VPI_TCP_SERVER

June 16, 2025

Jay Convertino

Contents

1 Usage

1.1 Introduction

VPI TCP Server is a library which allows for a Verilog simulation to interface with a TCP port. This library provides three functions.

- setup_tcp_server(ADDRESS, PORT), RETURNS File Descriptor (FD)
- recv_tcp_server(PORT, VECTOR), RETURNS number of bytes received (non-blocking, 0 is nothing available)
- send_tcp_server(PORT, VECTOR), RETURNS number of bytes send (non-blocking, 0 is nothing written)

Library supports up to 256 TCP server instances. Each instance is setup by setup_tcp_server. This returns a descriptor for that instance. Then that descriptor is used for nothing. The field PORT is used to associate setup_tcp_server with a recv_tcp_server and a send_tcp_server. This can be done in multiple calls.

You can use the following for including the library in your project:

```
dep_vpi:
  depend:
    - AFRL:vpi:tcp_server:1.0.0

targets:
  default: &default
    description: Default file set.
    filesets: [src, dep, dep_vpi]
```

1.2 Dependencies

The following are the dependencies of the cores.

- fusesoc 2.X
- iverilog (simulation)

1.2.1 fusesoc_info Depenecies

- dep_tb
  - AFRL:utility:sim_helper
- dep_gen
  - AFRL:utility:generators:1.0.0

2 Architecture

This VPI library provides three functions for the user to use during simulation for creating a TCP server. They are setup_tcp_server, recv_tcp_server, and send_tcp_server. These are used to setup the server on a port, receive data, and send data respectivly. These functions use ringbuffers and multithreading to seperate server I/O from the simulation so TCP access will not slow down the simulation.

The setup_tcp_server is given an address, usually local or a ethernet port address, to use and a port. It will attempt to use this information and create an active connection. The connection is stored and is based upon its port number. Meaning all send and recvs use the port number to differentiate the connects. This obviously has its flaws, but provides a simple interface to the end user. This function has to be called first before recv or send.

The recv_tcp_server will read data from the socket setup by setup_tcp_server. The port must match the port given setup. It will read and return the number of bytes into the vector. This will also return the number of bytes read. Since this is a non-blocking function this can be zero.

The send_tcp_server will write data to the socket setup by setup_tcp_server. The port must match the port given in setup. It will write and return the number of bytes written to the socket. This will also return the number of bytes written. This is non-blocking and can write zero bytes if it is unable to.

Please see 5 for more information per target.

3 Building

The all VPI TCP Server source files are written in C to target the VPI API from Verilog 2001. They should simulate in any modern simulation tool that has VPI support. The library comes as a fusesoc packaged core and can be included in any other testbench. Be sure to make sure you have meet the dependencies listed in the previous section.

3.1 fusesoc

Fusesoc is a system for building FPGA software without relying on the internal project management of the tool. Avoiding vendor lock in to Vivado or Quartus. These cores, when included in a project, can be easily integrated and targets created based upon the end developer needs. The core by itself is not a part of a system and should be integrated into a fusesoc based system. Simulations are setup to use fusesoc and are a part of its targets.

3.2 Source Files

3.2.1 fusesoc_info File List

- src
  - 'src/tcp_server.c': 'file_type': 'cSource'
  - 'src/send_tcp_server.c': 'file_type': 'cSource'
  - 'src/recv_tcp_server.c': 'file_type': 'cSource'
  - 'src/tcp_server.h': 'file_type': 'cSource', 'is_include_file': True
  - 'src/send_tcp_server.h': 'file_type': 'cSource', 'is_include_file': True
  - 'src/recv_tcp_server.h': 'file_type': 'cSource', 'is_include_file': True
  - 'src/tcp_server.sft': 'file_type': 'user'
- lib
  - 'lib_ringbuffer/build/libringBuffer.a': 'file_type': 'user', 'copyto': '.'
- header
  - 'lib_ringbuffer/ringBuffer.h': 'file_type': 'cSource', 'is_include_file': True
- tb
  - 'tb/tb_vpi.v': 'file_type': 'verilogSource'

3.3 Targets

3.3.1 fusesoc_info Targets

- default

  Info: Intergration default target for simulations.

