NetBurner

Networking in 1 Day!

NetBurner Runtime Libraries

Revision 1.91
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1. Introduction

This document is a reference manual for the NetBurner software libraries, and is intended to be used in conjunction with the NetBurner Network Programming Guide for network platforms, or the Mod5213 Programmers Guide for non-network platforms. These guides provide background, details and examples on how the functions in this document can be used in practice. All NetBurner documents are located in the documents directory created during installation. The default location is c:\nburn\docs.

This reference guide contains all the API function calls, some of which may not apply to your specific hardware platform. For example, the CAN functions are available on the Mod5213, but TCP/IP functions are not supported because it does not have a network interface. This reference manual also contains optional software APIs, such as SSL, that are purchased separately and are not part of the standard NetBurner development kit.

Hardware-specific software functions and information are provided in the c:\nburn\docs<platform> directory, where <platform> is the hardware platform you are using, such as a Mod5282. The platform documents contain schematics, memory maps, and any software features that are specific to the hardware platform you are using.

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Additional Documentation

All NetBurner License Documentation is located by default in your C:\Nburn\docs directory.

- Eclipse Getting Started Guide
- NetBurner Runtime Libraries (this document)
- NetBurner Network Programming Guide
- Mod5213 Programming Guide
- NetBurner PC Tools Guide
- Freescale microprocessor manuals
- Embedded Flash File System (EFFS) Programmers Guide
- Embedded Flash File System (EFFS) Reference Manual
- Platform Documents – The hardware specific documents for your device (eg Mod5282)

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3. AES Library (Advanced Encryption Standard)

3.1. Introduction

AES is a “block cipher” that has been adopted as an encryption standard, and is one of the most popular algorithms used in symmetric key cryptography today. It was invented by two Belgian cryptographers, Joan Daemen and Vincent Rijmen, and is also referred to as “Rijndael”. AES is the successor to the Data Encryption Standard (DES).

A “block cipher” is a “symmetric key cipher” that operates on a fixed length group of bits. A typical block size is 64 or 128 bits. Multiple blocks are used to process data larger than 128 bits, and padding is used to process data less than 128 bits.

3.2. Function Call Summary

Create encryption/decryption keys:

```
void aes_set_key( aes_context *ctx, unsigned char *key, int keysize )
```

Encrypt a block of data:

```
void aes_encrypt( aes_context *ctx, unsigned char input[16], unsigned char output[16] )
```

Decrypt a block of data:

```
void aes_decrypt( aes_context *ctx, unsigned char input[16], unsigned char output[16] )
```

Encrypt a block of data using Cipher Block Chaining (CBC)

```
void aes_cbc_encrypt( aes_context *ctx, unsigned char iv[16], unsigned char *input,
                      unsigned char *output, int len )
```

Decrypt a block of data using Cipher Block Chaining (CBC)

```
void aes_cbc_decrypt( aes_context *ctx, unsigned char iv[16], unsigned char *input,
                      unsigned char *output, int len )
```

3.3. Example

See the AES example located in c:\nburn\examples.

3.4. aes_set_key

Header File:

#include <aes.h>

Synopsis:

void aes_set_key(aes_context *ctx, unsigned char *key, int keysize);

Description:

Create a set of encrypt/decrypt keys

Parameters:

*ctx	Pointer to a structure that will contain the encryption and decryption keys
*key	Pointer to the secret key
keysize	Size of key, must be 128, 256 or 512 bits

3.5. aes_encrypt

Header File:

```
#include <aes.h>
```

Synopsis:

```
void aes_encrypt( aes_context *ctx,
                  unsigned char input[16],
                  unsigned char output[16] )
```

Description:

Encrypt a 16 byte block of data.

Parameters:

*ctx	Pointer to a structure containing the encryption and decryption keys
input[16]	Array of 16 bytes of data to be encrypted
output[16]	Array of 16 bytes to contain the encrypted data

3.6. aes_decrypt

Header File:

```
#include <aes.h>
```

Synopsis:

```
void aes_decrypt( aes_context *ctx,
                unsigned char input[16],
                unsigned char output[16] );
```

Description:

Decrypt a 16 byte block of data.

Parameters:

*ctx	Pointer to a structure containing the encryption and decryption keys
input[16]	Array of 16 bytes of data to be decrypted
output[16]	Array of 16 bytes to contain the decrypted data

3.7. aes_cbc_encrypt

Header File:

#include <aes.h>

Synopsis:

```
void aes_cbc_encrypt( aes_context *ctx,
                unsigned char iv[16],
                unsigned char *input,
                unsigned char *output,
                int len );
```

Description:

Encrypt a 16 byte block of data using Cipher Block Chaining (CBC)

Parameters:

*ctx	Pointer to a structure containing the encryption and decryption keys
iv[16]	Initialization vector (modified after use)
input[16]	Pointer to buffer holding the data to encrypt
output[16]	Pointer to buffer to hold the encrypted data
len	Length of data to be encrypted

3.8. aes_cbc_decrypt

Header File:

#include <aes.h>

Synopsis:

```
void aes_cbc_decrypt( aes_context *ctx,
                      unsigned char iv[16],
                      unsigned char *input,
                      unsigned char *output,
                      int len );
```

Description:

Encrypt a 16 byte block of data using Cipher Block Chaining (CBC)

Parameters:

*ctx	Pointer to a structure containing the encryption and decryption keys
iv[16]	Initialization vector (modified after use)
input[16]	Pointer to buffer holding the encrypted data
output[16]	Pointer to buffer to hold the unencrypted data
len	Length of data to be decrypted

4. CAN Library

4.1. Introduction

CAN or Controller Area Network is an advanced serial bus system that efficiently supports distributed control systems. CAN operates at data rates of up to 1 Megabit per second. CAN also has excellent error detection and confinement capabilities. CAN was initially developed in 1986 for the use in motor vehicles by Robert Bosch GmbH, in Germany, also holding the CAN license. For additional information, see the **CAN Homepage** of Robert Bosch GmbH. The first CAN silicon was fabricated in 1987 by Intel.

The CAN protocol is an international standard defined in ISO 11898 (for applications up to 1 Megabit per second) and ISO 11519 (for applications up to 125 Kilobits per second). The conformance test for the CAN protocol is defined in ISO 16845. ISO 16845 also guarantees the interchangeability of the CAN chips. See the **ISO** web site for additional information. CAN is also internationally standardized by the Society of Automotive Engineers (**SAE**).

The CAN communications protocol describes how information is passed between devices. CAN conforms to the Open Systems Interconnection (OSI) model (developed by the ISO - ISO 7498) which is defined in terms of layers. Each layer in a device "communicates" with the same layer in another device. Actual communication occurs between adjacent layers in each device. The devices are only connected by the physical medium via the physical layer of the OSI model.

The CAN architecture defines the lowest two layers of the OSI model - the Data Link Layer and the Physical Layer (lowest layer).

The **Data Link Layer** is the **only** layer that recognizes and understands the format of messages. This layer constructs the messages to be sent to the Physical Layer, and decodes the messages received from the Physical Layer. In CAN controllers, the Data Link Layer is usually implemented in hardware.

The **Physical Layer** specifies the physical and electrical characteristics of the CAN Bus, as well as the hardware that converts the characters of a message into electrical signals for transmitted messages, and electrical signals into characters for received messages. Although the other OSI layers may be implemented in either hardware (as chip level functions) or software, the Physical Layer is **always** "real" hardware.

The most common physical medium consists of a twisted wire pair (shielded or unshielded) with appropriate termination (i.e. 120 ohm resistance) at each end. ISO 11898 states that the impedance of the cable should be 120 +- 12 ohms. The basic CAN design specification called for a high bit rate, a high immunity to electrical interference, and an ability to detect any errors produced.

There are **no** standards for how CAN controllers are implemented, or how CAN controllers communicate with their host microcontroller.

The maximum bus length for a CAN network depends on the bit rate used. It is a requirement that the wave front of the bit signal have time to travel to the most remote node and back again (before the bit is sampled). So, if the bus length is near the maximum for the bit rate used (see the table on the next page), then the sampling point should be chosen very carefully.

Bus Length (in meters)	Maximum Bit Rate (bits/second)
40	1 Mbit/s
100	500 Kbit/s
200	250 Kbit/s
500	125 Kbit/s
6 km	10 Kbit/s

There are two principal CAN hardware implementations. Suitably configured, each implementation (Basic CAN and Full CAN) can handle both Normal and Extended CAN data formats. **Note:** Communication is identical for all implementations of CAN.

Basic CAN is used in less expensive standalone CAN controllers or in smaller microcontrollers with an integrated CAN controller. In the Basic CAN configuration, there is a strong bond between the CAN controller and the associated microcontroller. Therefore, the microcontroller, which will have other system related functions to administer, will be interrupted to deal with every (received and transmitted) CAN message.

Full CAN is used in more expensive, high performance CAN controllers and microcontrollers. Full CAN devices contain additional hardware to provide a separate "server" that will automatically receive and transmit CAN messages, without interrupting the associated microcontroller. Full CAN devices also service simultaneous requests, carry out extensive acceptance filtering on incoming messages, and greatly reduce the load on the microcontroller.

CAN identifiers come in two "flavors". These two "flavors" (i.e. protocol versions) define different formats of the message frame (with the main difference being the identifier length). Your Mod5234 supports both CAN versions. The two CAN protocol versions are:

Version 2.0A - Normal or Standard CAN - supports messages with 11 bit identifiers.

Version 2.0B - Extended CAN - supports messages with 29 bit identifiers (an 11 bit base identifier for compatibility with Version 2.0A and an 18 bit extension identifier).

In the NetBurner Software API, we **always** refer to **CAN identifiers** as **32 bit DWORDS**. A 32 bit DWORD is bigger than either (Normal or Extended) Identifier. A Normal identifier will always have bits 0 to 17 as zero. An Extended identifier can have bits 0 to 17 low. Extended identifiers that are received will have bit 29 set to 1. Note: Any ID input into the system will be treated as Extended if bit 29 is set, or if bits 0 to 17 are not zero.

There are **three** types of CAN controllers:

1. **Part A** (Version 2.0A)
2. **Part B Passive** (Version 2.0A)
3. **Part B** (Version 2.0B)

Version 2.0B (i.e. Part B) controllers are **completely** backward compatible with Version 2.0A (both Part A and Part B Passive) controllers. Each CAN controller is able to handle the different parts of the CAN standard as shown on the next page.

Message Format\CAN Chip Type	Part A	Part B Passive	Part B
11 bit ID (Normal or Standard) Ver. 2.0A	OK	OK	OK
29 bit ID (Extended) Ver. 2.0B	ERROR	Tolerated– but ignored	OK

Note: If 29 bit identifiers are used on a CAN bus which contains Part A (Version 2.0A) controllers the bus will not work (as shown above). However, it is possible to use both Part B Passive (Version 2.0A) and Part B (Version 2.0B) controllers on a single network (also as shown above).

CAN is a multi-master Bus with an open linear structure, consisting of one logic bus line and equal nodes. The number of nodes is **not** limited by the protocol. In either of the two CAN protocols (i.e. Version 2.0A and Version 2.0B), the bus nodes do not have a specific address. Instead, the address information is contained in the identifiers of the transmitted messages - indicating both the message content and the priority of the message. Therefore, the number of nodes on a network may be changed dynamically without disturbing the communication of the other nodes.

A high degree of system and configuration flexibility is achieved because of CAN's content-oriented addressing scheme. Therefore, it is very easy to add additional stations (i.e. receivers) to an existing CAN network - without making any hardware or software modifications to the existing stations. This feature follows the concept of modular electronics, and permits multiple reception and synchronization of distributed processes. Data (needed as information by one or more stations) can be transmitted via the network in such a way that it is unnecessary for each station to know who produced it. This feature allows for the easy servicing and upgrading of networks (data transmission is not based on the availability of specific types of stations). Multicasting and Broadcasting are also supported by CAN.

There are two Bus states: Dominant and Recessive. The CAN Bus logic uses a "Wired-AND" mechanism. Dominant bits (logic 0) overwrite the recessive bits (logic 1). If all nodes on the network transmit recessive bits (Ones), the Bus is in the recessive state. However, as soon as one node transmits a dominant bit (Zero), the Bus state changes to dominant. A dominant state will always have precedence over a recessive state.

The CAN protocol handles Bus accesses according to an arbitration process known as Carrier Sense Multiple Access/Collision Detection (CSMA/CD). By using this non-destructive bitwise arbitration process the CAN Bus:

Avoids collisions of messages whose transmission was started by more than one node simultaneously.

Sends the most important message out first without time loss.

A message in the CAN Standard/Normal or Extended Frame format begins with a start bit called the Start Of Frame (SOF). This is a dominant bit for hard synchronization of all nodes on the network.

The Arbitration Field (12 bits) consists of the Message Identifier (11 bits) and the Remote Transmission Request (RTR) bit. The RTR bit is used to distinguish between a Data Frame (RTR bit is dominant) and a Remote Frame (RTR bit is recessive).

