOB_C	2	For use with non-ATM endpoints. Intermediate network nodes may map the data to another format.
BCOB_X_UNSPEC	3	Use for best-effort ATM traffic.
BCOB_X_CBR	4	Use for constant bit rate (CBR) ATM traffic.
BCOB_X_VBR	5	Use for variable bit rate (VBR) ATM traffic.

3.3.7 The MaxCSDU Variables

CSDU is a shortened version of CPCS-SDU, which stands for common-part convergence sublayer service data unit. The 2-byte MaxCSDU integer value specifies the maximum size for the data units (packets) at the convergence sublayer of the AAL layer. This variable is subject to negotiation during connection setup, so the MaxCSDU sizes that are actually used are not necessarily those requested with the SETUP, MPSETUP, or REGISTER command.

Valid values range from 8 to 0x2FF8, and must be divisible by 8.

Separate MaxCSDU sizes are specified for the forward and the back channels of a VC. The fwdMaxCSDU size specifies a maximum packet size for the forward channel (that is, the channel on which the calling party transmits and the called party receives). The bwdMaxCSDU size specifies a maximum packet size for the back channel (that is, the channel on which the calling party receives and the called party transmits).

Note: The forward and back channels are always labeled from the calling party's viewpoint.

3.4 SVC Code Sample

An extensive sample of ATM-over-SVC code is provided in the file /usr/lib/atm/examples/sigtest.c.

3.5 SVC Commands

The following sections describe each ATM SVC ioctl() command in detail. The commands are organized alphabetically.

Note: In these descriptions, *forward* refers to the channel carrying data from the calling party to the called party, and *backward* refers to the channel carrying data (in the opposite direction) from the called party to the calling party.

3.5.1 ATMIOC_ACCEPT

The ATMIOC_ACCEPT ioctl() command accepts a connection setup request that has already been retrieved by an ATMIOC_LISTEN call. The file descriptor used in this call must be a new file descriptor for the same device used in the ATMIOC_REGISTER call. The application must block until the ATM software replies, which it does when an ATM UNI CONNECT ACKNOWLEDGE message returns from the calling party. The request is not removed from the queue until the call setup has completed (either by creating the SVC or by acknowledging a rejection). While waiting for the CONNECT ACKNOWLEDGE message, the program that made the ioctl() call is put to sleep.

Invoking this ioctl() command causes the ATM signaling software to generate an ATM UNI CONNECT message. (An ATMIOC_LISTEN ioctl() command must have completed successfully before the ATMIOC_ACCEPT command can be invoked.) If the application wants to open multiple SVCs

simultaneously for the associated traffic contract, it forks the new file descriptor (*new_fd_atm*) as soon as the ATMIOC_ACCEPT command returns. At that point, the application can retrieve (using ATMIOC_LISTEN) and accept (using ATMIOC_ACCEPT) the next item on the queue. The application can receive (read()) data from all its open SVCs.

When the application wants to close a receiving SVC (accept no more requests), it simply closes the file descriptor. If one or more child processes have been forked, and they are still running, they must be killed or must also close their file descriptors. When the original file descriptor is closed, the ATM signaling software generates an ATM UNI RELEASE message to the calling party.

3.5.1.1 Usage

Use the following format:

```
open (new_fd_atm, O_RDWR);
ioctl (new_fd_atm, ATMIOC_ACCEPT, &accept);
<wait for return, proceed as described in the next paragraph>
```

The *new_fd_atm* file descriptor is a new read-write file descriptor for the same ATM device used in the ATMIOC_REGISTER call, and *accept* is an atm_accept_t structure.

Once the ATMIOC_ACCEPT returns, one of the following actions must be taken:

- If it is desirable to continue accepting other calls on this SVC (specifically its BLLI value), the process should fork, then the parent process should close its copy of the *new_fd_atm* that was used in the ATMIOC_ACCEPT call. The parent process goes back to blocking on the ATMIOC_LISTEN call and processing new connection requests as they appear on the SVC's queue. The child process should close its copy of the file descriptor belonging to ATMIOC_LISTEN and use the open connection until it is finished, at which time it simply closes its file descriptor.
- If this is the only call for this SVC, the process should close the file descriptor from the ATMIOC_LISTEN call so that no more incoming calls are added to the queue. This releases the BLLI value associated with that SVC for registration by another process. The process can then proceed to read() and write() the *new_fd_atm* file descriptor.

3.5.1.2 Argument Values

The atm_accept_t structure should be prepared as described in Table 28.

Table 28. Recommended Values for the Argument of the ATMIOC_ACCEPT Command

Field in atm_accept_t	Type	Values
userHandle	int	The out value from ATMIOC_LISTEN.
callHandle	int	The out value from ATMIOC_LISTEN.

3.5.1.3 Success or Failure

If successful, ATMIOC_ACCEPT returns zero.

On failure, the ioctl() returns –1 with an error heading for descriptions of individual errors. For a description of possible errors, see Section 3.5.1.5, page 70

3.5.1.4 Relevant Structures

Following is an example of the atm_accept_t structure, as defined in the sys/atm_user.h file:

```
typedef struct {
      int userHandle;
      int callHandle;
} atm_accept_t;
```

3.5.1.5 Errors

Possible errors include:

EINTR	While waiting for the accept call to complete from over the network, the ioctl() was unexpectedly interrupted.
EINVAL	The file descriptor was already bound (for example, with ATMIOC_CREATEPVC, ATMIOC_SETUP, ATMIOC_MPSETUP, or ATMIOC_ACCEPT), or the userHandle or callHandle was not valid or belonged to a different application, or the supplied userHandle did not identify a registered queue, or the ATM software discovered that the queue was empty.

ENOTCONN	The connection request is no longer valid. It has timed out or has been released by the calling party.
EFAULT	An error occurred when the ATM software attempted to read the call's argument.
ENOSPC	The driver was not able to allocate a userHandle to the new file descriptor for the SVC.
ENODEV	The port was not in the up or down state or the port was not operational.

3.5.2 ATMIOC_ADDPARTY

The ATMIOC_ADDPARTY ioctl() command is invoked by a calling party to cause the ATM signaling software to add another party to an already existing point-to-multipoint connection. The ATM signaling software issues an ATM UNI ADDPARTY message. No backward channel is created for this SVC.

3.5.2.1 Usage

Use the following format:

ioctl (*mp_fd_atm*, ATMIOC_ADDPARTY, &*addparty*);

mp_fd_atm is the same file descriptor used in the ATMIOC_MPSETUP call and *addparty* is an atm_addparty_t structure.

3.5.2.2 Argument Values

The atm_addparty_t structure should be prepared as described in Table 29, page 71.

Table 29. Recommended Values for the Argument of the ATMIOC_ADDPARTY Command

Field in atm_addparty_t	Type	Values
addparams	struct	An addpartyparams_t structure as described in the following structures.
calledNumber	struct	See Section 3.3.1, page 59.

Field in `atm_addparty_t`	Type	Values
	`int`	A locally unique tag, supplied by the program making this call. The handle is for identifying each party on an existing multipoint connection or connection request. User is responsible for ensuring that all its active tags are unique within its own environment. This value is not used in any meaningful way by the ATM signaling software.
`reject`	`struct`	See Section 3.3.3, page 64. Upon failure, this field equals the out value, as follows. If the add request fails to create an SVC, this structure contains the reason. A zero indicates that the failure occurred in the driver (before contacting the ATM signaling daemon). A nonzero value indicates that the failure or rejection occurred at the called endpoint or at an intermediate system. The `cause` field identifies the cause for the failure as described in Table 67, page 180.

3.5.2.3 Success or Failure

If successful, `ATMIOC_ADDPARTY` returns zero.

When a failure occurs within the driver, the `ioctl()` returns –1 with an error stored in `errno`. For descriptions of individual errors, see Section 3.5.2.6, page 73. When the error occurs within the driver, the `reject` field is zero. When a failure is due to a negative response from the network, the `ioctl()` wakes the sleeping program and returns –1 with an `EIO` error stored in `errno`. The `reject` out value should be read.

3.5.2.4 Out Values

When the `ioctl()` fails to create a VCC for the party, the out value in the `reject` field of the argument contains one of the causes described in Table 67, page 180. A `reject` field of zero indicates that the `ioctl()` failed within the driver (not due to a negative response from the network).

3.5.2.5 Relevant Structures

The `atm_address_t` and `reject_reason_t` structures are described in Section 3.3, page 59.

Following is an example of the `addpartyparams_t` structure, as defined in the `sys/atm_user.h` file:

```
typedef struct {
      addpartyparams_t addparams;
      reject_reason_t reject;
} atm_addparty_t;

typedef struct {
      atm_address_t calledNumber;
      int partyHandle;
} addpartyparams_t;
```

3.5.2.6 Errors

Possible errors include:

EFAULT	An error occurred when the ATM software attempted to read the call's argument.
EINVAL	The SVC associated with the file descriptor is not connected or is not a multipoint connection (for example, the ATMIOC_MPSETUP command has not been called or did not succeed).
EIO	The add party call was rejected by the network (an intermediate system) or by the called party. The reasons have been written into the reject field of the argument (which is a reject_reason_t structure). See Section 3.3.3, page 64, and Table 67, page 180.
ENODEV	The port was not in the up or down state or the port was not operational.

3.5.3 ATMIOC_DROPPARTY

The ATMIOC_DROPPARTY ioctl() command is invoked by a calling party to cause the ATM signaling software to drop a called party from an existing point-to-multipoint connection. This ioctl() command causes the ATM signaling software to issue an ATM UNI DROPPARTY message.

3.5.3.1 Usage

Use the following format:

ioctl (*mp_fd_atm*, ATMIOC_DROPPARTY, &*dropparty*);

mp_fd_atm is the same file descriptor used in the ATMIOC_MPSETUP or ATMIOC_ADDPARTY call that was used to add the party, and *dropparty* is an atm_dropparty_t structure.

3.5.3.2 Argument Values

The atm_dropparty_t structure should be prepared as described in Table 30, page 74.

Table 30. Recommended Values for the Argument of the ATMIOC_DROPPARTY Command

Field in atm_dropparty_t	Type	Values
partyHandle	int	The tag that was supplied by the program when it added this party to the SVC.

3.5.3.3 Success or Failure

If successful, ATMIOC_DROPPARTY returns zero.

On failure, the ioctl() returns –1 with an error stored in errno. For descriptions of individual errors, see Section 3.5.3.5, page 74.

3.5.3.4 Relevant Structures

Following is an example of the atm_dropparty_t structure, as defined in the sys/atm_user.h file:

```
typedef struct {
      int partyHandle;
} atm_dropparty_t;
```

3.5.3.5 Errors

Possible errors include:

EFAULT	An error occurred when the ATM software attempted to read the call's argument.
EINVAL	The SVC associated with the file descriptor is not connected or is not a multipoint connection (for

	example, the ATMIOC_MPSETU command has not been called or did not succeed).
ENODEV	The port was not in the up or down state or the port was not operational.

3.5.4 ATMIOC_GETVCCTABLEINFO

The ATMIOC_GETVCCTABLEINFO ioctl() command retrieves the entire virtual channel table (both transmit and receive VCs) from any IRIS ATM port. The port must be in the up state.

3.5.4.1 Usage

Use the following format:

```
ioctl (fd_atm, ATMIOC_GETVCCTABLEINFO, &sioc);
```

sioc is an atmsioc_t structure.

3.5.4.2 Argument Values

The pointer to *sioc* identifies an instance of an atmsioc_t structure. The atmsioc_t structure should be set up as summarized in Table 31, page 75.

Table 31. Recommended Values for the Argument of the ATMIOC_GETVCCTABLEINFO Command

Field of atmsioc_t	Recommended Value	Comments
**ptr*	Pointer to vcce[]	Pointer to location for retrieved information. Upon return, the out value equals the recommended value. Out value is an array of atm_vcce_t structures.
len	size of(vcce[MAX_FWD_VCS+MAX_RVS_VCS]);	Maximum possible size of the table. Upon return, the out value equals the recommended value. Out value is length of retrieved table.

3.5.4.3 Success or Failure

If successful, `ATMIOC_GETVCCTABLEINFO` returns zero. The out values should be read.

On failure, the `ioctl()` returns –1 with an error stored in `errno`. For descriptions of individual errors, see Section 3.5.4.6, page 77.

3.5.4.4 Out Values

The *len* field in the argument (*sioc*) is updated to contain the actual length of the retrieved data, as described in Table 31, page 75. The retrieved data is written to the array of `atm_vcce_t` structures. Each table entry is one `atm_vcce_t` structure, as described in Table 32.

Table 32. Values Retrieved by the `ATMIOC_GETVCCTABLEINFO` Command

Field of `atm_vcce_t`	Type	Description
`vpi`	`int`	Value for VPI
`vci`	`int`	Value for VCI
`xmit_cellrate`	`struct cellrate_t`	Transmit cellrate
`recv_cellrate`	`struct cellrate_t`	Receive (backward) cellrate
`xmitQOS`	`int`	Transmit quality of service
`recvQOS`	`int`	Receive (backward) quality of service

3.5.4.5 Relevant Structures

The `atmsioc_t` structure and the `atm_vcce_t` structure, as defined in the `sys/atm_user.h` file, are as follows:

```
typedef struct atmsioc {
      void *ptr;
      u_int len;
} atmsioc_t;

typedef struct {
```

```
        int         vpi;
        int         vci;
        cellrate_t  xmit_cellrate;
        cellrate_t  recv_cellrate;
        int         xmitQOS;
        int         recvQOS;
} atm_vcce_t;
```

3.5.4.6 Errors

Possible errors include:

EFAULT	An error occurred when the driver was copying the data.
EINVAL	The *len* specified in the argument is too small to contain the information being retrieved.
ENODEV	The port was not in the up state.

3.5.5 ATMIOC_LISTEN

The ATMIOC_LISTEN `ioctl()` command retrieves connection setup requests from the input queue created by the ATMIOC_REGISTER call. The program calling this `ioctl()` must block until the ATM software replies, which it does whenever there is a request on the queue. If there are currently no requests waiting, the caller of the `ioctl()` is put to sleep and awakened when a request becomes available.

Each invocation of this `ioctl()` retrieves the topmost (longest awaiting) item on the queue. Each retrieval provides identification tags (handles) and the negotiated traffic contract for the SVC, which may be different from the parameters specified in the ATMIOC_REGISTER call. The request is not actually removed from the queue until the request has been completely processed by an ATMIOC_ACCEPT or ATMIOC_REJECT.

> **Note:** An ATMIOC_REGISTER `ioctl()` command must have completed successfully before ATMIOC_LISTEN can be invoked.

3.5.5.1 Usage

Use the following format:

`ioctl (`*registered_fd_atm*`, ATMIOC_LISTEN, &`*listen*`);`

registered_fd_atm is the file descriptor used in the ATMIOC_REGISTER call, and *listen* is an atm_listen_t structure.

3.5.5.2 Argument Values

The argument is a pointer to an empty atm_listen_t structure (described in Table 33, page 78).

3.5.5.3 Success or Failure

If successful, ATMIOC_LISTEN returns zero. The out values should be read.

On failure, the ioctl() returns –1 with an error stored in errno. For descriptions of individual errors, see Section 3.5.5.6, page 79.

3.5.5.4 Out Values

When the ATMIOC_LISTEN ioctl() command completes successfully, each field of the call's argument contains information about one connection setup request from the input queue for the SVC associated with the file descriptor. The retrieved information describes the traffic contract for the connection, as described in Table 33.

Table 33. Values Retrieved by the ATMIOC_LISTEN Command

Field in atm_listen_t	Type	Values
userHandle	int	Unique value provided by the ATM signaling software to identify the application that invoked ATMIOC_LISTEN. The value must be used in future ioctl() calls for this SVC.
callHandle	int	Unique value provided by the ATM signaling software to identify this connection (SVC). The value must be used in future ioctl() calls for this SVC.
fwdMaxCSDU	u_short	The negotiated fwdMaxCSDU for the SVC. Value is always equal to or smaller than the value specified in ATMIOC_REGISTER. See Section 3.3.7, page 67.

Field in atm_listen_t	Type	Values
bwdMaxCSDU	u_short	The negotiated bwdMaxCSDU for the SVC. Value is always equal to or smaller than the value specified in ATMIOC_REGISTER. See Section 3.3.7, page 67
blli	char	The blli value for the SVC. See Section 3.3.5, page 66.
caller	struct	The ATM address of the calling party, as taken from the setup request. See Section 3.3.1, page 59.
xmitcellrate	struct	The cellrate for the SVC. See Section 3.3.2, page 62.