- sim

  Info: Test VPI TCP server.

3.4 Directory Guide

Below highlights important folders from the root of the directory.

1. **docs** Contains all documentation related to this project.
    - **manual** Contains user manual and github page that are generated from the latex sources.
2. **src** Contains source files for tcp server vpi interface.
3. **tb** Contains test bench files.

4 Simulation

A barebones test bench for iverilog is included in tb/tb_vpi.v . This can be run from fusesoc with the following.

```
$ fusesoc run --target=sim AFRL:vpi:tcp_server:1.0.0
```

5 Code Documentation

- **TCP SERVER FILE SOURCE, DOXYGEN**

The next section documents the library.

TCP_SERVER

1.0

Generated by Doxygen 1.9.8

Chapter 1

Data Structure Documentation

1.1 s_process_data Struct Reference

`#include <tcp_server.h>`

Data Fields

- PLI_INT32 num_ab_val_pairs
- PLI_INT32 array_byte_size
- struct s_ringBuffer * p_ringbuffer
- pthread_t thread
- vpiHandle systf_handle
- vpiHandle arg1_handle
- vpiHandle arg2_handle

1.1.1 Field Documentation

1.1.1.1 arg1_handle

`vpiHandle s_process_data::arg1_handle`

1.1.1.2 arg2_handle

`vpiHandle s_process_data::arg2_handle`

1.1.1.3 array_byte_size

`PLI_INT32 s_process_data::array_byte_size`

1.1.1.4 num_ab_val_pairs

`PLI_INT32 s_process_data::num_ab_val_pairs`

1.1.1.5 p_ringbuffer

```
struct s_ringBuffer* s_process_data::p_ringbuffer
```

1.1.1.6 systf_handle

```
vpiHandle s_process_data::systf_handle
```

1.1.1.7 thread

```
pthread_t s_process_data::thread
```

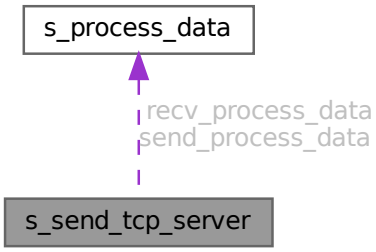
The documentation for this struct was generated from the following file:

- tcp_server.h

1.2 s_send_tcp_server Struct Reference

```
#include <tcp_server.h>
```

Collaboration diagram for s_send_tcp_server:



Data Fields

- int kill_thread
- struct pollfd poll_connection
- struct sockaddr_in * p_socket_info
- pthread_t connection_thread
- char * p_address
- unsigned short port
- vpiHandle systf_handle
- struct s_process_data recv_process_data
- struct s_process_data send_process_data

1.2.1 Field Documentation

1.2.1.1 connection_thread

```
pthread_t s_send_tcp_server::connection_thread
```

1.2.1.2 kill_thread

```
int s_send_tcp_server::kill_thread
```

1.2.1.3 p_address

```
char* s_send_tcp_server::p_address
```

1.2.1.4 p_socket_info

```
struct sockaddr_in* s_send_tcp_server::p_socket_info
```

1.2.1.5 poll_connection

```
struct pollfd s_send_tcp_server::poll_connection
```

1.2.1.6 port

```
unsigned short s_send_tcp_server::port
```

1.2.1.7 recv_process_data

```
struct s_process_data s_send_tcp_server::recv_process_data
```

1.2.1.8 send_process_data

```
struct s_process_data s_send_tcp_server::send_process_data
```

1.2.1.9 systf_handle

```
vpiHandle s_send_tcp_server::systf_handle
```

The documentation for this struct was generated from the following file:

