OPEN AT® IP CONNECTIVITY DEVELOPMENT GUIDE (WIPlib V2.00)

Revision: 005
Date: March 16, 2007

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Open AT® IP Connectivity Development Guide (WIPlib V2.00)

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Overview

The aim of this document is to provide Wavecom customers with a full description of the APIs associated with the Open AT® IP Connectivity library.

Document History

Level	Date	History Of the Evolution	Writer
001	May 22 2006	Creation	Wavecom
002	August 7 2006	Preliminary	Wavecom
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004	December 15 2006	Final	Wavecom
005	March 16, 2007	Update for maintenance version	Wavecom

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1 Introduction

1.1 Related Documents

None

1.2 Abbreviations and Glossary

ADL	Application Development Layer
API	Application Programming Interface
APN	Access Point Name
AT	Attention
BSD	Berkeley Software Distribution
CHAP	Challenge Handshake Authentication Protocol
CID	Context Identifier
DNS	Domain Name Service
EDGE	Enhanced Data rates for GSM Evolution
FTP	File Transfer Protocol
GGSN	Gateway GPRS Support Node
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communication
HTTP	Hyper Text Transfer Protocol
ICMP	Internet Control Message Protocol
IGMP	Internet Group Management Protocol
IMAP	Internet Message Access Protocol
IN/OUT/GLB	In, Out or Global. See Glossary.
IP	Internet Protocol
IPCP	Internet Protocol Control Protocol
LCP	Link Control Protocol
M	Mandatory
MS-CHAP	Microsoft Challenge Handshake Authentication
MS	Mobile Station
MSS	Maximum Segment Size
NA	Not Applicable
NU	Not Used
O	Optional
PAP	Password Authentication Protocol

PDP	Packet Data Protocol
POP3	Post Office Protocol
POSIX	Portable Operating System Interface
PPP	Point-to-Point Protocol
RFC	Request For Comments
SMS	Short Messaging Service
SMTP	Simple Mail Transfer Protocol
TCP	Transmission Control Protocol
TOS	Type Of Service
TTL	Time To Live
UART	Universal Asynchronous Receiver Transmitter
UDP	User Data Protocol
USB	Universal Serial Bus
WIFI	Wireless Fidelity
3G	The third generation of developments in wireless technology

1.3 Glossary

In/out/Glb: used in function parameters:

- "In" if the parameter is given to the function
- "Out" if the parameter is the result of the function
- "Glb" (for Global) if the parameter is used for both

2 Global Architecture

2.1 Concepts

A network operation involves reading and writing data through channels. Once a channel is properly opened and set up, reading and writing through it is largely protocol independent.

Wavecom provides a generic, high-level API that abstracts the underlying protocols of communication channels. This API relies on the following key concepts:

Channels are opaque data which represent a means of communication; for example, an open and connected socket. This interface could be reused for other protocols such as X -MODEM over an UART, SMS over GSM.

Events, being single-threaded, need non-blocking operations. The channels have a callback function registered with them, which describe how to react to noteworthy events, mainly read, write, close and an error.

Options are used to provide user defined configurations. The APIs are available in two formats.

APIs with no options (BASIC): These APIs uses default settings. For example, wip_netInit API is used to initialize the WIP library with default settings.

APIs with options (OPT): These APIs accept a series of variable arguments of the form (OPTION_ID_0, optionValue_0, OPTION_ID_n, optionValue_n, END_MARKER) and are used to configure with user defined settings .Note that the options provided by the user will be checked at runtime for consistency.

The channels that are implemented to support IP are:

- TCP server sockets
- TCP communication sockets
- UDP sockets (communication sockets, as there is no notion of server in UDP)
- ICMP/Ping sockets

2.2 Feature Description

Open AT® customers are provided with an advanced set of APIs that give them complete IP connectivity control. This allows an Open AT® application to communicate using IP connectivity on different types of bearers (UART, GSM, GPRS, and EDGE) simultaneously.

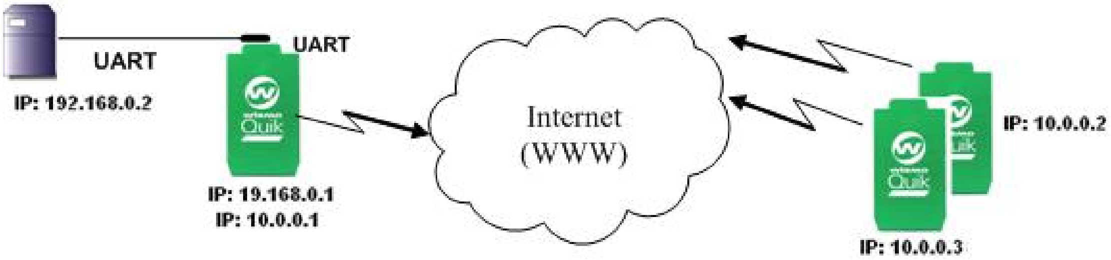


Figure 1 Communication between Four Equipments

Notice that Wireless CPU® #1(the one on the left) has two IP addresses, one for each link.

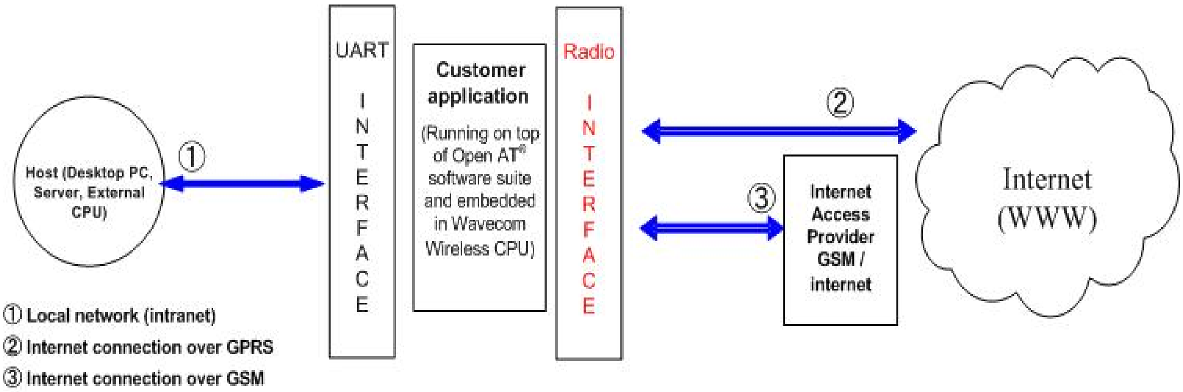

Host (Desktop PC, Server, External CPU)
①
UART INTERFACE
Customer application
(Running on top of Open AT® software suite and embedded in Wavecom Wireless CPU)
Radio INTERFACE
②
③
Internet Access Provider GSM / internet
Internet
(WWW)
① Local network (intranet)
② Internet connection over GPRS
③ Internet connection over GSM

Figure 2 Uses of the New IP Stack (Use Cases 2 and 3 are Exclusive)

Open AT® also supports 'pure' IP APIs which can provide better capabilities and control.

The socket abstraction layer gives high-level access to communication abilities, through a channel and its dedicated API. The following types of channels are implemented:

- a TCP channel implementation, which allows users to create and use client and server TCP sockets
- a UDP channel implementation, which allows users to create and use UDP sockets
- a PING channel implementation, which allows users to configure and send ICMP ECHO requests, or “pings”, and to receive feedback on response times, routing errors or timeout errors

The bearers are handled by the bearer manager which provides IP connectivity using various links. Several bearers can be activated simultaneously. The following links are currently supported:

- GSM data
- GPRS
- direct connection on an UART

Features of the TCP/IP protocol Stack include:

- IP, ICMP, UDP, TCP Protocols
- all RFC 1122 requirements for host-to-host interoperability
- fragmentation and reassembly of IP datagrams
- support for multiple network interfaces (forwarding of packets between interfaces is not enabled by default)
- loopback interface

Socket Layer:

- configuration of socket receive and send buffers
- control of some IP header fields such as TTL, TOS, "Don’t fragment" flag

TCP Sockets:

- congestion control (slow start, congestion avoidance, fast retransmit and fast recovery)
- option for disabling the Naggle algorithm
- immediate notification of all connection state changes
- support for normal connection termination and reset of the connection

DNS Resolver:

- integrated into the socket abstraction layer
- support for primary and secondary DNS servers

The PPP is required by GSM and UART bearers, the following features are supported:

- client and server mode
- authentication using PAP, CHAP, MS-CHAPv1 or MS-CHAPv2
- auto-configuration of IP address, primary and secondary DNS servers

2.3 New Interface

The new version of the IP stack provides a rich and simple user interface. The advantages of this new interface are as follows:

- clearly distinguishes the management of the bearer (GSM/GPRS) from the IP sockets management
- provides the user with the flexibility to configure and set IP related parameters. For example, during configuration of the bearer using PPP protocol, the user can select different authentication mechanisms such as PAP, CHAP/MS_CHAP
- provides an interface to configure the maximum number of sockets that can be used by the customer application
- allows the customer application to manage the socket dynamically (BSD-like interface)

2.4 Use Cases

This feature can be used by all Open AT® users who communicate with IP, using GPRS, serial links, or any IP-compatible physical peripherals (WIFI, Ethernet) or radio bearers (EDGE, 3G) supported by Wavecom Wireless CPU®.

The channel abstraction can also be used to encapsulate all kinds of network-oriented protocols such as X-MODEM, FTP, HTTP, POP, IMAP and SMS. With the uniform channel API, an application can change the communication channel it uses easily without any modification of its source code (except channel opening).

2.5 Channels Logical Hierarchy

Although there is no native support for object-oriented inheritance in C, different channels implementing various services are related to one another in terms of the services they support. These channels support a minimal number of common APIs which include creation, closing, reaction to events, and advanced configuration option lists. Most of the channels additionally support read and write operations. Many future channel types support concurrent download and upload of data, identified by a resource string: FTP, HTTP, IMAP, POP and access to local file system. These APIs defined as successive extensions should be seen as refinements of channel types and subtypes. To present them, we will specify abstract channel types, which introduce these APIs; actual protocols will be concrete implementations of these abstract interfaces.

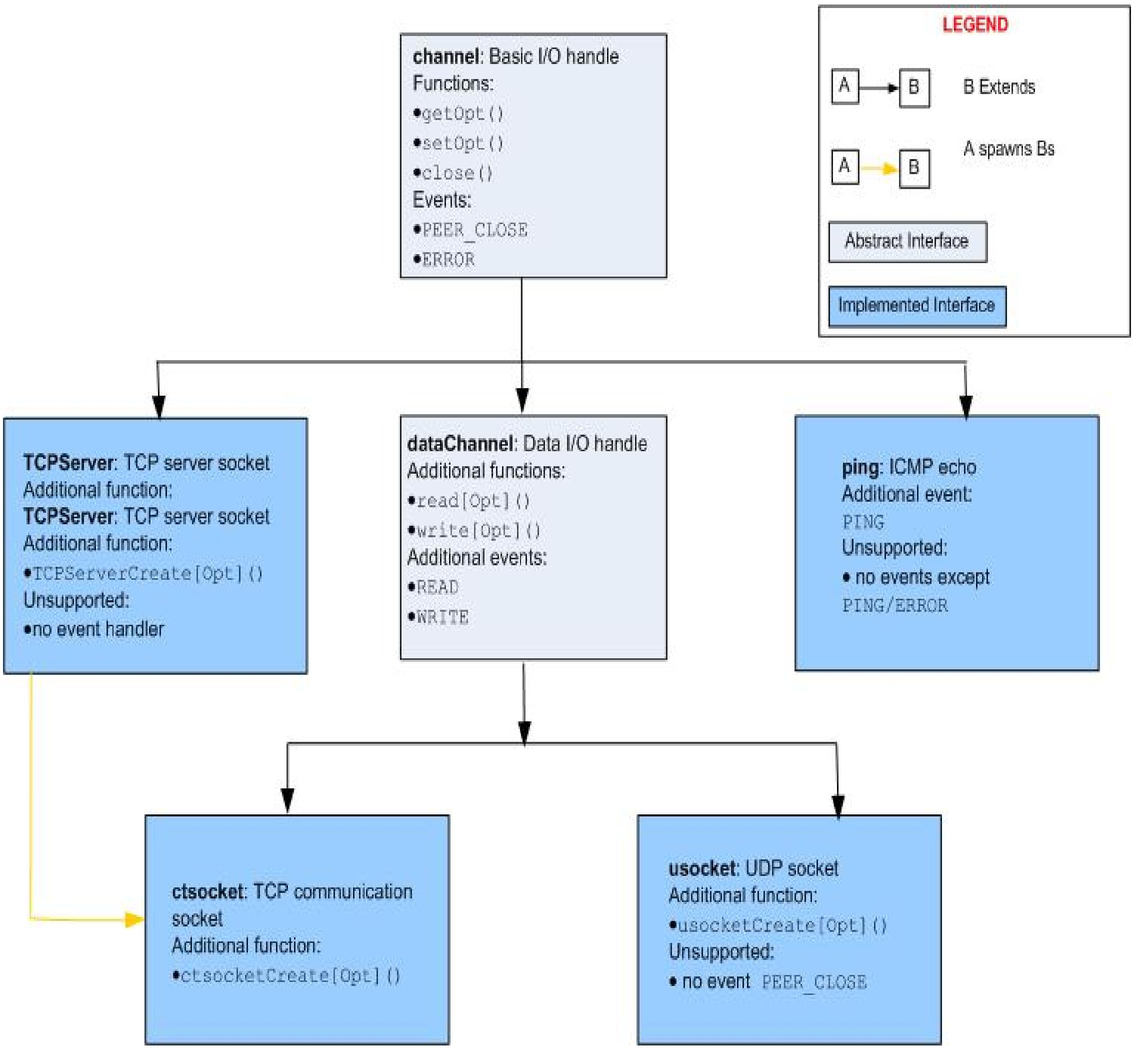


Figure 3 Channel Classes Hierarchy

2.5.1 Channel: Abstract, Basic I/O Handle

This channel supports the getOpts, setOpts and close operations. There is no real implementation of a channel; it is only the common interface for actual protocols.

Events that are supported by this channel include WIP_CEV_PEER_CLOSE and ERROR. ERROR has an errno number and an error message as parameters.

2.5.2 Data Channel: Abstract Data Transfer Handle

This is also an abstract channel type. It supports functions such as read, readOpts, write, writeOpts, as well as channel functions (close, getOpts, setOpts).

It supports events such as:

- READ (data has arrived)
- WRITE (buffer space has been freed to send some data)
- channel events

READ has an u32 readable field indicating the number of readable bytes, and WRITE has an u32 writable field which indicates how much data can be written. As a specialization of channel, it also supports the event WIP_CEV_PEER_CLOSE.

2.5.3 TCPServer: Server TCP Socket

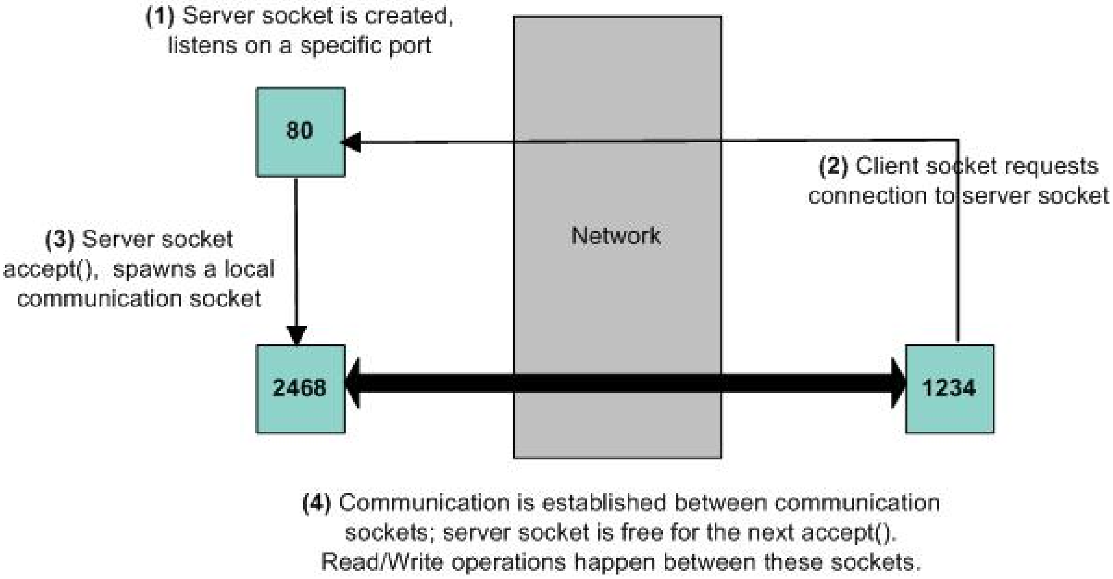

(1) Server socket is created, listens on a specific port
80
(2) Client socket requests connection to server socket
Network
(3) Server socket accept(), spawns a local communication socket
2468
1234
(4) Communication is established between communication sockets; server socket is free for the next accept(). Read/Write operations happen between these sockets.

Figure 4 TCP Socket Spawning Process

TCPServer does not have a specialized dataChannel; it neither supports read nor supports write. Its purpose is to listen for connection requests, accept them, and spawn a TCP communication socket peered with the one that requested the communication. TCPServers supports create, getopt, setopt and close operations.

2.5.3.1 Spawning

Spawning a communication is a common POSIX pattern. A globally known server channel creates secondary, communication channels. In the TCP server case, a server TCP socket listens on a familiar port such as 80 for HTTP and 21 for FTP. Whenever a remote socket contacts the server socket, a communication is established between the client socket and a specially created socket on the server side, which is spawned by the server socket. A direct communication between the server and the client socket must be avoided, as that would monopolize the server socket.

2.5.4 TCPClient: Communication TCP Socket

TCPClients read and write a reliable and ordered byte stream. In addition to the dataChannel interface it inherits from, it supports creation through wip_TCPClientCreate[Opts]() (creation can also happen through Spawning by TCPServer, equivalent of BSD's accept()) it also supports the Abort() and Shutdown() functions.

Creation of TCP clients can happen due to local creation and connection requests on a remote server socket. This includes:

- creating the socket
- connecting it to a host through a server socket
- setting up a callback to react to network events happening to the socket

All of this happens at once in a single wip_TCPServerCreate() API call, so that the user is not exposed to partially configured communication sockets that are not yet in a usable state. As soon as it is created, the socket is up and running, until it is closed and the user is not exposed to the POSIX automaton.

Shutdown allows closing communication in only one way. After a shutdown, one of the peered sockets will only be allowed to send data and the other one will only be allowed to receive them.

Aborting a socket is a special way to close it, generally in response to an error. If an abort is requested on one socket, the peer closes it with an error message and does not wait till the pending data is handled.

2.5.5 UDP: UDP Socket

UDP sockets support the reading and writing of datagrams which are atomic data packets. However this does not guarantee that they arrive at the destination or that they arrive in order and are not duplicated. In addition to channel operations, they support a specific wip_UDPCreate() creation function. Since UDP does not work in a connected mode, there is no way for a socket to receive a WIP_CEV_PEER_CLOSE event. Write operations on UDP sockets are performed synchronously.

2.6 Options

Options are used for advanced channel control. First, the configuration of an open channel can be altered with setOpts() and read with getOpts(). Some options are mainly used at creation time (for example, while creating an account name for an anonymous FTP session). To handle such initialization-time options, for every foobarCreate() function, there is a dual foobarCreateOpts() function, which takes the same parameters as the former, plus a series of options settings. Finally, some protocols support special forms of read and write operations. In these cases, readOpts() and writeOpts() functions must be used instead of read() and write(); as expected, they take the same parameters as their counterparts without options, plus a series of options.

2.6.1 Option Series

In C language, a variable number of parameters can be passed to a function, for which types are not checked (because of the special "..." parameter). For the functions that accept options, we rely on a set of int constant values which identify channel options, prefixed with WIP_COPT_; for example, WIP_COPT_USERNAME, WIP_COPT_TRUNCATE and WIP_COPT_PORT. An option identifier is followed by its actual contents. For instance, WIP_COPT_USERNAME is followed by a const ascii* pointer which contains the user name as a string. The option name indicates the next data type to the function. It is possible for an option to take several parameters, or no parameter at all. Finally, C does not provide a way for a function accepting a variable number of parameters, to know when it has reached its last parameter. Therefore, a special option identifier WIP_COPT_END, which takes no value, indicates the end of the option series.

2.6.2 Example

Here is a simple write operation:

```
err = wip_write ( channel, buffer, buf_len );
```

A more elaborate writing, with some special settings would be as follows:

```
err = wip_writeOpts ( channel, buffer, buf_len,

                      WIP_COPT_DONTFRAG, true,

                      WIP_COPT_TTL, 5,

                      WIP_COPT_END );
```

The set of options accepted by an Opts functions depend on the underlying protocol of the channel. The function checks at runtime whether or not the options it receives are supported, and causes an ENOTSUPPORTED error when it receives an unsupported option. It is better to sort these options by channel type than by function. Hence, the API specification will hereafter be split by channel type rather than by function.

3 Initialization of the IP Connectivity Library

The IP connectivity library must be initialized by an application. During initialization, some parameters of the TCP/IP stack can be provided, such as the number of sockets and the memory used by network buffers. The default configuration should provide settings that are equivalent to the previous version of the TCP/IP stack.

The other modules of the IP connectivity library, the bearer manager and the socket communication layer, are also initialized by the functions described in the sections that follow.

3.1 Required Header File

The header file for the IP connectivity initialization is wip_net.h.

3.2 The wip_netInit Function

The wip_netInit function initializes the TCP/IP stack with a default configuration. This function or its variant wip_netInitOpts must be first called by the application before using any IP communication library service.

The memory is allocated for each predefined socket, network buffer etc. The memory required for the configuration can be calculated by, the size of the different elements such as number of sockets, socket buffers etc. The size of the different element is as follows:

Option	Size in Bytes
WIP_NET_OPT_SOCK_MAX	380
WIP_NET_OPT_BUF_MAX	1544
WIP_NET_OPT_IP_ROUTE_MAX	24
WIP_NET_OPT_RSLV_QUERY_MAX	128
WIP_NET_OPT_RSLV_CACHE_MAX	224

3.2.1 Prototype

```
s8 wip_netInit ( void );
```

3.2.2 Parameters

None

3.2.3 Returned Values

This function returns

- 0 if the TCP/IP stack has been successfully initialized
- in case of an error, the function returns a negative error code WIP_NET_ERR_NO_MEM only if an application is subscribed to adl_errSubscribe() otherwise, the module restarts

3.3 The wip_netInitOpts Function

The wip_netInitOpts function initializes the TCP/IP stack with some user defined options. This function or its variant wip_netInit must be called first by the application before using any IP communication library service.

The memory is allocated for each predefined socket, network buffer etc. The memory required for the configuration can be calculated by, the size of the different elements such as number of sockets, socket buffers etc. Refer section 3.2 for the size of different elements.

Since memory management is a delicate thing, it is recommended not to change default values to bigger ones. However, in case customer application requires such specific needs, it is recommended to subscribe to error management services through adl_errSubscribe() API : it will let the application catching memory related traps.

3.3.1 Prototype

```
s8 wip_netInitOpts ( int   opt,

                     ... );
```

3.3.2 Parameters

opt:

In: First option in the list of options.