The Control Field (6 bits) contains the IDentifier Extension (IDE) bit (dominant to specify that the frame is a Standard Frame), a reserved dominant bit, and the Data Length Code (DLC) (4 bits). The DLC is used to indicate the number of data bytes in the Data Field. If the message is used as a Remote Frame, the DLC contains the number of requested data bytes. The Data Field that follows can hold up to 8 data bytes.

The Cyclic Redundancy Field is used detect possible transmission errors. The integrity of the frame (Remote or Data) is guaranteed by the following Cyclic Redundant Check (CRC) sum. The CRC sum contains a 15 bit cyclic redundancy check code and a recessive delimiter bit.

The ACKnowledge (ACK) Field consists of two parts: the ACK Slot and the ACK Delimiter. The bit in the ACK Slot is initially sent as a recessive bit. This recessive bit is converted to a dominant bit by those receivers on the network that have received the data correctly. Correct messages are acknowledged by the receivers regardless of the result of the acceptance test (i.e. positive acknowledgement). The ACK Delimiter is also a recessive bit.

The end of the message is indicated by the End Of Frame (EOF) Field. This field contains seven recessive bits.

The Intermission Frame Space (IFS) Field follows the EOF. This is the minimum number of bits separating consecutive messages. After a three bit Intermission period, the Bus is recognized to be free. Note: The Bus Idle time may be any arbitrary length including zero.

A message in the CAN Extended Frame format (i.e. Version 2.0B) is almost the same as a message in the CAN Standard or Normal Frame format (i.e. Version 2.0A). One obvious difference is the length of the identifier used. The Extended Frame format identifier is made up of the existing 11 bit identifier (base identifier) and an 18 bit extension (identifier extension), for a total length of 29 bits. The distinction between the CAN Standard Frame format and the CAN Extended Frame format is made by using the IDE bit. The IDE bit is recessive to specify that the frame is an Extended Frame.

A Substitute Remote Request (SRR) bit is also included in the Arbitration Field (in Version 2.0B). The SRR bit is always transmitted as a recessive bit to ensure that, in the case of arbitration between a Standard Data Frame and an Extended Data Frame, the Standard Data Frame will always have priority if both messages have the same base (11 bit) identifier.

CAN provides superior error-detection and error handling mechanisms (e.g. a CRC check and a high immunity against electromagnetic interference). Erroneous messages are automatically retransmitted. Temporary errors are recovered. Permanent errors are followed by an automatic switch-off of defective nodes (stations). There is guaranteed system-wide data consistency.

CAN implements **five** different types of error detection - three at the message level and two at the bit level.

At the **message level** the **three** types of error detection are:

Cyclic Redundancy Check (CRC) - As already mentioned, the CRC safeguards the information in a frame by adding redundant check bits at the transmission end. At the receiving end, these bits are re-computed and tested against the received bits. If they do not match - a CRC error has occurred.

Frame Check - This mechanism verifies the structure of the transmitted frame by checking the bit fields against the fixed format and the frame size. If they do not match - a frame check error has occurred. Errors detected by frame checks are called Format errors.

ACK Errors - As already mentioned, frames received are acknowledged by all receivers through positive acknowledgement. If no acknowledgement is received by the transmitter of the message - an ACK error has occurred.

At the **bit level** the **two** types of error detection are:

Bit Monitoring - The ability of the transmitter to detect errors is based on monitoring the CAN bus signals. Each transmitting station also observes the bus level, detecting differences between the bit sent and the bit received. This permits the reliable detection of global errors, and the detection of errors that are local to the individual transmitter.

Bit Stuffing - The coding of the individual bits is tested at bit level. The bit representation used by CAN is called "Non Return to Zero" (NRZ) coding, which guarantees maximum efficiency in bit coding. The synchronization edges are generated by means of bit stuffing. This means that after five consecutive equal bits, the transmitter inserts into the bit stream a "stuff bit" with a complementary value which is removed by the receivers.

If one or more errors are discovered (by at least one station), the current (message) transmission is aborted by sending an "error flag". This error flag prevents other stations (on the same network) from accepting the message, and ensures the consistency of data throughout the network. After the transmission of an erroneous message (that has been aborted), the sender automatically re-attempts transmission (i.e. automatic re-transmission) of the message. However, in the event of a defective station, all messages (including valid ones) could be aborted.

Therefore, the CAN protocol also provides a mechanism to distinguish between sporadic errors, permanent errors and local failures at the station. This is accomplished by the statistical assessment of station error situations. The aim is - recognizing a station's (own) defects. Then, that station could switch to another mode, so that the rest of the CAN network is not negatively affected. For example, the defective station could switch itself off to prevent valid messages from erroneously being recognized as invalid.

A CAN higher level protocol (also known as the Application Layer) is a protocol implemented "on top" of the two existing lower-level CAN layers (i.e. the Physical Layer and the Data Link Layer). The application levels are linked to the physical medium by the layers of various emerging protocols, dedicated to a particular industry plus any number of propriety schemes as defined by individual CAN users.

Many systems (e.g. the automotive industry) use a propriety Application Layer; but for many other industries, this approach is not cost-effective. Several organizations have developed standardized open Application Layers to ensure ease of system integration. See the CAN in Automation (**CiA**) web site for additional information.

Suggested Reading:

CAN System Engineering: From Theory to Practical Applications by Wolfhard Lawrenz (ISBN - 0387949399)

Controller Area Network by Konrad Etschberger (ISBN - 3000073760)

4.2. CanRxMessage Class

Header File:

#include <canif.h>   // Found in C:\Nburn\<HWPlatform>\include

Synopsis:

Class CanRxMessage

Description:

The CanRxMessage Class will hold incoming messages. **Before** using this class, the application must have called CanInit, and be configured to **receive** incoming data on one or more ID's. There are two constructors that can be used to instantiate the class: using a FIFO and using an ID.

The NetBurner Hardware Platforms that support CAN are:

CB34EX (canif.h is located in C:\Nburn\CB34EX\include)
MOD5213 (canif.h is located in C:\Nburn\MOD5213\include)
MOD5234 (canif.h is located in C:\Nburn\MOD5234\include)
MOD5282 (canif.h is located inC:\Nburn\MOD5282\system)

4.3. Constructors and Destructor

4.3.1. CanRxMessage - FIFO

Synopsis:

CanRxMessage(OS_FIFO * pFifo, WORD timeout);

Description:

This constructor builds a CanRxMessage from a FIFO. The FIFO **must be** registered to listen for incoming messages. The FIFO is a function of the RTOS. To use the FIFO, the application must:

1. Declare an OS_FIFO object
2. Initialize the FIFO with the OSFifoInit function
3. Register the FIFO to listen to a specific ID
4. Create an instance of a CanRxMessage with the FIFO constructor

Parameters:

Type	Name	Description
OS_FIFO	***** pFifo	A pointer to the FIFO used to communicate between the CAN subsystem and the CanRxMessage Class. The FIFO **must** be initialized first.
WORD	timeout	How long to wait for confirmation. 0 = wait forever and 0xFFFF = don't wait at all.

Returns:

If **no** messages are received in the timeout interval (i.e. time ticks), then the returned CanRxMessage will be marked as **invalid**

A Timeout value of **0** (zero) **will** wait forever

Note: The **default** value is **1/20th** of a second

Example:

```
OS_FIFO fifo;
OSFifoInit( &fifo );
int chan = RegisterCanRxFifo( 0x1234, &fifo );
if ( chan > 0 )
{
    CanRxMessage can_msg( &fifo, 30*TICKS_PER_SECOND );
}
```

4.3.2. CanRxMessage - ID

Synopsis:

```
 CanRxMessage( DWORD id, WORD timeout );
```

Description:

This constructor sends a RTR (Remote Transmission Request) to the device at a **specified** ID and waits for a response.

Parameters:

Type	Name	Description
DWORD	id	The identifier to match on received frames.
WORD	timeout	How long to wait for confirmation. 0 = wait forever and 0xFFFF = don't wait at all.

Returns:

If **no** messages are received in the timeout interval (i.e. time ticks), then the returned CanRxMessage will be marked as **invalid**

A Timeout value of **0** (zero) **will** wait forever. **Note:** The **default** timeout value is **1/20th of a second**.

The CAN system uses **any** unused channel to send and receive the buffer. This constructor can return an **invalid** message for **two** reasons:

1. The timeout interval has **transpired**
2. There were **no** free channels available to send the request

4.3.3. ~CanRxMessage

Synopsis:

~CanRxMessage( );

Description:

The CanRxMessage destructor. This is called automatically when an instance goes out of scope.

Parameters:

None

4.4. Member Functions

4.4.1. GetLength

Synopsis:

BYTE GetLength( );

Description:

This member function gets the amount of data stored in the message.

Parameters:

None

Returns:

The number of bytes stored as an unsigned 8 bit value

4.4.2. GetData

Synopsis:

BYTE GetData(BYTE * buffer, BYTE max_len);

Description:

This member function copies the data in a message object to the location pointed to by buffer up to a maximum of max_len in bytes.

Parameters:

Type	Name	Description
BYTE	* buffer	A pointer to the buffer to put the data in.
BYTE	max_len	The maximum length to store (in bytes).

Returns:

The number of bytes stored

4.4.3. GetId

Synopsis:

DWORD GetId( );

Description:

This member function gets the ID of the message. In the NetBurner Software API, we **always** refer to **CAN identifiers** as **32 bit DWORDS**. A 32 bit DWORD is **bigger** than either (Normal or Extended) Identifier.

A Normal identifier will **always** have bits 0 to 17 as zero. An Extended identifier **can have** bits 0 to 17 low. Therefore, Extended identifiers that are received **will** have bit 29 set to 1. **Note:** Any ID input into the system will be treated as Extended **if** bit 29 is set, **or** if bits 0 to 17 are **not** zero.

Parameters:

None

Returns:

The ID of the message object

4.4.4. GetTimeStamp

Synopsis:

WORD GetTimeStamp( );

Description:

Each CAN message contains a time stamp indicating when it is sent. This member function gets the time stamp from where it was sent.

Parameters:

None

Returns:

The time stamp of the message object

4.4.5. IsValid

Synopsis:

BOOL IsValid( );

Description:

Each CanRxMessage object constructor has a timeout value. If a message object is created and a timeout occurs the message object contains no data, and is marked as "invalid". This member function answers the question: Is this CanRxMessage a valid message.

Parameters:

None

Returns:

TRUE --- If the CanRxMessage object contains a valid message
FALSE --- If the message is invalid

4.5. Functions

4.5.1. CanInit

Synopsis:

int CanInit(DWORD bit_rate, DWORD Global_Mask, BYTE irq_level=4);

Description:

This function initializes the CAN system. It must be called before any other CAN functions or the creation of CanRxMessage objects.

Parameters:

Type	Name	Description
DWORD	bit_rate	The bit rate to run the CAN system at.
DWORD	Global_Mask	The mask used to mask received IDs.
BYTE	irq_level	The interrupt level you want the CAN system to operate at.

Note: The system will get as close as possible, but 1000000, 500000, 250000, and 125000 are the **only** values that are known to work.

Value	Meaning
0	Don't care
1	Care

Returns:

CAN_OK --- On success
CAN_RATE_FAIL --- If the bit rate could not be set within 1.5%
CAN_ALREADOPEN --- If the CAN system is already running - you must call CanShutDown first

4.5.2. CanShutDown

Synopsis:

void CanShutDown( );

Description:

This function shuts down the CAN system.

Parameters:

None

Returns:

Nothing --- This is a void function

4.5.3. ChangeGlobalMask

Synopsis:

```
void ChangeGlobalMask( DWORD Global_Mask );
```

Description:

This function **changes** the global receive mask **after** the CAN system is started.

Parameters:

Type	Name	Description
DWORD	Global_Mask	The mask used to mask received IDs.

Returns:

Nothing --- This is a void function

4.5.4. FreeCanChannels

Synopsis:

int FreeCanChannels( );

Description:

The CAN system has 16 available channels. Use this function return to determine which channels are currently free.

Parameters:

None

Returns:

The number of channels that are currently not in use

4.5.5. IsChannelFree

Synopsis:

BOOL IsChannelFree(int channel);

Description:

This function tells you if a specific channel is currently free.

Parameters:

Type	Name	Description
int	channel	The specified channel.

Returns:

TRUE --- If the specified channel is currently free

4.5.6. RegisterCanRxFifo

Synopsis:

int RegisterCanRxFifo(DWORD id, OS_FIFO * pFifo, int channel=-1);

Description:

This function tells the CAN system to start listening for a specific CAN ID. Any incoming CAN frames that match the ID as set by the appropriate mask will be placed into the FIFO. The FIFO is a function of the RTOS. To use the FIFO, the application must:

- Declare an OS_FIFO object
- Initialize the FIFO with the OSFifoInit function.
- Register the FIFO to listen to a specific ID.
- Create an instance of a CanRxMessage with the FIFO constructor.