- tcp_server.h

Chapter 2

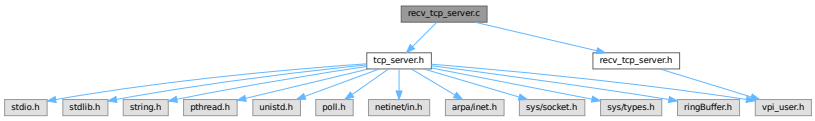
File Documentation

2.1 recv_tcp_server.c File Reference

Functions for TCP server data receive.

```
#include "tcp_server.h"
#include "recv_tcp_server.h"
```

Include dependency graph for recv_tcp_server.c:



Functions

- void * recv_thread (void *data)

  RECV TCP SETUP THREAD TO FILL RINGBUFFER.
- PLI_INT32 recv_tcp_server_end_sim_cb (p_cb_data data)

  RECEIVE TCP SERVER DATA END SIM CALLBACK.
- PLI_INT32 recv_tcp_server_start_sim_cb (p_cb_data data)

  RECEIVE TCP SERVER DATA START SIM CALLBACK.
- PLI_INT32 recv_tcp_server_compiletf (PLI_BYTE8 *user_data)

  Compile time call, check the arguments for validity.
- PLI_INT32 recv_tcp_server_calltf (PLI_BYTE8 *user_data)

  recv_tcp_server_calltf is a callback for the recv_tcp_server function.

2.1.1 Detailed Description

Functions for TCP server data receive.

Author

Jay Convertino(johnathan.convertino.1@us.af.mil)

Date

2024-02-22

2.1.2 Function Documentation

2.1.2.1 recv_tcp_server_calltf()

```
PLI_INT32 recv_tcp_server_calltf (
             PLI_BYTE8 * user_data )
```

recv_tcp_server_calltf is a callback for the recv_tcp_server function.

read_binary_calltf is a callback for the recv_tcp_server function.

2.1.2.2 recv_tcp_server_compiletf()

```
PLI_INT32 recv_tcp_server_compiletf (
             PLI_BYTE8 * user_data )
```

Compile time call, check the arguments for validity.

RECEIVE TCP SERVER DATA COMPILE SETUP.

2.1.2.3 recv_tcp_server_end_sim_cb()

```
PLI_INT32 recv_tcp_server_end_sim_cb (
            p_cb_data data )
```

RECEIVE TCP SERVER DATA END SIM CALLBACK.

2.1.2.4 recv_tcp_server_start_sim_cb()

```
PLI_INT32 recv_tcp_server_start_sim_cb (
            p_cb_data data )
```

RECEIVE TCP SERVER DATA START SIM CALLBACK.

2.1.2.5 recv_thread()

```
void * recv_thread (
            void * data )
```

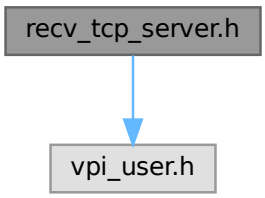
RECV TCP SETUP THREAD TO FILL RINGBUFFER.

2.2 recv_tcp_server.h File Reference

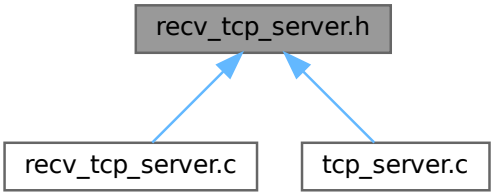
Functions for TCP server data receive.

```
#include <vpi_user.h>
```

Include dependency graph for recv_tcp_server.h:



This graph shows which files directly or indirectly include this file:



Functions

- PLI_INT32 recv_tcp_server_compiletf (PLI_BYTE8 *user_data)
  RECEIVE TCP SERVER DATA COMPILE SETUP.
- PLI_INT32 recv_tcp_server_calltf (PLI_BYTE8 *user_data)
  read_binary_calltf is a callback for the recv_tcp_server function.

