IRIS® HIPPI API Programmer's Guide

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Chapter 1

Description of IRIS HIPPI Implementation

Overview of IRIS HIPPI Implementation

This document describes the Silicon Graphics implementation of the High-Performance Parallel Interface (HIPPI) protocol.

Conformance with HIPPI Standards

The Silicon Graphics implementation of HIPPI provides the services and conforms to the protocols described in the HIPPI standards for HIPPI-PH, HIPPI-FP, the host portion of HIPPI-SC, and HIPPI-LE. Also see the section "How HIPPI Protocol Items Are Handled With the HIPPI-PH Access Method" on page 11, and the section "How HIPPI Protocol Items Are Handled With the HIPPI-FP Access Method" on page 18.

Basic Architecture

IRIS HIPPI supports transmission and reception as separate channels. Because of this design, it is possible for a system to have applications that only receive, applications that only send, and / or applications that do both. In addition, each channel can be accessed with a different access method. (The access methods are described in "The Device File and Access Methods" on page 6.)

For transmission, IRIS HIPPI supports four different functionality scenarios, summarized in Table 1-1 and described in the text below the table. Each

functionality scenario is a combination of one connection control method (the rows of Table 1-1) and one packet control method (the columns of Table 1-1).

A connection can be single-packet or many-packet. A single-packet connection is when one packet is sent and then the HIPPI subsystem automatically closes the connection. A many-packet connection is a connection that is kept open for as long as the application wants. In the latter case, the application must indicate when it wants the connection closed.

A packet can be single-write or multiple-write. A single-write packet is a HIPPI packet that is created by the HIPPI subsystem from an application's single *write()* call. A multiple-write packet is created from two or more *write()* calls. In the latter case, the application must indicate the start of each packet.

Table 1-1 Functionality Scenarios for IRIS HIPPI Transmission

		Packet Control	
		single-write = 1 packet	**multiple-writes = 1 packet**
Connection Control	**single-packet connection**	1	2
	many-packet or long-term connection	3	4

1. Single-packet connection, single-write packet:
    - The application does one *write()*, which causes the connection to be opened.
    - One packet is sent. It consists of the data in the *write()* call.
    - The HIPPI subsystem automatically closes the connection.

2. Single-packet connection, multiple-write packet:
   - The application indicates the length of a packet.
   - The application does the first *write()* call, which causes the connection to be opened.
   - The application continues to do *write()* calls.
   - A packet is sent. Data from the *write()* calls, up to the specified packet length, are sent as one packet. The packet length can be indeterminate.
   - The HIPPI subsystem closes the connection.
3. Many-packet connection, single-write packets:
   - The application asks for a long-term connection.
   - The application does the first *write()* call and the connection is opened.
   - One packet is sent. It consists of the data in the *write()* call.
   - The application does any number of *write()* calls.
   - One packet is created and sent from each *write()*.
   - The connection remains open until the application closes it.
4. Many-packet connection, multiple-write packets:
   - The application asks for a long-term connection.
   - The application indicates the length of a packet. This length may be indeterminate or a specified bytecount.
   - The application does the first *write()* call and the connection is opened.
   - The application does any number of *write()* calls.
   - A packet is sent. Data from the *write()* calls, up to the specified packet length, are sent as one packet. The packet length can be indeterminate.
   - The application may indicate the end of the packet at any time.
   - The application can send any number of packets by indicating a length for each new packet.
   - The connection remains open until the application closes it.

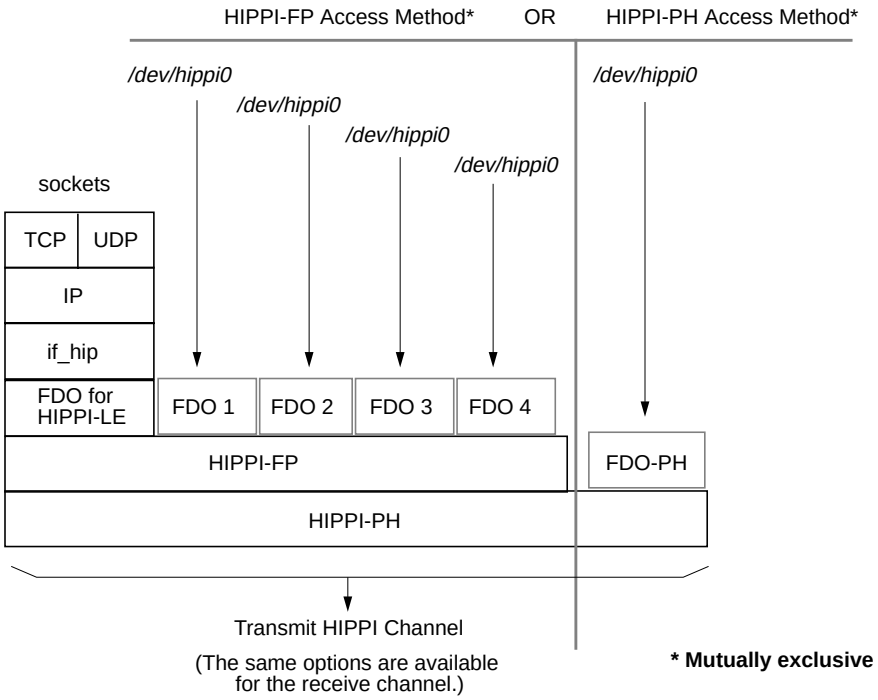


Figure 1-1 Interfaces for Controlling One Channel of the HIPPI Subsystem

The IRIS HIPPI implementation consists of 4 main components:

- the device file (*/dev/hippi#*) and access methods for controlling the HIPPI subsystem, illustrated in Figure 1-1
- transmission-related information objects (FDOs) for each open device file descriptor
- reception-related information objects (ULPOs) for different upper-layer protocol applications (ULPs)
- the application programming interface (API)

Each of these components is described in a section below.

The Transmission Information Object for File Descriptors

A portion of the IRIS HIPPI subsystem, within the UNIX kernel, maintains transmission information objects, referred to as *file descriptor objects* (FDOs). An FDO is maintained for each open file descriptor. The HIPPI subsystem uses this information for generating HIPPI packets on transmission. Applications change the values through the IRIS HIPPI API. The values are persistent, so they can be used on sequentially sent packets, without resetting.

- the ULP's identification number (that is, the ULP-id)
- access mode (read-only, write-only, read and write)
- the I-field used when establishing a connection
- the size of the first burst for each packet
- the setting for the B-bit in the FP header (used by HIPPI-FP only)
- the setting for the P-bit of the FP header (used by HIPPI-FP only)
- the size of the D1 area (used by HIPPI-FP only)

The Upper Layer Protocol Object

A portion of the IRIS HIPPI subsystem, within the UNIX kernel, maintains reception information objects, called *upper-layer protocol objects* (ULPOs). A ULPO is maintained for each ULP-id. Each ULPO consists of a set of information that the HIPPI subsystem uses when receiving HIPPI packets. Each application must have a ULPO associated with (bound to) it. With HIPPI-FP, the information in one ULPO can be shared among a group of applications. Applications use the HIPPI API (*ioctl* calls) to change their ULPO values.

Note: HIPPI-LE (over which TCP/IP runs) is an example of a ULP.[1] ULPs that customers may develop include IPI-3 and "raw" protocols. ♦

[1] Currently the information in the HIPPI-LE's ULPO cannot be shared with other network-layer applications.

Each ULPO maintains the following information:

- the ULP's identification number (that is, the ULP-id), used only by HIPPI-FP
- the number of applications using this ULP-id, used only by HIPPI-FP
- the received bytecount for the packet currently being read

The API

The IRIS HIPPI product includes an application programming interface (API) that allows customer-developed applications to change the information in their ULPO and FDO and to control the HIPPI subsystem. The API is through a UNIX "character special" device file.

By invoking different IRIS HIPPI API commands, customer-developed programs define their access method, data flow (packet) control, connection control, and HIPPI protocol processing.

Further details on the API are provided in Chapter 2.

The Device File and Access Methods

The IRIS HIPPI implementation provides the */dev/hippi0* device file for accessing and controlling the HIPPI subsystem. Two different access methods (described below) are provided. Both use the */dev/hippi0* device file. The access method is defined when the device file is bound.

IRIS HIPPI offers two mutually exclusive methods for accessing the HIPPI subsystem: HIPPI-FP and HIPPI-PH. The HIPPI-FP access method requires the use of FP headers and provides automatic processing of that header. The HIPPI-PH method does not require use of the FP header, thus allowing an application to bypass the HIPPI-FP layer.

Besides the difference (discussed above) in the point of access, the main differences between the two access methods revolve around coexistence with other ULPs (including HIPPI-LE and the TCP/IP stack), as listed below:

- For HIPPI-FP, received packets are demultiplexed using ULP-ids. For HIPPI-PH, all packets are placed on a single input queue.

- For HIPPI-FP, access to the HIPPI subsystem is blocked when a ULP is accessing the device. With the HIPPI-PH access method, no blocking occurs.

Further details are provided in the “The HIPPI-PH Access Method” on page 8, and “The HIPPI-FP Access Method” on page 14.

Implementation Details

The Silicon Graphics IRIS HIPPI Product (HIPPI board, device driver, interface, and firmware) has been designed to meet the ANSI X3T9 Standards Committee’s working and preliminary draft standards for the High-Performance Parallel Interface.[2] The HIPPI board design includes the following implementation details that are either not mentioned in the ANSI documentation for the HIPPI standard, or are considered by the design team to be ambiguously defined in the standards documentation:

- Once a receiving channel has been created and configured to accept connections, all incoming connection requests are accepted by the HIPPI board. The HIPPI subsystem does not wait for upper-layer input. (That is, the HIPPI board does not generate the service primitive PH_RING.Indicate and does not allow the application to respond with a PH_ANSWER.Request for each connection). The upper layers may discard data that has been received from undesirable connections.
- Each instance of a ULPO must be assigned a ULP-id that is unique within the ULPOs for a specific HIPPI board. A valid ULP-id is a number between 0 and 255 decimal (inclusive); 4 is reserved for and used by the IRIX™ module implementing 8802.2 Link Encapsulation (HIPPI-LE); 7 is reserved for IPI-3 implementations.

[2] HIPPI-LE working draft dated June 30, 1992; HIPPI-FP preliminary draft dated June 24, 1991; HIPPI-PH working draft dated December 16, 1992.

The HIPPI-PH Access Method

The HIPPI-PH access method controls the HIPPI protocol stack at the HIPPI-PH layer. With this access method, the HIPPI-FP protocol is bypassed; the IRIS HIPPI subsystem does no checking for or processing of HIPPI-FP protocol items. Accessing the HIPPI subsystem in this manner is well-suited for applications requiring full or almost full use of the HIPPI device, and situations where (for other reasons) the application does not wish to use the HIPPI-FP protocol.

Description of HIPPI-PH

HIPPI-PH supports the following functions for reception:

- Accepts all incoming HIPPI packets. Does not reject any packet, and does not demultiplex using the ULP-id.
- Enqueues the entire packet on the input queue for retrieval by the application. Does not interpret anything in the packet (not an FP header or D1 data).
- The HIPPI subsystem maintains a received bytecount value (offset) that can be used by applications to identify packet boundaries

HIPPI-PH supports the following functions for transmission:

- Provides two choices for setting up the HIPPI connection: a single-packet connection (where the HIPPI subsystem creates and tears down a connection for each packet), and a long-term connection (where the HIPPI subsystem keeps the connection up across one, many, or all packets). In long-term connections, the application controls the timing of the disconnect.
- Provides two methods for creating packets: “multiple-write” packets (where the **PACKET** signal is asserted across multiple *write()* calls) and single-write packets (where the **PACKET** signal is deasserted when the data from one *write()* has been transmitted). The maximum bytecount for any *write()* is 2 megabytes, so a single-write packet cannot be larger than 2 megabytes.
- Allows an application to send an “infinite” sized packet.