Parameters:

Type	Name	Description
DWORD	id	The identifier to match on received frames. The id is modified by the global mask.
OS_FIFO	***** pFifo	A pointer to the FIFO, used to communicate between the CAN subsystem and the CanRxMessage Class. The FIFO must be initialized first. The same FIFO can be passed to multiple receive registration functions.
int	channel	There are a total of 16 CAN channels. You can either specify a channel to use for the receive request, or you can specify a value of -1, which allows the system to select an unused channel.

Returns:

A value 0 to 15 --- The channel this request is assigned to.
Note: This value must be stored to later call **UnRegisterCanFifo**
CAN_CHANNEL_USED --- If the channel is used or there are no free channels

Example:

```
OS_FIFO fifo;
OSFifoInit( &fifo );
int chan = RegisterCanRxFifo( 0x1234, &fifo );
if (chan > 0)
{
   CanRxMessage can_msg( &fifo, 30*TICKS_PER_SECOND );
}
```

4.5.7. RegisterCanSpecialRxFifo

Synopsis:

int RegisterCanSpecialRxFifo(DWORD id, DWORD spl_mask, OS_FIFO * pFifo, int channel=-1);

Description:

This function instructs the CAN system to start listening for a specific CAN ID. Any incoming CAN frames that match the ID (as set by the appropriate mask) will be placed into the FIFO. **Note:** Some applications may require more than one channel mask. The NetBurner CAN device can have up to 3 masks:

The global mask for channels 0 -13
A mask for channel 14
A mask for channel 15

Note: The masks for channels 14 and 15 are set using the spl_mask parameter unique to this function.

Parameters:

Type	Name	Description
DWORD	id	The identifier to match on received frames. This is modified by the passed in mask.
DWORD	spl_mask	There are only two channels available for use with the special mask so use this call sparingly and only if really needed.
OSFifo	***** pFifo	A pointer to the FIFO, used to communicate between the CAN subsystem and the CanRxMessage Class. The FIFO must be initialized first. The same FIFO can be passed to multiple receive registration functions.
int	channel	There are a total of 16 CAN channels. You can either specify a channel to use for the receive request, or you can specify a value of -1, which allows the system to select an unused channel.

Returns:

A value 0 to 15 --- The channel this request is assigned to.
Note: This value must be stored to later call UnRegisterCanFifo
CAN_CHANNEL_USED --- If the channel is used or there are no free channels

4.5.8. UnRegisterCanFifo

Synopsis:

int UnRegisterCanFifo(int channel);

Description:

This function disconnects a receiver channel from a FIFO.

Parameters:

Type	Name	Description
int	channel	The channel to remove.

Returns:

CAN_OK --- If successful
CAN_CHANNEL_NOT_USED --- If the channel is not currently in use

4.5.9. SendMessage

Synopsis:

int SendMessage(DWORD id, BYTE * data, BYTE len, WORD timeout, int channel = -1);

Description:

This function sends a message to a device with the specified id. To send a message, one of the 16 channels must be available. **Note:** The channel will automatically be freed once the message has been sent.

Parameters:

Type	Name	Description
DWORD	id	The identifier to send.
BYTE	***** data	A pointer to the data to send.
BYTE	len	The length of the data. It **must** be less than or equal to 8 bytes.
WORD	timeout	How long to wait for confirmation it sent. 0 = wait forever. 0xFFFF = don't wait at all. Any other timeout value blocks until it is actually sent.
int	channel	The channel to use. A value of -1 will allow the system to select an unused channel.

Returns:

CAN_OK --- If the message was sent
CAN_CHANNEL_USED --- Can't send because the channel was already in use or no channels available
CAN_TIMEOUT --- Did not send in the time allotted

4.6. MACROS

4.6.1. CAN_EXTENDED_ID_BIT

Synopsis:

#define CAN_EXTENDED_ID_BIT(0x20000000)

Description:

This macro takes the single bit used by the API to indicate an extended ID.

4.6.2. ExtToNbId

Synopsis:

#define ExtToNbId(id) (id | CAN_EXTENDED_ID_BIT)

Description:

This macro will make a system recognized Extended ID from either an Extended (29 bit) CAN Identifier or from a Normal (11 bit) CAN Identifier.

4.6.3. NormToNbId

Synopsis:

#define NormToNbId(id) ((id & 0x7ff)<<18)

Description:

This macro creates a Normal ID, and also an ID set from a normal id in the range 0 to 2048.

4.6.4. IsNBIdExt

Synopsis:

```
#define IsNBIdExt( id ) ( ( id & ( CAN_EXTENDED_ID_BIT|0x3FFFF ) )!=0 )
```

Description:

This macro determines if the ID is extended.

4.6.5. NbToExtId

Synopsis:

```
#define NbToExtId( id ) ( id & 0x1FFFFFFF )
```

Description:

This macro strips the extra flag, removing the API extended flag from the ID.

4.6.6. NbToNormId

Synopsis:

```
#define NbToNormId( id ) ( ( id >> 18 )& 0x7FF )
```

Description:

This macro will shift a Normal ID so that it has a value 0 to 1023. Some CAN systems will treat normal ID's as an integer from 0 to 2048. Other CAN systems may treat normal IDs as 28 bit values where the bottom 17 bits are zero. This macro will convert our Normal ID format into the 0 to 2048 format.

5. Command Processor Library

5.1. Introduction

The Command Processor is a system program that accepts user commands and converts them into the machine commands required by the operating system. The Command Processor receives and executes operating system commands. After you enter a command, the command processor analyzes the syntax to make sure the command is valid, and then either executes the command or issues an error warning.

Header File

#include <command.h>   // Found in C:\Nburn\include

Functions

CmdStartCommandProcessor --- Starts the command processor
CmdAddCommandFd --- Adds an established fd connection to the list of fds managed by the command processor
CmdRemoveCommandFd --- Removes an established fd
CmdListenOnTcpPort --- Listens for a connection on a TCP port
CmdStopListeningOnTcpPort --- Stops listening for connections on the specified port
*****CmdAuthenticateFunc --- Authenticates the username and password
*****CmdCmd_func --- Processes a command
*****CmdConnect_func --- Called whenever a new connection is established
*****CmdPrompt_func --- Called to display a command prompt
*****CmdDisConnect_func --- Called whenever a command is disconnected
SendToAll --- Send to all connected sockets, excluding "Listening" sockets

Globals

CmdIdleTimeout
*****Cmdlogin_prompt

5.2. CmdStartCommandProcessor

Synopsis:

```
int CmdStartCommandProcessor( int priority );
```

Description:

This function starts the Command Processor.

Parameters:

Type	Name	Description
int	priority	The UCOS task priority

Returns:

CMD_OK --- On Success
CMD_FAIL --- On Failure

Example:

The newdemo application --- Located by default in your C:\Nburn\examples directory.

Warning: This application will not run on a SB72

5.3. CmdAddCommandFd

Synopsis:

int CmdAddCommandFd(int fd, int require_auth, int time_out_conn, int local_echo=TRUE)

Description:

This function adds an established file descriptor (fd) connection to the list of file descriptors managed by the command processor.

Parameters:

Type	Name	Description
int	fd	The file descriptor
int	require_auth	Do we authenticate the connection on this file descriptor
int	time_out_conn	Do we time out the connection on this file descriptor
int	local_echo=TRUE	The command processor will echo the file descriptor.

Returns:

CMD_OK --- On Success
CMD_FAIL --- On Failure
CMD_TO_MANY_FDS --- If there are too many file descriptors

5.4. CmdRemoveCommandFd

Synopsis:

int CmdRemoveCommandFd(int fd);

Description:

This function removes an established file descriptor (either a TCP or a Serial connection).

Parameters:

Type	Name	Description
int	fd	The file descriptor

Returns:

CMD_OK --- On Success
CMD_FAIL --- On Failure

5.5. CmdListenOnTcpPort

Synopsis:

int CmdListenOnTcpPort(WORD port, int do_telnet_processing, int max_connections)

Description:

This function starts listening for a connection on a TCP port. Telnet is a user command and an underlying TCP/IP protocol for accessing remote computers.

Parameters:

Type	Name	Description
WORD	port	The port number
int	do_telnet_processing	1 = Negotiate a Telnet session 0 = Standard TCP connection
int	max_connections	Maximum number of connections allowed on this port (system maximum is 30).

Returns:

CMD_OK --- On Success
CMD_FAIL --- On Failure

5.6. CmdStopListeningOnTcpPort

Synopsis:

int CmdStopListeningOnTcpPort(WORD port);

Description:

This function stops listening for connections on the specified port. **Note:** This function also closes all open connections that were based on that specified port.

Parameters:

Type	Name	Description
WORD	port	TCP port number

Returns:

CMD_OK --- On Success
CMD_FAIL --- On Failure

5.7. *CmdAuthenticateFunc

Synopsis:

extern int (* CmdAuthenticateFunc)(const char * name, const char *passwd)

This function is of the form:

int AuthenticateCommand (const char * name, const char * passwd);

Description:

This external authentication function CALLBACK is used to verify the Username and Password. Note: If this function pointer is not NULL, then each new Telnet session will be asked to authenticate the Username and Password.

Parameters:

Type	Name	Description
const char	*name	A pointer to the Username.
const char	*passwd	A pointer to the Password.

Returns:

CMD_OK --- If the authentication was OK
CMD_CLOSE --- If the authentication causes the session to terminate (i.e. close)

5.8. *CmdCmd_func

Synopsis:

extern int (* CmdCmd_func)(const char *command, FILE *fRespondto, void *pData)

This function is of the form:

int ProcessCommand(const char * command, int fd_respondeto);

Description:

This is the command processing CALLBACK function.

Parameters:

Type	Name	Description
const char	*command	A pointer to the NULL terminated ASCII text of the command.
FILE	*fRespondto	The file descriptor (fd) that all response should be sent to. Note: Use fprintf or fiprintf to write to the file descriptor.
void	*pData	The pointer to a data object.

Returns:

CMD_OK --- If the command was OK
CMD_CLOSE --- If the command causes the session to terminate (i.e. close)

5.9. *CmdConnect_func

Synopsis:

extern void* (* CmdConnect_func)(FILE *fRespondto);

This function is of the form:

void ConnectCommand (FILE * fRespondto);

Description:

This is the connect CALLBACK function. **Note: I**f this function pointer is not NULL, then the system will call this function every time a new session is started.

Parameters:

Type	Name	Description
FILE	*fRespondto	The file descriptor (fd) that all response should be sent to. **Note:** Use fprintf or fiprintf to write to the file descriptor.

Returns:

An arbitrary void * data item to be associated with this session

5.10. *CmdPrompt_func

Synopsis:

extern void (* CmdPrompt_func)(FILE *fRespondto, void *pData)

This function is of the form:

void PromptCommand(int fd_respondeto)

Description:

This is a prompt Callback function. **Note:** If this function pointer is not NULL, then the system will call this function every time a new prompt line needs to be displayed.

Parameters:

Type	Name	Description
FILE	*fRespondto	The file descriptor (fd) that all response should be sent to. **Note:** Use fprintf **or** fiprintf to write to the file descriptor.
void	*pData	The pointer to a data object that can be used in the prompt. The value of pData is the value returned by *CmdConnect_func. This means that you can change the value of pData for each connection, and make that value part of the command prompt (e.g. NB:1>, NB:2>, NB:3>, etc.).

Returns:

Nothing --- This is a void function

Example:

```
#include <command.h>

void ProcessPrompt( FILE *fp, void *pData )
{
   // The following code will produce the prompt: "MyPrompt> "
   fiprintf( fp, "\nMyPrompt> " );
}

void UserMain( void *pd )
{
   CmdPrompt_func = ProcessPrompt;
   while ( 1 )
      OSTimeDly( TICKS_PER_SECOND );
}
```

5.11. *CmdDisConnect_func

Synopsis:

extern void (* CmdDisConnect_func)(FILE *fRespondto, int cause, void *pData)

This function is of the form:

void DisconnectCommand(int fd_respondeto, int cause);

Description:

This is a disconnect CALLBACK function. Note: If this function pointer is not NULL, then the system will call this function every time a session is terminated.

Parameters:

Type	Name	Description
FILE	*fRespondto	The file descriptor (fd) that all responses should be sent to. **Note:** Use fprintf **or** fiprintf to write to the file descriptor.
int	cause	The reason why it is disconnected. The current values of cause are: #define CMD_DIS_CAUSE_TIMEOUT (1) #define CMD_DIS_CAUSE_CLOSED (2) #define CMD_DIS_SOCKET_CLOSED (3) --- Do not send a response for this case. #define CMD_DIS_AUTH_FAILED (4) --- Do not send a response for this case.
void	*pData	The pointer to a data object.

Returns:

Nothing --- This is a void function

5.12. SendToAll

Synopsis:

void SendToAll (char *buffer, int len, BOOL include_serial_ports)

Description:

This function will send to all connected sockets, excluding "Listening sockets".

Parameters:

Type	Name	Description
char	*buffer	Pointer to the buffer.
int	len	The length of what is in the buffer.
BOOL	include_serial_ports	Do you want to include Serial ports or just TCP ports?