2.2.1 Detailed Description

Functions for TCP server data receive.

Author

Jay Convertino(johnathan.convertino.1@us.af.mil)

Date

2024-02-22

$recv_tcp_server takes 2 arguments. First the fd returned from $setup_tcp_server, and then a register for data in size bytes. The function returns the number of bytes read.

2.2.2 Function Documentation

2.2.2.1 recv_tcp_server_calltf()

```
PLI_INT32 recv_tcp_server_calltf (
             PLI_BYTE8 * user_data )
```

read_binary_calltf is a callback for the recv_tcp_server function.

read_binary_calltf is a callback for the recv_tcp_server function.

2.2.2.2 recv_tcp_server_compiletf()

```
PLI_INT32 recv_tcp_server_compiletf (
             PLI_BYTE8 * user_data )
```

RECEIVE TCP SERVER DATA COMPILE SETUP.

RECEIVE TCP SERVER DATA COMPILE SETUP.

2.3 recv_tcp_server.h

Go to the documentation of this file.

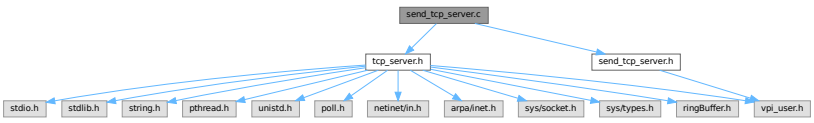
```
00001 //*************************************************************************
00030 //*************************************************************************
00031
00032 #ifndef __RECV_TCP_SERVER
00033 #define __RECV_TCP_SERVER
00034
00035 // Include the VPI library of routines (object based).
00036 #include <vpi_user.h>
00037
00038 //*************************************************************************
00040 //*************************************************************************
00041 PLI_INT32 recv_tcp_server_compiletf(PLI_BYTE8 *user_data);
00042
00043 //*************************************************************************
00045 //*************************************************************************
00046 PLI_INT32 recv_tcp_server_calltf(PLI_BYTE8 *user_data);
00047
00048 #endif
```

2.4 send_tcp_server.c File Reference

Functions for TCP server data send.

```
#include "tcp_server.h"
#include "send_tcp_server.h"
```

Include dependency graph for send_tcp_server.c:



Functions

- void * send_thread (void *data)

  SEND TCP SERVER THREAD TO EMPTY RINGBUFFER.
- PLI_INT32 send_tcp_server_end_sim_cb (p_cb_data data)

  SEND TCP SERVER DATA END SIM CALLBACK.
- PLI_INT32 send_tcp_server_start_sim_cb (p_cb_data data)

  SEND TCP SERVER DATA START SIM CALLBACK.
- PLI_INT32 send_tcp_server_compiletf (PLI_BYTE8 *user_data)

  Compile time call, check the arguments for validity.
- PLI_INT32 send_tcp_server_calltf (PLI_BYTE8 *user_data)

  Called by the simulator, each time it is requested.

2.4.1 Detailed Description

Functions for TCP server data send.

Author

Jay Convertino(johnathan.convertino.1@us.af.mil)

Date

2024-23-02

2.4.2 Function Documentation

2.4.2.1 send_tcp_server_calltf()

```
PLI_INT32 send_tcp_server_calltf (
             PLI_BYTE8 * user_data )
```

Called by the simulator, each time it is requested.

2.4.2.2 send_tcp_server_compiletf()

```
PLI_INT32 send_tcp_server_compiletf (
             PLI_BYTE8 * user_data )
```

Compile time call, check the arguments for validity.

SEND TCP SERVER DATA COMPILE SETUP.

2.4.2.3 send_tcp_server_end_sim_cb()

```
PLI_INT32 send_tcp_server_end_sim_cb (
             p_cb_data data )
```

SEND TCP SERVER DATA END SIM CALLBACK.