...:

In: This function supports several parameters. These parameters are a list of options. The list of option names must be followed by option values. The list must be terminated by WIP_NET_OPT_END. The following options are currently defined:

Option	Value	Description	Default
WIP_NET_OPT_SOCK_MAX	u16	Total number of sockets (UDP and TCP)	8
WIP_NET_OPT_BUF_MAX	u16	Total number of network buffers.	32
WIP_NET_OPT_IP_ROUTE_MAX	u16	Size of IP routing table.	0
WIP_NET_OPT_RSLV_QUERY_MAX	u16	Maximum number of DNS resolver queries	4
WIP_NET_OPT_RSLV_CACHE_MAX	u16	Size of DNS resolver cache.	4
WIP_NET_OPT_END	none	End of option list.	-

3.3.3 Returned Values

The function returns

- 0 if the TCP/IP stack has been successfully initialized
- In case of an error, a error code as described below:

Error code	Description
`WIP_NET_ERR_OPTION`	Invalid option
`WIP_NET_ERR_PARAM`	Invalid option value
`WIP_NET_ERR_NO_MEM`	Memory allocation error

NOTE	This function returns a negative error code WIP_NET_ERR_NO_MEM, only if an application is subscribed to adl_errSubscribe() otherwise, the Wireless CPU® restarts.

3.4 The wip_netExit Function

The wip_netExit function terminates the TCP/IP stack and releases all resources (memory) allocated by wip_netInit or wip_netInitOpts.

NOTE	All bearers must be closed before calling that function.

3.4.1 Prototype

```
s8 wip_netExit ( void );
```

3.4.2 Parameters

None

3.4.3 Returned Values

The function always returns 0.

3.5 The wip_netSetOpts Function

The wip_netSetOpts function is used to set TCP/IP protocols options. See the table in the Parameters section for the available options.

3.5.1 Prototype

```
s8 wip_netSetOpts ( int   opt,

                    ... );
```

3.5.2 Parameters

opt:

In: First option in the list of options

...:

In: This function supports several parameters. These parameters are a list of options. The list of option names must be followed by option values. The list must be terminated by WIP_NET_OPT_END. The following options are currently defined:

Option	Value	Description
WIP_NET_OPT_IP_TTL	u8	Default TTL of outgoing datagrams
WIP_NET_OPT_IP_TOS	u8	Default TOS of outgoing datagrams
WIP_NET_OPT_IP_FRAG_TIMEO	u16	Time to live in seconds of incomplete fragments
WIP_NET_OPT_TCP_MAXINITWIN	u16	Number of segments of initial TCP window
WIP_NET_OPT_TCP_MIN_MSS	u16	Default MSS for off-link connections
WIP_NET_OPT_END	none	End of option list

3.5.3 Returned Values

The function returns

- 0 on success
- In case of an error, a negative error code as described below:

Error Code	Description
`WIP_NET_ERR_OPTION`	Invalid option
`WIP_NET_ERR_PARAM`	Invalid option value

3.6 The wip_netGetOpts Function

The wip_netGetOpts function returns the current value of the TCP/IP protocols options that are passed in the argument list.

3.6.1 Prototype

```
s8 wip_netGetOpts ( int   opt,

                    ... );
```

3.6.2 Parameters

For a list of options followed by pointers to options values, see section on the wip_netSetOpts Function. The list must be terminated by WIP_NET_OPT_END.

3.6.3 Returned Values

The function returns

- 0 on success
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_NET_ERR_OPTION	Invalid option
WIP_NET_ERR_PARAM	Cannot get requested option value for internal reasons

4 IP Bearer Management

The IP bearer management API is used to initialize the TCP/IP network interfaces that work on top of the communication devices provided by ADL, including, but not limited to:

- UART
- GSM data
- GPRS

The bearer management module is responsible for establishing the IP connectivity of the TCP/IP stack and configuring all the sub-layers of the network interface such as PPP, GSM data, and GPRS.

The API is asynchronous, all functions are non-blocking and events are reported through a callback function.

Some types of bearers (like UART, GSM) support a server mode where the bearer can wait for incoming connections. Authentication of the caller must be carried out by the application.

The API is not related to a specific type of bearer, and all bearer specific settings are handled by the Options mechanism. Support for new types of bearer devices (like USB, Bluetooth, Ethernet, and so on) can be added by defining new options, without breaking the API.

Several network interfaces/bearers can be activated at the same time. IP routing is used for redirecting the data flow through the different interfaces.

The DNS resolver can also be configured by the bearer management module if the related information is provided by the server.

4.1 State Machine

The bearer management API exports a state machine to an application that is common for all bearer devices. The following states are defined:

State	Description
CLOSED	The IP bearer is closed; the device can be used by other software modules.
DISCONNECTED	The IP bearer is opened but not activated.
CONNECTING	Connection in progress.
CONNECTED	IP layer is configured; bearer can send and receive IP data
DISCONNECTING	Application has requested to disconnect the link; disconnection in progress.
PEER_DISCONNECTING	Peer has requested to disconnect the link or link-layer has detected a problem; disconnection in progress.
LISTENING	Waiting for connection requests/calls (server mode).
PEER_CONNECTING	Connection request from peer accepted by application, connection in progress.

The state transitions are shown in the figure below:

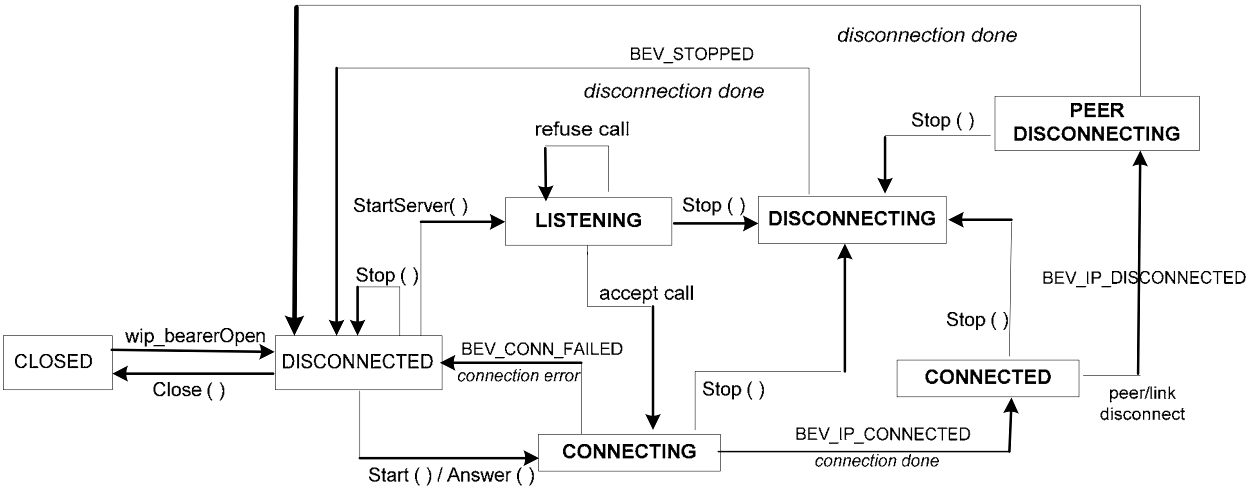


Figure 5 Bearer Management API State Diagram

The transitions are triggered by API function calls from the Open AT® application or by the events reported by the link layer.

During some transitions, an event is reported to an Open AT® application through the event notification callback function as follows:

Event	Description
`WIP_BEV_CONN_FAILED`	Connection failure, WIP_BOPT_ERROR returns the cause of the failure
`WIP_BEV_IP_CONNECTED`	IP communication ready
`WIP_BEV_IP_DISCONNECTED`	IP communication terminated, WIP_BOPT_ERROR returns the cause of the disconnection
`WIP_BEV_STOPPED`	Disconnection completed after wip_bearerStop was called

When the bearer is in the Listening state, an Open AT® application can accept or refuse the connection request, through the server event notification callback as shown below:

Action	Description
`Accept call`	The notification callback has accepted the connection
`Refuse call`	The notification callback has refused the connection

4.2 Required Header File

The header file for the IP bearer management is wip_bearer.h.

4.3 IP Bearer Management Types

4.3.1 The wip_bearer_t Structure

The wip_bearer_t type is an opaque structure that stores a bearer handle.

4.3.2 The wip_bearerType_e Type

The wip_bearerType_e enumeration stores the type of a bearer.

```
typedef enum {
  WIP_BEARER_NONE,
  WIP_BEARER_UART_PPP,
  WIP_BEARER_GSM_PPP,
  WIP_BEARER_GPRS
} wip_bearerType_e;
```

4.3.3 The wip_bearerInfo_t Structure

The wip_bearerInfo_t structure contains the name and type of a bearer.

```
typedef struct {
  ascii name[WIP_BEARER_NAME_MAX];
  wip_bearerType_e  type;
} wip_bearerInfo_t;
```

4.3.4 The wip_ifindex_t Structure

The wip_ifindex_t type is an opaque structure that stores an interface index. Interface indexes are used by the TCP/IP stack to reference a network interface.

4.4 The wip_bearerOpen Function

The wip_bearerOpen function attaches a bearer device to a network interface. Depending on the type of bearer, the network interface will implement PPP or will work in packet mode. The bearer is identified by a string. The caller must specify an event handler callback and a context to process the bearer-related asynchronous events.

The bearer is initialized with a default configuration that can be changed by wip_bearerSetOpts. The bearer and its associated network must be activated by wip_bearerStart or wip_bearerStartServer in order to enable IP communication.

4.4.1 Prototype

```
s8 wip_bearerOpen ( wip_bearer_t   *br,

                    const ascii   *device,

                    wip_bearerHandler_f   brHdlr,

                    void   *context );
```

4.4.2 Parameters

br:

Out: Filled with bearer handle if the open function was successful.

context:

In: Pointer to application defined context that is passed to the event handler callback.

device:

In: Bearer name, the currently supported devices are listed below:

Device	Description
UART1	UART 1, PPP mode
UART1x	DLC 'x' on UART 1, 'x' from 1 to 4, PPP mode
UART2	UART 2, PPP mode
UART2x	DLC 'x' on UART 2, 'x' from 1 to 4, PPP mode
GSM	GSM data, PPP mode
GPRS	GPRS, packet mode

NOTE	If one physical UART is multiplexed into DLCs (DLC1, DLC2, DLC3, DLC4), only one among these DLCs can be used for PPP over session.

brHdlr:

In: Event handler callback, the function has the following prototype:

```
typedef void (*wip_bearerHandler_f) ( wip_bearer_t   br,

                                      s8   event,

                                      void   *context );
```

br:

In: Bearer handle

event:

In: Event name, the following events are currently defined:

Event	Description
WIP_BEV_CONN_FAILED	Connection failure, WIP_BOPT_ERROR returns the cause of the failure
WIP_BEV_IP_CONNECTED	IP communication ready
WIP_BEV_IP_DISCONNECTED	IP communication terminated, WIP_BOPT_ERROR returns the cause of the disconnection
WIP_BEV_STOPPED	Disconnection completed after wip_bearerStop was called

context:

In: Pointer to application context

Returned Values:

None

4.4.3 Returned Values

The function returns

- 0 on success
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_BERR_NO_DEV	The device does not exist

Error Code	Description
`WIP_BERR_ALREADY`	The device is already opened
`WIP_BERR_NO_IF`	The network interface is not available
`WIP_BERR_NO_HDL`	No free handle

NOTE	WIP_BEV_DIAL_CALL and WIP_BEV_PPP_AUTH_PEER are to be used only in handler installed by wip_bearerStartServer; they have no meaning outside that context.

4.5 The wip_bearerClose Function

The wip_bearerClose function detaches the bearer from the network interface and releases all associated resources. If the bearer is not stopped the underlying connection is terminated but no event is generated. After the call, the associated TCP/IP network is closed and it will be available for another bearer association.

4.5.1 Prototype

```
s8 wip_bearerClose ( wip_bearer_t   br );
```

4.5.2 Parameters

br:

In: Bearer handle

4.5.3 Returned Values

The function returns

- 0 on success
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_BERR_BAD_HDL	Invalid handle
WIP_BERR_BAD_STATE	Bearer was not stopped before closing

4.6 The wip_bearerSetOpts Function

The wip_bearerSetOpts function sets configuration options of a bearer.

NOTE	It should be called before wip_bearerStart to setup the connection parameters

4.6.1 Prototype

```
s8 wip_bearerSetOpts ( wip_bearer_t   br,

                       int   opt,

                       ... );
```

4.6.2 Parameters

br:

In: Bearer handle

opt:

In: First option in the list of options

...:

In: List of option names followed by option values. The list must be terminated by WIP_BOPT_END.

The following options are currently defined:

Option	Value	Description
WIP_BOPT_NAME	ascii	Name of bearer device (get only)
WIP_BOPT_TYPE	wip_bearerType_e	Type of bearer (get only)
WIP_BOPT_IFINDEX	wip_ifindex_t	Index of network interface (get only)
WIP_BOPT_ERROR	s8	Error code indicating the cause of the disconnection (get only)
WIP_BOPT_RESTART	bool	Automatically restart server after connection is terminated
WIP_BOPT_END	none	End of option list

Option	Value	Description
WIP_BOPT_LOGIN	ascii	Username
WIP_BOPT_PASSWORD	ascii	Password
Dialing Options		
WIP_BOPT_DIAL_PHONENB	ascii	Phone number
WIP_BOPT_DIAL_RINGCOUNT	u16	Number of rings to wait before sending the WIP_BEV_DIAL_CALL event
WIP_BOPT_DIAL_MSNULLMODEM	bool	Enable MS-Windows null-modem protocol ("CLIENT"/"SERVER" handshake)
WIP_BOPT_DIAL_SPEED	u32	Speed (in bits per second) of the connection (get only) PPP Options
WIP_BOPT_PPP_PAP	bool	Allow PAP authentication
WIP_BOPT_PPP_CHAP	bool	Allow CHAP authentication
WIP_BOPT_PPP_MSCHAP1	bool	Allow MSCHAPv1 authentication
WIP_BOPT_PPP_MSCHAP2	bool	Allow MSCHAPv2 authentication
WIP_BOPT_PPP_ECHO	bool	Send LCP echo requests to check if peer is alive
GPRS options		
WIP_BOPT_GPRS_APN	ascii	Address of GGSN
WIP_BOPT_GPRS_CID	u8	Cid of the PDP context
WIP_BOPT_GPRS_HEADERCOMP	bool	Enable PDP header compression
WIP_BOPT_GPRS_DATACOMP	bool	Enable PDP data compression
IP Options		
WIP_BOPT_IP_ADDR	wip_in_addr_t	Local IP address
WIP_BOPT_IP_DST_ADDR	wip_in_addr_t	Destination IP address
WIP_BOPT_IP_DNS1	wip_in_addr_t	Address of primary DNS server

Option	Value	Description
WIP_BOPT_IP_DNS2	wip_in_addr_t	Address of secondary DNS server
WIP_BOPT_IP_SETDNS	bool	Configure DNS resolver when connection is established
WIP_BOPT_IP_SETGW	bool	Set interface as default gateway when connection is established

NOTE	The options WIP_BOPT_IP_DST_ADDR, WIP_BOPT_IP_DNS1 and WIP_BOPT_IP_DNS2 are "read only" for GPRS/GSM client.

4.6.3 Returned Values

The function returns

- 0 on success
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_BERR_BAD_HDL	Invalid handle
WIP_BERR_OPTION	Invalid option
WIP_BERR_PARAM	Invalid option value

4.7 The wip_bearerGetOpts Function

The wip_bearerGetOpts function retrieves configuration options and status variables of a bearer. It can be called after the connection is established to get the configuration parameters given by the peer (IP and DNS server addresses, link specific parameters, and so on).

4.7.1 Prototype

```
s8 wip_bearerGetOpts ( wip_bearer_t   br,

                       int   opt,

                       ... );
```

4.7.2 Parameters

br:

In: Bearer handle

opt:

In: First option in the list of options

...:

In/Out: For the list of options followed by pointers to option values, see section on the wip_bearerSetOpts Function.

4.7.3 Returned Values

The function returns

- 0 on success
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_BERR_BAD_HDL	Invalid handle
WIP_BERR_OPTION	Invalid option

4.8 The wip_bearerStart Function

The wip_bearerStart function establishes the bearer connection. Depending on the type of bearer the following operations are made:

UART Device

- start the window's null-modem protocol handshake (if enabled)
- start PPP in client mode, IP connectivity is established by the PPP interface

GSM Device

- setup GSM data connection
- start PPP in client mode, IP connectivity is established by the PPP interface

GPRS Device

- set up GPRS connection
- configure IP address and DNS resolver with information returned by GGSN and enable IP communication on the interface

NOTE	There is no mechanism that deals with actions conflicts on bearer management application side (ADL or AT parser in firmware). E.g. ATH from external terminal stops the bearer link for GSM/GPRS bearer. ATDxxx; will stop the GPRS bearer etc.

4.8.1 Prototype

```
s8 wip_bearerStart ( wip_bearer_t   br );
```

4.8.2 Parameters

br:

In: Bearer handle

4.8.3 Events

After calling wip_bearerStart, the following events can be received:

Event	Description
WIP_BEV_IP_CONNECTED	The connection is completed
WIP_BEV_IP_DISCONNECTED	Peer has disconnected the link, or a link failure has been detected, call wip_bearerGetOpts with WIP_BOPT_ERROR option to get the cause of disconnection

WIP_BEV_IP_DISCONNECTED	The connection has failed to complete, call wip_bearerGetOpts with WIP_BOPT_ERROR option to get the cause of failure

After a connection failure, the WIP_BOPT_ERROR option can returns one of the following error codes:

Error	Description
WIP_BERR_LINE_BUSY	Line busy
WIP_BERR_NO_ANSWER	No answer
WIP_BERR_NO_CARRIER	No carrier
WIP_BERR_NO_SIM	No SIM card inserted
WIP_BERR_PIN_NOT_READY	PIN code not entered
WIP_BERR_GPRS_FAILED	GPRS setup failure
WIP_BERR_PPP_LCP_FAILED	LCP negotiation failure
WIP_BERR_PPP_AUTH_FAILED	PPP authentication failure
WIP_BERR_PPP_IPCP_FAILED	IPCP negotiation failure
WIP_BERR_PPP_LINK_FAILED	PPP peer not responding to echo requests
WIP_BERR_PPP_TERM_REQ	PPP session terminated by peer
WIP_BERR_CALL_REFUSED	Incoming call refused

4.8.4 Returned Values

The function returns

- 0 on success
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_BERR_OK_INPROGRESS	Connection started, an event will be sent after completion
WIP_BERR_BAD_HDL	Invalid handle
WIP_BERR_BAD_STATE	The bearer is not stopped
WIP_BERR_DEV	Error from link layer initialization

4.9 The wip_bearerAnswer Function

The wip_bearerAnswer function is used to answer an incoming phone call and start the bearer in the passive (server) mode. This function is only supported by the GSM bearer.

4.9.1 Prototype

```
s8 wip_bearerAnswer ( wip_bearer_t   br,

                      wip_bearerServerHandler_f   brSrvHdlr,

                      void   *context );
```

4.9.2 Parameters

br:

In: Bearer handle

brSrvHdlr:

In: Server event handler callback. The brSrvHdlr can only handle WIP_BEV_PPP_AUTH_PEER kind of event. Refer section 4.10.2 for details on the call back function prototype.

context:

In: Pointer to application context

4.9.3 Events

See event list of wip_bearerStart

4.9.4 Returned Values

The function returns

- 0 on success
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_BERR_BAD_HDL	Invalid handle
WIP_BERR_BAD_STATE	Bearer is not stopped
WIP_BERR_NOT_SUPPORTED	Not a GSM bearer
WIP_BERR_DEV	Error from link layer initialization

4.10 The wip_bearerStartServer Function

The wip_bearerStartServer function starts the bearer in passive (server) mode. The bearer waits for incoming connection requests. The WIP_BEV_DIAL_CALL event is generated when a call is received, the server handler callback can accept or refuse the call. If the call is accepted, the protocol layers configuration is started.

UART Device

- wait for incoming PPP connection on the UART port (WIP_BEV_PPP_AUTH_PEER is received)

GSM Device

- first wait for incoming GSM call in data mode (WIP_BEV_DIAL_CALL is received => accepting the call will establish the radio link).
- then wait for incoming PPP connection on that radio link (WIP_BEV_PPP_AUTH_PEER is received)

GPRS Device

- this function is not supported by the GPRS bearer

4.10.1 Prototype

```
s8 wip_bearerStartServer ( wip_bearer_t   br,

                           wip_bearerServerHandler_f   brSrvHdlr,

                           void   *context );
```

4.10.2 Parameters

br:

In: Bearer handle

brSrvHdlr:

In: Server event handler callback, the function has the following prototype:

```
typedef s8 (*wip_bearerServerHandler_f) ( wip_bearer_t   br

                                          wip_bearerServerEvent_t   *event,

                                          void   *context );
```

event:

In: Event data, the structure bearerServerEvent_t has the following definition:

```
typedef struct {
  s8 kind;
  union wip_bearerServerEventContent_t {
    struct wip_bearerServerEventContentDialCall_t {
      ascii  *phonenb;
    } dial_call;
    struct wip_bearerServerEventContentPppAuth_t {
      ascii *user;
      int userlen;
      ascii *secret;
      int secretlen;
    } ppp_auth;
  } content;
} wip_bearerServerEvent_t;
```

The structure members are described below.

kind:

In: Event name. This contains the following event names:

Kind	Description
WIP_BEV_DIAL_CALL	Signals an incoming call. When this event occurs the structure dial_call should be used to extract the parameters. This structure contains the phone number of caller. The callback function must return a positive value to accept the call.
WIP_BEV_PPP_AUTH_PEER	Signals a PPP peer authentication request. When this event occurs the structure ppp_auth should be used to extract the parameters. This structure contains the user name provided by the peer. The callback function must return a positive value if the user name is correct, and fill the secret buffer with the secret data (password) associated with the user. The bearer will then check if the secret data given by the peer is correct.

phonenb:

Phone number of the caller

user:

User name given by caller

userlen:

Length of user name

secret:

Pointer to a buffer to be filled with the secret data of the user

secretlen:

Initialized with the maximum allowed length of the secret, must contains the length of the secret after the call.

context:

In: Pointer to application context.

Returned Values:

A positive value is returned to accept the incoming connection, else the call is rejected.

4.10.3 Events

See events of wip_bearerStart.

4.10.4 Returned Values

The function returns

- 0 on success
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_BERR_BAD_HDL	Invalid handle
WIP_BERR_BAD_STATE	The bearer is not stopped
WIP_BERR_NOT_SUPPORTED	Bearer does not support passive mode
WIP_BERR_DEV	Error from link layer initialization

4.11 The wip_bearerStop Function

The wip_bearerStop function terminates connection on a bearer. If the connection is still in progress, the connection is aborted. The following operations are made:

- the network interface is closed, and in case of PPP interface, the PPP connection is gradually stopped
- the link connection (GSM, GPRS) is terminated
- the WIP_BEV_STOPPED event is sent after all layers are properly shut down
- If the bearer is already stopped, then the function has no effect.

4.11.1 Prototype

```
s8 wip_bearerStop ( wip_bearer_t   br );
```

4.11.2 Parameters

br:

In: Bearer handle

4.11.3 Events

After calling wip_bearerStop, the following events can be received:

Event	Description
WIP_BEV_STOPPED	The bearer is disconnected

4.11.4 Returned Values

This function returns

- 0 on success
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_BERR_OK_INPROGRESS	Disconnection in progress, a WIP_BEV_STOPPED event will be sent after completion
WIP_BERR_BAD_HDL	Invalid handle

4.12 The wip_bearerGetList Function

The wip_bearerGetList function returns the list of all available bearers. This function always returns the same values for a given platform.