3.5.5.5 Relevant Structures

The atm_listen_t structure is described in Table 33, page 78. The atm_address_t and cellrate_t structures, and the MaxCSDU and blli variables are described in Section 3.3, page 59.

Following is an example of the atm_listen_t structure, as defined in the sys/atm_user.h file:

```
typedef struct {
      int userHandle;
      int callHandle;
      u_short fwdMaxCSDU;
      u_short bwdMaxCSDU;
      char blli;
      atm_address_t caller;
      cellrate_t xmitcellrate;
} atm_listen_t;
```

3.5.5.6 Errors

Possible errors include:

EFAULT	An error occurred when the ATM software was accessing the call's argument.
EINTR	While waiting for a request to appear on the queue, the call was interrupted unexpectedly.

ENODEV	The port was not in the up or down state or the port was not operational.

3.5.6 ATMIOC_MPSETUP

The ATMIOC_MPSETUP ioctl() command is invoked by a calling party to cause the ATM signaling software to initiate an ATM UNI SETUP request message for the first party on a point-to-multipoint channel. No backward channel is created, so the device must be write-only. The application must block until the ATM driver replies, which it does when the SVC is either ready to use or has been refused. The driver puts the calling process to sleep until the call is complete or has been rejected. To maximize throughput, set the size for the VC's user protocol data units (CSPDUs) to MAX_CS_PDU.

When the remote endpoint accepts the connection request, the driver wakes the caller up and returns the negotiated traffic contract, which can be different (smaller) than what was specified in the call. Once open, the SVC is accessed by write() calls to the specified file descriptor. The file descriptor opened for the ATM device (*fd_atm*) should be writable only.

To add additional parties and drop individual parties on this SVC, use the ATMIOC_ADDPARTY and ATMIOC_DROPPARTY commands.

To tear down this SVC, the application uses the ATMIOC_DROPPARTY command for each party that has been added to the SVC. This causes the ATM signaling software to generate an ATM UNI DROPPARTY message for each party, until only one party remains, at which point a RELEASE message is generated. After the final party is dropped, the application can close the file descriptor.

Note: If the application closes the file descriptor without calling ATMIOC_DROPPARTY for each party, the software still smoothly releases and tears down the SVC.

3.5.6.1 Usage

Use the following format:

```
ioctl (fd_atm, ATMIOC_MPSETUP, &mpsetup);
```

fd_atm is a write-only file descriptor for the desired ATM hardware, and mpsetup is an atm_mpsetup_t structure.

3.5.6.2 Argument Values

The `atm_mpsetup_t` structure should be prepared as described in Table 34, page 81.

Table 34. Recommended Values for the Argument of the `ATMIOC_MPSETUP` Command

Field in `atm_mpsetup_t`	Type	Values
`mpcallparams`	`struct`	Call setup parameters for point-to-multipoint calls
`calledNumber`	`struct`	See Section 3.3.1, page 59.
`callingNumber`	`struct`	See Section 3.3.1, page 59.
`fwdCSDU`	`u_short`	See Section 3.3.7, page 67. Upon return, this field equals the out value. When the `ioctl()` returns successfully, this field contains the negotiated value, which may be smaller than the original value.
`fwdCellRate`	`struct`	See Section 3.3.2, page 62.
`fwdQOS`	`char`	See Section 3.3.4, page 65.
`blliCount`	`char`	0–3. Number of BLLI values in `blli[]` field. When this count is set to zero, the software specifies `BLLI_NULL` (which is the same as setting `blliCount`=1 and `blli[0]=BLLI_NULL`).
`blli[3]`	`char`	See Section 3.3.5, page 66. Upon return, this field is equal to the out value. `blli[0]` indicates the `BLLI` selected for this VCC, which can be any of the original selections.
`bearerClass`	`char`	See Section 3.3.6, page 67.
`sscsType`	`char`	Zero. Reserved for future use.
`bhli`	`char`	Zero. Reserved for future use.

Field in atm_mpsetup_t	Type	Values
partyHandle	int	A locally unique tag supplied by the program making this call. The handle is for identifying each party on an existing multipoint connection or connection request. User is responsible for ensuring that all its active tags are unique within its own evironment. This value is not used in any meaningful way by the ATM signaling software.
reject	struct	See Section 3.3.3, page 64. Upon failure, this field is equal to the out value, as follows. If the setup request fails to create an SVC, this structure contains the reason. A zero indicates that the failure occurred in the driver (before contacting the ATM signaling daemon). A nonzero value indicates that the failure or rejection occurred at the called endpoint or at an intermediate system. The cause field identifies the cause for the failure as described in Table 67, page 180.

3.5.6.3 Success or Failure

If successful, ATMIOC_MPSETUP returns zero. The out values should be read.

When a failure occurs within the driver (before it has placed the request onto the network), the ioctl() returns –1 with an error stored in errno. For descriptions of individual errors, see Section 3.5.6.6, page 83. Under this condition, the reject field is zero. When a failure is due to a negative response from the network, the ioctl() wakes the sleeping program and returns –1 with an EIO error stored in errno. The reject out value contains information about the network's reason for the failure, so it should be read.

3.5.6.4 Out Values

When the ioctl() is successful, the calling party should check the values in the fwdMaxCSDU and blli[0] fields of the call's argument to discover the negotiated parameters. If the new values are acceptable, the calling party can start using the SVC. If the traffic contract is unacceptable (which really should not ever occur since the negotiated values are always lower), the application should close the file descriptor to close the connection. This action causes the IRIS ATM signaling subsystem to generate a RELEASE message.

When the ioctl() fails to create an SVC, the out value in the reject field of the argument contains one of the causes described in Table 67, page 180. A

`reject` field of zero indicates that the `ioctl()` failed within the driver (not due to a negative response from the network).

3.5.6.5 Relevant Structures

The `atm_address_t`, `cellrate_t`, and `reject_reason_t` structures, and the MaxCSDU, QOS, bearerClass, and blli variables are described in Section 3.3, page 59.

Following is an example of the `mpcallparams_t` structure, as defined in the `sys/atm_user.h` file:

```
typedef struct {
      mpcallparams_t callparams;
      reject_reason_t reject;
} atm_mpsetup_t;

typedef struct {
      atm_address_t calledNumber;
      atm_address_t callingNumber;
      u_short fwdMaxCSDU;
      cellrate_t fwdCellRate;
      char fwdQOS;
      char blliCount;
      char blli[3];
      char bearerClass;
      char sscsType; /* reserved*/
      char bhli; /* reserved*/
      int partyHandle;
} mpcallparams_t;
```

3.5.6.6 Errors

Possible errors include:

`EFAULT`	An error occurred when the ATM software attempted to read the call's argument.
`EINTR`	While waiting for a response from the switch, the driver was interrupted. The setup request cannot be completed. Try again.
`EINVAL`	The file descriptor was already bound (for example, with `ATMIOC_CREATEPVC`, `ATMIOC_SETUP`, `ATMIOC_MPSETUP`, or

	ATMIOC_ACCEPT) or the access mode (read or write) was incorrect.
EIO	The setup call was rejected by the network (an intermediate system) or by the called party. The reasons have been written into the reject field of the argument (which is a reject_reason_t structure). See Section 3.3.3, page 64, and Table 67, page 180.
ENODEV	The port was not in the up or down state or the port was not operational.
ENOSPC	The driver was not able to allocate a userHandle to the SVC.

3.5.7 ATMIOC_REGISTER

The ATMIOC_REGISTER ioctl() command is invoked by an application to inform the IRIS ATM signaling software that it is present and ready as a called party. The file descriptor must be open for read-write access. The application must block until the ATM driver replies, which it does when the SVC is either ready to use or has been refused. The driver puts the calling process to sleep until the software has completed the SVC registration. When the ATM subsystem replies to this ioctl(), the application should immediately call ATMIOC_LISTEN to retrieve the first queued connection request.

Each ATMIOC_REGISTER call defines a traffic contract. For each registered traffic contract, the ATM subsystem maintains a queue of incoming connection (SVC) setup requests. The ATM signaling software compares the registered traffic contracts to incoming connection setup request parameters. When the incoming values are higher than the registered values, the software negotiates down to the traffic contract. When the incoming values are equal to or smaller than the traffic contract, the software accepts the setup request and places it on the queue. This ioctl() fails if the specified traffic contract is currently registered.

When this ioctl() returns successfully, the ATM signaling software has created a queue of the length specified by the application and has started queuing incoming connection (ATM UNI SETUP) requests. As long as the file descriptor remains open, the ATM signaling software continues to queue requests.

When the application no longer accepts connection requests for this traffic contract, it simply closes the file descriptor. The ATM signaling software generates `ATM UNI RELEASE` messages for the unretrieved requests remaining in the queue, and stops accepting requests for the associated traffic contract. Once the file descriptor is closed, the application cannot retrieve any more of the queued connection requests.

3.5.7.1 Usage

Use the following format:

`ioctl (`*`fd_atm`*`, ATMIOC_REGISTER, &`*`register`*`);`

fd_atm is a read-write file descriptor for the desired ATM hardware, and *register* is an `atm_register_t` structure.

3.5.7.2 Argument Values

The `atm_register_t` structure should be prepared as described in Table 35, page 85.

Table 35. Recommended Values for the Argument of the `ATMIOC_REGISTER` Command

Field in `atm_register_t`	Type	Values
`fwdMaxCSDU`	`u_short`	Upper limit for size of a `CPCS-SDU` on calling party's forward channel. This value is compared to the requested value on incoming setup requests. A request is queued when the incoming value is equal to or smaller than this value. See Section 3.3.7, page 67.
`bwdMaxCSDU`	`u_short`	Upper limit for size of a `CPCS-SDU` on calling party's backward channel. This value is compared to the requested value on incoming setup requests. A request is queued when the incoming value is equal to or smaller than this value. See Section 3.3.7, page 67.
`listenQlength`	`short`	Maximum number of incoming setup requests that can be queued for this traffic contract.
`blli`	`char`	`BLLI` that is acceptable for these SVCs. When `BLLI_ANY` is specified, all incoming `BLLI` values are acceptable. See Section 3.3.5, page 66.

Field in atm_register_t	Type	Values
sscsType	char	Zero. Reserved for future use.
cause	int	Upon failure, this field is equal to the out value, as follows. If the register request fails to create an VCC, this field contains the reason. A zero indicates that the failure occurred in the driver (before contacting the ATM signaling daemon). A nonzero value indicates that the failure or rejection occurred at the network. The value identifies the cause for the failure as described in Table 67, page 180.

3.5.7.3 Success or Failure

If successful, ATMIOC_REGISTER returns zero.

When a failure occurs within the driver, the ioctl() returns –1 with an error stored in errno. For descriptions of individual errors, see Section 3.5.7.6, page 87. When the error occurs within the driver, the cause field is zero. When a failure is due to a negative response from the network, the ioctl() wakes the sleeping program and returns –1 with an EIO error stored in errno. The cause out value should be read.

3.5.7.4 Out Values

When the ioctl() fails to create a VCC for the party, the out value in the cause field of the argument contains one of the causes described in Table 67, page 180. A cause field of zero indicates that the ioctl() failed within the driver (not due to a negative response from the network).

3.5.7.5 Relevant Structures

The MaxCSDU and blli variables are described in Section 3.3, page 59.

Following is an example of the atm_register_t structure, as defined in the sys/atm_user.h file:

```
typedef struct {
      u_short fwdMaxCSDU;
      u_short bwdMaxCSDU;
      short listenQlength; /* Nmbr of outstndng reqs to queue */
      char blli;
      char sscsType; /* reserved for future use */
      int cause;  /* if ioctl fails with EIO, cause contains */
```

```
                /* a value from Table 67, page 180 */
} atm_register_t;
```

3.5.7.6 Errors

Possible errors include:

`EFAULT`	An error occurred when the ATM software attempted to read the call's argument.
`EINVAL`	The file descriptor was already bound (for example, with `ATMIOC_CREATEPVC`, `ATMIOC_SETUP`, `ATMIOC_MPSETUP`, or `ATMIOC_ACCEPT`) or the access mode (read or write) was incorrect or the *listenQlength* value was not valid.
`EIO`	The registration request was rejected, and the reason has been written into the `cause` field of the argument. See Table 67, page 180, for a complete list of the possible values (causes).
`ENOSPC`	The driver was not able to allocate a `userHandle` to the SVC.
`ENODEV`	The port was not in the up or down state or the port was not operational.

3.5.8 `ATMIOC_REJECT`

The `ATMIOC_REJECT` `ioctl()` command refuses a connection setup request (that has already been retrieved by `ATMIOC_LISTEN`) and indicates the reason for the rejection. (An `ATMIOC_LISTEN` `ioctl()` must have completed successfully before `ATMIOC_REJECT` can be invoked.) `ATMIOC_REJECT` is invoked on the same file descriptor as the `ATMIOC_LISTEN` call. This `ioctl()` causes the ATM signaling software to issue an `ATM UNI RELEASE` message.

The explanation for the rejection is given in the call's argument and can be any of the ATM UNI cause codes, summarized in Table 67, page 180.

The program calling this `ioctl()` can retrieve the next request from the queue immediately.

Note: This `ioctl()` cannot be used to release an existing SVC or to stop queuing SVC requests onto a registered queue. To stop accepting SVC setup requests, an application must close the file descriptor associated with the `ATMIOC_REGISTER`. To clear an active SVC, the calling application closes the file descriptor associated with `ATMIOC_SETUP`.

3.5.8.1 Usage

Use the following format:

`ioctl (`*listen_fd_atm*`, ATMIOC_REJECT, &`*reject*`);`

listen_fd_atm is the same file descriptor used in the `ATMIOC_LISTEN` call, and *reject* is an `atm_reject_t` structure.

3.5.8.2 Argument Values

The `atm_reject_t` structure should be prepared as described in Table 36, page 88.

Table 36. Recommended Values for the Argument of the `ATMIOC_REJECT` Command

Field in `atm_reject_t`	Type	Values
`callHandle`	`int`	This value must be the out value from `ATMIOC_LISTEN` for this SVC.
`cause`	`int`	The reason the application is rejecting the setup request. Can be any of the ATM UNI causes listed in Table 67, page 180.

3.5.8.3 Success or Failure

If successful, `ATMIOC_REJECT` returns zero.

On failure, the `ioctl()` returns –1 with an error stored in `errno`. For descriptions of individual errors, see Section 3.5.8.5, page 89.

3.5.8.4 Relevant Structures

Following is an example of the `atm_reject_t` structure, as defined in the `sys/atm_user.h` file:

```
typedef struct {
      int callHandle;
      int cause;
} atm_reject_t;
```

3.5.8.5 Errors

Possible errors include:

EFAULT	An error occurred when the ATM software attempted to read the call's argument.
EINVAL	The supplied `callHandle` did not identify a registered queue or the ATM software discovered that the queue was empty.
ENODEV	The port was not in the up or down state or the port was not operational.

3.5.9 ATMIOC_SETUP

The ATMIOC_SETUP `ioctl()` command is invoked by a calling party to set up a point-to-point SVC with traffic contract parameters specified in the call's argument. The application must block until the ATM driver replies, which it does when the SVC is either ready to use or has been refused. The driver puts the calling process to sleep until the call is complete or has been rejected.

This `ioctl()` causes the ATM signaling software to initiate an ATM UNI SETUP request message for creation of both a forward and a backward channel. To maximize throughput, set the size for the forward VC's user protocol data units (CSPDUs) to MAX_CS_PDU. When the remote endpoint accepts the connection request, the driver wakes the caller up and returns the negotiated traffic contract, which can be different (smaller) than what was specified in the call. Once open, the SVC is accessed by `read()` operations from and `write()` operations to the specified file descriptor. The file descriptor opened for the ATM device (*fd_atm*) should be readable and writable.[2]

To tear down this SVC, the application simply closes the file descriptor. This causes the ATM signaling software to generate an ATM UNI RELEASE message.

2 It is not possible to create a unidirectional SVC.

3.5.9.1 Usage

Use the following format:

```
ioctl (fd_atm, ATMIOC_SETUP, &setup);
```

fd_atm is a read-write file descriptor for the desired ATM hardware and *setup* is an `atm_setup_t` structure.

3.5.9.2 Argument Values

The `atm_setup_t` structure should be prepared as described in Table 37.