Returns:

Nothing --- This is a void function

5.13. Globals

5.13.1. CmdIdleTimeout

Synopsis:

extern int CmdIdleTimeout;

Description:

The number of seconds a connection is idle before it is terminated due to inactivity.

5.13.2. *Cmdlogin_prompt

Synopsis:

extern const char *Cmdlogin_prompt;

Description:

If this is not NULL, then it will be sent to the socket on connection (before authentication is tried).

6. DHCP Library

6.1. Introduction

This Library provides a DHCP Client to dynamically get IP Addresses using the RFC1541 DHCP protocol. To use this Library you must call the StartDHCP( ) function after the IP stack is initialized. Once the DHCP Client is stared, it will automatically renew the DHCP address when necessary.

The Network Programmers Guide provides a complete section on using DHCP as a simple function call, and also a detailed implementation in which you can create your own DHCP object for more detailed control.

Header File

#include <dhcpclient.h>   // Found in C:\Nburn\include

Most Commonly Used Functions

GetDHCPAddress	Returns DHCP_OK on success. Automatic DHCP renewal.
GetDHCPAddressIfNecessary	Same as GetDHCPAddress, but checks to verify EthernetIP is 0.0.0.0 so no static IP address is configured.
ValidDhcpLease	Returns TRUE if lease is valid
GetRemainingDhcpLeaseTime	Returns the number of seconds remaining on the current lease

Advanced Functions for DHCP Objects

The following functions require an intimate understanding of the RFC DHCP implementation. Before using any of these functions please read the Changing IP Address section of the Network Programming Guide, which provides examples on how to use these functions.

StartDHCP	Starts the DHCP client
StopDHCP	Stops the DHCP client, and release any active DHCP lease
RebindDHCP	Forces a DHCP rebind
RenewDHCP	Forces a DHCP renew
GetDhcpRebindTime	Returns time at which a rebind will occur in seconds (system clock)
GetDhcpRenewTime	Returns time at which a renew will occur in seconds (system clock)
GetDhcpExpirationTime	Returns time at which a lease will expire in seconds (system clock)
GetDHCPState	Get the current DHCP state
SetDHCPDiscoverSeconds	Set the number of second to be advertised when trying to get a DHCP address

6.2. Global Variables

const char *pDHCPOfferName   Pointer to define a name for the DHCP device

Type	Name	Description
IPADDR	DhcpClientIP	The allocated IP Address.
IPADDR	DhcpClientMask	The allocated Subnet Mask.
IPADDR	DhcpServerIP	The Server ID.
IPADDR	DhcpRelayIP	The Relay Agent.
IPADDR	DhcpRouterIP	The Gateway IP Address.
IPADDR	DhcpDNSIP	The DNS IP Address.
Volatile DWORD	DhcpLeaseTimer	Tracks the current lease time.
DWORD	DhcpLeaseStart	IP Address lease start time in seconds.
DWORD	DhcpLeaseTime	IP Address lease time in seconds.
DWORD	DhcpRenewTime	Time to renewing state in seconds.
DWORD	DhcpRebindTime	Time to rebinding state in seconds.
const char	*pDHCPOfferName	The name to give this DHCP client. **Note:** This name **must** be set before calling StartDHCP.

6.3. DHCP Example

The most common method of starting DHCP is with the GetDhcpAddress( ) function, which will automatically handle renewing the DHCP lease.

```
void UserMain( void *pd )
{
   iprintf( "Mod5270 Factory Demo Program\r\n" );

   InitializeStack();           // Initialize TCP/IP stack

   if ( EthernetIP == 0 )
   {
      iprintf( "Trying DHCP\r\n" );
      GetDHCPAddress();
      iprintf( "DHCP assigned the IP address of :" );
      ShowIP( EthernetIP );
      iprintf( "\r\n" );
   }

   // remainder of application

}
```

6.4. GetDHCPAddress

Synopsis:

int GetDHCPAddress( );

Description:

This function encapsulates all of the code necessary to start the DHCP Client and automatically renew the lease.

Parameters:

None

Return Values:

DHCP_OK (0) --- The system found a DHCP address
DHCP_FAILED (-1) --- The system failed to acquire a DHCP address

6.5. GetDHCPAddressIfNecessary

Synopsis:

int GetDHCPAddressIfNecessary(int interface = 0);

Description:

This function encapsulates all of the code necessary to start the DHCP Client and automatically renew the lease. It is the most common way to use DHCP. It is similar to GetDHCPAddress, but adds a check to verify the Ethernet IP address is 0.0.0.0 before attempting to get a DHCP IP address. The assumption is that if a static IP address is configured, then DHCP should not be used.

Parameters:

The network interface. If no parameter is specified, the default interface will be used.

Return Values:

DHCP_OK (0) --- The system found a DHCP address
DHCP_FAILED (-1) --- The system failed to acquire a DHCP address

6.6. GetRemainingDhcpLeaseTime

Synopsis:

DWORD GetRemainingDhcpLeaseTime( );

Description:

DHCP uses the concept of a "lease" or amount of time that a given IP address will be valid for a computer. Therefore, call this function to retrieve the number of seconds remaining for the current valid "lease".

Parameters:

None

Returns:

The amount of times left (in seconds) on the current DHCP "lease"

6.7. ValidDhcpLease

Synopsis:

BOOL ValidDhcpLease( );

Description:

DHCP uses the concept of a "lease" or amount of time that a given IP Address will be valid for a computer. Therefore, call this function to determine the validity of the DHCP "lease".

Parameters:

None

Returns:

1 - TRUE --- If the “lease” is valid
0 - FALSE --- If the “lease” is not valid

6.8. StartDHCP

Synopsis:

void StartDHCP(OS_SEM * pDhcpSemaphore);

Description:

This function starts the DHCP client, and should only be used if you have a requirement to create your own DHCP instance. Most application will use the functions: GetDhcpAddress( ) or GetDhcpAddressIfNecessary( ) that start the DHCP service automatically.

If you point the DHCP global variable pDHCPOfferName to a name, the DHCP system will assign that name. It will return immediately, and you need to either watch the semaphore, or monitor the status of DHCP using the GetDHCPState function before you assume that the IP Address has been setup. When you use this function to start DHCP it will automatically renew the DHCP lease.

Parameters:

Type	Name	Description
OS_SEM	*pDhcpSemaphore	A pointer to a Semaphore - to notify when DHCP is complete. **Note:** It may be passed in as **NULL.**

Returns:

Nothing --- This is a void function

Example Code:

Refer to the Network Programming Guide for detailed information on creating your own DHCP instance.

#include <dhcpclient.h>

```
{
   OS_SEM DHCPSem;
   OSSemInit(&DHCPSem,0);// Initialize the Semaphore
   StartDHCP(&DHCPSem); // Start DHCP
   if (OSSemPend(&dhcpSem,20*TICKS_PER_SECOND)==OS_TIMEOUT) // Wait 20 sec
   {
      // DHCP did not initialize, handle the error here
   }
}
```

6.9. StopDHCP

Synopsis:

void StopDHCP( );

Description:

This function stops the DHCP client and releases any DHCP leases we own. Standard DHCP Client operation does not need to call this function, it should only be used when creating your own DHCP object.

Parameters:

None

Returns:

Nothing --- This is a void function

6.10. RebindDHCP

Synopsis:

void RebindDHCP( );

Description:

DHCP uses the concept of a "lease" or amount of time that a given IP Address will be valid for a computer. Therefore, calling this function will result in a "lease" rebind (i.e. a forced rebinding of the lease). Standard DHCP Client operation does not need to call this function, it should only be used when creating your own DHCP object.

Parameters:

None

Returns:

Nothing --- This is a void function

6.11. RenewDHCP

Synopsis:

void RenewDHCP( );

Description:

DHCP uses the concept of a "lease" or amount of time that a given IP Address will be valid for a computer. Therefore, calling this function **will** result in the "lease" being renewed (i.e. a **forced** renew of the lease). Standard DHCP Client operation does not need to call this function, it should only be used when creating your own DHCP object.

Parameters:

None

Returns:

Nothing --- This is a void function

6.12. GetDHCPState

Synopsis:

int GetDHCPState( );

Description:

This function returns the current state of the DHCP lease.

Parameters:

None

Returns:

SDHCP_DISCOVER --- The system is discovering the DHCP servers
SDHCP_OFFER --- The system has responded to an Offer
SDHCP_ACK --- The System has acknowledged the Offer
SDHCP_INIT --- The System is reinitializing
SDHCP_CMPL --- The System has completed the last transaction
SDHCP_RENEW --- The System is in the process of renewing
SDHCP_REBIND --- The System has failed the Renew and is trying to Rebind
SDHCP_RELEASE --- The System is trying to release the Lease
SDHCP_NOTSTARTED --- The System has not been initialized

6.13. GetDhcpRenewTime

Synopsis:

```
DWORD GetDhcpRenewTime() { return DhcpRenewTime; }
```

Description:

Returns time at which a renew will occur (50% of lease time), in seconds. The value is referenced to the system seconds counter: Secs.

Parameters:

None

Returns:

Returns time at which a renew will occur in seconds. The value is referenced to the system seconds counter: Secs.

6.14. GetDhcpRebindTime

Synopsis:

DWORD GetDhcpRenewTime()

Description:

Returns time at which a rebind will occur (approx. 87.5% of lease time) in seconds. The value is referenced to the system seconds counter: Secs.

Parameters:

None

Returns:

Returns time at which a rebind will occur in seconds. The value is referenced to the system seconds counter: Secs.

6.15. GetDhcpExpirationTime

Synopsis:

DWORD GetDhcpExpirationTime()

Description:

Returns time at which a lease will expire in seconds. The value is referenced to the system seconds counter: Secs.

Parameters:

None

Returns:

Returns time at which a lease will expire in seconds. The value is referenced to the system seconds counter: Secs.

7. FTP Client Library

7.1. Introduction

The FTP Client module provides code for sending and receiving files from a FTP server. Most embedded platforms, including the NetBurner embedded development environment, do not have a built-in file system (although you could implement a file system on your own). This means that the Client FTP code does not use files as you might think of them on a computer's hard drive. Instead, you will create data streams that are associated with file names. In other words, a "file" is just a collection of bytes that can be stored in Flash memory or RAM.

When you read a file from the external FTP server using the FTPGetFile function, you will receive a file descriptor (fd), not a file. If you read the bytes/data from this file descriptor you will receive the contents of the remote file as a stream of data. The received data is stored in Flash or RAM.

When you create a file on a remote FTP server using the FTPSendFile, function, then you write the stream of data that will become the remote file associated with the file descriptor. If the remote FTP server has a file system (e.g. a Unix server running a FTP daemon), then the stream of data you wrote would likely be stored as a file on a computer's hard drive.

Some basic knowledge of the inner workings of FTP will be helpful in using this module. Two recommended references are TCP/IP Illustrated Volume 1 (Chapter 27) by Richard Stevens, and/or RFC 959.

Header File

```
#include <ftp.h>     // Found in C:\Nburn\include
```

FTP Client Module Description

The basic procedure to use the FTP Client module is:

Open the FTP session (with the FTP_InitializeSession function)
Send commands within the FTP session (with the FTPGetList, FTPGetFileNames, FTPGetFile, and/or FTPSendFile functions)
Close the session (with the FTP_CloseSession function)

FTP Client Functions to Initialize and/or Close a FTP Session

FTP_InitializeSession --- Create/Initialize a connection to an FTP Server
FTP_CloseSession --- Close the FTP session

FTP Client Directory Functions

FTPGetDir --- Get the current working directory
FTPSetDir --- Set the current working directory
FTPDeleteDir --- Delete a directory

FTPMakeDir --- Make a directory
FTPUpDir --- Move up one directory level

FTP Client Miscellaneous File Functions

FTPDeleteFile --- Delete a file on the server
FTPRenameFile --- Rename a file on the server

FTP Client Send File Function

FTPSendFile --- Setup to send a file on an existing FTP session

FTP Client Get File Functions

FTPGetFile --- Setup to receive a file on an existing FTP session
FTPGetList --- Setup to receive a directory on an existing FTP session
FTPGetFileNames --- Setup to receive a just the file names from the existing FTP session

FTP Client Low Level Functions

FTPRawCommand --- Send a command and get a response from the control connection
FTPGetCommandResult --- Get a response from the control connection without sending a command
FTPRawStreamCommand --- Send a command and get a response over a stream connection

FTP Client Example Program

See FTPClient example application in \nburn\examples\FTPClient

7.2. FTP_InitializeSession

Synopsis:

```
int FTP_InitializeSession( IPADDR server_address, WORD port, PCSTR UserName,
                           PCSTR PassWord, DWORD time_out )
```

Description:

This function creates and initializes a connection to an FTP server. This call creates a connection to a FTP server, and logs in with the username and password specified in the function call. The session handle returned from this call is used by the FTP file and directory functions. **Note:** The FTP_CloseSession function is used to close the session.