4.12.1 Prototype

```
wip_bearerInfo_t *wip_bearerGetList ( void );
```

4.12.2 Parameters

None

4.12.3 Returned Values

The function returns

- an array of bearerInfo_t on success
- NULL pointer is returned on error. The end of the array is indicated by an entry with WIP_BEARER_NONE type and "" name. The memory used by the array is allocated dynamically and must be freed by calling wip_bearerFreeList

NOTE	The list of available bearers is not dynamically updated by other ADL calls. E.g. if customer application start a GSM call independently of WIP API, then wip_bearerGetList will still describe GSM bearer as available even if it is not the case at the moment. Availability of a bearer is only tested when the bearer is started by calling wip_bearerStart, wip_bearerAnswer or wip_bearerStartServer

4.13 The wip_bearerFreeList Function

The wip_bearerFreeList function frees the memory previously allocated by wip_bearerGetList.

4.13.1 Prototype

```
void wip_bearerFreeList ( wip_bearerInfo_t   *binfo );
```

4.13.2 Parameters

binfo:

In: Pointer that was returned by wip_bearerGetlist

4.13.3 Returned Values

None

5 Internet Protocol Support Library

The Internet Protocol support library provides support for internet addresses.

5.1 Required Header File

The header file for the IP Support Library related functions is wip_inet.h.

5.2 The wip_in_addr_t Structure

The wip_in_addr_t type stores a 32-bit IPv4 address in network-byte order.

```
typedef u32 wip_in_addr_t;
```

5.3 The wip_inet_aton Function

The wip_inet_aton function converts an internet address in standard dot notation to a wip_in_addr_t type.

5.3.1 Prototype

```
bool wip_inet_aton ( const ascii   *str,

                     wip_in_addr_t   *addr );
```

5.3.2 Parameters

`str:`

In: Null terminated string that contains the IP address to convert in dot notation

`addr:`

Out: Filled with converted IP address

5.3.3 Returned Values

The function returns

- TRUE if the provided string contains a valid IP address
- FALSE if it does not contain a valid IP address

5.4 The wip_inet_ntoa Function

The wip_inet_ntoa function converts an internet address to a string in the standard dot notation.

5.4.1 Prototype

```
bool wip_inet_ntoa ( wip_in_addr_t   addr,

                     ascii   *buf,

                     u16   buflen );
```

5.4.2 Parameters

addr:

In: IP address

buf:

In: Pointer to destination buffer

buflen:

In: Length of destination buffer

5.4.3 Returned Values

The function returns

- TRUE if the provided buffer is large enough to store the result string
- else FALSE is returned

6 Socket Layer

6.1 Common Types

6.1.1 Channels

Channels are opaque to the user and must be manipulated only through API functions.

```
typedef struct channel *wip_channel_t;
```

6.1.2 Event Structure

A channel event is composed of a constant indicating the kind of event which happened, as described by the kind field. Every kind of event corresponds to a specific set of data. These specific data types are gathered in specific structures, which in turn are included in the channelEvent structure through a union content. If event.kind is WIP_CEV_READ, only the event.content.read union field is relevant. If kind is WIP_CEV_WRITE, event.content.write is relevant; WIP_CEV_PEER_CLOSE corresponds to event.content.peer_close, WIP_CEV_ERROR to event.content.error, and WIP_CEV_PING to event.content.ping.

```
typedef struct wip_event_t {
  enum wip_event_kind_t {
    WIP_CEV_DONE,
    WIP_CEV_ERROR,
    WIP_CEV_OPEN,
    WIP_CEV_PEER_CLOSE,
    WIP_CEV_PING,
    WIP_CEV_READ,
    WIP_CEV_WRITE,                /*File-handling related events*/
    WIP_CEV_CLOSE_DIR,
    WIP_CEV_READ_DIR,
    WIP_CEV_REWIND_DIR,
    WIP_CEV_LAST = WIP_CEV_REWIND_DIR
  } kind;
  wip_channel_t channel;
  union wip_event_content_t {
    struct wip_event_content_read_t {
      u32 readable;                /* how many bytes can be read */
    } read;
    struct wip_event_content_write_t {
      u32 writable;                /* how many bytes can be written */
    } write
    struct wip_event_content_ping_t {
      int packet_idx;              /* Index of the packet in the sent
                                   sequence*/
      u32 response_time;           /* Time taken by the echo to come back, in
                                   ms. */
      bool timeout;                /* Did the echo take too long to come back?
                                   If timeout is true, response_time is
                                   meaningless  (and set to 0) */
    } ping;
    struct wip_event_content_error_t {
      wip_error_t errnum;          /* Error */
    } error;
    struct wip_event_content_done_t {
      int result;
      int aux;
    } done
  } content;
} wip_event_t;
```

6.1.3 Opaque Channel Type

Channels are not to be inspected directly by the user, who might only interact with them through API functions. The corresponding type is therefore opaque to them.

```
typedef struct channel *wip_channel_t;
/* The [wip_channel_struct_t] structure is not declared in the public API.
The user can only work with pointers as abstract datatypes.*/
```

6.1.4 Event Handler Callback wip_eventHandler_f

```
typedef void (*wip_eventHandler_f) ( wip_event_t   *ev,

                                     void   *ctx );
```

When a channel is created, a callback function must be passed to react to channel events. This callback type is wip_eventHandler_f, and takes the following as parameters:

ev: The structure describing the event

ctx: A pointer to user data which is passed at channel creation time. This allows the user to associate connection specific data to the channel. If not required it will be set to NULL.

6.1.5 Options

Here is a table which sums up the options that can be passed to channels through the “Opts” functions, together with their meaning, and the type of parameter(s) they take. For instance, WIP_COPT_PORT takes an s16 as a parameter. This means that when used in an option-setting context, WIP_COPT_PORT is to be followed by an s16 parameter, then by the next option (or WIP_COPT_END). When used in an option-getting context, it will be followed by a pointer to an integer, where the port number will be written.

Option	Description	Set Type	Get Type
WIP_COPT_END	Indicates that the last option of the list is reached	none	<none>
WIP_COPT_KEEPALIVE	Sends a NOOP command every n tenth of seconds, so that the server and any NAT on the way won't shut down the connection	u32 n	u32 n
WIP_COPT_SND_BUFSIZE	Size of the emission buffer associated with a socket	u32	u32
WIP_COPT_RCV_BUFSIZE	Size of the reception buffer associated with a socket	u32	u32

Option	Description	Set Type	Get Type
WIP_COPT_SND_LOWAT	Minimum amount of available space that must be available in the emission buffer before triggering a WIP_CEV_WRITE event.	u32	u32
WIP_COPT_RCV_LOWAT	Minimum amount of available space that must be available in the reception buffer before triggering a WIP_CEV_READ event	u32	u32
WIP_COPT_RCV_TIMEOUT	For PING channels, timeout for ECHO requests.	u32	u32
WIP_COPT_ERROR	Number of the last error experienced by that socket	none	s32
WIP_COPT_NREAD	Number of bytes that can currently be read on that socket.	none	u32
WIP_COPT_NWRITE	Number of bytes that can currently be written on that socket. For a PING, size of the request (default=20)	u32	u32
WIP_COPT_CHECKSUM	Whether the checksum control must be performed by an UDP socket.	bool	bool

Option	Description	Set Type	Get Type
WIP_COPT_NODELAY	When set to TRUE, TCP packets are sent immediately, even if the buffer is not full enough When set to FALSE, the packets will be sent either, a) by combining several small packets into a bigger packet b) when the data is ready to send and the stack is idle Note: Data has to be buffered and managed by the user application. There is no provision in WIP API's to wait for data block to be fully filled before sending it.	bool	bool
WIP_COPT_MAXSEG	Maximum size of TCP packets	u32	u32
WIP_COPT_TOS	Type of Service (cf. RFC 791)	u8	u8
WIP_COPT_TTL	Time-To-Live for packets	u8	u8
WIP_COPT_DONTFRAG	If set. UDP datagrams are not allowed to be fragmented when going through the network.	bool	bool
WIP_COPT_PEEK	When true, the message is not deleted from the buffer after reading, so that it can be read again.	bool	none
WIP_COPT_PORT	Port occupied by this socket.	u16	u16

Option	Description	Set Type	Get Type

`WIP_COPT_STRADDR`	Local address of the socket.	`ascii`	`ascii *buf,`
			`u32 buf_len`

`WIP_COPT_ADDR`	Local address of the socket, as a 32 bits integer.	`wip_in_addr_t`	`wip_in_addr_t*`
`WIP_COPT_PEER_PORT`	Port of the peer socket.	`u16`	`u16`

`WIP_COPT_PEER_STRADDR`	Address of the peer socket. If set to NULL on a pseudo-connected UDP socket, remove the connection	`ascii`	`ascii *buf,`
			`u32 buf_len`

`WIP_COPT_PEER_ADDR`	Address of the peer socket, as a 32 bits integer.	`wip_in_addr_t`	`wip_in_addr_t*`
`WIP_COPT_TRUNCATE`	Whether an UDP read operation truncated the received data, due to a lack of buffer space.	`bool`	`bool`
`WIP_COPT_REPEAT`	Number of PING echo requests to send.	`s32`	`s32`
`WIP_COPT_INTERVAL`	Time between two PING echo requests, in ms.	`u32`	`u32`
`WIP_COPT_SUPPORT_READ`	Fails if the channel does not support wip_read() operations. If supported, does nothing.	`none`	`none`
`WIP_COPT_SUPPORT_WRITE`	Fails if the channel does not support wip_write() operations. If supported, does nothing.	`none`	`none`

NOTE	It does make sense to put zero sized buffers. For instance, if user knows that the socket will be used only for sending data and never for reading data, then read buffer size can be set to zero to save some memory.

6.2 Common Channel Functions

This section describes common channel functions that can be used for various purposes such as to close, read or write from a channel.

6.2.1 The wip_close Function

The wip_close function closes a channel.

NOTE	The actual resource release does not happen immediately. Instead, the channel is put on a "closing queue" and will be closed at a safe time. This way, the user can request to close a channel at any time – even while handling an event triggered by the channel that the user wants to close.

6.2.1.1 Prototype

```
int wip_close ( wip_channel_t   c );
```

6.2.1.2 Parameters

`c:`

In: The channel that must be closed.

6.2.1.3 Returned Values

This function returns

- 0 on success
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_CERR_MEMORY	Insufficient memory to queue the channel

6.2.2 The wip_read Function

The wip_read function is used to read from a channel. For more details see section on Options.

6.2.2.1 Prototype

```
int wip_read ( wip_channel_t   c,

               void   *buffer,

               u32   buf_len );
```

6.2.2.2 Parameters

c:

In: The channel to read from

buffer:

Out: Pointer to the buffer where read data must be put

buf_len:

In: Size of the buffer

6.2.2.3 Returned Values

This function returns

- number of bytes actually read on success
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_CERR_CSTATE	The channel is not ready to read data (still in initialization, or is already closed).
WIP_CERR_NOT_SUPPORTED	This channel does not support data reading.

6.2.3 The wip_readOpts Function

The wip_readOpts function is used to read from a channel. For more details see section on Options.

6.2.3.1 Prototype

```
int wip_readOpts ( wip_channel_t  c,

                   void   *buffer,

                   u32   buf_len,

                   ... );
```

6.2.3.2 Parameters

c:

In: The channel to read from

buffer:

Out: Pointer to the buffer where read data must be put

buf_len:

In: Size of the buffer

...:

List of option names followed by option values. The list must be terminated by WIP_COPT_END. Supported options depend on the kind of channel and are mentioned in sections 6.3.6 and 6.5.9.

6.2.3.3 Returned Values

This function returns:

- number of bytes actually read
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_CERR_CSTATE	The channel is not ready to read data (still in initialization, or is already closed)
WIP_CERR_NOT_SUPPORTED	This channel does not support data reading, or it has been provided with an option it does not support.
WIP_CERR_INVALID	Some option has been passed with an invalid value.

6.2.4 The wip_write Function

The wip_write function is used to write to a channel. For more details see section on Options.

6.2.4.1 Prototype

```
int wip_write ( wip_channel_t   c,

                void   *buffer,

                u32    buf_len );
```

6.2.4.2 Parameters

c:

In: The channel to write to

buffer:

Out: Pointer to the buffer where data to write is to be found

buf_len:

In: Size of the buffer

6.2.4.3 Returned Values

This function returns

- number of bytes actually written
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_CERR_CSTATE	The channel is not ready to write data (still in initialization, or is already closed).
WIP_CERR_NOT_SUPPORTED	This channel does not support data writing.

6.2.5 The wip_writeOpts Function

The wip_writeOpts function is used to write to a channel. For more details see section on Options.

6.2.5.1 Prototype

```
int wip_writeOpts ( wip_channel_t   c,

                    void   *buffer,

                    u32   buf_len,

                    ... );
```

6.2.5.2 Parameters

c:

In: The channel to write to

buffer:

Out: Pointer to the buffer where data to be written can be found

buf_len:

In: Size of the buffer

...:

List of option names followed by option values. The list must be terminated by WIP_COPT_END. Supported options depend on the kind of channel and are mentioned in sections 6.3.7 and 6.5.10.

6.2.5.3 Returned Values

This function returns

- number of bytes actually written
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_CERR_CSTATE	The channel is not ready to write data (still in initialization, or is already closed)
WIP_CERR_NOT_SUPPORTED	This channel does not support data writing, or it has been provided with an option it does not support.
WIP_CERR_INVALID	Some option has been passed with an invalid value.

6.2.6 The wip_getOpts Function

The wip_getOpts function is used to get options from a channel. For more details see section on Options.

6.2.6.1 Prototype

```
int wip_getOpts ( wip_channel_t   c,

                  ... );
```

6.2.6.2 Parameters

`c:`

In: The channel to get options from

`...:`

List of option names followed by option values. The list must be terminated by WIP_COPT_END. Supported options depend on the kind of channel and are mentioned in sections 6.3.4, 6.4.3, 6.5.7, 6.6.3, 8.5, 9.15, 10.3.2 and 11.2.3.

6.2.6.3 Returned Values

This function returns

- zero on success
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_CERR_NOT_SUPPORTED	The function has been provided with an option it does not support.
WIP_CERR_INVALID	Some option has been passed with an invalid value.
WIP_CERR_CSTATE	The channel is not ready to get options (still in initialization, or is already closed)

6.2.7 The wip_setOpts Function

The wip_setOpts function is used to set options for a channel. For more details see section on Options.

6.2.7.1 Prototype

```
int wip_setOpts ( wip_channel_t   c,

                  ... );
```

6.2.7.2 Parameters

c:

In: The channel in which options will be set

...:

List of option names followed by option values. The list must be terminated by WIP_COPT_END. Supported options depend on the kind of channel and are mentioned in sections 6.3.5, 6.4.4, 6.5.8, 6.6.4, 8.4 and 9.14.

6.2.7.3 Returned Values

This function returns

- zero on success
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_CERR_NOT_SUPPORTED	The function has been provided with an option it does not support.
WIP_CERR_INVALID	Some option has been passed with an invalid value.

6.2.8 The wip_setCtx Function

The wip_setCtx function is used to change the context associated with the event handler of a channel.

6.2.8.1 Prototype

```
void wip_setCtx ( wip_channel_t   c,

                  void   *ctx );
```

6.2.8.2 Parameters

c:

The channel for which the event context must be changed

ctx:

The new context

6.2.8.3 Returned Values

None

6.2.9 The wip_getState Function

Channel creation might rely on asynchronous processes such as the completion of DNS query. There is therefore no guarantee that immediately after the wip_xxxCreate function returns, the channel is ready for read/write operations. Moreover, some events, especially errors, can put a channel in an unusable state. These different states are summarized by the wip_cstate_t enumeration, and the current state of a channel can be read with wip_getState.

6.2.9.1 Prototype

```
wip_cstate_t wip_getState ( wip_channel_t   c );
```

6.2.9.2 Parameter

c:

The channel for which the state must be determined

6.2.9.3 Returned Values

This function returns the state of c as one of the values below:

```
typedef enum wip_cstate_t {
  WIP_CSTATE_BUSY,                    /* some configuration is happening,
                                      eventually the state will become
                                      READY*/
  WIP_CSTATE_READY,                   /* Ready to support Read/Write
                                      operations.*/
  WIP_CSTATE_TO_CLOSE,                /* Channel is broken; the only thing to
                                      do with is to close it.*/
  WIP_CSTATE_LAST=WIP_CSTATE_TO_CLOSE

} wip_cstate_t;
```

6.3 UDP: UDP Sockets

UDP sockets are not connected; they do not have a peer socket with which they exclusively exchange data. However, as in POSIX sockets, we offer a pseudo-connected optional API. The user can specify a destination socket, to which every outbound packet will be sent through a given socket, until further notice. If no pseudo-connection is established, it is mandatory to specify the destination address and port for every write operation, through WIP_COPT_XXX options; therefore, a call to wip_write() on an unconnected UDP will fail.

6.3.1 State Charts

The functional behavior of UDP sockets is formalized on the following statechart. The green background label represents events, and the blue background represents functions called by the user.

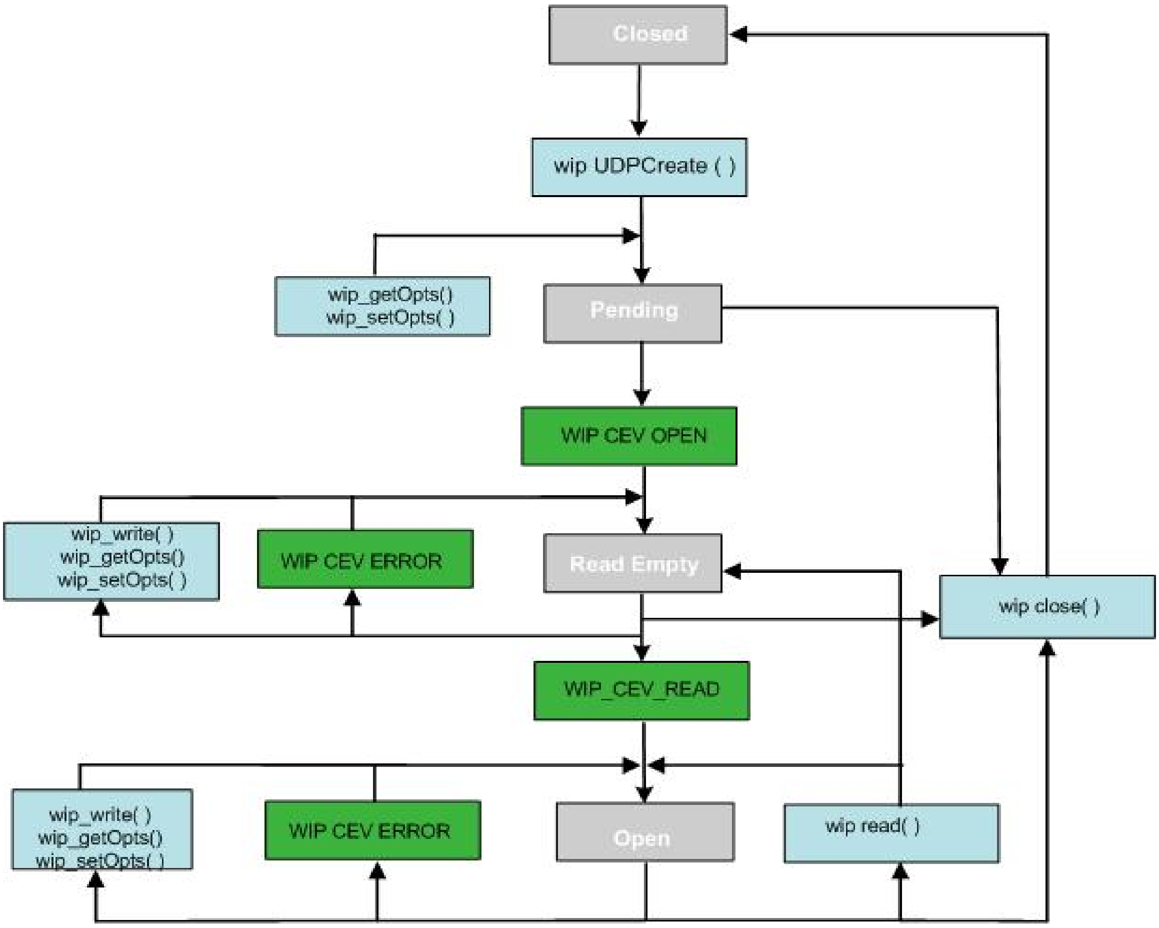
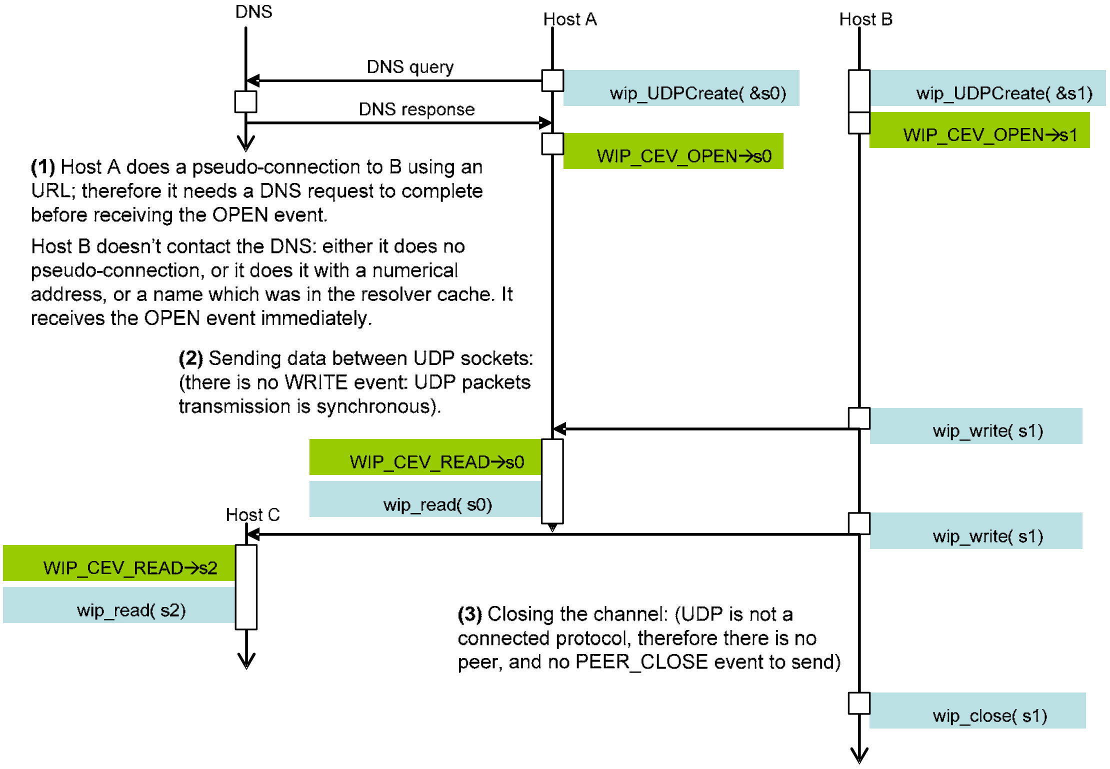


Figure 6 UDP Channel State Diagram

A more intuitive example of temporal dataflow, inferred from this state diagram is given below. It shows typical UDP channels opening, data transfers between sockets, and channel closing.



(1) Host A does a pseudo-connection to B using an URL; therefore it needs a DNS request to complete before receiving the OPEN event.

Host B doesn't contact the DNS: either it does no pseudo-connection, or it does it with a numerical address, or a name which was in the resolver cache. It receives the OPEN event immediately.

(2) Sending data between UDP sockets: (there is no WRITE event: UDP packets transmission is synchronous).