Table 37. Recommended Values for the Argument of the `ATMIOC_SETUP` Command

Field in `atm_setup_t`	Recommended Value	Values
`ppcallparams`	`struct`	Call setup parameters for point-to-point calls
`calledNumber`	`struct`	See Section 3.3.1, page 59.
`callingNumber`	`struct`	See Section 3.3.1, page 59.
`fwdMaxCSDU`	`u_short`	See Section 3.3.7, page 67. Set to `MAX_CS_PDU` for optimal throughput. Upon return, this field equals the out value, as follows: When the `ioctl()` returns successfully, this field contains the negotiated value, which may be smaller than the original value.
`bwdMaxCSDU`	`u_short`	See Section 3.3.7, page 67. Upon return, this field equals the out value, as follows: When the `ioctl()` returns successfully, this field contains the negotiated value, which may be smaller than the original value.
`fwdCellRate`	`struct`	See Section 3.3.2, page 62.
`bwdCellRate`	`struct`	See Section 3.3.2, page 62.
`fwdQOS`	`char`	See Section 3.3.4, page 65.
`bwdQOS`	`char`	See Section 3.3.4, page 65.
`blliCount`	`char`	0–3. Number of `BLLI` values in `blli[]` field. When this count is set to zero, the software specifies `BLLI_NULL` (which is the same as setting `blliCount`=1 and `blli[0]`=`BLLI_NULL`).

Field in atm_setup_t	Recommended Value	Values
blli[3]	array of char	See Section 3.3.5, page 66. Upon return, this field equals the out value, as follows: When the ioctl() returns successfully, the first element (blli[0]) contains the negotiated value, which can be any one of the original values.
bearerClass	char	See Section 3.3.6, page 67.
sscsType	char	Zero. Reserved for future use.
reject	struct	See Section 3.3.3, page 64. Upon failure, this field equals the out value, as follows: If the setup request fails to create a SVC, this structure contains the reason. A zero indicates that the failure occurred in the driver (before contacting the ATM signaling daemon). A nonzero value indicates that the failure or rejection occurred at the called endpoint or at an intermediate system. The cause field identifies the cause for the failure as described in Table 67, page 180.

3.5.9.3 Success or Failure

If successful, ATMIOC_SETUP returns zero. The out values should be read.

When a failure occurs within the driver (before it has placed the request onto the network), the ioctl() returns –1 with an error stored in errno. For descriptions of individual errors, see Section 3.5.9.6, page 92. Under this condition, the reject field is zero. When a failure is due to a negative response from the network, the ioctl() wakes the sleeping program and returns –1 with an EIO error stored in errno. The reject out value contains information about the network's reason for the failure, so it should be read.

3.5.9.4 Out Values

The calling party should check the values in the xxxMaxCSDU and blli[0] fields of the call's argument to discover the negotiated parameters. If the new values are acceptable, the calling party can start using the SVC. If the traffic contract is unacceptable (which really should not ever occur since the negotiated values are always lower), the application should close the file descriptor to close the connection. This action causes the IRIS ATM signaling subsystem to generate a RELEASE message.

When the ioctl() fails to create an SVC, the out value in the reject field of the argument contains one of the causes described in Table 67, page 180. A

`reject` field of zero indicates that the `ioctl()` failed within the driver (not due to a negative response from the network).

3.5.9.5 Relevant Structures

The `atm_address_t`, `cellrate_t`, and `reject_reason_t` structures, and the MaxCSDU, QOS, bearerClass, and blli variables are described in Section 3.3, page 59.

Following is an example of the `ppcallparams` structure, as defined in the `sys/atm_user.h` file:

```
typedef struct {
      ppcallparams_t callparams;
      reject_reason_t reject;
} atm_setup_t;

typedef struct {
      atm_address_t calledNumber;
      atm_address_t callingNumber;
      u_short fwdMaxCSDU, bwdMaxCSDU;
      cellrate_t fwdCellRate,bwdCellRate;
      char fwdQOS, bwdQOS;
      char blliCount;
      char blli[3];
      char bearerClass;
      char sscsType; /* reserved for future use */
      char bhli; /* reserved for future use */
} ppcallparams_t;
```

3.5.9.6 Errors

Possible errors include:

`EFAULT`	An error occurred when the ATM software attempted to read the call's argument.
`EINTR`	While waiting for a response from the switch, the driver was interrupted. The setup request cannot be completed. Try again.
`EINVAL`	The file descriptor was already bound (for example, with `ATMIOC_CREATEPVC`, `ATMIOC_SETUP`, `ATMIOC_MPSETUP`, or

	ATMIOC_ACCEPT) or the access mode (read or write) was incorrect.
EIO	The setup call was rejected by the network (an intermediate system) or by the called party. The reasons have been written into the `reject` field of the argument (which is a `reject_reason_t` structure). See Section 3.3.3, page 64, and Table 67, page 180.
ENODEV	The port was not in the up or down state or the port was not operational.
ENOSPC	The driver was not able to allocate a `userHandle` to the SVC.

Commands for Use by ILMI Modules [4]

This chapter summarizes the IRIS ATM application interface calls provided for use by interim local management interface (ILMI) modules. The calls allow an ILMI module to communicate with the IRIS ATM subsystem in retrieving and configuring user network interface (UNI) and management information base (MIB) information. In most situations, these calls do not need to be used by customer-developed applications because the IRIS ATM ILMI software (`atmilmid`) does the tasks described in this chapter. However, these commands are provided for customers who want to use their own ILMI software for ATM network management. For a summary of these commands, see Table 38.

Table 38. Summary of ILMI `ioctl()` Commands

Command	Port State	Description	More Info
`ATMIOC_GETMIBSTATS`	up/dn	Retrieves data from an ATM subsystem for the ATM UNI MIB.	Section 4.2.3, page 101
`ATMIOC_GETPORTINFO`	up/dn	Retrieves status and hardware specification information about the device.	Section 4.2.4, page 102
`ATMIOC_GETATMLAYERINFO`	up/dn	Retrieves configuration information about the ATM layer of the device.	Section 4.2.2, page 99
`ATMIOC_GETVCCTABLEINFO`	up/dn	Retrieves information about all the VCCs currently open on the device.	Section 4.2.5, page 105
`ATMIOC_GETATMADDR`	up/dn	Retrieves the device's ATM address.	Section 4.2.1, page 96
`ATMIOC_SETATMADDR`	up/dn	Sets (configures) the ATM address for the device.	Section 4.2.6, page 108
`ATMIOC_GETMACADDR`		Retrieves the device's MAC address.	Section 5.2.4, page 122

4.1 Include Files for ILMI Programs

The following files must be included in any program using ILMI ATM-specific `ioctl()` calls:

- `''sys/atm.h''`
- `''sys/atm_user.h''`

4.2 ILMI Commands

The following sections describe each ATM ILMI `ioctl()` command in detail. The commands are organized alphabetically.

4.2.1 ATMIOC_GETATMADDR

The `ATMIOC_GETATMADDRioctl()` command is invoked by an ILMI module to retrieve the ATM address that is currently being used on the device (port).

4.2.1.1 Usage

Use the following format:

`ioctl (`*fd_atm*`,ATMIOC_GETATMADDR, &`*address*`);`

address is an `atm_address_t` structure.

4.2.1.2 Argument Values

The argument is a pointer to an empty `atm_address_t` structure (described in Table 39, page 97).

4.2.1.3 Success or Failure

If successful, `ATMIOC_GETATMADDR` returns zero. The out values should be read.

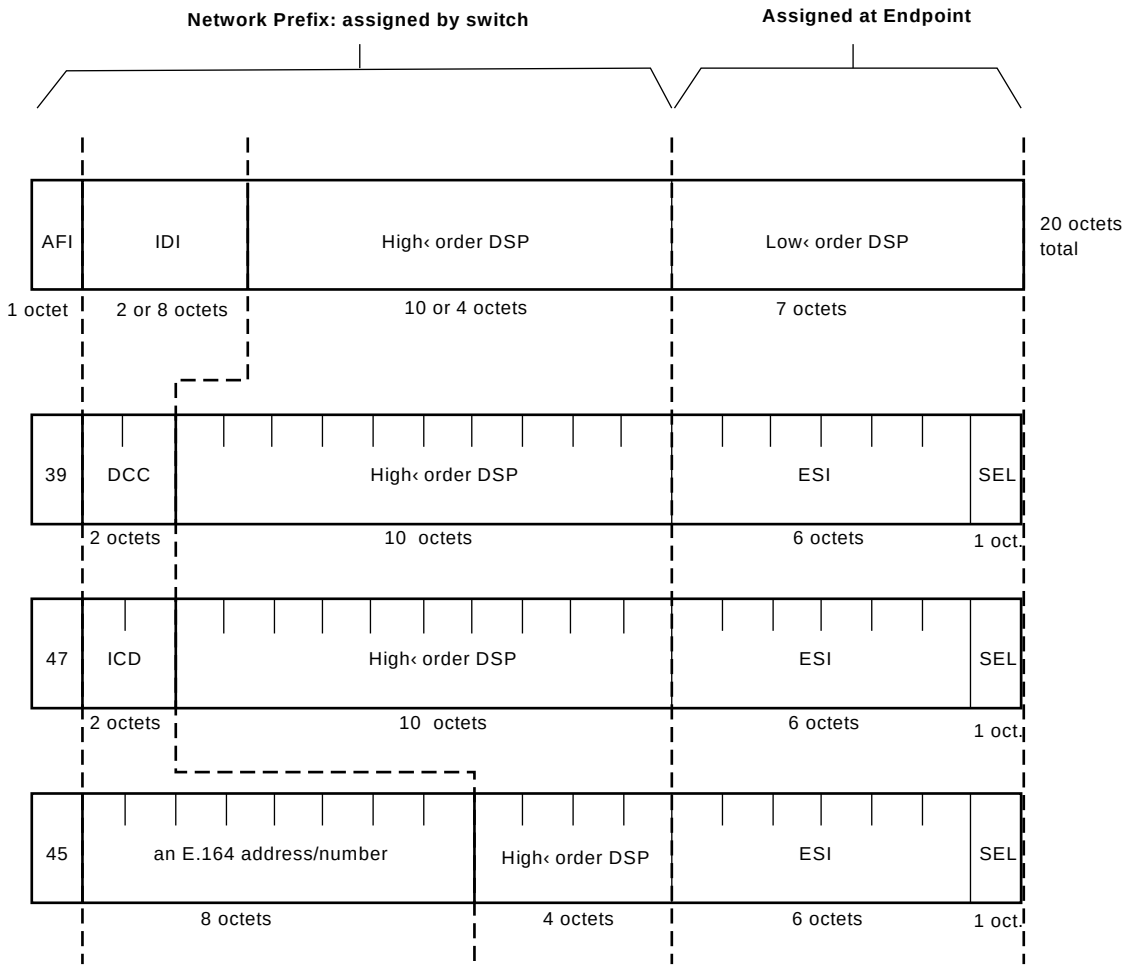
On failure, the `ioctl()` returns –1 with an error stored in `errno`. For descriptions of individual errors, see Section 4.2.1.6, page 99.

4.2.1.4 Out Values

The retrieved ATM address, described in Table 39 and Figure 10, page 98, is copied into the call's argument. The address can be either the ATM network service access point (NSAP) or the native-E.164 format.

Table 39. Values Retrieved by the `ATMIOC_GETATMADDR` Command

Field in `atm_address_t`	Type	Values
`addrType`	`char`	The type of ATM address: 0 = `NULLADDR_TYPE` 0x02 = `NSAP_TYPE` 0x11 = `E164_TYPE`
`addr`	`union`	
`nsap`	`char nsap_address_t[20]`	See Figure 10, page 98.
`e164`	`e164_address_t`	Up to 15 bytes. See the definition in Section 4.2.1.5, page 99.



AFI = authority and format identifier (8 bits)
IDI = initial domain identifier (16 or 64 bits)
DSP = domain specific part (136 or 88 bits)

DCC = data country code (16 bits)
ICD = international code designator (16 bits)
ESI = end system identifier; can be a MAC address (48 bits)
IRIS ATM registers port's MAC address for this field.
SEL = end system selector; defined by local system, not by ATM standard (8 bits)
IRIS ATM software makes this field match the logical network interface number, so *atm1* uses SEL=0x01 and *atm47* uses SEL=0x2F.

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Figure 10. ATM Address: NSAP Format

4.2.1.5 Relevant Structures

The `atm_address_t` structure is defined in the `sys/atm_user.h` file, as follows:

```
typedef struct atm_address {
      char addrType;
      union {
          nsap_address_t nsap;
          e164_address_t e164;
      } addr;
} atm_address_t;
typedef char nsap_address_t[20];
typedef struct e164_address {
      unsigned char len;
      char addr[15];
} e164_address_t;
```

4.2.1.6 Errors

Possible errors include:

`EFAULT`	An error occurred when the ATM software attempted to write the call's argument.
`ENODEV`	The port was not in the up or down state or the port was not operational.

4.2.2 ATMIOC_GETATMLAYERINFO

The `ATMIOC_GETATMLAYERINFO ioctl()` command is invoked by an ILMI application to retrieve information about the ATM layer for inclusion in an ATM management information database (MIB).

4.2.2.1 Usage

Use the following format:

`ioctl (`*fd_atm*`, ATMIOC_GETATMLAYERINFO, &`*layerinfo*`);`

layerinfo is an `atm_layerinfo_t` structure.

4.2.2.2 Argument Values

The argument is a pointer to an empty `atm_layerinfo_t` structure.

4.2.2.3 Success or Failure

If successful, `ATMIOC_GETATMLAYERINFO` returns zero. The out values should be read.

On failure, the `ioctl()` returns –1 with an error stored in `errno`. For descriptions of individual errors, see Section 4.2.2.6, page 101.

4.2.2.4 Out Values

The retrieved values are copied to the structure pointed to by the call's argument, described in Table 40, page 100.

Table 40. Values Retrieved by the `ATMIOC_GETATMLAYERINFO` Command

Field in `atm_layerinfo_t`	Type	Values
`maxVPCs`	`int`	0 to 0xFF (inclusive)
`maxVCCs`	`int`	0 to 0xFFFFFF (inclusive)
`configuredVPCs`	`int`	0 to 0xFF (inclusive)
`configuredVCCs`	`int`	0 to 0xFFFFFF (inclusive)
`maxVPIbits`	`int`	0 to 0x8 (inclusive)
`maxVCIbits`	`int`	0 to 0x20 (inclusive)
`uniType`	`int`	The type of UNI maintained for the port: 1 = `PUBLIC_UNI` 2 = `PRIVATE_UNI 2`

4.2.2.5 Relevant Structures

The `atm_layerinfo_t` structure is described in Table 40, page 100, and defined in the `sys/atm_user.h` file, as follows:

```
typedef struct {
      int maxVPCs;
      int maxVCCs;
```

```
        int configuredVPCs;
        int configuredVCCs;
        int maxVPIbits;
        int maxVCIbits;
        int uniType;
} atm_layerinfo_t;
```

4.2.2.6 Errors

Possible errors include:

EFAULT	An error occurred when the ATM software attempted to write the call's argument.
ENODEV	The port was not in the up or down state.

4.2.3 ATMIOC_GETMIBSTATS

The ATMIOC_GETMIBSTATS ioctl() command is invoked by an ILMI application to retrieve overall performance information about the UNI for inclusion in an ATM management information database (MIB).

4.2.3.1 Usage

Use the following format:

ioctl (*fd_atm*, ATMIOC_GETMIBSTATS, &*mibstats*);

mibstats is an atm_getmibstats_t structure.

4.2.3.2 Argument Values

The argument is defined as a pointer to an empty atm_getmibstats_t structure.

4.2.3.3 Success or Failure

If successful, ATMIOC_GETMIBSTATS returns zero. The out values should be read.

On failure, the ioctl() returns –1 with an error stored in errno. For descriptions of individual errors, see Section 4.2.3.6, page 102.

4.2.3.4 Out Values

The retrieved values are copied to the structure pointed to by the call's argument, described in Table 41, page 102.

Table 41. Values Retrieved by the `ATMIOC_GETMIBSTATS` Command

Field in `atm_getmibstats_t`	Type	Description
`receivedCells`	`int`	Total number of ATM cells received.
`droppedReceivedCells`	`int`	Total number of ATM incoming cells that were dropped due to errors or unknown VPI or VCI addresses.
`cellsTransmitted`	`int`	Total number of ATM cells transmitted.