Parameters:

Type	Name	Description
IPADDR	server_address	The IP Address of the FTP Server.
WORD	port	The port number to connect to on the Server.
PCSTR	UserName	The account User Name.
PCSTR	PassWord	The account password.
DWORD	time_out	The number of time ticks to wait.

Return Values:

> 0 --- FTP session handle
FTP_TIMEOUT --- Time out
FTP_PASSWORDERROR --- Password error
FTP_CONNECTFAIL --- Network error
FTP_NETWORKERROR --- Network error

7.3. FTP_CloseSession

Synopsis:

int FTP_CloseSession(int session);

Description:

This function closes the specified FTP session. This function should be called when an FTP session is complete.

Warning: Failure to call this function will result in memory/resource leaks.

Parameters:

Type	Name	Description
int	session	The FTP session handle.

Return Values:

FTP_OK --- Closed successfully
FTP_TIMEOUT --- Time out
FTP_COMMANDFAIL --- Command error
FTP_NETWORKERROR --- Network error
FTP_BADSESSION --- Invalid session number

7.4. FTPGetDir

Synopsis:

int FTPGetDir(int ftp_Session, char * dir_buf, int nbytes, WORD timeout)

Description:

This function gets the current working directory name on the FTP server. This function also copies the name of the current working directory into the buffer specified by dir_buf.

Parameters:

Type	Name	Description
int	ftp_Session	The FTP session handle returned from the FTP_InitializeSession call.
char	*dir_buf	A pointer to the buffer that will hold the directory name.
int	nbytes	The maximum number of bytes to copy.
WORD	timeout	The number of ticks to wait for timeout.

Return Values:

> 0 --- The number of bytes read
FTP_TIMEOUT --- Time out
FTP_COMMANDFAIL --- Could not execute command
FTP_CONNECTFAIL --- FTP failure
FTP_NETWORKERROR --- Network error

7.5. FTPSetDir

Synopsis:

int FTPSetDir(int ftp_Session, const char * new_dir, WORD timeout)

Description:

This function sets the current working directory of the FTP Server.

Parameters:

Type	Name	Description
int	ftp_Session	The FTP session handle returned from the FTP_InitializeSession call.
const char	*new_dir	The name of the directory to change to
WORD	timeout	The number of timer ticks to wait for timeout.

Return Values:

FTP_OK --- Set successfully
FTP_TIMEOUT --- Time out
FTP_COMMANDFAIL --- Command failed (e.g. a nonexistent directory)
FTP_CONNECTFAIL --- FTP failure
FTP_NETWORKERROR --- Network error

7.6. FTPDeleteDir

Synopsis:

int FTPDeleteDir(int ftp_Session, const char * dir_to_delete, WORD timeout)

Description:

This function deletes a directory on the FTP server.

Parameters:

Type	Name	Description
int	ftp_Session	The FTP session handle returned from the FTP_InitializeSession call.
const char	*dir_to_delete	The name of the directory to be deleted.
WORD	timeout	The number of ticks to wait for a timeout.

Return Values:

FTP_OK --- Deleted successfully
FTP_TIMEOUT --- Time out
FTP_COMMANDFAIL --- Command failed (e.g. a nonexistent directory)
FTP_CONNECTFAIL --- FTP failure
FTP_NETWORKERROR --- Network error

7.7. FTPMakeDir

Synopsis:

int FTPMakeDir(int ftp_Session, const char * dir_to_make, WORD timeout)

Description:

This function makes a directory on the FTP server.

Parameters:

Type	Name	Description
int	ftp_Session	The FTP session handle returned from the FTP_InitializeSession call.
const char	*dir_to_make	The name of the directory to create.
WORD	timeout	The number of ticks to wait for a timeout.

Return Values:

FTP_OK --- Created successfully
FTP_TIMEOUT --- Time out
FTP_COMMANDFAIL --- Command failed (e.g. a nonexistent directory)
FTP_CONNECTFAIL --- FTP failure
FTP_NETWORKERROR --- Network error

7.8. FTPUpDir

Synopsis:

int FTPUpDir(int ftp_Session, WORD timeout)

Description:

This function moves up one directory level in the directory hierarchy on the FTP server.

Parameters:

Type	Name	Description
int	ftp_Session	The FTP session handle returned from the FTP_InitializeSession call.
WORD	timeout	The number of ticks to wait for a timeout.

Return Values:

FTP_OK --- Changed directory successfully
FTP_TIMEOUT --- Time out
FTP_COMMANDFAIL --- Command failed (e.g. a nonexistent directory)
FTP_CONNECTFAIL --- FTP failure
FTP_NETWORKERROR --- Network error

7.9. FTPDeleteFile

Synopsis:

int FTPDeleteFile(int ftp_Session, const char * file_name, WORD timeout)

Description:

This function deletes a file on the FTP server.

Parameters:

Type	Name	Description
int	ftp_Session	The FTP session handle returned from the FTP_InitializeSession call.
const char	*file	The file name to be deleted.
WORD	timeout	The number of ticks to wait for a timeout.

Return Values:

FTP_OK --- Deleted successfully
FTP_TIMEOUT --- Time out
FTP_COMMANDFAIL --- Command failed (e.g. a nonexistent directory)
FTP_CONNECTFAIL --- FTP failure
FTP_NETWORKERROR --- Network error

7.10. FTPRenameFile

Synopsis:

```
int FTPRenameFile( int ftp_Session, const char * old_file_name, const char * new_file_name,
                   WORD timeout )
```

Description:

This function renames a file on the FTP server.

Parameters:

Type	Name	Description
int	ftp_Session	The FTP session handle returned from the FTP_InitializeSession call.
const char	*old_file_name	The file name to be renamed.
const char	*new_file_name	The new file name.
WORD	timeout	The number of ticks to wait for a timeout.

Return Values:

FTP_OK --- Renamed successfully
FTP_TIMEOUT --- Time out
FTP_COMMANDFAIL --- Command failed (e.g. a nonexistent directory)
FTP_CONNECTFAIL --- FTP failure
FTP_NETWORKERROR --- Network error

7.11. FTPSendFile

Synopsis:

int FTPSendFile(int ftp_Session, const char * full_file_name, BOOL bBinaryMode, WORD timeout)

Description:

This function call initializes the send file process to send a file to a FTP server. It sets up a new TCP connection that will be used to transfer the file data. To actually send the file data, use the returned file descriptor and the standard I/O write commands, such as write, writestring, or writeall. After sending the data, close the returned file descriptor with the close function.

Important: After the file has been sent, you must call FTPGetCommandResult to get the result from the write. **Warning:** **Failing to do this will cause the system to get out of sync**. A return value of 226 is normal.

Parameters:

Type	Name	Description
int	ftp_Session	The FTP session handle returned from the FTP_InitializeSession call.
const char	*full_file_name	The file name that the FTP server should assign to the data sent.
BOOL	bBinaryMode	True if the file is to be transferred in binary mode. False for ASCII.
WORD	timeout	The number of ticks to wait for a timeout.

Return Values:

> 0 --- FTP write file descriptor
FTP_TIMEOUT --- Time out
FTP_COMMANDFAIL --- Command failed (e.g. a nonexistent directory)
FTP_CONNECTFAIL --- FTP failure
FTP_NETWORKERROR --- Network error

Example:

```
// Setup to send file and get file descriptor fd
// The “ftp” session handle would has already been created by the
// FTP_Initialize Session()call
int fd = FTPSendFile(ftp,”FOOBAR.TXT”,FALSE,100);
if (fd > 0)
{
   writestring(fd,”This is a test file\r\n”);
   writestring(fd,”This is line 2 of the test file\r\n”);
   writestring(fd,”Last Line\r\n”);
   close(fd);
   rv = FTPGetCommandResult(ftp,tmp_resultbuff,255,100);
   if (rv != 226)
   iprintf(“Write Error Command result = %d
   %s\r\n",rv,tmp_resultbuff);
}
else
  iprintf(“Failed to create file FOOBAR.TXT\r\n”);
```

7.12. FTPGetFile

Synopsis:

int FTPGetFile(int ftp_Session, const char * full_file_name, BOOL bBinaryMode, WORD timeout)

Description:

This function call initializes the receive file process used to get a file from a FTP server. It sets up a new TCP connection that will be used to transfer the file data. To actually receive the file data, use the returned file descriptor and the standard I/O read commands, such as the ReadWithTimeout function.

Note: It would be unwise to use the read function, because it would block forever if the connection were lost to the FTP Server. After reading the data, close the returned file descriptor with the close function.

Important: After the file descriptor has been returned, you must call the FTPGetCommandResult function to get the result from the read. **Warning: Failing to do this will cause the system to get out of sync.** A return value of 226 is normal.

Parameters:

Type	Name	Description
int	ftp_Session	The FTP session handle returned from the FTP_InitializeSession call.
const char	*full_file_name	The complete file name to be transferred, including path.
BOOL	bBinaryMode	True if the file is to be transferred in binary mode. False for ASCII.
WORD	timeout	The number of ticks to wait for a timeout.

Return Values:

> 0 --- FTP read file descriptor
FTP_TIMEOUT --- Time out
FTP_COMMANDFAIL --- Command failed (e.g. a nonexistent directory)
FTP_CONNECTFAIL --- FTP failure
FTP_NETWORKERROR --- Network error

Example:

```
// Setup file transfer and get file descriptor fdr
int fdr = FTPGetFile( ftp, "FOOBAR.TXT", FALSE, 100 );
if (fdr > 0)
{
   // The following function reads data from the specified file until complete.
   // This is the location where you could use
   // a different mechanism to retrieve the data.
   ShowFileContents( fdr );
   close( fdr );

   // Now read the command result code from the GetFile command
   rv = FTPGetCommandResult( ftp, tmp_resultbuff, 255, 100);
   if (rv != 226)
   iprintf("Error Command result = %d %s\r\n", rv, tmp_resultbuff );
}
else
   iprintf( "Failed to get file FOOBAR.TXT\r\n" );

// This function reads the data stream from the fd and
// displays it to stdout, which is usually the com1 serial
// port on the NetBurner board.
void ShowFileContents( int fdr )
{
iprintf( "\r\n[" );
int rv;
do
{
   rv = ReadWithTimeout(fdr,tmp_resultbuff,255,20);
   if (rv < 0)
      iprintf("RV = %d\r\n",rv);
   else
   {
      tmp_resultbuff[rv] = 0;
      iprintf("%s",tmp_resultbuff);
   }
}

while (rv > 0);
iprintf("]\r\n");
}
```

7.13. FTPGetList

Synopsis:

int FTPGetList(int ftp_Session, const char * full_dir_name, WORD timeout);

Description:

This function initializes the get directory process to receive a full directory listing from the FTP server. A new TCP connection is created to receive the file listing from the server. To actually receive the list use the returned file descriptor to read the list using the standard I/O read commands, such as ReadWithTimeout. After reading the data, close the returned file descriptor with the close function.

Important: After you have received the list, you must call the FTPGetCommandResult function to get the result from the read. **Warning:** **Failing to do this will cause the system to get out of sync.** A return value of 226 is normal.

Parameters:

Type	Name	Description
int	ftp_Session	The FTP session handle returned from the FTP_InitializeSession call.
const char	*full_dir_name	The complete directory name to be transferred. Can be NULL.
WORD	timeout	The number of ticks to wait for a timeout.

Return Values:

> 0 --- FTP read file descriptor
FTP_TIMEOUT --- Time out
FTP_COMMANDFAIL --- Command failed (e.g. a nonexistent directory)
FTP_CONNECTFAIL --- FTP failure
FTP_NETWORKERROR --- Network error

Example:

```
int fdr = FTPGetList(ftp,NULL,100);
if (fdr > 0)
{
   //This function reads data from the fd until complete.
   ShowFileContents(fdr);

   // You would probably use a different function.
   // The source for this function is shown in the module example.
   close(fdr);

   // Now read the command result code from the GetList command
   rv = FTPGetCommandResult(ftp,tmp_resultbuff,255,100);
   if (rv != 226)
      iprintf("Error Command result = %d %s\r\n",rv,tmp_resultbuff);
}
else
   iprintf("Failed to get file list\r\n");

// This function reads the data stream from the fd and displays
// it to stdout, which is usually the com1 serial port on the
// NetBurner board.
void ShowFileContents(int fdr)
{
   iprintf("\r\n[");
   int rv;
   do
   {
      rv = ReadWithTimeout(fdr,tmp_resultbuff,255,20);
      if (rv < 0)
      {
         iprintf("RV = %d\r\n",rv);
      }
      else
      {
         tmp_resultbuff[rv] = 0;
         iprintf("%s",tmp_resultbuff);
      }
   }
   while (rv > 0);
   iprintf("]\r\n");
}
```

7.14. FTPGetFileNames

Synopsis:

int FTPGetFileNames(int ftp_Session, const char * full_dir_name, WORD timeout)

Description:

This function initializes the get directory process to receive just the file names listing from the server. It sets up a new TCP connection to receive the file listing from the server. To actually receive the list, use the returned file descriptor to read the data using the standard I/O read commands, such as ReadWithTimeout.