(3) Closing the channel: (UDP is not a connected protocol, therefore there is no peer, and no PEER_CLOSE event to send)

Figure 7 UDP Channel Temporal Diagram

6.3.2 The wip_UDPCreate Function

The wip_UDPCreate function creates a channel encapsulating an UDP socket.

6.3.2.1 Prototype

```
wip_channel_t wip_UDPCreate ( wip_eventHandler_f   handler,

                              void   *ctx );
```

6.3.2.2 Parameters

`handler:`

The call back handler which receives the network events related to the UDP socket. Possible events kinds are WIP_CEV_READ, WIP_CEV_WRITE and WIP_CEV_ERROR. If set to NULL, all the events received in this socket will be discarded.

`ctx:`

User data to be passed to the event handler every time it is called

6.3.2.3 Returned Values

This function returns

- the created channel
- NULL on error

6.3.3 The wip_UDPCreateOpts Function

The wip_UDPCreateOpts function creates a channel encapsulating an UDP socket, with advanced options.

6.3.3.1 Prototype

```
wip_channel_t wip_UDPCreateOpts ( wip_eventHandler_f   handler,

                                  void   *ctx,

                                  ... );
```

6.3.3.2 Parameters

`handler:`

The call back handler which receives the network events related to the UDP socket. Possible event kinds are WIP_CEV_READ, WIP_CEV_WRITE and WIP_CEV_ERROR. If set to NULL, all events received in this socket will be discarded.

`ctx:`

User data to be passed to the event handler every time it is called

`...:`

List of option names followed by option values. The list must be terminated by WIP_COPT_END. The supported options are:

Option	Value	Description
WIP_COPT_SND_BUFSIZE	u32	Size of the emission buffer associated with a socket.
WIP_COPT_RCV_BUFSIZE	u32	Size of the reception buffer associated with a socket.
WIP_COPT_CHECKSUM	bool	Whether the checksum control must be performed by an UDP socket.
WIP_COPT_TOS	u8	Type of Service (cf. RFC 791)
WIP_COPT_TTL	u8	Time-To-Live for packets.
WIP_COPT_DONTFRAG	bool	If set. UDP datagrams are not allowed to be fragmented when going through the network.
WIP_COPT_PORT	u16	Port occupied by this socket.
WIP_COPT_STRADDR	ascii*	Local address of the socket.
WIP_COPT_ADDR	wip_in_addr_t	Local address of the socket.

Option	Value	Description
WIP_COPT_PEER_PORT	u16	Port of the peer socket.
WIP_COPT_PEER_STRADDR	ascii*	Address of the peer socket. If set to NULL on a pseudo-connected UDP socket, remove the connection.
WIP_COPT_PEER_ADDR	wip_in_addr_t	Address of the peer socket.

6.3.3.3 Returned Values

This function returns

- the created channel
- NULL on error

6.3.4 The wip_getOpts Function

The options supported by the wip_getOpts function, applied to a UDP are:

Option	Value	Description
WIP_COPT_END	none	End of the option
WIP_COPT_SND_BUFSIZE	u32*	Size of the emission buffer associated with a socket
WIP_COPT_RCV_BUFSIZE	u32*	Size of the reception buffer associated with a socket
WIP_COPT_ERROR	s32*	Number of the last error experienced by that socket.
WIP_COPT_NREAD	u32*	Number of bytes that can currently be read on that socket.
WIP_COPT_NWRITE	u32*	Number of bytes that can currently be written on that socket. For a PING, size of the request (default=20)
WIP_COPT_CHECKSUM	bool*	Whether the checksum control must be performed by an UDP socket.
WIP_COPT_TOS	u8*	Type of Service (cf. RFC 791)
WIP_COPT_TTL	u8*	Time-To-Live for packets.
WIP_COPT_DONTFRAG	bool*	If set. UDP datagrams are not allowed to be fragmented when going through the network.
WIP_COPT_PORT	u16*	Port occupied by this socket.
WIP_COPT_STRADDR	ascii* buffer, u32 buf_len	Local address of the socket.
WIP_COPT_ADDR	wip_in_addr_t*	Local address of the socket, as a 32 bits integer.
WIP_COPT_PEER_PORT	u16*	Port of the peer socket.
WIP_COPT_PEER_STRADDR	ascii* buff, u32 buf_len	Address of the peer socket. If set to NULL on a pseudo-connected UDP socket, remove the connection.

Option	Value	Description
WIP_COPT_PEER_ADDR	wip_in_addr_t*	Address of the peer socket, as a 32 bits integer.
WIP_COPT_SUPPORT_READ	none	Fails if the channel does not support wip_read() operations. If supported, does nothing.
WIP_COPT_SUPPORT_WRITE	none	Fails if the channel does not support wip_write() operations. If supported, does nothing.

6.3.5 The wip_setOpts Function

The options supported by the wip_setOpts function, applied to a UDP are:

Option	Value	Description
WIP_COPT_END	none	End of the option
WIP_COPT_SND_BUFSIZE	u32	Size of the emission buffer associated with a socket.
WIP_COPT_RCV_BUFSIZE	u32	Size of the reception buffer associated with a socket.
WIP_COPT_CHECKSUM	bool	Whether the checksum control must be performed by an UDP socket.
WIP_COPT_TOS	u8	Type of Service (cf. RFC 791)
WIP_COPT_TTL	u8	Time-To-Live for packets.
WIP_COPT_DONTFRAG	bool	If set. UDP datagrams are not allowed to be fragmented when going through the network.
WIP_COPT_PEER_PORT	u16	Port of the peer socket.
WIP_COPT_PEER_STRADDR	ascii*	Address of the peer socket. If set to NULL on a pseudo-connected UDP socket, remove the connection.
WIP_COPT_PEER_ADDR	wip_in_addr_t	Address of the peer socket, as a 32 bits integer.

NOTE	WIP_COPT_SND_BUFSIZE and WIP_COPT_RCV_BUFSIZE can be set to 0. For instance, if user always wants to send data and not to receive any incoming data, then it will be useful to set socket read buffer size to zero, to save memory.

6.3.6 The wip_readOpts Function

The options supported by the wip_readOpts function, applied to a UDP are:

Option	Value	Description
WIP_COPT_END	none	End of the option
WIP_COPT_PEEK	bool (set)	When true, the message is not deleted from the buffer after reading, so that it can be read again.
WIP_COPT_PEER_PORT	u16* (get)	Port of the peer socket.
WIP_COPT_PEER_STRADDR	ascii *buffer, u32 buf_len (get)	Address of the peer socket. If set to NULL on a pseudo-connected UDP socket, remove the connection.
WIP_COPT_PEER_ADDR	wip_in_addr_t* (get)	Address of the peer socket, as a 32 bits integer.

6.3.7 The wip_writeOpts Function

The options supported by the wip_writeOpts function, applied to a UDP are:

Option	Value	Description
`WIP_COPT_END`	`none`	End of the option
`WIP_COPT_PEEK`	`bool (set)`	When true, the message is not deleted from the buffer after reading, so that it can be read again.
`WIP_COPT_PEER_PORT`	`u16* (get)`	Port of the peer socket.

`WIP_COPT_PEER_STRADDR`	`ascii *buffer,`
	`u32 buf_len (get)`
		Address of the peer socket. If set to NULL on a pseudo-connected UDP socket, remove the connection.

`WIP_COPT_PEER_ADDR`	`wip_in_addr_t* (get)`	Address of the peer socket, as a 32 bits integer.

6.4 TCPServer: Server TCP Sockets

TCP server sockets do not support direct data communications. Instead, they spawn new TCPClient TCP communication sockets whenever a peer socket requests a connection. They do not have a meaningful event handler, as they cannot be closed (they have no peer socket) and cannot experience an error once they have been successfully created.

The state diagram is as follows:

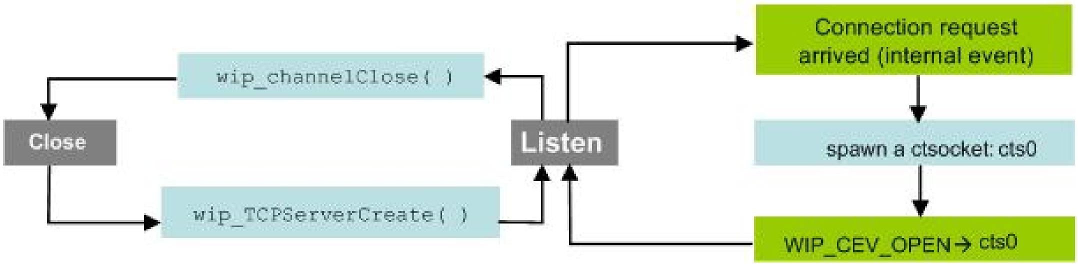


Figure 8 TCP Server Channel State Diagram

There is no relevant temporal diagram to give here. Once the server socket is created, the only direct interaction the user can have with it is by closing it. Reacting to communication socket spawning is done by handling the WIP_CEV_OPEN events of the spawned sockets.

6.4.1 The wip_TCPServerCreate Function

The wip_TCPServerCreate function creates a channel encapsulating a TCP server socket.

6.4.1.1 Prototype

```
wip_channel_t wip_TCPServerCreate ( u16   port,

                                    wip_eventHandler_f   spawnedHandler,

                                    void   *ctx );
```

6.4.1.2 Parameters

port:

The port number on which TCP server socket listens

spawnedHandler:

The call back handler which receives the events related to the TCP clients. It is important to realize that this handler will react to events happening to the resulting communication sockets, not to those happening to the server socket. The context initially linked with this handler is ctx, although it can be later changed, on a per-TCP client basis, through wip_setCtx().

ctx:

User data passed to the event handlers of the spawned sockets

6.4.1.3 Returned Values

This function returns

- the created channel
- NULL on error

6.4.2 The wip_TCPServerCreateOpts Function

The wip_TCPServerCreateOpts function creates a channel encapsulating a TCP server socket with user defined settings.

6.4.2.1 Prototype

```
wip_channel_t wip_TCPServerCreateOpts ( u16   port,

                                        wip_eventHandler_f   spawnedHandler,

                                        void   *ctx,

                                        ... );
```

6.4.2.2 Parameters

port:

The port number on which TCP server socket listens

spawnedHandler:

The call back handler which receives the events related to the TCP clients. It is important to realize that this handler will react to events happening to the resulting communication sockets, not to those happening to the server socket. The context initially linked with this handler is ctx, although it can be later changed, on a per-TCPClient basis, through wip_setCtx().

ctx:

User data passed to the event handlers of the spawned sockets

...:

Same as wip_TCPServerCreate(), plus a list of option names must be followed by option values. The list must be terminated by WIP COPT END. The options supported by wip_TCPServerCreateOpts() are:

Option	Value	Description
WIP_COPT_END	none	End of the option
WIP_COPT_SND_BUFSIZE	u32 (inherited by spawned TCPClients)	Size of the emission buffer associated with a socket.
WIP_COPT_RCV_BUFSIZE	u32 (inherited by spawned TCPClients)	Size of the reception buffer associated with a socket.
WIP_COPT_SND_LOWAT	u32 (inherited by spawned TCPClients)	Minimum amount of available space that must be available in the emission buffer before triggering a WIP_CEV_WRITE event.

Option	Value	Description
WIP_COPT_RCV_LOWAT	u32 (inherited by spawned TCPClients)	Minimum amount of available space that must be available in the reception buffer before triggering a WIP_CEV_READ event.
WIP_COPT_NODELAY	bool (inherited by spawned TCPClients)	When set to TRUE, TCP packets are sent immediately, even if the buffer is not full enough When set to FALSE, the packets will be sent either, a) by combining several small packets into a bigger packet b) when the data is ready to send and the stack is idle Note: Data has to be buffered and managed by the user application. There is no provision in WIP API's to wait for data block to be fully filled before sending it.
WIP_COPT_TOS	u8 (inherited by spawned TCPClients)	Type of Service (cf. RFC 791)
WIP_COPT_TTL	u8 (inherited by spawned TCPClients)	Time-To-Live for packets sent.

Most of these options are inherited by spawned TCPClients. That is, they have no effect on the TCPServer itself, but when the TCPServer creates new TCPClients through an accept function call, these TCPClients are initialized with those options.

6.4.2.3 Returned Values

This function returns

- the created channel
- NULL on error

6.4.3 The wip_getOpts Function

The options supported by the wip_getOpts function, applied to a TCPServer are:

Option	Value	Description
WIP_COPT_END	none	End of the option
WIP_COPT_KEEPALIVE	u32* n	Sends a NOOP command every n tenth of seconds, so that the server and any NAT on the way won't shut down the connection
WIP_COPT_SND_BUFSIZE	u32*	Size of the emission buffer associated with a socket.
WIP_COPT_RCV_BUFSIZE	u32*	Size of the reception buffer associated with a socket.
WIP_COPT_SND_LOWAT	u32	Minimum amount of available space that must be available in the emission buffer before triggering a WIP_CEV_WRITE event.
WIP_COPT_RCV_LOWAT	u32*	Minimum amount of available space that must be available in the reception buffer before triggering a WIP_CEV_READ event.
WIP_COPT_NODELAY	bool*	When set to TRUE, TCP packets are sent immediately, even if the buffer is not full enough When set to FALSE, the packets will be sent either, a) by combining several small packets into a bigger packet b) when the data is ready to send and the stack is idle Note: Data has to be buffered and managed by the user application. There is no provision in WIP API's to wait for data block to be fully filled before sending it.
WIP_COPT_TOS	u8*	Type of Service (cf. RFC 791)
WIP_COPT_TTL	u8*	Time-To-Live for packets sent through this socket; Time-To-Live for this packet, when used in a wip_writeOpts().

Option	Value	Description
WIP_COPT_PORT	u16*	Port occupied by this socket.
WIP_COPT_STRADDR	ascii* buff, u32 buf_len	Local address of the socket.
WIP_COPT_ADDR	wip_in_addr_t*	Local address of the socket, as a 32 bits integer.

6.4.4 The wip_setOpts Function

The options supported by the wip_setOpts function, applied to a TCPServer are:

Option	Value	Description
WIP_COPT_END	none	End of the option
WIP_COPT_KEEPALIVE	u32 n	Sends a NOOP command every n tenth of seconds, so that the server and any NAT on the way won't shut down the connection
WIP_COPT_SND_BUFSIZE	u32 (inherited by spawned TCPClients)	Size of the emission buffer associated with a socket.
WIP_COPT_RCV_BUFSIZE	u32 (inherited by spawned TCPClients)	Size of the reception buffer associated with a socket.
WIP_COPT_SND_LOWAT	u32 (inherited by spawned TCPClients)	Minimum amount of available space that must be available in the emission buffer before triggering a WIP_CEV_WRITE event.
WIP_COPT_RCV_LOWAT	u32 (inherited by spawned TCPClients)	Minimum amount of available space that must be available in the reception buffer before triggering a WIP_CEV_READ event.
WIP_COPT_NODELAY	bool (inherited by spawned TCPClients)	When set to TRUE, TCP packets are sent immediately, even if the buffer is not full enough When set to FALSE, the packets will be sent either, a) by combining several small packets into a bigger packet b) when the data is ready to send and the stack is idle Note: Data has to be buffered and managed by the user application. There is no provision in WIP API's to wait for data block to be fully filled before sending it

Option	Value	Description
`WIP_COPT_TOS`	`u8 (inherited by spawned TCPClients)`	Type of Service (cf. RFC 791)
`WIP_COPT_TTL`	`u8 (inherited by spawned TCPClients)`	Time-To-Live for packets.

NOTE	WIP_COPT_SND_BUFSIZE and WIP_COPT_RCV_BUFSIZE can be set to 0. For instance, if user always wants to send data and not to receive any incoming data, then it will be useful to set socket read buffer size to zero, to save memory.

6.5 TCPClient: TCP Communication Sockets

Communication TCP sockets, can either be created as client TCP sockets, or spawned by a server TCP socket. Although there are two distinct ways to create communication sockets, on client-side and server-side, once they are created and connected together, they are symmetrical and share the same API.

6.5.1 Read/Write Events

6.5.1.1 Read Events

READ event will be received:

- first time if there is more than WIP_COPT_RCV_LOWAT bytes to read in the socket's read buffer
- when read attempt returns less data than the requested data and there is more than WIP_COPT_RCV_LOWAT bytes available in the buffer

Let's consider an example,

WIP_COPT_RCV_BUFSIZE (MAX) has been set to 5840 bytes and WIP_COPT_RCV_LOWAT (MIN) has been set to 1000 bytes.

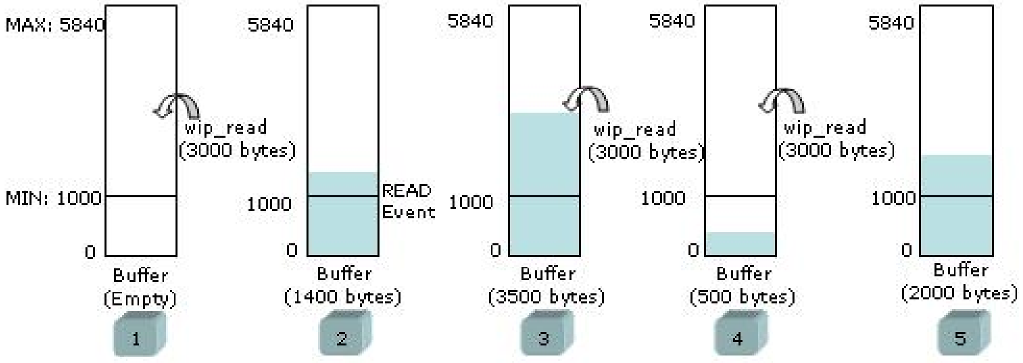


Figure 9 Generation of Read event

In this example, the diagram shown above explains the scenario when READ events are received:

Step 1: Attempt is made to read data (3000 bytes).The buffer is empty as data has not been received, so no READ event is received and read will fail.

Step 2: Received 1400 bytes of data in the buffer. In this case, READ event will be received as the size of readable data in the buffer is more than WIP_COPT_RCV_LOWAT, and no READ event has been sent since the last unsuccessful attempt to read.

Step 3: More data (2100 bytes) is received in the buffer. In this case, READ event will not be received, as READ event was already received in Step 2. Data is read (3000 bytes) from the buffer. Size of readable data in the buffer is 500 bytes.

Step 4: Data is read (1500 bytes) from the buffer. Read attempt reads (500 bytes) less data than the requested data, as the available data in the buffer is less.

Step 5: More data (1500 bytes) is received in the buffer. In this case, since the size of the readable data in the buffer (2000 bytes) is more than WIP_COPT_RCV_LOWAT, and there has been an incomplete read (at step 4) since last time a READ event has been received, a new READ event will be received.

NOTE	1. The dgm_size field in the event is not set when a READ event occurs. It will not be reliable, because the amount of readable data might change when new data arrives between when the event is generated, and when it is processed by the application. dgm_size is only applicable for datagram-oriented protocols 2. No READ event will be received when data is read from the buffer and the size of readable data is more than WIP_COPT_RCV_LOWAT and more data is received.

6.5.1.2 Write Events

WRITE event will be received when:

- channel is opened for the first time
- write attempt writes less data than the requested data and there are more than WIP_COPT_SND_LOWAT bytes available in the buffer

Let’s consider an example,

WIP_COPT_SND_BUFSIZE (MAX) has been set to 5840 bytes and WIP_COPT_SND_LOWAT (MIN) has been set to 1000 bytes.

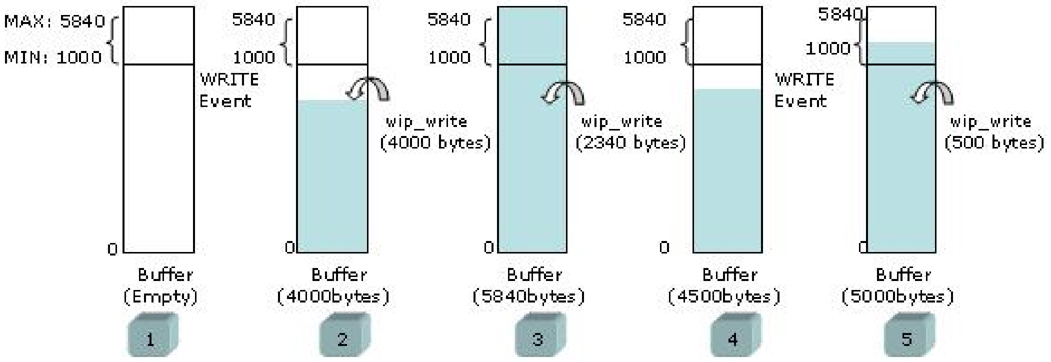


Figure 10 Generation of Write event

In this example, the diagram shown above explains the scenario when WRITE events are received:

Step 1: WRITE event is received as the channel is opened for the first time and the buffer is empty.

Step 2: 4000 bytes of data are written to the buffer. In this case, WRITE event will not be received as there is still memory (1840 bytes) to write more data

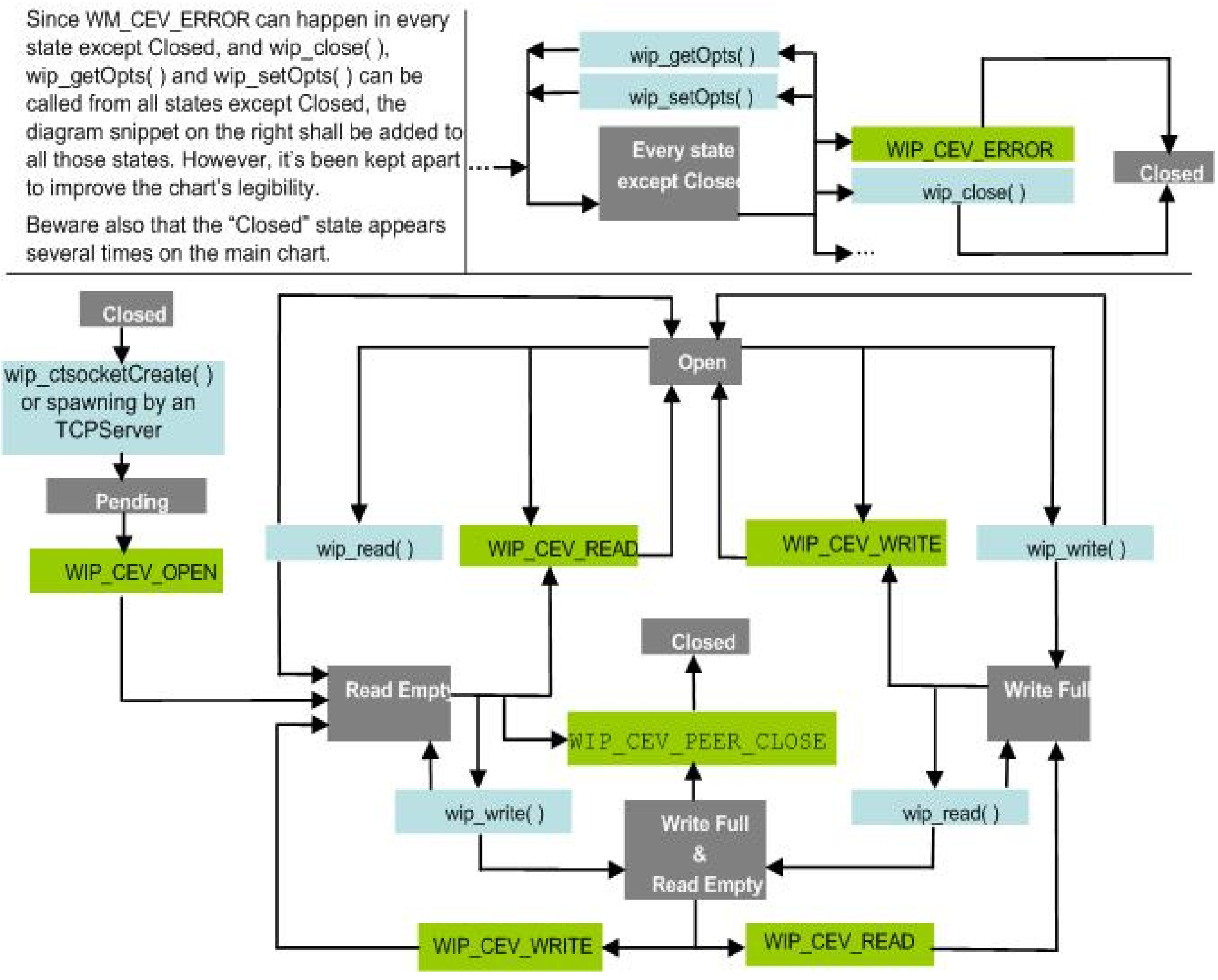
Step 3: Attempt is made to write data (2340 bytes) more than available buffer size. In this case, only 1840 bytes of data is written successfully to the buffer as the free buffer size is 1840 bytes. Remaining data (500 bytes) will be written to the buffer when the free buffer size becomes equal or more than WIP_COPT_SND_LOWAT.