4.2.3.5 Relevant Structures

The `atm_getmibstats_t` structure is described in Table 41, and included below as defined in the `sys/atm_user.h` file:

```
typedef struct {
      int receivedCells;
      int droppedReceivedCells;
      int cellsTransmitted;
} atm_getmibstats_t;
```

4.2.3.6 Errors

Possible errors include:

`EFAULT`	An error occurred when the ATM software attempted to write the call's argument.
`ENODEV`	The port was not in the up or down state.

4.2.4 `ATMIOC_GETPORTINFO`

The `ATMIOC_GETPORTINFO` `ioctl()` command is invoked by an ILMI application to retrieve information about the hardware for inclusion in an ATM management information database (MIB).

4.2.4.1 Usage

Use the following format:

`ioctl (`*fd_atm*`, ATMIOC_GETPORTINFO, &`*portinfo*`);`

portinfo is an `atm_portinfo_t` structure.

4.2.4.2 Argument Values

The argument is a pointer to an empty `atm_portinfo_t` structure.

4.2.4.3 Success or Failure

If successful, `ATMIOC_GETPORTINFO` returns zero. The out values should be read.

On failure, the `ioctl()` returns –1 with an error stored in `errno`. For descriptions of individual errors, see Section 4.2.4.6, page 104.

4.2.4.4 Out Values

The retrieved values are copied to the structure pointed to by the call's argument, described in Table 42.

Table 42. Values Retrieved by the ATMIOC_GETPORTINFO Command

Field in atm_portinfo_t	Type	Values
portOperStatus	int	The status of the port: 1 = OPSTATUS_OTHER 2 = OPSTATUS_INSERVICE 3 = OPSTATUS_OUTOFSERVICE 4 = OPSTATUS_LOOPBACK
portXmitType	int	The physical layer protocol: 1 = XMITTYPE_UNKNOWN 2 = XMITTYPE_SONETSTS3C 3 = XMITTYPE_DS3 4 = XMITTYPE_4B5B 5 = XMITTYPE_8B10B
portMediaType	int	The type of transport medium used on the port: 1 = MEDIATYPE_UNKNOWN 2 = MEDIATYPE_COAX 3 = MEDIATYPE_SINGLEMODE 4 = MEDIATYPE_MULTIMODE 5 = MEDIATYPE_SHIELDEDTP 6 = MEDIATYPE_UNSHIELDEDTP

4.2.4.5 Relevant Structures

The atm_portinfo_t structure is described in Table 42, and defined in the sys/atm_user.h file, as follows:

```
typedef struct {
      int portOperStatus;
      int portXmitType;
      int portMediaType;
} atm_portinfo_t;
```

4.2.4.6 Errors

Possible errors include:

EFAULT — An error occurred when the ATM software attempted to write the call's argument.

ENODEV	The port was not in the up or down state.

4.2.5 ATMIOC_GETVCCTABLEINFO

The ATMIOC_GETVCCTABLEINFO ioctl() command is invoked by an ILMI module to retrieve information about each open virtual channel (VC). The retrieved listing includes permanent and switched VCs.

4.2.5.1 Usage

Use the following format:

```
ioctl (fd_atm, ATMIOC_GETVCCTABLEINFO, &sioc);
```

sioc is an atmsioc_t structure.

4.2.5.2 Argument Values

The pointer to *sioc* identifies an instance of an atmsioc_t structure. The atmsioc_t structure should be set up as summarized in Table 43.

Table 43. Recommended Values for the Argument of the ATMIOC_GETVCCTABLEINFO Command

Field of atmsioc_t	Recommended Value	Comments
**ptr*	Pointer to atm_vcce_t[]	Pointer to location for retrieved information. Upon return, this field is equal to the out value, which is an array of atm_vcce_t structures.
len	Size of (atm_vcce_t[MAX_FWD_VCS+ MAX_RVS_VCS])	Maximum possible size of the table. Upon return, this field is equal to the out value, which is the length of the retrieved table.

4.2.5.3 Success or Failure

If successful, ATMIOC_GETVCCTABLEINFO returns zero. The out values should be read.

On failure, the ioctl() returns –1 with an error stored in errno. For descriptions of individual errors, see Section 4.2.5.6, page 108.

4.2.5.4 Out Values

The *len* field in the argument (*sioc*) is updated to contain the actual length of the retrieved data, as described in Table 43, page 105. The retrieved data is written at the location indicated by the *sioc* pointer as an array of `atm_vcce_t` structures. Each table entry is one `atm_vcce_t` structure, as described in Table 44, page 106.

Table 44. Values Retrieved by the `ATMIOC_GETVCCTABLEINFO` Command

Field in `atm_vcce_t`	Type	Values
`vpi`	`int`	The VC's virtual path identifier.
`vci`	`int`	The VC's virtual channel identifier.
`xmit_cellrate`	`struct cellrate_t`	The VC's transmit cellrate. See Table 45, page 106.
`recv_cellrate`	`struct cellrate_t`	The VC's receive cellrate. See Table 45, page 106.
`xmitQOS`	`int`	The quality of service on the VC's transmit channel.
`recvQOS`	`int`	The quality of service on the VC's receive channel.

Table 45. Cellrate Values

Field	Type	Values
`cellrate_type`	`char`	From Table 21, page 62.
`rate`	`union`	One of the following structures.
`pcr_0_01`	`struct`	
`pcr0`	`int`	Peak cellrate for cell loss priority (CLP) 0, in cells per second
`pcr01`	`int`	Peak cellrate for CLP 0+1, in cells per second
`pcr_01`	`struct`	
`pcr01`	`int`	Peak cellrate for CLP 0+1, in cells per second
`psb_0_01`	`struct`	

Field	Type	Values
pcr01	int	Peak cellrate for CLP 0+1, in cells per second
scr0	int	Sustainable cellrate for CLP 0, in cells per second
mbs0	int	Maximum burst size for CLP 0, in cells per burst
psb_01	struct	
pcr01	int	Peak cellrate for CLP 0+1, in cells per second
scr01	int	Sustainable cellrate for CLP 0+1, in cells per second
mbs01	int	Maximum burst size for CLP 0+1, in cells per burst

4.2.5.5 Relevant Structures

The atm_vcce_t structure is described in Table 44, page 106, and included below as defined in the sys/atm_user.h file. The cellrate_t structure is described in Table 45, page 106, and is also defined in the sys/atm_user.h file, as follows:

```
typedef struct {
      int vpi;
      int vci;
      cellrate_t xmit_cellrate;
      cellrate_t recv_cellrate;
      int xmitQOS;
      int recvQOS;
} atm_vcce_t;
typedef struct {
      char cellrate_type;
      union {
          /* for cellrate_type = CRT_PEAK, CRT_PEAK_TAG */
          struct {
              int pcr0;
              int pcr01;
          } pcr_0_01;
          /* for cellrate_type = CRT_PEAK_AGG, CRT_BEST_EFFORT */
          struct {
              int pcr01;
          } pcr_01;
          /* for cellrate_type = CRT_PSB, CRT_PSB_TAG */
          struct {
              int pcr01;
```

```
            int scr0;
            int mbs0;
        } psb_0_01;
        /* for cellrate_type = CRT_PSB_AGG */
        struct {
            int pcr01;
            int scr01;
            int mbs01;
        } psb_01;
    } rate;
} cellrate_t;
```

4.2.5.6 Errors

Possible errors include:

EFAULT	An error occurred when the ATM software attempted to write the call's argument.
EINVAL	The argument's length is too small to accommodate the table. No data has been copied out.
ENODEV	The port was not in the up or down state.

4.2.6 ATMIOC_SETATMADDR

The ATMIOC_SETATMADDR ioctl() command is invoked by an ILMI module to set the ATM address for the port. The program making this call must have super user access privileges.

4.2.6.1 Usage

Use the following format:

ioctl (*fd_atm*, ATMIOC_SETATMADDR, &*address*);

address is an atm_address_t structure.

4.2.6.2 Argument Values

The atm_address_t structure should be prepared as described in Table 46.

Table 46. Recommended Values for the Argument of the ATMIOC_SETATMADDR Command

Field in atm_address_t	Type	Values
addrType	char	The type of ATM address: 0 = NULLADDR_TYPE 0x02 = NSAP_TYPE 0x11 = E164_TYPE
addr	union	
nsap	char nsap_address_t[20]	20 bytes, as illustrated in Figure 10, page 98.
e164	struct e164_address_t	
len	u_char	Number of digits in addr array.
addr	char addr[15]	Up to 15 digits.

4.2.6.3 Success or Failure

If successful, ATMIOC_SETATMADDR returns zero.

On failure, the ioctl() returns –1 with an error stored in errno. For descriptions of individual errors, see Section 4.2.6.5, page 110.

4.2.6.4 Relevant Structures

The atm_address_t structure is defined in the sys/atm_user.h file, as follows:

```
typedef struct atm_address {
      char addrType;
      union {
          nsap_address_t nsap;
          e164_address_t e164;
      } addr;
} atm_address_t;
typedef char nsap_address_t[20];
typedef struct e164_address {
      unsigned char len;
      char addr[15];
```

```
} e164_address_t;
```

4.2.6.5 Errors

Possible errors include:

EFAULT	An error occurred when the ATM software attempted to read the call's argument.
ENODEV	The port was not in the up or down state or the port was not operational.
EPERM	The program does not have super user access privileges.

Commands for Communicating with the Hardware [5]

This chapter summarizes the IRIS ATM application interface calls that communicate with IRIS ATM boards. These calls are device-specific and are not supported on devices other than the one for which they are created.

Table 47 provides a summary of hardware calls for the IRIS ATM-OC3c HIO mezzanine board.

Table 47. Summary of Hardware Calls for the IRIS ATM-OC3c HIO Mezzanine Board

Type of Operation	Command (or function)	Usage	Board State	Description	More Info
Retrieving board status and information					
	`ATMIOC_GETIOSTAT`		all	Retrieves internal driver statistics.	Section 5.2.3, page 120
	`ATMIOC_GETSTAT`		all	Retrieves current status information from hardware.	Section 5.2.7, page 126
	`ATMIOC_GETCONF`		up/dn	Reads configuration information from board.	Section 5.2.2, page 116
	`ATMIOC_GETOPT`	root only	up/dn	Retrieves settings for board's operating modes or options.	Section 5.2.5, page 123

Type of Operation	Command (or function)	Usage	Board State	Description	More Info
	ATMIOC_GETRATEQ		up	Retrieves the setting for one of the board's eight transmission rates.	Section 5.2.6, page 124
	ATMIOC_GETMACADDR		up/dn	Retrieves the medium access control (MAC) address from the board.	Section 5.2.4, page 122
Configuring the board					
	ATMIOC_SETCONF	root only	up/dn	Configures the board.	Section 5.2.8, page 132
	ATMIOC_SETOPT	root only	up/dn	Sets (configures) the board's operating modes or options: loopback and clock recovery.	Section 5.2.9, page 135
	ATMIOC_SETRATEQ	root only	up	Sets the transmission rate on one of the eight queues.	Section 5.2.10, page 138
Controlling the board					
	ATMIOC_CONTROL	root only	all	Transitions the board to a different state: UP: to up state, INIT: to down state, RESET: to pre-init state	Section 5.2.1, page 114

Table 48 provides a summary of hardware calls for the IRIS ATM-OC3c 4Port XIO board.

Table 48. Summary of Hardware Calls for the IRIS ATM-OC3c 4Port XIO Board

Type of Operation	Command (or function)	Usage	Port's State	Description	More Info
Retrieving port status and information					
	ATMIOC_GETIOSTAT			Retrieves internal driver statistics.	Section 5.2.3, page 120
	ATMIOC_GETSTAT		all	Retrieves current status information from hardware.	Section 5.2.7, page 126
	ATMIOC_GETCONF		up/dn	Reads configuration information from port.	Section 5.2.2, page 116
	ATMIOC_GETOPT	root only	up/dn	Retrieves settings for port's operating modes/options.	Section 5.2.5, page 123
	ATMIOC_GETMACADDR		up/dn	Retrieves the medium access control (MAC) address from port.	Section 5.2.4, page 122
Configuring the port					
	ATMIOC_SETCONF	root only	dn	Configures the ATM-OC3c port.	Section 5.2.8, page 132
	ATMIOC_SETOPT	root only	up/dn	Sets (configures) the port's operating modes/options: loopback and clock recovery.	Section 5.2.9, page 135

Type of Operation	Command (or function)	Usage	Port's State	Description	More Info
Controlling the port					
	`ATMIOC_CONTROL`	root only	all	Transitions the hardware to a different state: `UP`: to up state, `INIT`: to down state, `RESET`: to pre-init state	Section 5.2.1, page 114

5.1 Include Files for Hardware Calls

The following file must be included in any program using the ATM-specific `ioctl()` calls for controlling the hardware:

- `''sys/atm_user.h''`

5.2 Hardware Commands

The following sections describe each ATM hardware control `ioctl()` command in detail. The commands are organized alphabetically.

5.2.1 `ATMIOC_CONTROL`

The `ATMIOC_CONTROL ioctl()` command changes the state of the ATM-OC3 port. This command is available only to the super user.

Before power-on, the state of the ATM-OC3c port is dead. Once powered on, the ATM-OC3 port has the following three possible states:

- Pre-initialized (pre-init): The port is ready to be initialized. This state exists after each reset of the port. The only commands available in this state are `ATMIOC_CONTROL` with the `INIT` argument and `ATMIOC_GETSTAT`.
- Down: The port is initialized, active, and ready to respond to the driver; however, the port is not receiving or transmitting over its network connection. In this state, the port's on-board memory can be configured and written, and firmware can be downloaded into the programmable read-only memory (PROM).
- Up: The port is receiving and transmitting over its network connection.

5.2.1.1 Usage

Use the following format:

`ioctl (`*fd_atm*`, ATMIOC_CONTROL,` *int*`);`

int is one of the values from Table 49.

5.2.1.2 Argument Values

The *int* argument's values are described in Table 49.

Table 49. Values for the Argument of the `ATMIOC_CONTROL` Command

int	Port State	Description
`ATM_CONTROL_RESET`	Any	Allowed under all conditions. Shuts down port, throws away all in-progress data and host-to-port commands, and puts port into pre-initialized state. Wakes up processes that are awaiting completion of host-to-port commands and returns `ENODEV` to them. With an XIO board, a reset of port 1 or 2 causes both ports to be reset, and a reset of port 3 or 4 causes both to be reset.
`ATM_CONTROL_INIT`	Pre-init	Initializes port and brings it to down state. Not allowed when there are open file descriptors for the device.
`ATM_CONTROL_UP`	Down	Brings port to up state. Only allowed when port is in down state.

5.2.1.3 Success or Failure

If successful, `ATMIOC_CONTROL` returns zero.

On failure, the `ioctl()` returns –1 with an error stored in `errno`. For descriptions of individual errors, see Section 5.2.1.4.

5.2.1.4 Errors

Possible errors include:

`EBUSY` When trying to initialize (bring to the down state) the port, the driver found that there are file

	descriptors open for this device. These must be closed before initializing the port.
EINVAL	When trying to initialize or bring the port to the up state, the driver found that the port was not in the required state.
EIO	When trying to initialize the port, the driver could not successfully bring the port into the down state.
EPERM	The calling application does not have super user access privileges.
ETIME	When trying to bring the port to the up state, the driver's call to the device timed out.

5.2.2 ATMIOC_GETCONF

The ATMIOC_GETCONF ioctl() command retrieves the ATM-OC3c port's current configuration.

5.2.2.1 Usage

Use the following format:

```
ioctl (fd_atm, ATMIOC_GETCONF, &conf);
```

conf is an atm_conf_t structure.

5.2.2.2 Argument Values

The argument is a pointer to an atm_conf_t structure, described in Table 50, page 117, or Table 51, page 118 (depending on the specific hardware).

5.2.2.3 Success or Failure

If successful, ATMIOC_GETCONF returns zero. The out values should be read.

On failure, the ioctl() returns –1 with an error stored in errno. For descriptions of individual errors, see Section 5.2.2.6, page 120.

5.2.2.4 Out Values

The retrieved configuration values are written into the argument as described in Table 50 (for the IRIS ATM-OC3c HIO mezzanine hardware) or Table 51, page 118 (for the IRIS ATM-OC3c 4Port XIO hardware).

