Freeway®
Transport Subsystem Interface Reference Guide

DC 900-1386D

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Preface

Purpose of Document

This document describes Protogate's transport subsystem interface (TSI). The TSI helps you develop applications interfacing with a Freeway communications server or embedded intelligent communications processor (ICP).

Note

In this document, the term "Freeway" can mean either a Freeway server or an embedded ICP. For the embedded ICP, also refer to the user guide for your ICP and operating system (for example, the *ICP2432 User Guide for Windows NT*).

Intended Audience

This document should be read by application programmers. You should be familiar with the C programming language and have some knowledge of networks.

If your application will use Protogate's data link interface (DLI), which uses the TSI, you will need to use TSI only for configuration (see Chapter 3 of this document). Additionally, you should be familiar with the *Freeway Data Link Interface Reference Guide*.

If your application will interface directly to the TSI, you should be familiar with the programming details described in this document. If your TSI application will interface to one of Protogate's protocol services running on a Freeway ICP, you will also need to be familiar with the *Freeway Client-Server Interface Control Document* and your particular protocol programmer's guide.

Organization of Document

Chapter 1 is an overview of Freeway and the TSI.

Chapter 2 describes various TSI concepts that you should understand before writing an application program.

Chapter 3 describes the TSI configuration services.

Chapter 4 gives details of each TSI function.

Appendix A lists additional error codes not included in the reference sections. It also provides summary tables of all TSI error codes as they relate to specific TSI function calls.

Appendix B compares I/O handling in the UNIX, VMS, and VxWorks environments.

Appendix C describes the TSI logging and tracing capabilities.

Protogate References

The following general product documentation list is to familiarize you with the available Protogate Freeway and embedded ICP products. The applicable product-specific reference documents are mentioned throughout each document (also refer to the "readme" file shipped with each product). Most documents are available on-line at Protogate's web site, www.protogate.com.

General Product Overviews

• *Freeway 1100 Technical Overview*	25-000-0419
• *Freeway 2000/4000/8800 Technical Overview*	25-000-0374
• *ICP2432 Technical Overview*	25-000-0420
• *ICP6000X Technical Overview*	25-000-0522

Hardware Support

• *Freeway 1100/1150 Hardware Installation Guide*	DC-900-1370
• *Freeway 1200/1300 Hardware Installation Guide*	DC-900-1537
• *Freeway 2000/4000 Hardware Installation Guide*	DC-900-1331
• *Freeway 3100 Hardware Installation Guide*	DC-900-2002
• *Freeway 3200 Hardware Installation Guide*	DC-900-2003
• *Freeway 3400 Hardware Installation Guide*	DC-900-2004
• *Freeway 3600 Hardware Installation Guide*	DC-900-2005
• *Freeway 8800 Hardware Installation Guide*	DC-900-1553
• *Freeway ICP6000R/ICP6000X Hardware Description*	DC-900-1020
• *ICP6000(X)/ICP9000(X) Hardware Description and Theory of Operation*	DC-900-0408
• *ICP2424 Hardware Description and Theory of Operation*	DC-900-1328
• *ICP2432 Hardware Description and Theory of Operation*	DC-900-1501
• *ICP2432 Electrical Interfaces (Addendum to DC-900-1501)*	DC-900-1566
• *ICP2432 Hardware Installation Guide*	DC-900-1502

Freeway Software Installation and Configuration Support

• *Freeway Message Switch User Guide*	DC-900-1588
• *Freeway Release Addendum: Client Platforms*	DC-900-1555
• *Freeway User Guide*	DC-900-1333
• *Freeway Loopback Test Procedures*	DC-900-1533

Embedded ICP Software Installation and Programming Support

• *ICP2432 User Guide for Digital UNIX*	DC-900-1513
• *ICP2432 User Guide for OpenVMS Alpha*	DC-900-1511
• *ICP2432 User Guide for OpenVMS Alpha (DLITE Interface)*	DC-900-1516
• *ICP2432 User Guide for Solaris STREAMS*	DC-900-1512
• *ICP2432 User Guide for Windows NT*	DC-900-1510
• *ICP2432 User Guide for Windows NT (DLITE Interface)*	DC-900-1514

Application Program Interface (API) Programming Support

• *Freeway Data Link Interface Reference Guide*	DC-900-1385

Freeway Transport Subsystem Interface Reference Guide	DC-900-1386
QIO/SQIO API Reference Guide	DC-900-1355

Socket Interface Programming Support

Freeway Client-Server Interface Control Document	DC-900-1303

Toolkit Programming Support

Freeway Server-Resident Application and Server Toolkit Programmer Guide	DC-900-1325
OS/Impact Programmer Guide	DC-900-1030
Protocol Software Toolkit Programmer Guide	DC-900-1338

Protocol Support

ADCCP NRM Programmer Guide	DC-900-1317
Asynchronous Wire Service (AWS) Programmer Guide	DC-900-1324
AUTODIN Programmer Guide	DC-908-1558
Bit-Stream Protocol Programmer Guide	DC-900-1574
BSC Programmer Guide	DC-900-1340
BSCDEMO User Guide	DC-900-1349
BSCTRAN Programmer Guide	DC-900-1406
DDCMP Programmer Guide	DC-900-1343
FMP Programmer Guide	DC-900-1339
Military/Government Protocols Programmer Guide	DC-900-1602
N/SP-STD-1200B Programmer Guide	DC-908-1359
SIO STD-1300 Programmer Guide	DC-908-1559
X.25 Call Service API Guide	DC-900-1392
X.25/HDLC Configuration Guide	DC-900-1345
X.25 Low-Level Interface	DC-900-1307

Document Conventions

This document follows the most significant byte first (MSB) and most significant word first (MSW) conventions for bit-numbering and byte-ordering. In all packet transfers between the client applications and the ICPs, the ordering of the byte stream is preserved.

The term "Freeway" refers to any of the Freeway server models (for example, Freeway 500/3100/3200/3400 PCI-bus servers, Freeway 1000 ISA-bus servers, or Freeway 2000/4000/8800 VME-bus servers). References to "Freeway" also may apply to an embedded ICP product using DLITE (for example, the embedded ICP2432 using DLITE on a Windows NT system).

Physical "ports" on the ICPs are logically referred to as "links." However, since port and link numbers are usually identical (that is, port 0 is the same as link 0), this document uses the term "link."

Program code samples are written in the "C" programming language.

Revision History

The revision history of the *Freeway Transport Subsystem Interface Reference Guide*, Protogate document DC 900-1386D, is recorded below:

Document Revision	Release Date	Description
DC 900-1386A Special Freeway Server 2.5 Release	February 1997	Initial release using new document number: Include *Release Notes* for changes that potentially affect existing user applications.
DC 900-1386B	June 1998	Incorporate previous release notes: • Modify *Buffer Management* Section 2.3 on page 31 • Enhance error detection and reporting (Chapter 4 and Appendix A) • Regarding "*Error Handling for Dead Socket Detection*," refer to the *Freeway Data Link Interface Reference Guide* Dual Ethernet support is now handled by the "Added Interfaces" configuration described in the *Freeway User Guide* Simpact's browser interface is no longer supported Modify Section 1.1 on page 17 for embedded ICPs Add tSyncSelect function (Section 4.11 on page 114) Add new error codes to Appendix A
DC 900-1386C	December 1999	Add LocalPort TSI configuration parameter (Table 3–3 on page 58)

Document Revision	Release Date	Description
DC 900-1386D	March 2002	Update contact information for Protogate, Inc. Also, reference new Freeway model numbers.

Customer Support

If you are having trouble with any Protogate product, call us at (858) 451-0865 Monday through Friday between 8 a.m. and 5 p.m. Pacific time.

You can also fax your questions to us at (877) 473-0190 any time. Please include a cover sheet addressed to “Customer Service.”

We are always interested in suggestions for improving our products. You can use the report form in the back of this manual to send us your recommendations.

Chapter 1 Overview

This document describes Protogate's transport subsystem interface (TSI) to the Freeway communications server. The TSI presents a consistent, high-level, common interface across multiple clients, operating systems, and transport services. The TSI provides connection-oriented data services to your client application with a subroutine library. This library provides functions that permit your application to access, configure, establish and terminate connections, and exchange data with a TSI peer application. Within the Freeway server, the TSI is used by Freeway's message multiplexor (MsgMux) to communicate with client applications.

Note

In this document, the term "Freeway" can mean either a Freeway server or an embedded ICP. For the embedded ICP, also refer to the user guide for your ICP and operating system (for example, the *Freeway User Guide*).

1.1 Product Overview

Protogate provides a variety of wide-area network (WAN) connectivity solutions for real-time financial, defense, telecommunications, and process-control applications. Protogate's Freeway server offers flexibility and ease of programming using a variety of LAN-based server hardware platforms. Now a consistent and compatible embedded intelligent communications processor (ICP) product offers the same functionality as the Freeway server, allowing individual client computers to connect directly to the WAN.

Both Freeway and the embedded ICP use the same data link interface (DLI). Therefore, migration between the two environments simply requires linking your client application with the proper library. Various client operating systems are supported (for example, UNIX, VMS, and Windows NT).

Protogate protocols that run on the ICPs are independent of the client operating system and the hardware platform (Freeway or embedded ICP).

1.1.1 Freeway Server

Protogate's Freeway communications servers enable client applications on a local-area network (LAN) to access specialized WANs through the DLI. The Freeway server can be any of several models (for example, Freeway 1100/1150, Freeway 1200/1300, Freeway 2000/4000, or Freeway 8000/8800). The Freeway server is user programmable and communicates in real time. It provides multiple data links and a variety of network services to LAN-based clients. Figure 1–1 shows the Freeway configuration.

To maintain high data throughput, Freeway uses a multi-processor architecture to support the LAN and WAN services. The LAN interface is managed by a single-board computer, called the server processor. It uses the commercially available VxWorks operating system to provide a full-featured base for the LAN interface and layered services needed by Freeway.

Freeway can be configured with multiple WAN interface processor boards, each of which is a Protogate ICP. Each ICP runs the communication protocol software using Protogate's real-time operating system.

1.1.2 Embedded ICP

The embedded ICP connects your client computer directly to the WAN (for example, using Protogate's ICP2432 PCIbus board). The embedded ICP provides client applications with the same WAN connectivity as the Freeway server, using the same data link interface (via the DLITE embedded interface). The ICP runs the communication protocol software using Protogate's real-time operating system. Figure 1–2 shows the embedded ICP configuration.

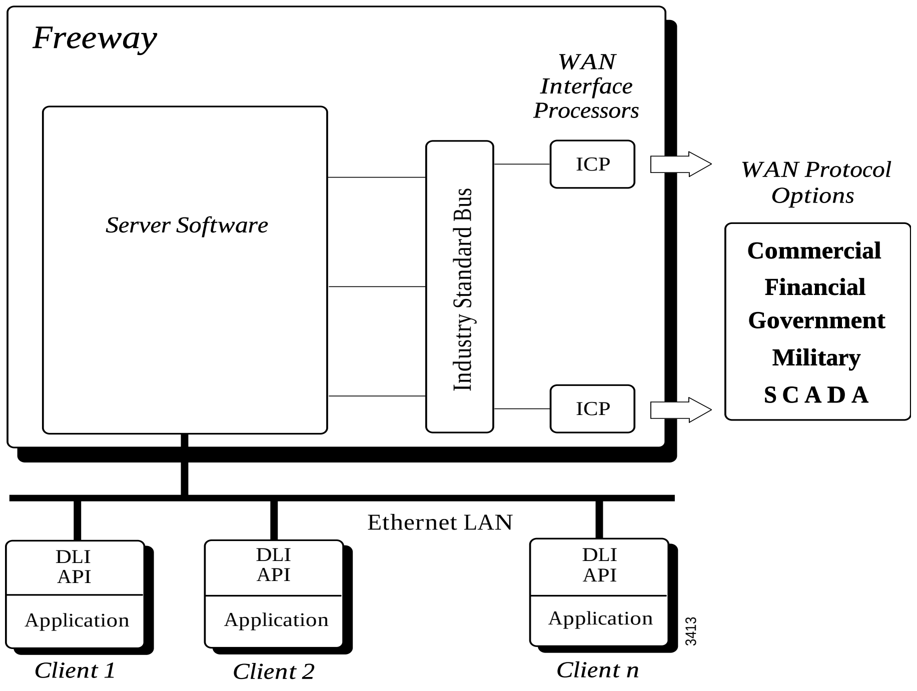


Figure 1–1: Freeway Configuration

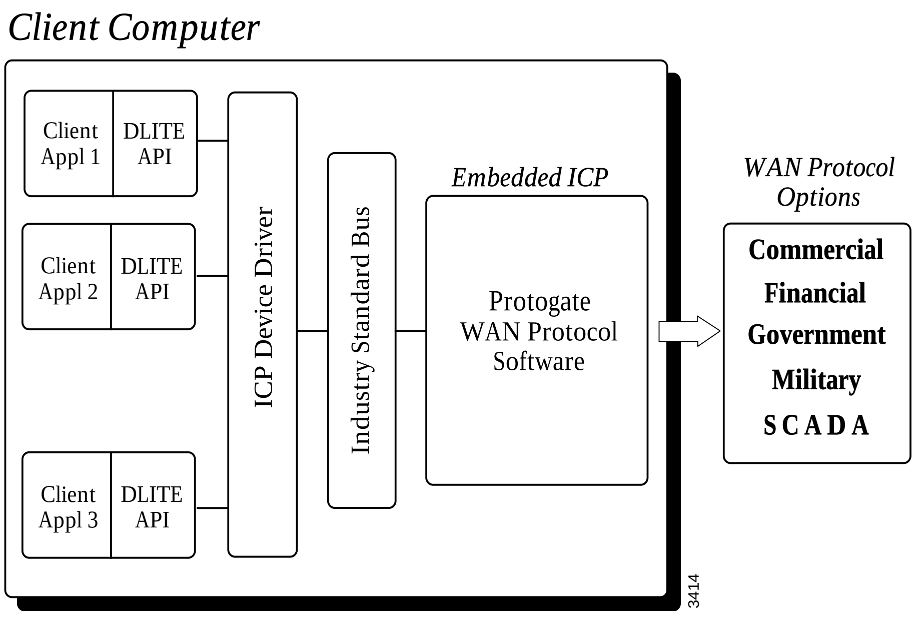


Figure 1–2: Embedded ICP Configuration

Summary of product features:

- Provision of WAN connectivity either through a LAN-based Freeway server or directly using an embedded ICP
- Elimination of difficult LAN and WAN programming and systems integration by providing a powerful and consistent data link interface
- Variety of off-the-shelf communication protocols available from Protogate which are independent of the client operating system and hardware platform
- Support for multiple WAN communication protocols simultaneously
- Support for multiple ICPs (two, four, eight, or sixteen communication lines per ICP)
- Wide selection of electrical interfaces including EIA-232, EIA-449, EIA-530, and V.35
- Creation of customized server-resident and ICP-resident software, using Protogate's software development toolkits
- Freeway server standard support for Ethernet and Fast Ethernet LANs running the transmission control protocol/internet protocol (TCP/IP)
- Freeway server standard support for FDDI LANs running the transmission control protocol/ internet protocol (TCP/IP)
- Freeway server management and performance monitoring with the simple network management protocol (SNMP), as well as interactive menus available through a local console, telnet, or rlogin

1.2 Freeway Client-Server Environment Using TSI

Freeway acts as a gateway that connects a client on a local-area network to a wide-area network. Through Freeway, a client application can exchange data with a remote data link application. Your client application must interact with the Freeway server and its resident ICPs before exchanging data with the remote data link application.

One of the major Freeway components is the message multiplexor (MsgMux) that manages the data traffic between the LAN and the WAN environments. The client application typically interacts with the Freeway MsgMux through a TCP/IP BSD-style socket interface (or a shared-memory interface if it is a server-resident application (SRA)). The ICPs interact with the MsgMux through the DMA and/or shared-memory interface of the industry-standard bus to exchange WAN data.

From the client application's point of view, the complexities are handled through a simple and consistent transport subsystem interface (TSI) which provides connection-oriented functions (tConnect, tWrite, tRead, and tDisconnect). If your application interfaces directly with the TSI, many of the overhead details (such as I/O, header, and protocol specifics) must be handled by your application. In this case, you must be familiar not only with this document, but also with the *Freeway Client-Server Interface Control Document*. If your TSI application will communicate with a remote data link application, you must also be familiar with the appropriate protocol programmer's guide.

Figure 1–3 shows a typical Freeway connected to a locally attached client by a TCP/IP network across an Ethernet LAN interface. Running a client TSI application in the Freeway client-server environment requires the basic steps described in Section 1.2.1 through Section 1.2.5.

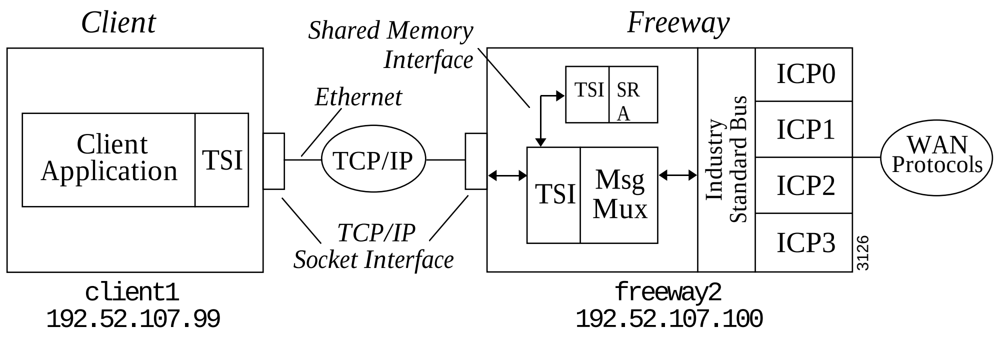


Figure 1–3: A Typical Freeway Environment

1.2.1 Establishing Freeway Internet Addresses

Freeway must be addressable in order for a client application to communicate with it. In the Figure 1–3 example, the TCP/IP Freeway server name is freeway2, and its unique Internet address is 192.52.107.100. The client machine where the client application resides is client1, and its unique Internet address is 192.52.107.99. Refer to the *Freeway User Guide* to initially set up your Freeway and download the operating system, server, and protocol software to Freeway.

1.2.2 Defining the TSI Configuration

After establishing the addressing for your client machine and Freeway server, you must define the TSI connections between your client application and Freeway. To accomplish this, you first define the configuration parameters in a TSI ASCII configuration file, and then you run the tsicfg preprocessor program to create a binary configuration file (see Chapter 3). The tInit function uses the binary configuration file to initialize the TSI environment. If your application uses the DLI, refer to the *Freeway Data Link Interface Reference Guide* for DLI configuration.

1.2.3 Establishing a Freeway TSI Connection

After the TSI configuration is properly defined, your client TSI application uses the tConnect function to establish a TSI connection with the Freeway MsgMux through the TCP/IP BSD-style socket interface.

1.2.4 Exchanging Data through the Freeway Message Multiplexor

After the TSI connection is established, the client application can then exchange data through the Freeway MsgMux using the tRead and tWrite functions. If your application needs to exchange data with a remote data link application through a Freeway ICP, you must handle the protocol-specific link configuration and other details pertaining to the ICP. In this case, refer to your particular protocol programmer's guide.

1.2.5 Closing a Freeway Session

When your application finishes exchanging data, it calls the tDisconnect function to disconnect from the Freeway MsgMux.

1.3 TSI Overview and Features

The TSI provides a transport-independent data transfer mechanism with a common interface across varying operating systems. The TSI shields data transfer applications from any dependencies on the underlying transport service (TCP/IP sockets, shared memory, and so on). In addition, TSI applications are easily ported, due to the consistent TSI interface across all supported operating systems.

The TSI consists of the TSI configuration preprocessor program, tsicfg, and a statically linked reference library containing a set of flexible and easy-to-use functions to establish, maintain, and terminate a connection with a TSI peer application.

The tsicfg preprocessor provides flexibility to the TSI application by allowing the run-time characteristics of the TSI to be modified *without recompiling the application software*. The TSI can be configured to use blocking or non-blocking I/O. Non-blocking I/O allows an application to service multiple TSI connections without blocking on any one connection. The tsicfg preprocessor program is described in Chapter 3.

The TSI operates within a client-server scheme, in which a TSI “server” application listens for incoming connection requests from TSI “client” applications. However, any TSI application can function as both a client and a server; that is, a TSI application can both listen for incoming connection requests and send connection requests to other TSI server applications. Figure 1–4 shows some possible applications within a TSI environment.

As shown in Figure 1–5, a TSI “server” application is used by Freeway’s MsgMux. Thus TSI “client” applications can communicate in a peer relationship with the Freeway TSI “server” application. Remote client applications can use the TSI’s TCP/IP socket interface, while server-resident applications (SRAs) can use the TSI’s shared-memory interface. Each TSI client application shown in Figure 1–5 is in a peer relationship with the Freeway TSI server application (that is, there is a TSI connection between each client TSI and the Freeway MsgMux).