- Allows an application to specify that the first burst of any packet be a short burst.
- Allows an application to terminate a multiple-write packet before its bytecount is transmitted.
- Allows an application to use the HIPPI subsystem as a “raw” data pipeline. For example, the FP header is not required and the I-field can be set to any value.
- HIPPI-PH supports the four different functionality scenarios for transmission, summarized in Table 1-1.

Applications using the HIPPI-PH access method can open the device for transmit only (illustrated in Figure 1-2), receive only (also illustrated in Figure 1-2), or for both (illustrated in Figure 1-3). Once the device is open and bound, any of the functionality scenarios in Table 1-1 can be used.

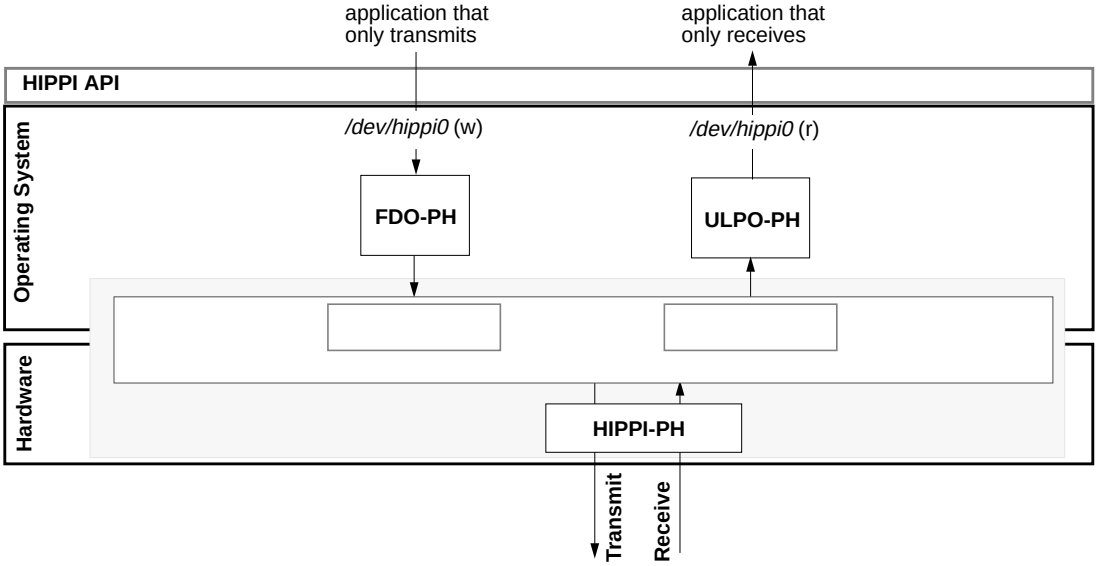


Figure 1-2 Block Diagram for Two Applications Using HIPPI-PH: One Receive-Only and One Transmit-Only

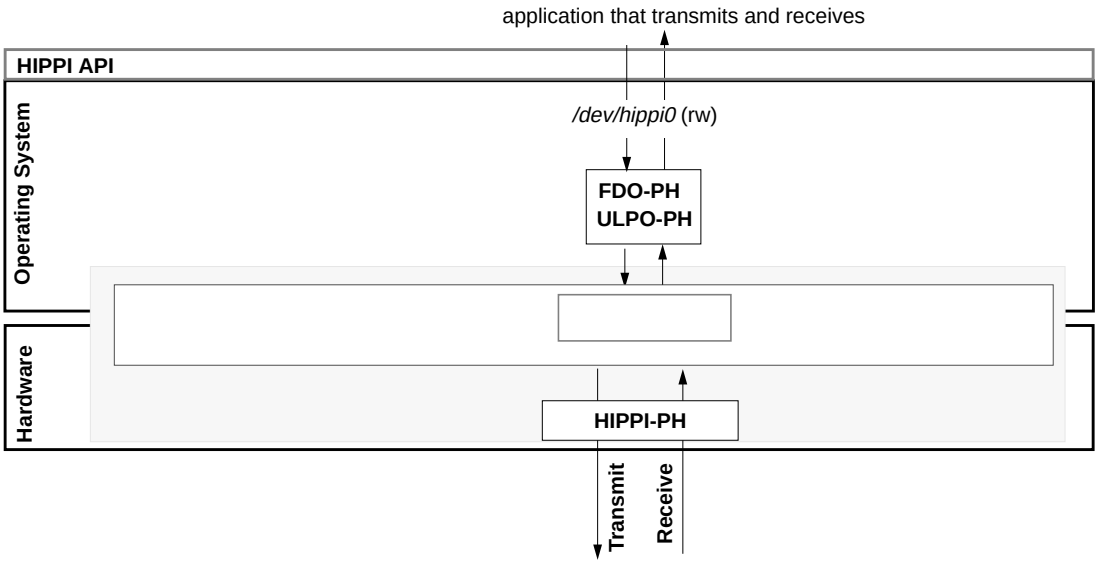


Figure 1-3 Block Diagram for One Application Using HIPPI-PH: Receive and Transmit

There are certain constraints associated with using the HIPPI-PH access method, as listed below. However, with HIPPI-PH overall, there are fewer constraints on what the application can do with the interface than with HIPPI-FP.

- If more than one application operates a channel (transmit or receive) of the HIPPI board, an arbitration and synchronization mechanism between the applications must be developed to prevent race conditions.
- The HIPPI network interface cannot be *ifconfig*'ed up, which means that the TCP/IP protocol stack cannot use the HIPPI board.
- For receiving, if a HIPPI-FP header exists in the packet, it is not interpreted (and not demultiplexed) by the HIPPI subsystem.
- All *read()*s and *write()*s must specify buffers that are 8-byte word-aligned. This is because direct memory access (DMA) occurs directly to/from user application space and the HIPPI device only handles word-aligned DMAs.
- The data lengths for all *read()*s and *write()*s must be multiples of 8 bytes.

HIPPI-PH Output

When a device is opened for writing and bound with the HIPPI-PH access method, the HIPPI subsystem transmits only data that the application passes to it. No additional data, encapsulation, or HIPPI protocols are added by the HIPPI subsystem. The only information used from the application's FDO is the I-field and the short burst setting.

The application can define the first burst as short within each packet.

HIPPI-PH Input

When a device is opened for reading and bound with the HIPPI-PH access method, the HIPPI subsystem receives **all** inbound data; all packets are enqueued on the reading queue. The HIPPI subsystem does not attempt to interpret an FP header; therefore, if an FP / D1 header exists, these are passed to the application as part of the data stream. No demultiplexing is performed on the ULP-id. No special handling features are available.

The application can retrieve a packet bytecount (offset) value that simplifies identification of packet boundaries.

How HIPPI Protocol Items Are Handled With the HIPPI-PH Access Method

This section describes how the HIPPI-PH access method handles the HIPPI I-field and the HIPPI Framing Protocol.

How I-Fields Are Handled on Transmission

The FDO maintains a value for the I-field. The HIPPI subsystem uses the value each time it sets up a connection. Applications use an *ioctl()* call to set the I-field value to a new one whenever desired. The HIPPI subsystem does not interpret or alter the I-field in any way during transmission.

How I-Fields Are Handled on Reception

The HIPPI subsystem does not interpret or alter the I-field in any way for reception.

How the Framing Protocol and D1 Data Are Handled on Transmission

The HIPPI-PH access method does not generate an FP header or D1 data area for packets on transmission. An application may utilize the HIPPI Framing Protocol by generating its own FP header / D1 data and transmitting these just as it does all other packet data (with *write* calls), as illustrated in Figure 1-4. An application may invoke an *ioctl()* call to define the bytecount for the first (short) burst; the data for that first burst is taken from the first *write()* call, as illustrated in Figure 1-5.

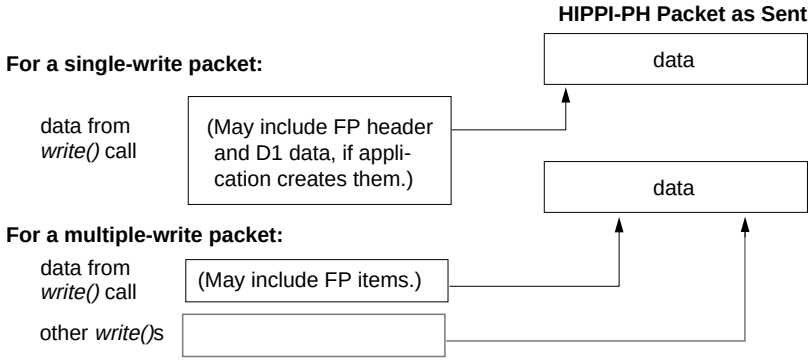


Figure 1-4 Creation of HIPPI-PH Packet

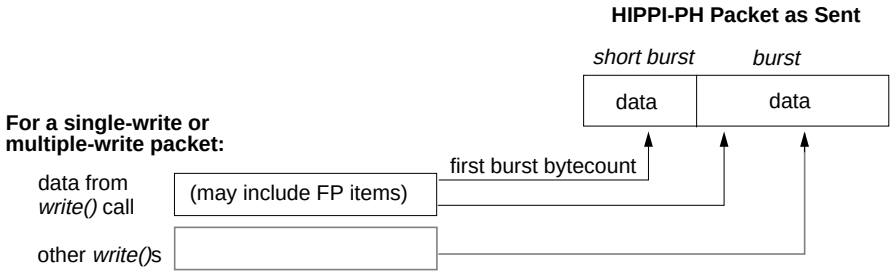


Figure 1-5 Creation of HIPPI-PH Packet With First Short Burst

How the Framing Protocol and D1 Data Are Handled on Reception

On incoming packets, HIPPI-PH does not check for the presence of an FP header nor does it interpret the FP header if one exists. If an FP header / D1 area are present in a packet, the HIPPI subsystem treats that packet just as it does any other packet (enqueuing the contents of the packet on the receive queue without any interpretation, separation, or special processing).

The HIPPI-FP Access Method

Description of HIPPI-FP

- The HIPPI-FP access method controls the HIPPI protocol stack at the HIPPI-FP layer and provides for sharing of the HIPPI receive and/or transmit channels among applications, as illustrated in Figure 1-6. Up to 32 different applications (open file descriptors) can use the IRIS HIPPI subsystem simultaneously in any combination of transmitting-only, receiving-only, and transmitting-and-receiving.