2.4.2.4 send_tcp_server_start_sim_cb()

```
PLI_INT32 send_tcp_server_start_sim_cb (
             p_cb_data data )
```

SEND TCP SERVER DATA START SIM CALLBACK.

2.4.2.5 send_thread()

```
void * send_thread (
             void * data )
```

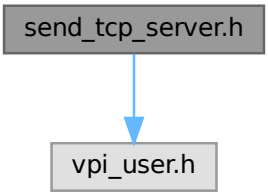
SEND TCP SERVER THREAD TO EMPTY RINGBUFFER.

2.5 send_tcp_server.h File Reference

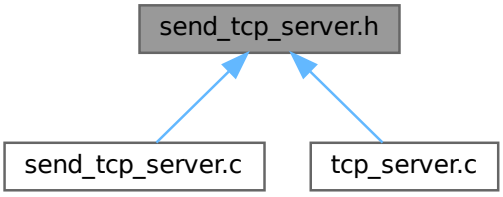
Function to send data over a tcp server.

```
#include <vpi_user.h>
```

Include dependency graph for send_tcp_server.h:



This graph shows which files directly or indirectly include this file:



Functions

- PLI_INT32 send_tcp_server_compiletf (PLI_BYTE8 *user_data)
  SEND TCP SERVER DATA COMPILE SETUP.
- PLI_INT32 send_tcp_server_calltf (PLI_BYTE8 *user_data)
  Called by the simulator, each time it is requested.

2.5.1 Detailed Description

Function to send data over a tcp server.

Author

Jay Convertino(johnathan.convertino.1@us.af.mil)

Date

2024-24-2

2.5.2 Function Documentation

2.5.2.1 send_tcp_server_calltf()

```
PLI_INT32 send_tcp_server_calltf (
            PLI_BYTE8 * user_data )
```

Called by the simulator, each time it is requested.

2.5.2.2 send_tcp_server_compiletf()

```
PLI_INT32 send_tcp_server_compiletf (
            PLI_BYTE8 * user_data )
```

SEND TCP SERVER DATA COMPILE SETUP.

SEND TCP SERVER DATA COMPILE SETUP.

2.6 send_tcp_server.h

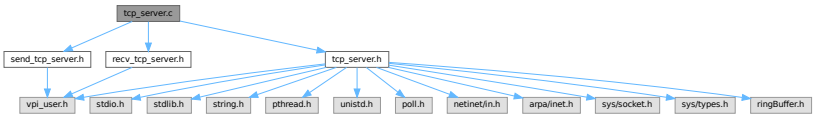
Go to the documentation of this file.

```
00001 //************************************************************************
00027 //************************************************************************
00028
00029 #ifndef __SEND_TCP_SERVER
00030 #define __SEND_TCP_SERVER
00031
00032 // Include the VPI library of routines (object based).
00033 #include <vpi_user.h>
00034
00035 //************************************************************************
00037 //************************************************************************
00038 PLI_INT32 send_tcp_server_compiletf(PLI_BYTE8 *user_data);
00039
00040 //************************************************************************
00042 //************************************************************************
00043 PLI_INT32 send_tcp_server_calltf(PLI_BYTE8 *user_data);
00044
00045 #endif
```

2.7 tcp_server.c File Reference

```
#include "send_tcp_server.h"
#include "recv_tcp_server.h"
#include "tcp_server.h"
```

Include dependency graph for tcp_server.c:



Functions

- void * connection_keep_alive (void *p_data)
- PLI_INT32 setup_tcp_server_start_sim_cb (p_cb_data data)

  SETUP TCP SERVER DATA START SIM CALLBACK.
- PLI_INT32 setup_tcp_server_end_sim_cb (p_cb_data data)

  SETUP TCP SERVER END SIM CALLBACK.
- PLI_INT32 tcp_server_sizetf (PLI_BYTE8 *user_data)

  Returns the size, in bits, of the function return type.
- PLI_INT32 setup_tcp_server_compiletf (PLI_BYTE8 *user_data)

  Compile time call, check the arguments for validity.
- PLI_INT32 setup_tcp_server_calltf (PLI_BYTE8 *user_data)

  setup_tcp_server_calltf is the callback for the setup_tcp_server function.
- void recv_tcp_server_reg_systf (void)

  Setup recv_tcp_server function.
- void send_tcp_server_reg_systf (void)

  Setup send_tcp_server function.
- void setup_tcp_server_reg_systf (void)

  Setup setup_tcp_server function.