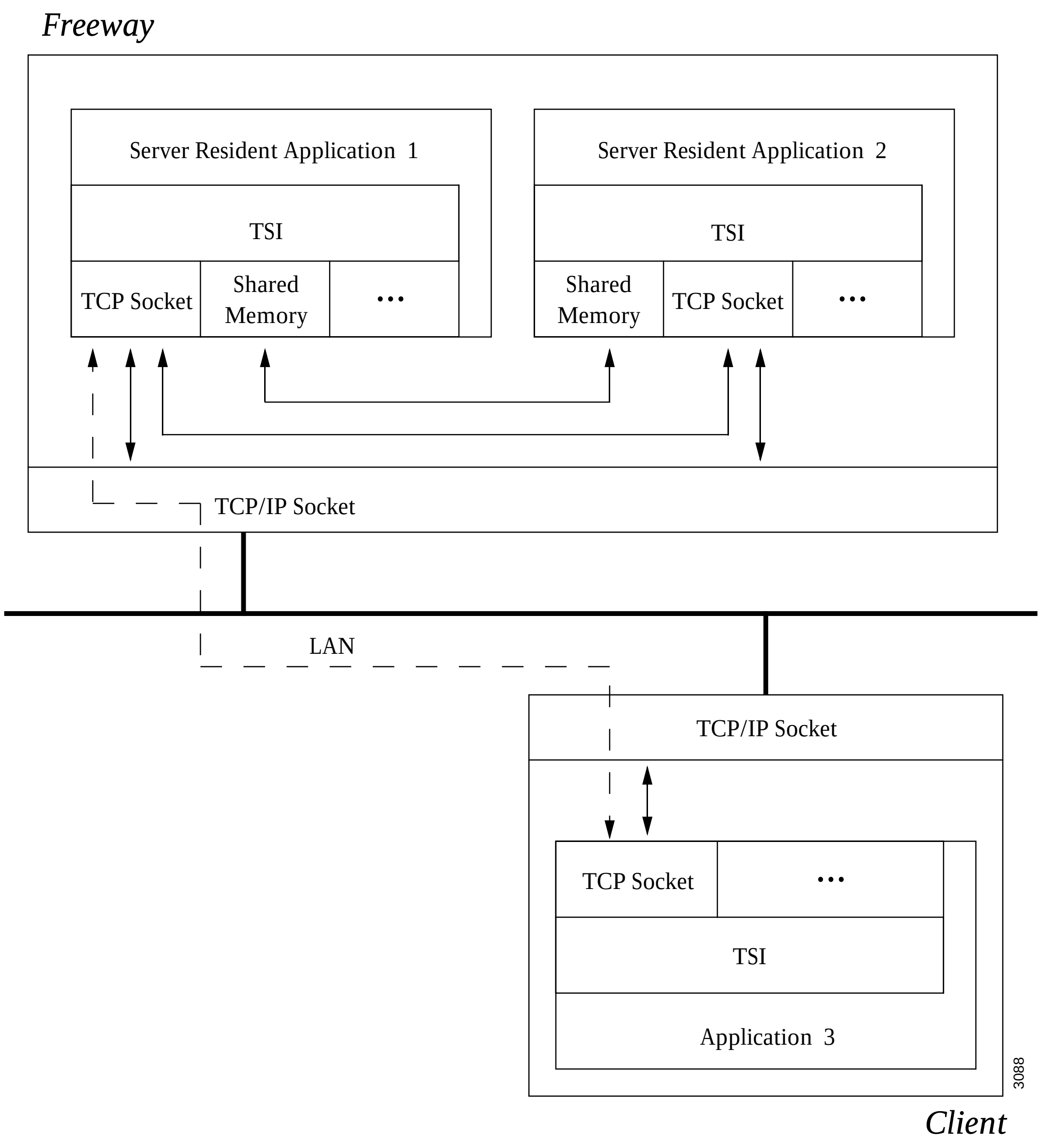


Figure 1–4: TSI Environment

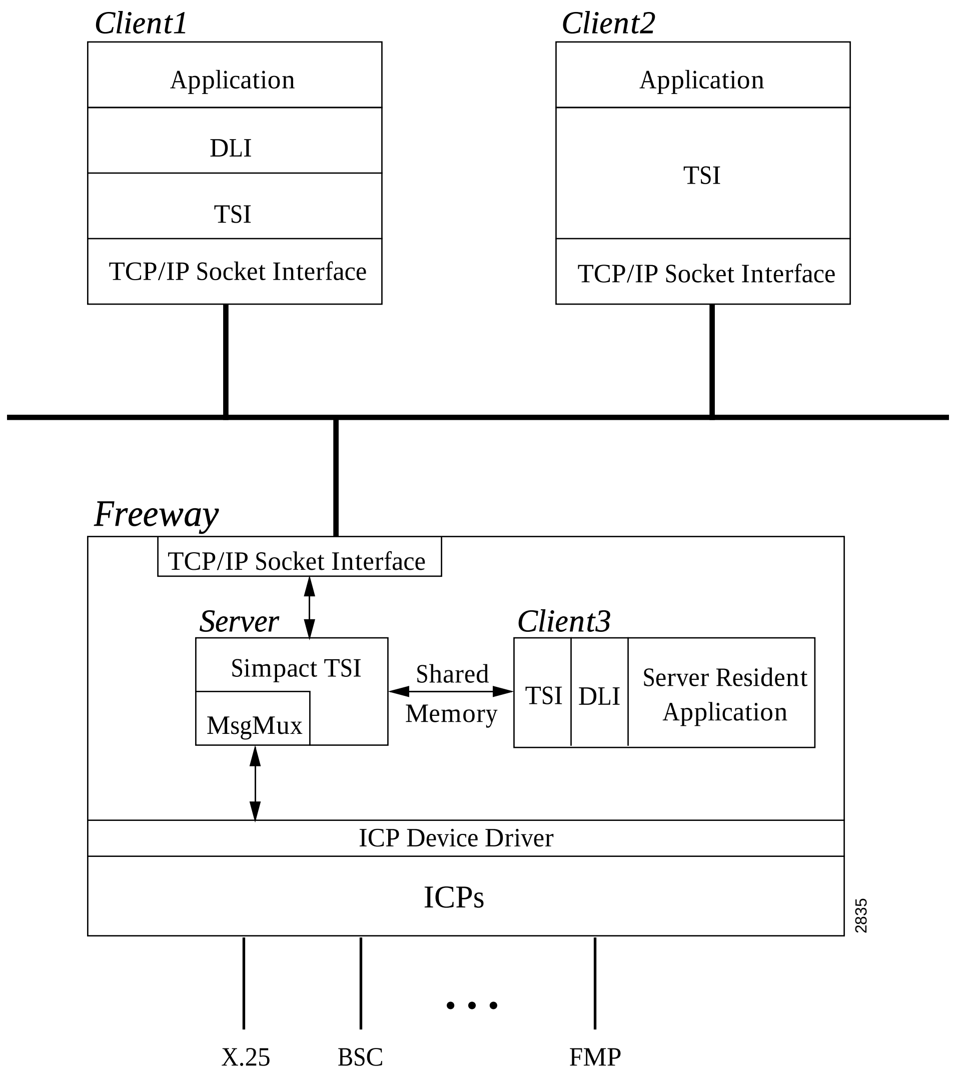


Figure 1–5: TSI in the Freeway Operating Environment

The major features of the TSI are summarized as follows:

- Communicates with the Freeway server's message multiplexor (MsgMux)
- Communicates with other TSI applications
- Provides transport-service-dependent operations
- Permits transport-service-independent applications
- Supports multiple TSI connections to multiple servers
- Supports blocking I/O
- Supports non-blocking I/O with notification by I/O completion handler (IOCH) or polling
- Provides advanced queuing techniques to minimize internal task switches under the VxWorks operating system
- Provides efficient buffer management to avoid excess memory movement
- Provides flexible text-based configuration services
- Provides an off-line configuration preprocessor program (tsicfg) to increase syntax and semantic checking capability and to reduce real-time (on-line) processing of the configuration parameters
- Provides configuration for all significant TSI service parameters

Chapter 2 TSI Concepts

Note

In this document, the term “Freeway” can mean either a Freeway server or an embedded ICP. For the embedded ICP, also refer to the user guide for your ICP and operating system (for example, the *ICP2432 User Guide for Windows NT*).

The following TSI concepts are described in this chapter:

- configuration at various levels of the Freeway environment
- blocking versus non-blocking I/O
- buffer management
- system resource requirements

2.1 Configuration in the Freeway Environment

There are several types of configuration required for a client TSI application to run in the Freeway environment:

- Freeway server configuration
- transport subsystem interface (TSI) connection configuration
- protocol-specific ICP link configuration (if applicable)

The Freeway server is normally configured only once, during the installation procedures described in the *Freeway User Guide*. TSI connection configuration is defined by specifying parameters in a TSI ASCII configuration file and then running the tsicfg preprocessor program to create a binary configuration file. Chapter 3 describes TSI configuration.

If your application communicates with one of Protogate's data link protocols running on the ICP, you must be familiar with link configuration as described in your particular protocol programmer's guide.

2.2 Blocking versus Non-blocking I/O

Note

Earlier Freeway releases used the term "synchronous" for blocking I/O and "asynchronous" for non-blocking I/O. Some parameter names reflect the previous terminology.

Non-blocking I/O applications are useful when doing I/O to multiple channels with a single process where it is not possible to "block" (sleep) on any one channel. Blocking I/O applications are useful when it is reasonable to have the calling process wait for I/O completion. For example, if you wish to design an application requiring the input of a keyboard as well as background processing, non-blocking I/O would be more efficient, because your process can perform other tasks while waiting for keyboard input.

In the Freeway environment, the term blocking I/O indicates that the open, close, connect, disconnect, read and write functions do not return until the I/O is complete. For non-blocking I/O, these functions might return after the I/O has been queued at the client, but before the transfer to Freeway is complete. The client must handle I/O completions at the software interrupt level in the completion handler established by the tInit or tConnect function, or by periodic use of tPoll to query the I/O completion status.

The effects on different TSI functions, resulting from the choice of blocking or non-blocking I/O, are explained in each function description in Chapter 4.

2.2.1 I/O Completion Handler for Non-Blocking I/O

When your application uses non-blocking I/O and an I/O condition occurs, the current task is preempted by a high-priority task called an I/O completion handler (IOCH) which is designated to handle the I/O. This high-priority IOCH is written by the application programmer and should adhere to the following real-time criteria to prevent the IOCH from impacting overall system performance:

- minimize the amount of processing performed within the IOCH so other vital system operations are not prevented from executing
- allow the non-preemptive priority routines to complete the processing
- avoid activities such as disk I/O which might block the operations

2.3 Buffer Management

This section describes how the Freeway buffer management system operates. For users who do not need a detailed understanding of the system design, Section 2.3.1 gives a system buffer overview and an example for reconfiguring your system buffers. Section 2.3.2 through Section 2.3.6 give the detailed information for those interested.

Note

Freeway buffer management is implemented in the TSI; however DLI uses the TSI system for its own buffer management. Therefore, the DLI perspective is also presented throughout this section. If your application interfaces to the TSI only (not the DLI), you can disregard the DLI-specific information.

2.3.1 Overview of the Freeway System Buffer Relationships

In the Freeway environment, user-configurable buffers exist in the ICP, the client, and the server. These buffers must be coordinated for proper operation between the client application, the Freeway server, and the ICP. The default sizes for each of these buffers are designed for operation in a typical Freeway system. However, if your system requires reconfiguration of buffer sizes, the basic procedure is as follows (Section 2.3.1.1 gives an example calculation):

Step 1: As a general rule, define the ICP buffer size first. ICP buffers must be large enough to contain the largest application data buffer transmitted or received. Most Protogate protocols on a Freeway ICP provide a data link interface (DLI) configuration parameter (such as msgBlkSize for BSC) through which the user can configure the ICP message buffer size. The typical default ICP buffer size for most Protogate protocols is 1024. Refer to your protocol-specific *Programmer's Guide* to determine the parameter name and default.

Note

If your application does not interface to the DLI, the protocol-specific ICP buffer size is also software configurable. Refer to your protocol-specific *Programmer's Guide*.

Step 2: Define the client buffers in the client's TSI configuration file. The TSI buffer pool is defined in the configuration file's "main" section. An optional connection-specific maximum buffer size is allowed in each connection definition. These two configurations are detailed in Section 2.3.2.1 and Section 2.3.2.2, respectively. The buffer size specified in the associated connection definition must be large enough to contain the ICP buffer size.

Note

If your application uses the DLI, the client buffer size must also be large enough to contain the DLI header.

Step 3: Define the server buffers in the MuxCfg server TSI configuration file, which is located in your boot directory. This file is similar to the client TSI configuration file. As with the client, define the TSI buffer pool size in the MuxCfg file's "main" section. Then define the optional connection-specific maximum buffer size for each connection. Simply define the connection buffer size for the largest associated client requirement. The buffer pool size must be at least as large as the largest connection buffer size. Section 3.5 on page 65 discusses the MuxCfg file in detail, and Figure 3–4 on page 66 shows a MuxCfg file.

2.3.1.1 Example Calculation to Change ICP, Client, and Server Buffer Sizes

Step 1: Determine the maximum bytes of data your application must be able to transfer. For this example calculation, we are assuming a maximum of 1500 bytes to be transferred using the BSC protocol and interfacing to Protogate's DLI. This is the value that must be assigned to the ICP buffer size (the DLI msgBlkSize parameter for BSC).

Step 2: Based on the above 1500-byte msgBlkSize parameter, calculate a new MaxBufSize for the ICP, client and server. Table 2–1 summarizes the values used in this example.

MaxBufSize = msgBlkSize + DLI header size

MaxBufSize = 1500 bytes + 96 bytes = 1596 bytes

Step 3: Make the required changes to the protocol-specific portion of the client DLI configuration file as shown in Figure 2–1.

Table 2–1: Required Values for Calculating New MaxBufSize Parameter

Item	Requirement	Description
BSC msgBlkSize parameter[1]	1500 bytes	ICP buffer size (the maximum actual data size)
DLI header size	96 bytes[2]	If your application uses the DLI, the buffer size must include this DLI header size

[1] For BSC, the protocol-specific DLI parameter is msgBlkSize (default is 1024 bytes).

[2] On most client platforms the DLI header is 76 bytes; however, this size is platform dependent. For initial installations Protogate recommends assuming a DLI header size of 96 bytes to calculate buffer sizes in the configuration files.

```
main                          // DLI “main” section:                //
{
        …
}
Session1                      // Session-specific parameters        //
{
        …

// BSC protocol-specific parameters for Session1:                    //

        msgBlkSize = 1500;
        …
}                             // End of Session1 parameters         //
```

Figure 2–1: Client DLI Configuration File Changes (BSC Example)

Step 4: Make the required changes to the client TSI configuration file as shown in Figure 2–2.

```
main                          // TSI “main” section:                //
{
        MaxBufSize = 1596 ;   // Must be 1596 (or greater)          //
        …
}
Conn1                         // Connection-specific parameters     //
{
        MaxBufSize = 1596;
        …
}
```

Figure 2–2: Client TSI Configuration File Changes

Step 5: Make the required changes to the server MuxCfg TSI configuration file (located in your boot directory) as shown in Figure 2–3.

```
main                                // MuxCfg "main" section:                  //
{
        MaxBufSize = 1596  ;        // Must be 1596 (or greater)               //
        . . .
}
MuxConn1                            // Connection-specific parameters          //
{
        MaxBufSize = 1596;
        . . .
}
```

Figure 2–3: Server MuxCfg TSI Configuration File Changes

2.3.2 Client TSI Buffer Configuration

For users who need to understand the details of the buffer management system, review Section 2.3.2 through Section 2.3.6 carefully. After you define the ICP buffer size as described in *Step 1* on page 32, the next step is to define the client TSI buffers.

The TSI provides its own buffer management scheme. Definitions in the client TSI configuration file allow you to create fixed-sized buffers in a TSI-controlled buffer pool (see Section 2.3.2.1). Each connection can then optionally be assigned a unique maximum buffer size (see Section 2.3.2.2). TSI applications can then access these buffers using the tBufAlloc and tBufFree TSI functions.

Note

For applications using Protogate's data link interface, the DLI uses the TSI buffer management system for its own buffer management. The dlBufAlloc and dlBufFree DLI functions provide access to buffers in the TSI buffer pool.

Your application is not required to use the TSI buffer management facilities, but Protogate highly recommends it for the following reasons:

- TSI allocates all buffers up front, resulting in better real-time performance than allocation through C malloc and free functions
- The number of TSI buffers is configurable for operating environments with limited system resources
- TSI allocates the buffer pool on boundaries which minimize memory access overhead
- TSI overhead is invisible to the user

2.3.2.1 TSI Buffer Pool Definition

The TSI buffer pool is configured through two parameter definitions in the "main" section of the client TSI configuration file (Section 3.3.1 on page 54). The MaxBufSize parameter specifies the maximum size of each buffer in the TSI buffer pool. The MaxBuffers parameter specifies the maximum number of buffers available in the TSI buffer pool and must support the maximum number of I/O requests that could be outstanding at any one time. After adjusting MaxBufSize as described below, the product of the MaxBufSize and MaxBuffers parameters defines the TSI buffer pool size.

MaxBufSize defines the maximum size of each buffer. This is the actual data size the TSI user application has available for its own use. When the buffer pool is defined, TSI calculates an "effective" buffer size which is MaxBufSize plus the additional bytes required for a TSI header plus any alignment bytes. Alignment bytes are required only if the value of MaxBufSize plus the TSI header bytes is not divisible by 4.

This "effective" buffer size is invisible to the user application (regardless of whether it interfaces to the DLI or the TSI); all interactions with the TSI buffer management facilities are based on MaxBufSize and the connection-specific parameter described in Section 2.3.2.2. If you define MaxBufSize as 1000 bytes, TSI assures that the buffer pool can provide 1000 bytes for TSI application data.

Figure 2–4 illustrates an example buffer calculation assuming the following sizes:

- MaxBufSize is 1000 bytes
- The TSI header is 18 bytes
- The necessary alignment to make the total divisible by 4 is 2 bytes

TSI adds 18 bytes to the MaxBufSize value to include the TSI header, making the actual size of the buffer allocated by TSI 1018 bytes. Because this actual size is not divisible by 4, TSI increments the value to the next modulo-4 value, in this case, 1020. Regardless of the final size, your TSI application has control of only MaxBufSize bytes.

The TSI application program can obtain the value of MaxBufSize using a tPoll request for the system configuration. Refer to the TSI_POLL_GET_SYS_CFG option (described on page 101 and in Section 4.1.3.1 on page 76), which returns the iMaxBufSize field (described on page 77).

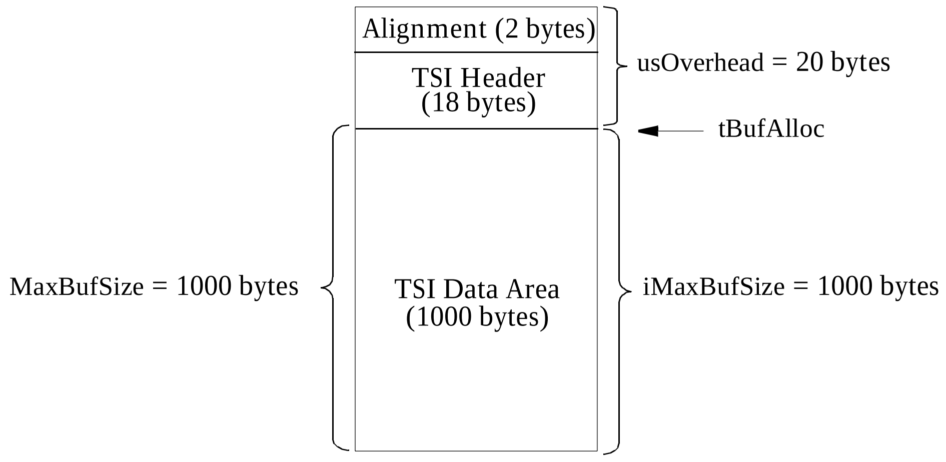


Figure 2–4: TSI Buffer Size Example

Note

The Figure 2–4 example, as viewed from the DLI application's perspective is shown in Figure 2–5. Of the 1000 bytes specified by the TSI MaxBufSize parameter, 76 bytes are required for the DLI header. After calling dlOpen, the DLI application program can call dlPoll with the DLI_POLL_GET_SESS_STATUS option, which returns the usMaxSessBufSize field. This value is the actual data size available to the DLI application (924 bytes in the Figure 2–5 example).

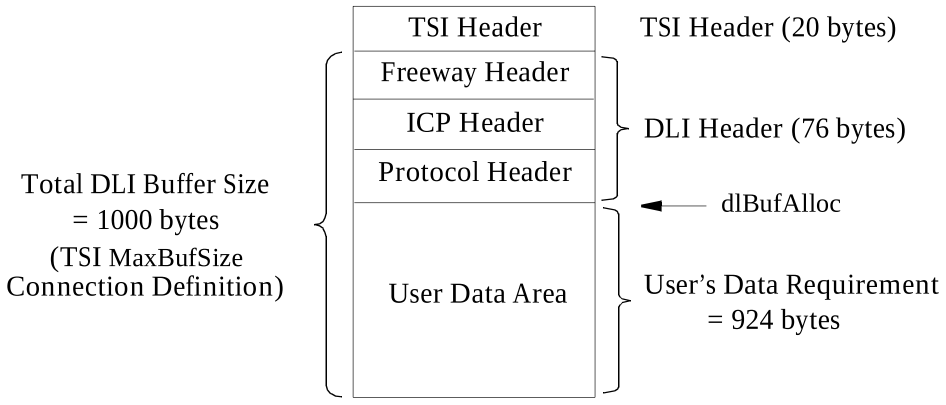


Figure 2–5: DLI Buffer Size Example

2.3.2.2 Connection-Specific Buffer Definition

After the TSI buffer pool is defined, you have the option of defining a unique maximum buffer size for each connection in the client TSI configuration file. If undefined, the connection buffer size defaults to the MaxBufSize "main" definition for the TSI buffer pool described in the previous Section 2.3.2.1.

Note

The maximum connection buffer size should be at least as large as the defined ICP buffer size, plus any additional client requirements. For example, if you are using the DLI, you must include DLI overhead bytes in the total size of the application data area (see Figure 2–5).

To define a unique buffer size for a connection, use the *connection-specific* MaxBufSize parameter described in Section 3.3.2 on page 56. This connection buffer size is the buffer size the system allows the user for tWrite requests. No connection buffer size can be larger than MaxBufSize defined for the TSI buffer pool.

The connection buffer size does not change the actual size of the buffer (actual buffers are all MaxBufSize as defined for the TSI buffer pool); it only limits the acceptable size of application write buffers given to TSI through a tWrite request. It enforces a maximum data size that can be sent to the server in any one tWrite request. The tWrite function returns a TSI_WRIT_ERR_INVALID_LENGTH error if the write is attempted with a buffer exceeding the connection's maximum buffer size.

The tRead requests are not limited by the connection buffer size. The size of read requests, when using tRead, is defined by MaxBufSize for the TSI buffer pool (in the "main" definition of the TSI configuration file).

2.3.2.3 TSI Buffer Size Negotiation

A connection's maximum buffer size can be changed "silently." When the client's connection to the Freeway server is accomplished, the client TSI and the server TSI negotiate a maximum buffer size for the established connection. If the sizes are different, the side with the larger connection buffer size changes its size to that of the smaller. After the connection is established, the negotiated maximum buffer size is available using a tPoll request for connection status. Refer to the TSI_POLL_GET_CONN_STATUS option (described on page 101 and in Section 4.1.3.2 on page 78), which returns the usMaxConnBufSize field (described on page 79). Note that this "final" size is not available until the connection has been successfully established.

Note

The DLI application program can obtain the actual data size (after the TSI negotiation process during dlOpen) using a dlPoll request with the DLI_POLL_GET_SESS_STATUS option, which returns the usMaxSessBufSize field. Refer to the example provided in the *Freeway Data Link Interface Reference Guide.* A similar approach would apply to using the TSI usMaxConnBufSize field obtained by calling tPoll with the TSI_POLL_GET_CONN_STATUS option.

2.3.3 Server TSI Buffer Configuration

After defining the ICP buffers and the client TSI buffers, the final step is to define the server TSI buffers. The same TSI buffer management design details apply to the server TSI buffers that were described in Section 2.3.2 on page 35 for the client TSI buffers. The only difference is that the server buffer definitions are specified in the MuxCfg server TSI configuration file, which is located in your boot directory. As with the client, define the TSI buffer pool size in the MuxCfg file's "main" section. Then define the optional connection-specific maximum buffer size for each connection. Simply define the connection buffer size for the largest associated client requirement. The buffer pool size must be at least as large as the largest connection buffer size. Section 3.5 on page 65 discusses the MuxCfg file in detail, and Figure 3–4 on page 66 shows a MuxCfg file. Refer back to Section 2.3.1.1 on page 33 for a sample calculation of ICP, client, and server buffer sizes.

2.3.4 Buffer Allocation and Release

The TSI application obtains a buffer from the TSI buffer pool using the tBufAlloc function. The returned buffer address points to the available data area as shown in Figure 2–4 on page 37. The size returned is always the MaxBufSize defined for the buffer pool (Table 3–1 on page 54). While the entire data area is available for user data, note the restrictions discussed previously in Section 2.3.2.2 regarding limits placed on tWrite requests by the connection's maximum buffer size definition. The user application releases a buffer back to the TSI buffer pool using the tBufFree function.

Note DLI applications use the dlBufAlloc and dlBufFree functions to access buffers in the TSI buffer pool.

2.3.5 Cautions for Changing Buffer Sizes

If you need to change the buffer size of your application, keep the following cautions in mind:

- If you increase the ICP buffer size, there may be corresponding changes required in the client and server buffer sizes.
- If you have limited resources and increase the client or server MaxBufSize parameter, consider decreasing the number of buffers allocated in the buffer pool (the MaxBuffers parameter in the client TSI configuration file and the server MuxCfg file).
- Client read buffers too small for an inbound data buffer are returned to the client application with a TSI_READ_ERR_OVERFLOW error indication. Write requests with buffers too large are returned with a TSI_WRIT_ERR_INVALID_LENGTH error indication.

2.3.6 Using Your Own Buffers

If your TSI application needs to use its own buffers, it must know the exact number of overhead bytes used to store the TSI header information. Your application should call tPoll to get the TSI system configuration information (Section 4.8 on page 100) so that it can allocate buffers correctly. Each buffer must be at least iMaxBufSize + usOverhead bytes in size (these values are described on page 77). Your application must give TSI the address of the memory buffer that is at usOverhead bytes from the beginning of the data area. Figure 2–6 shows a comparison of using the "C" malloc function versus the TSI tBufAlloc function for buffer allocation. Figure 2–7 is a "C" code fragment demonstrating the use of the malloc function.