Step 4: Data is flushed (1340 bytes) from the buffer and now the free buffer is 1340 bytes. In this case, WRITE event will be received, as the free buffer is more than WIP_COPT_SND_LOWAT and there has been no WRITE event since last time a WRITE event has been received.

Step 5: Remaining data (500 bytes) is written to the buffer. In this case, WRITE event will not be received, as there is still memory (840 bytes) to write more data.

6.5.2 Statecharts

The complete state diagram of a TCP communication socket is given below:



Since WM_CEV_ERROR can happen in every state except Closed, and wip_close( ), wip_getOpts( ) and wip_setOpts( ) can be called from all states except Closed, the diagram snippet on the right shall be added to all those states. However, it's been kept apart to improve the chart's legibility.

Beware also that the "Closed" state appears several times on the main chart.

Figure 11 TCP Communication Channel State Diagram

This state diagram might be considered too complex for practical reference. The "OpenReady", "Read empty", "Write full", "Write full and Read empty" states can be unified. The resulting state diagram will be simpler, but will not predict whether non-blocking read/write operations will succeed. It does not precisely specify when the WIP_CEV_READ, WIP_CEV_WRITE and WIP_CEV_PEER_CLOSE events can occur.

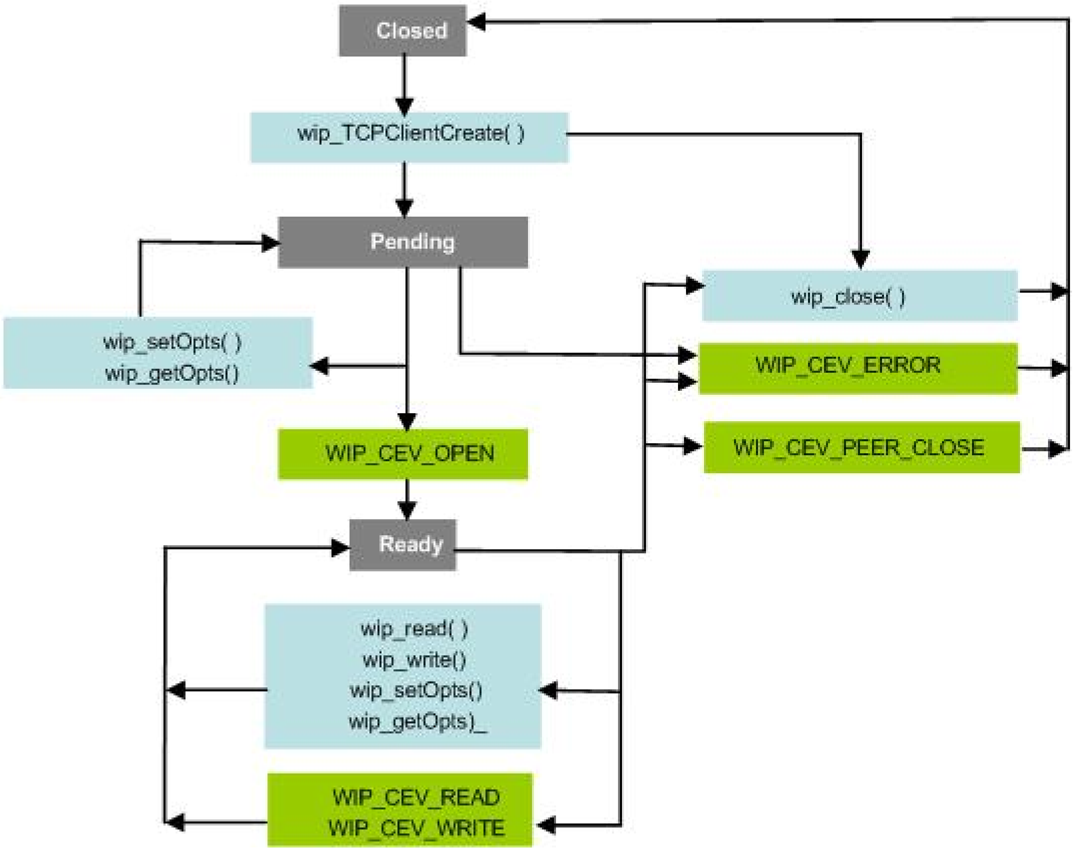


Figure 12 TCP Communication Channel Simplified State Diagram

A typical temporal flow example follows:

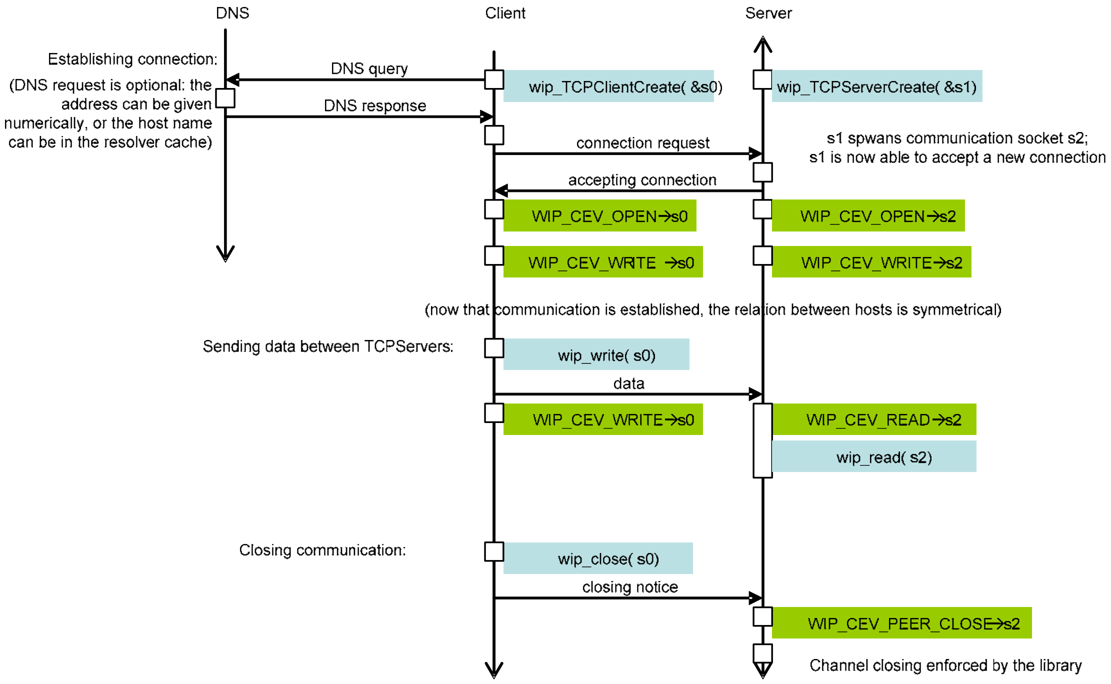

DNS
Client
Server
Establishing connection:
(DNS request is optional: the address can be given numerically, or the host name can be in the resolver cache)
DNS query
DNS response
wip_TCPClientCreate(&s0)
wip_TCPServerCreate(&s1)
connection request
s1 spwans communication socket s2; s1 is now able to accept a new connection
accepting connection
WIP_CEV_OPEN→s0
WIP_CEV_OPEN→s2
WIP_CEV_WRITE →s0
WIP_CEV_WRITE→s2
(now that communication is established, the relation between hosts is symmetrical)
Sending data between TCPServers:
wip_write(s0)
data
WIP_CEV_WRITE→s0
WIP_CEV_READ→s2
wip_read(s2)
Closing communication:
wip_close(s0)
closing notice
WIP_CEV_PEER_CLOSE→s2
Channel closing enforced by the library

Figure 13 TCP Communication Channel Temporal Diagram

6.5.3 The wip_TCPClientCreate Function

The wip_TCPClientCreate function creates a channel encapsulating a TCP client socket.

6.5.3.1 Prototype

```
wip_channel_t wip_TCPClientCreate ( const ascii   *serverAddr,
                                    u16   serverPort,
                                    wip_eventHandler_f   evHandler,
                                    void   *ctx );
```

6.5.3.2 Parameters

`serverAddr:`

Address of the destination server which can be either a DNS address, or a numeric one in the form "xxx.xxx.xxx.xxx".

`serverPort:`

Port of the server socket to connect to

`evHandler:`

The call back handler which receives the network events related to the socket. Possible events kinds are WIP_CEV_READ, WIP_CEV_WRITE, WIP_CEV_PEER_CLOSE and WIP_CEV_ERROR. If set to NULL, all events received in this socket will be discarded.

`ctx:`

User data to be passed to the event handler every time it is called

6.5.3.3 Returned Values

This function returns

- the created channel
- NULL on error

6.5.4 The wip_TCPClientCreateOpts Function

The wip_TCPClientCreateOpts function creates a channel encapsulating a TCP client socket, with advanced options.

6.5.4.1 Prototype

```
wip_channel_t wip_TCPClientCreateOpts ( const ascii   *serverAddr,

                                        u16   serverPort,

                                        wip_eventHandler_f   evHandler,

                                        void   *ctx,

                                        ... );
```

6.5.4.2 Parameters

The parameters are the same as the parameters for the wip_TCPClientCreate() function, plus list of option names. The list of option names must be followed by option values. The list must be terminated by WIP_COPT_END .The options supported by wip_TCPServerCreateOpts() are:

Option	Value	Description
WIP_COPT_END	none	End of the option
WIP_COPT_KEEPALIVE	u32 n	Sends a NOOP command every n tenth of seconds, so that the server and any NAT on the way won't shut down the connection
WIP_COPT_SND_BUFSIZE	u32	Size of the emission buffer associated with a socket.
WIP_COPT_RCV_BUFSIZE	u32	Size of the reception buffer associated with a socket.
WIP_COPT_SND_LOWAT	u32	Minimum amount of available space that must be available in the emission buffer before triggering a WIP_CEV_WRITE event.
WIP_COPT_RCV_LOWAT	u32	Minimum amount of available space that must be available in the reception buffer before triggering a WIP_CEV_READ event.

Option	Value	Description
WIP_COPT_NODELAY	bool	When set to TRUE, TCP packets are sent immediately, even if the buffer is not full enough When set to FALSE, the packets will be sent either, a) by combining several small packets into a bigger packet b) when the data is ready to send and the stack is idle Note: Data has to be buffered and managed by the user application. There is no provision in WIP API's to wait for data block to be fully filled before sending it.
WIP_COPT_MAXSEG	u32	Maximum size of TCP packets
WIP_COPT_TOS	u8	Type of Service (cf. RFC 791)
WIP_COPT_TTL	u8	Time-To-Live for packets.
WIP_COPT_STRADDR	ascii*	Local address of the socket.
WIP_COPT_PORT	u16	Port occupied by this socket.

6.5.4.3 Returned Values

This function returns

- the created channel
- NULL on error

6.5.5 The wip_abort Function

The wip_abort function aborts a TCP communication, causing an error on the peer socket.

6.5.5.1 Prototype

```
int wip_abort ( wip_channel_t   c );
```

6.5.5.2 Parameters

c:

The socket that must be aborted

6.5.5.3 Returned Values

This function returns

- zero on success
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_CERR_NOT_SUPPORTED	Returned when abort is requested on TCP server or UDP channels
WIP_CERR_INTERNAL	Impossible to abort the TCP communication due to internal reasons

6.5.6 The wip_shutdown Function

The wip_shutdown function shuts down input and/or output communication on the socket. If both communications are shut down, the socket is closed. If the output communication is closed, the peer socket receives by a WIP_CEV_PEER_CLOSE error event.

6.5.6.1 Prototype

```
int wip_shutdown ( wip_channel_t   c,
                   bool   read,
                   bool   write );
```

6.5.6.2 Parameters

c:

The socket that must be shut down

read:

Whether the input communication must be shut down

write:

Whether the output communication must be shut down

6.5.6.3 Returned Values

This function returns

- zero on success
- In case of an error, a negative error code as described below:

Error Code	Description
WIP_CERR_NOT_SUPPORTED	Returned when abort is requested on TCP server or UDP channels
WIP_CERR_INTERNAL	Impossible to abort the TCP communication due to internal reasons

6.5.7 The wip_getOpts Function

The options supported by the wip_getOpts function, applied to a TCPClient are:

Option	Value	Description
WIP_COPT_END	none	End of the option
WIP_COPT_KEEPALIVE	u32* n	Sends a NOOP command every n tenth of seconds, so that the server and any NAT on the way won't shut down the connection
WIP_COPT_SND_BUFSIZE	u32*	Size of the emission buffer associated with a socket.
WIP_COPT_RCV_BUFSIZE	u32*	Size of the reception buffer associated with a socket.
WIP_COPT_SND_LOWAT	u32*	Minimum amount of available space that must be available in the emission buffer before triggering a WIP_CEV_WRITE event.
WIP_COPT_RCV_LOWAT	u32*	Minimum amount of available space that must be available in the reception buffer before triggering a WIP_CEV_READ event.
WIP_COPT_ERROR	s32*	Number of the last error experienced by that socket.
WIP_COPT_NREAD	u32*	Number of bytes that can currently be read on that socket.
WIP_COPT_NWRITE	u32*	Number of bytes that can currently be written on that socket. For a PING, size of the request (default=20)

Option	Value	Description
WIP_COPT_NODELAY	bool*	When set to TRUE, TCP packets are sent immediately, even if the buffer is not full enough When set to FALSE, the packets will be sent either, a) by combining several small packets into a bigger packet b) when the data is ready to send and the stack is idle Note: Data has to be buffered and managed by the user application. There is no provision in WIP API's to wait for data block to be fully filled before sending it
WIP_COPT_MAXSEG	u32*	Maximum size of TCP packets
WIP_COPT_TOS	u8*	Type of Service (cf. RFC 791)
WIP_COPT_TTL	u8*	Time-To-Live for packets.
WIP_COPT_PORT	u16*	Port occupied by this socket.
WIP_COPT_STRADDR	ascii* buff, u32 buf_len	Local address of the socket.
WIP_COPT_ADDR	wip_in_addr_t*	Local address of the socket, as a 32 bits integer.
WIP_COPT_PEER_PORT	u16*	Port of the peer socket.
WIP_COPT_PEER_STRADDR	ascii* buff, u32 buf_len	Address of the peer socket. If set to NULL on a pseudo-connected UDP socket, remove the connection.
WIP_COPT_PEER_ADDR	wip_in_addr_t*	Address of the peer socket, as a 32 bits integer.
WIP_COPT_SUPPORT_READ	none	Fails if the channel does not support wip_read() operations. If supported, does nothing.
WIP_COPT_SUPPORT_WRITE	none	Fails if the channel does not support wip_write() operations. If supported, does nothing.

6.5.8 The wip_setOpts Function

The options supported by the wip_setOpts function, applied to a TCP clients are:

Option	Value	Description
WIP_COPT_END	none	End of the option
WIP_COPT_KEEPALIVE	u32	Sends a NOOP command every n tenth of seconds, so that the server and any NAT on the way won't shut down the connection
WIP_COPT_SND_BUFSIZE	u32	Size of the emission buffer associated with a socket.
WIP_COPT_RCV_BUFSIZE	u32	Size of the reception buffer associated with a socket.
WIP_COPT_SND_LOWAT	u32	Minimum amount of available space that must be available in the emission buffer before triggering a WIP_CEV_WRITE event.
WIP_COPT_RCV_LOWAT	u32	Minimum amount of available space that must be available in the reception buffer before triggering a WIP_CEV_READ event.
WIP_COPT_NODELAY	bool	When set to TRUE, TCP packets are sent immediately, even if the buffer is not full enough When set to FALSE, the packets will be sent either, a) by combining several small packets into a bigger packet b) when the data is ready to send and the stack is idle Note: Data has to be buffered and managed by the user application. There is no provision in WIP API's to wait for data block to be fully filled before sending it
WIP_COPT_TOS	u8	Type of Service (cf. RFC 791)
WIP_COPT_TTL	u8	Time-To-Live for packets.

6.5.9 The wip_readOpts Function

The options supported by the wip_readOpts function, applied to a TCPClient are:

Option	Value	Description
WIP_COPT_END	none	End of the option
WIP_COPT_PEEK	bool (set)	When true, the message is not deleted from the buffer after reading, so that it can be read again.

6.5.10 The wip_writeOpts Function

The option supported by the wip_writeOpts function, applied to a TCPClient is:

Option	Value	Description
`WIP_COPT_END`	none	End of the option

6.6 Ping: ICMP Echo Request Handler

The ping service is presented as a channel. It does not support read/write operations, the only thing it can do is receive and react to WIP_CEV_PING events.

Ping channels will generate WIP_CEV_PING events when receiving network responses. The ping channel has a reception timeout, set by WIP_COPT_RCV_TIMEOUT. If a network response arrives before [timeout], a WIP_CEV_PING event is generated, with its [timeout] flag set to false. If the ping packet has been sent, but the response didn't arrive within [timeout], a WIP_CEV_PING is generated, but its [timeout] flag is set to TRUE. However, if the ping packet couldn't be emitted at all (invalid hostname, non-routable address, network down...), no WIP_CEV_PING is generated; only a WIP_CEV_ERROR describing why the packet couldn't be sent is emitted.

6.6.1 The wip_pingCreate Function

The wip_pingCreate function creates a channel supporting a ping session.

6.6.1.1 Prototype

```
wip_channel_t wip_pingCreate ( const ascii   *peerAddr,

                               wip_eventHandler_f   evHandler,

                               void   *ctx );
```

6.6.1.2 Parameters

peerAddr:

Address of host that the user wants to ping. This can be either a DNS address, or a numeric one in the form “xxx.xxx.xxx.xxx”.

evHandler:

The call back handler which receives the network events related to the socket. Possible event kinds are WIP_CEV_PING and WIP_CEV_ERROR.

ctx:

It is the user data to be passed to the event handler every time it is called.

6.6.1.3 Returned Values

This function returns

- the created channel
- NULL on error

6.6.2 The wip_pingCreateOpts Function

The wip_pingCreateOpts function creates a channel supporting a ping session. When a response arrives, a PING event is sent to the event handler. The response contains:

- a packet index from 0 to n-1, n being the number of sent packet sets with WIP_COPT_REPEAT
- a response time in milliseconds
- a Boolean indicating whether the packet arrived too late (after the timeout limit set by WIP_COPT_RCV_TIMEOUT)

6.6.2.1 Prototype

```
wip_channel_t wip_pingCreateOpts ( const ascii   *destAddr,

                                   wip_eventHandler_f   handler,

                                   void   *ctx,

                                   ... );
```

6.6.2.2 Parameters

destAddr:

Address of host that the user wants to ping. This can be either a DNS address, or a numeric one in the form “xxx.xxx.xxx.xxx”.

handler:

The call back handler which receives the network events related to the socket. Possible events kinds are WIP_CEV_PING and WIP_CEV_ERROR.

ctx:

It is the user data to be passed to the event handler every time it is called

... :

The parameters are the same as the parameters for the wip_pingCreate() function, plus a WIP_COPT_END-terminated series of option parameters. The options supported by wip_pingCreateOpts() are:

Option	Value	Description
WIP_COPT_END	none	End of the option
WIP_COPT_REPEAT	s32	Number of PING echo requests to send.
WIP_COPT_INTERVAL	u32	Time between two PING echo requests, in ms.
WIP_COPT_RCV_TIMEOUT	u32	For PING channels, timeout for ECHO requests.

Option	Value	Description
`WIP_COPT_TTL`	`u8`	Time-To-Live for packets.
`WIP_COPT_NWRITE`	`u32`	Number of bytes that can currently be written on that socket. For a PING, size of the request (default=20)

6.6.2.3 Returned Values

This function returns

- the created channel on success
- NULL on error

6.6.3 The wip_getOpts Function

The options supported by the wip_getOpts function, applied to a ping are:

Options	Value	Description
WIP_COPT_END	none	End of the option
WIP_COPT_REPEAT	s32*	Number of PING echo requests to send.
WIP_COPT_INTERVAL	u32*	Time between two PING echo requests, in ms.
WIP_COPT_RCV_TIMEOUT	u32*	For PING channels, timeout for ECHO requests.
WIP_COPT_TTL	u8*	Time-To-Live for packets.
WIP_COPT_NWRITE	u32*	Number of bytes that can currently be written on that socket. For a PING, size of the request (default=20)

6.6.4 The wip_setOpts Function

The options supported by the wip_setOpts function, applied to a ping are:

Options	Value	Description
WIP_COPT_END	none	End of the option
WIP_COPT_INTERVAL	u32	Time between two PING echo requests, in ms.
WIP_COPT_RCV_TIMEOUT	u32	For PING channels, timeout for ECHO requests.
WIP_COPT_REPEAT	s32	Number of PING echo requests to send.
WIP_COPT_TTL	u8	Time-To-Live for packets.
WIP_COPT_NWRITE	u32	Number of bytes that can currently be written on that socket. For a PING, size of the request (default=20)

7 FILE

As in WIP, communication happens through abstract channels, called wip_channel_t. The control of a file resource such as FTP or HTTP will be ensured by a connection channel; variables holding a connection channel will typically be called cx. Whenever a connection channel has to transfer data, it will do so asynchronously, by creating a dedicated data transfer channel; variables holding data transfer channels will typically be called c.

For instance, when we want to send data to a connection channel, we will call wip_putFile(), which will return a data transfer channel. This channel will receive events related to the file transfer:

- WIP_CEV_OPEN when it is ready to receive data
- WIP_CEV_WRITE, if it went through an overflow of data to send, then becomes available again to send more data
- WIP_CEV_ERROR in case of underlying protocol error

It will also support wip_write(), so that the application can actually send the data which represent the file contents; finally, wip_close() will free the data transfer channel, and signal that the whole file has been written. wip_setOpts() allows to pass protocol-dependent settings to the channel.

Similarly, wip_getFile() will retrieve files from the connection, also by spawning a data transfer channel; this data transfer channel will experience WIP_CEV_OPEN, WIP_CEV_READ, WIP_CEV_ERROR events, and WIP_CEV_PEER_CLOSE once the whole file has been read. It also supports wip_read() and wip_close().

File listing also implies asynchronous data transfer, and will also happen through a spawned data transfer channel, as detailed below.

It might seem surprising that both connection channels and data transfer channels are supported by the same wip_channel_t C type. Indeed, connection and data transfer channels both support wip_setOpts(), wip_getOpts() and wip_close() functions (plus a couple of other, less important, functions), they must therefore share the same type. Moreover, some dynamic type checking is performed, so that if an application tries to use wip_getFile() on a data channel, or wip_read() on a connection channel, an explicit error message will be issued.