Warning: It would be unwise to use the read function, because it would block forever if the connection were lost to the FTP Server. After reading the data, close the returned file descriptor with the close function.

After the file connection has been established, you must call the FTPGetCommandResult function to get the result from the read. **Warning: Failing to do this will cause the system to get out of sync.** A return value of 226 is normal.

Parameters:

Type	Name	Description
int	ftp_Session	The FTP session handle returned from the FTP_InitializeSession call.
const char	*full_dir_name	The complete file name to be transferred, including the path.
WORD	timeout	The number of ticks to wait for a timeout.

Return Values:

int --- The command success code
> 0 --- FTP read file descriptor
FTP_TIMEOUT --- Time out
FTP_CONNECTFAIL --- FTP failure
FTP_NETWORKERROR --- Network error

Example:

```
int fdr = FTPFileNames(ftp,NULL,100);
if (fdr > 0)
{
   // This function reads data from the fd until complete. You may
   // want to use a different method here.
   ShowFileContents(fdr);
   close(fdr);

   // Now read the command result code from the GetList command
   rv = FTPGetCommandResult(ftp,tmp_resultbuff,255,100);
   if (rv != 226)
   iprintf("Error Command result = %d %s\r\n",rv,tmp_resultbuff);
}
else
   iprintf("Failed to get file list\r\n");

// This function reads the data stream from the fd and
// displays it to stdout, which is usually the com1 serial
// port on the NetBurner board.
void ShowFileContents(int fdr)
{
   iprintf("\r\n[");
   int rv;
   do
   {
      rv = ReadWithTimeout(fdr,tmp_resultbuff,255,20);
      if (rv < 0) iprintf("RV = %d\r\n",rv);
      else
      {
         tmp_resultbuff[rv] = 0;
         iprintf("%s",tmp_resultbuff);
      }
   }
   while (rv > 0);
   iprintf("]\r\n");
}
```

7.15. FTPRawCommand

Synopsis:

int FTPRawCommand(int ftp_Session, const char * cmd, char * cmd_buf, int nbytes, WORD timeout)

Description:

This function sends a command and gets a response from the FTP control connection. This command is the basis for most of the FTP commands in the FTP module. It is used where a stream return is not expected. **Important:** Using this command requires that you are familiar with the FTP Protocol details.

Parameters:

Type	Name	Description
int	ftp_Session	The FTP session handle returned from the FTP_InitializeSession call.
const char	*cmd	The command to send - **not** including the \r\n termination.
char	*cmd_buf	The buffer to hold the result from the server which includes a CLF/LF at the end.
int	nbytes	The maximum number of bytes in server response to copy (including numeric code and null terminator).
WORD	timeout	The number of ticks to wait for a timeout.

Return Values:

> 0 --- The FTP numeric response code
FTP_TIMEOUT --- Time out
FTP_COMMANDFAIL --- Command failed (e.g. a nonexistent directory)
FTP_CONNECTFAIL --- FTP failure
FTP_NETWORKERROR --- Network error

7.16. FTPGetCommandResult

Synopsis:

int FTPGetCommandResult(int ftp_Session, char * cmd_buf, int nbytes, WORD timeout)

Description:

This function gets a response from the control connection without sending a command. This command may be used after the following four functions to get the command result:

FTPGetList
FTPGetFileNames
FTPGetFile
FTPSendFile

Parameters:

Type	Name	Description
int	ftp_Session	The FTP session handle returned from the FTP_InitializeSession call.
char	*cmd_buf	The buffer to hold the result.
int	nbytes	The maximum number of bytes to copy.
WORD	timeout	The number of ticks to wait for a timeout.

Return Values:

> 0 --- The FTP read file descriptor
FTP_TIMEOUT --- Time out
FTP_COMMANDFAIL --- Command failed (e.g. a nonexistent directory)
FTP_CONNECTFAIL --- FTP failure
FTP_NETWORKERROR --- Network error

7.17. FTPRawStreamCommand

Synopsis:

```
int FTPRawStreamCommand( int ftp_Session, const char * cmd, int  * pResult,
                         char * cmd_buf, int nbytes, WORD timeout )
```

Description:

This function sends a command and gets a response over a stream connection. This command is the basis for functions such as FTPGetList and FTPGetFiles. It is used where a stream return is expected.

After you have received or sent the data stream you must call FTPGetCommandResult to get the result from the read or write. **Warning: Failing to do this will cause the system to get out of sync.** A return value of 226 is normal. However, other values such as 250 are also possible depending on the FTP server.

Parameters:

Type	Name	Description
int	ftp_Session	The FTP session handle returned from the FTP_InitializeSession call.
const char	*cmd	The command to send - **not** including the \r\n termination.
int	*pResult	The FTP command result code.
char	*cmd_buf	The buffer to hold the command connection results from the server, which includes a CR/LF at the end.
int	nbytes	The maximum number of bytes to copy into the cmd_buf (includes numeric response code and null terminator).
WORD	timeout	The number of ticks to wait for a timeout.

Return Values:

> 0 --- FTP data channel file descriptor (Note: The FTP server will drop the data channel after completion of sending data to the client that will cause a read error)
FTP_TIMEOUT --- Time out
FTP_COMMANDFAIL --- Command failed (e.g. a nonexistent directory)
FTP_CONNECTFAIL --- FTP failure
FTP_NETWORKERROR --- Network error

8. FTP Server Library

8.1. Introduction

Implementing an FTP server in an embedded system without a built-in file system is not a trivial undertaking. Most embedded applications do not require a file system, and a file system is not part of the standard NetBurner package. If a file system is required for a specific application, it is the responsibility of the programmer to implement the required features. A file system could be the trivially simple example of a single file, or it could be quite complex.

Using the FTP Server requires that you, the programmer, write the functions defined in the FTP documentation. These functions are "callback" functions that allow you to customize the FTP server actions to suit your particular application. **Note:** All callback functions required for your application **must** be implemented by you.

The NetBurner examples (C:\Nburn\examples) directory has three FTP server sample applications:

ftpd_trivial --- A simple example that reads and writes a single file.
ftpd_expose_html --- A more complex example that exposes all HTML served files to the FTP server.
ftpd_code_update --- This example shows you how to upgrade the NetBurner firmware and reset the system using FTP.

Header File

#include <ftpd.h>   // Found by default in C:\Nburn\include

Operational Functions

FTPDStart --- Starts the FTP Server task
FTPDStopReq --- Sends a stop request to the currently running FTPD

FTP Session Callback typedef

(FTPDCallBackReportFunct) --- The typedef for all directory reporting callbacks

FTP Session Callback Functions (These functions must be implemented by the programmer)

FTPDSessionStart --- Function called to indicate the start of a user session
FTPDSessionEnd --- Function called to indicate a user session will be terminated

FTP Directory Callback Functions (These functions must be implemented by the programmer)

FTPD_DirectoryExists --- Function called by the FTP Server to test for the existence of a directory
FTPD_CreateSubDirectory --- Function called by the FTP Server to create a directory
FTPD_DeleteSubDirectory --- Function called by the FTP Server to delete a directory
FTPD_ListSubDirectories --- Function called by the FTP Server to list all subdirectories under the current directory

FTP File Callback Functions (These functions must be implemented by the programmer)

FTPD_FileExists --- Function to report on the whether or not a file exists
FTPD_SendFileToClient --- Function to send the contents of a file to a file descriptor
FTPD_AbleToCreateFile --- Function to report on the ability to create/receive a file
FTPD_GetFileFromClient --- Function to create/get a file
FTPD_DeleteFile --- Function to delete a file
FTPD_DeleteFile --- User supplied function to delete a file
FTPD_ListFile --- Lists every file in the current directory
FTPD_ListFile --- User supplied function that lists every file in the directory
FTPD_Rename --- User supplied function to rename a file

8.2. FTPDStart

Synopsis:

int FTPDStart(WORD port, BYTE server_priority)

Description:

This function starts the FTP Server task, which listens for incoming connections.

Warning: Only one instance of the FTPD is allowed.

Parameters:

Type	Name	Description
WORD	port	The TCP port to listen to for incoming FTP requests.
BYTE	server_priority	The uC/OS task priority for the FTP Server.

Return Values:

FTPD_RUNNING --- The FTPD is already running
FTPD_LISTEN_ERR --- The listen socket could not be opened
FTPD_OK --- The FTPD was successfully started
FTPD_FAIL --- The FTPD task could not be created

8.3. FTPDStopReq

Synopsis:

int FTPDStopReq( )

Description:

This function sends a stop request to the currently running FTPD.

Parameters:

None

Return Values:

FTPD_RUNNING --- The FTPD is still running
FTPD_NOT_RUNNING --- The FTPD is no longer running

8.4. (FTPDCallBackReportFunct)

Synopsis:

typedef void (FTPDCallBackReportFunct)(int handle, const char * name_to_report)

Description:

This is the typedef for all directory reporting callbacks. This callback type definition is used by the directory reporting functions.

Parameters:

Type	Name	Description
int	handle	The handle passed into the listing function.
const char	*name_to_report	The file name to report for use in a directory listing.

Return Value:

Nothing --- This is a void function

8.5. FTPDSessionStart

Synopsis:

void * FTPDSessionStart(const char * user, const char * passwd, const IPADDR hi_ip)

Description:

This function is called to indicate the start of a user Session. This function is called following the creation of a **new** FTP session. This function needs to determine the validity of the user/password pair. The returned void pointer **will** be passed to **all** access functions, which will then be asked to determine the validity of the operation based on the permissions associated with the return value.

Parameters:

Type	Name	Description
const char	*user	The name of the user attempting to establish an FTP session.
const char	*passwd	The password of the user attempting to establish an FTP session.
const	IPADDR hi_ip	The IP Address of the Server trying to establish this connection.

Return Values:

NULL --- The user name/password set is invalid
(obj) --- A non-null void pointer to an object that will be associated with this login session

8.6. FTPDSessionEnd

Synopsis:

void FTPDSessionEnd(void * pSession)

Description:

This function is called to indicate that a user session will be terminated. This callback function gives the user program the opportunity to clean up any storage associated with the void pointer returned from the FTPDSessionStart call.

Parameters:

Type	Name	Description
void	*pSession	The void * object returned from the FTPDSessionStart function call.

Return Value:

Nothing --- This is a void function

8.7. FTPD_DirectoryExists (User Defined)

Synopsis:

int FTPD_DirectoryExists(const char * full_directory, void * pSession)

Description:

This function called by the FTP Server to test for the existence of a directory. This function is called by the FTP Server as the result of an attempt to change to a new directory. This function can also be used to validate the permissions of the session. **This function must be implemented by the programmer.**

Parameters:

Type	Name	Description
const char	*full_directory	The name of the new directory to test.
void	*pSession	The void * object returned from the FTPDSessionStart function call.

Return Values:

FTPD_OK --- The requested directory exists
FTPD_FAIL --- The requested directory does not exist, or access is not permitted for the user

8.8. FTPD_CreateSubDirectory (User Defined)

Synopsis:

int FTPD_CreateSubDirectory(const char * current_directory, const char * new_dir, void * pSession)

Description:

This function is called by the FTP Server to create a directory. This function is called by the FTP Server as the result of an attempt to create a new directory. This function can also be used to validate the permissions of the session. **This function must be implemented by the programmer.**

Parameters:

Type	Name	Description
const char	*current_directory	The current value of the session directory.
const char	*new_dir	The directory to create under the current_directory.
void	*pSession	The void * object returned from the FTPDSessionStart function call.

Return Values:

FTPD_OK --- The requested directory was created
FTPD_FAIL --- The requested directory could not be created

8.9. FTPD_DeleteSubDirectory (User Defined)

Synopsis:

int FTPD_DeleteSubDirectory(const char *current_directory, const char * sub_dir, void * pSession)

Description:

This function is called by the FTP Server to delete a directory. This function is called by the FTP Server as the result of an attempt to delete a subdirectory. This function call can be used to validate the permissions of this session. **This function must be implemented by the programmer.**

Parameters:

Type	Name	Description
const char	*current_directory	The current value of the session directory.
const char	*sub_dir	The directory to delete under the current_directory
void	*pSession	The void * object returned from the FTPDSessionStart function call.

Return Values:

FTPD_OK --- The requested directory was deleted
FTPD_FAIL --- The requested directory could not be deleted

8.10. FTPD_ListSubDirectories (User Defined)

Synopsis:

```
int FTPD_ListSubDirectories( const char * current_directory, void  * pSession,
                             FTPDCallBackReportFunct * pFunc, int handle )
```

Description:

This function is called by the FTP Server to list all subdirectories under the current directory. This function is called by the FTP Server as the result of a client's attempt to list the contents of a directory. **This function must be implemented by the programmer.**

Parameters:

Type	Name	Description
const char	*current_directory	The current value of the session directory.
void	*pSession	The void * object returned from the FTPDSessionStart function call.
FTPDCallBackReportFunct	*pFunc	The pointer to the callback function to be called for each subdirectory.
int	handle	The handle value to be passed back into the pFunc.