Note

For information about using your own buffers in a DLI application, see the *Freeway Data Link Interface Reference Guide.*

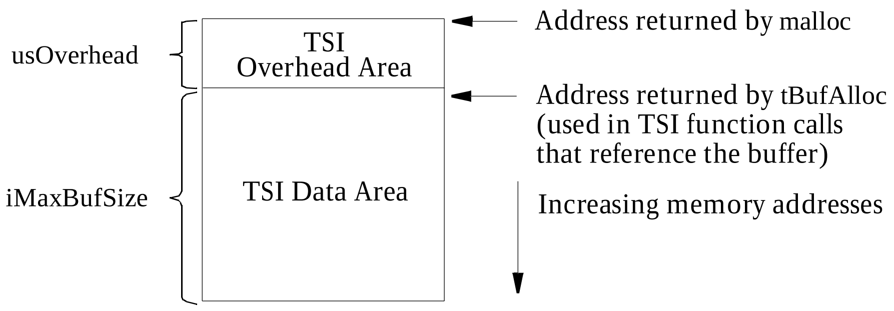

usOverhead
iMaxBufSize
TSI
Overhead Area
TSI Data Area
Address returned by malloc
Address returned by tBufAlloc
(used in TSI function calls
that reference the buffer)
Increasing memory addresses

Figure 2–6: Comparison of malloc and tBufAlloc Buffers

```
...
PCHAR               pBuf;
TSI_SYS_CFG         sysCfg;
int                 iBufSize, iConnID;
...
tPoll (0, TSI_POLL_GET_SYS_CFG, (PCHAR*)NULL, (PINT)NULL, (PCHAR)&sysCfg);
iBufSize = (int) sysCfg. usOverhead + sysCfg. iMaxBufSize;
pBuf = (PCHAR) malloc (iBufSize);
...
tWrite (iConnID, &pBuf[sysCfg. usOverhead], 100, TSI_WRITE_NORMAL);
...
```

Figure 2–7: Using the malloc Function for Buffer Allocation

2.3.7 Buffer Management (Client versus Server-Resident Applications)

Writing a server-resident application (SRA) using the TSI interface is much like writing a client application. The usual sequence of steps in a client application is:

1. Call tBufAlloc (Section 4.2 on page 80) to obtain a buffer.
2. Load the buffer with data.
3. Call tWrite (Section 4.13 on page 120), which copies the data for further processing.
4. Call tBufFree (Section 4.3 on page 82) to release the buffer allocated in Step 1.
5. Call tRead (Section 4.10 on page 109), supplying a NULL pointer for the buffer address so that the TSI allocates the buffer for the client application.
6. Call tBufFree (Section 4.3 on page 82) to release the buffer allocated by the TSI in Step 5.

However, there is one significant difference in the way buffers are managed for an SRA which uses the TSI interface (refer back to Figure 1–3 on page 23 to see how an SRA fits in a typical Freeway environment). When the TSI code at the SRA interacts with the TSI code at the MsgMux, the *address* of the buffer is passed instead of copying the contents of the buffer. At this point, the write is complete for the SRA; however, the buffer is still in use. Eventually the MsgMux writes the buffer to the ICP through the ICP driver. When the driver completes the write, the MsgMux releases the buffer. Therefore, even though the SRA allocated the buffer, it must not release it.

Therefore, Step 4 above is eliminated, and the modified sequence of steps for an SRA is shown below. Refer to the *Freeway Server-Resident Application and Server Toolkit Programmer Guide* for more information on SRAs.

1. Call tBufAlloc (Section 4.2 on page 80) to obtain a buffer.
2. Load the buffer with data.
3. Call tWrite (Section 4.13 on page 120), which passes the address of the buffer. Eventually the MsgMux writes the buffer to the ICP through the ICP driver. When the driver completes the write, the MsgMux releases the buffer.
4. Call tRead (Section 4.10 on page 109), supplying a NULL pointer for the buffer address so that the DLI allocates the buffer for the SRA.
5. Call tBufFree (Section 4.3 on page 82) to release the buffer allocated by the TSI in Step 5.

2.4 System Resource Requirements

When designing your TSI application, you must consider TSI resource requirements. They can be calculated as follows:

Total memory requirements = program size
+ (number of buffers x size of buffer)
+ (number of connections x 300)
+ (number of connections x size of I/O queues x 44)
+ 32,000

Where:

- "number of buffers" is defined by the TSI MaxBuffers parameter (page 54)
- "size of buffer" is defined by the TSI MaxBufSize parameter (page 55)
- "number of connections" is defined by the TSI MaxConns parameter (page 55)
- "size of I/O queues" is defined by the sum of the TSI MaxInQ parameter (page 56) and the TSI MaxOutQ parameter (page 56)

2.4.1 Signal Processing

The TSI disables all signals during processing. The signals are ultimately delivered when they are re-enabled at the end of the TSI call. If this constraint causes a problem for your client application, consider implementing one of the following:

- use non-blocking I/O as described in Section 2.2 on page 30
- use the Timeout TSI configuration parameter (page 57)

Under VMS, ASTs are disabled instead of signals.

Chapter 3

TSI Configuration

Note

In this document, the term “Freeway” can mean either a Freeway server or an embedded ICP. For the embedded ICP, also refer to the user guide for your ICP and operating system (for example, the *ICP2432 User Guide for Windows NT*).

3.1 Configuration Process Overview

The transport subsystem interface (TSI) consists of two major components:

- The tsicfg configuration preprocessor program defines the TSI environment prior to run time, using a text configuration file that you create or modify.
- The TSI reference library is used to build your TSI application.

The advantage of using the tsicfg preprocessor program is that you do not have to rebuild your application when you redefine the TSI environment.

The TSI configuration process is a part of the installation procedure and the loopback testing procedure described in the *Freeway User Guide*. However, during your client application development and testing, you might need to perform TSI configuration repeatedly.

The TSI configuration process is summarized as follows:

1. Create or modify a text file specifying the configuration of the transport subsystem interface (TSI) connections.

2. Execute the tsicfg preprocessor program with the text file from Step 1 as input. This creates the TSI binary configuration file. If the optional TSI binary configuration filename is supplied, the binary file is given that name plus the .bin extension. If the optional filename is not supplied, the binary file is given the same name as your TSI text configuration file plus the .bin extension.

   tsicfg *TSI-text-configuration-filename [TSI-binary-configuration-filename]*

Note

You must rerun tsicfg whenever you modify the text configuration file so that the TSI functions can apply the changes.

When your application calls the tInit function, the TSI binary configuration file is used to configure the TSI connections. Figure 3–1 shows the TSI architecture.

Note

The *Freeway User Guide* describes the make files and command files provided to automate the above process and copy the resulting binary configuration files to the appropriate directories. Additionally, each protocol programmer's guide describes the related protocol specifics of the TSI configuration process.

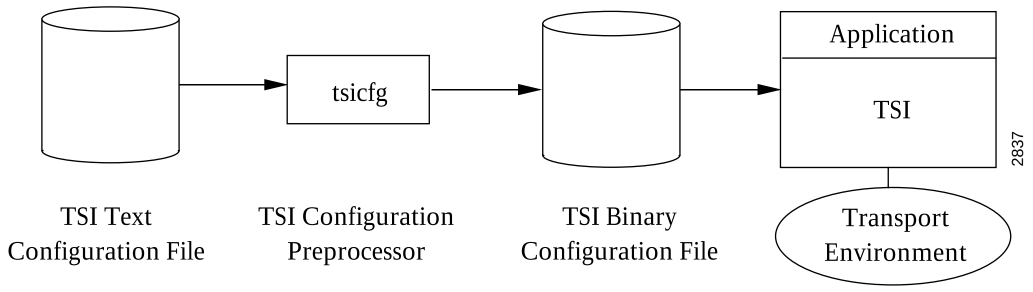

Application
tsicfg
TSI
2837
TSI Text Configuration File
TSI Configuration Preprocessor
TSI Binary Configuration File
Transport Environment

Figure 3–1: TSI Architecture

3.2 Introduction to TSI Configuration

The tsicfg configuration preprocessor program translates a TSI text configuration file into a binary configuration file. During the translation process, tsicfg processes and verifies each configuration entry in the text configuration file, and the results are stored in the binary configuration file. This process ensures the validity of the configuration parameters before their use by the TSI reference library. The TSI configuration services provide the following features:

- Free-formatted configuration language
- Informative parameter names
- Procedure-like definition entry for each connection definition
- Extensive syntax checking capability
- Extensive semantic checking capability
- Connection-based definition capability

The TSI reference library is a set of function calls used by applications to exchange data between two or more applications over a well-defined transport interface (for example, TCP/IP, shared-memory, APPC/LU 6.2, and so on). The TSI reference library uses the TSI binary configuration file to configure the TSI services as well as connections managed by the TSI. Together with the TSI configuration services, the TSI reference library provides a simple network programming environment for transport-independent applications. It also provides end users the ability to configure individual TSI connections according to their needs.

3.2.1 TSI Configuration Language

The TSI text configuration file contains an optional “main” definition followed by one or more unique connection definitions. The “main” definition specifies general TSI characteristics and must use the name “main.” Each connection definition entry in the TSI text configuration file defines a specific type of TSI connection to be established between the TSI application and a peer TSI application. Refer to Section 3.6.2 for details of the language grammar. The TSI configuration is described as follows:

```
main
{
        parameter-name = parameter-value;          // comments are ignored       //
}

connection-name
{
        parameter-name = parameter-value;
}
```

Each definition entry must be assigned a name that is unique within the configuration file; tsicfg makes no attempt to ensure the uniqueness of names within the same configuration file. Each connection-name uniquely identifies a connection within the same configuration file; it is supplied by the user. Each parameter-name is uniquely defined by tsicfg; the parameter-value is supplied by the user. Comments are considered white spaces and are ignored by tsicfg.

3.2.2 Rules of the TSI Configuration File

A connection or a parameter name must adhere to the following naming rules:

1. It is similar to variable names in the C language.
2. It can be a string of alphabetic (A through Z, a through z, and _) and numeric (0 through 9) characters.
3. The first character must be alphabetic.
4. The length must not be more than 20 characters.
5. Connection names are case-sensitive while parameter names are not.
6. The TSI does not verify the duplication of connection definition entries at the connection level or at the parameter level. That means if you have defined the same connection entry more than once, the first one is used. If you have defined a parameter within a connection definition entry more than once, the last value is used.

3.2.3 Binary Configuration File Management

The binary configuration file is created in the same directory as the location of the text configuration file (unless a different path is supplied with the optional filename described in Section 3.1 on page 47). On all but VMS systems, if a file already exists in that directory with the same name, the existing file is renamed by appending the .BAK extension. If the renamed file duplicates an existing file in the directory, that existing file is removed by the configuration preprocessor program.

Note

The default binary configuration name contains the period '.' character which plays a special role in the processing of the configuration files. See Section 3.2.4.

3.2.4 On-line Configuration File Processing

TSI can perform the configuration processing on-line. While this feature is available, Protogate recommends adherence to the off-line configuration file process previously described in Section 3.1 on page 47, which is better managed and slightly more efficient.

The off-line process can be performed on-line during TSI initialization (tInit) by providing a configuration filename without an embedded '.' character. When such a filename is recognized, TSI attempts to open the file as a text file and calls the TSI configuration preprocessor program (tsicfg). The output file is named "filename".bin. An error in the configuration file aborts the tInit processing with an appropriate error in the TSI log file.

This on-line method requires the configuration text file and the tsicfg preprocessor program to reside in the same directory as the application executable. The resulting .bin file is placed in this same directory.

Note

Unless on-line configuration is desired, be sure a ‘.’ character appears in the configuration filename provided to tInit.

3.3 TSI Connection Definition

There are two groups of TSI configuration parameters: the “main” definition and the connection definitions. Some of the parameters are found in both sets; in this case, the parameter value in the “main” definition applies to the TSI application in general, while the value in a specific connection definition applies only to those TSI connections using that connection definition (unique connection-name). The connection definition parameters allow the application to use connections with different operating characteristics at the same time. For example, a client TSI application using the TCP/IP socket interface can connect to multiple TSI server applications on various remote host machines. For each host machine, the client specifies a connection definition in its TSI configuration file with the server parameter set to the IP (Internet Protocol) address of the remote host. In addition, if the configuration needs of the application change (for example, the IP address of a remote host changes), only the configuration file needs to be modified; the application does not need to be modified or re-compiled.

The configuration parameters can be one of three types of values: integer, boolean, or character string. Integer values can be specified as ANSI C decimal, octal, or hexadecimal constants. Boolean and string values are specified as ANSI C character strings (enclosed in double quotes). Boolean values must consist of a string containing the word “yes” or the word “no.” The TSI configuration preprocessor ignores the case of boolean values; that is, “Yes” and “YES” are also valid boolean values. In addition, tsicfg ignores the case of parameter names. The parameter definitions in the following sections are given in upper and lower case for readability only. TSI uses a default value for any parameters not explicitly defined.

3.3.1 Parameters for the “main” Definition

The first section in the TSI text configuration file, which is called “main,” specifies the TSI configuration for non-connection-specific operations. If a “main” definition is not specified in the TSI text configuration file, a default “main” entry is used.

The “main” TSI parameters are shown alphabetically in Table 3–1, along with the defaults. You need to include only those parameters whose values differ from the defaults.

Table 3–1: TSI Parameters for “main” Definition

Parameter	Default	Valid Values	Description
AsyncIO	“no”[a]	boolean	Boolean value specifying the use of blocking or non-blocking I/O. A value of “no” specifies blocking I/O.
DualAddress	n/a	n/a	This parameter is replaced by the “Added Interfaces” configuration described in the *Freeway User Guide*.
InterruptTrace	“no”	boolean	A boolean value specifying whether interrupts should be locked out during tracing.
LogLev	0	0–7	An integer value defining the level of logging the TSI performs and stores in the file name defined by the LogName parameter. A higher level specifies more detailed logging; 0 specifies no logging.
LogName	“tsilog”	string (ð 80)	A string of characters defining the name (path) of the file for storing the TSI logging information. If the path is not included, the current directory is assumed.
MaxBuffers	1024	4–4096	An integer value specifying the maximum number of buffers to be allocated during run time for the TSI buffer pool. To prevent your application running out of buffers, take care when you specify MaxBuffers to consider the number of TSI connections you need and the queue sizes (MaxInQ and MaxOutQ on page 56). See Section 2.3 on page 31 for details on buffer management.

[a] For Protogate’s Freeway server TSI, AsyncIO must be set to “yes” (refer to Section 3.5 on page 65)

Table 3–1: TSI Parameters for “main” Definition *(Cont’d)*

Parameter	Default	Valid Values	Description
MaxBufSize	1024 + TSI overhead	1–64000	An integer value specifying the maximum size of each buffer in the TSI buffer pool. This user-supplied value does not include TSI overhead; the TSI overhead value is calculated by TSI and supplied to the user via the usOverhead parameter (page 77). See Section 2.3 on page 31 for details on buffer management.
MaxConns	1024	1–1024	An integer value defining the maximum number of connections the TSI can manage at one time.
ServerName	“Freeway”	string (ð 20)	A string of characters specifying the name of a TSI “server” application that runs in the VxWorks environment. This parameter applies only to TSI “server” applications using the shared-memory interface; the purpose is to identify themselves to server-resident applications (SRAs) operating as shared-memory clients. The Server parameter in a shared-memory “client” connection’s configuration definition must match the ServerName parameter in the “server’s” configuration definition. Also see the Server parameter (page 57)
StackSize	10240	1–64000	An integer value specifying the value of the stack to be used by the TSI for spawning its internal tasks. This parameter applies only to the VxWorks environment.
TraceLev	0	0–31	An integer value defining the level of tracing (or the sum of several levels) which the TSI performs for this session. This parameter can be overridden by the connection definitions following the “main” section. See also Appendix C. 0 = no trace 1 = read only 2 = write only 4 = interrupt only 8 = application IOCH 16 = user’s data
TraceName	“tsitrace”	string (ð 80)	A string of characters defining the name (path) of the file for storing the TSI tracing information. If the path is not included, the current directory is assumed.
TraceSize	0	512–1048576	An integer value specifying the size of the internal trace buffer. The default is zero (tracing is not performed). The smallest allowable size is 512.

3.3.2 Parameters for the Connection Definition (Non-transport Specific)

Each additional connection definition specifies unique TSI connections; that is, each definition has a unique connection-name. The TSI parameters are shown alphabetically in Table 3–2, along with the defaults. You need to include only those parameters whose values differ from the defaults.

Table 3–2: TSI Parameters for Non-Transport Specific Connection

Parameter	Default	Values	Description
AsyncIO	"no" [a]	boolean	Boolean value specifying the use of blocking or non-blocking I/O. A value of "no" specifies blocking I/O.
LogLev	0	0–7	An integer value defining the level of logging the TSI performs for this connection. A higher level specifies more detailed logging, while 0 specifies no logging. This value overrides the LogLev defined in the "main" section.
MaxBufSize	MaxBufSize defined in "main"	1 to MaxBufSize defined in "main"	An integer value specifying the maximum data size of the TSI buffers for this connection only. The value must be less than or equal to the "main" entry. The default value is the size specified in the "main" section.
MaxErrors	10	10–100	An integer value specifying the number of I/O errors the TSI can tolerate before declaring the connection is unusable.
MaxInQ	10	2–1000	An integer value specifying the number of entries in the TSI internal input queue. Make sure MaxBuffers defined in the "main" section (page 54) is adequate for your requirements, especially if your application uses non-blocking I/O. Use caution when changing the queue size parameters. TSI allocates buffers for each connection based on this parameter, and increasing the queue size could cause a buffer allocation problem on the server.
MaxOutQ	10	2–1000	An integer value specifying the number of entries in the TSI internal output queue. See MaxInQ above.

[a] For Protogate's Freeway server TSI, AsyncIO must be set to "yes" (refer to the *Freeway User Guide*)

Table 3–2: TSI Parameters for Non-Transport Specific Connection *(Cont'd)*

Parameter	Default	Values	Description
Server	none	string (ð 20)	A string of characters identifying the TSI "server" application with which to connect. This parameter is used differently for each transport interface: • For "tcp-socket" connections, this parameter specifies the host machine on which the TSI "server" resides. The string can be either the machine's host name or its IP address in "dot" notation (for example, "freeway2" or "192.52.107.100"). This parameter is used in conjunction with the WellKnownPort parameter (page 58) to establish "tcp-socket" connections. Note that your application may be blocked while TSI searches for the server's name if your network has Domain Name Server (DNS) setup. • For "shared-memory" connections, this parameter identifies the TSI peer "server" application or process. The client connection's Server parameter must match the server application's ServerName parameter (page 55) defined in the "main" entry of the server application's configuration file. The Server parameter is used in conjunction with the ShmPeerName parameter(page 59) to establish "shared-memory" connections.
Timeout	60	0–63999	An integer value specifying the number of seconds the TSI uses to time activities within this connection.
TraceLev	0	0–31	An integer value defining the level of tracing (or the sum of several levels) which the DLI performs for this session. If specified, this value overrides the "main" TraceLev parameter. See also Appendix C. 0 = no trace 1 = read only 2 = write only 4 = interrupt only 8 = application IOCH 16 = user's data
Transport	no default (must be specified)	string (ð 20)	A string of characters specifying the transport interface to be used by this connection. There are no defaults. Supported transport interfaces include "tcp-socket" for TCP/IP sockets and "shared-memory" for VxWorks shared-memory (server-resident applications).

3.3.3 Parameters for Connection Definition (TCP/IP Socket Transport)

The TSI configuration parameters required for a TCP/IP socket transport connection are shown alphabetically in Table 3–3, along with the defaults. You need to include only those parameters whose values differ from the defaults. See Section 3.4.1 for an example.

Table 3–3: TSI Parameters for TCP/IP Socket Transport Connection

Parameter	Default	Valid Values	Description
TCPKeepAlive	"no"	Boolean	A Boolean value specifying whether or not TCP/IP should enable periodic transmission to keep a connected link active while there are no user data transmissions on the link.
TCPNoDelay	"no"	Boolean	A Boolean value specifying whether or not TCP/IP should send a small packet as soon as possible.
WellKnownPort	0x2010	5001, 32676	An integer value (usually specified in hexadecimal) specifying the TCP/IP port to be used by this connection. A "server" connection (tListen) will bind to this port, while a "client" connection (tConnect) will attempt to connect to this port on the server's host machine (specified by the client connection's Server parameter, page 57).
LocalPort	0x0000	1024–65535 (0x0400-0xFFFF)	An integer value (usually specified in hexadecimal) specifying the local IP port used to connect to a DLI/TSI server, such as a Freeway. The default value of 0 allows the operating system to select any unused local IP port. Since the client application uses the specified local IP port for each connection attempt using a given TSI connection definition, this parameter can be used to force a Freeway to terminate a connection which was not terminated normally (for example, if the client machine crashed without properly closing its sockets, or if the client machine closed its sockets while the network was physically disconnected).

3.3.4 Parameters for Connection Definition (Shared-Memory Transport)

The TSI configuration parameters required for a VxWorks shared-memory transport connection (server-resident applications) are shown alphabetically in Table 3–4, along with the defaults. You need to include only those parameters whose values differ from the defaults. See Section 3.4.2 for an example.

Table 3–4: TSI Parameters for Shared-Memory Transport Connection

Parameter	Default	Valid Values	Description
ShmKey	n/a	n/a	Reserved.
ShmMaxInQ	10	2–1000	An integer value specifying the size of the TSI internal shared-memory input queue. It is recommended that this parameter value match the value of the connection's MaxInQ parameter (page 56).
ShmMaxOutQ	10	2–1000	An integer value specifying the size of the TSI internal shared-memory output queue. It is recommended that this parameter value match the value of the connection's MaxOutQ parameter (page 56).
ShmPeerName	no default	string (ð 20)	A string of characters specifying the connection-name of a TSI "server" connection (tListen) to which this "client" connection wishes to connect. This parameter is used in conjunction with the connection's Server parameter (page 57) in establishing a "shared-memory" connection.

3.4 Example TSI Configurations

This section describes the supported transport interfaces. Because TSI was intended to shield the application from any transport interface dependencies, the same application can be run over different transport interfaces; the user needs to modify only the application's TSI configuration file. The application might need to make modifications due to operating system dependencies (especially under VxWorks); however, the interface to TSI should remain basically constant. Recall that TSI applications "connect" using the tConnect and tListen calls which take a connection-name (associated with a connection definition) as a parameter. The transport-specific parameters within each connection definition control this connection process.

3.4.1 TCP/IP Socket Transport Interface

To configure a TSI connection to use the TCP/IP socket transport interface, the connection definition's Transport parameter (page 57) must have the value "tcp-socket". The TCP/IP socket-specific parameters (see Table 3–3 on page 58) include:

- WellKnownPort
- LocalPort
- TCPKeepAlive
- TCPNoDelay

The WellKnownPort parameter along with the Server parameter (page 57) specify a "connection point." Assume that we have two TSI applications executing on two machines connected by a TCP/IP network. An example would be the two applications labeled *Client1* and *Server* or the two applications labeled *Client2* and *Server* in Figure 1–5 on page 27.

A possible TSI configuration for the two applications is shown in Figure 3–2. "Server" application X (connection-name "TCPserver") wishes to listen for an incoming connection, while "client" application Y (connection-name "TCPclient") wishes to connect to "server" application X.

```
------------------------------------------------------------------
// “Server” Application X                  // “Client” Application Y
// TSI configuration file        :         // TSI configuration file:
// The server’s host machine               //
// name is “freeway2” at                   //
// IP address 192.52.107.100               //
main                                       main
{                                          {
    LogName = "server.log";                        LogName = "client.log";
    TraceName = "server.trc";                      TraceName = "client.trc";
    TraceSize = 64000;                             TraceSize = 64000;
    .                                              .
    .                                              .
    .                                              .
}                                           }

// Begin Connection Definition:            // Begin Connection Definition:
TCPserver        // connection-name        TCPclient      // connection-name
{                                          {
    transport = "tcp-socket";                      transport = "tcp-socket";
    asyncIO = "Yes";                               asyncIO = "no";
    .                                              .
    .                                              .
    .                                              .
                                                   Server = "freeway2";
    WellKnownPort = 0x2010;                        WellKnownPort = 0x2010;
}                                          }
------------------------------------------------------------------
```

Figure 3–2: Example Configuration for TCP/IP Socket Transport Interface

Notice the following points regarding the two TSI configuration files in Figure 3–2:

- The “server” application performing the tListen call (application X) needs to specify only the WellKnownPort parameter in the TSI configuration file, not the Server parameter. This is because the “server” TSI software automatically uses the address of the machine on which it is running.