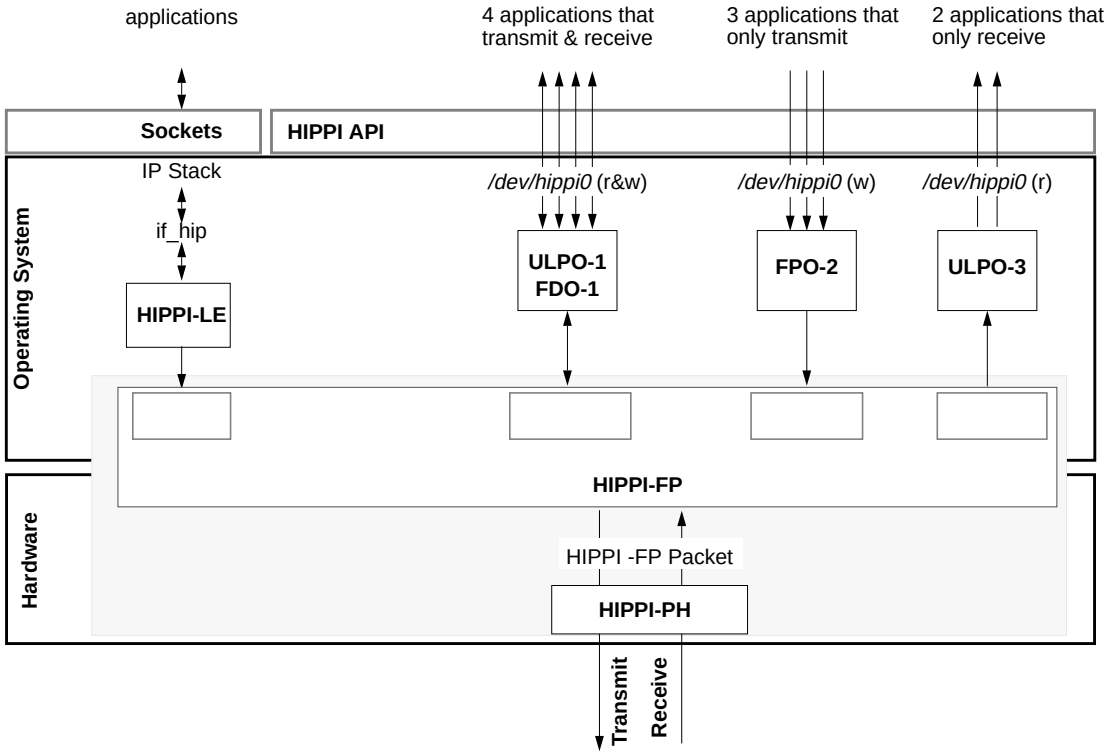


Figure 1-6 Block Diagram for Using HIPPI-FP

HIPPI-FP supports the following functions for reception:

- Up to 32 different applications (open file descriptors) can receive HIPPI packets simultaneously.
- Up to 8 different customer-developed ULPOs can be active simultaneously. Each application must bind to one ULPO. HIPPI-IPI is an example of a ULPO. (The HIPPI-LE module that is part of the HIPPI product does not count as one of these ULPOs.)
- The HIPPI subsystem demultiplexes incoming packets using the ULP-ids from the active ULPOs. It discards packets that do not match any of the ULP-ids in active ULPOs.
- The HIPPI subsystem verifies the presence of a valid FP header and discards packets that do not have a valid FP header.
- The HIPPI subsystem separates the FP header and D1 data from the D2 data so that the application's first *read()* retrieves the FP header and D1 data, while its subsequent *read()*s retrieve the D2 data.
- The HIPPI subsystem maintains a packet offset value (bytecount) that can be used by applications to identify packet boundaries.
- User-layer applications can use the IRIX default network stack, the Internet Protocol (IP) suite. The HIPPI product ships with a socket-based driver, *if_hip*, that supports the IP suite over HIPPI using HIPPI-LE. Customer-developed programs can coexist with this networking software. (This feature is not available in "mixed" configurations, where one of the HIPPI channels is being used by HIPPI-FP and the other by HIPPI-PH.)

  Note: The IP software requires equal-access to its lower layer services. If applications sharing the HIPPI subsystem with IP do not meet this requirement, the performance of IP is seriously compromised. ♦
- Special "auto-bind" device files can be set up with more general permissions in order to allow user access to specific ULPOs.

HIPPI-FP supports the following functions for transmission:

- Up to 32 different applications (open file descriptors) can transmit HIPPI packets simultaneously.
- Up to 8 different customer-developed FDOs can be active simultaneously. Each application must bind to one FDO. HIPPI-IPI is

an example of an FDO. (The HIPPI-LE module that is part of the HIPPI product does not count as one of these FDOs.)

- The HIPPI subsystem creates an FP header for each packet.
- Allows an application to specify that the first burst of any packet contains only the FP header and, optionally, a D1 area. The word count of this first burst can be short (1 to 255 words) or standard (256 words). The B bit in the FP header is automatically set.
- Allows an application to specify the presence of D1 data and the size of the D1 area. The P bit in the FP header is automatically set.
- HIPPI-FP supports the four different functionality scenarios for transmission, summarized in Table 1-1.

With HIPPI-FP, there are certain constraints, as listed below:

- For transmitting, a HIPPI-FP header is attached to every outgoing packet. If the application does not specify an FP header, the HIPPI subsystem uses a default one.
- For receiving, each incoming packet must have a valid HIPPI-FP header. The HIPPI subsystem demultiplexes incoming packets based upon the ULP identifier in the FP header.
- Incoming connection requests cannot be selectively rejected by the ULPO or application; each incoming connection request results in acceptance of the packet. However, the HIPPI subsystem discards packets with ULP-ids that do not match any of those that are currently bound. All applications that have opened a HIPPI file descriptor for receiving (reading) and have bound to a ULPO will receive all incoming packets destined to the bound ULP-id.
- All *read()*s and *write()*s must specify buffers that are 8-byte word-aligned. This is because direct memory access (DMA) occurs directly to or from user application space and the HIPPI device only handles word-aligned DMAs.
- The data lengths for all *read()*s and *write()*s must be multiples of 8 bytes.

HIPPI-FP Output

The destination endpoint is specified by an *ioctl()* call that sets the I-field for all subsequent packets (until the value is changed). The I-field can be changed at any time, and the *ioctl()* call is efficient enough that there is no problem with setting the I-field just before each *write()* call for a series of single-write packets.

HIPPI FP headers are automatically generated on output. The default FP header (illustrated in Figure 1-7) has the ULP identifier (specified at bind time), does not have any D1 area, and the P and B bits are off. If an application defines a size for the D1 area or specifies a first burst containing only FP header and D1 area, this information is included in the header. The D2_Size field in the FP header is filled with the proper value.

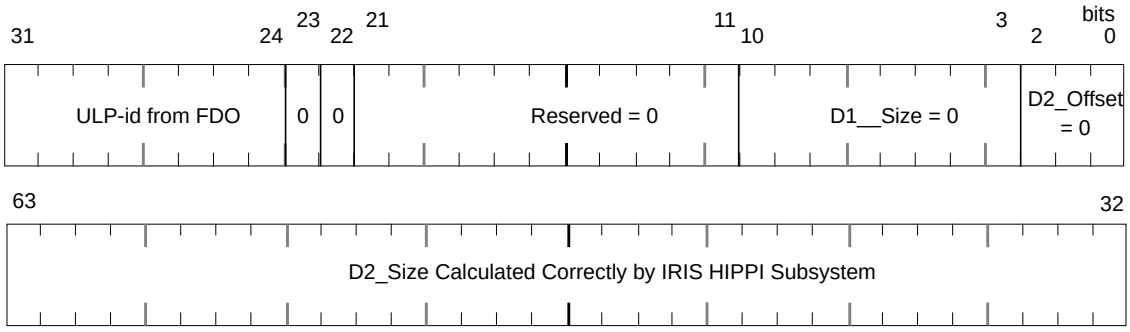


Figure 1-7 Default FP Header for HIPPI-FP Transmission

HIPPI-FP Input

When a device is opened for reading and bound to a ULPO with the HIPPI-FP access method, the associated application is able to retrieve all HIPPI packets that arrive with the bound ULP-id. The demultiplexing on ULP-ids is done on the HIPPI board so that DMA can occur directly to user-space. If multiple applications share a ULPO, demultiplexing the packets must be handled by an application-level program.

HIPPI-FP separates the FP header and D1_Data_Area from the D2 area. The application's first *read()* call returns the FPheader / D1data exactly. (The return value tells how large these areas are). Subsequent *read()* calls return

the D2 area until the D2 data is completely read. By monitoring the HIPPI subsystem's packet offset value, the application can tell when the next *read()* is going to return the FPheader / D1area for a new packet.

It is possible to receive packets that are very large because reception can be broken up into multiple *read()*s. This also helps provide for some scattering of data, but small *read()*s are inefficient.

An application can retrieve a packet bytecount (offset) value that simplifies identification of packet boundaries.

How HIPPI Protocol Items Are Handled With the HIPPI-FP Access Method

This section describes how the HIPPI-FP access method handles the HIPPI I-field and the HIPPI Framing Protocol.

How I-Fields Are Handled on Transmission

Each FDO contains a value for the I-field that the HIPPI subsystem includes each time it sets up a connection. Applications use an *ioctl()* call to set the value to a new one whenever desired. The HIPPI subsystem does not interpret nor alter the I-field in any way during transmission.

How I-Fields Are Handled on Reception

The HIPPI subsystem does not interpret nor alter the I-field in any way during reception.

How the Framing Protocol Is Handled on Transmission

When accessed with the HIPPI-FP access method, the HIPPI subsystem uses the HIPPI Framing Protocol on all connections for receiving and transmitting, as explained below.

The HIPPI subsystem creates an FP header for each packet that it transmits. The default value for the generated FP header is as follows:

- D2_Size (that is, bits 63:32 of the FP header) is set to the size of the *write()* call for a single-write packet or, for a multiple-write packet, the bytecount indicated by the *ioctl()* call that starts the packet.
- ULP-id (that is, bits 31:24) is set to the ULP-id that was provided by the application when it bound to the ULPO.
- Control (P and B) and reserved bits are off (that is, bits 23:11 are set to zero).
- D1_Area_Size and D1_Offset are set to zero.

To include D1 data in a packet, an application specifies the size of the D1 area, using an *ioctl()* call. This action sets the D1_Area_Size in the FDO and causes the P bit in the FP header to be set ON. The application then does its *write* (or first *write* for a multiple-write packet), pointing to contiguous D1 and D2 data.

To place only the FP header and D1 data (optional) in the first burst and to set the B-bit, an application invokes an *ioctl()* call, specifiying the size of the first burst. If the specified size is less than 256 words, the IRIS HIPPI subsystem handles the burst as a short burst. The HIPPI subsystem creates a first burst of the indicated size (short or standard length) that contains the following data:

- The required, and automatically generated, FP header (8 bytes).
- An optional number of D1 data bytes, up to a maximum of 1016.

The D2 size for the FP header is calculated by the IRIS HIPPI subsystem, as described immediately below.

- For a single-write packet, the D2 data size is the *size* of the *write()* call minus the D1_Area_Size, as shown in Figure 1-8.
- For any multiple-write packet, the D2 data size is as specified by an *ioctl()* command, as shown in Figure 1-9 (illustrating contiguous D1 and D2 data) and Figure 1-10 (illustrating FP header and D1 data separated into the first burst).