Return Values:

FTPD_OK --- The requested listing was successfully delivered
FTPD_FAIL --- The requested directory could not be listed

Example:

Everything inside the callback function stub must be supplied by the programmer.

The FTP server will automatically call this function and provide values for the function variables. It is the programmer's responsibility to execute pFunc( ) with the provided handle and a pointer to the string representing the subdirectory name. **Note: pFunc( ) must be executed once for each subdirectory name.** In the example below, the variables number_of_directories and DirectoryName **must** be declared **and** initialized elsewhere in the application program:

```
int FTPD_ListSubDirectories(const char *current_directory, void *pSession,
FTPDCallBackReportFunct *pFunc, int handle);
{
  for (int n = 0; n < number_of_dir; n++)
  pFunc(handle, DirectoryName[n]);
  return FTPD_OK;
}
```

8.11. FTPD_FileExists (User Defined)

Synopsis:

int FTPD_FileExists(const char * full_directory, const char * file_name, void * pSession)

Description:

This function reports on whether or not a file exists. This function checks for the existence of a file, usually just before an attempt is made to download the file. **This function must be implemented by the programmer.**

Parameters:

Type	Name	Description
const char	*full_directory	The current value of the session directory.
const char	*file_name	The name of the file to check.
void	*pSession	The void * object returned from the FTPDSessionStart function call.

Return Values:

FTPD_OK --- The requested file exists
FTPD_FAIL --- The requested file does not exist

8.12. FTPD_SendFileToClient (User Defined)

Synopsis:

```
int FTPD_SendFileToClient( const char * full_directory, const char * file_name,
                           void * pSession, int fd )
```

Description:

This function sends the contents of a file to a file descriptor. This function sends a file to an FTP client.
This function must be implemented by the programmer.

Parameters:

Type	Name	Description
const char	*full_directory	The current value of the session directory.
const char	*file_name	The name of the file to send.
void	*pSession	The void * object returned from the FTPDSessionStart function call.
int	fd	The file descriptor to send to.

Return Values:

FTPD_OK --- The requested file was sent
FTPD_FAIL --- The requested file was not sent

8.13. FTPD_AbleToCreateFile (User Defined)

Synopsis:

int FTPD_AbleToCreateFile(const char * full_directory, const char * file_name, void * pSession)

Description:

This function will report on the ability to create/receive a file. This function determines if a file can be created. **This function must be implemented by the programmer.**

Parameters:

Type	Name	Description
const char	*full_directory	The current value of the session directory.
const char	*file_name	The name of the file to create.
void	*pSession	The void * object returned from the FTPDSessionStart function call.

Return Values:

FTPD_OK --- The requested file can be written (i.e. created)
FTPD_FAIL --- The requested file could not be created

8.14. FTPD_GetFileFromClient (User Defined)

Synopsis:

```
int FTPD_GetFileFromClient( const char * full_directory, const char * file_name,
                            void * pSession, int fd )
```

Description:

This function is used to create/get a file or to receive a file from the FTP client. **This function must be implemented by the programmer.**

Parameters:

Type	Name	Description
const char	*full_directory	The current value of the session directory.
const char	*file_name	The name of the file to create.
void	*pSession	The void * object returned from the FTPDSessionStart function call.
int	fd	The file descriptor that will be used to receive the file.

Return Values:

FTPD_OK --- The requested file was written (i.e. created)
FTPD_FAIL --- The requested file was not created

8.15. FTPD_DeleteFile

Synopsis:

int FTPD_DeleteFile(const char * current_directory, const char * file_name, void * pSession)

Description:

This function is used to delete a file.

Parameters:

Type	Name	Description
const char	*current_directory	The current value of the session directory.
const char	*file_name	The name of the file to delete.
void	*pSession	The void * object returned from the FTPDSessionStart function call.

Return Values:

FTPD_OK --- The requested file was deleted
FTPD_FAIL --- The requested file was not deleted

8.16. FTPD_DeleteFile (User Defined)

Synopsis:

int FTPD_DeleteFile(const char * current_directory, const char * file_name, void * pSession)

Description:

This is a user written function to delete a file. This function must be implemented by the programmer.

Parameters:

Type	Name	Description
const char	*current_directory	The current value of the session directory.
const char	*file_name	The name of the file to delete.
void	*pSession	The void * object returned from the FTPDSessionStart function call.

Return Values:

FTPD_OK --- The requested file was deleted
FTPD_FAIL --- The requested file could not be deleted

8.17. FTPD_ListFile

Synopsis:

```
int FTPD_ListFile( const char * current_directory, void * pSession, FTPCallBackReportFunct * pFunc,
                   int handle )
```

Description:

This is a callback function, with the name of every file in the directory.

Parameters:

Type	Name	Description
const char	*current_directory	The current value of the session directory.
void	*pSession	The void * object returned from the FTPDSessionStart function call.
FTPCallBackReportFunct	*pFunc	The pointer to the callback function to be called for each file name. This is a callback function provided and used by the NetBurner internal FTP code.
int	handle	The handle value to be passed back into the pFunc. This is a handle provided and used by the NetBurner internal FTP code.

Return Values:

FTPD_OK --- The requested files were listed
FTPD_FAIL --- The requested files were not listed

8.18. FTPD_ListFile (User Defined)

Synopsis:

```
int FTPD_ListFile( const char * current_directory, void * pSession,
                   FTPDCallBackReportFunct * pFunc, int handle );
```

Description:

This function is a user supplied function that lists all files in the current directory. **This function must be implemented by the programmer.**

Parameters:

Type	Name	Description
const char	*current_directory	The current value of the session directory.
void	*pSession	The void * object returned from the FTPDSessionStart function call.
FTPCallBackReportFunct	*pFunc	The pointer to the callback function to be called for each file name. This is a callback function provided and used by the NetBurner internal FTP code.
int	handle	The handle value to be passed back into the pFunc. This is a handle provided and used by the NetBurner internal FTP code.

Return Values:

FTPD_OK --- The requested files were listed
FTPD_FAIL --- The requested files were not listed

Example:

Everything inside the callback function stub must be supplied by the programmer. The FTP server will automatically call this function and provide values for the function variables.

Important: It is the programmer's responsibility to execute pFunc( ) with the provided handle and a pointer to the string representing the file name.

Note: pFunc( ) must be executed once for each file name. In the example on the next page, the variables number_of_directories and FileNames must be declared and initialized elsewhere in the application program:

```
int FTPD_ListFile( const char *current_directory, void *pSession,
                   FTPDCallBackReportFunct *pFunc, int handle );
 {
   for (int n = 0; n < numberof_files; n++)
   pFunc(handle, FileNames[n]);
   return FTPD_OK;
 }
```

8.19. FTPD_Rename (User Defined)

Synopsis:

```
int FTPD_Rename( const char * current_directory, const char  * cur_file_name,
                 const char * new_file_name, void * pSession )
```

Description:

This is a user written function; this function is used to rename a file. **This function must be implemented by the programmer.**

Parameters:

Type	Name	Description
const char	*current_directory	The current value of the session directory.
const char	*cur_file_name	The current name of the file to rename.
const char	*new_file_name	The new file name.
void	*pSession	The void * object returned from the FTPDSessionStart function call.

Return Values:

FTPD_OK --- The requested file was deleted
FTPD_FAIL --- The requested file could not be renamed

9. HTTP and HTML Libraries

Header Files

```
#include <http.h>        // Found in C:\Nburn\include
#include <htmlfiles.h>   // Found in C:\Nburn\include
```

HTTP Dameon Functions

StartHTTP --- Starts the HTTP server
StopHTTP --- Stops the HTTP subsystem
SetNewPostHandler --- Setup a custom Post Handler
SetNewGetHandler --- Setup a custom Get Handler
SetNewHeadHandler --- Setup a custom Head Handler
HTTP Password Processing --- Basic HTML Password Support
CheckAuthentication --- Checks the HTTP request for password information
RequestAuthentication --- Rejects the current HTTP request and request for a password

HTML Header Functions

SendHTMLHeader --- Sends an html response header
SendHTMLHeaderWCookie --- Sends an html response header with a cookie
SendTextHeader --- Sends a text header
SendGifHeader --- Sends a gif header

Other HTML Responses

RedirectResponse --- Sends a response that redirects the request to the new page
NotFoundResponse --- Sends a response that indicates the page can't be found

Form Posting Functions

ExtractPostData --- Decodes post data
ExtractPostFile --- Extracts a file from the post data stream
EnableMultiPartForms --- Enables multipart form posts
DisableMultiPartForms --- Frees up the buffer

Useful HTML/HTTP Functions

writesafestring --- Writes out a string while escaping all special characters
httpstricmp --- This is a special case insensitive prefix match compare

HTML Encoded File Functions

SendFullResponse --- Sends a complete encoded file as a response
SendFileFragment --- Sends an encoded file as a part of a response

HTTP Password Support Functions

#include <httppass.h>   // Found in C:\Nburn\include

CheckAuthentication --- Check the HTTP request for password information
RequestAuthentication --- Rejects the current HTTP request and request for password

9.1. StartHTTP

Synopsis:

void StartHTTP(WORD port = 80)

Description:

This function starts the HTTP Server. You must have initialized the IP stack before starting the HTTP Server. If no port number is specified, the default of 80 will be used.

Parameters:

Type	Name	Description
WORD	port	The port on which to open the HTTP Server. This defaults to the standard HTTP port (i.e. port 80).

Returns:

Nothing --- This is a void function

Example:

Simple Html --- Found by default in C:\Nburn\examples

9.2. StopHTTP

Synopsis:

void StopHTTP( )

Description:

Use this function to shutdown the HTTP Server.

Parameters:

None

Returns:

Nothing --- This is a void function

9.3. SetNewPostHandler

Synopsis:

typedef int (http_posthandler)(int sock, PSTR url, PSTR pData, PSTR rxb)

http_posthandler * SetNewPostHandler(http_posthandler * newhandler)

Description:

When the HTTP Server receives a POST request from an HTML form that request needs to be processed by a custom function, this call sets up that function. **Note:** This custom function must be of the form:

int yourposthandler(int sock, PSTR url, PSTR pData, PSTR rxb);

Parameters:

Type	Name	Description
int	sock	The File descriptor for the socket that this function should send a response to.
PSTR (char *)	url	The URL that this POST was directed at. This is used to select what form this was posted from.
PSTR	pData	The encoded data fields from the form. See the ExtractPostData function to decode this data.
PSTR	rxb	A pointer to the entire HTTP request. This is not usually needed.

Returns:

The function pointer to the previously registered post handler

Example:

FlashForm --- Found by default in C:\Nburn\examples

9.4. SetNewGetHandler

Synopsis:

typedef int (http_gethandler)(int sock, PSTR url, PSTR rxb)

http_gethandler * SetNewGetHandler(http_gethandler * newhandler)

Description:

When the HTTP Server receives a GET request, that request needs to be processed. The default GET processing looks for files stored in the compressed file data section by CompHtml. This allows **both** static and dynamic HTML responses; this is usually sufficient. If your application **needs** to have complete (program) control of GET requests (e.g. to implement Password protection), you may **replace** the **default** GET processing by registering a **new** function. **Note:** This custom function **must** be of the form:

int yourgethandler(int sock, PSTR url, PSTR rxb);

Parameters:

Type	Name	Description
int	sock	The File descriptor for the socket that this function should send a response to.
PSTR (char *)	url	The URL that this GET was directed at. This is used to select what form this was posted from.
PSTR	rxb	A pointer to the entire HTTP request.

Returns:

The function pointer to the previously registered get handler

Example:

Simple HTML --- Found by default in C:\Nburn\examples

The Default GET Handler:

```
int BaseDoGet(int sock, PSTR url, PSTR rxBuffer)
{
   if (*url==0)   // The default value
   {
      RedirectResponse(sock,default_page);
      return 1;
   }

   if (httpstricmp(url,"ECHO"))
   {
      while (*url) url++;
      *url=' ';
      SendTextHeader(sock);
      writestring(sock,rxBuffer);
      return 1;
   }

   if(!SendFullResponse(url,sock))
   {// we failed
      NotFoundResponse(sock,url);
      DBPRINT(DB_HTTP,"Did not find:");
      DBPRINT(DB_HTTP,url);
      DBPRINT(DB_HTTP,"\r\n");
   }
   return 0;
}
```

9.5. SetNewHeadHandler

Synopsis:

typedef int (http_headhandler)(int sock, PSTR url, PSTR rxb)

http_headhandler * SetNewHeadHandler(http_headhandler * newhandle)

Description:

When the HTTP server receives a HEAD, the default response does nothing. If you want to handle HEAD requests in any special way, you can write a custom function to do so. You **must** use this call to register this function.

The custom function **must** be of the form:

int yourheadhandler(int sock, PSTR url, PSTR rxb);

Parameters:

Type	Name	Description
int	sock	The File descriptor for the socket that this function should send a response to.
PSTR (char *)	url	The URL that this GET was directed at.
PSTR	rxb	A pointer to the entire HTTP request.