- The “client” application performing the tConnect call (application Y) specifies the Server parameter as the host name (or IP address) of the remote machine as well as the WellKnownPort parameter to which the remote application is bound. If the "client" application Y needs to connect to a similar "server" application running on a different machine, only the Server and WellKnownPort parameters of the "TCPclient" connection definition must be modified.

Using the Figure 3–2 connection definitions, the "server" application X would call tListen using the connection-name "TCPserver":

```
ID = tListen ("TCPserver", funcptr);
```

The "client" application Y would call tConnect using the connection-name "TCPclient":

```
ID = tConnect ("TCPclient", funcptr);
```

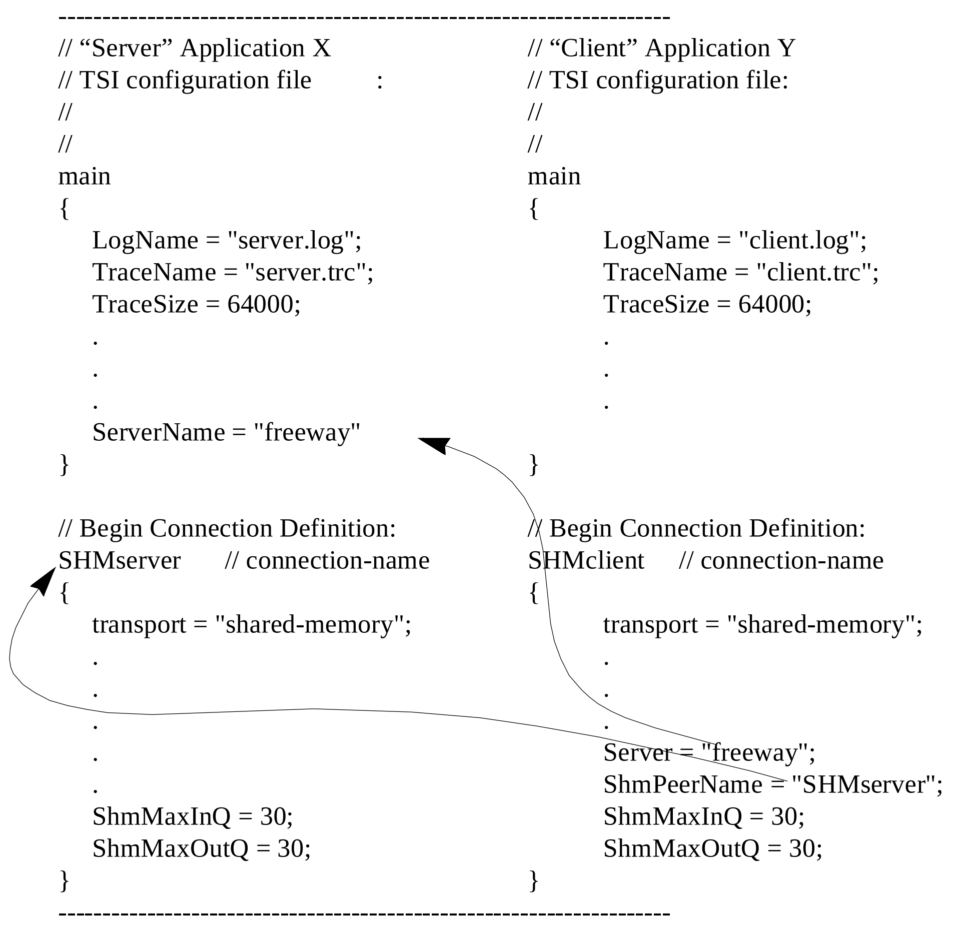
3.4.2 Shared-Memory Transport Interface (VxWorks Only)

To configure a TSI connection to use the shared-memory transport interface, the connection definition's Transport parameter (page 57) must have the value "shared-memory". The shared-memory-specific parameters (see Table 3–4 on page 59) include:

- ShmMaxInQ
- ShmMaxOutQ
- ShmPeerName
- ShmKey

The ShmPeerName parameter along with the ServerName "main" parameter (page 55) specify a "connection point." Assume that we have two TSI applications ("server" and "client") executing as in the previous TCP/IP example; however, shared-memory applications must be running on the same machine under VxWorks. An example would be the two applications labeled *Client3* and *Server* in Figure 1–5 on page 27.

A possible TSI configuration for each application is shown in Figure 3–3. "Server" application X (connection-name "SHMserver") wishes to listen for an incoming connection, while "client" application Y (connection-name "SHMclient") wishes to connect to "server" application X.



```
-------------------------------------------------------------------
// "Server" Application X                  // "Client" Application Y
// TSI configuration file     :            // TSI configuration file:
//                                         //
//                                         //
main                                       main
{                                          {
    LogName = "server.log";                        LogName = "client.log";
    TraceName = "server.trc";                      TraceName = "client.trc";
    TraceSize = 64000;                             TraceSize = 64000;
    .                                              .
    .                                              .
    .                                              .
    ServerName = "freeway"
}                                          }

// Begin Connection Definition:            // Begin Connection Definition:
SHMserver     // connection-name           SHMclient    // connection-name
{                                          {
    transport = "shared-memory";                   transport = "shared-memory";
    .                                              .
    .                                              .
    .                                              .
    .                                              Server = "freeway";
    .                                              ShmPeerName = "SHMserver";
    ShmMaxInQ = 30;                                ShmMaxInQ = 30;
    ShmMaxOutQ = 30;                               ShmMaxOutQ = 30;
}                                          }
-------------------------------------------------------------------
```

Figure 3–3: Example Configuration for Shared-Memory Transport Interface

Notice the following points regarding the two TSI configuration files in Figure 3–3:

- The Server parameter is used to match a peer TSI shared-memory application, and its value must match the value of the peer's ServerName "main" parameter.

- The ShmPeerName parameter is used to match a particular connection definition (connection-name) in the peer's configuration file.

Using the Figure 3–3 connection definitions, the "server" application X would call tListen using the connection-name "SHMserver":

```
ID = tListen ("SHMserver", funcptr);
```

The "client" application Y would call tConnect using the connection-name "SHMclient":

```
ID = tConnect ("SHMclient", funcptr);
```

3.5 Protogate's Freeway Server TSI Configuration

During the software installation procedures described in the *Freeway User Guide*, the default Protogate server TSI configuration file named MuxCfg (see Figure 3–4) was installed in the freeway/boot directory on the boot server. Freeway uses the information in the MuxCfg file to configure the Protogate server-resident TSI software so it can communicate (using the Freeway message multiplexor) with the client TSI software. Refer back to Figure 1–5 on page 27 to see the server TSI software relative to the Freeway message multiplexor.

There is one critical difference in the Protogate server TSI software, namely that it *must* use TSI non-blocking I/O support (that is, the AsyncIO parameter must be set to "yes", as shown in Figure 3–4). Changing the AsyncIO parameter to "no" or omitting it, will prevent the Protogate server TSI software from operating as designed.

Caution

Before modifying the MuxCfg file for the Protogate server TSI software, you should be familiar with the parameter descriptions in Table 3–1 through Table 3–4 (page 54 through page 59). Of particular importance are those parameters that control server resources, such as the TSI buffer pool size (MaxBuffers parameter on page 54) or message size (MaxBufSize parameter on page 55). Improper values could adversely affect server operation.

Also keep the following points in mind if you must modify the MuxCfg file:

- The Transport parameter (page 57) has no default and must be defined.
- Unlike a client TSI configuration file (such as shown in Figure 3–2 on page 61), the Server parameter (page 57) is not required for MuxCfg because the server TSI software automatically uses the address of the machine on which it is running.
- The parameters can appear in any order in the configuration file and can be upper-case, lower-case, or a mixture.
- If a parameter is not explicitly contained in the file, the default is used (defaults are identified in Figure 3–4).

```
//
// source control identifier
// @(#)$Id$
//
//------------------------------------------------------------------------//
//
// Default TSI configuration file for the Protogate server-resident software:
//
//          Date        Initials                      Abstracts
//          12may94     pmt                           Original coding...
//
// Note that the parameters commented as default could have been omitted
//------------------------------------------------------------------------//
main
{
          AsyncIO = "yes";                            // must be specified as yes
          LogLev = 0;                                 // default
          MaxBuffers = 2048;
          MaxConns = 128;                             // default
          MaxBufSize = 1024;                          // default
          StackSize = 10240;                          // default
          TraceName = "/ram1/msgmux.trc";
          TraceSize = 64000;
          TraceLev= 3;
}
//
server1                                               // connection-name
{
          AsyncIO = "yes";                            // must be specified as yes
          LogLev = 0;
          MaxBufSize = 1024;                          // default
          MaxErrors = 10;                             // default
          MaxInQ = 10;                                // default
          MaxOutQ = 10;                               // default
          TCPKeepAlive = "no";                        // default
          TCPNoDelay = "no";                          // default
          Timeout = 63999;
          TraceLev = 3;
          Transport = "tcp-socket";                   // must be specified (no default)
          WellKnownPort = 0x'2010';                   // default
}
```

Figure 3–4: TSI Configuration File (MuxCfg) for Protogate Server-Resident TSI

3.6 Miscellaneous TSI Configuration Details

After you are familiar with the fundamentals of working with the tsicfg preprocessor program, the additional details described in this section might be of interest.

3.6.1 TSI Configuration Error Messages

The TSI configuration preprocessor, tsicfg, can display one of the following error or warning messages:

Invalid type specified — STRING expected   Your parameter value does not match the expected type. *Action:* Review your configuration source code for errors, and try again.

Invalid type specified — BOOLEAN expected   You must use a Boolean value (“YES” or “NO”) for this parameter. *Action:* Review your configuration source code for errors and try again.

Invalid type specified — DEC/HEX/OCT expected   The expected type is decimal, hexadecimal, or octal data format. *Action:* Review your configuration source code for errors and try again.

Invalid type specified — FLOAT expected   The expected type is floating point format. *Action:* Review your configuration source code for errors and try again.

Invalid range specified   The provided parameter value is out of range. *Action:* Review your configuration source code for errors and try again.

Internal error!   This is an internal error in the tsicfg program. *Action:* Rerun tsicfg with your source file. If this error consistently occurs, save your configuration source code and contact Protogate for further assistance.

No “main” — Default is used   This is a warning message that your configuration source code does not have the “main” section specified as the first entry in the configuration source code. *Action:* None if you do not wish to define the “main” section yourself. Otherwise, consider adding the “main” section as the very first section in the text configuration file.

Redefined “main” — Definition ignored This is a warning message that either you defined the “main” section twice or that you did not code the “main” section as the very first entry in your text configuration file. *Action:* Review your text configuration file, correct the problem, and rerun tsicfg.

Invalid transport name You specified a protocol name that is not supported by the TSI. *Action:* Review your text configuration file and this manual for the supported transport protocols. Correct the error and try again.

Undefined parameter name The provided parameter name is not defined. *Action:* Review your configuration source code for errors and try again.

Invalid parameter for specified protocol This parameter does not belong to this protocol. *Action:* Review your configuration source code for errors and try again.

Failed processing file tsicfg failed to complete processing your configuration file. *Action:* Review your configuration source code for errors and try again.

syntax error - cannot backup This is an internal LEX/YACC error. *Action:* Retry the operation.

out of memory This is an internal LEX / YACC error. *Action:* Retry the operation.

yacc stack overflow This is an internal YACC error. *Action:* Retry the operation.

syntax error A syntax error was encountered in your configuration source code. *Action:* Locate and correct the error and try the operation again.

3.6.2 Protogate Definition Language (PDL) Grammar

The following *extended BNF* metalanguage describes the language used to create the TSI text configuration file. The following is a brief description of the symbols used:

1. A string inside of <> is a *non-terminal* symbol. Its definition is located somewhere down the list.
2. Strings inside of {} separated by a vertical bar (|) make up a list of options. You can select one or none of the options.
3. A string inside of [] is an optional string.
4. *Terminal* symbols are those not surrounded by <>.

Context Free Grammar

```
<config_entry> ::= <connection_name> <leftbr> <config_stmt_list> <rightbr>
<connection_name> ::= <identifier>
<config_stmt_list> ::= <config_stmt>{<config_stmt_list>}
<config_stmt> ::= [<parameter_name> <equal><parameter_value>;]
<paramter_name> ::= <identifer>
<parameter_value> ::= {<string> | 0x<hex> | <decimal> | 0<octal>
                       0b<binary> | <float>}
<string> ::= <doublequote><str><doublequote>
<str> ::= [<char>{<str>}]
<decimal> ::= <decdigit>[<decimal>]
<octal> ::= <octdigit>[<octal>]
<binary> ::= <bindigit>[<binary>]
<hex> ::= <hexdigit>[<hex>]
<float> ::= <decimal>.<decimal>
<equal> ::= =
<leftbr> ::= {
<rightbr> ::= }
<doublequote> ::= "
```

<char> ::= 1…255

<decdigit> ::= 0…9

<hexdigit> ::= <decdigit>, a–f

<octdigit> ::= 0…7

<bindigit> ::= 0…1

<alpha> ::= a–z, A–Z, _

<digit> :: <decdigit>

<identifer> ::= <alpha>[<restid>]

<restid> ::= <alphadigit>[<restid>]

<alphadigit> ::= <alpha> | <digit>

Chapter

4 TSI Functions

Note

In this document, the term “Freeway” can mean either a Freeway server or an embedded ICP. For the embedded ICP, also refer to the user guide for your ICP and operating system (for example, the *ICP2432 User Guide for Windows NT*).

4.1 Overview of TSI Functions

This chapter describes the transport subsystem interface (TSI) functions used by your application program to interface to Protogate’s Freeway communications server. The TSI is provided as a C library to be linked with your application program. Section 4.1.3 describes TSI data structures that the application programmer uses with the TSI. Table A–1 on page 137 summarizes the error codes related to the TSI functions.

4.1.1 TSI Error Handling

The tserrno variable is globally available to your application and offers similar services to errno provided in the C language. The TSI uses tserrno to store all its error codes. Your application should check this value on all returns from TSI function calls. Applicable error codes are listed with each function call described in this chapter. Appendix A gives a complete list of TSI error codes.

Note

While developing your TSI application, if a particular error occurs consistently, contact Protogate for further assistance.

4.1.2 Categories of TSI Functions

The TSI library can be categorized as shown in Table 4–1.

Table 4–1: TSI Function Groups

Category	TSI Functions	Usage
Preparation and termination	tInit, tTerm	Initialize and terminate TSI services
Connection handling	tConnect, tListen, tDisconnect	Establish and terminate a connection with a peer TSI application
Data transfer	tRead, tWrite, tPoll, tPost[1], tSyncSelect	Exchange data with a peer TSI application and obtain specific information related to your connection
Buffer management	tBufAlloc, tBufFree	Obtain and release fixed-size TSI buffers

[1] Server-resident application only

4.1.2.1 Summary of TSI Functions

The TSI functions used in writing a client application are presented alphabetically in Section 4.2 through Section 4.13. For easy reference after you are familiar with the details of each function call, Table 4–2 summarizes the TSI function syntax and parameters, listed in the most likely calling order.

Caution

When using non-blocking I/O, there must always be at least one tRead request queued to avoid loss of data or responses from the ICP.

An overview of using the TSI functions is:

- Start up communications (tInit, tConnect, tBufAlloc)
- Send requests and data using tWrite
- Receive responses using tRead
- For blocking I/O, use tSyncSelect to query read availability status for multiple connections
- For non-blocking I/O, handle I/O completions at the software interrupt level in the completion handler established by the tInit or tConnect function, or by periodic use of tPoll to query the I/O completion status.

Shut down communications (tBufFree, tDisconnect, tTerm)

Table 4–2: TSI Functions: Syntax and Parameters (Listed in Typical Call Order)

TSI Function	Parameter(s)	Parameter Usage
int tInit (see page 91)	(char *cCfgFile, char *pUsrCB, int (*fUsrIOCH)(char *pUsrCB));	TSI binary configuration file name Optional I/O complete control block Optional IOCH and parameter
int tConnect (see page 84)	(char *cTransportName, int (*fUsrIOCH) (char *pUsrCB, int iConnID));	TSI connection definition entry Optional I/O completion handler Parameters for IOCH
int tPost (see page 107)	(void);	
int tListen (see page 95)	(char *cTransportName, int (*fUsrIOCH) (char *pUsrCB, int iConnID));	TSI connection definition entry Optional I/O completion handler Parameters for IOCH
int tPoll (see page 100)	(int iConnID, int iPollType, char **ppBuf, int *piBufLen, char *pStat);	Connection ID (tConnect/tListen) Request type Poll-type dependent parameter Size of I/O buffer (bytes) Status or configuration buffer
char *tBufAlloc (see page 80)	(void);	
int tRead (see page 109)	(int iConnID, char **ppBuf, int iBufLen);	Connection ID (tConnect/tListen) Buffer to receive data Maximum bytes to be returned
int tWrite (see page 120)	(int iConnID, char *pBuf, int iBufLen, int iWritePriority);	Connection ID (tConnect/tListen) Source buffer for write Number of bytes to write Normal or expedite write

Table 4–2: TSI Functions: Syntax and Parameters (Listed in Typical Call Order)

TSI Function	Parameter(s)	Parameter Usage
int tSyncSelect (see page 114)	(int iNbrConnID, int connIDArray[], int readStatArray[]);	Number of connection IDs Packed array of connection IDs Array containing read status for IDs
char *tBufFree (see page 82)	(char *pBuf);	Buffer to return to pool
int tDisconnect (see page 88)	(int iConnID, int iDiscType);	Connection ID (tConnect/tListen) Mode (normal or force)
int tTerm (see page 117)	(void);	

4.1.3 TSI Data Structures

This section describes the following TSI data structures that your application can access using the tPoll function.

- TSI system configuration structure
- TSI connection status structure
- TSI connection definition list

4.1.3.1 TSI System Configuration

After initializing the TSI services (tInit), your application can obtain system configuration parameters from TSI by calling tPoll with the TSI_POLL_GET_SYS_CFG option (Section 4.8). The information includes the size of buffers in the TSI data pool and the overhead TSI uses for header storage. This information is useful if your application uses its own buffers instead of TSI buffer management's. Your application receives the system configuration information in the data structure shown in Figure 4–1. Table 4–3 describes the fields.

```
typedef struct                  _TSI_SYS_CFG
{
            int                 iMaxBufSize;
            unsigned short      usMaxConns;
            unsigned short      usMaxBufs;
            unsigned short      usNumActiveConns;
            unsigned short      usNumBufsUsed;
            unsigned short      usNumBufsAvail;
            unsigned short      usOverhead;
            unsigned short      usVersion;
            unsigned short      usRevision;
            BOOLEAN             tfAsyncIO;
            unsigned char       cTraceFileName[TSI_MAX_NAME];
}           TSI_SYS_CFG;
```

Figure 4–1: TSI System Configuration Data Structure

Table 4–3: TSI System Configuration Data Structure Fields

Field	Description
iMaxBufSize	The maximum area available for user data in buffers from the TSI buffer pool.
usMaxConns	The maximum number of connections that can be active simultaneously. This value is configurable using the MaxConns TSI configuration parameter (page 55) in the “main” configuration section.
usMaxBufs	The maximum number of buffers available for your application. This value is configurable using the MaxBuffers TSI configuration parameter (page 54) in the “main” configuration section.
usNumActiveConns	The number of connections currently in use. This number should be less than or equal to usMaxConns.
usNumBufsUsed	The number of buffers currently in use. This number should be less than or equal to usMaxBufs.
usNumBufsAvail	The number of buffers currently available for use. This number plus usNumBufsUsed should be equal to usMaxBufs.
usOverhead	The number of additional bytes that must precede your data area in a buffer that your application requests the TSI to read or to write. Your application needs to be aware of this value only if it does not wish to use the TSI buffer management scheme. This value, usOverhead + iMaxBufSize, must be equal to the MaxBufSize TSI configuration parameter (page 55).
usVersion	The current version of the TSI. You must know this number when you call Protogate’s customer support.
usRevision	The current revision of the TSI.
tfAsyncIO	A BOOLEAN value indicating whether or not the TSI was configured to use non-blocking I/O (zero specifies blocking I/O).
cTraceFileName	The name of the file the TSI uses to trace the data that flows through the layer.

4.1.3.2 TSI Connection Status

After establishing a connection, your application can obtain connection-related information by calling tPoll with the TSI_POLL_GET_CONN_STATUS option (Section 4.8). This information includes the negotiated buffer size (usMaxConnBufSize), which is the actual data size available for this connection's user data. Your application receives the connection status information in the TSI_CONN_STAT data structure shown in Figure 4–2. Table 4–4 describes the fields.

Note

Refer to the *Freeway Data Link Interface Reference Guide* for an example program to request DLI session status. Requesting TSI connection status is similar.

```
typedef struct          _TSI_CONN_STAT
{
            short       iQReadSize;
            short       iQWriteSize;
            short       iQNumRead;
            short       iQNumWrite;
            short       iQNumReadDone;
            short       iQNumWriteDone;
            short       iConnStatus;
            short       iNumErrors;
            short       iMaxErrors;
            short       usMaxConnBufSize
            short       iNumCalls;
            BOOLEAN     tfOverflow
}           TSI_CONN_STAT;
```

Figure 4–2: TSI Connection Status Data Structure

4.1.3.3 TSI Connection Definition List

The connection definition list is returned to your application if it invokes tPoll with the TSI_POLL_GET_CFG_LIST option. The configuration list is returned through the ppBuf argument, and the number of the connection definitions is given by the piBufLen argument. Refer to tPoll, Section 4.8, for information on this list of connection definitions.

Table 4–4: TSI Connection Status Data Structure Fields

Field	Description
iQReadSize	The size of the input queue. This value can be configured using the MaxInQ TSI configuration parameter (page 56) in the connection definition section.
iQWriteSize	The size of the output queue. This value can be configured using the MaxOutQ TSI configuration parameter (page 56) in the connection definition section.
iQNumRead	The current number of read requests in the read queue. This value is less than or equal to iQReadSize.
iQNumWrite	The current number of write requests in the write queue. This value is less than or equal to iQWriteSize.
iQNumReadDone	The current number of read requests that are complete or timed out in the input queue. This value is less than or equal to iQReadSize.
iQNumWriteDone	The current number of write requests that are complete or timed out in the output queue. This value is less than or equal to iQWriteSize.
iConnStatus	The current status of the connection. The valid connection status values are: TSI_STATE_NOT_CONNECTED The current TSI connection is being ended. TSI_STATE_NOT_IN_USE The current TSI connection is not available for use because it failed to establish a connection or has finished disconnecting. A cleanup is underway. TSI_STATE_NOT_CONNECTED The TSI is still trying to establish a connection with Freeway or the peer TSI application. TSI_STATE_CONNECTED The TSI successfully established a connection with Freeway or the peer TSI application. Your application can now read or write to this connection.
iNumErrors	The current number of I/O errors that has occurred for this connection since the connection was established. Your application can monitor this value to check the health of an active connection.
iMaxErrors	The maximum number of errors this connection can tolerate before it rejects I/O requests from your application. This value can be defined using the MaxErrors TSI configuration parameter (page 56) in the connection definition section.
usMaxConnBufSize	The maximum buffer area available to the user for the transfer of data. The value can vary between connections, and the value is valid only after the connection is established. This size does not include any TSI overhead requirements.
iNumCalls	Reserved
tfOverflow	Reserved

4.2 tBufAlloc

The tBufAlloc function allocates a ***fixed-size buffer*** that is maintained by TSI services. Your application can use these buffers to exchange data with peer TSI applications or for any other purpose. To avoid a buffer depletion problem, your application must return all unused buffers to TSI using tBufFree (Section 4.3).