7.1 Required Header File

The header file for the FILE service is wip_file.h.

7.2 The wip_getFile Function

The wip_getFile function is used to download a file from the server. The connection channel is not used for reading a file content. Instead, this function create and return dedicated data transfer channel, which support read events and function calls.

7.2.1 Prototype

```
wip_channel_t wip_getFile ( wip_channel_t   ftp_cx,

                            ascii   *file_name,

                            wip_eventHandler_f   evh,

                            void   *ctx );
```

7.2.2 Parameters

`ftp_cx:`

It is the connection channel

`file_name:`

It is the name of the file to download from the server. Some protocols might support unnamed files; in this case, NULL is an acceptable value.

`evh:`

It is the event handler to be attached to the newly created data transfer channel. It is the responsibility of the event handler, provided by the user, to read the arriving data, and to put them in the appropriate place. When the file transfer is finished, a WIP_CEV_PEER_CLOSE event is sent to the event handler.

`ctx:`

It is the user data passed to the event handler, evh every time it is called.

7.2.3 Returned Values

The function returns

- data transfer channel on success
- NULL on failure

7.3 The wip_getFileOpts Function

The wip_getFileOpts function is used to download a file from the server with the user defined options like logging in with an account and password rather than anonymously. The connection channel is not used for reading a file content. Instead, this function creates and returns dedicated data transfer channel, which support read events and function calls.

7.3.1 Prototype

```
wip_channel_t wip_getFileOpts ( wip_channel_t   ftp_cx,
                                ascii   *file_name,
                                wip_eventHandler_f   evh,
                                void   *ctx,
                                ... );
```

7.3.2 Parameters

The parameters are the same as the parameters for the wip_getFile function, plus list of option names. The option names must be followed by option values. The list must be terminated by WIP_COPT_END. Supported options depend on the kind of connection channel and are mentioned in sections 8.8, 9.8 and 11.3.2.

7.3.3 Returned Values

The function returns

- data transfer channel on success
- NULL on failure

7.4 The wip_putFile Function

The wip_putFile function is used to upload a file to the server. The connection channel is not used for writing file content. Instead, these functions create and return dedicated data transfer channel, which supports write events and function calls.

7.4.1 Prototype

```
wip_channel_t wip_putFile ( wip_channel_t   ftp_cx,

                            ascii   *file_name,

                            wip_eventHandler_f   evh,

                            void   *ctx );
```

7.4.2 Parameters

`ftp_cx:`

It is the connection channel.

`file_name:`

It is the name of the file to upload on the server. Some protocols might support unnamed files; in this case, NULL is an acceptable value.

`evh:`

It is the event handler to be attached to the newly created data transfer channel. The possible event kind is WIP_CEV_WRITE.

`ctx:`

It is the user data passed to the event handler evh every time it is called.

7.4.3 Returned Values

The function returns

- data transfer channel on success
- NULL on failure

7.5 The wip_putFileOpts Function

The wip_putFileOpts function is used to upload a file to the server with the user defined options. The connection channel is not used for writing file content. Instead, these functions create and return dedicated data transfer channel, which supports write events and function calls.

7.5.1 Prototype

```
wip_channel_t wip_putFileOpts ( wip_channel_t   ftp_cx,

                                ascii   *file_name,

                                wip_eventHandler_f   evh,

                                void   *ctx,

                                ... );
```

7.5.2 Parameters

The parameters are the same as the parameters for the wip_putFile function, plus list of option names. The option names must be followed by option values. The list must be terminated by WIP_COPT_END. Supported options depend on the kind of connection channel and are mentioned in sections 8.10, 9.10 and 10.3.1.

7.5.3 Returned Values

The function returns

- data transfer channel on success
- NULL on failure

7.6 The wip_cwd Function

The wip_cwd function changes the current working directory on the server. Once this command is successfully terminated, a WIP_CEV_DONE event is sent to the event handler. If the change does not succeed (typically because dir_name doesn't exist in the current directory), a WIP_CEV_ERROR is sent to the handler.

The cx will be put in WIP_CSTATE_BUSY mode until the server response arrives, which means that no other command will be accepted by cx until WIP_CEV_DONE or WIP_CEV_ERROR arrives.

7.6.1 Prototype

```
int wip_cwd ( wip_channel_t   cx,

              ascii   *name );
```

7.6.2 Parameters

cx:

This is the connection channel whose working directory is to be changed.

name:

This is the name of the new working directory.

7.6.3 Returned Values

The function returns

- a status code 0 if the request has been sent successfully
- a negative error code on error

7.7 The wip_mkdir Function

The wip_mkdir function is used to create a new directory in the current working directory. The success or failure is reported as WIP_CEV_DONE or WIP_CEV_ERROR events on cx's event handler.

The cx will be put in WIP_CSTATE_BUSY mode until the server response arrives, which means that no other command will be accepted by cx until WIP_CEV_DONE or WIP_CEV_ERROR arrives.

7.7.1 Prototype

```
int wip_mkdir ( wip_channel_t   cx,

                ascii   *name );
```

7.7.2 Parameters

cx:

This is the connection channel whose working directory is to be changed.

name:

This is the name of the new working directory.

7.7.3 Returned Values

The function returns

- 0 on success
- negative error code on error

7.8 The wip_deleteFile Function

The wip_deleteFile function is used to delete a file. The success or failure is reported as WIP_CEV_DONE or WIP_CEV_ERROR events on cx's event handler.

The cx will be put in WIP_CSTATE_BUSY mode until the server response arrives, which means that no other command will be accepted by cx until WIP_CEV_DONE or WIP_CEV_ERROR arrives.

7.8.1 Prototype

```
int wip_deleteFile ( wip_channel_t   cx,

                     ascii   *name );
```

7.8.2 Parameters

cx:

This is the connection channel on which file will be deleted.

name:

It is the name of the file to delete.

7.8.3 Returned Values

The function returns

- 0 on success
- negative error code on error

7.9 The wip_deleteDir Function

The wip_deleteDir function is used to delete an empty directory. The success or failure is reported as WIP_CEV_DONE or WIP_CEV_ERROR events on cx's event handler.

The cx will be put in WIP_CSTATE_BUSY mode until the server response arrives, which means that no other command will be accepted by cx until WIP_CEV_DONE or WIP_CEV_ERROR arrives.

7.9.1 Prototype

```
int wip_deleteDir ( wip_channel_t   ftp_cx,

                    ascii   *dir_name );
```

7.9.2 Parameters

cx:

This is the Connection channel on which file will be deleted.

name:

This is the name of the directory to be deleted.

7.9.3 Returned Values

The function returns

- 0 on success
- negative error code on error

7.10 The wip_renameFile Function

The wip_renameFile function is used to change file name. The file is expected to be in the current working directory. The success or failure is reported as WIP_CEV_DONE or WIP_CEV_ERROR events on cx's event handler.

The cx will be put in WIP_CSTATE_BUSY mode until the server response arrives, which means that no other command will be accepted by cx until WIP_CEV_DONE or WIP_CEV_ERROR arrives.

7.10.1 Prototype

```
int wip_renameFile ( wip_channel_t   cx,

                     ascii   *old_name,

                     ascii   *new_name );
```

7.10.2 Parameters

cx:

This is the connection channel on which file will be renamed old_name.

old_name:

This is the previous name of the file.

new_name:

This is the new name to give to the file.

7.10.3 Returned Values

The function returns

- 0 on success
- negative error code on error

7.11 The wip_getFileSize Function

The wip_getFileSize function is used to get the file size in bytes. On success, a WIP_CEV_DONE event is sent to ftp_ctx, with event->content.done.aux set to the file's size. On failure, a WIP_CEV_ERROR event is triggered.

7.11.1 Prototype

```
int wip_getFileSize ( wip_channel_t   cx,

                      ascii   *name );
```

7.11.2 Parameters

cx:

This is the connection channel of the file whose size is required.

name:

This is the name of the file whose size is required.

7.11.3 Returned Values

The function returns

- 0 on success
- negative error code on error

7.12 The wip_list Function

As for other kinds of data transfer with the network, directory listing must happen asynchronously. When the server replies, its reply is handled in the standard WIP way: a data transfer channel is created by the connection channel; information about files is gathered through wip_read, and the application is informed that data is available through WIP_CEV_READ events, preceded by an initial WIP_CEV_OPEN when the channel initialization is done.

Information arrives on the spawned data transfer channel in the form of wip_fileInfo_t structures:

```
typedef struct wip_fileInfo_t {
  u16 size;
  u16 nentries;
  union {
    u32 u32;
    ascii *ascii;
    void *ptr;
  } *entries;
  u8 data[];
} wip_fileInfo_t;
```

This structure contains a table of data entries, which can be access through known index. For instance, FTP will define the following entry numbers:

```
enum {
  WIP_FOPT_NAME;
  WIP_FOPT_SIZE;
  WIP_FOPT_CANREAD;
  WIP_FOPT_CANWRITE;
  WIP_FOPT_ISDIRECTORY;
};
```

Values can be accessed by using these indexes on the entries. For instance, the following code displays the name and size of the file described by the wip_fileInfo_t structure:

```
printf ( “The file %s is %i bytes long.\n”,
         fi.entries [WIP_FOPT_NAME].u32,
         fi.entries [WIP_FOPT_SIZE].ascii);
```

Event generation: The resulting channel from after wip_list function call is a stream channel i.e.

- a WIP_CEV_OPEN event is sent before the listing is ready to begin
- a WIP_CEV_READ is sent when the first chunk of data is available
- after a call to wip_read() failed to entirely fill the buffer, the next arrival of data is signaled by a new WIP_CEV_READ event
- a WIP_CEV_PEER_CLOSE after the last data is arrived

Reading on the channel: The channel is filled with wip_fileInfo_t structures. wip_read() will only write entire structures, therefore if the buffer size is not a multiple of sizeof(wip_fileInfo_t), it cannot be entirely filled. All file Info structures have been read when WIP_CEV_PEER_CLOSE event is received.

Structure initialization: Initializing a wip_fileInfo_t structure is quite difficult, due to various pointer settings and memory manipulations. A function wip_fileInfoInit() is provided to ease this.

7.12.1 Prototype

```
wip_channel_t wip_list ( wip_channel_t   cx,
                         ascii   *dir_name,
                         wip_eventHandler_f   evh,
                         void   *ctx );
```

7.12.2 Parameters

cx:

This is the Connection channel

dir_name:

This is the name of the directory whose content must be listed (can be NULL, in this case the CWD will be listed)

evh:

This is the Event handler which will receive the events `ctx:`

This is the evh user data

7.12.3 Returned Values

The function returns spawned transfer channel.

7.13 The wip_fileInfoInit Function

Initializing a wip_fileInfo_t structure is quite difficult, due to various pointer settings and memory manipulations. A function wip_fileInfoInit() is provided to ease this.

7.13.1 Prototype

```
wip_fileInfo_t *wip_fileInfoInit ( void   *buffer,

                                   u32   buf_len,

                                   ...);
```

7.13.2 Parameters

buffer:

The memory area where the file Info structure will be built

buf_len:

The amount of memory available in buffer

...:

A list of entry descriptions, terminated with WIP_FOPT_END. Each description has one of the following forms:

- option index, WIP_FOPT_TYPE_U32
- option index, WIP_FOPT_TYPE_S32
- option index, WIP_FOPT_TYPE_PTR, data_len
- option index, WIP_FOPT_TYPE_ASCII, string_len

option_index will typically be a WIP_FOPT_XXX index.

If the **WIP_FOPT_TYPE** given is u32 or s32, then the integer entry is initialized to zero. If it is a **ptr** or an **ascii***, it is initialized as a pointer, in an area in the buffer after the **wip_fileInfo_t**, to a reserved memory area of **data_len** (resp. **string_len**) bytes. This area is initialized with zeros as well.

The field size and **nentries** of the returned **wip_fileInfo_t** structure are set to the correct values as well. **size** takes the additional memory areas (for ascii and ptr entries) into account.

Notice that the **WIP_FOPT_XXX** indexes do not need to be passed in increasing order, and do not need to be contiguous either. Any “gap” in the entries would be set to zero.

7.13.3 Returned Values

The function returns

- A pointer to the created wip_fileInfo_t structure on success; this pointer will be equal to buffer.
- NULL on error (most likely a "not enough memory" error)

8 FTP Client

FTP client offers the ability to transfer files to and from an FTP server, through TCP/IP. Wavecom's FTP client has the following specificities:

- it is based on Wavecom's wip_channel_t abstract channel interface, and its file transfer abstract API
- it does not rely on a local file system

An FTP session mainly consists of connection to the FTP server; this connection is represented as a wip_channel_t. This connection will support various operations, among which the most important are file getting and file putting. Whenever the user requires the FTP session to get or put a file from/to the server, a new data transfer connection is opened, which is intended to read/write the file from/to the server. Several data transfer sessions can happen simultaneously, which means that the application can read/write several files concurrently.

8.1 Required Header File

The header file for the FTP service is wip_ftp.h.

8.2 The wip_FTPCreate Function

An anonymous FTP connection is created through a call to wip_FTPCreate. The wip_FTPCreate function takes an event handler as a parameter, which will be in charge of reacting to network-caused events on the FTP session.

The FTP connection is not ready as soon as the creation function returns. The user is notified that the connection is ready when WIP_CEV_OPEN event is received in the event handler. If the initialization fails (e.g., the password is not accepted, or the server is not reachable), a WIP_CEV_ERROR will be received in the event handler.

8.2.1 Prototype

```
wip_channel_t wip_FTPCreate ( ascii   *server_name,

                              wip_eventHandler_f   evh,

                              void   *ctx );
```

8.2.2 Parameters

`server_name:`

In: The name of the server, either as a DNS resolved name, or in dotted notation, e.g. "192.168.1.1".

`evh:`

In: The event handler is the one that receives reactions from the network.

`ctx:`

In: This is the user data to be passed to the event handler every time it is called.

8.2.3 Returned Values

The function returns

- the created channel on success
- NULL on error

8.3 The wip_FTPCreateOpts Function

The wip_FTPCreateOpts function is used to create FTP connection with user defined options like, logging in with an account and password rather than anonymously.

8.3.1 Prototype

```
wip_channel_t wip_FTPCreateOpts ( ascii   *server_name,

                                  wip_eventHandler_f   evh,

                                  void   *ctx,

                                  ... );
```

8.3.2 Parameters

The parameters are the same as the parameters for the wip_FTPCreate() function, plus list of option names. The option names must be followed by option values. The list must be terminated by WIP_COPT_END .The options supported by wip_FTPCreateOpts() are:

Option	Value	Description
WIP_COPT_TYPE	ascii	Translation of carriage returns. 'I' for image (no translation, the default) 'A' for ASCII 'E' for EBCDIC
WIP_COPT_PASSIVE	bool	Active or Passive Default is passive mode
WIP_COPT_USER	ascii*	User name Default is "anonymous"
WIP_COPT_PASSWORD	ascii*	Password Default is "wipftp@wavecom.com"
WIP_COPT_ACCOUNT	ascii*	Account Default is empty string

Option	Value	Description
`WIP_COPT_PEER_PORT`	`u16`	Server FTP port Default is 21
`WIP_COPT_LIST_PLUGIN`	`wip_eventHandler_f`	Plug-in handling the results from the LIST FTP command (non-standard, server-dependent)
`WIP_COPT_KEEPALIVE`	`u32`	Sends a NOOP command every n tenth of seconds, so that the server and any NAT on the way won't shut down the connection

8.3.3 Returned Values

The function returns

- the created channel on success
- NULL on error

Note	wip_netInitOpts() should be set with the option WIP_NET_OPT_SOCK_MAX to perform FTP in active or passive mode. The minimum number of sockets should be set to • 3 for active mode (1 server socket and 2 client sockets) • 2 for passive mode (2 sockets initiated on client side)

8.4 The wip_setOpts Function

The FTP session channel accepts all TCP client options, since an FTP connection is a TCP socket.

The options supported by wip_setOpts function, applied to FTP are:

Options	Value	Description
WIP_COPT_END	none	End of the option
WIP_COPT_KEEPALIVE	u32	Sends a NOOP command every n tenth of seconds, so that the server and any NAT on the way won't shut down the connection
WIP_COPT_SND_BUFSIZE	u32	Size of the emission buffer associated with a socket.
WIP_COPT_RCV_BUFSIZE	u32	Size of the reception buffer associated with a socket.
WIP_COPT_SND_LOWAT	u32	Minimum amount of available space that must be available in the emission buffer before triggering a WIP_CEV_WRITE event.
WIIP_COPT_RCV_LOWAT	u32	Minimum amount of available space that must be available in the reception buffer before triggering a WIP_CEV_READ event.

Options	Value	Description
`WIP_COPT_NODELAY`	`bool`	When set to TRUE, TCP packets are sent immediately, even if the buffer is not full enough When set to FALSE, the packets will be sent either, a) by combining several small packets into a bigger packet b) when the data is ready to send and the stack is idle Note: Data has to be buffered and managed by the user application. There is no provision in WIP API's to wait for data block to be fully filled before sending it.
`WIP_COPT_TOS`	`u8`	Type of Service (cf. RFC 791)
`WIP_COPT_TTL`	`u8`	Time-To-Live for packets.
`WIP_COPT_TYPE`	`ascii`	Transition of carriage returns. "I" for image (no transition, the default) "A" for ASCII "E" for EBCDIC
`WIP_COPT_PASSIVE`	`bool`	Active or Passive Default is passive mode
`WIP_COPT_LIST_PLUGIN`	`wip_eventHandler_f`	Plug-in handling the results from the LIST FTP command (non-standard, server-dependent)

Refer section 6.2.7 for more details on wip_setOpts function.

8.5 The wip_getOpts Function

The FTP session channel accepts all TCP client options, since an FTP connection is a TCP socket.

The options supported by wip_getOpts function, applied to FTP are:

Options	Value	Description
WIP_COPT_END	none	End of the option
WIP_COPT_SND_BUFSIZE	u32*	Size of the emission buffer associated with a socket.
WIP_COPT_RCV_BUFSIZE	u32*	Size of the reception buffer associated with a socket.
WIP_COPT_SND_LOWAT	u32*	Minimum amount of available space that must be available in the emission buffer before triggering a WIP_CEV_WRITE event.
WIP_COPT_RCV_LOWAT	u32*	Minimum amount of available space that must be available in the reception buffer before triggering a WIP_CEV_READ event.
WIP_COPT_ERROR	s32*	Number of the last error experienced by that socket.
WIP_COPT_NREAD	u32*	Number of bytes that can currently be read on that socket.
WIP_COPT_NWRITE	u32*	Number of bytes that can currently be written on that socket. For a PING, size of the request (default=20)

Options	Value	Description
WIP_COPT_NODELAY	bool*	When set to TRUE, TCP packets are sent immediately, even if the buffer is not full enough When set to FALSE, the packets will be sent either, a) by combining several small packets into a bigger packet b) when the data is ready to send and the stack is idle Note: Data has to be buffered and managed by the user application. There is no provision in WIP API's to wait for data block to be fully filled before sending it.
WIP_COPT_TOS	u8*	Type of Service (cf. RFC 791)
WIP_COPT_TTL	u8*	Time-To-Live for packets.
WIP_COPT_PORT	u16*	Port occupied by this socket.
WIP_COPT_STRADDR	ascii* buff, u32 buf_len	Local address of the socket.
WIP_COPT_ADDR	wip_in_addr_t*	Local address of the socket, as a 32 bits integer.
WIP_COPT_PEER_PORT	u16*	Port of the peer socket.
WIP_COPT_PEER_STRADDR	ascii* buff, u32 buf_len	Address of the peer socket. If set to NULL on a pseudo-connected UDP socket, remove the connection.
WIP_COPT_PEER_ADDR	wip_in_addr_t*	Address of the peer socket, as a 32 bits integer.
WIP_COPT_SUPPORT_READ	none	Fails if the channel does not support wip_read() operations. If supported, does nothing.
WIP_COPT_SUPPORT_WRITE	none	Fails if the channel does not support wip_write() operations. If supported, does nothing.

Options	Value	Description
WIP_COPT_TYPE	ascii	Transition of carriage returns. "I" for image (no transition, the default) "A" for ASCII "E" for EBCDIC
WIP_COPT_PASSIVE	bool	When set, TCP packets are sent immediately, even if the buffer is not full enough.
WIP_COPT_LIST_PLUGIN	wip_eventHandler_f	Plug-in handling the results from the LIST FTP command (non-standard, server-dependent)

Refer section 6.2.6 for more details on wip_getOpts function.

8.6 The wip_close Function

The FTP session is closed with wip_close function. Refer section 6.2.1 for more details on wip_close function.

8.7 The wip_getFile Function

The function wip_getFile is used to download a file from the FTP server. Refer section 7.2 for more details on wip_getFile function.

8.8 The wip_getFileOpts Function

The wip_getFileOpts function is used to download a file from the FTP server with user defined options. The options supported by the wip_getFileOpts function, applied to a FTP are the same WIP_COPT_XXX options as TCP client channels, plus the options which are mentioned below:

Option	Value	Description
`WIP_COPT_FILE_NAME`	`ascii*, u32`	Name of the file being received
`WIP_OFFSET`	`u32 n`	Restart the transfer at the nth byte
`WIP_COPT_END`	`none`	End of the option

Refer section 7.3 for more details on wip_getFileOpts function.

8.9 The wip_putFile Function

The wip_putFile function is used to upload a file to the FTP server. Refer section 7.4 for more details on wip_putFile function.

8.10 The wip_putFileOpts Function

The wip_putFileOpts function is used to upload a file to the server with the user defined options. The options supported by the wip_putFileOpts function, applied to a FTP are the same WIP_COPT_XXX options as TCP client channels, plus the options which are mentioned below:

Option	Value	Description
WIP_COPT_FILE_NAME	ascii*, 32	Name of the file being received
WIP_OFFSET	u32 n	Restart the transfer at the nth byte
WIP_COPT_END	none	End of the option

Refer section 7.5 for more details on wip_putFileOpts function.

9 HTTP Client

HTTP client provides an application interface for generating HTTP requests using Wavecom TCP/IP implementation (WIP plug-in). It is based on WIP abstract channel interface. The following features are provided:

- support for HTTP version 1.1 (default) and 1.0
- persistent connections (with HTTP 1.1)
- connection to a HTTP proxy server
- basic and digest (MD5) authentication
- chunked transfer coding
- setting HTTP request headers
- getting HTTP response headers
- GET, HEADER, POST and PUT methods

HTTP requests are generated in two phases. First, application must create a HTTP channel with wip_HTTPCreate() or wip_HTTPCreateOpts() that will store information common to all further HTTP requests like

- HTTP version
- address of proxy server
- HTTP request headers

This channel will also maintain persistent connections. A new channel is then created for each HTTP request using wip_getFile() or wip_putFile().

9.1 Required Header File

The header file for the HTTP client interface definitions is wip_http.h.

9.2 The wip_httpVersion_e Type

The wip_httpVersion_e type defines the HTTP version of the session.

```
typedef enum {
WIP_HTTP_VERSION_1_0,
WIP_HTTP_VERSION_1_1
} wip_httpVersion_e;
```

The WIP_HTTP_VERSION_1_0 constant indicates HTTP 1.0.

The WIP_HTTP_VERSION_1_1 constant indicates HTTP 1.1.