Table 50. Values Retrieved by `ATMIOC_GETCONF` for the HIO Mezzanine Board

Field	Default Value	Comments
`sign`	`ATM_MAGIC`	ATM-OC3c board's signature.
`vers`	varies	ATM-OC3c board's EPROM version
`flags`	0x0608	Hardware and firmware capabilities. See Table 52, page 119.
`xtype`	2	Transmission type: 1 =`XT_UNKNOWN` 2 =`XT_STS3C`, SONET STS-3c PHY at 155.52 Mbps 3 =`XT_DS3`=3, DS3 PHY at 44.736 Mbps 4 =`XT_4B5B`=4, 4B/5B encoding PHY at 100 Mbps 5 =`XT_8B10B`, 8B/10B encoding PHY at 155.52 Mbps
`mtype`	4	Media type: 1 =`MT_UNKNOWN` 2 =`MT_COAX`, coaxial cable 3 =`MT_SMF`, single mode fiber 4 =`MT_MMF`, multimode fiber 5 =`MT_STP`, shielded twisted pair 6 =`MT_UTP`, unshielded twisted pair
`maxvpibits`	8	Maximum number of bits that can be used for a VPI. Range of possible values is 0 to 8.
`maxvcibits`	16	Maximum number of bits that can be used by a VCI. Range of possible values is 0 to 16.
`hi_pri_qs`	4	Number of transmission rate queues on the board that are treated as high-priority queues. For further explanation, see Section 1.5.1, page 18.

Field	Default Value	Comments
lo_pri_qs	4	Number of transmission rate queues on the board that are treated as low-priority queues. For further explanation, see Section 1.5.1, page 18.
xmt_large_size	12K	Size (in bytes) of large-sized transmit buffers.
xmt_large_bufs	78	Number of large-sized transmit buffers.
xmt_small_size	2K	Size (in bytes) of small-sized transmit buffers.
xmt_small_bufs	78	Number of small-sized transmit buffers.
rcv_large_size	12K	Size (in bytes) of large-sized receive buffers.
rcv_large_bufs	69	Number of large-sized receive buffers.
rcv_small_size	0	Size (in bytes) of small-sized receive buffers.
rcv_small_bufs	0	Number of small-sized receive buffers. This size buffer is used only for AAL3/4.
reserved	0	Do not use.

Table 51. Values Retrieved by ATMIOC_GETCONF for an XIO Port

Field	Default Value	Comments
maxvpibits	0	Maximum number of bits that can be used for a VPI. Range of possible values is 0 to 8.
maxvcibits	12	Maximum number of bits that can be used by a VCI. Range of possible values is 0 to 16.
xmt_large_size	4032	Size (in bytes) of large-sized transmit buffers.
xmt_large_bufs	384	Number of large-sized transmit buffers.
xmt_small_size	384	Size (in bytes) of small-sized transmit buffers.
xmt_small_bufs	512	Number of small-sized transmit buffers.
rcv_large_size	4096	Size (in bytes) of large-sized receive buffers.
rcv_large_bufs	384	Number of large-sized receive buffers.
rcv_small_size	96	Size (in bytes) of small-sized receive buffers.

Field	Default Value	Comments
rcv_small_bufs	512	Number of small-sized receive buffers. This size buffer is only used for AAL3/4.
tst_size	8660	Size of port's cell-slot table. For further explanation, see Section 1.5.2, page 20.
reserved	0	Do not use.

5.2.2.5 Relevant Structures

Table 50, page 117, and Table 52, page 119, describe the atm_conf_t structure for HIO hardware, as defined in the atm_b2h.h file. Table 51, page 118, describes the atm_conf_t structure for XIO hardware, as defined in the quadoc3_b2h.h file. (These files are automatically included in the atm_user.h file.)

Table 52. Capability Flags for atm_conf_t

Flag	Mask	Description
ATM_CAP_AAL_1	0x0001	AAL1 supported.
ATM_CAP_AAL_2	0x0002	AAL2 supported.
ATM_CAP_AAL_34	0x0004	AAL3/4 supported.
ATM_CAP_AAL_5	0x0008	AAL5 supported.
ATM_CAP_AAL_0	0x0010	AAL0 (raw) supported.
ATM_CAP_AAL_5_NOTRAILER	0x0020	AAL5 without trailer supported.
ATM_CAP_AAL_MASK	0x003f	AAL mask.
ATM_CAP_BARANGE	0x0100	Firmware supports variable size buffers (malloc).
ATM_CAP_IN_CKSUM	0x0200	Port's firmware does IP checksums.
ATM_CAP_LOOP_TIMING	0x0400	Port does loop timing. Set with ATMIOC_SETOPT.
ATM_CAP_DIAG_LOOPBACK	0x0800	Port receives what it sends. Set with ATMIOC_SETOPT.
ATM_CAP_LINE_LOOPBACK	0x1000	Port sends what it receives. Set with ATMIOC_SETOPT.

5.2.2.6 Errors

Possible errors include:

`EFAULT`	An error occurred when the driver was copying the retrieved data to the area specified by the pointer.
`ENODEV`	The port was not in the up or down state.
`ETIME`	The driver's command to the port timed out.

5.2.3 `ATMIOC_GETIOSTAT`

The `ATMIOC_GETIOSTAT` `ioctl()` command retrieves driver-internal I/O statistics. This command does not cause any interaction between the hardware and the IRIS ATM driver.

5.2.3.1 Usage

Use the following format:

`ioctl (`*fd_atm*`, ATMIOC_GETIOSTAT, &`*iostat*`);`

iostat is an `atm_iostat_t` structure.

5.2.3.2 Argument Values

The argument is a pointer to an `atm_iostat_t` structure.

5.2.3.3 Success or Failure

If successful, `ATMIOC_GETIOSTAT` returns zero. The out values should be read.

On failure, the `ioctl()` returns –1 with an error stored in `errno`. For descriptions of individual errors, see Section 5.2.3.6, page 122.

5.2.3.4 Out Values

The retrieved values are written to the argument, summarized in Table 53, page 121.

5.2.3.5 Relevant Structures

The `atm_iostat_t` structure (described in Table 53, page 121) is embedded in the hardware driver for each type of hardware. The structure is slightly different for each type of hardware (see notes within Table 53, page 121).

Table 53. Values Retrieved by the `ATMIOC_GETIOSTAT` Command

Field	Description
`ipkts`	Count of total incoming packets over character device (CDEV) interfaces using the port.
`ibytes`	Count of total incoming bytes over CDEV interfaces using the port.
`ierrs`	Count of total incoming errors over CDEV interfaces using the port.
`opkts`	Count of total outgoing packets over CDEV interfaces using the port.
`obytes`	Count of total outgoing bytes over CDEV interfaces using the port.
`oerrs`	Count of total outgoing errors over CDEV interfaces using the port.
`xcmd_dly`	HIO board only: Count of commands that were delayed (not immediately placed on the command queue) due to heavy use of the driver-to-board command interface.
`xmit_dly`	HIO board only: Count of transmit commands that were delayed (not immediately placed on the command queue) due to heavy use of the driver-to-board command interface.
`intrs`	Count of host-to-port interrupts.
`b2hs`	Count of port-to-host interrupts.
`xmit_reqs`	Count of transmit requests.
`h2b_kicks`	HIO board only: Number of times host has reset the board.
`xmit_intrs`	Count of transmit interrupts indicating that the port's download (direct memory access (DMA)) of the host's packet has been completed.
`odone_intrs`	Count of transmit packet done messages sent by port to host. When this count equals the `xmit_reqs` count, all data on the transmit queues has been processed completely.
`recv_intrs`	Count of receive interrupts indicating that a packet arrived.
`fet_stat`	Number of times board has responded to host requests for this port's status.

5.2.3.6 Errors

Possible errors include:

EFAULT	An error occurred when the driver was copying the retrieved data to the area specified by the pointer.
ENODEV	The port was not in the up or down state.

5.2.4 ATMIOC_GETMACADDR

The ATMIOC_ GETMACADDR ioctl() command reads the media access control (MAC) address from the ATM-OC3c port.

5.2.4.1 Usage

Use the following format:

```
ioctl (fd_atm, ATMIOC_GETMACADDR, &addr);
```

The *addr* variable is an array of atm_macaddr_t structures.

5.2.4.2 Argument Values

The argument is a pointer to an atm_macaddr_t[6], an array of 6 unsigned characters.

5.2.4.3 Success or Failure

If successful, ATMIOC_GETMACADDR returns zero. The out values should be read.

On failure, the ioctl() returns –1 with an error stored in errno. For descriptions of individual errors, see Section 5.2.4.5.

5.2.4.4 Out Values

The retrieved MAC address is written to the call's argument.

5.2.4.5 Errors

Possible errors include:

EADDRNOTAVAIL	The checksum on the retrieved address is not correct.
EFAULT	An error occurred when the driver was copying the retrieved data to the area specified by the pointer.
ENODEV	The port was not in the up or down state.
ETIME	The driver's command to the port timed out.

5.2.5 ATMIOC_GETOPT

The ATMIOC_GETOPT ioctl() command retrieves the current settings for the ATM-OC3c port's loopback and clock recover options. Requires super user access.

5.2.5.1 Usage

Use the following format:

```
ioctl (fd_atm, ATMIOC_GETOPT, &int);
```

5.2.5.2 Argument Values

The argument is a pointer to an unsigned integer.

5.2.5.3 Success or Failure

If successful, ATMIOC_GETOPT returns zero. The out values should be read.

On failure, the ioctl() returns –1 with an error stored in errno. For descriptions of individual errors, see Section 5.2.5.5, page 124.

5.2.5.4 Out Values

The retrieved option setting (mask) is written to the location provided in the argument. Table 60, page 136, summarizes the values and masks that are meaningful. The options are described in Table 61, page 137. The value that indicates normal operation, which is also the default, is ATM_OPT_LOOP_TIMING (for the HIO mezzanine board) or ATM_PHYOPTS_LOOPT (for an XIO port), which is mask 0x0001.

5.2.5.5 Errors

Possible errors include:

`EPERM`	The invoker does not have super user access privileges.
`EFAULT`	An error occurred when the driver was copying the retrieved data to the area specified by the pointer.
`ENODEV`	The port was not in the up or down state.
`ETIME`	The driver's command to the port timed out.

5.2.6 `ATMIOC_GETRATEQ`

The `ATMIOC_GETRATEQ ioctl()` command retrieves information about one rate queue from the IRIS ATM-OC3c HIO mezzanine board. The board must be in the up state.

Note: This call does not work with other hardware.

5.2.6.1 Usage

Use the following format:

`ioctl (`*fd_atm*`, ATMIOC_GETRATEQ, &`*rateq*`);`

rateq is an `atm_rate_q_t` structure.

5.2.6.2 Argument Values

The argument is a pointer to an `atm_rate_q_t` structure, set up as described in Table 54. The `rate_queue_number` field of the argument must be set to one of the values described in Table 55.

Table 54. Recommended Values for the Argument of the ATMIOC_GETRATEQ Command

Fields	Value	Description
rate_queue_number	From Table 55, page 125.	The queue whose rate is to be retrieved.
rate_value	Zero	Upon return, the out value equals the rate_value, an 11-bit code from Table 64, page 141.

The following table lists values for the rate_queue_number field.

Table 55. Rate Queue Identification Values

Name	int	Description
RQ_A0	0	High priority Bank A, queue 0
RQ_A1	1	High priority Bank A, queue 1
RQ_A2	2	High priority Bank A, queue 2
RQ_A3	3	High priority Bank A, queue 3
RQ_B0	4	Low priority Bank B, queue 0
RQ_B1	5	Low priority Bank B, queue 1
RQ_B2	6	Low priority Bank B, queue 2
RQ_B3	7	Low priority Bank B, queue 3

5.2.6.3 Success or Failure

If successful, ATMIOC_GETRATEQ returns zero. The out value should be read.

On failure, the ioctl() returns –1 with an error stored in errno. For descriptions of individual errors, see Section 5.2.6.6, page 126.

5.2.6.4 Out Values

The retrieved value is written to the least significant word (the rate_value field) of the atm_rate_q_t structure that is identified by the argument. The rate value is one of the rate codes summarized in Table 64, page 141.

5.2.6.5 Relevant Structures

Table 54, page 125, describes the `atm_rate_q_t` structure, and its definition is included in the following code, as it is in the `atm_b2h.h` file (included in the `atm_user.h` file):

```
typedef struct atm_rate_q {
      u_int rate_queue_number;
      u_int rate_value;
} atm_rate_q_t;
```

5.2.6.6 Errors

Possible errors include:

`EFAULT`	An error occurred when the driver was copying the retrieved data to the area specified by the pointer.
`EINVAL`	The specified rate queue identification number is invalid.
`ENODEV`	The board is not in the up state.

5.2.7 ATMIOC_GETSTAT

The `ATMIOC_GETSTAT` `ioctl()` command reads and returns the ATM-OC3c port's operational status and monitored performance data. Unless specified differently, all statistics are accumulated since the last time the port was reset.

5.2.7.1 Usage

Use the following format:

`ioctl (`*fd_atm*`, ATMIOC_GETSTAT, &`*stat*`);`

stat is an `atm_stat_t` structure.

5.2.7.2 Argument Values

The argument is a pointer to an empty `atm_stat_t` structure (described in Table 56, page 127).

5.2.7.3 Success or Failure

If successful, `ATMIOC_GETSTAT` returns zero. The out values should be read.

On failure, the `ioctl()` returns –1 with an error stored in `errno`. For descriptions of individual errors, see Section 5.2.7.6, page 132.

5.2.7.4 Out Values

The retrieved statistical data are written to the argument, described in Table 56. Figure 11, page 130, illustrates individual bits within the `SONET_status` field of the `atm_stat_t` structure.

Table 56. Values Retrieved by the `ATMIOC_GETSTAT` Command

Field	Description
`hwstate`	The current state of the port: 0 = `ATM_HWSTATE_PREINIT` 1 = `ATM_HWSTATE_DEAD` 2 = `ATM_HWSTATE_DOWN` 3 = `ATM_HWSTATE_UP` These states are described in Section 5.2.1, page 114.
`rx_pdu_ok`	Total protocol data units (PDUs) received correctly.
`rx_pdu_timeout`	Received PDU error: reassemblies that never completed.
`rx_pdu_bfr_oflo`	Received PDU error: reassemblies that exceeded buffer size.
`rx_pdu_crc_error`	Received PDU error: AAL5 CRC-32 error.
`rx_pdu_aal5len_err`	Received PDU error: size violates AAL5 standard.
`rx_pkt_reserved[3]`	Not used.
`rx_pdu_unknown_err`	Received PDU error: none of the PDU errors previously listed.
`rx_cell_ok`	Total ATM cells received correctly.
`rx_cell_invalid`	Received ATM cell error: unrecognized or bad VPI/VCI.
`rx_cell_nobuf`	Received ATM cell error: no receive buffers were available and cell was dropped.
`rx_cell_reserved[4]`	Not used.
`rx_cell_unknown_err`	Received ATM cell error: none of the ATM cell errors previously listed.

Field	Description
tx_pdu_ok	Total PDUs transmitted correctly.
tx_pdu_reserved[6]	Not used.
tx_pdu_unknown_err	Transmitted PDU error: none of the PDU errors previously listed.
tx_cell_ok	Total ATM cells transmitted correctly.
tx_cell_reserved[7]	Not used.
SONET_sbe	SONET section overhead BIP-8 errors (B1 byte).
SONET_lbe	SONET line overhead BIP-24 errors (that is, the BIP-8 [B2 byte] from the line overhead of each STS-1).
SONET_lfe	SONET line overhead far-end-block-errors (FEBE bits in Z2 byte). This information is contained within received SONET frames, but it describes the error rate on the transmit data stream. Reported errors could have occurred anywhere along the SONET line.
SONET_pbe	SONET path overhead BIP-8 errors (B3 byte).
SONET_pfe	SONET path overhead far-end-block-errors (FEBE bits in G1 byte). This information is contained within received SONET frames but it describes the error rate on the transmit data stream. Reported errors could have occurred anywhere along the SONET path.
SONET_chcs	Correctable ATM header error check (HEC) errors.
SONET_uhcs	Noncorrectable ATM HEC errors.
SONET_reserved[5]	Not used.
SONET_status	See Table 57.

Table 57. Bits in SONET_status Field

Status Item	Mask within Field	Description
SONET_LOSV	0x40000000	Section layer: loss-of-signal error state currently exists in the receiving hardware.
SONET_LOFV	0x20000000	Section layer: loss-of-frame error state currently exists in the receiving hardware.