Though you are not required to use tBufAlloc, you should consider using it for all TSI I/O operations for the following reasons:

- The TSI buffer services account for buffer overhead requirements.
- The TSI allocates all buffers up front, resulting in better real-time performance than the normal C malloc and free functions
- The number of TSI buffers is configurable for operating environments with limited system resources (MaxBuffers, page 54)

To enhance performance, the TSI implementation uses the memory area just before the data area to store its headers. Due to this implementation, if your application does not wish to use the TSI buffer management, it must allocate sufficient memory for not only its data but also the TSI headers. To obtain the amount of memory required for the TSI overhead, your application can invoke tPoll with the TSI_POLL_GET_SYS_CFG option (usOverhead field on page 77). Your application can also use tPoll with the TSI_POLL_GET_SYS_CFG option to obtain the status of buffer management (see Table 4–3 on page 77). Refer to Section 2.3 on page 31 for more information on buffer management issues.

Synopsis

```
char    *tBufAlloc ( void );
```

Parameters

None

Returns

If the tBufAlloc function completes successfully, it returns an address that points to the buffer area to be used by your application. Note that the address returned is the address of the data area of the TSI buffer; this address must be used by any further manipulations on the buffer such as tRead, tWrite, tPoll, and tBufFree. Otherwise it returns NULL, and tserrno contains one of the following error codes (listed alphabetically):

TSI_BUFA_ERR_NEVER_INIT The TSI was never initialized; that is, tInit was never called.

Action: Review your application and try again.

TSI_BUFA_ERR_NO_BUFS The TSI exhausted buffers. Possible problems are: (1) your application did not release buffers after use, or (2) your application is configured for non-blocking I/O, and it has too many outstanding connections with a large queue size (for example, MaxBuffers = 1000, 10 outstanding connections, and each has 100 entries in the queue).

Action: Severe error; consider increasing the number of buffers in the TSI configuration file (MaxBuffers on page 54). Review your application and make sure it releases unused buffers to the TSI.

TSI_BUFA_ERR_SEVERE_ERR The TSI internal call to QAdd failed.

Action: If this error occurs consistently, contact Protogate for assistance.

For additional error codes, refer to Appendix A.

4.3 tBufFree

Your application must use tBufFree to release the TSI buffers that it allocated using tBufAlloc. It must also release any read buffer that TSI allocated in tRead (Section 4.10). The buffer is returned to the TSI internal free buffer pool. It is the responsibility of your application to prevent buffer depletion by releasing the unused TSI buffers.

Synopsis

```
char *tBufFree (
        char        *pBuf );                    /* Buffer to return to buffer pool                      */
```

Parameters

char *pBuf   This field contains the data address of the TSI buffer that was returned by tBufAlloc (or that was allocated by tRead).

Returns

If the tBufFree function completes successfully, it returns the value of pBuf. Otherwise it returns NULL, and tserrno contains one of the following error codes (listed alphabetically):

TSI_BUFF_ERR_INVALID_BUF   The buffer pointer provided to tBufFree is either NULL or –1.

Action: Review your application and try again.

TSI_BUFF_ERR_NEVER_INIT   The TSI was never initialized; that is, tInit is never called.

Action: Review your program and try again.

TSI_BUFF_ERR_NOT_ALLOCATED   The TSI invoked tBufFree to free a buffer and the buffer is not allocated.

Action: Make sure that your application frees only a TSI buffer and that it frees it only once. Review your application and try again.

TSI_BUFF_ERR_SEVERE_ERR The TSI invoked tBufFree to free a buffer and either the buffer pool is empty or the buffer does not belong to the TSI.

Action: Review your application and try again.

For additional error codes, refer to Appendix A.

4.4 tConnect

The tConnect function establishes a connection to a peer TSI application. The connection parameters are provided through the TSI configuration file. The TSI searches its configuration file for a match of the connection name provided as the first parameter of this function call. Once found, the TSI loads the connection parameters into memory and begins to establish a connection with the peer TSI application. The destination is part of the TSI connection parameters.

For non-blocking I/O, tConnect returns as soon as it detects a potential blocking condition. Your application is not blocked while the TSI attempts to complete the connection request. When the connection is made, the TSI calls one or both of the IOCH functions provided through the tInit and tConnect calls. If no IOCH functions are provided, none is called. Either tInit or tConnect can be used to supply the IOCH; however, the tConnect IOCH requires a connection ID, and is called for that particular connection only.

Your application uses the iConnID returned from this call for all other TSI calls (tRead, tWrite, and so on). If this connection is configured for non-blocking I/O, you must ensure that the connection is fully established before you call the tRead, tWrite, or tDisconnect functions.

Note

If you need to request connection status to obtain the maximum buffer size (which may change due to negotiation procedures during tConnect), your application should wait until after a successful tConnect before calling tPoll with the TSI_POLL_GET_SESS_STATUS option (Section 4.1.3.2 on page 78). See Section 2.3.2.3 on page 39 for details of the negotiation process.

If your application did not previously call tInit, tConnect makes the tInit call. The default values are used.

Synopsis

```
int tConnect (
        char        *cTransportName,        /* TSI connection definition entry name             */
        int         (*fUsrIOCH) (char *pUsrCB, int iConnID) );
                                            /* Optional IOCH for specific connection            */
```

Parameters

char *cTransportName   A string of characters that specifies the name of the desired connection definition entry in the TSI binary configuration file. The associated configuration entry defines the characteristics of the connection you are about to make.

int (*fUsrIOCH) (char *pUsrCB, int iConnID)   This field should contain the address of the I/O completion handler (IOCH) that the TSI invokes immediately after it services an I/O condition *for this connection*. The IOCH is invoked by the TSI only if this connection is configured for non-blocking I/O. You must write the IOCH yourself. When an I/O condition occurs for this connection, the TSI invokes this IOCH with the pUsrCB value (that you provided through tInit) and the connection ID returned by this call. You can provide a different fUsrIOCH for each connection ID or use the same fUsrIOCH for all IDs. If your application does not wish the TSI to invoke your IOCH, this parameter should be NULL.

Returns

The tConnect function returns a connection ID or ERROR. The connection ID can have a value from zero to the maximum number of connections (MaxConns parameter, page 55) minus one. If the connection definition for the function parameter cTransportName specifies blocking I/O, a returned connection ID indicates that the connection has completed successfully. If the connection definition specifies non-blocking I/O and a connection ID is returned, the application must examine tserrno and invoke tPoll with the TSI_POLL_GET_CONN_STATUS option to determine when the connection has successfully completed. If the connection has not completed upon return, tserrno is set to TSI_EWOULDBLOCK.

If the tConnect function returns ERROR, the connection failed, and your application must check tserrno which contains one of the following error codes (listed alphabetically):

TSI_CONN_ERR_CLOSE_FAILED The TSI failed to close its transport-dependent connection when it failed to complete the connection request.

Action: If this error occurs consistently, contact Protogate for assistance.

TSI_CONN_ERR_CONN_INIT_FAILED TSI failed to initialize a connection entry for your application.

Action: Check the TSI connection configuration.

TSI_CONN_ERR_INVALID_PROT The transport parameter in the connection definition of the TSI configuration file is not valid.

Action: Check whether your configuration program, tsicfg, is at the same level as your library.

TSI_CONN_ERR_INVALID_STATE The TSI encountered an invalid state in its state processing machine.

Action: If this error occurs consistently, contact Protogate for assistance.

TSI_CONN_ERR_OPEN_FAILED The TSI failed to establish a transport-dependent connection to the peer TSI application.

Action: Terminate your application and review your TSI configuration file.

TSI_CONN_ERR_QADD_FAILED The TSI failed to insert its internal request in the internal I/O queue.

Action: Severe error; terminate your application and try again.

TSI_CONN_ERR_RETRY_EXCEEDED The TSI retry count exceeded its limit.

Action: Terminate your application and review your configuration parameter for this connection.

TSI_CONN_ERR_SOCK_ALLOC_FAILED The TSI failed to allocate the resources necessary to support the connection.

Action: Review your connection configuration parameters. You can also review your error log for additional information.

TSI_CONN_ERR_TINIT_FAILED The TSI failed to initialize its services. This error occurs only if your application does not explicitly call the tInit function.

Action: Check your binary configuration file. If the default binary configuration file (tsicfg.bin) was used by the TSI, verify its existence.

TSI_EWOULDBLOCK The requested action could not be completed immediately. The TSI would have blocked this operation if your connection was using blocking I/O.

Action: Use tPoll to check whether your request completed. You can program your application to be notified by one of the IOCH routines that you provided when you invoked the tInit, tConnect, or tListen function. Refer to Appendix B for information on managing TSI applications using non-blocking I/O.

For additional error codes, refer to Appendix A.

4.5 tDisconnect

The tDisconnect function terminates an active connection between your application and the peer TSI application.

If this connection is configured for non-blocking I/O, the application must examine tserrno and invoke tPoll with the TSI_POLL_GET_CONN_STATUS option to determine when the connection has been successfully disconnected.

It is suggested that your application perform I/O cleanup and then issue a *Normal* tDisconnect request to the TSI. Issuing tTerm while active connections exist should be the last option.

Synopsis

```
int tDisconnect (
        int        iConnID,             /* Connection ID from tConnect/tListen          */
        int        iDiscType );         /* Disconnect mode (normal or force)             */
```

Parameters

int iConnID   The connection ID is provided by the TSI through the tConnect or tListen function call. This ID uniquely identifies a TSI connection between your application and the peer TSI application.

int iDiscType   This parameter allows your application to request the TSI to terminate an active connection in either of the following close modes (whether the connection is using blocking or non-blocking I/O):

TSI_DISC_FORCE   When your application issues a *Force* disconnect for an active connection, the TSI empties the I/O queues and proceeds with the disconnect process without considering the status of the I/O queues. Note that when your application issues a tTerm while active connections exist, the TSI itself issues a *Force* disconnect request before it frees the TSI service structure.

TSI_DISC_NORMAL The TSI rejects a *Normal* disconnect request if its internal input and output queues contain outstanding I/O requests. Your application should consider checking the I/O queue prior to calling tDisconnect with this mode. You can obtain the status of I/O queues using the tPoll call.

Returns

If the tDisconnect function completes successfully, it returns OK. Otherwise, it returns ERROR, and tserrno contains one of the following error codes (listed alphabetically):

TSI_DISC_ERR_CLOSE_FAILED The TSI failed to close the listener.

Action: Severe error; if this error occurs consistently, contact Protogate for assistance.

TSI_DISC_ERR_DISC_FAILED The disconnect failed and the connection has been returned to the connected state.

Action: If this error occurs consistently, contact Protogate for assistance.

TSI_DISC_ERR_INVALID_ID The provided connection ID is invalid.

Action: Review your program's logic. If this error occurs consistently, contact Protogate for assistance.

TSI_DISC_ERR_INVALID_STATE The TSI encountered an invalid state in its state processing machine.

Action: Review the TSI trace and error logs. If this error occurs consistently, contact Protogate for assistance.

TSI_DISC_ERR_INVALID_TYPE Invalid disconnect type requested (use TSI_DISC_NORMAL or TSI_DISC_FORCE).

Action: Review your program's logic.

TSI_DISC_ERR_NEVER_INIT The TSI was never initialized. You must invoke tInit before using this function.

Action: Correct your program's logic and try again.

TSI_DISC_ERR_Q_NOT_EMPTY Your application requested a normal disconnect on a given connection, and the internal I/O queues for that connection are not empty.

Action: Review your program's logic, and try again.

TSI_DISC_ERR_QADD_FAILED The TSI failed to add the disconnect packet to its internal queue.

Action: If this error occurs consistently, contact Protogate for assistance.

TSI_DISC_ERR_SEVERE_ERROR The TSI failed to access its internal I/O queues.

Action: Severe error; terminate your application and try again.

TSI_EWOULDBLOCK The requested action could not be completed immediately. The TSI would have blocked this operation if your connection was using blocking I/O.

Action: Use tPoll to check whether your request completed. You can program your application to be notified by one of the IOCH routines that you provided when you invoked the tInit, tConnect, or tListen function. Refer to Appendix B for information on managing TSI applications using non-blocking I/O.

For additional error codes, refer to Appendix A.

4.6 tInit

The tInit function is usually the first TSI function your application calls. It initializes the TSI services based upon the “main” definition in the TSI binary configuration file (described in Section 3.3.1 on page 54) provided through the first parameter, cCfgFile. This function call is optional; if your application does not explicitly call tInit, the tListen or tConnect function calls it implicitly, in which case the default values are used.

Even though the TSI does not require your application to call tInit prior to its being used, it is suggested that your application always call tInit and tTerm. If tTerm is not called before your application ends, connection and system resources might not be released properly.

Synopsis

```
int tInit (
      char      *cCfgFile,              /* TSI binary configuration file name          */
      char      *pUsrCB,                /* I/O complete control block                  */
      int       (*fUsrIOCH) (char *pUsrCB)); /* Optional IOCH                          */
```

Parameters

char *cCfgFile The binary configuration file that contains all TSI run-time parameters. This file results from execution of the TSI configuration program, tsicfg, upon a TSI text configuration file. If this parameter is a NULL pointer, the default file, tsicfg.bin, is used. Whether or not you supply the configuration file name, the binary configuration file must exist for the TSI to operate. An optional on-line configuration method is described in Section 3.2.4 on page 52.

char *pUsrCB This field should contain the address of the data area that is accessible by your supplied I/O completion handler (IOCH), fUsrIOCH, below. When the TSI is configured for non-blocking I/O, it invokes your supplied IOCH function after it services an I/O condition. The TSI passes this field as the first parameter to your supplied fUsrIOCH function.

int (*fUsrIOCH) (char *pUsrCB) This field should contain the address of the I/O completion handler (IOCH) that TSI invokes immediately after it processes all active connections. You must write the IOCH yourself. The IOCH is called only if the TSI is configured for non-blocking I/O. If your application does not wish the TSI to invoke your IOCH, this parameter should be NULL. Either tInit or tConnect can be used to supply the IOCH; however, the tConnect IOCH requires a connection ID, and is called for that particular connection only.

Returns

If tInit completes successfully, it returns OK. Otherwise it returns ERROR, and tserrno contains one of the following error codes (listed alphabetically):

TSI_INIT_ERR_ACT_ADD_REM_FAILED The TSI failed to add its internal active connection queue.

Action: Check your system resources. Refer to Section 2.4 on page 44 to calculate system resources required by the TSI.

TSI_INIT_ERR_ACT_QINIT_FAILED The TSI failed to initialize its internal active connection queue.

Action: Check your system resources. Refer to Section 2.4 on page 44 to calculate system resources required by the TSI.

TSI_INIT_ERR_ALREADY_INIT Your application already issued tInit.

Action: Review your program logic and try again.

TSI_INIT_ERR_BUF_ADD_REM_FAILED The TSI failed to set up its buffer pool queue.

Action: Severe error; terminate your application and try again.

TSI_INIT_ERR_BUF_QINIT_FAILED The TSI failed to initialize its buffer pool queue.

Action: Check your system resources. Refer to Section 2.4 on page 44 to calculate system resources required by the TSI.

TSI_INIT_ERR_CFG_LOAD_FAILED The TSI failed to load the system configuration parameters from the provided binary configuration file.

Action: Check the binary configuration file used by the TSI. If your application calls tInit directly, make sure the binary configuration file containing the configuration your application provides exists. If your application does not call tInit directly, the TSI calls this function for you; make sure the default configuration file (tsicfg.bin) exists. Verify the binary file name includes a '.' character. If a text file is supplied (as discussed in Section 3.2.4 on page 52), verify the file name and its existence in the current directory (where the application program is executing). Review your program logic and try again.

TSI_INIT_ERR_LOG_INIT_FAILED The TSI failed to initialize its internal logging and tracing facility.

Action: Check your logging-related and tracing-related parameters in the currently used TSI configuration file.

TSI_INIT_ERR_NO_MEM The TSI memory initialization failed.

Action: Make sure your operating environment provides sufficient memory resources for your application.

TSI_INIT_ERR_NO_RESOURCE No memory resource is available for the TSI to start its services.

Action: Make sure your operating environment provides sufficient memory resources for your application.

TSI_INIT_ERR_NO_TRACE_BUFFER No memory is available for the TSI trace buffer.

Action: Check your system resources. Refer to Section 2.4 on page 44 to calculate system resources required by the TSI.

TSI_INIT_ERR_SETRLIMIT_FAILED The TSI call to setrlimit failed. SUNOS, AIX, and SOLARIS only.

Action Check your system resources.

TSI_INIT_ERR_TASK_VAR_FAILED The TSI failed to establish its internal task variables (VxWorks only).

Action: If this error occurs consistently, contact Protogate for assistance.

TSI_INIT_ERR_TSICB_ALLOC_FAILED The TSI failed to allocate memory for its internal system control block.

Action: Check your system resources. Refer to Section 2.4 on page 44 to calculate system resources required by the TSI. If this error occurs consistently, contact Protogate for assistance.

For additional error codes, refer to Appendix A.

4.7 tListen

The tListen function waits for a connection request from a peer TSI application. It is similar to the tConnect function, except that the TSI waits for the peer TSI application to make a connection request (via tConnect). As with tConnect, the TSI searches the configuration file for a match of the connection name provided as the first parameter of this function call, then loads the parameters into memory. Once a connection request is received and validated, a connection is then made available to the application. Your application must issue another tListen call if it wishes to receive any additional connection requests.

For non-blocking I/O, tListen returns immediately as soon as it detects a potential blocking condition. Your application is not blocked while the TSI is waiting for a connection request. When the connection is made, the TSI calls one or both of the IOCH functions provided through the tInit and tListen calls. If no IOCH functions are provided, none is called. When using non-blocking I/O, the application can have up to TSI_MAX_LISTEN (defined in tsidefs.h file) outstanding “listens” for each connection definition in the application’s TSI configuration file. For example, at startup the application can call tListen multiple times to have several “listening connections” waiting for incoming connection requests.

Your application uses the iConnID returned from this call for all other TSI calls (tRead, tWrite, and so on). If this connection is configured for non-blocking I/O, you must ensure that the connection is fully established before you call the tRead, tWrite, or tDisconnect functions.

Synopsis

```
int tListen (
        char      *cTransportName,      /* Transport name in TSI config file              */
        int       (*fUsrIOCH) (char *pUsrCB, int iConnID) );
                                        /* Optional IOCH for specific connection          */
```

Parameters

char *cTransportName A string of characters that specifies the name of the desired transport definition entry in the TSI binary configuration file. The associated configuration entry defines the characteristics of the connection to be completed when a connection request arrives.

int (*fUsrIOCH) (char *pUsrCB, int iConnID) This field should contain the address of the I/O completion handler (IOCH) that TSI invokes immediately after it services an I/O condition *for this connection*. The TSI invokes the IOCH only if this connection is configured for non-blocking I/O. You must write the IOCH yourself. When an I/O condition occurs for this connection, the TSI invokes passes the pUsrCB value (that you provided with tInit) and the connection ID returned by this call. You can provide a different fUsrIOCH for each connection or use the same fUsrIOCH for all IDs. If your application does not wish the TSI to invoke your IOCH, this parameter should be NULL. The tInit function (Section 4.6) can also be used to define a general-purpose IOCH that is not restricted to one particular connection.

Returns

The tListen function returns a non-negative connection ID or ERROR. The connection ID can have a value from zero to the maximum number of connections (MaxConns parameter, page 55) minus one. If the connection definition for the function parameter cTransportName specifies blocking I/O, a returned connection ID indicates that the connection has completed successfully. If the connection definition specifies non-blocking I/O and a connection ID is returned, the application must examine tserrno and invoke tPoll with the TSI_POLL_GET_CONN_STATUS option to determine when the connection has successfully completed. If the connection has not completed upon return, tserrno is set to TSI_EWOULDBLOCK.

If this function returns ERROR, the connection failed and tserrno contains one of the following error codes (listed alphabetically):

TSI_EWOULDBLOCK The requested action could not be completed immediately. The TSI would have blocked this operation if your connection was using blocking I/O.

Action: Use tPoll to check whether your request completed. You can program your application to be notified by one of the IOCH routines that you provided when you invoked the tInit, tConnect, or tListen function. Refer to Appendix B for information on managing TSI applications using non-blocking I/O.

TSI_LSTN_ERR_CLOSE_FAILED The TSI failed to close its transport-dependent connection when it failed to complete the connection request.

Action: If this error occurs consistently, contact Protogate for assistance.

TSI_LSTN_ERR_CONN_INIT_FAILED The TSI failed to initialize a connection for the listener.

Action: Check whether your connection name (first argument of tListen) is properly defined in the TSI configuration. Check your error log for additional error codes.

TSI_LSTN_ERR_INVALID_PROT The value of the transport parameter in your configuration file is invalid.

Action: Check whether configuration program, tsicfg, is at the same level as your library.

TSI_LSTN_ERR_INVALID_STATE The TSI encountered an invalid state in its state processing machine.

Action: If this error occurs consistently, contact Protogate for assistance.

TSI_LSTN_ERR_LSTN_FAILED The TSI failed to establish a transport-dependent connection to the peer TSI application.

Action: Review your TSI configuration file.

TSI_LSTN_ERR_NO_LISTENERS The TSI failed to remove a connection from the internal listening queue.

Action: If this error occurs consistently, contact Protogate for assistance.

TSI_LSTN_ERR_NOT_SERVER A non-listener TSI connection tried to execute a transport-dependent listen.

Action: If this error occurs consistently, contact Protogate for assistance.

TSI_LSTN_ERR_QADD_FAILED The TSI failed to add a connection entry into its internal queue.

Action: Severe error; if this error occurs consistently, contact Protogate for assistance.

TSI_LSTN_ERR_QFULL The internal listening queue for this connection definition (cTransportName) is full and is not able to accept more listening requests.

Action: Your application can post another listening request later, when one of the queued listeners completes a connection.

TSI_LSTN_ERR_QINIT_FAILED The TSI failed to allocate an internal listening queue for the listener.

Action: Severe error; terminate your application and try again.

TSI_LSTN_ERR_SETOPT_FAILED This error is specific to the TCP/IP socket interface. The TSI failed in setting socket options on a newly accepted socket.

Action: If this error occurs consistently, contact Protogate for assistance.

TSI_LSTN_ERR_SOCK_ALLOC_FAILED The TSI failed to allocate a TCP/IP socket for the listener.

Action: Review the TSI log for additional information.

TSI_LSTN_ERR_TINIT_FAILED The TSI failed to initialize its services. This error can occur only if your application did not explicitly call the tInit function.

Action: Check your binary configuration file. If the default binary configuration file (tsicfg.bin) was used by the TSI, verify its existence.

For additional error codes, refer to Appendix A.

4.8 tPoll

The tPoll function queries information related to I/O operations, connection status, or system configuration status. The poll type parameter specifies the type of query; the most common uses are to acquire the status of a TSI connection and to poll for I/O completions (only for those connections using non-blocking I/O). Your application can call tPoll as often as necessary.

Synopsis

```
int tPoll (
        int     iConnID,        /* Connection ID from tConnect/tListen     */
        int     iPollType,      /* Request type                            */
        char    **ppBuf,        /* Poll-type dependent parameter           */
        int     *piBufLen,      /* Size of I/O buffer in bytes             */
        char    *pStat );       /* Status or configuration buffer          */
```

Parameters

int iConnID The connection ID (returned from a tConnect or tListen function) that uniquely identifies an active connection serviced by the TSI. If a connection ID is not relevant to the iPollType parameter specified (TSI_POLL_GET_SYS_CFG, TSI_POLL_GET_CFG_LIST, TSI_POLL_TRACE_OFF, TSI_POLL_TRACE_ON, TSI_POLL_TRACE_WRITE), this parameter should be set to zero.

int iPollType This parameter specifies the type of poll request to the TSI. Valid poll types are:

TSI_POLL_GET_CFG_LIST Request the TSI to get a list of all TSI connection definition names defined in the application's TSI configuration file. The list is returned through the ppBuf parameter in NULL-terminated string lists (see Section 4.1.3.3 on page 78). The number of connection definition names in the list is returned in the piBufLen parameter. The list does not contain the definition of the "main" section.