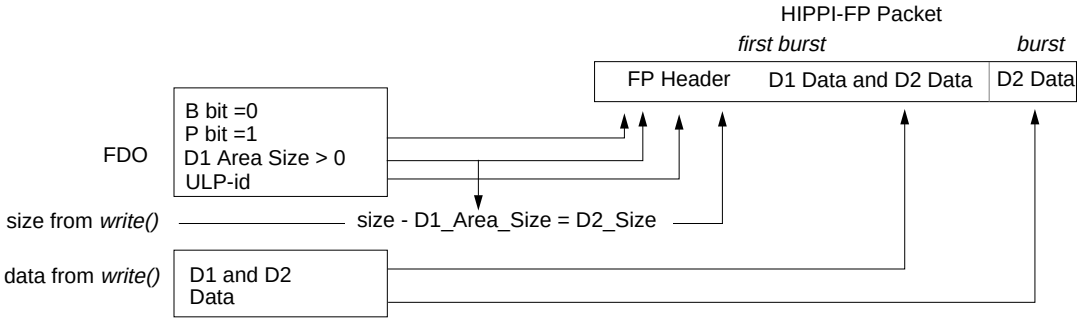


Figure 1-8 Single-Write HIPPI-FP Packet With D1 Data

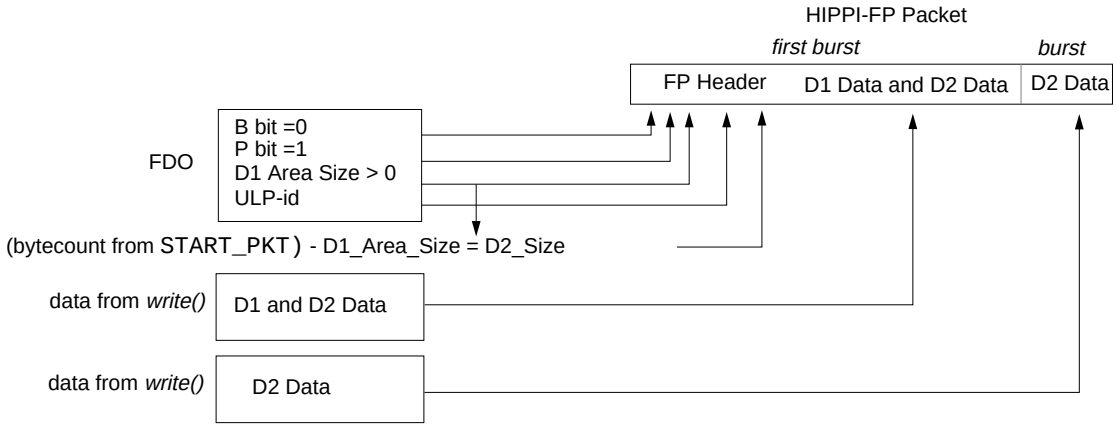


Figure 1-9 Multiple-Write HIPPI-FP Packet: Contiguous D1 and D2 Data

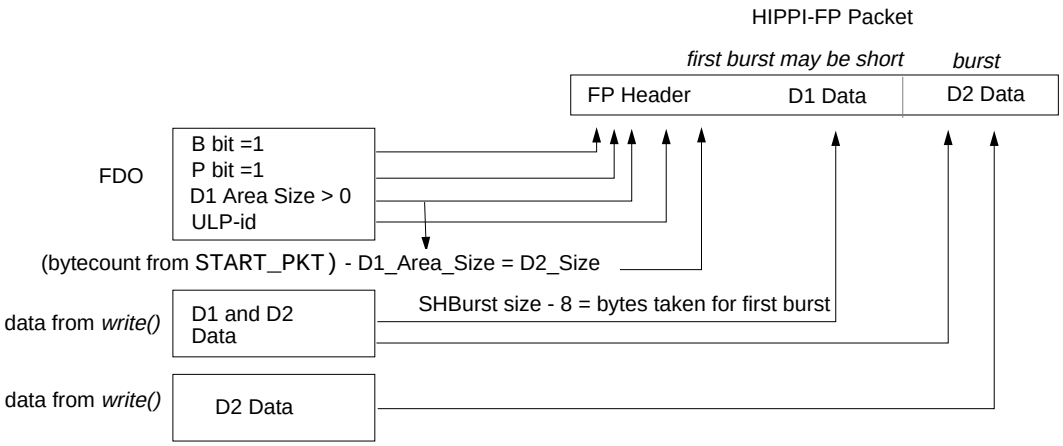


Figure 1-10 Multiple-Write HIPPI-FP Packet: Separate FP Header and D1 Data

How the Framing Protocol Is Handled on Reception

With each reception of a packet, the HIPPI subsystem interprets the FP header information, as required by the standard. The application's first *read()* retrieves the FPheader / D1data; subsequent *read()* calls retrieve D2 data. It is the responsibility of the reading application(s) to keep track of which *read()*s retrieve which kinds of data. The HIPPI subsystem demultiplexes incoming packets, using the ULP-id field. Incoming packets for unrecognized ULP-ids are discarded by the HIPPI subsystem.

Mixing HIPPI-PH and HIPPI-FP

HIPPI-PH and HIPPI-FP access methods can be used simultaneously so that they share one HIPPI board. There are two restrictions for this configuration:

- Each HIPPI-channel (receive and transmit) must be used by either HIPPI-PH or HIPPI-FP, but not both. For example, a number of applications and ULPOs can use HIPPI-FP for receiving demultiplexed data while a sending application uses HIPPI-PH, as illustrated in Figure 1-11.

- The TCP / IP over HIPPI-LE protocol stack cannot be supported because it requires HIPPI-FP access for both transmit and receive.

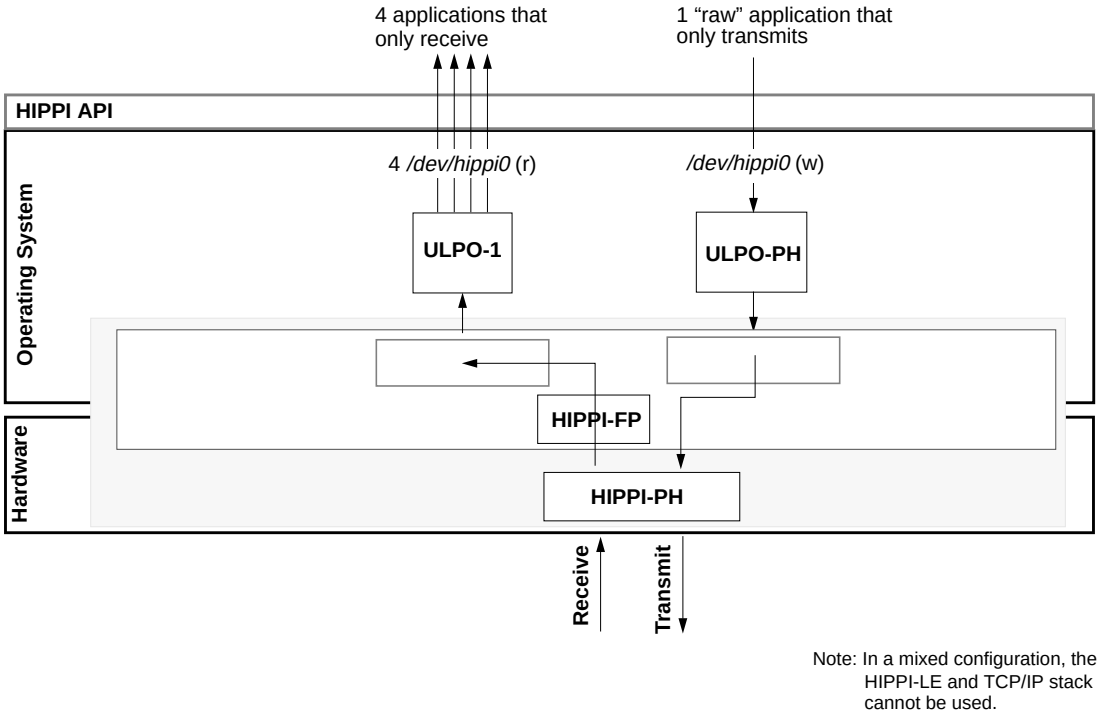


Figure 1-11 Block Diagram for Mixing HIPPI-PH and HIPPI-FP

Chapter 2

Programming Notes for IRIS HIPPI API

This chapter describes how to interface an application to the IRIS HIPPI subsystem. A reference section containing an alphabetical listing of all the *ioctl()* calls in the HIPPI application programming interface (API) is provided in "API Reference" on page 36.

Programming for the HIPPI-PH Access Method

This section describes how to program a module that accesses the HIPPI subsystem at the physical layer (that is, it does not use the HIPPI Framing Protocol).

Includes

The following file must be included in any program using the IRIS HIPPI API:

```
#include <sys/hippi.h>
```

Special Instructions

For maximum throughput, DMA between the HIPPI board and the host application occurs directly to or from user application space. Because of this, and the fact that the DMA component (ASIC) has a 64-bit interface, all application *read()*s and *write()*s must specify buffers that are 8-byte

word-aligned, and the data bytecount must be a multiple of 8. (See *memalign*(3C) for a method of allocating 8-byte aligned memory).

Opening and Binding to the Device

An application can open a HIPPI device (for example, *hippi0* or *hippi1*) for read-only, write-only, or read-and-write access. The acronym `fd_hippi0`, in the examples below, refers to the file descriptor for the opened HIPPI device.

It is important that the application open the HIPPI device with only the read / write flag settings that it needs. For example, if an application is not going to be doing *read()*s, it should set only the WRITE flag. When the READ flag is set, the HIPPI subsystem is told to expect HIPPI packets, so incoming packets are always accepted by the HIPPI device. The HIPPI subsystem holds each accepted packet until an application reads it. If no application consumes the incoming packets, the HIPPI device stalls for lack of buffer space.

To set up an application as a HIPPI-PH user, use one of the following sets of calls at the “beginning of time”:

- For a transmit-only connection:

```
fd_hippi0=open (“/dev/hippi0”, O_WRONLY);
ioctl (fd_hippi0, HIPIOC_BIND_ULP, HIPPI_ULP_PH
```

- For a receive-only connection:

```
fd_hippi0=open (“/dev/hippi0”, O_RDONLY);
ioctl (fd_hippi0, HIPIOC_BIND_ULP, HIPPI_ULP_PH
```

- For a transmit and receive connection:

```
fd_hippi0=open (“/dev/hippi0”, O_RDWR);
ioctl (fd_hippi0, HIPIOC_BIND_ULP, HIPPI_ULP_PH
```

Transmitting

For an application to transmit over its HIPPI-PH connection, one of the following sets (scenarios) of calls must be made. The order of the calls is unimportant except for the initial *write()* call, which actually starts sending

the data. Four functionality scenarios are supported. (See Table 1-1 for details on the four transmission functionality scenarios.)

Many of the *ioctl()* calls write or set a value for a stored ULPO or FDO parameter. These values are not cleared when a transmission completes, so prior settings can be reused with subsequent *write()* calls without resetting. All the calls should be made for the first transmission (since the device was opened) in order to initialize them to non-default values.

All application *write()*s must specify buffers that are 8-byte word-aligned, and the data bytecount must be a multiple of 8. (See *memalign*(3C)).

Notice the following:

1. When the `HIPIOCW_CONNECT` call is used, the HIPPI subsystem sets up a "permanent" connection. In contrast, when the `HIPIOCW_CONNECT` call is not used, the connection is disconnected as soon as the packet has been sent.
2. When the `HIPIOCW_START_PKT` call is used, many *write()*s may make up one packet. In contrast, when the `HIPIOCW_START_PKT` call is not used, one *write()* is a single packet.

Functionality Scenario 1

This scenario describes transmissions of small packets (under 2 megabytes) that use one *write()* for each packet. The connection disconnects when the packet has been completely sent.

The application makes an *ioctl()* call to specify the I-field, then makes the *write()* call. The maximum sized packet with this method is 2 megabytes. The packet and connection are both terminated when the data from the single *write()* call has completed.

```
ioctl (fd_hippi0, HIPIOCW_I, I-fieldValue);
/* I-field does not need to be reset for each pkt */

write (fd_hippi0, buffer, size);

/* PACKET line goes low (false) after one write */
/* connection is dropped after one write */
```

Functionality Scenario 3

This scenario describes transmission of small packets (under 2 megabytes) that use only one *write()* for each packet. The connection is kept open.

The application makes an *ioctl()* call to specify the I-field for its "permanent" connection, then makes a *write()* call to send the first packet. The maximum-sized packet with this method is 2 megabytes. The **PACKET** signal is dropped when the *write()* call completes. The connection, however, is not terminated, so the next packet can be another single-write, or a multiple-write (Functionality Scenario #4).

```
ioctl (fd_hippi0, HIPIOCW_CONNECT, I-fieldValue);
write (fd_hippi0, buffer, size);  /* first packet*/
/* PKT line goes low after one write. Connection is not dropped */
write (fd_hippi0, buffer, size);  /* second packet*/
/* PKT line goes low after one write. Connection is not dropped */

/* When application wants connection to be torn down, */
/* it tells the HIPPI subsystem to disconnect: */

ioctl (fd_hippi0, HIPIOCW_DISCONN);
```

Functionality Scenario 2

This scenario describes transmission of large packets that require many *write()* calls and where the connection disconnects when the packet has been completely sent.