Status Item	Mask within Field	Description
SONET_OOFV	0x10000000	Section layer: out-of-frame error state currently exists in the receiving hardware.
SONET_FERF	0x02000000	Line layer: far-end-receive-failure state currently exists in the receiving hardware.
SONET_LAIS	0x01000000	Line layer: alarm-indication-signal state currently exists in the receiving hardware.
SONET_PLOP	0x00200000	Path layer: loss-of-pointer error state currently exists in the receiving hardware.
SONET_PAIS	0x00080000	Path layer: alarm-indication-signal error state currently exists in the receiving hardware.
SONET_PYEL	0x00040000	Path layer: yellow-signal error state currently exists in the receiving hardware.
SONET_PSL_MASK	0x0000ff00	Path layer: contents of the Signal Label (C2 byte) on incoming frames. A new value is captured when 3 consecutive frames have the same value. For the IRIS ATM hardware, this value should be 0x13 (hex) at all times. The offset (value for shifting) to this field within the `atm_stat_t` structure is SONET_PSL_SHFT (value of 8).
SONET_OOCD	0x00000080	Out-of-cell-delineation state currently exists. The IRIS ATM receiving hardware is trying to synchronize with the cell boundaries in the synchronous payload envelope (SPE) of the incoming SONET frame.
SONET_TSOCI	0x00000040	Start-of-cell error has occurred on the IRIS ATM transmit hardware.
SONET_TFOVR	0x00000020	First in/First out (FIFO) overrun has occurred on the IRIS ATM transmit hardware.
SONET_RFOVR	0x00000002	FIFO overrun has occurred on the IRIS ATM receive hardware.
SONET_RFUDR	0x00000001	FIFO underrun has occurred on the IRIS ATM receive hardware.
SONET_UNUSED	0x8cd3001c	Ignore these bits.

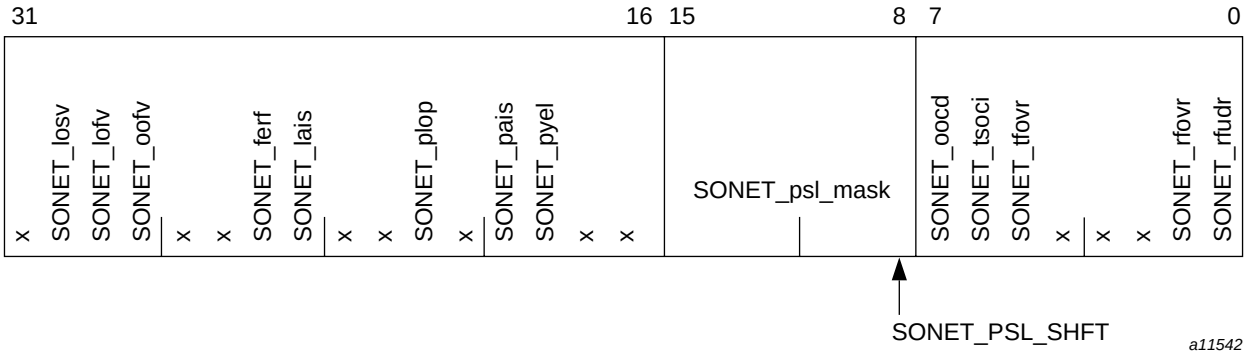

Figure 11. Bit Descriptions for `SONET_status` Field within the `atm_stat_t` Structure

5.2.7.5 Relevant Structures

The `atm_stat_t` structure is described in Table 56, page 127, and is defined in the `atm_user.h` file, as follows:

```
typedef struct atm_stat {
      u_int   hwstate;
#define ATM_HWSTATE_PREINIT     0
#define ATM_HWSTATE_DEAD        1
#define ATM_HWSTATE_DOWN        2
#define ATM_HWSTATE_UP          3

/* Receive counts */
      u_int   rx_pdu_ok;

/* Receive PDU errors (pdu drops) */
      u_int   rx_pdu_timeout;     /* pdu reassembly never completed */
      u_int   rx_pdu_bfr_oflo;    /* pdu reassembly exceeded buf size */
      u_int   rx_pdu_crc_err;     /* AAL5 CRC errors */
      u_int   rx_pdu_aal5len_err; /* AAL5 length errors */
      u_int   rx_pdu_reserved[3];
      u_int   rx_pdu_unknown_err; /* none of the above */

/* Receive cell counts */
      u_int   rx_cell_ok;         /* cells received okay */
      u_int   rx_cell_invalid;    /* cells received on bad VPI/VCI */
      u_int   rx_cell_nobuf;      /* pdu dropped due to no buf avail */
      u_int   rx_cell_reserved[4];
```

```
      u_int   rx_cell_unknown_err;/* none of the above */

/* Transmit counts */
      u_int   tx_pdu_ok;
      u_int   tx_pdu_reserved[6];
      u_int   tx_pdu_unknown_err; /* trouble transmitting */

/* Transmit cell counts */
      u_int   tx_cell_ok;
      u_int   tx_cell_rserved[7];

/* SONET counts */
      u_int   SONET_sbe;          /* SONET Section BIP-8  errors  */
      u_int   SONET_lbe;          /* SONET Line    BIP-24 errors  */
      u_int   SONET_lfe;          /* SONET Line    FEBEs          */
      u_int   SONET_pbe;          /* SONET Path    BIP-8  errors  */
      u_int   SONET_pfe;          /* SONET Path    FEBEs          */
      u_int   SONET_chcs;         /* Correctable   ATM HEC errors */
      u_int   SONET_uhcs;         /* Uncorrectable ATM HEC errors */
      u_int   SONET_reserved[5];

      u_int   SONET_status;

} atm_stat_t;


/* bit fields in SONET_status */
#define SONET_LOSV      0x40000000 /* loss-of-signal state */
#define SONET_LOFV      0x20000000 /* loss-of-frame  state */
#define SONET_OOFV      0x10000000 /* out-of-frame   state */
#define SONET_FERF      0x02000000 /* Far-end-receive-failure */
#define SONET_LAIS      0x01000000 /* Line Alarm Indication Signal */
#define SONET_PLOP      0x00200000 /* Loss of Path */
#define SONET_PAIS      0x00080000 /* Path Alarm Indication Signal */
#define SONET_PYEL      0x00040000 /* Path Yellow Condition */
#define SONET_PSL_MASK  0x0000ff00 /* Path Signal Label (C2) */
#define SONET_PSL_SHFT  8
#define SONET_OOCD      0x00000080 /* out-of-cell-delineation */
#define SONET_TSOCI     0x00000040 /* Xmit start-of-Cell error */
#define SONET_TFOVR     0x00000020 /* Xmit FIFO overrun */
#define SONET_RFOVR     0x00000002 /* Recv FIFO overrun */
#define SONET_RFUDR     0x00000001 /* Recv FIFO underrun */
#define SONET_UNUSED    0x8cd3001c /* ignore these bits */
```

5.2.7.6 Errors

Possible errors include:

`EFAULT`	An error occurred when the driver was copying the retrieved data to the area specified by the pointer.
`ENOMEM`	The driver was unable to place a command on the host-to-port command queue due to lack of memory.

5.2.8 `ATMIOC_SETCONF`

The `ATMIOC_SETCONF` `ioctl()` command configures the ATM-OC3c port. The new configuration takes effect when the port is next brought into the up state. This command is available only to the super user.

5.2.8.1 Usage

Use the following format:

`ioctl (`*fd_atm*`, ATMIOC_SETCONF, &`*conf*`);`

conf is an `atm_conf_t` structure.

5.2.8.2 Argument Values

The pointer to *conf* identifies an instance of an `atm_conf_t` structure. The desired configuration values must be in the `atm_conf_t` structure, as described in Table 58, page 133 (when the hardware is the IRIS ATM-OC3c HIO mezzanine board) or Table 59, page 134 (when the hardware is the IRIS ATM-OC3c 4Port XIO board).

Table 58. Recommended Values for the Argument of the ATMIOC_SETCONF Command for the HIO Board

Field	Recommended Setting	Comments
sign	ATM_MAGIC	ATM-OC3c board's signature.
vers	varies	ATM_MIN_VERS, ATM_VERS_MASK, ATM_CKSUM_VERS as defined in sys/atm_b2h.h. ATM-OC3c board's / FLASH EPROMs version.
flags	0x1E28	Flags indicating various functions for which the ATM-OC3c board and its firmware's are capable. For example: 0x0008 = ATM_CAP_AAL_5, board uses AAL5 0x0200 =ATM_CAP_IN_CKSUM, board does IP checksum (the full set of values are in sys/atm_b2h.h)
xtype	2	Transmission type: 1 =XT_UNKNOWN 2 =XT_STS3C, SONET STS-3c PHY at 155.52 Mbps 3 =XT_DS3=3, DS3 PHY at 44.736 Mbps 4 =XT_4B5B=4, 4B/5B encoding PHY at 100 Mbps 5 =XT_8B10B, 8B/10B encoding PHY at 155.52 Mbps
mtype	4	Media type: 1 =MT_UNKNOWN 2 =MT_COAX, coaxial cable 3 =MT_SMF, single-mode fiber 4 =MT_MMF, multi-mode fiber 5 =MT_STP, shielded twisted pair 6 =MT_UTP, unshielded twisted pair
maxvpibits	8	Maximum number of bits that can be used for a VPI. Range of possible values is 0 to 8.
maxvcibits	16	Maximum number of bits that can be used by a VCI. Range of possible values is 0 to 16.
hi_pri_qs	4	Number of high priority rate queues supported by the board. For further explanation, see Section 1.5.1, page 18.
lo_pri_qs	4	Number of low priority rate queues supported by the board. For further explanation, see Section 1.5.1, page 18.
xmt_large_size	12K	Size (in bytes) of large-sized transmit buffers.
xmt_large_bufs	78	Number of large-sized transmit buffers.

Field	Recommended Setting	Comments
xmt_small_size	2K	Size (in bytes) of small-sized transmit buffers.
xmt_small_bufs	78	Number of small-sized transmit buffers.
rcv_large_size	12K	Size (in bytes) of large-sized receive buffers.
rcv_large_bufs	69	Number of large-sized receive buffers (for AAL5).
rcv_small_size	0	Size (in bytes) of small-sized receive buffers (for AAL3/4).
rcv_small_bufs	0	Number of small-sized receive buffers (for AAL3/4).
reserved	not valid	Reserved for future use.

Table 59. Recommended Values for the Argument of the ATMIOC_SETCONF Command for an XIO Port

Field	Recommended Setting	Comments
maxvpibits	0	Maximum number of bits that can be used for a VPI. Range of possible values is 0 to 8.
maxvcibits	12	Maximum number of bits that can be used by a VCI. Range of possible values is 0 to 16.
xmt_large_size	4032	Size (in bytes) of large-sized transmit buffers.
xmt_large_bufs	384	Number of large-sized transmit buffers.
xmt_small_size	384	Size (in bytes) of small-sized transmit buffers.
xmt_small_bufs	512	Number of small-sized transmit buffers.
rcv_large_size	4096	Size (in bytes) of large-sized receive buffers.
rcv_large_bufs	384	Number of large-sized receive buffers (for AAL5).
rcv_small_size	96	Size (in bytes) of small-sized receive buffers (for AAL3/4).
rcv_small_bufs	512	Number of small-sized receive buffers (for AAL3/4).
tst_size	8660	Number of slots in the cell-slot table that controls VC transmission rates. Range of possible values is 8 to 8660. For further explanation, see Section 1.5.2, page 20.
reserved	0	Reserved for future use.

5.2.8.3 Success or Failure

If successful, `ATMIOC_SETCONF` returns zero.

On failure, the `ioctl()` returns –1 with an error stored in `errno`. For descriptions of individual errors, see Section 5.2.8.5, page 135.

5.2.8.4 Relevant Structures

The `atm_conf_t` structure is explained in Table 58, page 133, or Table 59, page 134, depending on the installed hardware.

5.2.8.5 Errors

Possible errors include:

`EFAULT`	An error occurred during a copy of the data.
`ENODEV`	The port was not in the up or down state.
`EPERM`	The invoker does not have super user access privileges.
`ETIME`	The driver's call to the port timed out.

5.2.9 `ATMIOC_SETOPT`

The `ATMIOC_SETOPT` `ioctl()` command configures the ATM-OC3c port's loopback and clock recover options. If the port is in the up state, it starts functioning with the new options almost immediately. These options are useful for testing purposes or for operation without an ATM switch. This command is available only to the super user.

Caution: Altering the options to anything other than the default (which is the loop timing bit set to 1, and the other option bits set to 0) makes the port dysfunctional for operation with a switch.

5.2.9.1 Usage

Use the following format:

`ioctl (`*`fd_atm`*`, ATMIOC_SETOPT,` *`opt`*`);`

opt is type `u_int`.

5.2.9.2 Argument Values

The *opt* argument is an unsigned integer that sets to 1 (enables) the bit or bits (illustrated in Figure 12, page 136) that control the hardware options. The normal and default setting is 0x1 (LOOP_TIMING=1, LINE_LOOPBACK=0, and DIAG_LOOPBACK=0). Table 60, page 136, summarizes other values and the masks that are available. The options are described in Table 61, page 137.

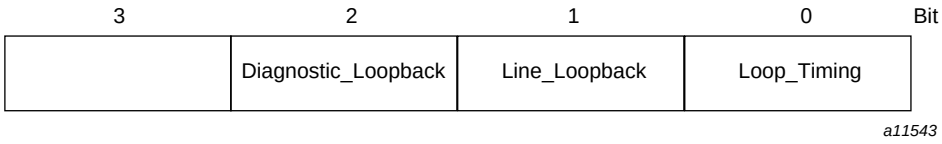

Figure 12. Physical Options

Table 60. Recommended Values for the Argument of the ATMIOC_SETOPT Command

Possible Values	Can Be Combined With	Do Not Combine With
LOOP_TIMING (*opt*=0x1) (This is the default.)	Normal operation or LINE_LOOPBACK (*opt*=0x5)	DIAG_LOOPBACK
DIAG_LOOPBACK (*opt*=0x2)	Nothing	LOOP_TIMING or LINE_LOOPBACK
LINE_LOOPBACK (*opt*=0x4)	LOOP_TIMING (*opt*=0x5)	Normal operation or DIAG_LOOPBACK

Table 61. ATM-OC3c Hardware Options

Mask	Option	Description
0x1	Loop Timing (`ATM_OPT_LOOP_TIMING` for HIO board, and `ATM_PHYOPTS_LOOPT` for XIO board)	When Loop Timing is enabled (bit 0 is set to 1), the port's logic obtains its SONET transmission clock from the clock signal recovered from the incoming fiber. Typically, this option is enabled when the port is attached to an ATM switch, such as normal operation or Line Loopback testing. When Loop Timing is disabled (bit 0 is set to 0), the port uses its own clock (from the on-board crystal). This bit must be set to 0 for Diagnostic Loopback testing. It is also appropriate to set this bit to 0 when the port's output line is attached to its own input line or when the port is attached to another ATM system that is not a switch.
0x2	Diagnostic Loopback (1 in Figure 13, page 138) (`ATM_OPT_DIAG_LOOPBACK` for HIO board, and `ATM_PHYOPTS_DLE` for XIO board)	When Diagnostic Loopback is enabled (bit 1 is set to 1), the SUNI chip's internal loopback path is enabled, so that the R-FRED receives from the F-FRED. This option must be disabled for normal operation and when Line Loopback is enabled. Refer to Figure 13, page 138.
0x4	Line Loopback (2 in Figure 13, page 138) (`ATM_OPT_LINE_LOOPBACK` for HIO board, and `ATM_PHYOPTS_LLE` for XIO board)	When Line Loopback is enabled (bit 2 is set to 1), the SUNI chip's external loopback path is enabled, so that the SUNI transmits to the outgoing ODL exactly what it receives from the incoming ODL. This option must be disabled for normal operation and when Diagnostic Loopback is enabled. Refer to Figure 13, page 138.

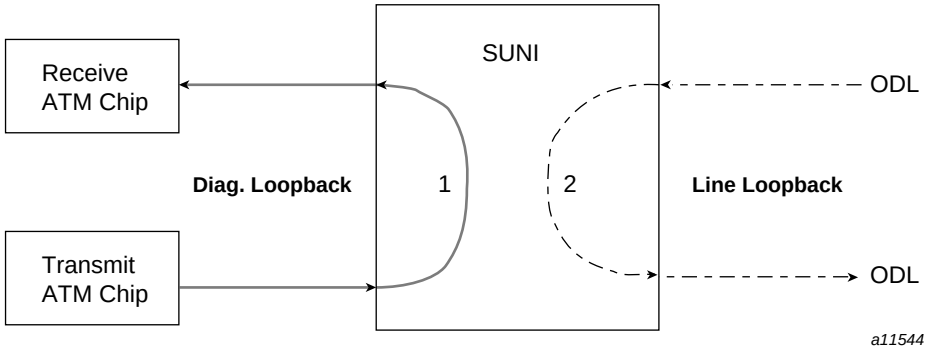

Figure 13. Loopback Options for IRIS ATM-OC3c Ports

5.2.9.3 Success or Failure

If successful, `ATMIOC_SETOPT` returns zero.