TSI_POLL_GET_CONN_STATUS Request the TSI to get the current connection status of the connection ID, iConnID, given. The connection status is returned through the TSI_CONN_STAT structure (see Section 4.1.3.2 on page 78). The pointer to the TSI_CONN_STAT structure must be provided through the pStat parameter.

TSI_POLL_GET_SYS_CFG Request the TSI to get the TSI system configuration. The system configuration is returned through the TSI_SYS_CFG structure (see Section 4.1.3.1 on page 76). The pointer to the TSI_SYS_CFG structure must be provided through the pStat parameter.

TSI_POLL_READ_CANCEL Request the TSI to remove a read request from this connection's (iConnID parameter) input queue regardless of the completion status of the read request. If the content of the ppBuf (*ppBuf) parameter is NULL, the TSI removes the first entry in the input queue regardless of its completion status. If the content of ppBuf is not NULL, the TSI searches through its input queue for a matching address pointer. If it finds a match, it removes that request regardless of its completion status.

TSI_POLL_READ_COMPLETE Request the TSI to remove the first read request from this connection's input queue if it is either complete, timed-out, or a read error occurred. The address and length of the buffer are returned through the ppBuf and piBufLen parameters. This request removes the first entry in the input queue only if the request is marked “read complete,” “read timed-out,” or “read error.” In all cases, the application is responsible for freeing the returned buffer.

TSI_POLL_TRACE_OFF Request the TSI to disable tracing services. See Appendix C.

TSI_POLL_TRACE_ON Request the TSI to enable tracing services. See Appendix C.

TSI_POLL_TRACE_STORE Use this poll type to write your own information into the TSI trace buffer. Use the pStat parameter to indicate the area of memory to be copied to the trace buffer and the piBufLen parameter to indicate the length of the area to be copied. The length of your trace area must be less than or equal to the size of the trace buffer (TraceSize on page 55). Otherwise, your trace area will be truncated when copied into the TSI trace buffer.

TSI_POLL_TRACE_WRITE Request the TSI to write the contents of the trace buffer to the trace file.

TSI_POLL_WRITE_CANCEL Request the TSI to remove a write request from this connection's (iConnID parameter) output queue regardless of the completion status of the write request. If the content of the ppBuf (*ppBuf) parameter is NULL, the TSI removes the first entry in the output queue regardless of its completion status. If the content of ppBuf is not NULL, the TSI searches through the output queue for a matching address pointer. If it finds a match, it removes that request regardless of its completion status.

TSI_POLL_WRITE_COMPLETE Request the TSI to remove the first write request from this connection's output queue if it is either complete or timed-out. The address and length of the buffer are returned through the ppBuf and piBufLen parameters. This request removes the first entry in the output queue only if the request is marked "write complete," "write timed-out," or "write error." In any case, the application is responsible for freeing the returned buffer.

char **ppBuf This parameter specifies an address of a pointer to a buffer area. This parameter must not be NULL when the poll type is TSI_POLL_READ_COMPLETE, TSI_POLL_READ_CANCEL, TSI_POLL_WRITE_COMPLETE, or TSI_POLL_WRITE_CANCEL.

int *piBufLen This field is used to return the length of the buffer pointed to by the content of the ppBuf parameter (for I/O completes and cancels) or the number of entries in the configuration list for the TSI_POLL_GET_CFG_LIST option.

char *pStat This field can be a pointer to a connection status or a system configuration structure. If the request is for the connection status, this field is the address of the user-supplied TSI_CONN_STAT structure (Section 4.1.3.2 on page 78). Otherwise, it points to the user-supplied TSI_SYS_CFG structure (Section 4.1.3.1 on page 76).

Returns

If the tPoll function completes successfully, it returns OK. Otherwise it returns ERROR, and tserrno contains one of the following error codes (listed alphabetically):

TSI_POLL_ERR_BAD_PTR The ppBuf parameter supplied to tPoll was a NULL pointer. This error pertains only to the TSI_POLL_READ_COMPLETE, TSI_POLL_WRITE_COMPLETE, TSI_POLL_READ_CANCEL, and TSI_POLL_WRITE_ CANCEL options.

Action: Modify your application to supply the address of a pointer.

TSI_POLL_ERR_BUF_NOT_FOUND The TSI could not find the buffer pointed to by *ppBuf in its I/O queues. This error pertains only to the TSI_POLL_READ_ CANCEL and TSI_POLL_WRITE_CANCEL options.

Action: Severe error; if this error occurs consistently, contact Protogate for assistance.

TSI_POLL_ERR_GETLIST_FAILED The TSI failed to get a list of connection definition entries from the TSI configuration file.

Action: Verify the configuration file.

TSI_POLL_ERR_INTERNAL An internal TSI error occurred.

Action: Note the events leading to the error, obtain the TSI log, and contact Protogate for assistance.

TSI_POLL_ERR_INVALID_ID Your connection is no longer valid.

Action: Review your error log, terminate your application, and try again.

TSI_POLL_ERR_INVALID_IOQ The TSI could not access the connection's I/O queues. This error pertains only to the TSI_POLL_READ_COMPLETE, TSI_POLL_WRITE_COMPLETE, TSI_POLL_READ_CANCEL, and TSI_POLL_WRITE_ CANCEL options.

Action: Severe error; if this error occurs consistently, contact Protogate for assistance.

TSI_POLL_ERR_INVALID_REQ_TYPE The iPollType parameter did not contain a valid value.

Action: Review your application to ensure that a valid poll option is used.

TSI_POLL_ERR_NEVER_INIT The TSI was never initialized.

Action: Revise your program and try again.

TSI_POLL_ERR_OVERFLOW The buffer returned in the ppBuf parameter was too small to handle the incoming TSI packet. The overflow portion of the incoming packet was discarded. Note that this buffer must still be freed by the application. This error pertains only to the TSI_POLL_READ_COMPLETE option.

Action: Increase the buffer size supplied to tRead up to the maximum defined for the connection.

TSI_POLL_ERR_QEMPTY The pertinent I/O queue is empty. This error pertains only to the TSI_POLL_READ_COMPLETE, TSI_POLL_WRITE_COMPLETE, TSI_POLL_READ_CANCEL, and TSI_POLL_WRITE_CANCEL options.

Action: This can be a normal condition if the application is attempting to empty the corresponding queue.

TSI_POLL_ERR_QREM_FAILED The TSI failed to remove a buffer from a non-empty I/O queue. This error pertains only to the non-specific (no buffer pointer was supplied) TSI_POLL_READ_CANCEL and TSI_POLL_WRITE_CANCEL options.

Action: Severe error; if this error occurs consistently, contact Protogate for assistance.

TSI_POLL_ERR_READ_NOT_COMPLETE The head entry in the TSI read queue is still pending (but has not timed out or incurred an error in processing). This error code pertains only to the TSI_POLL_READ_COMPLETE option.

Action: This is a normal condition when polling for I/O completions.

TSI_POLL_ERR_READ_TIMEOUT The head entry in the TSI read queue has timed out. Note that the buffer returned in the ppBuf parameter must still be freed by the application. This error code pertains only to the TSI_POLL_READ_ COMPLETE option.

Action: Consider raising the timeout parameter value in the connection definition of the TSI configuration file.

TSI_POLL_ERR_SOCK_CLOSED A fatal error occurred on this buffer's attempted I/O operation. The connection between the client application and Freeway has been closed.

Action: Cancel all outstanding read and write requests, and free the buffers. Close the connection. After a successful close, another connection can be attempted. Examine the error logs for details of the failure.

TSI_POLL_ERR_UNBIND The connection between the client application and Freeway has been closed. The system has performed “Unbind” processing. The connection was closed either because of a “Force Unbind” received from the peer entity (Freeway or client), or because of a failure with the I/O connection.

Action: Cancel all outstanding read/write requests and free the buffers. Close the connection. After a successful close, another connection can be attempted. Examine the message logs on the peer system (if the error occurred in the client application, examine the Freeway log).

TSI_POLL_ERR_WRITE_NOT_COMPLETE The head entry in the TSI write queue is still pending (but has not timed out or incurred an error in processing). This error code pertains only to the TSI_POLL_WRITE_COMPLETE option.

Action: This is a normal condition when polling for I/O completions.

TSI_POLL_ERR_WRITE_TIMEOUT The head entry in the TSI write queue has timed out. Note that the buffer returned in the ppBuf parameter must still be freed by the application. This error code pertains only to the TSI_POLL_WRITE_ COMPLETE option.

Action: Consider raising the timeout parameter value in the connection definition of the TSI configuration file.

For additional error codes, refer to Appendix A.

4.9 tPost

The tPost function operates only in the VxWorks environment where the basic non-blocking I/O system services are not provided. It signals the TSI to begin processing I/O requests queued by your application.

Currently, tPost implements a controlled task switch environment for VxWorks through the use of binary semaphore mechanisms. Your application must call this function as the last operation before it relinquishes task control to the operating system (for example, sleeping or taking semaphores). Your application must take special consideration to operate in a VxWorks environment. Refer to Appendix B for designing and implementing server-resident applications under a VxWorks environment.

Synopsis

```
int     tPost ( void );
```

Parameters

None

Returns

If the tPost function completes successfully, it returns OK. Otherwise it returns ERROR, and tserrno contains one of the following error codes (listed alphabetically):

TSI_POST_ERR_CLIENT_INVALID_SEM   The TSI call to the VxWorks semGive function failed because the semaphore ID is not valid.

Action: Internal error. If this error occurs consistently, contact Protogate for assistance.

TSI_POST_ERR_NEVER_INIT   The TSI was never initialized (tInit).

Action: Correct your program and try again.

TSI_POST_ERR_SERVER_INVALID_SEM The TSI call to the VxWorks semGive function failed because the semaphore ID is not valid.

Action: Internal error. If this error occurs consistently, contact Protogate for assistance.

For additional error codes, refer to Appendix A.

4.10 tRead

The tRead function requests the TSI to receive data from the peer TSI application over the specified connection ID.

The use of tRead varies slightly when using non-blocking I/O as opposed to blocking I/O. If the read is for a connection using non-blocking I/O, note the following:

- If tRead returns ERROR and tserrno is set to TSI_READ_ERR_QFULL, the input queue for this connection is full and cannot accept any more requests at this time.
- If tRead returns ERROR and tserrno is set to TSI_EWOULDBLOCK, the read could not be completed immediately, but was queued to the input queue. Upon completion, the read can be retrieved from the queue by calling tPoll with the TSI_POLL_READ_COMPLETE option.

Synopsis

```
int tRead (
        int     iConnID,        /* Connection ID from tConnect/tListen      */
        char    **ppBuf,        /* Buffer to receive data                   */
        int     iBufLen );      /* Maximum bytes to be returned             */
```

Parameters

int iConnID   The connection ID uniquely identifies an active connection serviced by the TSI. This ID is returned from the tConnect or tListen function call.

char **ppBuf   This field contains the *address of a pointer* to a read buffer. The buffer can be allocated using the tBufAlloc function or a similar C function. However, if the buffer is allocated by a function other than tBufAlloc, your application must provide sufficient header space for the TSI control information (usOverhead field on page 77). If its content is NULL, TSI allocates a buffer for your application.

This parameter must not be NULL, but it can be the *address of a NULL pointer* (*ppBuf = NULL), which instructs the TSI to allocate a TSI read buffer for the application. Upon return, the TSI fills in this pointer with the address of the allocated TSI buffer. If you let TSI allocate the read buffer, *your application is still responsible for releasing that buffer* when it no longer needs it, using tBufFree.

int iBufLen This field specifies the maximum number of bytes to be read. This value must be greater than zero and less than the maximum buffer size configured (iMaxBufSize, page 77, as reported by the tPoll call with the TSI_POLL_GET_SYS_CFG option). The TSI is a message-based transport service, meaning that data is not transferred as a continuous stream of bytes; the data is broken up into discrete packets (messages) that also contain TSI control information. When an application requests a read, it is returned in the next incoming packet. Because the application does not know the data size of the incoming packet, it is suggested that the application always request to read the maximum buffer size allowed and supply an appropriate sized buffer (or let TSI allocate the buffer). Incoming packets are handled as follows:

- If the data length of the next incoming packet is less than or equal to iBufLen, tRead returns the length of the incoming packet.

- If the data length of the next incoming packet is greater than iBufLen, tRead returns ERROR and tserrno is set to TSI_READ_ERR_OVERFLOW. The buffer is truncated to the number of bytes requested, and the remaining data is discarded.

Returns

The tRead function returns the number of bytes transferred if the TSI successfully completes the I/O request. For both blocking and non-blocking I/O connections, a positive return value signifies a successful completion of the read. Otherwise, the return code is ERROR, and tserrno contains one of the following error codes (listed alphabetically):

TSI_EWOULDBLOCK The requested action could not be completed immediately. The TSI would have blocked this operation if your connection was using blocking I/O.

Action: Use tPoll to check whether your request completed. You can program your application to be notified by one of the IOCH routines that you provided when you invoked the tInit, tConnect, or tListen function. Refer to Appendix B for information on managing TSI applications using non-blocking I/O.

TSI_READ_ERR_INTERNAL A TSI internal error was detected during read processing. The TSI log will indicate the specific error.

Action: Obtain the TSI error log, and contact Protogate for assistance.

TSI_READ_ERR_INVALID_BUF This function was invoked with a NULL ppBuf pointer.

Action: Correct your application and try again.

TSI_READ_ERR_INVALID_ID Your connection ID is no longer valid.

Action: Review your application and try again.

TSI_READ_ERR_INVALID_LENGTH Your requested read length (iBufLen) must be greater than zero and less than or equal to the maximum buffer length allowed by the TSI.

Action: Use tPoll to obtain the maximum buffer size allowed by the TSI (iMaxBufSize). Review your program and try again.

TSI_READ_ERR_INVALID_STATE This connection is not in a proper state to accept a read request.

Action: Review your program and try again.

TSI_READ_ERR_LIMIT_EXCEEDED This connection has a large number of I/O errors that exceeded the maximum number of errors allowed.

Action: Consider increasing the maximum I/O errors parameter in the connection definition entry. Review your operating environments.

TSI_READ_ERR_NEVER_INIT The TSI was never initialized. Your application must initialize the TSI (tInit) before calls to other TSI functions (except tConnect and tListen) are made.

Action: Review your application.

TSI_READ_ERR_NO_BUFS Your application requested that the TSI allocate a buffer, but the allocation failed.

Action: Review your program and make sure you free unused buffers. Also, check to see if you configured enough buffers for your application.

TSI_READ_ERR_OVERFLOW The TSI encountered an overflow of data in your read request. The read length specified was smaller than the size of the incoming TSI packet. See the discussion under the Description heading.

Action: Increase the buffer size supplied to tRead up to the maximum defined for the connection.

TSI_READ_ERR_QADD_FAILED The TSI failed to add your request to its internal I/O queues for this connection.

Action: Severe error; terminate your application and try again.

TSI_READ_ERR_QFULL The TSI cannot accept more read requests because its input queue is full.

Action: Your application must remove complete or timed-out read requests, using the tPoll call, before it can request more reads. Review your program and handle this error accordingly.

TSI_READ_ERR_READ_TIMEOUT Your request was not completed in a timely manner.

Action: Consider increasing the timeout value in the configuration parameters for this connection.

TSI_READ_ERR_SELECT The TSI received an error from a system select call during a read attempt using blocking I/O.

Action: Retry the operation. If the error persists, review your application.

TSI_READ_ERR_SOCK_CLOSED A system read attempt failed, and TSI has closed the connection.

Action: Cancel all outstanding read and write requests, and free the buffers. Close the connection. After a successful close, another connection can be attempted. Examine the log files for abnormal conditions prior to the read failure.

TSI_READ_ERR_UNBIND This connection between Freeway and the client application has been closed. The system has performed "Unbind" processing. The connection was closed either because of a "Force Unbind" received from the peer entity (Freeway or client), or because of a failure with the I/O connection.

Action: Cancel all outstanding read/write requests and free the buffers. Close the connection. After a successful close, another connection can be attempted. Examine the log files on the peer system (if the error occurred in the client application, examine the Freeway log).

For additional error codes, refer to Appendix A.

4.11 tSyncSelect

The tSyncSelect function queries a set of connection IDs for a read data available condition. This feature is available only for clients in a Freeway server environment (it is not supported in an embedded ICP environment) using blocking I/O. The client application can query a connection(s) for read data, and if available, perform the read operation without blocking. This operation does not block; it interrogates the system for read data available and immediately returns this status to the user.

The user builds a connection ID array (connIDArray) containing the list of connections for which read availability is requested. The number of connections can be from 1 to the defined maximum number of connections (see the TSI MaxConns parameter on page 55). Connection IDs must begin at position 0 in the array (first position in the array), and be packed (no non-used positions). The contents of this array are not modified by the interface. The number of connection IDs packed in this array is passed in iNbrConnID. In addition, a result array is passed which will contain the returned read availability status of the connections in the corresponding array position of the connection ID array. A connection's availability status is either TRUE (data available) or FALSE (data not available).

Synopsis

```
int tSyncSelect (
        int     iNbrConnID,         /* # of connection ids in connIDArray        */
        int     connIDArray[],      /* packed array of connection ids for        */
                                    /*    requested read data status             */
        int     readStatArray[]);   /* array containing read data status         */
                                    /*     for connections in connIDArray        */
```

Parameters

int iNbrConnID   The number of connection IDs to be queried in the following connection ID array. If a value of 0 is passed (no connection IDs to be queried), the function returns zero (0).

int connIDArray[] An array containing the connection IDs whose read availability status is requested. The connection IDs are those returned from tConnect. Connection ids must begin at position 0 (the first array element), and be packed (no non-used positions). These values are not modified by the call.

int readStatArray[] An array passed to the interface for the returned TRUE/FALSE read availability status for connections in the corresponding positions of the connection ID array (connIDArray). This array is modified by the interface. If an error occurs in the call, the contents of this array are indeterminable; all elements should be ignored.

Returns

If the tSyncSelect function completes successfully, it returns the number of connections in the connection ID array that have read data available (if 3 of 7 connections in the array have read data available, a value of 3 is returned). If no connections have data available, 0 is returned.

Successful completion also returns the readStatArray with a TRUE/FALSE value in each position corresponding to the connection ID in the connection ID array. TRUE means that connection has data available; FALSE means data is not currently available. If the function returns a 0 or ERROR, values in this array are indeterminable; they should be ignored. If this function is successful, it modifies iNbrConnID positions in this array.

For any error condition, the tSyncSelect return code is ERROR, and terrno contains one of the following error codes (listed alphabetically):

TSI_SYNCSELECT_ERR_INVALID_STATE A connection(s) in the connection ID array (connIDArray) is not in the proper state to accept this request. connections must be “opened” (in the “ready” state) before this operation can be performed.

Action: Ensure all connections in the connection ID array have successfully opened.

TSI_SYNCSELECT_ERR_SELECT_ERROR An error was returned from the system select function.

Action: Review the TSI log file for the specific error, and take corrective action.

Example

One connection is open, tConnect returned with a connection ID of 4.

```
connIDArray[0] = 4;
if ( (nbrReads = tSyncSelect( 1, connIDArray, readStatArray ) ) == ERROR )
{
        error processing
}
if ( nbrReads )     /* with only one read in array, we need not look further */
{
        if ( readStatArray[0] == TRUE )
        {
        /* process read available for connection connIDArray[0] – tRead */
        }
}
```

With multiple connections in array, go through readStatArray iNbrConnID times or until nbrReads of TRUE are found.

4.12 tTerm

The tTerm function closes all connections and frees all TSI-related system resources. Under normal conditions your application should call tTerm to close all active connections before it exits to the operating system. You should also make an effort to call tTerm when your application ends abnormally.

The tTerm function can be invoked at any time during the life of your application. To use the TSI again, you must call tInit to re-establish the TSI operating environment. It is not recommended that you call tTerm too often in your application because of the timing cost associated with it. However, in some applications this capability might be essential if your system and network resources are scarce and your application is not time-critical. If you call tTerm while there are active connections, the TSI issues a forced tDisconnect on the active connections before it brings down its service structure. Issuing tTerm while active connections exist should be the last option.

Note

The successful writing of client trace files to the client file system requires successful completion of the tTerm function. When the client application abnormally terminates, TSI trace files are not written.

Synopsis

```
int         tTerm ( void );
```

Parameters

None

Returns

If this function completes successfully, it returns OK. Otherwise it returns ERROR, and tserrno contains one of the following error codes (listed alphabetically):

TSI_TERM_ERR_ACT_REM_FAILED The TSI failed to terminate its internal active connection queue.

Action: Severe error; terminate your application and try again.

TSI_TERM_ERR_ACT_TERM_FAILED The TSI failed to terminate its internal active connection queue.

Action: Severe error; terminate your application and try again.

TSI_TERM_ERR_BUF_FREE_FAILED The TSI failed in removing buffers used by the application.

Action: Severe error; terminate your application and try again.

TSI_TERM_ERR_BUFM_TERM_FAILED The TSI failed to terminate buffer management services.

Action: Review your TSI configuration services and TSI error log.

TSI_TERM_ERR_DISC_FAILED The TSI failed to disconnect an active connection.

Action: Severe error; terminate your application and try again.

TSI_TERM_ERR_LOG_END_FAILED The TSI failed to terminate its internal logging and tracing facility.

Action: Check your logging-related and tracing-related parameters in the currently used TSI configuration file.

TSI_TERM_ERR_NEVER_INIT The TSI was never initialized with a call to tInit.

Action: Review your program's logic, and try again.

TSI_TERM_ERR_RES_FREE_FAILED The TSI failed to free connection-related resources.

Action: Review the TSI connection log, terminate your application and try again.

For additional error codes, refer to Appendix A.

4.13 tWrite

The tWrite function requests the TSI to send data to a peer TSI application over the specified connection ID.

For both blocking and non-blocking I/O connections, a positive return value signifies a successful completion of the write. If the write is for a connection using non-blocking I/O, note the following:

- If tWrite returns ERROR and tserrno is set to TSI_WRIT_ERR_QFULL, the output queue for this connection is full and cannot accept any more requests at this time.
- If tWrite returns ERROR and tserrno is set to TSI_EWOULDBLOCK, the write could not be completed immediately, but was queued to the output queue. Upon completion, the write can be retrieved from the queue by calling tPoll with the TSI_POLL_WRITE_COMPLETE option.

Synopsis

```
int tWrite (
    int      iConnID,             /* Connection ID from tConnect/tListen     */
    char     *pBuf,               /* Source buffer for transfer              */
    int      iBufLen,             /* Number of bytes to transfer             */
    int      iWritePriority );    /* Normal or expedite queueing             */
```

Parameters

int iConnID This field uniquely identifies an active connection serviced by the TSI. This ID is returned from a tConnect or tListen function call.

char *pBuf This field contains the address of the write buffer to be sent to the peer TSI application. This parameter must not be NULL. The buffer can be allocated using the tBufAlloc function or a similar C function. However, if the buffer is allocated by a function other than tBufAlloc, your application must provide sufficient header space for the TSI control information (usOverhead field on page 77).