The application makes an *ioctl()* call to specify the I-field, and one to define the size (bytecount) of the packet. It then makes the first *write()* call; subsequent *write()* calls are treated as part of the same packet until the bytecount is reached. The **PACKET** and **CONNECTION** signals are automatically dropped after the specified number of bytes have been sent. This scheme allows an application to send very large packets. It also allows some data gathering on output. (Note, however, that if packets are formed using small-sized *write()* calls, performance degrades considerably.)

```
ioctl (fd_hippi0, HIPIOCW_I, I-fieldValue);
ioctl (fd_hippi0, HIPIOCW_SHBURST, firstburstsize);  /* only if size is changing */
ioctl (fd_hippi0, HIPIOCW_START_PKT, bytecount);
write (fd_hippi0, buffer, size);     /* buffer can point to FPheader + D1 data */
```

```
write (fd_hippi0, buffer, size);    /* size=only a part of the complete pkt*/
write (fd_hippi0, buffer, size);    /* max size for each write is 2MB*/
write (fd_hippi0, buffer, size);
etc.

/* connection is dropped when packet is completely sent */
```

Functionality Scenario 4

This scenario describes transmission of large packets that require many *write()* calls and where the connection is kept open.

The application makes an *ioctl()* call to specify the I-field for its "permanent" connection and one to specify the size (bytecount) of the packet. Each *write()* is treated as part of the same packet, until the bytecount is satisfied, at which time the packet is ended. When the application wants to terminate the connection, it makes an *ioctl()* call to disconnect.

```
ioctl (fd_hippi0, HIPIOCW_CONNECT, I-fieldValue);
ioctl (fd_hippi0, HIPIOCW_SHBURST, firstburstsize);  /* only if size is changing */
ioctl (fd_hippi0, HIPIOCW_START_PKT, bytecount);
write (fd_hippi0, buffer, size);  /* buffer can point to FPheader + D1 data */
write (fd_hippi0, buffer, size);  /* size=only a part of the complete pkt*/
write (fd_hippi0, buffer, size);  /* max size for each write is 2MB */
etc.
/*when pkt's bytecount is complete, PKT line goes low*/
/*connection is not dropped*/

/* Optional: if the application wishes to start another packet,
/* it does this: */
ioctl (fd_hippi0, HIPIOCW_SHBURST, firstburstsize);  /* only if size is changing */
ioctl (fd_hippi0, HIPIOCW_START_PKT, bytecount);
...
/* When the application wants the connection to be torn down, */
/* it tells the HIPPI subsystem to disconnect */
ioctl (fd_hippi0, HIPIOCW_DISCONN);
```

Special Use of Functionality Scenario 4

For an infinite-sized packet on a long-term (“permanent”) connection.

The application makes an *ioctl()* call to specify the I-field for its “permanent” connection and one to specify the bytecount of the packet. The bytecount is specified as HIPPI_D2SIZE_INFINITY. All *write()* calls are then treated as one “infinite-sized” packet (that is, the **PACKET** signal is not deasserted), until the packet is specifically terminated by the application with a special *ioctl()* call. The connection is not dropped until the application disconnects it.

```
ioctl (fd_hippi0, HIPIOCW_CONNECT, I-fieldValue);
ioctl (fd_hippi0, HIPIOCW_SHBURST, firstburstsize);  /* only if size is changing */
ioctl (fd_hippi0, HIPIOCW_START_PKT, HIPPI_D2SIZE_INFINITY);
/*infinity=0xFFFFFFFF) */
write (fd_hippi0, buffer, size);   /*max size for each write is 2MB*/
write (fd_hippi0, buffer, size);
etc.

/* Optional: if the application wishes to terminate this packet, it does this */
ioctl (fd_hippi0, HIPIOCW_END_PKT);

/* Optional: if the application wishes to start another packet,
/* it does one of these: */
ioctl (fd_hippi0, HIPIOCW_START_PKT, HIPPI_D2SIZE_INFINITY);
/* or */
ioctl (fd_hippi0, HIPIOCW_START_PKT, bytecount);

/* When the application wishes to tear down the connection, */
/* it does one of these: */
ioctl (fd_hippi0, HIPIOCW_END_PKT);
ioctl (fd_hippi0, HIPIOCW_DISCONN);
/* or */
ioctl (fd_hippi0, HIPIOCW_DISCONN);
```

Receiving

In HIPPI-PH mode, all incoming data is accepted when the device file is opened for reading. The HIPPI subsystem does not reject any connection requests.

To retrieve its data, the application uses the calls below. All *read()*s retrieve sequentially received data. If a packet contained an FP header and D1 data, the HIPPI subsystem does not interpret them and does not separate them from the D2 data, so the first *read()* may contain FP header, D1 data, and/or D2 data. To determine packet boundaries, the application can use an *ioctl()* call to retrieve the current offset (received bytecount) for the packet. When the returned value is 0, the next *read()* retrieves the first bytes from a new packet.

All application *read()*s must specify buffers that are 8-byte word aligned and the data bytecount must be a multiple of 8. (See *memalign*(3C)).

```
offset = ioctl (fd_hippi0, HIPIOCR_PKT_OFFSET);  /*when 0, nxt read is new pkt*/
read (fd_hippi0, buffer, size);
offset = ioctl (fd_hippi0, HIPIOCR_PKT_OFFSET);  /*when 0, nxt read is new pkt*/
read (fd_hippi0, buffer, size);
etc.
```

When the application wishes to stop receiving data, it closes the file descriptor using the following call:

```
close (fd_hippi0);
```

Programming for the HIPPI-FP Access Method

This section describes how to program a module that conforms with the HIPPI Framing Protocol and is capable of sharing the receive and/or transmit channels through the HIPPI subsystem with other upper layer protocols (ULPs).

When an application opens the HIPPI device (for example, */dev/hippi0*), the application gets a file descriptor for a "cloned" device. (The device is cloned in order to allow sharing of the device. By this mechanism, the application can do binds to the HIPPI file descriptor without affecting other applications that have opened the same device.)

Using a HIPPI *ioctl()* call, the application "binds" itself to one ULPO and FDO. This action associates the application with one set of HIPPI information that is then used by the HIPPI subsystem whenever it services that application's read/write requests. The application specifies which ULPO by specifying the ULPO's 8-bit identifier.

It is important that the application open the HIPPI device with only the read / write flag settings that it needs. For example, if an application is not going to be doing *read()*s, it should set only the WRITE flag. When the READ flag is set, the HIPPI device is told to accept HIPPI packets on that ULP-id. All incoming packets for that ULP-id are accepted by the HIPPI device. The HIPPI subsystem holds each accepted packet until an application reads it. If no application consumes the incoming packets, the HIPPI device stalls for lack of buffer space.

Includes

The following files must be included in any program using the HIPPI API:

```
#include <sys/hippi.h>
```

Special Instructions

For maximum throughput, DMA between the HIPPI board and the host application occurs directly to / from user application space. Because of this, and the fact that the DMA component (ASIC) has a 64-bit interface, all application *read()*s and *write()*s must specify buffers that are 8-byte word-aligned, and the data bytecount must be a multiple of 8. (See *memalign*(3C)).

Opening and Binding to the Device

An application can open a HIPPI device (*hippi0*) for read-only, write-only, or read-and-write access. The acronym `fd_hippi0,` in the examples below, refers to the file descriptor for the opened HIPPI device.

To set up an application as a HIPPI-FP user, use one of the following sets of calls at the “beginning of time.” Within the calls in these examples, the *ULP-id* is a positive number in the range 0-255 decimal (inclusive), where 4 is reserved for the IRIX 8802.2 Link Encapsulation (HIPPI-LE) ULP, and 6 and 7 are reserved for HIPPI-IPI3 implementations. Each ULP’s identification must be unique among the ULPs that are bound to that HIPPI board.

- For a transmit-only connection:

```
fd_hippi0=open (“/dev/hippi0”, O_WRONLY);
ioctl (fd_hippi0, HIPIOC_BIND_ULP, ULP-id);
```

- For a receive-only connection:

```
fd_hippi0=open (“/dev/hippi0”, O_RDONLY);
ioctl (fd_hippi0, HIPIOC_BIND_ULP, ULP-id);
```

- For a transmit and receive connection:

```
fd_hippi0=open (“/dev/hippi0”, O_RDWR);
ioctl (fd_hippi0, HIPIOC_BIND_ULP, ULP-id);
```

Transmitting

For a HIPPI-FP application to transmit over its HIPPI connection, one of the sets of calls documented below in the “Functionality Scenarios” must be made. The order of the calls is unimportant except for the initial *write()* call, which actually starts sending the data. Four functionality scenarios are supported. (See Table 1-1 for details on the four transmission functionality scenarios.)

Many of the *ioctl()* calls write or set a value for a storedULPO or FDO parameter. These values are not cleared when a transmission completes, so prior settings can be reused with subsequent *write()* calls without resetting. All the calls should be made for the first transmission (since the device was opened) in order to initialize them to non-default values.

All application *write()*s must specify buffers that are 8-byte word-aligned, and the data bytecount must be a multiple of 8. (See *memalign*(3C)).

Notice the following:

1. When the `HIPIOCW_CONNECT` call is used, the HIPPI subsystem sets up a “permanent” connection. In contrast, when the `HIPIOCW_CONNECT` call is not used, the connection is disconnected as soon as the packet has been sent.
2. When the `HIPIOCW_START_PKT` call is used, many *write()*s may make up one packet. In contrast, when the `HIPIOCW_START_PKT` call is not used, one *write()* is a single packet.

Functionality Scenario 1

This scenario describes transmissions of small packets (under 2 megabytes) that use one *write()* for each packet. The connection disconnects when the packet has been completely sent.

The application makes an *ioctl()* call to specify the I-field, then makes the *write()* call. The maximum sized packet with this method is 2 megabytes. The packet and connection are both terminated when the data from the single *write()* call has completed.

```
ioctl (fd_hippi0, HIPIOCW_I, I-fieldValue);
/* I-field does not need to be reset for each pkt */
ioctl (fd_hippi0, HIPIOCW_D1_SIZE, bytecount);      /* only if size is changing*/
write (fd_hippi0, buffer, size);

/* PKT line goes low (false) after one write */
/* connection is dropped after one write */
```

Functionality Scenario 3

This scenario describes transmission of small packets (under 2 megabytes) that use only one *write()* for each packet. The connection is kept open.

The application makes an *ioctl()* call to specify the I-field for its "permanent" connection, then makes a *write()* call to send the first packet. The maximum sized packet with this method is 2 megabytes. The **PACKET** signal is dropped when the *write()* call completes. The connection, however, is not terminated, so the next packet can be another single-write or a multiple-write one (Functionality Scenario #4).

```
ioctl (fd_hippi0, HIPIOCW_CONNECT, I-fieldValue);
ioctl (fd_hippi0, HIPIOCW_D1_SIZE, bytecount);    /* only if size is changing*/
write (fd_hippi0, buffer, size);              /* first packet*/
/* PKT line goes low after one write. Connection is not dropped */
write (fd_hippi0, buffer, size);              /* second packet*/
/* PKT line goes low after one write. Connection is not dropped */

/* When application wants connection to be torn down, */
/* it tells the HIPPI subsystem to disconnect: */
```

```
ioctl (fd_hippi0, HIPIOCW_DISCONN);
```

Functionality Scenario 2

This scenario describes the transmission of large packets that require many *write()* calls and where the connection disconnects when the packet has been completely sent.