Variables

- unsigned int g_num_of_connections = 0
- struct s_send_tcp_server g_send_tcp_server [MAX_CONNECTIONS]
- void(* vlog_startup_routines [ ])(void)

  register the new file functions

2.7.1 Function Documentation

2.7.1.1 connection_keep_alive()

```
void * connection_keep_alive (
            void * p_data )
```

2.7.1.2 recv_tcp_server_reg_systf()

```
void recv_tcp_server_reg_systf (
            void  )
```

Setup recv_tcp_server function.

2.7.1.3 send_tcp_server_reg_systf()

```
void send_tcp_server_reg_systf (
            void  )
```

Setup send_tcp_server function.

2.7.1.4 setup_tcp_server_calltf()

```
PLI_INT32 setup_tcp_server_calltf (
            PLI_BYTE8 * user_data )
```

setup_tcp_server_calltf is the callback for the setup_tcp_server function.

2.7.1.5 setup_tcp_server_compiletf()

```
PLI_INT32 setup_tcp_server_compiletf (
            PLI_BYTE8 * user_data )
```

Compile time call, check the arguments for validity.

2.7.1.6 setup_tcp_server_end_sim_cb()

```
PLI_INT32 setup_tcp_server_end_sim_cb (
            p_cb_data data )
```

SETUP TCP SERVER END SIM CALLBACK.

2.7.1.7 setup_tcp_server_reg_systf()

```
void setup_tcp_server_reg_systf (
             void  )
```

Setup setup_tcp_server function.

2.7.1.8 setup_tcp_server_start_sim_cb()

```
PLI_INT32 setup_tcp_server_start_sim_cb (
             p_cb_data data )
```

SETUP TCP SERVER DATA START SIM CALLBACK.

2.7.1.9 tcp_server_sizetf()

```
PLI_INT32 tcp_server_sizetf (
             PLI_BYTE8 * user_data )
```

Returns the size, in bits, of the function return type.

2.7.2 Variable Documentation

2.7.2.1 g_num_of_connections

```
unsigned int g_num_of_connections = 0
```

2.7.2.2 g_send_tcp_server

```
struct s_send_tcp_server g_send_tcp_server[MAX_CONNECTIONS]
```

2.7.2.3 vlog_startup_routines

```
void(* vlog_startup_routines[])(void) (
             void  )
```

Initial value:

```
= {
  recv_tcp_server_reg_systf,
  send_tcp_server_reg_systf,
  setup_tcp_server_reg_systf,
  0
}
```

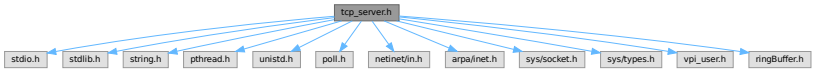
register the new file functions

2.8 tcp_server.h File Reference

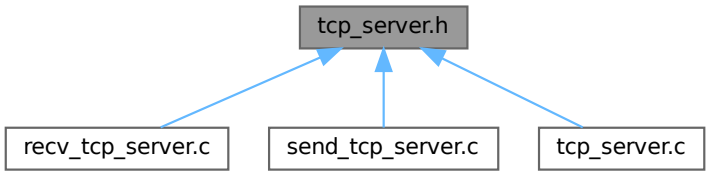
Functions to write raw binary files properly in verilog.