On failure, the `ioctl()` returns -1 with an error stored in `errno`. For descriptions of individual errors, see Section 5.2.9.4, page 138.

5.2.9.4 Errors

Possible errors include:

`ENODEV`	The port was not in the up or down state.
`EPERM`	The invoker does not have super user access privileges.
`ETIME`	The driver's call to the port timed out.

5.2.10 `ATMIOC_SETRATEQ`

The `ATMIOC_SETRATEQ` `ioctl()` command sets the transmission rate for an individual rate queue on an IRIS ATM-OC3c HIO mezzanine board. The new setting starts operating immediately. The board must be in the up or down state and the rate queue must be free (that is, not currently associated with any open VC).

See Section 1.5.1, page 18, for a description of the transmission rate queues and how they are managed by the IRIS ATM driver.

Note: This call works only with the IRIS ATM-OC3c HIO mezzanine board.

5.2.10.1 Usage

Use the following format:

```
ioctl (fd_atm, ATMIOC_SETRATEQ, &rateq);
```

rateq is an `atm_rate_q_t` structure.

5.2.10.2 Argument Values

The pointer identifies an `atm_rate_q_t` structure that should be set up as shown in Table 62, page 139. The rate code (*rate_value*) must be one of the codes from Table 64, page 141.

Table 62. Recommended Values for the Argument of the `ATMIOC_SETRATEQ` Command

Field of `atm_rate_q_t`	Recommended Value	Comment
`rate_queue_number`	From Table 63, page 139.	The rate queue identification number.
`rate_value`	0 or a code from Table 64, page 141.	A code from Table 64, page 141. To unlock the rate queue, thus making it available to the driver for dynamic resetting, set the field to zero.

Table 63. Rate Queue Identification Numbers

`rate_queue_number`	`int`	Description
`RQ_A0`	0	High priority Bank A, queue 0
`RQ_A1`	1	High priority Bank A, queue 1
`RQ_A2`	2	High priority Bank A, queue 2
`RQ_A3`	3	High priority Bank A, queue 3
`RQ_B0`	4	Low priority Bank B, queue 0
`RQ_B1`	5	Low priority Bank B, queue 1
`RQ_B2`	6	Low priority Bank B, queue 2
`RQ_B3`	7	Low priority Bank B, queue 3

5.2.10.3 Success or Failure

If successful, `ATMIOC_SETRATEQ` returns zero.

On failure, the `ioctl()` returns –1 with an error stored in `errno`. For descriptions of individual errors, see Section 5.2.10.4.

5.2.10.4 Errors

Possible errors include:

`EBUSY`	The specified rate queue currently is servicing one or more VCs. The queue must be freed (that is, torn down) before it can be reconfigured.
`EFAULT`	An error occurred when the driver was copying the data.
`EINVAL`	The specified rate queue identification number is invalid.
`ENODEV`	The board is not in the up state.
`ENOMEM`	The driver was unable to place the command on the host-to-board command queue due to lack of memory.
`EPERM`	The invoker does not have super user access privileges.

Rate Queue Information for IRIS ATM-OC3c HIO Mezzanine Hardware [A]

To configure the transmission rate queues on the IRIS ATM-OC3c HIO mezzanine board (on CHALLENGE and Onyx systems only), use the codes from the left column (Code) of Table 64. The right column (ATM Cells per Second) of the table summarizes the rate (in number of ATM cells per second) that each code configures.

One ATM cell consists of 53 bytes: 48 bytes of user payload and 5 bytes of ATM overhead. If you are interested in a different rate metric than cells per second, the following formulas can be used to make the conversion. The *cells-per-second* value in each formula is a value from the ATM Cells per Second column in Table 64.

- To calculate payload-bits per second, use: *cells-per-second* * 384
- To calculate payload-bytes per second, use: *cells-per-second* * 48
- To calculate VCC-bits per second, use: *cells-per-second* * 424
- To calculate VCC-bytes per second, use: *cells-per-second* * 53

Table 64. Rates Available for Rate Queues on the ATM-OC3c HIO Board

Code	ATM Cells per Second
0x701	306
0x702	308
0x703	309
0x704	310
0x705	311
0x706	313
0x707	314
0x708	315
0x709	316
0x70A	318

Code	ATM Cells per Second
0x70B	319
0x70C	320
0x70D	322
0x70E	323
0x70F	324
0x710	326
0x711	327
0x712	328
0x713	330
0x714	331
0x715	332
0x716	334
0x717	335
0x718	337
0x719	338
0x71A	340
0x71B	341
0x71C	343
0x71D	344
0x71E	346
0x71F	347
0x720	349
0x721	350
0x722	352
0x723	354
0x724	355
0x725	357
0x726	358

Code	ATM Cells per Second
0x727	360
0x728	362
0x729	363
0x72A	365
0x72B	367
0x72C	369
0x72D	370
0x72E	372
0x72F	374
0x730	376
0x731	377
0x732	379
0x733	381
0x734	383
0x735	385
0x736	387
0x737	389
0x738	391
0x739	393
0x73A	395
0x73B	397
0x73C	399
0x73D	401
0x73E	403
0x73F	405
0x740	407
0x741	409
0x742	411

Code	ATM Cells per Second
0x743	413
0x744	416
0x745	418
0x746	420
0x747	422
0x748	425
0x749	427
0x74A	429
0x74B	432
0x74C	434
0x74D	436
0x74E	439
0x74F	441
0x750	444
0x751	446
0x752	449
0x753	452
0x754	454
0x755	457
0x756	460
0x757	462
0x758	465
0x759	468
0x75A	471
0x75B	473
0x75C	476
0x75D	479
0x75E	482

Code	ATM Cells per Second
0x75F	485
0x760	488
0x761	491
0x762	494
0x763	498
0x764	501
0x765	504
0x766	507
0x767	511
0x768	514
0x769	517
0x76A	521
0x76B	524
0x76C	528
0x76D	531
0x76E	535
0x76F	539
0x770	543
0x771	546
0x772	550
0x773	554
0x774	558
0x775	562
0x776	566
0x777	570
0x778	574
0x779	579
0x77A	583

Code	ATM Cells per Second
0x77B	587
0x77C	592
0x77D	596
0x77E	601
0x77F	606
0x780	610
0x781	615
0x782	620
0x783	625
0x784	630
0x785	635
0x786	640
0x787	646
0x788	651
0x789	657
0x78A	662
0x78B	668
0x78C	673
0x78D	679
0x78E	685
0x78F	691
0x790	698
0x791	704
0x792	710
0x793	717
0x794	723
0x795	730
0x796	737

Code	ATM Cells per Second
0x797	744
0x798	751
0x799	758
0x79A	766
0x79B	774
0x79C	781
0x79D	789
0x79E	797
0x79F	805
0x7A0	814
0x7A1	822
0x7A2	831
0x7A3	840
0x7A4	849
0x7A5	859
0x7A6	868
0x7A7	878
0x7A8	888
0x7A9	898
0x7AA	908
0x7AB	919
0x7AC	930
0x7AD	941
0x7AE	953
0x7AF	965
0x7B0	977
0x7B1	989
0x7B2	1002

Code	ATM Cells per Second
0x7B3	1015
0x7B4	1028
0x7B5	1042
0x7B6	1056
0x7B7	1070
0x7B8	1085
0x7B9	1100
0x7BA	1116
0x7BB	1132
0x7BC	1149
0x7BD	1166
0x7BE	1184
0x7BF	1202
0x7C0	1221
0x601	1225
0x602	1230
0x603	1235
0x7C1	1240
0x605	1245
0x606	1250
0x607	1255
0x7C2	1260
0x609	1265
0x60A	1270
0x60B	1276
0x7C3	1281
0x60D	1286
0x60E	1291

Code	ATM Cells per Second
0x60F	1297
0x7C4	1302
0x611	1308
0x612	1313
0x613	1319
0x7C5	1324
0x615	1330
0x616	1335
0x617	1341
0x7C6	1347
0x619	1353
0x61A	1359
0x61B	1365
0x7C7	1371
0x61D	1377
0x61E	1383
0x61F	1389
0x7C8	1395
0x621	1401
0x622	1408
0x623	1414
0x7C9	1420
0x625	1427
0x626	1433
0x627	1440
0x7CA	1447
0x629	1453
0x62A	1460

Code	ATM Cells per Second
0x62B	1467
0x7CB	1474
0x62D	1481
0x62E	1488
0x62F	1495
0x7CC	1502
0x631	1510
0x632	1517
0x633	1524
0x7CD	1532
0x635	1539
0x636	1547
0x637	1555
0x7CE	1563
0x639	1570
0x63A	1578
0x63B	1586
0x7CF	1594
0x63D	1603
0x63E	1611
0x63F	1619
0x7D0	1628
0x641	1636
0x642	1645
0x643	1653
0x7D1	1662
0x645	1671
0x646	1680

Code	ATM Cells per Second
0x647	1689
0x7D2	1698
0x649	1708
0x64A	1717
0x64B	1727
0x7D3	1736
0x64D	1746
0x64E	1756
0x64F	1766
0x7D4	1776
0x651	1786
0x652	1796
0x653	1806
0x7D5	1817
0x655	1827
0x656	1838
0x657	1849
0x7D6	1860
0x659	1871
0x65A	1883
0x65B	1894
0x7D7	1905
0x65D	1917
0x65E	1929
0x65F	1941
0x7D8	1953
0x661	1965
0x662	1978

Code	ATM Cells per Second
0x663	1990
0x664	2003
0x665	2016
0x666	2029
0x667	2042
0x7DA	2056
0x669	2070
0x66A	2083
0x66B	2097
0x7DB	2111
0x66D	2126
0x66E	2140
0x66F	2155
0x7DC	2170
0x671	2185
0x672	2201
0x673	2216
0x7DD	2232
0x675	2248
0x676	2264
0x677	2281
0x7DE	2298
0x679	2315
0x67A	2332
0x67B	2350
0x7DF	2367
0x67D	2385
0x67E	2404

Code	ATM Cells per Second
0x67F	2422
0x7E0	2441
0x681	2461
0x682	2480
0x683	2500
0x7E1	2520
0x685	2541
0x686	2561
0x687	2583
0x7E2	2604
0x689	2626
0x68A	2648
0x68B	2671
0x7E3	2694
0x68D	2717
0x68E	2741
0x68F	2765
0x7E4	2790
0x691	2815
0x692	2841
0x693	2867
0x7E5	2894
0x695	2921
0x696	2948
0x697	2976
0x7E6	3005
0x699	3034
0x69A	3064

Code	ATM Cells per Second
0x69B	3094
0x7E7	3125
0x69D	3157
0x69E	3189
0x69F	3222
0x7E8	3255
0x6A1	3289
0x6A2	3324
0x6A3	3360
0x7E9	3397
0x6A5	3434
0x6A6	3472
0x6A7	3511
0x7EA	3551
0x6A9	3592
0x6AA	3634
0x6AB	3676
0x7EB	3720
0x6AD	3765
0x6AE	3811
0x6AF	3858
0x7EC	3906
0x6B1	3956
0x6B2	4006
0x6B3	4058
0x7ED	4112
0x6B5	4167
0x6B6	4223

Code	ATM Cells per Second
0x6B7	4281
0x7EE	4340
0x6B9	4401
0x6BA	4464
0x6BB	4529
0x7EF	4596
0x6BD	4664
0x6BE	4735
0x6BF	4808
0x7F0	4883
0x501	4902
0x502	4921
0x503	4941
0x6C1	4960
0x505	4980
0x506	5000
0x507	5020
0x6C2	5040
0x509	5061
0x50A	5081
0x50B	5102
0x6C3	5123
0x50D	5144
0x50E	5165
0x50F	5187
0x7F1	5208
0x511	5230
0x512	5252

Code	ATM Cells per Second
0x513	5274
0x6C5	5297
0x515	5319
0x516	5342
0x517	5365
0x6C6	5388
0x519	5411
0x51A	5435
0x51B	5459
0x6C7	5482
0x51D	5507
0x51E	5531
0x51F	5556
0x520	5580
0x7F2	5580
0x521	5605
0x522	5631
0x523	5656
0x6C9	5682
0x525	5708
0x526	5734
0x527	5760
0x6CA	5787
0x529	5814
0x52A	5841
0x52B	5869
0x6CB	5896
0x52D	5924

Code	ATM Cells per Second
0x52E	5952
0x52F	5981
0x7F3	6010
0x531	6039
0x532	6068
0x533	6098
0x6CD	6127
0x535	6158
0x536	6188
0x537	6219
0x6CE	6250
0x539	6281
0x53A	6313
0x53B	6345
0x6CF	6378
0x53D	6410
0x53E	6443
0x53F	6477
0x7F4	6510
0x541	6545
0x542	6579
0x543	6614
0x6D1	6649
0x545	6684
0x546	6720
0x547	6757
0x6D2	6793
0x549	6831

Code	ATM Cells per Second
0x54A	6868
0x54B	6906
0x6D3	6944
0x54D	6983
0x54E	7022
0x54F	7062
0x7F5	7102
0x551	7143
0x552	7184
0x553	7225
0x6D5	7267
0x555	7310
0x556	7353
0x557	7396
0x6D6	7440
0x559	7485
0x55A	7530
0x55B	7576
0x6D7	7622
0x55D	7669
0x55E	7716
0x55F	7764
0x7F6	7813
0x561	7862
0x562	7911
0x563	7962
0x6D9	8013
0x565	8065

Code	ATM Cells per Second
0x566	8117
0x567	8170
0x6DA	8224
0x569	8278
0x56A	8333
0x56B	8389
0x6DB	8446
0x56D	8503
0x56E	8562
0x56F	8621
0x7F7	8681
0x571	8741
0x572	8803
0x573	8865
0x6DD	8929
0x575	8993
0x576	9058
0x577	9124
0x6DE	9191
0x579	9259
0x57A	9328
0x57B	9398
0x6DF	9470
0x57D	9542
0x57E	9615
0x57F	9690
0x7F8	9766
0x581	9843

Code	ATM Cells per Second
0x582	9921
0x583	10000
0x6E1	10081
0x585	10163
0x586	10246
0x587	10331
0x6E2	10417
0x589	10504
0x58A	10593
0x58B	10684
0x6E3	10776
0x58D	10870
0x58E	10965
0x58F	11062
0x7F9	11161
0x591	11261
0x592	11364
0x593	11468
0x6E5	11574
0x595	11682
0x596	11792
0x597	11905
0x598	12019
0x6E6	12019
0x599	12136
0x59A	12255
0x59B	12376
0x6E7	12500

Code	ATM Cells per Second
0x59D	12626
0x59E	12755
0x59F	12887
0x7FA	13021
0x5A1	13158
0x5A2	13298
0x5A3	13441
0x6E9	13587
0x5A5	13736
0x5A6	13889
0x5A7	14045
0x6EA	14205
0x5A9	14368
0x5AA	14535
0x5AB	14706
0x6EB	14881
0x5AD	15060
0x5AE	15244
0x5AF	15432
0x7FB	15625
0x5B1	15823
0x5B2	16026
0x5B3	16234
0x6ED	16447
0x5B5	16667
0x5B6	16892
0x5B7	17123
0x6EE	17361

Code	ATM Cells per Second
0x5B9	17606
0x5BA	17857
0x5BB	18116
0x6EF	18382
0x5BD	18657
0x5BE	18939
0x5BF	19231
0x7FC	19531
0x401	19608
0x402	19685
0x403	19763
0x5C1	19841
0x405	19920
0x406	20000
0x407	20080
0x5C2	20161
0x409	20243
0x40A	20325
0x40B	20408
0x5C3	20492
0x40D	20576
0x40E	20661
0x40F	20747
0x6F1	20833
0x411	20921
0x412	21008
0x413	21097
0x5C5	21186

Code	ATM Cells per Second
0x415	21277
0x416	21368
0x417	21459
0x5C6	21552
0x419	21645
0x41A	21739
0x41B	21834
0x5C7	21930
0x41D	22026
0x41E	22124
0x41F	22222
0x6F2	22321
0x421	22422
0x422	22523
0x423	22624
0x5C9	22727
0x425	22831
0x426	22936
0x427	23041
0x5CA	23148
0x429	23256
0x42A	23364
0x42B	23474
0x5CB	23585
0x42D	23697
0x42E	23810
0x42F	23923
0x6F3	24038