The application makes an *ioctl()* call to specify the I-field, and another call to define the size (bytecount) of the packet. It then makes the first *write()* call; subsequent *write()* calls are treated as part of the same packet until the bytecount is reached. The **PACKET** and **CONNECTION** signals are automatically dropped after the specified number of bytes have been sent. This scheme allows an application to send very large packets. It also allows some data gathering on output. (Note, however, that if packets are formed using small-sized *write()* calls, performance degrades considerably.)

```
ioctl (fd_hippi0, HIPIOCW_I, I-fieldValue);
ioctl (fd_hippi0, HIPIOCW_D1_SIZE, bytecount);    /* only if size is changing*/
ioctl (fd_hippi0, HIPIOCW_SHBURST, firstburstsize); /*only if burst_1 is chnging*/
ioctl (fd_hippi0, HIPIOCW_START_PKT, bytecount);
write (fd_hippi0, buffer, size);     /* buffer can include D1 data */
write (fd_hippi0, buffer, size);    /* size=only a part of the complete pkt*/
write (fd_hippi0, buffer, size);    /* max size for each write is 2MB*/
write (fd_hippi0, buffer, size);
etc.

/* connection is dropped when pkt is completely sent */
```

Functionality Scenario 4

This scenario describes transmission of large packets that require many *write()* calls and where the connection is kept open.

The application makes an *ioctl()* call to specify the I-field for its “permanent” connection, and another call to specify the size (bytecount) of the packet. Each *write()* is treated as part of the same packet, until the bytecount is satisfied, at which time the packet is ended. When the application wants to terminate the connection, it makes an *ioctl()* call to disconnect.

```
ioctl (fd_hippi0, HIPIOCW_CONNECT, I-fieldValue);
```

```
ioctl (fd_hippi0, HIPIOCW_SHBURST, firstburstsize);  /*only if burst_1 is chnging*/
ioctl (fd_hippi0, HIPIOCW_D1_SIZE, bytecount);    /* only if size is changing*/
ioctl (fd_hippi0, HIPIOCW_START_PKT, bytecount);
write (fd_hippi0, buffer, size);  /* buffer can include D1 data */
write (fd_hippi0, buffer, size);  /* size=only a part of the complete pkt*/
write (fd_hippi0, buffer, size);  /* max size for each write is 2MB */
etc.
/*when pkt completes, PKT line goes low*/
/*connection is not dropped*/

/* When the application wants the connection to be torn down, */
/* it tells the HIPPI subsystem to disconnect */

ioctl (fd_hippi0, HIPIOCW_DISCONN);
```

Special Use of Functionality Scenario 4

For an infinite-sized packet on a long-term (“permanent”) connection.

The application makes an *ioctl()* call to specify the I-field for its “permanent” connection, and another call to specify the bytecount of the packet. The bytecount is specified as HIPPI_D2SIZE_INFINITY. All *write()* calls are then treated as one “infinite-sized” packet (that is, the **PACKET** signal is not deasserted), until the connection is specifically disconnected by the application.

```
ioctl (fd_hippi0, HIPIOCW_CONNECT, I-fieldValue);
ioctl (fd_hippi0, HIPIOCW_SHBURST, firstburstsize);  /*only if burst_1 is chnging*/
ioctl (fd_hippi0, HIPIOCW_D1_SIZE, bytecount);    /* only if size is changing*/
ioctl (fd_hippi0, HIPIOCW_START_PKT, HIPPI_D2SIZE_INFINITY);
/*infinity=0xFFFFFFFF) */
write (fd_hippi0, buffer, size);   /*max size for each write is 2MB*/
write (fd_hippi0, buffer, size);
etc.

/* Optional: if the application wishes to terminate this packet
/* and start another without dropping the connection, it does this: */

ioctl (fd_hippi0, HIPIOCW_END_PKT);
ioctl (fd_hippi0, HIPIOCW_START_PKT, bytecount);
etc.
```

```
/* When the application wishes to tear down the connection */
ioctl (fd_hippi0, HIPIOCW_END_PKT);
ioctl (fd_hippi0, HIPIOCW_DISCONN);
```

Receiving

To receive data, the application uses the calls below. The first *read()* of a ULP's queue retrieves a packet's FP header and D1 area. Subsequent *read()* calls retrieve D2 data. When the `HIPIOCR_PKT_OFFSET` returns zero, the next *read()* will retrieve a new packet's header and D1 area.

All application *read()*s must specify buffers that are 8-byte word-aligned, and the data bytecount must be a multiple of 8. (See *memalign*(3C)).

```
read (fd_hippi0, buffer, size);  /* FPheader and D1 data */
read (fd_hippi0, buffer, size);  /* D2 data */
read (fd_hippi0, buffer, size);  /* D2 data */
offset = ioctl (fd_hippi0, HIPIOCR_PKT_OFFSET);  /*when 0, nxt read is new pkt*/
```

When the application wishes to stop receiving data, it closes the file descriptor using the following call:

```
close (fd_hippi0);
```

API Reference

This section describes the HIPPI *ioctl* calls that comprise the API to the IRIS HIPPI subsystem. These calls are defined in the *sys/hippi.h* file. Each application program that wants to use the services of the HIPPI connection uses these calls to define its ULPO and FDO values, to set up its connection(s), and to transmit or receive data.

The API calls are listed in Table 2-1.

Table 2-1 HIPPI-PH API

Purpose	API Call	Page
Device Management:		
Obtain statistics	`HIPIOC_GET_STATS`	39
Connection Management:		
Start / stop accepting connections	`HIPIOC_ACCEPT_FLAG`	37
Set timeout for source's connection	`HIPIOC_STIMEO`	41
Prepare to open a single-packet connection	`HIPIOCW_I`	47
Prepare to open a long-term connection	`HIPIOCW_CONNECT`	44
Terminate a long-term connection	`HIPIOCW_DISCONN`	48
Packet Control:		
Received packet's bytecount	`HIPIOCR_PKT_OFFSET`	43
Send a single-write packet	After setting the I-field, no additional call is necessary, other than the *write()*.	
Send a multiple-write packet	`HIPIOCW_START_PKT`	53
Define first burst of a multiple-write packet	`HIPIOCW_SHBURST`	51
Terminate a packet	`HIPIOCW_END_PKT`	49
Retrieve errors from failed *read()* and *write()* calls	`HIPIOCR_ERRS` `HIPIOCW_ERR`	42 50
Define HIPPI-FP Fields:		
Define D1 Area Size and set P-bit	`HIPIOCW_D1_SIZE`	46

HIPIOC_ACCEPT_FLAG

`HIPIOC_ACCEPT_FLAG` configures the HIPPI board to accept or refuse connection requests.

Note: After each execution of */usr/etc/hipcntl bringup*, */etc/init.d/network*, or each restart of the system, the IRIS HIPPI software sets this flag ON (accepting). ♦

Usage

HIPPI device control for HIPPI-FP and HIPPI-PH.

```
ioctl (fd_hippi0, HIPIOCW_ACCEPT_FLAG, value);
```

The arg

The *value* is 1 to accept connection requests, and 0 to reject connection requests.

Failures and Errors

This call fails for the following reasons:

- The IRIS HIPPI board is shutdown (for example, *hipcntl shutdown* or `HIPPI_SETONOFF` has been called).

HIPIOC_BIND_ULP

`HIPIOC_BIND_ULP` is used to bind an application's open file descriptor (*/dev/hippi0*, */dev/hippi1*, etc.) to a ULPO and FDO. If an application wishes to both transmit and receive, it can bind once to a read-and-write file descriptor, or it can make this call twice (once to a write-only file descriptor and once to a read-only one).

- When the HIPPI-FP access method is used, up to 32 different applications can be bound simultaneously.
- When the HIPPI-FP access method is used, up to eight different ULPOs can be bound to each HIPPI subsystem
- When the HIPPI-PH method is used, only one ULPO (that being, HIPPI_ULP_PH) can be bound for each HIPPI channel.

Usage

Initialization of HIPPI-FP.

```
ioctl (fd_hippi0, HIPIOC_BIND_ULP, ULP-id);
```

Initialization of HIPPI-PH.

```
ioctl (fd_hippi0, HIPIOC_BIND_ULP, HIPPI_ULP_PH);
```

The arg

For HIPPI-FP, the `arg` is the identification for the ULPO that the application uses (range 0-255 decimal inclusive), where 4 is reserved for the IRIX 8802.2 Link Encapsulation (HIPPI-LE), and 6 and 7 are reserved for HIPPI-IPI. Each ULPO implementation must have an identification, and each identification must be unique among the ULPO's open (bound) for the particular HIPPI board (device).

The HIPPI-PH, the `arg` is HIPPI_ULP_PH.

Failures and Errors

This call fails for the following reasons:

- The maximum number of ULPOs are already bound to the HIPPI device.
- A HIPPI-PH ULPO is already bound for this file descriptor.

HIPIOC_GET_STATS

HIPIOC_GET_STATS is used to obtain statistics about the HIPPI device. The HIPPI product ships with a utility (*hipcntl*) for doing this kind of monitoring, so this *ioctl* call is not usually needed by customer-developed applications.

Usage

Monitoring of HIPPI-PH and HIPPI-FP devices and connections.

Note: This *ioctl* is typically used by *hipcntl*, the HIPPI control and configuration utility.

```
ioctl (fd_hippi0, HIPIOC_GET_STATS, &hippi_stats);
```

The arg

The arg is a pointer to a hippi_stats structure.

The hippi_stats structure is provided below for reference.

```
typedef struct hippi_stats {
   u_long hst_flags;                    /* status flags */
#define HST_FLAG_DSIC 0x0001            /* SRC sees IC */
#define HST_FLAG_SDIC 0x0002            /* DST sees IC */
#define HST_FLAG_DST_ACCEPT 0x0010      /* DST is accepting connections */
#define HST_FLAG_DST_PKTIN 0x0020       /* DST: PACKET input is high */
#define HST_FLAG_DST_REQIN 0x0040       /* DST: REQUEST input is high */
#define HST_FLAG_SRC_REQOUT 0x0100      /* SRC: REQUEST is asserted */
#define HST_FLAG_SRC_CONIN 0x0200       /* SRC: CONNECT input is high */

    /* Source statistics */
    u_long hst_s_conns;                 /* total connections attempted */
    u_long hst_s_packets;               /* total packets sent */
    u_long hst_s_rejects;               /* connection attempts rejected */
    u_long hst_s_dm_seqerrs;            /* data sm sequence error */
    u_long hst_s_cd_seqerrs;            /* conn sm sequence error, dst */
    u_long hst_s_cs_seqerrs;            /* conn sm sequence error, src */
    u_long hst_s_dsic_lost;
    u_long hst_s_timeo;                 /* timed out connection attempts*/
    u_long hst_s_connls;                /* connections dropped by other side*/
    u_long hst_s_par_err;               /* source parity error */
    u_long hst_s_resvd[6];              /* reserved for future compatibility*/
```

```
    /* Destination statistics */
    u_long hst_d_conns;             /* total connections accepted */
    u_long hst_d_packets;           /* total packets received */
    u_long hst_d_badulps;           /* pkts dropped due to unknown ULP*/
    u_long hst_d_ledrop;            /* HIPPI-LE packets dropped */
    u_long hst_d_llrc;              /* conns dropped due to llrc error */
    u_long hst_d_par_err;           /* conns dropped due to parity err */
    u_long hst_d_seq_err;           /*conns dropped due to sequence err*/
    u_long hst_d_sync;              /* sync errors */
    u_long hst_d_illbrst;           /* packets with illegal burst sizes */
    u_long hst_d_sdic_lost;         /* conns dropped due to sdic lost */
    u_long hst_d_nullconn;          /* connections with zero packets */
    u_long hst_d_resvd[5];          /* reserved for future compatibility*/

} hippi_stats_t;
```

Failures and Errors

This call fails for the following reasons:

- The driver is unable to copy the statistics from the board.
- The IRIS HIPPI board is shutdown (for example, *hipcntl shutdown* or `HIPPI_SETONOFF` has be called).