Caution

Normally, if the client application allocates the write buffer using tBufAlloc, it must release the buffer using tBufFree when the write request completes. A server-resident application is an exception (see Section 2.3.7 on page 43).

int iBufLen This field specifies the number of bytes to be sent. This value must be greater than zero and less than the maximum buffer size configured (iMaxBufSize, page 77, as reported by the tPoll call with the TSI_POLL_GET_SYS_CFG option).

int iWritePriority This field specifies the priority of the write operation. Your application can use this field to expedite a request to the peer TSI application. The default type is a normal write operation. Note that this field has no meaning for a connection using blocking I/O, as only one write can be pending at a time. Valid types are:

TSI_WRITE_EXPEDITE If this type is used, your current request is inserted before any output requests whose actual output operation has not started and after any output request that has already started or that was issued with TSI_WRITE_EXPEDITE. This exercises the priority queue concept.

TSI_WRITE_NORMAL If this type is used, your output request is added to the end of the connection internal output queue. This exercises the FIFO concept of queue.

Returns

The tWrite function returns the transfer count if the TSI successfully completes the I/O. Otherwise, the return code is ERROR, and tserrno contains one of the following error codes (listed alphabetically):

TSI_EWOULDBLOCK The requested action could not be completed immediately. The TSI would have blocked this operation if your connection was using blocking I/O.

Action: Use tPoll to check whether your request completed. You can program your application to be notified by one of the IOCH routines that you provided when you invoked the tInit, tConnect, or tListen function. Refer to Appendix B for information on managing TSI applications using non-blocking I/O.

TSI_WRIT_ERR_INVALID_BUF Your application invoked this function with a NULL pBuf pointer.

Action: Correct your application and try again.

TSI_WRIT_ERR_INTERNAL A TSI internal error was detected during write processing. The TSI log will indicate the specific error.

Action: Have the TSI error log available, and contact Protogate.

TSI_WRIT_ERR_INVALID_ID Your connection ID is no longer valid.

Action: Review your log, terminate your program, and try again.

TSI_WRIT_ERR_INVALID_LENGTH The buffer length (iBufLen) must be greater than zero and less than the maximum buffer length allowed by the TSI.

Action: Use tPoll to obtain the maximum buffer length allowed by the TSI (iMaxBufSize). Correct your application and try again.

TSI_WRIT_ERR_INVALID_STATE This connection is not in a proper state to accept a write request.

Action: Review your program and try again.

TSI_WRIT_ERR_INVALID_WRITE_TYPE tWrite allows either TSI_WRITE_NORMAL or TSI_WRITE_EXP.

Action: Review your program's logic, and try again.

TSI_WRIT_ERR_LIMIT_EXCEEDED This connection has a large number of I/O errors that exceeded the maximum number of errors allowed.

Action: Consider increase the maximum I/O errors parameter in the connection definition entry. Review your operating environments.

TSI_WRIT_ERR_NEVER_INIT The TSI was never initialized. Your application must initialize the TSI (tInit) before it can use it.

Action: Review your application.

TSI_WRIT_ERR_QADD_FAILED The TSI failed to add your write request to its internal I/O queues for this connection.

Action: Severe error; terminate your application and try again.

TSI_WRIT_ERR_QFULL The TSI cannot accept more write requests because its output queue is full.

Action: Your application must remove complete or timed-out write requests, using the tPoll call, before it can request more writes. Review your program and handle this error accordingly.

TSI_WRIT_ERR_SELECT The TSI received an error from a system select call during a write attempt using blocking I/O.

Action: Retry the operation. If the error persists, review your application.

TSI_WRIT_ERR_SOCK_CLOSED A system write attempt failed, and TSI has closed the connection.

Action: Cancel all outstanding read and write requests, and free the buffers. Close the connection. After a successful close, another connection can be attempted. Examine the log files for abnormal conditions prior to the write failure.

TSI_WRIT_ERR_UNBIND This connection between Freeway and the client application has been closed. The system has performed "Unbind" processing. The connection was closed either because of a "Force Unbind" received from the peer entity (Freeway or client), or because of a failure with the I/O connection.

Action: Cancel all outstanding read/write requests and free the buffers. Close the connection. After a successful close, another connection can be attempted. Examine the log files on the peer system (if the error occurred in the client application, examine the Freeway log).

TSI_WRIT_ERR_WRITE_TIMEOUT Your request was not completed in timely manner.

Action: Increase the timeout value in the configuration for this connection.

For additional error codes, refer to Appendix A.

Appendix

A

TSI Common Error Codes

This chapter describes the internal and command-specific TSI error codes.

Note

While developing your TSI application, if a particular error occurs consistently, contact Protogate for further assistance.

A.1 Internal Error Codes

To assist you in debugging your application, the following codes (listed alphabetically) describe internal error conditions of TSI services. These codes are returned in the global variable tserrno.

TSI_CINIT_ERR_CFG_LOAD_FAILED TSI failed to load the configuration entry from the TSI configuration file.

Action: Ensure that your tsicfg program and your TSI library is up-to-date. Make sure your application uses a correct connection entry name through the first parameter of the tConnect or tListen function call. Note that the connection entry name is case-sensitive.

TSI_CINIT_ERR_DEQ_FAILED TSI failed to dequeue its internal active connection entry.

Action: If this error occurs consistently, it is considered a severe error; contact Protogate for further assistance.

TSI_CINIT_ERR_GET_ENTRY_FAILED TSI failed to add the newly created connection entry to its internal connection queue.

Action: Severe error. Terminate your application and try again.

TSI_CINIT_ERR_QFULL TSI failed to add a new connection entry to its internal connection queue.

Action: Consider increasing the number of connections (MaxConns parameter) through the TSI configuration file. If this error occurs consistently even though the maximum number of connections is adequately defined, contact Protogate for further assistance.

TSI_CINIT_ERR_RESA_FAILED TSI failed to allocate system resources for this newly created connection.

Action: Review more error messages to pinpoint the problems. Recalculate your system resource requirements and adjust your configuration file accordingly.

TSI_CLNT_ERR_EVT_PROC_FAILED TSI failed to complete its internal event processing routine.

Action: If this error occurs consistently, contact Protogate for further assistance. VxWorks only.

TSI_CLNT_ERR_TASK_VAR_FAILED TSI failed to add task variables to the VxWorks system. Severe error.

Action: Contact Protogate for further assistance. VxWorks only.

TSI_EVTG_ERR_ILL_CMD_TYPE A TSI command packet with an invalid command field was processed. Severe error.

Action: Terminate your application and try again.

TSI_INTERN_ERR_01 A TSI error occurred during write processing without being correctly identified. TSI_WRIT_ERR_INTERNAL is returned to the application.

Action: If this error occurs consistently, contact Protogate for further assistance.

TSI_INTERN_ERR_02 A TSI error occurred during read processing without being correctly identified. TSI_READ_ERR_INTERNAL is returned to the application.

Action: If this error occurs consistently, contact Protogate for further assistance.

TSI_INTERN_ERR_03 A TSI_INTERN_ERR_01 or TSI_INTERN_ERR_02 error has been recognized in returning a buffer from a tPoll request for read/write completions. TSI_POLL_ERR_INTERNAL is returned to the application.

Action: If this error occurs consistently, contact Protogate for further assistance.

TSI_INT_ERR_SELECT_FAILED TSI failed to perform a select on its active socket file descriptors. Severe error.

Action: Terminate your application and try again. Non-blocking I/O with socket interface only.

TSI_INTR_ERR_CLIENT_SPAWN_FAILED TSI failed to spawn its internal IOClient task. Severe error.

Action: Ensure that your VxWorks system resources are properly configured. Make sure that your linkage completes successfully. VxWorks only.

TSI_INTR_ERR_SEM_FAILED TSI failed to create a binary semaphore for its internal usage. Severe error.

Action: Ensure that your VxWorks system resource is properly configured. VxWorks only.

TSI_INTR_ERR_SERVER_SPAWN_FAILED TSI failed to spawn its internal IOServer task. Severe error.

Action: Ensure that your VxWorks system resources are properly configured. Make sure that your linkage completes successfully. VxWorks only.

TSI_INTR_ERR_SIG_ERR TSI failed to install its SIGIO signal to UNIX or a UNIX-like system. Severe error.

Action: Make sure your TSI application does not use SIGIO signal. UNIX or UNIX-like only.

TSI_INTR_ERR_SOCKET_SPAWN_FAILED TSI failed to spawn its internal IOSocket task. Severe error.

Action: Ensure that your VxWorks system resources are properly configured. Make sure that your linkage completes successfully. VxWorks only.

TSI_IO_ERR_INVALID_EXEC_STATE The TSI has gone through an invalid state transition. Severe error.

Action: Make sure that your network is functioning properly. Terminate your application and try again.

TSI_LOGI_ERR_LOG_OPEN_FAILED TSI failed to open its internal error log.

Action: Check access authority for the current directory.

TSI_LOGI_ERR_TRC_OPEN_FAILED TSI failed to open the trace file for input.

Action: Check access authority for the current directory.

TSI_MEMI_ERR_CALLOC_FAILED TSI failed to obtained adequate memory resources to operate.

Action: Recalculate your system resource requirements. If needed, reconfigure your TSI configuration file. VxWorks with shared-memory package only.

TSI_MEMI_ERR_NEVER_INIT TSI is not initialized correctly.

Action: Review your program logic and try again. VxWorks with shared-memory package only.

TSI_MEMI_ERR_SM_CREAT_FAILED TSI failed to create shared memory for its operating environment.

Action: Recalculate your system resource requirements. If needed, reconfigure your TSI configuration file. VxWorks with shared-memory package only.

TSI_RECV_PACK_ERR_NO_BUFS The TSI failed to obtain a buffer for an internal control packet.

Action: Ensure that your TSI configuration file includes an adequate number of buffers.

TSI_RECV_PACK_ERR_QADD_FAILED The TSI failed to queue a read for an incoming control packet. Severe error.

Action: Ensure that your TSI configuration file defines an adequate queue size.

TSI_RESA_ERR_BUFIO_FAILED TSI failed to obtain two internal IO buffers for the newly created connection. The connection request will fail.

Action: Ensure that your TSI configuration file includes adequate buffer configuration.

TSI_RESA_ERR_INVALID_PROT TSI failed to recognize the protocol specified in the configuration file.

Action: Ensure that your tsicfg and your TSI library are up-to-date.

TSI_RESA_ERR_QIO_FAILED TSI failed to create its internal IO queue for the newly requested connection.

Action: Recalculate your system resource requirements. If needed, re-configure your TSI to match your limited system resources and try again.

TSI_SEND_PACK_ERR_NO_BUFS The TSI failed to obtain a buffer for an internal control packet.

Action: Ensure that your TSI configuration file includes an adequate number of buffers.

TSI_SEND_PACK_ERR_QADD_FAILED The TSI failed to queue a write for an outgoing control packet. Severe error.

Action: Ensure that your TSI configuration file defines an adequate queue size.

TSI_SHM_ERR_CTL_PROC_QTERM_FAIL An error occurred while terminating the TSI shared-memory queues.

Action: If this error occurs consistently, contact Protogate for assistance.

TSI_SHM_ERR_CTRL_PROC_FAILED An error occurred while the TSI was processing a shared-memory control packet.

Action: If this error occurs consistently, contact Protogate for assistance.

TSI_SHM_ERR_INVALID_STATUS An invalid status was reached while executing a shared-memory open. Severe error.

Action: If this error occurs consistently, contact Protogate for assistance.

TSI_SHM_ERR_KILL_SIG1_FAILED The TSI failed to send SIGUSR1 to process a shared-memory open.

Action: Make sure that your TSI application does not use SIGUSR1 on VxWorks. Terminate your application and try again. If this error occurs consistently, contact Protogate for assistance.

TSI_SHM_ERR_NOT_OPEN The TSI attempted to close a shared-memory transport that was not open.

Action: Review your application logic. Terminate your application and try again.

TSI_SHM_ERR_NO_BUFS The TSI failed to obtain a buffer for an internal control packet.

Action: Ensure that your TSI configuration file includes an adequate number of buffers.

TSI_SHM_ERR_NO_RESOURCE The TSI failed to initialize the shared-memory queues for a connection.

Action: Your application probably has inadequate memory resources; check the TSI configuration.

TSI_SHM_ERR_OPEN_PROC_NO_BUFS The TSI failed to obtain a buffer for an internal control packet.

Action: Ensure that your TSI configuration file includes an adequate number of buffers.

TSI_SHM_ERR_OPEN_PROC_NO_LSTN A shared-memory open request was rejected. No outstanding listens were posted to the requested Transport Name.

Action: Ensure that your TSI configuration file includes an adequate number of buffers.

TSI_SHM_ERR_PIPE_OPEN_FAILED The TSI failed to open its peer’s shared-memory open request pipe.

Action: Ensure that the client connection definition's server parameter matches the server main definition's servername parameter in the corresponding TSI configuration files.

TSI_SHM_ERR_PIPE_READ_FAILED A TSI shared-memory listening connection incurred an error attempting to read from the shared-memory request pipe.

Action: Severe error. Terminate your application and try again.

TSI_SHM_ERR_PIPE_SEL_FAILED A TSI shared-memory listening connection incurred an error attempting to perform a select on the shared-memory request pipe.

Action: Severe error. Terminate your application and try again.

TSI_SHM_ERR_PIPE_WRITE_FAILED A TSI shared-memory client connection incurred an error attempting to write an open request to the shared-memory request pipe.

Action: Severe error. Terminate your application and try again.

TSI_SHM_ERR_QREM_AT_CTLBUF_FAIL The TSI incurred an error attempting to remove a TSI control packet from the connection's queue.

Action: Severe error. Terminate your application and try again.

TSI_SOCK_ERR_ACCEPT_ERR An accept on a TSI listening socket failed.

Action: Check system resources to ensure that the system limit for open file descriptors has not been reached.

TSI_SOCK_ERR_ALREADY_CLOSED The TSI attempted to close a socket that was not open.

Action: Internal logic error. Contact Protogate to report problem.

TSI_SOCK_ERR_CLOSE_ERR The TSI incurred an error while closing an open socket.

Action: Terminate your application and try again.

TSI_SOCK_ERR_CONNECT_ERR The TSI failed to connect a client socket.

Action: Severe error. Terminate your application and try again.

TSI_SOCK_ERR_GET_HNAME_FAILED The TSI failed to convert the server host name to an IP address.

Action: Ensure that the TSI configuration file contains a valid host name for the serverName parameter.

TSI_SOCK_ERR_INVALID_IOQ_STATUS The IO status field of a TSI socket packet contains an invalid status. Severe error.

Action: Terminate your application and try again.

TSI_SOCK_ERR_INVALID_RTN_VALUE The TSI generated an invalid internal value.

Action: If this error occurs consistently, contact Protogate for further assistance.

TSI_SOCK_ERR_NO_SOCKET The TSI did not have a valid socket file descriptor to perform a socket open or listen.

Action: Terminate your application and try again.

TSI_SOCK_ERR_READ_FAILED The TSI encountered an error performing a read from a socket.

Action: Check the TSI log file just prior to this error for more detailed information.

TSI_SOCK_ERR_SELECT_ERR The TSI encountered an error performing a select on a socket.

Action: Terminate your application and try again.

TSI_SOCK_ERR_SEM_CREATE_FAILED TSI failed to create an internal semaphore for its internal socket task.

Action: Recalculate your system resource requirements. If needed, reconfigure your TSI configuration file. VxWorks only.

TSI_SOCK_ERR_SOCKET_CLOSED A socket that the TSI was attempting to perform IO upon closed.

Action: Check the peer software and attempt to discover why the peer socket closed.

TSI_SOCK_ERR_TASK_VAR_FAILED TSI failed to add task variables to the VxWorks system. Severe error.

Action: Contact Protogate for further assistance. VxWorks only.

TSI_SOCK_ERR_WRITE_FAILED The TSI encountered an error performing a write to a socket.

Action: Check the TSI log file just prior to this error for more detailed information.

TSI_SOCKA_ERR_BIND_FAILED TSI failed to bind a well-known port to its listening socket.

Action: Make sure that your well-known port is not being used by any other application within your system. Terminate your application and try again.

TSI_SOCKA_ERR_FCNTL_FAILED TSI failed to set the socket file descriptor to a non-blocking I/O mode.

Action: Ensure that your TCP/IP software package supports non-blocking I/O and that your application is configured to use non-blocking I/O. Otherwise, contact Protogate for further assistance.

TSI_SOCKA_ERR_LISTEN_FAILED TSI failed to listen for a connection request through a well-known port specified in the TSI configuration file.

Action: If this error occurs consistently, contact Protogate for further assistance.

TSI_SOCKA_ERR_SETOPT_FAILED TSI failed to set TCP/IP TCP_NODELAY and KEEP_ALIVE options.

Action: Ensure that your TCP/IP socket interface package supports these socket options. If your TCP/IP software does not support these options, consider turning them off using the TSI configuration file. Otherwise, contact Protogate for further assistance.

TSI_SOCKA_ERR_SOCKET_FAILED TSI failed to obtain a new socket for the newly requested connection.

Action: Consider increasing the maximum number of file descriptors through system resource services (UNIX: getrlimit function).

TSI_SRVR_ERR_EVT_PROC_FAILED TSI failed to complete its internal event processing routine.

Action: If this error occurs consistently, contact Protogate for further assistance. VxWorks only.

TSI_SRVR_ERR_PIPE_CREATE_FAILED TSI failed to create a named pipe for its internal shared-memory protocol package.

Action: If you develop a server-resident application, make sure your linkage completes successfully. VxWorks only.

TSI_SRVR_ERR_PIPE_OPEN_FAILED TSI failed to open its internal named pipe.

Action: Terminate your application and try again. VxWorks only.

TSI_SRVR_ERR_SIG_ERR TSI failed to install an interrupt handler for SIGUSR1 signal.

Action: Ensure that your TSI application in the VxWorks environment does not use the SIGUSR1 signal. VxWorks only.

TSI_SRVR_ERR_TASK_VAR_FAILED TSI failed to add task variables to VxWorks system. Severe error.

Action: Contact Protogate for further assistance. VxWorks only.

A.2 Command-Specific Error Codes

Table A–1 lists alphabetically all the error codes related to specific TSI commands described in Chapter 4. These codes are returned in the global variable tserrno.

Table A–1: TSI Command-specific Error Codes

Command(s) Causing Error	Error Code	Reference Page
tBufAlloc	TSI_BUFA_ERR_NEVER_INIT	page 81
	TSI_BUFA_ERR_NO_BUFS	page 81
	TSI_BUFA_ERR_SEVERE_ERR	page 81
tBufFree	TSI_BUFF_ERR_INVALID_BUF	page 82
	TSI_BUFF_ERR_NEVER_INIT	page 82
	TSI_BUFF_ERR_NOT_ALLOCATED	page 82
	TSI_BUFF_ERR_SEVERE_ERR	page 83
tConnect	TSI_CONN_ERR_CLOSE_FAILED	page 86
	TSI_CONN_ERR_CONN_INIT_FAILED	page 86
	TSI_CONN_ERR_INVALID_PROT	page 86
	TSI_CONN_ERR_INVALID_STATE	page 86
	TSI_CONN_ERR_OPEN_FAILED	page 86
	TSI_CONN_ERR_QADD_FAILED	page 86
	TSI_CONN_ERR_RETRY_EXCEEDED	page 87
	TSI_CONN_ERR_SOCK_ALLOC_FAILED	page 87
	TSI_CONN_ERR_TINIT_FAILED	page 87
tDisconnect	TSI_DISC_ERR_CLOSE_FAILED	page 89
	TSI_DISC_ERR_DISC_FAILED	page 89
	TSI_DISC_ERR_INVALID_ID	page 89
	TSI_DISC_ERR_INVALID_STATE	page 89
	TSI_DISC_ERR_INVALID_TYPE	page 89
	TSI_DISC_ERR_NEVER_INIT	page 90
	TSI_DISC_ERR_Q_NOT_EMPTY	page 90
	TSI_DISC_ERR_QADD_FAILED	page 90
	TSI_DISC_ERR_SEVERE_ERROR	page 90

Table A–1: TSI Command-specific Error Codes (*Cont'd*)

Command(s) Causing Error	Error Code	Reference Page
tConnect	TSI_EWOULDBLOCK	page 87
tDisconnect		page 90
tListen		page 97
tRead		page 111
tWrite		page 122
tInit	TSI_INIT_ERR_ACT_ADD_REM_FAILED	page 92
	TSI_INIT_ERR_ACT_QINIT_FAILED	page 92
	TSI_INIT_ERR_ALREADY_INIT	page 92
	TSI_INIT_ERR_BUF_ADD_REM_FAILED	page 92
	TSI_INIT_ERR_BUF_QINIT_FAILED	page 93
	TSI_INIT_ERR_CFG_LOAD_FAILED	page 93
	TSI_INIT_ERR_LOG_INIT_FAILED	page 93
	TSI_INIT_ERR_NO_MEM	page 93
	TSI_INIT_ERR_NO_RESOURCE	page 93
	TSI_INIT_ERR_NO_TRACE_BUFFER	page 94
	TSI_INIT_ERR_SETRLIMIT_FAILED	page 94
	TSI_INIT_ERR_TASK_VAR_FAILED	page 94
	TSI_INIT_ERR_TSICB_ALLOC_FAILED	page 94

Table A–1: TSI Command-specific Error Codes (*Cont'd*)

Command(s) Causing Error	Error Code	Reference Page
tListen	TSI_LSTN_ERR_CLOSE_FAILED	page 97
	TSI_LSTN_ERR_CONN_INIT_FAILED	page 97
	TSI_LSTN_ERR_INVALID_PROT	page 97
	TSI_LSTN_ERR_INVALID_STATE	page 97
	TSI_LSTN_ERR_LSTN_FAILED	page 98
	TSI_LSTN_ERR_NO_LISTENERS	page 98
	TSI_LSTN_ERR_NOT_SERVER	page 98
	TSI_LSTN_ERR_QADD_FAILED	page 98
	TSI_LSTN_ERR_QFULL	page 98
	TSI_LSTN_ERR_QINIT_FAILED	page 98
	TSI_LSTN_ERR_SETOPT_FAILED	page 98
	TSI_LSTN_ERR_SOCK_ALLOC_FAILED	page 99
	TSI_LSTN_ERR_TINIT_FAILED	page 99
tPoll	TSI_POLL_ERR_BAD_PTR	page 103
	TSI_POLL_ERR_BUF_NOT_FOUND	page 103
	TSI_POLL_ERR_GETLIST_FAILED	page 103
	TSI_POLL_ERR_INTERNAL	page 103
	TSI_POLL_ERR_INVALID_ID	page 104
	TSI_POLL_ERR_INVALID_IOQ	page 104
	TSI_POLL_ERR_INVALID_REQ_TYPE	page 104
	TSI_POLL_ERR_NEVER_INIT	page 104
	TSI_POLL_ERR_OVERFLOW	page 104
	TSI_POLL_ERR_QEMPTY	page 104
	TSI_POLL_ERR_QREM_FAILED	page 105
	TSI_POLL_ERR_READ_NOT_COMPLETE	page 105
	TSI_POLL_ERR_READ_TIMEOUT	page 105
	TSI_POLL_ERR_SOCK_CLOSED	page 105
	TSI_POLL_ERR_UNBIND	page 106
	TSI_POLL_ERR_WRITE_NOT_COMPLETE	page 106
	TSI_POLL_ERR_WRITE_TIMEOUT	page 106

Table A–1: TSI Command-specific Error Codes (*Cont'd*)

Command(s) Causing Error	Error Code	Reference Page
tPost	TSI_POST_ERR_CLIENT_INVALID_SEM	page 107
	TSI_POST_ERR_NEVER_INIT	page 107
	TSI_POST_ERR_SERVER_INVALID_SEM	page 108
tRead	TSI_READ_ERR_INTERNAL	page 111
	TSI_READ_ERR_INVALID_BUF	page 111
	TSI_READ_ERR_INVALID_ID	page 111
	TSI_READ_ERR_INVALID_LENGTH	page 111
	TSI_READ_ERR_INVALID_STATE	page 111
	TSI_READ_ERR_LIMIT_EXCEEDED	page 112
	TSI_READ_ERR_NEVER_INIT	page 112
	TSI_READ_ERR_NO_BUFS	page 112
	TSI_READ_ERR_OVERFLOW	page 112
	TSI_READ_ERR_QADD_FAILED	page 112
	TSI_READ_ERR_QFULL	page 112
	TSI_READ_ERR_READ_TIMEOUT	page 113
	TSI_READ_ERR_SELECT	page 113
	TSI_READ_ERR_SOCK_CLOSED	page 113
	TSI_READ_ERR_UNBIND	page 113
tSyncSelect	TSI_SYNCSELECT_ERR_INVALID_STATE	page 115
	TSI_SYNCSELECT_ERR_SELECT_ERROR	page 116
tTerm	TSI_TERM_ERR_ACT_REM_FAILED	page 118
	TSI_TERM_ERR_ACT_TERM_FAILED	page 118
	TSI_TERM_ERR_BUF_FREE_FAILED	page 118
	TSI_TERM_ERR_BUFM_TERM_FAILED	page 118
	TSI_TERM_ERR_DISC_FAILED	page 118
	TSI_TERM_ERR_LOG_END_FAILED	page 118
	TSI_TERM_ERR_NEVER_INIT	page 118
	TSI_TERM_ERR_RES_FREE_FAILED	page 119

Table A–1: TSI Command-specific Error Codes (*Cont'd*)

Command(s) Causing Error	Error Code	Reference Page
tWrite	TSI_WRIT_ERR_INTERNAL	page 122
	TSI_WRIT_ERR_INVALID_BUF	page 122
	TSI_WRIT_ERR_INVALID_ID	page 122
	TSI_WRIT_ERR_INVALID_LENGTH	page 122
	TSI_WRIT_ERR_INVALID_STATE	page 122
	TSI_WRIT_ERR_INVALID_WRITE_TYPE	page 123
	TSI_WRIT_ERR_LIMIT_EXCEEDED	page 123
	TSI_WRIT_ERR_NEVER_INIT	page 123
	TSI_WRIT_ERR_QADD_FAILED	page 123
	TSI_WRIT_ERR_QFULL	page 123
	TSI_WRIT_ERR_SELECT	page 123
	TSI_WRIT_ERR_SOCK_CLOSED	page 123
	TSI_WRIT_ERR_UNBIND	page 124
	TSI_WRIT_ERR_WRITE_TIMEOUT	page 124

Appendix B UNIX, VxWorks, and VMS I/O

B.1 UNIX Environment

In a UNIX environment, the TSI gains access to non-blocking I/O services through the use of the UNIX signal delivery mechanism. At initialization, TSI installs a signal handler (or IOCH) to be executed upon delivery of the signal. When a signal is delivered to a TSI application, the TSI IOCH immediately suspends the delivery of that signal again until it completes its I/O services through the IOCH function. TSI exits the IOCH either when it runs out of system resources to accept additional I/O, or when it has no additional I/O to accept. In either case, system resources are tied up by TSI while it is in the IOCH function unless it is interrupted by another system service request (that is, another signal delivery) with a higher priority than its own. A TSI application using non-blocking I/O can provide TSI with its own IOCH; the TSI IOCH subsequently invokes the application IOCH after it completes its I/O services.