Code	ATM Cells per Second
0x431	24155
0x432	24272
0x433	24390
0x5CD	24510
0x435	24631
0x436	24752
0x437	24876
0x5CE	25000
0x439	25126
0x43A	25253
0x43B	25381
0x5CF	25510
0x43D	25641
0x43E	25773
0x43F	25907
0x7FD	26042
0x441	26178
0x442	26316
0x443	26455
0x5D1	26596
0x445	26738
0x446	26882
0x447	27027
0x5D2	27174
0x449	27322
0x44A	27473
0x44B	27624
0x5D3	27778

Code	ATM Cells per Second
0x44D	27933
0x44E	28090
0x44F	28249
0x6F5	28409
0x451	28571
0x452	28736
0x453	28902
0x5D5	29070
0x455	29240
0x456	29412
0x457	29586
0x5D6	29762
0x459	29940
0x45A	30120
0x45B	30303
0x5D7	30488
0x45D	30675
0x45E	30864
0x45F	31056
0x6F6	31250
0x461	31447
0x462	31646
0x463	31847
0x5D9	32051
0x465	32258
0x466	32468
0x467	32680
0x5DA	32895

Code	ATM Cells per Second
0x469	33113
0x46A	33333
0x46B	33557
0x5DB	33784
0x46D	34014
0x46E	34247
0x46F	34483
0x6F7	34722
0x471	34965
0x472	35211
0x473	35461
0x5DD	35714
0x475	35971
0x476	36232
0x477	36496
0x5DE	36765
0x479	37037
0x47A	37313
0x47B	37594
0x5DF	37879
0x47D	38168
0x47E	38462
0x47F	38760
0x7FE	39063
0x481	39370
0x482	39683
0x483	40000
0x5E1	40323

Code	ATM Cells per Second
0x485	40650
0x486	40984
0x487	41322
0x5E2	41667
0x489	42017
0x48A	42373
0x48B	42735
0x5E3	43103
0x48D	43478
0x48E	43860
0x48F	44248
0x6F9	44643
0x491	45045
0x492	45455
0x493	45872
0x5E5	46296
0x495	46729
0x496	47170
0x497	47619
0x5E6	48077
0x499	48544
0x49A	49020
0x49B	49505
0x5E7	50000
0x49D	50505
0x49E	51020
0x49F	51546
0x6FA	52083

Code	ATM Cells per Second
0x4A1	52632
0x4A2	53191
0x4A3	53763
0x5E9	54348
0x4A5	54945
0x4A6	55556
0x4A8	56818
0x5EA	56818
0x4A9	57471
0x4AA	58140
0x4AB	58824
0x5EB	59524
0x4AD	60241
0x4AE	60976
0x4AF	61728
0x6FB	62500
0x4B1	63291
0x4B2	64103
0x4B3	64935
0x5ED	65789
0x4B5	66667
0x4B6	67568
0x4B7	68493
0x5EE	69444
0x4B9	70423
0x4BA	71429
0x4BB	72464
0x5EF	73529

Code	ATM Cells per Second
0x4BD	74627
0x4BE	75758
0x4BF	76923
0x7FF	78125
0x4C1	79365
0x4C2	80645
0x4C3	81967
0x5F1	83333
0x4C5	84746
0x4C6	86207
0x4C7	87719
0x5F2	89286
0x4C9	90909
0x4CA	92593
0x4CB	94340
0x5F3	96154
0x4CD	98039
0x4CE	100000
0x4CF	102041
0x6FD	104167
0x4D1	106383
0x4D2	108696
0x4D3	111111
0x5F5	113636
0x4D5	116279
0x4D6	119048
0x4D7	121951
0x5F6	125000

Code	ATM Cells per Second
0x4D9	128205
0x4DA	131579
0x4DB	135135
0x5F7	138889
0x4DD	142857
0x4DE	147059
0x4DF	151515
0x6FE	156250
0x4E1	161290
0x4E2	166667
0x4E3	172414
0x5F9	178571
0x4E5	185185
0x4E6	192308
0x4E7	200000
0x4E8	208333
0x5FA	208333
0x4E9	217391
0x4EA	227273
0x4EB	238095
0x5FB	250000
0x4ED	263158 [1]
0x4EE	277778
0x4EF	294118
0x6FF	312500
0x4F1	333333
0x5FF	353207

1 Do not count on exceeding aggregate cell rates greater than 263158.

International Alphabet 5 [B]

This appendix contains the International Alphabet 5 (IA5) character set.

Table 65. Binary Values for IA5 Characters

Character	Binary Value (Hexadecimal Notation)
Control @, NULL	0x00
Control A, SOH	0x01
Control B, STX	0x02
Control C, ETX	0x03
Control D, EOT	0x04
Control E, ENQ	0x05
Control F, ACK	0x06
Control G, BELL	0x07
Control H, Backspace	0x08
Control I, HTAB	0x09
Control J, Line feed	0x0A
Control K, VT	0x0B
Control L, Form feed	0x0C
Control M, Carriage return	0x0D
Control N, SO	0x0E
Control O, SI	0x0F
Control P, DLE	0x10
Control Q, DC1	0x11
Control R, DC2	0x12
Control S, DC3	0x13
Control T, DC4	0x14

Character	Binary Value (Hexadecimal Notation)
Control U, NAK	0x15
Control V, SYN	0x16
Control W, ETB	0x17
Control X, Cancel	0x18
Control Y, EM	0x19
Control Z, SUB	0x1A
Control [, Escape	0x1B
Control \, FS	0x1C
Control J. GS	0x1D
Control Control, RS	0x1E
Control _, US	0x1F
Space	0x20
! (exclamation mark)	0x21
" (neutral double quotation mark)	0x22
# (number or pound sign)	0x23
$ (dollar sign)	0x24
% (percent sign)	0x25
& (ampersand)	0x26
’(apostrophe)	0x27
((left parenthesis)	0x28
) (right parenthesis)	0x29
* (asterisk)	0x2A
+ (plus, add)	0x2B
, (comma)	0x2C
– (hyphen, minus)	0x2D
. (period)	0x2E
/ (slash, solidus)	0x2F

Character	Binary Value (Hexadecimal Notation)
0 (zero)	0x30
1	0x31
2	0x32
3	0x33
4	0x34
5	0x35
6	0x36
7	0x37
8	0x38
9	0x39
: (colon)	0x3A
; (semicolon)	0x3B
< (less than)	0x3C
= (equal)	0x3D
> (greater than)	0x3E
? (question mark)	0x3F
@ (commercial at sign)	0x40
A	0x41
B	0x42
C	0x43
D	0x44
E	0x45
F	0x46
G	0x47
H	0x48
I	0x49
J	0x4A

Character	Binary Value (Hexadecimal Notation)
K	0x4B
L	0x4C
M	0x4D
N	0x4E
O	0x4F
P	0x50
Q	0x51
R	0x52
S	0x53
T	0x54
U	0x55
V	0x56
W	0x57
X	0x58
Y	0x59
Z	0x5A
[(left bracket)	0x5B
\ (back slash)	0x5C
] (right bracket)	0x5D
^ (up arrow)	0x5E
_ (under score)	0x5F
‘ (accent grave)	0x60
a	0x61
b	0x62
c	0x63
d	0x64
e	0x65

Character	Binary Value (Hexadecimal Notation)
f	0x66
g	0x67
h	0x68
i	0x69
j	0x6A
k	0x6B
l	0x6C
m	0x6D
n	0x6E
o	0x6F
p	0x70
q	0x71
r	0x72
s	0x73
t	0x74
u	0x75
v	0x76
w	0x77
x	0x78
y	0x79
z	0x7A
{ (left curly bracket)	0x7B
| (vertical bar)	0x7C
} (right curly bracket)	0x7D
~ (tilde)	0x7E
Delete	0x7F

Cause and Diagnostic Codes [C]

This appendix describes the information that is returned with ATM signaling requests. The cause codes that are described are provided as out values (in the `reject_reason_t` data structure or in the `cause` field of other data structures) for many of the ATM signaling commands. The value in the `cause` field matches the numbers assigned by the ATM user network interface (UNI) standard to the message texts.

Table 66 lists the cause codes (content of `cause` field) that are used by implementations that conform to the *ATM User-Network Interface Specification* (ATM UNI) standard. The Comments column points out codes that are specific to particular versions of the ATM UNI (for example, 3.0 and 3.1). Table 66 lists implementation-specific (local) cause codes used by the IRIS ATM signaling software. Table 68, page 181, summarizes the diagnostic information that accompanies some of the cause codes. IRIS ATM does not currently pass these up to the higher-layer applications.

Table 66. ATM UNI Cause Codes

Text for ATM UNI Cause	Value for `cause` Field	Comments
`Unallocated / Unassigned Number`	`1`	Additional information may be supplied. See Table 68, page 181.
`No Route to Specified Transit Network`	`2`	
`No Route to Destination`	`3`	Additional information may be supplied. See Table 68, page 181.
`Unacceptable VPCI_VCI`	`10`	
`Normal_3.1`	`16`	Not used with UNI 3.0. Used only with UNI 3.1.
`User Busy`	`17`	
`No User Responding`	`18`	

Text for ATM UNI Cause	Value for `cause` Field	Comments
`Call Rejected`	`21`	Additional information may be supplied. See Table 68, page 181.
`Number Changed`	`22`	Additional information may be supplied. See Table 68, page 181.
`User Rejects Calls With Calling Line Identification Restriction (CLIR)`	`23`	
`Destination Out of Order`	`27`	
`Invalid Number Format`	`28`	
`Response to STATUS ENQUIRY`	`30`	
`Normal_3.0`	`31`	Used only with UNI 3.0. Not used with UNI 3.1.
`Requested VPCI/VCI Unavailable`	`35`	
`VPCI Assignment Failure`	`36`	
`User Cell Rate Unavailable`	`37`	Not used with UNI 3.0. Used only with UNI 3.1.
`Network Out of Order`	`38`	
`Temporary Failure`	`41`	
`Access Information Discarded`	`43`	Additional information may be supplied. See Table 68, page 181.
`No VPCI/VCI Available`	`45`	
`Resource Unavailable, Unspecified`	`47`	
`QOS Unavailable`	`49`	Additional information may be supplied. See Table 68, page 181.
`User Cellrate Unavailable`	`51`	Used only with UNI 3.0. Not used with UNI 3.1. Additional information may be supplied. SeeTable 68, page 181.
`Bearer Capability Not Authorized`	`57`	
`Bearer Capability Not Presently Available`	`58`	

Text for ATM UNI Cause	Value for `cause` Field	Comments
`Service or Option Unavailable, Unspecified`	`63`	
`Bearer Capability Not Implemented`	`65`	
`Unsupported Combination of Traffic Parameters`	`73`	
`AAL Parameters Cannot Be Supported`	`78`	Not used with UNI 3.0. Used only with UNI 3.1.
`Invalid Call Reference`	`81`	
`Identified Channel Does Not Exist`	`82`	Additional information may be supplied. See Table 68, page 181.
`Incompatible Destination`	`88`	Additional information may be supplied. See Table 68, page 181.
`Invalid Endpoint Reference`	`89`	
`Invalid Transit Network Selection`	`91`	
`Too Many Pending Add Party Requests`	`92`	
`AAL Parameters Cannot Be Supported`	`93`	Used only with UNI 3.0. Not used with UNI 3.1.
`Mandatory Information Element Missing`	`96`	Additional information may be supplied. See Table 68, page 181.
`Message Type Nonexistent or Not Implemented`	`97`	Additional information may be supplied. See Table 68, page 181.
`Information Element Nonexistent or Not Implemented`	`99`	Additional information may be supplied. See Table 68, page 181.
`Invalid Information Element Contents`	`100`	Additional information may be supplied. See Table 68, page 181.
`Message Not Compatible With Call State`	`101`	Additional information may be supplied. See Table 68, page 181.
`Recovery On Timer Expiry`	`102`	Additional information may be supplied. See Table 68, page 181.
`Incorrect Message Length`	`104`	
`Protocol Error, Unspecified`	`111`	

Table 67. Silicon Graphics Cause Codes

Text for Silicon Graphics Cause	Value for `cause` Field	Comments
`CAUSE_LOCALERROR`	`128`	Local Error: unknown driver or signaling-daemon error.
`CAUSE_ALREADY`	`129`	Registration denied: broadband low layer information (BLLI) already taken, or application already registered.
`CAUSE_INVALBESTEFFORT`	`130`	Best Effort requires that both directions be Best Effort and `QOS_0`.
`CAUSE_INVALCELLRATE`	`131`	Invalid `cellrate` field.
`CAUSE_INVALBLLI`	`132`	Invalid broadband low layer information (BLLI) code specified.
`CAUSE_INVALBEARERCLASS`	`133`	Invalid bearer class.
`CAUSE_INVALADDRESSFMT`	`134`	Invalid address format.
`CAUSE_NOTMULTI`	`135`	Add or drop party on a point-to-point call.
`CAUSE_PARTYHANDLEINUSE`	`136`	Trying to add a party using a party handle that has already been used.
`CAUSE_INVALPARTYHANDLE`	`137`	Request was dropped because the party handle was not found.

Table 68. ATM UNI Diagnostics

Accompanying ATM UNI Cause	ATM UNI Diagnostic Provided	Diagnostic Values
`Unallocated / Unassigned Number`	1 octet	The diagnostics provide a description of the condition, whether the condition is normal or abnormal, and who supplied the diagnostic. For specific diagnostics, see Table 69, page 182.[1]
`Call Rejected`	2 octets	The diagnostics provide the following information: the most significant octet contains the reason, and a description of the condition. For a list of the reasons and conditions, see Table 70, page 183. The least significant octet contains either user-specific values or the identifier for the ATM UNI information element (IE), whichever is appropriate.
`No Route to Destination`	1 octet	Same as Unallocated Number.
`Number Changed`	6 to 25 octets	The new destination address formatted with a Called Party Number information element.
`Access Information Discarded`	1 or more octets	Each octet specifies one ATM UNI information element identifier.
`QOS Unavailable`	1 octet	Same as Unallocated Number.
`User Cell Rate Unavailable`	1 or more octets	Each octet specifies one subfield identifier from the ATM UNI User Cell Rate information element.
`Identified Channel Does Not Exist`	4 octets	Most significant two octets specify VPCI value. Least significant two octets specify VCI value.
`Incompatible Destination`	1 octet	The ATM UNI information element identifier.
`Mandatory Information Element Missing`	1 or more octets	Each octet is one ATM UNI information element identifier.

Accompanying ATM UNI Cause	ATM UNI Diagnostic Provided	Diagnostic Values
`Message Type Nonexistent or Not Implemented`	1 octet	Specifies one ATM UNI message type: for example, `SETUP`, `RELEASE`, `CONNECT`.
`Information Element Nonexistent or Not Implemented`	1 or more octets	Each octet is one ATM UNI information element identifier.
`Invalid Information Element Contents`	1 or more octets	Each octet is one ATM UNI information element identifier.
`Message Not Compatible With Call State`	One octet	Specifies one ATM UNI message type: for example, `SETUP`, `RELEASE`, `CONNECT`.
`Recovery On Timer Expiry`	3 octets	Each octet specifies one IA5 character to indicate one numeral identifying an ATM UNI timer. For example, for the timer called `T308`, the first octet specifies `3`, the second `0`, and the third `8`.

Table 69. Diagnostics for Unallocated/Unassigned Number

Condition	Normal/Abnormal	Who
0x80 Unknown	Normal	Provider
0x81 Permanent	Normal	Provider
0x82 Transient	Normal	Provider
0x84 Unknown	Abnormal	Provider
0x85 Permanent	Abnormal	Provider

1 IRIS ATM does not currently pass these diagnostics up to higher-layer applications.

Condition	Normal/Abnormal	Who
0x86 Transient	Abnormal	Provider
0x88 Unknown	Normal	User
0x89 Permanent	Normal	User
0x8A Transient	Normal	User
0x8C Unknown	Abnormal	User
0x8D Permanent	Abnormal	User
0x8E Transient	Abnormal	User

Table 70. Diagnostics for Call Rejected

Reason	Condition
0x80 user-specific	unknown
0x81 user-specific	permanent
0x82 user-specific	transient
0x84 IE missing	unknown
0x85 IE missing	permanent
0x86 IE missing	transient
0x88 IE missing	unknown
0x89 IE missing	permanent
0x8A IE missing	transient

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