HIPIOC_STIMEO

`HIPIOC_STIMEO` sets the period of time for which the IRIS HIPPI source channel waits before aborting a connection that is not moving data. The granularity for this timeout is 250 milliseconds.

Usage

Transmission for HIPPI-FP and HIPPI-PH.

```
ioctl (fd_hippi0, HIPIOC_STIMEO, milliseconds);
```

The arg

The range of valid values for *milliseconds* is 0 to FFFFFFFF inclusive (hexadecimal notation), which IRIS HIPPI rounds to the nearest 250 millisecond iterval.

Failures and Errors

This call fails for the following reasons:

- IRIS HIPPI board is shutdown (for example, *hipcntl shutdown* or `HIPPI_SETONOFF` has be called).

HIPIOCR_ERRS

`HIPIOCR_ERRS` returns the error status from the last *read()* call for the indicated file descriptor.

Usage

Error monitoring for reception with HIPPI-FP and HIPPI-PH.

```
error = ioctl (fd_hippi0, HIPIOCR_ERRS);
```

The arg

There is no `arg` for this call.

Returned Value

The returned *error* is a 6-bit vector indicating the errors that occurred on the last *read()*, as summarized in Table 2-2.

Table 2-2 Errors for Failed *read()* Calls

Bit Position	Hex Mask	Error
0	0x01	Destination parity error.
1	0x02	Destination LLRC error.
2	0x04	Destination sequence error.[a]
3	0x08	Destination sync error.
4	0x10	Destnnation illegal burst error.
5	0x20	Destination **SDIC** lost error.

a. Causes the SDIC lost error also.

Failures and Errors

This call fails for the following reasons:

- The application is not bound.
- If `error` (see Usage) is a negative value, then an error occurred while making the *ioctl()* call, and none of the bits should be interpreted.

HIPIOCR_PKT_OFFSET

`HIPIOCR_PKT_OFFSET` retrieves the offset for the packet being received.

Usage

Reception for HIPPI-FP and HIPPI-PH.

```
offset = ioctl (fd_hippi0, HIPIOCR_PKT_OFFSET);
```

The arg

There is no `arg` for this call.

Returned Value

The returned *offset* is an integer indicating the current offset (number of bytes received so far) for the packet in the next *read()*. When the *offset* is 0, the next *read()* starts a new packet.

When the returned *offset* reaches 0x7FFFFFFF, the counter sticks (that is, does not count any higher and does not roll over to zero). However, the counter will again return true count values when the next packet arrives.

Failures and Errors

This call fails for the following reasons:

- The file descriptor has not been opened for reading by this application.

HIPIOCW_CONNECT

`HIPIOCW_CONNECT` causes a long-term (many-packet) connection to be established with the next *write()*. The argument sets the value for the I-field that will be used on the connection request. Once this call has been made, the HIPPI-subsystem sets up a connection with the next *write()* call, and does not tear the connection down until the `HIPIOCW_DISCONN` call is invoked.

Note: For single-packet connections, use `HIPIOCW_I`. ♦

Usage

Transmission for HIPPI-FP and HIPPI-PH.

```
ioctl (fd_hippi0, HIPIOCW_CONNECT, I-fieldValue);
```

The arg

The *I-fieldValue* is a 32-bit number used as the I-field. IRIS HIPPI does not verify, alter, or interpret the I-field value.

For a HIPPI-SC compliant I-field, bit 31 of the I-field must be set to 0 and the remaining bits (30:0) must be partitioned into fields, as summarized in Table 2-3. (For more details about the I-field, see Figure A-2.)

“Locally-administered” schemes are legal and supported. For a locally-administered scheme, bit 31 must be set to 1 and bits 30:0 can be set to comply with any locally-defined protocol or can be set to zero (for example, I-field value = 80000000 hex).

Note: Using a “locally-administered” I-field severely limits interoperability, especially in the areas of routing and HIPPI switch control. ♦

Table 2-3 IRIS HIPPI Support for Fields in I-Field

Bits in I-field	Valid Values for IRIS HIPPI (binary)		Comments
	Locally-Defined	HIPPI-SC Compliant	
31	1	0	Both I-field formats (local and HIPPI-SC) are supported.
30:29	anything	anything	
28	anything	0	IRIS HIPPI hardware currently supports only 800 Mbits/second. It is the application's responsibility to set this correctly.
27	anything	0 / 1	It is the application's responsibility to set the direction bit correctly.
26:25	anything	00 / 01/11	All addressing schemes are supported.
24	anything	0 / 1	It is the application's responsibility to set the campon bit correctly.
23:0	anything	anything	All addressing schemes are supported.

Failures and Errors

This call fails for the following reasons:

- The application is not bound.
- The application has not disconnected from a long-term connection that was established with `HIPIOCW_CONNECT` prior to this request. (If no data has ever been sent, the connection is not necessarily open at the physical layer.)

HIPIOCW_D1_SIZE

`HIPIOCW_D1_SIZE` is used to set the size of the D1_Area and set the P-bit in a HIPPI-FP FDO. This call specifies a D1 area size that is placed in the FP header of all subsequently transmitted packets.

This call has the following characteristics:

- The size must be zero or a multiple of 8.
- When the D1 area size is greater than 0, the P-bit in the FP header is set to 1.

To send its D1 data, the application can concatenate the D2 data to the D1 data so that the first burst contains both kinds of data, or it can use `HIPIOCW_SHBURST` to place only the FP header and the D1 data in the first burst. The HIPPI subsystem uses all of this information to correctly calculate the values for the FP header, as explained in "How HIPPI Protocol Items Are Handled With the HIPPI-FP Access Method" on page 18.

Usage

Transmission for HIPPI-FP.

```
ioctl (fd_hippi0, HIPIOCW_D1_SIZE, bytecount);
```

The arg

The *bytecount* is the size in bytes to be placed in the D1_Area_Size field of the HIPPI-FP header of subsequent packets. Valid sizes fall within the range of 0-1016 (decimal), inclusive, and must be evenly divisible by 8.

Failures and Errors

This call fails for the following reasons:

- The application is not bound.
- The bound FDOO is HIPPI-PH.
- The *bytecount* is not valid.

HIPIOCW_I

`HIPIOCW_I` prepares the HIPPI subsystem to set up a single-packet connection. The command specifies a new value for the HIPPI I-field in the application's FDO. (The I-field is also known as CCI.) The HIPPI subsystem uses this value as the I-field for all subsequent connection requests (that is, at each *write* call), until `HIPIOCW_I` is called again. The HIPPI subsystem does not alter or interpret the I-field contents. The HIPPI subsystem drops each connection as soon as the data from the *write()* call is sent.

Note: For a long-term (many-packet) connection, use the `HIPIOCW_CONNECT` call. ♦

Usage

Transmission for HIPPI-PH and HIPPI-FP.

```
ioctl (fd_hippi0, HIPIOCW_DEFAULT_I, I-fieldValue);
```

The arg

The *I-fieldValue* is a 32-bit number. IRIS HIPPI does not verify, alter, or interpret the I-field value.

For a HIPPI-SC compliant I-field, bit 31 of the I-field must be set to 0 and the remaining bits (30:0) must be partitioned into fields, as summarized in Table 2-3. (For more details about the I-field, see Figure A-2.)

"Locally-administered" schemes are legal and supported. For a locally-administered scheme, bit 31 must be set to 1 and bits 30:0 can be set to comply with any locally-defined protocol or can be set to zero (for example, I-field value = 80000000 hex).

Note: Using a "locally-administered" I-field severely limits interoperability, especially in the areas of routing and HIPPI switch control. ♦

Failures and Errors

This call fails for the following reasons:

- The application is not bound.

HIPIOCW_DISCONN

`HIPIOCW_DISCONN` is used for terminating a permanent connection that was opened with the `HIPIOCW_CONNECT` call. This call causes the HIPPI subsystem to tear down the connection immediately.

Note: To terminate a packet without tearing down the connection, use `HIPIOCW_END_PKT`. ♦

Usage

Transmission for HIPPI-FP and HIPPI-PH.

```
ioctl (fd_hippi0, HIPIOCW_DISCONN);
```

The arg

There is no `arg` for this call.

Failures and Errors

This call fails for the following reasons:

- The application is not bound.
- No long-term (permanent) connection has been set up; there is nothing to disconnect.

HIPIOCW_END_PKT

`HIPIOCW_END_PKT` terminates the current packet (that is, causes the HIPPI subsystem to drive the **PACKET** signal false). This call is required only when the packet length was specified as infinite.

Usage

Transmission for HIPPI-FP and HIPPI-PH.

```
ioctl (fd_hippi0, HIPIOCW_END_PKT);
```

The arg

There is no `arg` for this call.

Failures and Errors

This call fails for the following reasons:

- The application is not bound.
- There is no inprogress packet; that is, this call has not been preceded by a `HIPIOCW_START_PKT` call.

HIPIOCW_ERR

`HIPIOCW_ERR` returns the error status from the last *write()* call for the indicated file descriptor.

Usage

Error monitoring for transmission with HIPPI-FP and HIPPI-PH.

```
error = ioctl (fd_hippi0, HIPIOCW_ERR);
```

The arg

There is no `arg` for this call.

Returned Value

The returned *error* is an integer, as summarized in Table 2-4.

Table 2-4 Errors for Failed *write()* Calls

Hex Value	Error
0	No error occurred on last *write()*.
1	Source sequence error.
2	Source lost **DSIC** error.
3	Source timed out connection.
4	Source lost **CONNECT** signal during transmission.
5	Connection **REQUEST** was rejected.
6	Interface is shut down.

Failures and Errors

This call fails for the following reasons:

- The application is not bound.

HIPIOCW_SHBURST

`HIPIOCW_SHBURST` defines the size of the first burst for all subsequent packets. The size may be shorter than a standard burst, or full-sized. The IRIS HIPPI subsystem's functionality is slightly different for HIPPI-PH and HIPPI-FP applications, as explained below.

Note: If the first burst is short, it is the responsibility of the application to pad out the D2 data to a multiple of 256 words, so that all the non-first bursts are full-sized. The IRIS HIPPI software does not verify the data size nor pad the final burst. ♦

For a HIPPI-PH application, the call causes the HIPPI subsystem to "break off" the indicated number of bytes from the data provided by the first *write()* call, and send these bytes as the first burst. When the desired first burst consists of 256 words, it is not necessary to make this call. When `HIPIOCW_SHBURST` is called with a *bytecount* of 0, the IRIS HIPPI subsystem creates standard-sized first bursts.

For a HIPPI-FP application, the call causes the IRIS HIPPI subsystem to create a first burst that contains only the FP header and D1 data and to set the B-bit in the FP header. When `HIPIOCW_SHBURST` is called with the following bytecounts, the first burst is created as described:

- With a *bytecount* of 0, the first burst is standard-sized and contains the FP header and 1016 bytes of data from the *write()* call. The B-bit is set to 0.
- With a *bytecount* of 8, the first burst is short and contains only the FP header. The B-bit is set to 1.
- When the *bytecount* is larger than 8 but smaller than 1024, the first burst is short; it contains 8 bytes of FP header and [*bytecount* minus 8] of D1 data. The HIPPI subsystem "breaks off" the D1 data bytes from the data provided with the first *write()* call. The B-bit is set to 1.

  Note: When D1 data is included, it is the application's responsibility to also call `HIPIOCW_D1_SIZE` to ensure a properly filled-out FP header. ♦
- When the *bytecount is* 1024, the first burst is standard-sized; it contains 8 bytes of FP header and 1016 bytes of D1 data. The HIPPI subsystem "breaks off" the D1 data bytes from the data provided with the first *write()* call. The B-bit is set to 1.