In short, non-blocking I/O operation is not only complex but also expensive. Therefore, it requires careful planning and design so that your application uses the system resources wisely.

B.1.1 Blocking I/O operations

Blocking I/O operation requires no IOCHs. Blocking I/O does not use any signal delivery mechanism to handle the delivery of data. Blocking I/O allows the orderly execution of your application and requires far less system resources than non-blocking I/O. Blocking I/O is also easier to debug and troubleshoot than non-blocking I/O. Careful design through the isolation of system and protocol dependency allows your application to work using either blocking I/O or non-blocking I/O. The TSI services allow your application to switch from blocking to non-blocking I/O, and vice versa, without the recompilation of your application code.

It is not efficient to handle multiple connections under blocking I/O operation, because your application is blocked until the data arrives or TSI times out while waiting. While your application is waiting for I/O in one connection, data from other connections is blocked.

B.1.2 Non-Blocking I/O Operations

The TSI uses the SIGIO signal for its non-blocking BSD socket interface. Therefore, your application should not block the delivery of SIGIO signals (for example, sigprocmask) at any time, especially when expecting data from the network.

If you use non-blocking I/O, design your application with robust IOCH function(s). Also, the application IOCH should perform as little work as possible and, before it exits, use some notification techniques to awaken the main routines to perform the remaining tasks. Some possible notification techniques are system semaphores, sleep and wakeup calls using the SIGALRM signal, and so on.

B.1.3 SOLARIS use of SIGALRM

The use of a default signal handler through SIGALRM signal can cause a system core dump inside the SOLARIS internal SIGALRM signal handler. You can work around it by providing your own signal handler for SIGALRM. The following code segment assists you in setting up a SIGALRM handler for the SIGALRM signal:

```
void genSigHdlr ( int signal )
{
        return;
}

void main ( )
{
        struct sigaction            SigAction;

        SigAction. sa_handler = genSigHdlr;
        sigfillset (&SigAction. sa_mask);
        SigAction. sa_flags = 0;

        if (sigaction (SIGALRM, &SigAction, (struct sigaction *)NULL) ==
              ERROR)
        {
              fprintf (stderr, "sigaction failed %d\n", errno);
              return ERROR;
        }
        .....
        return OK;
}
```

Notice that genSigHdlr does nothing but return to the system.

B.1.4 Polling I/O Operations

Your application can implement polling I/O operations if it uses TSI with non-blocking I/O but provides no IOCH functions. Since your application provides no mechanism for TSI to notify it when an I/O condition occurs, your application must poll TSI for the completion of I/O requests that it posts to TSI. Polling I/O operations involve the tPoll function (Section 4.8 on page 100). Polling I/O is helpful if your application manages multiple connections, data arrives at a predictable rate, and the timing of data is not critical.

B.2 VxWorks Environment

The TSI operates only in a VxWorks environment that is similar to that of the Freeway server. VxWorks has several features similar to UNIX; however, it has a unique operating environment and a real-time operating system. The use of the TSI by an application that runs on the Freeway server is often called a server-resident application (SRA). The SRA can be configured to interact with Protogate's message multiplexor subsystem through the shared-memory transport mechanism supported by TSI, or it can be configured to interact with other systems using the BSD socket interface which is also supported by TSI. Whichever transport your SRA program uses, you should understand not only the VxWorks operating system but also the way the Freeway server is configured and how Protogate implements TSI under VxWorks. For more information on SRAs, see Section 2.3.7 on page 43 and the *Freeway Server-Resident Application and Server Toolkit Programmer Guide*

B.2.1 Blocking I/O Operations

Blocking I/O in VxWorks is similar to that of the UNIX environment.

B.2.2 Non-Blocking I/O Operations

Non-blocking I/O in VxWorks with Protogate's Freeway server requires your application to cooperate with other tasks. VxWorks on Freeway is configured to operate in a cooperative manner. This means that VxWorks operates as a non-preemptive multitasking environment. When your application does not have data to be processed, it must relinquish the CPU so that other tasks can run. You can use your own interrupt service routine to notify or resume your application when its data arrives.

The TSI uses a binary semaphore to support non-blocking I/O delivery from both network and shared-memory environments. Since VxWorks running on Freeway is configured for a cooperative environment, your application must also act cooperatively. Your application must call tPost immediately before relinquishing its control to VxWorks. Your application must relinquish the control through taskDelay, binary semaphores, or other means; otherwise, only your task has control of the CPU which prevents other important tasks from running.

Your application should not use global variables freely if multiple instances of the same application are running concurrently. VxWorks global variables are shared among all tasks unless you define them as a particular task's variables (using taskVarAdd). Task variables are expensive to maintain by VxWorks and therefore should be used sparingly.

B.3 VMS Environment

The TSI uses the process-level Asynchronous System Trap (AST) for non-blocking data delivery from the network. Therefore, your application should not block the delivery of ASTs (using sys$setast) at any time, especially when expecting data from the network.

Appendix

C TSI Logging and Tracing

To support debugging efforts, TSI provides tracing and logging services to troubleshoot both application and network problems.

C.1 TSI Logging

There are two kinds of TSI logging services: general logging and connection-related logging. As the name implies, general logging includes error or information that is not related to any particular connection. Connection-related logging indicates error or information related to a specific connection. To monitor data, you must use the TSI tracing services described in Section C.2.

General logging is defined in the "main" section of the TSI text configuration file. The LogLev parameter (page 54) specifies the level of logging your application needs and can be from 0 to 7, with level 0 being no logging, level 1 being the most severe error, and 7 being the least severe. In the "main" section, the LogName parameter (page 54) defines the log file name where your logging information is to reside. The default file name is "tsilog". If you wish logging information to be output to the screen, define LogName as "stdout." The number of entries to "stdout" is unlimited. A disk file is limited to 1000 entries, and this number is not configurable.

Connection-related logging can be defined in each individual TSI connection definition. You can log for some connections but not for the others; and different connections can log errors at different levels. All error codes are defined in Appendix A and in each individual function description (for example, tConnect in Section 4.4 on page 84).

The following is the format of the each log entry:

```
SessX: TSI_YYY_ZZZ_Information(terrno/errno)
```

where:

X is connection ID. For general logging, X will be 999. Otherwise, it indicates a connection-related entry.

YYY is brief function name of TSI. For example, if ZZZ is CONN it indicates the log entry is from tConnect function.

ZZZ can be ERR or INFO. ERR indicates an error condition; INFO indicates information only.

tserrno is a TSI error code for this entry; errno is the last encountered ‘C’ errno value.

C.2 TSI Tracing

C.2.1 Trace Definitions

The TSI tracing facility captures and stores real-time data in its internal wrap-around buffer. The size of this buffer is configurable up to 1 megabyte of memory. There are two kinds of TSI tracing: general tracing and connection-specific tracing. In general tracing, trace data has no connection-specific information, whereas connection-specific trace data pertains to only one specific connection ID.

To activate tracing, first specify the TSI “main” configuration parameters. Specify the TraceSize parameter (page 55) up to 1 megabyte of memory. The TraceName parameter (page 55) defines the file name where your trace information is to reside.

Specify the level of tracing using the TraceLev parameter (page 55). This parameter defaults to zero if not defined (no tracing). The TraceLev parameter can be defined in the “main” section for general tracing or in each individual connection definition (page 56). Each connection definition can have a different TraceLev value.

The TraceLev parameter can be the sum of one or more of the following values:

1 = trace the read (input) data

2 = trace the write (output) data

4 = trace the TSI interrupt services

8 = trace the application IOCH services

16 = trace the user's data

For example, if you want to trace both read and write data, specify 3 for the TraceLev parameter. If you want to trace read, write, and user's data, specify 19 for the TraceLev parameter.

The most commonly used trace level is for I/O passing through the TSI service layer (TraceLev = 3). TSI also provides the interrupt and application I/O completion handler (IOCH) trace levels within TSI to assist the application in troubleshooting the IOCH mechanism. The user data trace level allows the application to store its own data in the trace buffer.

Note TSI does not decode user data with its tsidecode program (Section C.2.2).

You can turn tracing *on* or *off* at any time after TSI is initialized using tPoll with the TSI_POLL_TRACE_ON or TSI_POLL_TRACE_OFF options. Tracing is done internally with the TSI trace buffer. Trace data is not written to the trace file until tTerm is called or tPoll is called with the TSI_POLL_TRACE_WRITE option. Therefore, your application should always call tTerm before it exits to the operating system. If tracing is required and is defined in the TSI configuration file, it is automatically *on* when tInit is called. You can use tPoll with the TSI_POLL_TRACE_STORE option to store your own trace buffer inside the TSI trace buffer. Refer to tPoll (Section 4.8 on page 100) for more information. Since TSI tracing does not involve disk I/O until tTerm is executed, there is little or no performance impact.

C.2.2 Decoded Trace Layout

You can run either the tsidecode or dlidecode program against the trace file produced by TSI (run dlidecode only if your application is using DLI). The decoded output is displayed on the screen for UNIX-like systems. In VMS, the decoded output is written to the file named tsi.sum (or dli.sum). You can run dlidecode against the trace file produced by either DLI or TSI. Refer to the *Freeway Data Link Interface Reference Guide* for details on DLI tracing.

The format of the decoded trace can be described as follows. See Section C.2.3 for an actual decoded trace example.

```
line 1: Protogate 2000(C) TSI Trace Decoder
line 2: Max buffer size: xyz
line 3: TRACE SOURCE: yyy
-----------------------------------------------------------
line 4:   @@@@@ Actual Data offset aa Size = bb
line 5:              cc: hex data and printable ascii equivalent.
line 6:   @@@@@ Decode begins
line 7:   dd(desc)    Conn ee: time and date
line 8:       TSI header info:
line 9:       iHdrLen = ff iDataLen = gg uiSeqNo = hh
line 10:       iPacketType (ii) = textii iCmd (jj) = textjj
line 11:       DATA : hex data and printable ascii equivalent.
```

Each line of the above format is explained as follows:

line 1: indicates the copyright and the name of the tsidecode program. Note that tsidecode can run only against the TSI trace file, unlike dlidecode which can run on both DLI and TSI trace files.

line 2: prints the currently used maximum buffer size that is defined in the TSI configuration file (MaxBufSize on page 55). Note that the size excludes the overhead used by TSI; it describes the maximum number of actual data bytes allowed by TSI. See Section 2.3 on page 31.

line 3: prints the source of the trace.

line 4: describes the actual offset (aa) from the beginning of the trace file where this packet is stored and the number of bytes contained in this packet has (bb). Section C.2.4 describes how to read the TSI trace file in case you want to write your own decoder to decode your own trace data that you store in TSI trace buffer using tPoll with the TSI_POLL_TRACE_STORE option.

line 5: prints the actual hex values and their equivalent printable ASCII text. The offset (cc) is the actual offset from the beginning of the packet, based on 0. Each line contains up to 16 bytes from the trace packet. Note that line 5 can be repeated if the actual size of the trace packet is more than 16 bytes long.

line 6: indicates that the actual decoding begins. This is where the headers are broken into individual fields.

line 7: dd indicates the direction of the packet; dd can be ====> to indicate an outgoing packet or <==== to indicate an incoming packet. For non-I/O related packets (for example, user's data packet), dd is either ***** or #####. If the trace packet is for I/O, desc can be READ(1)/WRITE(2) n bytes. If the packet is a non-I/O packet, desc can be one of the following:

CONNECTION INTERRUPT BEGINS(4): indicates that TSI begins its interrupt handler to process I/O requests.

CONNECTION INTERRUPT ENDS(5): indicates that TSI ends its interrupt handler routine and is ready to return to TSI.

CONNECTION ISR(3): indicates that TSI is about to call the IOCH of a specific connection ID. The address of this IOCH was provided to TSI through the tConnect function.

APPLICATION ISR BEGINS(6): indicates that TSI is about to call the generic IOCH that was provided by the application to TSI through the tInit function.

APPLICATION ISR ENDS(7): indicates that the generic IOCH routine returns control to TSI.

AT(8): indicates that this trace buffer belongs to the application. The tsidecode program will not attempt to decode this packet. You have to write your own decode function to interpret your own data packet.

line 8: begins the TSI header information.

line 9 and line 10: show detailed information of the TSI header.

line 11: indicates the details of the data in both hex values and printable ASCII equivalent.

C.2.3 Example tsidecode Program Output

The following are example segments of decoded trace output from the TSI trace file using the tsidecode program (output using the dlidecode program would be virtually identical except for the first few lines):

```
Protogate 2000(C) TSI Trace Decoder

Max buffer size: 564

-----------------------------------------------------------------------------

@@@@@ Actual Data offset 8 Size = 0
@@@@@ Decoding begins

ERROR
            DATA  : 00 00 00 00 00 00 00 00 00 2e a8 3d 6a        ..........=j
```

```
-------------------------------------------------------------------------------

@@@@@ Actual Data offset 20 Size = 30
                000000: 00 00 00 14 00 00 00 0a 00 00 00 00 00 01 00 01  ................
                000016: 00 01 00 01 02 34 00 14 00 00 00 00 00 00        .....4........
@@@@@ Decoding begins

====>(WRITE 30 bytes)Conn 0: Fri Oct 21 15:15:07 1994

                TSI header info:
                iHdrLen = 20  iDataLen = 10 uiSeqNo = 0
                iPacketType(1) = CONTROL  iCmd(1) = BIND

                TSI BIND info:
                iMaxBufSize = 564 iMaxHdrSize = 20
                Segmenting = NO Buffering = NO Negotiable = NO


-------------------------------------------------------------------------------

@@@@@ Actual Data offset 62 Size = 30
                000000: 00 00 00 14 00 00 00 0a 00 00 00 00 00 01 00 01  ................
                000016: 00 01 00 01 02 34 00 14 00 00 00 00 00 00        .....4........
@@@@@ Decoding begins

====>(WRITE 30 bytes)Conn 1: Fri Oct 21 15:15:07 1994

                TSI header info:
                iHdrLen = 20  iDataLen = 10 uiSeqNo = 0
                iPacketType(1) = CONTROL  iCmd(1) = BIND

                TSI BIND info:
                iMaxBufSize = 564 iMaxHdrSize = 20
                Segmenting = NO Buffering = NO Negotiable = NO


-------------------------------------------------------------------------------

@@@@@ Actual Data offset 104 Size = 20
                000000: 00 00 00 14 00 00 00 00 00 00 00 06 00 01 00 06  ................
                000016: 00 01 00 01                                      ....
@@@@@ Decoding begins

<====(READ 20 bytes)Conn 0: Fri Oct 21 15:15:07 1994

                TSI header info:
                iHdrLen = 20  iDataLen = 0 uiSeqNo = 6
                iPacketType(1) = CONTROL  iCmd(6) = ACK
```

```
-------------------------------------------------------------------------------

@@@@@ Actual Data offset 136 Size = 96
                000000: 00 00 00 14 00 00 00 4c 00 00 00 01 00 02 00 00  .......L........
                000016: 00 01 00 01 00 00 00 00 00 00 00 00 00 0a 00 16  ................
                000032: 00 01 00 01 00 01 00 00 00 00 00 00 00 00 00 00  ................
                000048: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
                000064: 69 63 70 30 00 00 00 00 00 00 00 00 00 00 00 00  icp0............
                000080: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
@@@@@ Decoding begins

====>(WRITE 96 bytes)Conn 0: Fri Oct 21 15:15:07 1994

                TSI header info:
                iHdrLen = 20  iDataLen = 76 uiSeqNo = 1
                iPacketType(2) = DATA  iCmd(0) =

                DATA  : 00 00 00 00 00 00 00 00 00 0a 00 16 00 01 00 01  ................
                DATA  : 00 01 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
                DATA  : 00 00 00 00 00 00 00 00 00 00 00 00 69 63 70 30  ............icp0
                DATA  : 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
                DATA  : 00 00 00 00 00 00 00 00 00 00 00 00              ............


-------------------------------------------------------------------------------

@@@@@ Actual Data offset 244 Size = 20
                000000: 00 00 00 14 00 00 00 00 00 00 00 06 00 01 00 06  ................
                000016: 00 01 00 01                                      ....
@@@@@ Decoding begins

<====(READ 20 bytes)Conn 1: Fri Oct 21 15:15:07 1994

                TSI header info:
                iHdrLen = 20  iDataLen = 0 uiSeqNo = 6
                iPacketType(1) = CONTROL  iCmd(6) = ACK


-------------------------------------------------------------------------------

@@@@@ Actual Data offset 276 Size = 96
                000000: 00 00 00 14 00 00 00 4c 00 00 00 01 00 02 00 00  .......L........
                000016: 00 01 00 01 00 00 00 00 00 00 00 00 00 0a 00 16  ................
                000032: 00 01 00 01 00 01 00 01 00 00 00 00 00 00 00 00  ................
                000048: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
                000064: 69 63 70 30 00 00 00 00 00 00 00 00 00 00 00 00  icp0............
                000080: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
@@@@@ Decoding begins
```

```
====>(WRITE 96 bytes)Conn 1: Fri Oct 21 15:15:07 1994

                TSI header info:
                iHdrLen = 20  iDataLen = 76 uiSeqNo = 1
                iPacketType(2) = DATA  iCmd(0) =

                DATA  : 00 00 00 00 00 00 00 00 00 0a 00 16 00 01 00 01  ................
                DATA  : 00 01 00 01 00 00 00 00 00 00 00 00 00 00 00 00  ................
                DATA  : 00 00 00 00 00 00 00 00 00 00 00 00 69 63 70 30  ............icp0
                DATA  : 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
                DATA  : 00 00 00 00 00 00 00 00 00 00 00 00              ............


-------------------------------------------------------------------------------

@@@@@ Actual Data offset 384 Size = 20
                000000: 00 00 00 14 00 00 00 40 00 00 00 01 00 02 00 00  .......@........
                000016: 00 01 00 01                                      ....
@@@@@ Decoding begins

<====(READ 20 bytes)Conn 0: Fri Oct 21 15:15:07 1994

                TSI header info:
                iHdrLen = 20  iDataLen = 64 uiSeqNo = 1
                iPacketType(2) = DATA  iCmd(0) =



-------------------------------------------------------------------------------

@@@@@ Actual Data offset 416 Size = 64
                000000: 00 00 00 00 00 00 00 00 00 0a 00 16 00 01 00 01  ................
                000016: 00 00 00 00 00 03 00 00 00 00 00 00 00 00 00 00  ................
                000032: 00 00 00 14 00 00 00 00 00 03 00 00 46 72 65 65  ............Free
                000048: 77 61 79 20 52 65 6c 65 61 73 65 20 32 2e 30 00  way Release 2.0.
@@@@@ Decoding begins

<====(READ 64 bytes)Conn 0: Fri Oct 21 15:15:07 1994


                DATA  : 00 00 00 00 00 00 00 00 00 0a 00 16 00 01 00 01  ................
                DATA  : 00 00 00 00 00 03 00 00 00 00 00 00 00 00 00 00  ................
                DATA  : 00 00 00 14 00 00 00 00 00 03 00 00 46 72 65 65  ............Free
                DATA  : 77 61 79 20 52 65 6c 65 61 73 65 20 32 2e 30 00  way Release 2.0.

-------------------------------------------------------------------------------
```

C.2.4 Trace Binary Format

You can use the following information to write your own decoder if you need to provide your own trace information. The trace file format is shown in Figure C–1.

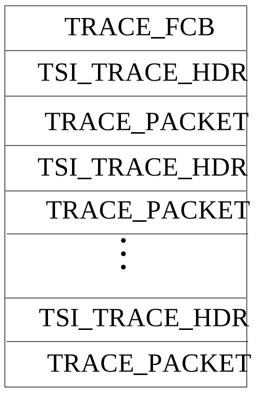


Figure C–1: TSI Trace File Format

Figure C–2 shows the TRACE_FCB ‘C’ structure.

```
typedef struct          _TRACE_FCB
{
            int         iMaxBufSize;
            short       iTraceSource;
            short       iPadding;
}                       TRACE_FCB, *PTRACE_FCB;
```

Figure C–2: TRACE_FCB ‘C’ Structure

Figure C–3 shows the format of each trace packet in the TSI_TRACE_HDR ‘C’ structure.

```
typedef struct          _TSI_TRACE_HDR
{
        unsigned short      usTrcType;          /* type of tracing              */
        unsigned short      usTrcConnID;        /* current connection ID        */
        int                 iTrcDataSize;       /* sizeof the trace packet      */
        time_t              tTrcTime            /* time stamp                   */
}                           TSI_TRACE_HDR, *PTSI_TRACE_HDR;
```

Figure C–3: TSI_TRACE_HDR ‘C’ Structure

C.3 Freeway Server Tracing

Tracing service is also provided from the Freeway server. Refer to the *Freeway User Guide* for more information. You can use the trace information from both the client application and the Freeway server to diagnose and troubleshoot your client application. The Freeway trace service is identical to that of the client application; however, the direction of the trace is the reverse of that of the client. For example, for the same data packet, the client would indicate a read packet while the server would indicate a write packet. Care therefore must be taken when translating the two traces.

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