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <pthread.h>
#include <unistd.h>
#include <poll.h>
#include <netinet/in.h>
#include <arpa/inet.h>
#include <sys/socket.h>
#include <sys/types.h>
#include <vpi_user.h>
#include "ringBuffer.h"
```

Include dependency graph for tcp_server.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct s_process_data
- struct s_send_tcp_server

Macros

- #define BUFFSIZE (1 << 23)
- #define DATACHUNK (1 << 21)
- #define MAX_CONNECTIONS 256
- #define RECV_NAME "$recv_tcp_server"
- #define SEND_NAME "$send_tcp_server"
- #define SETUP_NAME "$setup_tcp_server"

Variables

- struct s_send_tcp_server g_send_tcp_server [MAX_CONNECTIONS]

2.8.1 Detailed Description

Functions to write raw binary files properly in verilog.

Functions to create multiple TCP servers.

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2.8.2 Macro Definition Documentation

2.8.2.1 BUFFSIZE

```
#define BUFFSIZE (1 << 23)
```

2.8.2.2 DATACHUNK

```
#define DATACHUNK (1 << 21)
```

2.8.2.3 MAX_CONNECTIONS

```
#define MAX_CONNECTIONS 256
```

2.8.2.4 RECV_NAME

```
#define RECV_NAME "$recv_tcp_server"
```

2.8.2.5 SEND_NAME

```
#define SEND_NAME "$send_tcp_server"
```

2.8.2.6 SETUP_NAME

```
#define SETUP_NAME "$setup_tcp_server"
```

2.8.3 Variable Documentation

2.8.3.1 g_send_tcp_server

```
struct s_send_tcp_server g_send_tcp_server[MAX_CONNECTIONS]  [extern]
```

2.9 tcp_server.h

Go to the documentation of this file.

```
00001 //*****************************************************************************
00027 //*****************************************************************************
00028
00029 #ifndef __VPI_TCP_SERVER
00030 #define __VPI_TCP_SERVER
00031
00032 // c standard libraries
00033 #include <stdio.h>
00034 #include <stdlib.h>
00035 #include <string.h>
00036 // other libs
00037 // threads
00038 #include <pthread.h>
00039 // tcp
00040 #include <unistd.h>
00041 #include <poll.h>
00042 #include <netinet/in.h>
00043 #include <arpa/inet.h>
00044 #include <sys/socket.h>
00045 #include <sys/types.h>
00046 // Include the VPI library of routines (object based).
00047 #include <vpi_user.h>
00048 // include ringbuffer library
00049 #include "ringBuffer.h"
00050
00051 //ring buffer sizes
00052 // 4 MB
00053 #define BUFFSIZE  (1 << 23)
00054 // 1 MB
00055 #define DATACHUNK (1 << 21)
00056
00057 #define MAX_CONNECTIONS 256
00058
00059 #define RECV_NAME  "$recv_tcp_server"
00060 #define SEND_NAME  "$send_tcp_server"
00061 #define SETUP_NAME "$setup_tcp_server"
00062
00063 struct s_process_data
00064 {
00065   // PLI_INT32 error;
00066   PLI_INT32 num_ab_val_pairs;
00067   PLI_INT32 array_byte_size;
00068
00069   struct s_ringBuffer *p_ringbuffer;
00070
00071   pthread_t thread;
00072
00073   vpiHandle systf_handle;
00074   vpiHandle arg1_handle;
00075   vpiHandle arg2_handle;
00076 };
00077
00078 struct s_send_tcp_server
00079 {
00080   int kill_thread;
00081
00082   struct pollfd poll_connection;
00083   struct sockaddr_in *p_socket_info;
00084
00085   pthread_t connection_thread;
00086
00087   char *p_address;
00088   unsigned short port;
00089
00090   vpiHandle systf_handle;
00091
00092   struct s_process_data recv_process_data;
00093   struct s_process_data send_process_data;
00094 };
00095
00096 extern struct s_send_tcp_server g_send_tcp_server[MAX_CONNECTIONS];
00097
00098 #endif
```

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