9.3 The wip_httpMethod_e Type

The wip_httpMethod_e type defines the HTTP method of a message.

```
typedef enum {
  WIP_HTTP_METHOD_GET,
  WIP_HTTP_METHOD_HEAD,
  WIP_HTTP_METHOD_POST,
  WIP_HTTP_METHOD_PUT,
  WIP_HTTP_METHOD_DELETE,
  WIP_HTTP_METHOD_TRACE,
  WIP_HTTP_METHOD_CONNECT
} wip_httpMethod_e;
```

9.4 The wip_httpHeader_t Type

The wip_httpHeader_t structure defines a HTTP header field.

```
typedef struct {
  ascii *name;      /* field name*/
  ascii *value;     /* field value*/
} wip_httpHeader_t;
```

9.5 The wip_HTTPClientCreate Function

The wip_HTTPClientCreate function is used to create HTTP session channels

9.5.1 Prototype

```
wip_channel_t wip_HTTPClientCreate ( wip_eventHandler_f   handler,

                                     void    *ctx );
```

9.5.2 Parameters

handler:

The call back handler which receives the network events related to the channel. Currently no event is defined so it can be set to NULL.

ctx:

This is the user data to be passed to the event handler every time it is called.

9.5.3 Returned Values

The function returns

- the created channel
- else NULL on error

9.6 The wip_HTTPClientCreateOpts Function

The wip_HTTPClientCreateOpts function is used to create HTTP session channels with user defined options.

9.6.1 Prototype

```
wip_channel_t wip_HTTPClientCreate ( wip_eventHandler_f   handler,

                                     void   *ctx,

                                     ... );
```

9.6.2 Parameters

The parameters are the same as the parameters for the wip_HTTPClientCreate function, plus list of option names. The option names must be followed by option values. The list must be terminated by WIP_COPT_END. Each option can be followed by one or more values.

Option	Value	Description
WIP_COPT_END	none	This option defines the end of the option list.
WIP_COPT_RCV_BUFSIZE	u32	This option sets the size of the TCP socket receive buffer.
WIP_COPT_SND_BUFSIZE	u32	This option sets the size of the TCP socket send buffer.
WIP_COPT_PROXY_STRADDR	ascii *	This option sets the hostname of the HTTP proxy server; a NULL value disables the proxy server.
WIP_COPT_PROXY_PORT	u16	This option sets the port number of the HTTP proxy server, the default value is 80.
WIP_COPT_HTTP_VERSION	wip_httpVersion_e	This option defines the HTTP version to be used by the session.

Option	Value	Description
`WIP_COPT_HTTP_HEADER`	`ascii *, ascii *`	This option adds a HTTP message header field that will be sent on each request. The first value is the field name (without the colon), the second value is the field value (without CRLF), and a NULL value can be passed to remove a previously defined header field.
`WIP_COPT_HTTP_HEADER_LIST`	`wip_httpHeader_t *`	This option adds a list of HTTP message header fields to send with each request. The value points to an array of wip_httpHeader_t structures, the last element of the array has its name field set to NULL.

9.6.3 Returned Values

The function returns

- the created channel on success
- NULL on error

9.7 The wip_getFile Function

The wip_getFile function is used to send a HTTP request to the given URL. By default a HTTP GET request is sent, but other HTTP methods can be sent by this function thanks to the WIP_COPT_HTTP_METHOD option.

When HTTP 1.1 is used, a new TCP channel is not created for each request destined to the same server or proxy; instead the TCP connection is maintained by the HTTP session whenever possible.

The events which are received in the event handler are listed below.

Event	Description
WIP_CEV_OPEN	This event is sent when the response message header has been received. The wip_getOpts function can be used to retrieve response header information: WIP_COPT_HTTP_STATUS_CODE returns the 3-digit response status code, WIP_COPT_HTTP_STATUS_REASON returns the reason phrase, WIP_COPT_HTTP_HEADER returns the value of response header fields.
WIP_CEV_READ	This event is sent when response message body data is available for reading by the application.
WIP_CEV_PEER_CLOSE	This event is sent after the entire response message, including response header and response body data, has been received.
WIP_CEV_WRITE	This event is sent when request message body data can be written by the application.
WIP_CEV_ERROR	This event is sent when a socket error has occurred.

Refer section 7.2 for more details on wip_getFile function.

9.8 The wip_getFileOpts Function

The wip_getFileOpts function is used to send a HTTP request to the given URL with user defined options. The events which are received in the event handler are same as in section 9.7

The options supported by the wip_getFileOpts function, applied to a HTTP are:

Option	Value	Description
WIP_COPT_END	none	This option defines the end of the option list.
WIP_COPT_HTTP_METHOD	wip_httpMethod_e	This option defines the method of the HTTP message. The default method is WIP_HTTP_METHOD_GET; the other supported methods are WIP_HTTP_METHOD_HEAD, WIP_HTTP_METHOD_POST and WIP_HTTP_METHOD_PUT.
WIP_COPT_HTTP_HEADER	ascii *>,<ascii *	This option adds a HTTP message header field to the request. The first value is the field name (without the colon); the second value is the field value (without CRLF). This option overwrite fields previously defined by the session channel, a NULL value can be passed to remove a previously defined header field.
WIP_COPT_HTTP_HEADER_LIST	wip_httpHeader_t *	This option adds a list of HTTP message header fields to the request. The value points to an array of wip_httpHeader_t structures, the last element of the array has its name field set to NULL.

Refer section 7.3 for more details on wip_getFileOpts function.

9.9 The wip_putFile Function

The wip_putFile function sends a HTTP PUT request to the given URL. For more details on wip_putFile function, refer section 7.4

NOTE	The only difference with wip_getFile is the default HTTP method

9.10 The wip_putFileOpts Function

The wip_putFileOpts function sends a HTTP PUT request to the given URL with the user defined options. For more details on wip_putFileOpts function, refer section 7.5

Refer section 9.8 for a description of supported options.

9.11 The wip_read Function

The wip_read function is used to read the response message body. This function is not supported by session channels.

For more details on wip_read function, refer section 6.2.2.

9.12 The wip_write Function

The wip_write function is used to write the request message body. Not all requests have a message body. This function is not supported by session channels.

For more details on wip_write function, refer section 6.2.4

9.13 The wip_shutdown Function

The wip_shutdown function is used on a request channel to signals the end of the message body, it has no effect if the request has no message body. This function can also be used to skip data of the response message.

This function is not supported by session channels.

For more details on wip_shutdown function, refer section 6.5.6

9.14 The wip_setOpts Function

The wip_setOpts function is used to set or change options on a session channel, there is no option currently defined for a request channel.

Each option can be followed by one or more values see wip_HTTPClientCreate for a description of supported options.

For more details on wip_setOpts function, refer section 6.2.7

9.15 The wip_getOpts Function

The wip_getOpts function is used to retrieves options of a session or request channel

Session channel supports the following options:

Option	Value	Description
WIP_COPT_END	none	This option defines the end of the option list.
WIP_COPT_RCV_BUFSIZE	u32 *	This option returns the current size of the TCP socket receive buffer.
WIP_COPT_SND_BUFSIZE	u32 *	This option returns the current size of the TCP socket send buffer.
WIP_COPT_PROXY_STRADDR	ascii *,u32	This option returns the hostname of the HTTP proxy server.
WIP_COPT_PROXY_PORT	u16 *	This option returns the port number of the HTTP proxy server.
WIP_COPT_HTTP_VERSION	wip_httpVersion_e *	This option returns the selected HTTP version.

Request channel supports the following options:

Option	Value	Description
WIP_COPT_END	none	This option defines the end of the option list.
WIP_COPT_HTTP_STATUS_CODE	u32 *	This option returns the 3-digit status code of the response.
WIP_COPT_HTTP_STATUS_REASON	ascii *, u32	This option returns the reason phrase of the response, the first value points to the buffer where the reason phrase is to be written, the second value is the size of the buffer.
WIP_COPT_HTTP_HEADER	ascii *, ascii *, u32	This option returns the value of the HTTP message header field with the name given by the first value, the second value points to the buffer where the field value is to be written, the third value is the size of the buffer.

Refer section 6.2.6 for more details on wip_getOpts function.

9.16 The wip_abort Function

The wip_abort function is only supported by the session channel. This call closes the current persistent connection, if any. If a request is pending the request is aborted.

For more details on wip_abort function, refer section 6.5.5

9.17 The wip_close Function

On the session channel the wip_close function aborts any current request and release resources associated with the session channel.

NOTE	This does not close the request channel

On a request channel the wip_close function closes the channel and makes the session ready for another request. When HTTP1.1 is used this does not close the TCP communication channel, it can be reused if the next request is sent to the same server. If the request is not completed when wip_close() is called, the TCP communication is reset to indicate to the server that the request was incomplete.

For more details on wip_close function, refer section 6.2.1

10 SMTP Client API

The SMTP (Simple Mail Transfer Protocol) is a standard protocol for mail transfer and delivery between Internet Hosts in a reliable and efficient manner. It requests using Wavecom TCP/IP implementation (WIP plug-in). It is based on WIP abstract channel interface

SMTP mail sending process is generated in several phases:

- First, the application must create a SMTP session/connection channel with the interface wip_SMTPClientCreate() or wip_SMTPClientCreateOpts() that will store information common to all further SMTP requests: address of the mail server, authentication parameters. This channel will also maintain persistent connections.
- A DATA channel is then created for each SMTP request using wip_putFile() or wip_putFileOpts(): the created DATA channel will store the information as sender name, sender address, (main, cc and bcc) recipients lists, subject of the mail.
- The message body content is then sent over the DATA channel with the wip_write() interface.

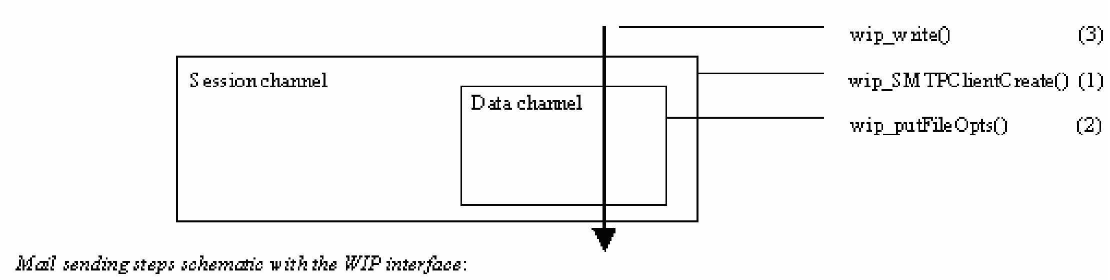

Session channel
Data channel
wip_write() (3)
wip_SMTPClientCreate() (1)
wip_putFileOpts() (2)
Mail sending steps schematic with the WIP interface:

Figure 14 Mail Sending Steps

10.1 Required Header File

The header file for the SMTP client interface definitions is wip_smtp.h.

10.2 The Session / Connection Channel

10.2.1 The wip_SMTPClientCreate Function

The wip_SMTPClientCreate() function is used to create an SMTP SESSION channel.

10.2.1.1 Prototype

```
wip_channel_t wip_SMTPClientCreate ( ascii   *server,
                                     wip_eventHandler_f   handler,
                                     void   *ctx );
```

10.2.1.2 Parameters

server:

The name of the server: either as a DNS resolved name, or in dotted notation, e.g. “192.168.1.1”.

handler:

The call back handler which receives the network events related to the channel.

The events defined in the table below are supported.

Event	Description
WIP_CEV_OPEN	This event is sent when the session channel is established
WIP_CEV_ERROR	This event is sent when a socket error has occurred. Use the wip_getOpts() to determine which reason causes the error

ctx:

This is the user data to be passed to the event handler every time it is called.

10.2.1.3 Returned value

The function returns

- the created SESSION channel,
- else NULL on error

10.2.2 The wip_SMTPClientCreateOpts Function

The wip_SMTPClientCreateOpts() allows the application to pass additional configuration options

10.2.2.1 Prototype

```
wip_channel_t wip_SMTPClientCreateOpts ( ascii   *server,

                                         wip_eventHandler_f   handler,

                                         void   *ctx,

                                         ... );
```

10.2.2.2 Parameters

server:

The name of the server: either as a DNS resolved name, or in dotted notation, e.g. “192.168.1.1”.

handler:

The call back handler which receives the network events related to the channel.

The events defined in the table below are supported.

Event	Description
WIP_CEV_OPEN	This event is sent when the session channel is established
WIP_CEV_ERROR	This event is sent when a socket error has occurred. Use the wip_getOpts() to determine which reason causes the error

...:

List of option names followed by option values. The list must be terminated by WIP_COPT_END. The supported options are:

Option	Value	Description
WIP_COPT_END	none	This option defines the end of the option list.
WIP_COPT_PEER_PORT	u16	This option sets the port number of the SMTP mail server, the default value is 25.
WIP_COPT_USER	ascii *	username (default is “anonymous”) Limited to 64 characters

WIP_COPT_PASSWORD	ascii *	password (defaults to “wipsmtp”) Limited to 64 characters

10.2.2.3 Returned value

The function returns

- the created SESSION channel
- else NULL on error

10.2.3 The wip_getOpts Function

The wip_getOpts() function is used to retrieve options of a SESSION channel. The options supported by the wip_getOpts() function, applied to SMTP client are:

Option	Value	Description
`WIP_COPT_GREETING`	`ascii *`	Get the greeting string
`WIP_OPT_ERROR`	`none`	Return the last error code defined in wip_option_t (wip_channel.h)
`WIP_COPT_REC`	`ascii *`	Verify a user name. The Email address should be formatted like this: local-part@domain

Refer section 6.2.6 for more details on the wip_getOpts function.

10.2.4 The wip_close Function

On the SESSION channel the wip_close() function aborts any current request and release resources associated with the session channel.

NOTE	This interface does not close the opened DATA channel. It is the application which is in charge of closing the opened channels

Refer section 6.2.1 for more details on wip_close function.

10.3 The Data Channel

10.3.1 The wip_putFileOpts Function

The wip_putFileOpts function allows the application to pass additional configuration options.

The events defined in the table below are supported.

Event	Comment
WIP_CEV_OPEN	This event is sent when the DATA channel is established and ready for data sending
WIP_CEV_WRITE	This event is sent when mail body data can be written by the application.
WIP_CEV_ERROR	This event is sent when a socket error has occurred. Use the wip_getOpts() to determine which reason causes the error

The options supported by the wip_putFileOpts() function, applied to a SMTP Client are:

Option	Value	Comment
WIP_COPT_END	none	This option defines the end of the option list.
WIP_COPT_SENDERNAME	ascii *	Sender name
WIP_COPT_SENDER	ascii *	Sender Email address
WIP_COPT_REC	ascii *	Recipients addresses list pointer
WIP_COPT_CC_REC	ascii *	Carbon Copy Recipients addresses list pointer
WIP_COPT_BCC_REC	ascii *	Blind Carbon Copy Recipients addresses list pointer
WIP_COPT_SUBJ	ascii *	Subject of the mail

NOTE	The Email addresses for the field SENDER / RCPT / CC_RCPT and BCC_RCPT are provided in literal format, for instance : sender@wavecom.fr Concerning the Email list for RCPT / CC_RCPT and BCC_RCPT fields, separator character is a coma “,” The RCPT / CC_RCPT and BCC_RCPT lists, the application is responsible for the ascii * string memory allocation and passes the address to that string in the options interface (because the entire string will not be recopied into wip SMTP contexts) WIP_COPT_SENDER and WIP_COPT_REC are mandatory to use wip_putFileOpts()

Refer section 7.5 for more details on wip_putFileOpts function.

10.3.2 The wip_getOpts Function

The wip_getOpts function is used to retrieve options of a session or request channel. The options supported by the wip_getOpts function, applied to a SMTP Client are:

Option	Value	Comment
WIP_OPT_ERROR	none	Return the last error code defined in wip_option_t (wip_channel.h)

Refer section 6.2.6 for more details on the wip_getOpts function.

10.3.3 The wip_write Function

The wip_write function is used to write the request mail data through an opened data channel (previously opened with a wip_putfile function).

NOTE	The wip_write will transfer the mail data in plain text as formatted by the application without any encoding process. The application is responsible of choosing the appropriated encoding algorithm for the data to send. Moreover, if the 5 characters string <CRLF><CRLF> (hexdecimal: 0x0d 0x0a 0x2E 0x0d 0x0a) is present in the message body, the mail transfer will be completed and sent; therefore application should ensure that this 5 characters string is not present in the message body. For encoding, the MIME specifications provides the standard mechanisms for structured message bodies

Refer section 6.2.4 for more details on the wip_write function.

10.3.4 The wip_close Function

On a DATA channel the wip_close function closes the DATA channel and completed the current pending mail transaction by sending the mail to the server and makes the session ready for another mail request.

Refer section 6.2.1 for more details on the wip_close function.

11 POP3 Client API

The POP3 (Post Office Protocol – Version 3) is a standard protocol for mail retrieving from a mail server by a workstation. It requests using Wavecom TCP/IP implementation (WIP plug-in). It is based on WIP abstract channel interface.

POP3 mail retrieving process is generated in several phases:

- First, the application must create a PÖP3 session/connection channel with the interface wip_POP3ClientCreate() or wip_POP3ClientCreateOpts() that will store information common to all further POP3 requests: address of the mail server, authentication parameters. This channel will also maintain persistent connections.
- Application should call the wip_listOpts() interface in order to open a list channel. Once the list channel is opened, the wip_read() call will retrieve in a structure the list of all the mail Id and their respective size.
- a DATA channel is then created for each POP3 request using wip_getFile() or wip_getFileOpts()

wip_read() is then applied to that DATA channel to extract the mail data until WIP_CEV_PEER_CLOSE event indicating that the end of the specified mail is entirely read

11.1 Required Header File

The header file for the POP3 client interface definitions is: wip_pop3.h.

11.2 The Session / Connection Channel

11.2.1 The wip_POP3ClientCreate Function

The wip_POP3ClientCreate function is used to create POP3 session channels.

11.2.1.1 Prototype

```
wip_channel_t wip_POP3ClientCreate ( ascii   *server,
                                     wip_eventHandler_f   handler,
                                     void   *ctx );
```

11.2.1.2 Parameters

server:

The name of the server: either as a DNS resolved name, or in dotted notation, e.g. “192.168.1.1”.

handler:

The call back handler which receives the network events related to the channel.

The events defined in the table below are supported.

Event	Description
WIP_CEV_OPEN	This event is sent when the session channel is established
WIP_CEV_DONE	This event is sent when the mail listing is completed This event is sent when the mail deleting is completed
WIP_CEV_ERROR	This event is sent when a socket error has occurred. Use the wip_getOpts() to determine which reason causes the error

ctx:

This is the user data to be passed to the event handler every time it is called.

11.2.1.3 Returned value

The function returns

- the created SESSION channel
- else NULL on error

11.2.2 wip_POP3ClientCreateOpts

The wip_POP3ClientCreateOpts allows the application to pass additional configuration options.

11.2.2.1 Prototype

```
wip_channel_t wip_POP3ClientCreateOpts ( ascii   *server,

                                         wip_eventHandler_f   handler,

                                         void   *ctx,

                                         ... );
```

11.2.2.2 Parameters

server:

The name of the server: either as a DNS resolved name, or in dotted notation, e.g. “192.168.1.1”.

handler:

The call back handler which receives the network events related to the channel.

The events defined in the table below are supported.

Event	Description
WIP_CEV_OPEN	This event is sent when the session channel is established
WIP_CEV_DONE	This event is sent when the mail listing is completed This event is sent when the mail deleting is completed
WIP_CEV_ERROR	This event is sent when a socket error has occurred. Use the wip_getOpts() to determine which reason causes the error

ctx:

This is the user data to be passed to the event handler every time it is called.

...:

A list of configuration options, the last option must be WIP_COPT_END. Each option can be followed by one or more values, the supported options and their associated values are defined in the table below.

Option	Value	Description
WIP_COPT_END	none	This option defines the end of the option list.
WIP_COPT_PEER_PORT	u16	This option sets the port number of the POP3 mail server, the default value is 110.
WIP_COPT_USER	ascii *	Username (default is "anonymous") Limited to 64 characters
WIP_COPT_PASSWORD	ascii *	Password (defaults to "wippop3") Limited to 64 characters

11.2.2.3 Returned Value

The function returns

- the created SESSION channel
- else NULL on error

11.2.3 The wip_getOpts Function

The wip_getOpts function is used to retrieve options of a SESSION channel. The options supported by the wip_getOpts function, applied to a POP3 Client are:

Option	Value	Comment
`WIP_COPT_GREETING`	`ascii *`	Get the greeting string
`WIP_OPT_ERROR`	`none`	Return the last error code defined in wip_option_t (wip_channel.h)

Refer section 6.2.6 for more details on the wip_getOpts function.

11.2.4 The wip_listOpts Function

The wip_listOpts function is used open a list channel in order to list all the available mails to be retrieved.

11.2.4.1 Prototype

```
wip_channel_t wip_listOpts ( wip_channel_t   session,

                             ascii   *name,

                             wip_eventHandler_f    handler,

                             void   *ctx,

                             ... )
```

11.2.4.2 Parameters

session:

The POP3 SESSION channel

name:

This field is ignored

handler:

The call back handler which receives the events related to the channel.

The events defined in the table below are supported.

ctx:

It is the user data to be passed to the event handler every time it is called.

Event	Comment
TBD	
WIP_CEV_ERROR	This event is sent when a socket error has occurred. Use the wip_getOpts() to determine which reason causes the error

...:

A list of configuration options, the last option must be WIP_COPT_END. Each option can be followed by one or more values, see wip_SMTPClientCreate() for a description of supported options.

11.2.4.3 Returned values

The function returns

- OK on success
- else a negative error code

11.2.5 The wip_read Function

The wip_read function is used to read the listed file structure from the list channel.

Refer section 6.2.2 for more details on the wip_read function.

11.2.6 The wip_deleteFile Function

The wip_deleteFile function is used to mark as deleted the specified mail Id.

Refer section 7.8 for more details on the wip_deleteFile function.

11.2.7 The wip_close Function

On the SESSION channel the wip_close function aborts any current request and release resources associated with the session channel.

NOTE	This interface does not close the opened DATA channel. It is the application which is in charge of closing the opened channels.

Refer section 6.2.1 for more details on the wip_close function.

11.3 The Data Channel

11.3.1 The wip_getFile Function

The wip_getFile function is used to open a DATA channel in order to retrieve a mail.

Following events are supported.

Event	Description
`WIP_CEV_OPEN`	This event is sent when the DATA channel is established and ready for data reading
`WIP_CEV_READ`	This event is sent when mail body data can be read by the application.
`WIP_CEV_PEER_CLOSE`	This event is sent when the entire mail has been read (end of file)
`WIP_CEV_ERROR`	This event is sent when a socket error has occurred. Use the wip_getOpts() to determine which reason causes the error

Refer section 7.2 for more details on wip_getFile function.

11.3.2 The wip_getFileOpts Function

The wip_getFileOpts allows the application to pass additional configuration options.

The events defined in the table below are supported.

Event	Description
WIP_CEV_OPEN	This event is sent when the DATA channel is established and ready for data reading
WIP_CEV_READ	This event is sent when mail body data can be read by the application.
WIP_CEV_PEER_CLOSE	This event is sent when the entire mail has been read (end of file)
WIP_CEV_ERROR	This event is sent when a socket error has occurred. Use the wip_getOpts() to determine which reason causes the error

The options supported by the wip_getFileOpts() function, applied to a POP3Client are:

Option	Value	Description
WIP_COPT_END	none	This option defines the end of the option list.
WIP_COPT_TOP	u32	Retrieve the header of the message with the specified number of lines
TBD		

Refer section 7.3 for more details on wip_getFileOpts function.

11.3.3 The wip_read Function

The wip_read function is used to read the request message body.

Refer section 6.2.2 for more details on wip_read function.

11.3.4 The wip_getOpts Function

The wip_getOpts function is used to retrieves options of a DATA channel.

Data channels support the following options:

Option	Value	Comment
WIP_COPT_END	none	This option defines the end of the option list.
TBD		

Refer section 6.2.6 for more details on the wip_getOpts function.