Usage

Transmission of multiple-write packets for HIPPI-FP and HIPPI-PH. Once called, the setting applies to all packets, until called again..

```
ioctl (fd_hippi0, HIPIOCW_SHBURST, bytecount);
```

The arg

For HIPPI-PH, the *bytecount* can be any value from 0-1024 decimal (inclusive) that is evenly divisible by 8.

For HIPPI-FP, the *bytecount* can be any value from 0-1024 decimal (inclusive) that is evenly divisible by 8. The minimum *bytecount* for a short first burst is 8 (that is, large enough to include the FP header) and, if `HIPIOCW_D1_SIZE` has been called, it must be [8 + D1_Area_Size].

Failures and Errors

This call fails for the following reasons:

- The application is not bound.
- The packet has not been setup as a multiple-write packet, using the `HIPIOCW_START_PKT` command.
- The size of *bytecount* is not valid.

HIPIOCW_START_PKT

`HIPIOCW_START_PKT` controls the HIPPI subsystem's **PACKET** signal. The signal is held high (**PACKET** = true) for the bytecount provided in the call's argument (or for HIPPI-FP, the bytecount plus 8, thus including the FP header). The bytecount should be so large that a number of *write()* calls are required to send it. This call must be made for each multiple-write packet.

Usage

Transmission for HIPPI-FP and HIPPI-PH.

```
ioctl (fd_hippi0, HIPIOCW_START_PKT, bytecount);
```

The arg

The *bytecount* is either the actual bytecount of the D1 and D2 areas of the packet or a value indicating "infinite." (Infinite packets are supported only when the connection is permanent or long-term.)

- The range of valid values for an actual *bytecount* is multiples of 8 between 0 and 0xFFFFFFF8 hexadecimal, inclusive. The maximum actual length for any packet is 4 gigabytes less 1 byte.
- An "infinite" or indeterminate packet is defined by a bytecount of `HIPPI_D2SIZE_INFINITY` (which is 0xFFFFFFFF).

Failures and Errors

This call fails for the following reasons:

- The application is not bound.
- A packet is currently in progress. For example, for an infinite packet, the `HIPIOCW_END_PKT` call has not terminated the current packet.

HIPPI_SETONOFF

`HIPPI_SETONOFF` does shutdown and bringup of the IRIS HIPPI board. ON (bringup) initializes everything on the board, leaving the board in the UP state. OFF (shutdown) completes inprogress work with errors, turns everything off, resets the onboard CPU. and transitions to the DOWN state. This command is intended for administration and maintenance purposes only; hence, it is only available to superuser (root).

Usage

Board shutdown and bringup. Only available to superuser (root).

```
ioctl (fd_hippi0, HIPPI_SETONOFF, arg);
```

The arg

The *arg* is 1 for ON (bringup) and 0 for OFF (shutdown). Multiple, sequential calls for OFF while the board is down result in multiple resets of the board's CPU, as described in Table 2-5.

Table 2-5 Actions Caused by HIPPI_SETONOFF

	Board = DOWN	Board = UP
Command = OFF (1)	reset onboard CPU	shutdown, which includes CPU reset
Command = ON (0)	bringup	error

Failures and Errors

This call fails for the following reasons:

- The application is not superuser (root).
- The file descriptor is bound. Closing the file descriptor will unbind it.
- For ON, there are other open (cloned) file descriptors that must be closed before the board can be brought up.

Important HIPPI Concepts

I-Field

The format for the standard HIPPI I-field (also referred to as CCI) that accompanies each connection request is shown in Figure A-1. The seven fields are described in Table A-1.

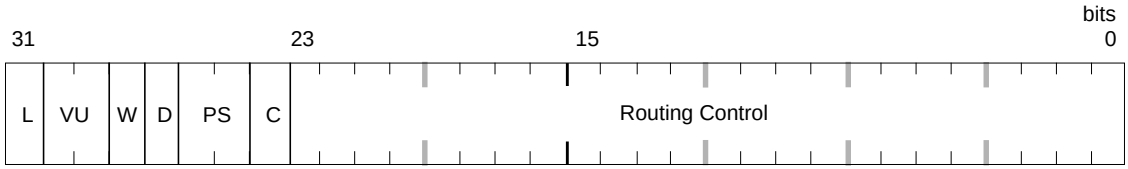


Figure A-1 I-Field Format

Table A-1 Fields of the HIPPI I-Field

Field	Bits	Dexcription
L	31	Local or Standard Format: 0=bits 30:0 of I-field conform to the usage described in this table 1=bits 30:0 are implemented in conformance to a private (locally-defined) protocol
VU	30:29	Vendor Unique Bits: Vendors of end-system HIPPI equipment may use these bits for any purpose. Switches do not alter or interpret these bits.

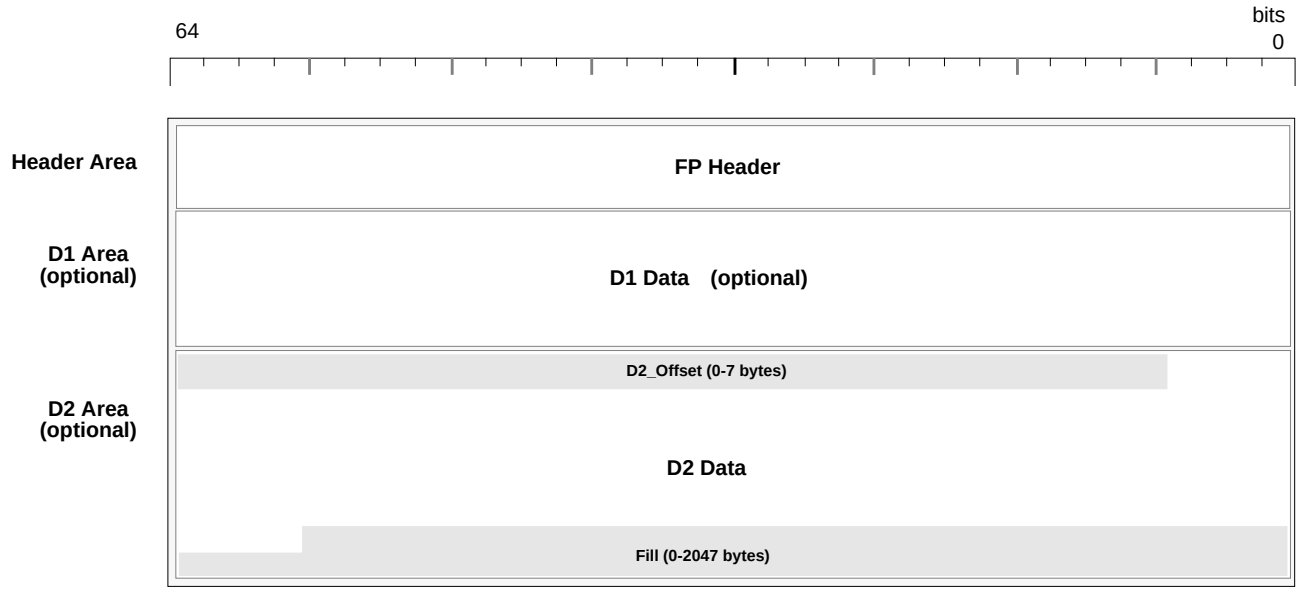
Table A-1 (continued) Fields of the HIPPI I-Field

Field	Bits	Dexcription
W	28	Width: 0=the data bus of the transmitting (source) HIPPI is 32 bits wide for 800 megabits / second 1=source's data bus is 64 bits wide for 1600 megabits / second
D	27	Direction: 0=least significant bits of Routing Control field contain the next address for switch to use 1=most significant bits of Routing Control field contain the next address for switch to use
PS	26:25	Path Selection: 00=source routing 01=Routing Control field contains logical addresses. Switch must select first route from a list of routes. 10=reserved 11=Routing Control field contains logical addresses. Switch selects route.
C	24	Camp-on: 0=switch does not retry if connection is rejected 1=switch continues trying to establish a connection until the source aborts the connection request
Routing Control	23:0	Routing Address: This field may contain source routing addresses or logical addresses, as indicated by the PS field. For source routing, the field contains a concatenated list of switch addresses that, when followed, lead to the destination. For logical addressing, the field contains two 12-bit addresses (destination and source) that are used by the intermediate switches to select a route from a table.

HIPPI-FP Packet

Each HIPPI packet using the HIPPI Framing Protocol (HIPPI-FP) has a required 64-bit segment called the FP header, and two optional segments called D1 Area and D2 Area, as illustrated in Figure A-2. The D1 area is intended for communicating control (D1) information. It can also be used for padding out the first burst in order to position the user (D2) data in the second burst. The D2 area contains user / application data. The size of the D1 area is defined within the FP header. The size of the D2 area is not specifically defined, but is implicit due to the protocol definition. The D2 area consists of D2 data and possibly an offset and filler. The D2 offset and D2 data are defined in the FP header. The size of the filler can be calculated by rounding up to the next 64-bit word boundary, because the D2 area is required to be an integral number of 64-bit words.

The format for the HIPPI-FP packet is as shown in Figure A-2. The FP header consists of seven fields, shown in Figure A-3 and described in Table A-2.



NOTE: The size of each included area must be an integral number of 64-bit words. The first word of each area must be 8-byte aligned.

Figure A-2 Packet Format for HIPPI Framing Protocol

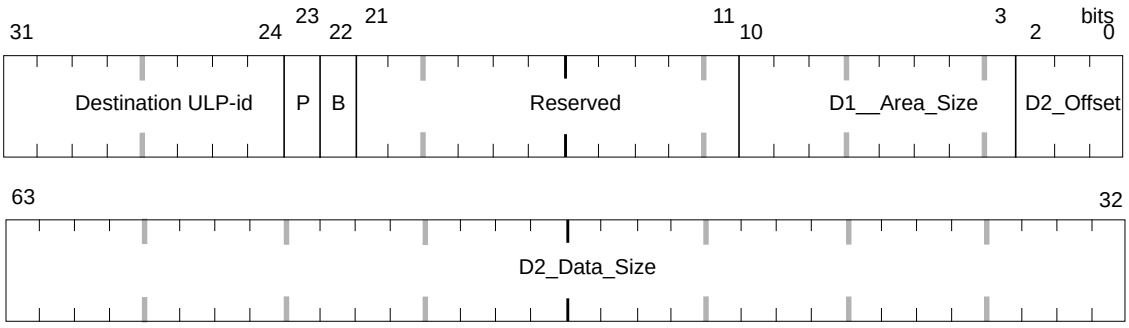


Figure A-3 FP Header Format

Table A-2 Fields of FP Header

Field	Bits	Range of Values (in hex)	Description
D2 Data Size	63:32	0 - FFFFFFFF	Number of bytes of D2 data in this packet not counting the D2 offset nor the D2 fill. A size of FFFFFFFF (hexadecimal) indicates a packet of unknown, indeterminate, or “infinite” length.
Dest ULP-id	31:24	0 - FF	The upper layer identification number for the destination.
P	23	0 / 1	Present: 0=there is no D1_Area in this packet 1=there is D1 data in the D1_Area of this packet
B	22	0 / 1	Burst Boundary: 0=D2 data starts before beginning of second burst of this packet 1=D2 data starts at beginning of second burst of this packet
Reserved	21:11	000	Must be zero.

Table A-2 (continued) Fields of FP Header

Field	Bits	Range of Values (in hex)	Description
D1 Area Size	10:3	0 - 7F	The number of 64-bit words in the D1 Area. The area does not necessarily contain valid D1 data; the area may be defined for padding purposes only.
D2 Offset	2:0	0 - 7	The number of bytes between the last byte of the D1 Area and the first byte of D2 data.

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