11.3.5 The wip_close Function

On a DATA channel the wip_close function closes the channel and makes the session ready for another request. If the request is not completed when wip_close() is called, the TCP communication is reset to indicate to the server that the request was incomplete.

Refer section 6.2.1 for more details on the wip_close function.

12 Examples of Application

12.1 Initializing a GPRS Bearer

```
#include <wip_bearer.h>
/* bearer events handler */
void myHandler( wip_bearer_t br, s8 event, void *context)
{
  switch( event) {
  case WIP_BEV_IP_CONNECTED:
    /*IP connectivity we can start IP application from here*/
    break;
  case WIP_BEV_IP_DISCONNECTED:
    /*stop IP application*/
    break;
  /* other events: */
  default:
    /*cannot start bearer: report error to higher levels*/
    break;
  }
}
/* bearer handle */
wip_bearer_t myBearer;

/* initialize and start GPRS bearer */
bool myConnectToGPRS( void)
{
  /* open bearer and install our event handler */
  if( wip_bearerOpen( &myBearer, "GPRS", myHandler, NULL) != 0) {
    /* cannot open bearer */
    return FALSE;
  }
  /* configure GPRS interface */
  if( wip_bearerSetOpts ( myBearer,
                          WIP_BOPT_GPRS_APN,      "my_apn",
                          WIP_BOPT_ LOGIN,    "my_login",
                          WIP_BOPT_ PASSWORD, "my_password",
                          WIP_BOPT_END) != 0) {
    /* cannot configure bearer */
    wip_bearerClose( myBearer);
    return FALSE;
  }

  /* start connection */
  if( wip_bearerStart( myBearer) != 0) {
    /* cannot start bearer */
    bearerClose( myBearer);
    return FALSE;
  }

  /* connection status will be reported to the event handler */
  return TRUE;
}
```

12.2 Simple TCP Client/Server

In this example, the server can receive requests “name”, “forename”, or “phone”, and will answer with the appropriate identification string. It can also receive “quit”, in which case it sends a farewell message and closes the connection.

12.2.1 Server

```
#define SERVER_PORT 1234

#define MSG_WELCOME      "Hello"
#define MSG_SYNTAX_ERROR "Unrecognized request.”\
"Use one of NAME, FORENAME, PHONE, QUIT.\n"

#define MY_NAME     "Wavecom"
#define MY_FORENAME "User"
#define MY_NAME     "+33 46 29 40 39"

void commHandler( wip_event_t *ev, void *ctx) {
  u8 *buffer[16];
  s32 nread;
  wip_channel_t c = ev->channel;

  switch( ev->kind) {

  case WIP_CEV_OPEN:
    wip_write( c, MSG_WELCOME, strlen( MSG_WELCOME);
    break;

  case WIP_CEV_READ:
    nread = wip_read( c, buffer, sizeof( buffer));
    if( !strncasecmp( buffer, "name", nread))
      wip_write( c, MY_NAME, strlen( MY_NAME));
    else if( !strncasecmp( buffer, "forename", nread))
```

```
      wip_write( c, MY_FORENAME, strlen( MY_FORENAME));
    else if( !strncasecmp( buffer, "phone", nread))
      wip_write( c, MY_PHONE, strlen( MY_PHONE));
    else if( !strncasecmp( buffer, "quit", nread))
      wip_close( c);
    else
      wip_write( c, MSG_SYNTAX_ERROR, strlen( MSG_SYNTAX_ERROR));
    return;

  case WIP_CEV_WRITE:
  case WIP_CEV_ERROR:
  case WIP_CEV_PEER_CLOSE:
    return;
  }
}

void initServer() {
  wip_channel_t server = wip_TCPServerCreate( SERVE_PORT_NUMBER,
&commHandler, NULL);
}
```

12.2.2 Client

The client will request, receive and display the forename, name and phone from the server, then quit by sending the “quit” request to the server. The state of the client is maintained by an enum state as the event handler’s context.

Maintaining the state through a state machine is quite typical of callback-based applications. In a multi-threaded application, the thread is maintained by putting the threads in idle mode and reviving them when an event occurs to them. Here, the event handler is called, from its first line, each time an event happens. The state can be used to remember what has already been done, and what the next thing to do is.

```
#define SERVER_PORT 1234
#define SERVER_ADDRESS "192.168.1.4"
```

```
enum state {
  JUST_OPEN,
  FORENAME_REQUEST_SENT,
  NAME_REQUEST_SENT,
  PHONE_REQUEST_SENT,
  QUIT_REQUEST_SENT };

void commHandler( wip_event_t *ev, enum state *ctx) {
  u8 *buffer[256];
  s32 nread;
  wip_channel_t c = ev->channel;
  switch( ev->kind) {
  case WIP_CEV_READ:
    nread = wip_read( c, buffer, sizeof( buffer) - 1);
    buffer[nread] = '\0';
    switch( *ctx) {
    case JUST_OPEN:
      printf( "Received greeting from server: %s\n", buffer);
      wip_write( c, "NAME", strlen( "NAME"));
      *ctx = FORENAME_REQUEST_SENT;
      break;
    case FORENAME_REQUEST_SENT:
      printf( "Forename:\t%s\n", buffer);
      wip_write( c, "FORENAME", strlen( "FORENAME"));
      *ctx = NAME_REQUEST_SENT;
      break;
    case NAME_REQUEST_SENT:
      printf( "Name:\t%s\n", buffer);
      wip_write( c, "PHONE", strlen( "PHONE"));
      *ctx = PHONE_REQUEST_SENT;
      break;
    case PHONE_REQUEST_SENT:
      printf( "Phone:\t%s\n", buffer);
      wip_write( c, "QUIT", strlen( "QUIT"));
      *ctx = QUIT_REQUEST_SENT;
      break;
    case QUIT_REQUEST_SENT:
      printf( "Server says goodbye:\t%s\n", buffer);
      wip_close( c);
      break;
    }
  }
 case WIP_CEV_WRITE:
 case WIP_CEV_ERROR:
 case WIP_CEV_PEER_CLOSE:
   break;
}

void startClient() {
  static enum state state = JUST_OPEN;

  wip_channel_t client = wip_TCPClientCreate( SERVER_ADDRESS,
                                              SERVER_PORT,
                                              &commHandler,
                                              &state );
}
```

12.3 Advanced TCP Example

This is a complex example. It is a rudimentary chat server. Clients connect to the server, and first send an integer, known as their ID. If the client is the first one to send this ID, then it is put on hold until a second one sends the same ID (state WAIT_FOR_SECOND_CX). If it is the second one to send this ID, then it is connected to the first client with this ID. Once the two clients are connected, everything written by one client is forwarded to the dual client. If there are already two clients with this ID, any attempt by a third client to use the same ID is rejected (message EMSG_3RD_CONNECT).

```
/* How many connection can be handled simultaneously */
#define CX_NUM      16
/* Port number of the server */
#define SERVER_PORT 1235
/* Error messages */
#define EMSG_NO_CTX      "Error: no available context on server\n"
#define EMSG_3RD_CONNECT "Error: you're the 3rd to request that id\n"

/* Connection context */
struct {
  /* Number identifying the connection */
  s32 cx_id;
  enum {
    /* This context is currently unused */
    FREE,
    /* One connection has been made, waiting for the second */
    WAIT_FOR_SECOND_CX,
    /* Both clients are connected, they can chat together */
    CONNECTED
  } state;
  /* First client to connect */
  wip_channel_t cx0;
  /* Second client to connect */
  wip_channel_t cx1;
```

```
} cx_state;

/* Connection contexts pool */
static struct cx_state cx_table[CX_NUM];

/* Handling events on communication sockets */
void commHandler( wip_event_t *ev, struct cx_state *ctx) {
  s32 err;
  wip_channel_t c = ev->channel;

  switch( ev->kind) {

  case WIP_CEV_READ:
    /* Some data arrived, that can be read */
    if( NULL == ctx) {
      /* unconnected socket: read id */
      s32 i, id;
      /*wait for more data*/
      if( ev->content.read.readable < sizeof( id))
        return;
      wip_read( c, &id, sizeof( id));
      /* find any open cx with that id */
      for( i = 0; i < CX_NUM; i++) {
        if( cx_table[i].cx_id == id) {
          ctx = cx_table + i;
          switch( ctx->state) {

          case FREE:
            /* This entry is unused, its cx_id field is meaningless;
            continue to the next ctx. */
            break;
          case CONNECTED:
            /* Only two connections can use a given id */
            wip_write( c, EMSG_3RD_CONNECT, strlen( EMSG_3RD_CONNECT));
            wip_close( c);
            return;

          case WAITING_FOR_SECOND_CX:
            /* This is the 2nd connection with this id: complete the ctx,
               and register it with that channel */
            ctx->cx1 = c;
            ctx->cx_state = CONNECTED;
            wip_setCtx( c, ctx);
            return;
          }
        }
      }
      /* No connection found with this id; find a FREE ctx in the pool */
      for( i = 0; i < CX_NUM; i++) {
        if( FREE == cx_table[i].cx_state) {
          ctx = cx_table + i;
          wip_setCtx( c, ctx);
          ctx->cx0 = c;
          ctx->cx_state = WAITING_FOR_SECOND_CX;
          if( err < 0) goto error;
          return;
        }
      }

      /* No free cx context available in the pool */
      wip_write( c, NO_CTX_MSG, strlen( NO_CTX_MSG));
      wip_close( c);
      return;
    } else {
     /* [ev->kind == WIP_CEV_READ && ctx != NULL]: connection is already
established */
      void *buffer;


      wip_channel_t dual = (ctx->cx0 == c) ? ctx->cx1 : ctx->cx0;
      s32 writeable_on_dual;
      s32 readable = ev->content.read.readable;

      wip_getOpts( dual,
                    WIP_COPT_NWRITE, &writeable_on_dual,
                    WIP_COPT_END);
      if( writeable_on_dual < readable) return;
      buffer = malloc( readable);
      wip_read( c, buffer, readable);
      wip_write( dual, buffer, readable);
      free( buffer);
      return;
    }

  case WIP_CEV_WRITE:
    /* There is some buffer space to write... Yet I've got nothing
       interesting to write in it: I'll write something when I'll receive
       something to read! */
    return;

  case WIP_CEV_ERROR:
  case WIP_CEV_PEER_CLOSE:
    /* If a socket closes, or something goes wrong, close the dual
       socket */
    if( ctx != NULL && ctx->cx_state == CONNECTED) {
      wip_close( ctx->cx0);
      wip_close( ctx->cx1);
      ctx->state = FREE;
    } else if( ctx != NULL) {
      wip_close( c);
      ctx->state = FREE;
    }
    else wip_close( c);
    return;
  }
}

/* Starting the server */
void initServer() {
  s32 i;
  wip_channel_t server;

  for( i = 0; i < CX_NUM; i++) cx_table[i].state = FREE;

  server = wip_TCPServerCreate( SERVER_PORT, commHandler, NULL);
}
```

12.4 Simple FTP Example

This program downloads a file named data.bin from the server ftp.wavecom.com and puts it in memory. However, since it makes no assumptions on the file's size, it requests it with wip_getFileSize() before allocating the buffer. Once the whole file has been read, the resulting buffer is passed to a DoSomethingWithIt() function.

For the sake of simplicity, this sample does no error checking.

```
#define SERVER "ftp.wavecom.com"
#define FILE_NAME "data.bin"
static u8 *buffer;
static int buf_size;

/* Handling events on the connection channel.*/
static evh_cx( wip_event_t *ev, void *ctx) {
  switch( ev->kind) {
    case WIP_CEV_OPEN:
      /* FTP connection just established*/
      wip_getFileSize( ev->channel, FILE_NAME);
      break;
    case WIP_CEV_DONE:
      /* response to the wip_getFileSize() call arrived. */
      buf_size = ev->content.done.aux;
      /* allocate the buffer */
      buffer = adl_getMem( buf_size);
      /* And start filling it with data */
      wip_getFile( ftp_cx, FILE_NAME, evh_data, NULL);
      break;
  }
   }
/* Handling events on the file transfer channel. */
static void evh_data( wip_event_t *ev, void *ctx) {
  static int nwritten;
  switch( ev->kind) {
   case WIP_CEV_OPEN:
     nwritten = 0;
     break;
case WIP_CEV_READ:
     nwritten += wip_read( ev->channel, buffer + nwritten,
                           buf_size - nwritten);
     /* We know that the whole file content is smaller than buf_size*/
     ASSERT( nwritten <= buf_size);

     break;

   case WIP_CEV_PEER_CLOSE:
     wip_close( ev->channel);
     DoSomethingWithIt( buffer, nwritten);
     break;
  }
}

/* When WIP is ready, open the FTP server */
void evh_bearer(wip_bearer_t b, s8 event, void *ctx) {
  if( WIP_BEV_IP_CONNECTED == event)
    wip_FTPCreate( SERVER, evh_cx, NULL);
}

int adl_main() {
  ...
  /* Configure a bearer. */
  wip_bearerOpen( ..., ..., evh_bearer, NULL);
  ...
    }
```

In a multithreaded environment, where blocking calls are acceptable, everything could have been put in a single thread, which would have been put asleep when waiting for events. The program would have looked like:

```
wip_blockingBearerStart( &bearer, …);
ftpcx = wip_blockingFTPCreate( SERVER);
size = wip_blockingGetFileSize( ftpcx, FILE_NAME);
buffer = adl_getMem( size);
nwritten = 0;
transfer = wip_blockingGetFile( ftpcx, FILE_NAME);
while( WIP_CSTATE_READY == wip_getState( transfer))
  nwritten += wip_blockingRead( transfer, buffer + nwritten,
                                size – nwritten);
wip_close( transfer);
doSomethingWithIt( buffer);
```

Notice that wip_blockingXxx() calls don’t exist in the current API; the snippet above is to be read as pseudo-code.

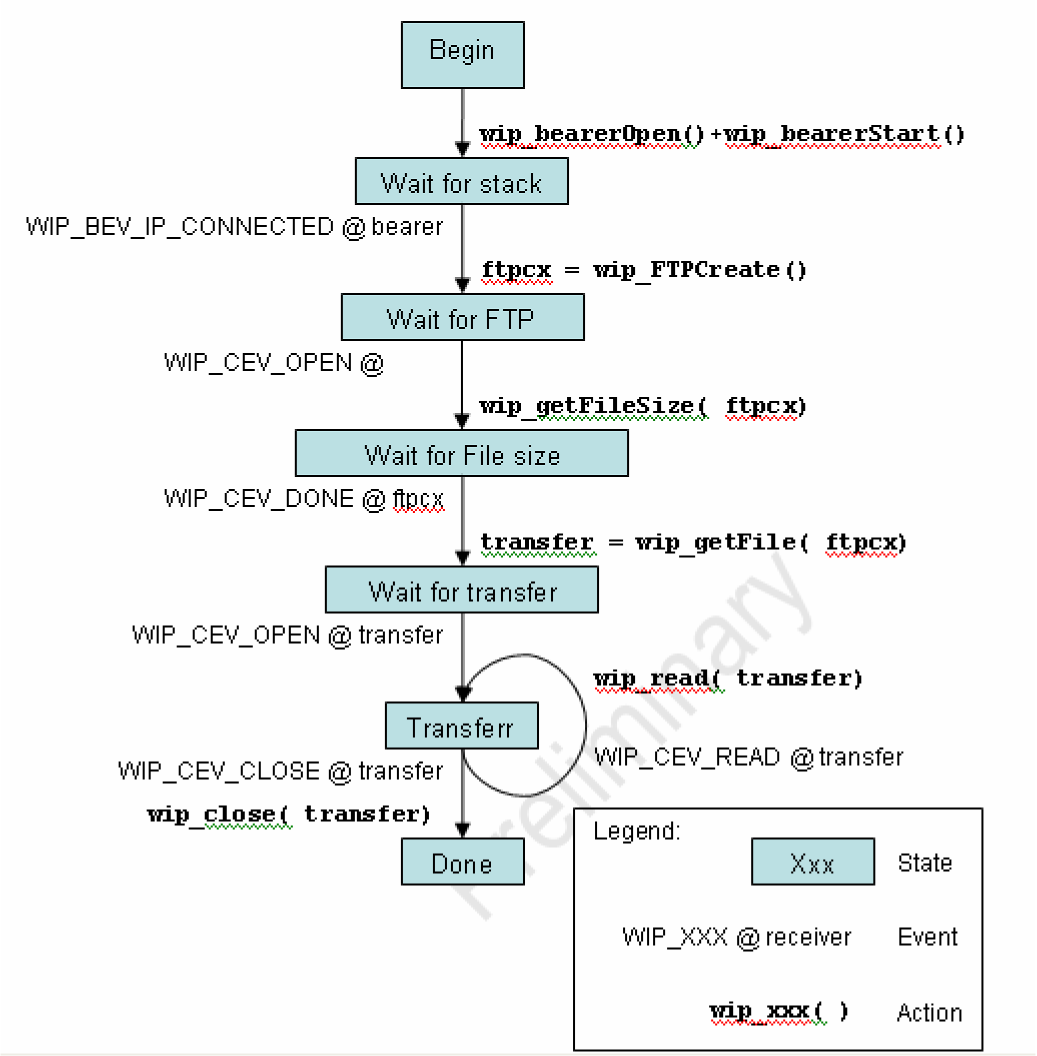


Figure 15 State machine of a simple FTP application

The corresponding state machine is represented above. It has the following noticeable property: each (event, receiver) couple occurs only once in the machine, which means there is no need to explicitly remember the machine's state: it can be deduced from the event. In a more complex example, it would be necessary to:

- create an enum type listing the possible state
- test the current state when an event happens
- update the state after an action is performed

In the event handlers, the switch statements would have looked like:

```
enum { STATE_YYY0, STATE_YYY1, /* etc. */ } state;

void evh_xxx( wip_event_t *ev, void *ctx) {
  switch( ev->kind) {
    case WIP_CEV_XXX0: switch( state) {
      case STATE_YYY0:
        /* Do whatever must be done when event XXX0 happens to ev->channel
           when in state YYY0 */
        someAction();
        /* relevant state transition. */
        state = STATE_YYY3;
        break;
      case STATE_YYY1:
        someOtherAction();
        state = STATE_YYY2;
        break;
        /* etc. */
    }

 case WIP_CEV_XXX1: switch( state) {
    /* etc. */
    }
    /* etc. */
  }
}
```

12.5 Advanced FTP Example

This program makes use of the file browsing API. It recursively downloads every files in an FTP server directory. As many downloads as possible are started concurrently; the program detects whenever TCP sockets are used (error WIP_CERR_RESOURCES).

```
TBD
```

12.6 Simple HTML Example

This example shows how to get a HTML page from a web server.

```
/* HTTP session */
wip_channel_t http;

/* event handler callback */
void http_event( wip_event_t *ev, void *ctx)
{
  wip_channel_t ch;
  s32 ret;

  /* get originating channel */ ch = ev->channel;

  switch( ev->kind) {
  case WIP_CEV_OPEN:
    /* get status code */
    wip_getOpts ( ch,
                    WIP_COPT_HTTP_STATUS_CODE, &ret,
                    WIP_COPT_END);
    if( ret != 200) {
      /* not OK... */
    }
    break;
  case WIP_CEV_READ:
    /* read html page */
    while( (ret = wip_read( ch, buf, sizeof( buf))) > 0) {
      /* ...process html data... */
    }
    break;

  case WIP_CEV_PEER_CLOSE:
    /* html page has been received */
    wip_close( ch);
    break;

  case WIP_CEV_ERROR:
    /* socket error... close channel */
    wip_close( ch);
    break;
  }
}

/* Application */
void MyFunction( void)
{
  /* Setup HTTP session */
  http = wip_HTTPClientCreateOpts(
                   NULL, NULL,
                   WIP_COPT_HTTP_HEADER, "User-Agent", "WIP-HTTP-Client/1.0",
                   WIP_COPT_END);

  /* Get a HTML page */
  wip_getFileOpts ( http,
                     "http://www.wavecom.com",
                     http_event, NULL,
                     WIP_COPT_HTTP_HEADER, "Accept", "text/html",
                     WIP_COPT_END);
}
```

12.7 Simple SMTP Example

This example shows how to send an Email through the SMTP client interface.

```
TBD
```

12.8 Simple POP3 Example

This example shows how to send an Email through the SMTP client interface.

```
TBD
```

13 Error Codes

13.1 IP Communication Plug-In Initialization and Configuration error codes

Error Code	Error Value	Description
WIP_NET_ERR_NO_MEM	-20	Memory allocation error
WIP_NET_ERR_OPTION	-21	Invalid option
WIP_NET_ERR_PARAM	-22	Invalid option value
WIP_NET_ERR_INIT_FAILED	-23	Initialization failed

13.2 Bearer service error codes

Error Code	Error Value	Description
WIP_BERR_NO_DEV	-20	The device does not exist
WIP_BERR_ALREADY	-21	The device is already opened
WIP_BERR_NO_IF	-22	The network interface is not available
WIP_BERR_NO_HDL	-23	No free handle
WIP_BERR_BAD_HDL	-24	Invalid handle
WIP_BERR_OPTION	-25	Invalid option
WIP_BERR_PARAM	-26	Invalid option value
WIP_BERR_OK_INPROGRESS	-27	Connection started, an event will be sent after completion
WIP_BERR_BAD_STATE	-28	The bearer is not stopped
WIP_BERR_DEV	-29	Error from link layer initialization
WIP_BERR_NOT_SUPPORTED	-30	Not a GSM bearer
WIP_BERR_LINE_BUSY	-31	Line busy
WIP_BERR_NO_ANSWER	-32	No answer
WIP_BERR_NO_CARRIER	-33	No carrier
WIP_BERR_NO_SIM	-34	No SIM card inserted
WIP_BERR_PIN_NOT_READY	-35	PIN code not entered
WIP_BERR_GPRS_FAILED	-36	GPRS setup failure
WIP_BERR_PPP_LCP_FAILED	-37	LCP negotiation failure
WIP_BERR_PPP_AUTH_FAILED	-38	PPP authentication failure
WIP_BERR_PPP_IPCP_FAILED	-39	IPCP negotiation failure
WIP_BERR_PPP_LINK_FAILED	-40	PPP peer not responding to echo requests
WIP_BERR_PPP_TERM_REQ	-41	PPP session terminated by peer
WIP_BERR_CALL_REFUSED	-42	Incoming call refused

13.3 Channel error codes

Error Code	Error Value	Description
WIP_CERR_ABORTED	-1000	Tried to read/write an aborted TCP client.
WIP_CERR_CSTATE	-999	The channel is not in WIP_CSTATE_READY state.
WIP_CERR_NOT_SUPPORTED	-998	The option is not supported by channel.
WIP_CERR_OUT_OF_RANGE	-997	The option value is out of range.
WIP_CERR_MEMORY	-996	adl_memGet() memory allocation failure.
WIP_CERR_INTERNAL	-995	WIP internal error (probable bug, shouldn't happen).
WIP_CERR_INVALID	-994	Invalid option or parameter value.
WIP_CERR_DNS_FAILURE	-993	Couldn't resolve a name to an IP address.
WIP_CERR_RESOURCES	-992	No more TCP buffers available.
WIP_CERR_PORT_IN_USE	-991	TCP server port already used.
WIP_CERR_REFUSED	-990	TCP connection refused by server.
WIP_CERR_HOST_UNREACHABLE	-989	No route to host.
WIP_CERR_NETWORK_UNREACHABLE	-988	No network reachable at all.
WIP_CERR_PIPE_BROKEN	-987	TCP connection broken.
WIP_CERR_TIMEOUT	-986	Timeout (for DNS request, TCP connection, PING response...)

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