Returns:

The function pointer to the previously registered head handler

9.6. CheckAuthentication

Synopsis:

int CheckAuthentication(PSTR url, char ** pPassword, char ** pUser)

Description:

This password support function checks the HTTP request for password information. This function examines the PASSWORD field stored in the HTTP request.

Parameters:

Type	Name	Description
PSTR	url	A pointer to the url as passed to the user provided get function.
char	**pPassword	A char pointer that will be set to point to the password in the request.
char	**pUser	A char pointer that will be set to point to the user name in the request.

Returns:

0 on Failure
1 on Success

Example:

```
#include <http.h>
#include <httppass.h>

static http_gethandler * oldhand;

// Initialize somewhere in your application:
oldhand=SetNewGetHandler(MyDoGet);

int MyDoGet(int sock, PSTR url, PSTR rxBuffer)
{
   char * pPass;
   char * pUser;

   if (!CheckAuthentication(url,&pPass,&pUser))
   {
       RequestAuthentication(sock,"YourNameHere");
       return 1;
   }
   else
   {
      if (password is not ok)
      {
         RequestAuthentication(sock,"YourNameHere");
         return 1;
      }
   }
   // If we got here the password was acceptable
   return (* oldhand)(sock,url,rxBuffer);
}
```

9.7. RequestAuthentication

Synopsis:

void RequestAuthentication(int sock, PCSTR name)

Description:

This password support function rejects the current HTTP request and request for password. This function will send a 401 authentication requested message to the socket.

Parameters:

Type	Name	Description
int	sock	The socket file descriptor to get the request.
PCSTR	name	The Name that should appear in the password request.

Returns:

Nothing ---This is a void function

9.8. SendHTMLHeader

Synopsis:

void SendHTMLHeader(int sock)

Description:

This function sends an HTML header response to the selected socket. This function is used if you are building your own HTML response (programmatically) from scratch.

Parameters:

Type	Name	Description
int	sock	The socket that you want to send the Redirect to.

Returns:

Nothing --- This is a void function

9.9. SendHTMLHeaderWCookie

Synopsis:

void SendHTMLHeaderWCookie(int sock, char * cookie)

Description:

This function sends an HTML response header and includes a cookie to be stored by the browser.

Parameters:

Type	Name	Description
int	sock	The socket that you want to send the Redirect to.
char	*cookie	A char pointer that will be set to point to the cookie.

Returns:

Nothing ---This is a void function

Example Application:

HtmlCookie --- Found in C:\Nburn\examples

9.10. SendTextHeader

Synopsis:

```
void SendTextHeader( int sock )
```

Description:

This function is used if you want to build a plain text response from scratch. **It should be sent before any other part of the HTTP response.**

Parameters:

Type	Name	Description
int	sock	The socket that you want to send the Redirect to.

Returns:

Nothing --- This is a void function

Example:

The default GET response ECHO uses this function

9.11. SendGifHeader

Synopsis:

```
void SendGifHeader( int sock )
```

Description:

This function sends a GIF response header. This function is used to set the header type for stored GIF files in the system. This function can be used to generate a GIF header for dynamically generated GIF files.

Parameters:

Type	Name	Description
int	sock	The socket that you want to send the Redirect to.

Returns:

Nothing ---This is a void function

9.12. RedirectResponse

Synopsis:

```
void RedirectResponse( int sock, PCSTR new_page );
```

Description:

When an HTTP GET or POST request should be redirected to a different page, use this function to do so.

Parameters:

Type	Name	Description
int	sock	The socket that you want to send the Redirect to.
PCSTR (const char *)	new_page	The URL of the redirected destination.

Returns:

Nothing --- This is a void function

9.13. NotFoundResponse

Synopsis:

```
void NotFoundResponse( int sock, PCSTR errored_page );
```

Description:

This function responds to an HTTP GET or POST request by indicating the page does not exist.

Parameters:

Type	Name	Description
int	sock	The socket that you want to send the Redirect to.
PCSTR (const char *)	errored_page	The URL of the requested page that does not exist.

Returns:

Nothing --- This is a void function

9.14. ExtractPostData

Synopsis:

```
int ExtractPostData( PCSTR name, PCSTR data, PSTR dest_buffer,
                     int maxlen );
```

Description:

This function takes the HTML post data sent to the DoPost function, extracts the data associated with a specific name, and returns it in dest_buffer.

Parameters:

Type	Name	Description
PCSTR	name	The name of the HTML form data element to extract the data from.
PCSTR	data	The data pointer passed in to the process post function.
PCSTR	dest_buffer	The location of the data after it has been extracted.
int	maxlen	The maximum length of the string.

Returns:

-1 --- If no data of that name was found
0 --- If the data field was presented, but empty
Otherwise, the number of chars extracted and copied into dest_buffer

Example Application:

FlashForm --- Found by default in your C:\Nburn\examples directory

9.15. ExtractPostFile

Synopsis:

```
ExtractPostFile( PCSTR name, PCSTR pData );
```

Description:

This function extracts a file from the post data stream. **Note:** The stream must be closed just like any other stream.

Parameters:

Type	Name	Description
PCSTR	name	The name of the HTML form data element to extract the data from.
PCSTR	pData	The encoded data fields from the form.

Returns:

> 0 --- If successful

9.16. EnableMultiPartForms

Synopsis:

```
BOOL EnableMultiPartForms( DWORD maxfile_size );
```

Description:

This function enables multipart form posts and set the max file size you will accept. This function also mallocs the file buffer.

Parameters:

Type	Name	Description
DWORD	maxfile_size	The maximum file size.

Returns:

True --- If successful

9.17. DisableMultiPartForms

Synopsis:

```
void DisableMultiPartForms( );
```

Description:

This function frees up the buffer.

Parameters:

None

Returns:

Nothing ---This is a void function

9.18. writesafestring

Synopsis:

```
void writesafestring( int fd, PCSTR str );
```

Description:

When sending HTML test responses certain characters (e.g. '<') are interpreted by the browser as formatting, not as text. **Note:** This function properly escapes the text so it will appear as desired, and sends it out the associated socket descriptor.

Parameters:

Type	Name	Description
int	fd	The file descriptor to send the string to.
PCSTR (const char *)	str	The NULL terminated string to send.

Returns:

The number of chars sent

9.19. httpstricmp

Synopsis:

```
int httpstricmp( PCSTR s1, PCSTR sisupper2 );
```

Description:

This function is used internally to match URLs with stored file prefixes.

Parameters:

Type	Name	Description
PCSTR	s1	The string to test.
PCSTR	sisupper2	The reference string (which **must** already be all **uppercase**).

Returns:

0 --- If the string prefixes do not match
1 --- If the string prefixes do match

Example:

`httpstricmp (s1,"LED.HTML" )` would return:

s1 Value	Return Value
LED	1
led.HTML	1
led.html?	1
LED.HTM?	0

9.20. SendFullResponse

Synopsis:

```
int SendFullResponse( char * name, int fd );
```

Description:

This function looks for the file named "name" in the files stored in the system with CompHtml. If it finds the file, it sends the proper HTTP header and renders the file to the socket. **Note:** If the stored file has embedded dynamic HTML, these functions will be filled in.

Parameters:

Type	Name	Description
char	*name	The name of the file to send.
int	fd	The file descriptor or socket to send the file to.

Returns:

1 --- If the file was found and returned
0 --- If the file was not found

9.21. SendFileFragment

Synopsis:

```
int SendFileFragment( char * name, int fd );
```

Description:

This function looks for the file named "name" in the files stored in the system with CompHtml. If it finds this file, it sends the file as a fragment. It does not send the HTTP header. If the stored file has embedded dynamic HTML, these functions will be filled in. If you want to build HTML responses with large chunks of pre-configured HTML, you can store these in the system and then send them out sequentially using this function.

Parameters:

Type	Name	Description
char	*name	The name of the file fragment to send.
int	fd	The file descriptor or socket to send the file to.

Returns:

1 --- If the file was found and returned
0 --- If the file was not found

10. Interrupts

10.1. INTERRUPT MACRO

Header Files:

```
#include <ucos.h>      // Found in C:\Nburn\include
#include <cfinter.h>   // Found in C:\Nburn\include (must be after ucos.h)
```

Synopsis:

```
INTERRUPT( function_name, sr_value )
```

Description:

The INTERRUPT macro sets up an interrupt function and the code block that will do the necessary things to save and restore the CPU registers. In addition, this macro tells the RTOS that an Interrupt is happening. All level 7 interrupts are non-maskable.

Parameters:

Type	Description
function_name	The name of the interrupt service routine.
sr_value	The SR register value that the processor will have during the interrupt.

The eight permitted SR register values are:

0x2000 - **Allows all** interrupts
0x2100 - **Blocks all** interrupts **below** level 2
0x2200 - **Blocks all** interrupts **below** level 3
0x2300 - **Blocks all** interrupts **below** level 4
0x2400 - **Blocks all** interrupts **below** level 5
0x2500 - **Blocks all** interrupts **below** level 6
0x2600 - **Blocks all** interrupts **below** level 7
0x2700 - **Blocks all** interrupts **below** level 7

Important: The code within an INTERRUPT macro can be called at any time. Certain OS and I/O functions cannot be called from within an Interrupt routine.

Warning: The following functions are not legal within an interrupt routine.

All µC/OS critical section functions:

USER_ENTER_CRITICAL
USER_EXIT_CRITICAL
UCOS_ENTER_CRITICAL
UCOS_EXIT_CRITICAL

All µC/OS init and pend functions (all OsxxPendNoWait functions are okay):

OSxxInit
OSxxPend
OSCritEnter
OSChangePrio
OSTaskDelete
OSLock
OSUnlock
OSTaskCreate
OSTimeDly

I/O functions from within the ISR (interrupt service routine):

write
writeall
read
printf
fprintf
iprintf
scanf
gets
puts

Memory management functions:

malloc
free
new
delete

Important: Once you use the INTERRUPT macro to define the interrupt function, you will need to use the SetIntc (set interrupt controller) function to set up your interrupt controller variables and point the interrupt vector at that function. Please refer to the appropriate Freescale hardware reference manual (in \Nburn\docs\FreescaleManuals) for your specific interrupt source number and controller number (only for processors that have more than one interrupt controller).

10.2. SetIntc (MCF5234 and MCF5282 Only)

Synopsis:

```
void SetIntc( int intc, long func, int source, int level, int prio )
```

Usage:

```
extern "C"
{
   void SetIntc( int intc, long func, int source, int level, int prio )
}
```

Description:

This function sets up the interrupt controller for a specified interrupt function and source.

Parameters:

Type	Name	Description
int	intc	The interrupt controller number: 0 or 1. This number can be found in your Freescale hardware reference manual.
long	func	The interrupt service routine function to call.
int	source	The source number that can be found in your Freescale hardware reference manual (in \Nburn\docs\FreescaleManuals).
int	level	The interrupt level you want to assign. This value can be anything from 1 to 6.
int	prio	The interrupt priority used to resolve who goes first if multiple interrupts at the same level are occurring. This value can be between 0 and 7.

Returns:

Nothing – this is a void function.

10.3. SetIntc (MCF5270 Only)

Synopsis:

```
void SetIntc( long func, int source, int level, int prio )
```

Usage:

```
extern "C"
{
   void SetIntc( long func, int source, int level, int prio )
}
```

Description:

This function sets up the interrupt controller for a specified interrupt function and source.

Parameters:

Type	Name	Description
long	func	The interrupt service routine function to call.
int	source	The source number that can be found in your Freescale hardware reference manual (in \Nburn\docs\FreescaleManuals).
int	level	The interrupt level you want to assign. This value can be anything from 1 to 6.
int	prio	The interrupt priority used to resolve who goes first if multiple interrupts at the same level are occurring. This value can be between 0 and 7.

Returns:

Nothing – this is a void function.

10.4. Pseudo-Example for MCF5234 and MCF5282 Only

```
/*
 * Include/define the proper preprocessor statements.
 */
#include <cfinter.h>

extern "C"
{
   void SetIntc( int intc, long func, int source, int level, int prio )
}

/**
 * Define the ISR function and SR mask.  The SR mask can be 0x2N00 where ‘N’
 * is a value between 0 and 7.  The SR mask indicates what interrupt levels will
 * be blocked while the ISR is running (refer to the Parameters subsection near
 * the beginning of this chapter).  The ‘N’ value must be at least as high as
 * the level of the interrupt define in SetIntc.  Note that level 7 is
 * un-maskable.
 */
INTERRUPT( My_ISR, 0x2N00 )
{
   /* Write your interrupt service routine here */
}

/**
 * The main task.
 */
void UserMain( void *pd )
{
   ...

   /*
    * Initialize the interrupt – the following is sets up the DMA Timer 1
    * interrupt source.
    */
   Setintc( 0,                /* Interrupt controller 0 */
            ( long ) My_ISR,   /* The function to call */
            20,               /* Interrupt source number from Freescale manual */
            3,                /* Interrupt level */
            1 );              /* Interrupt priority within level */

   ...
}
```

11. I/O System Library

Header File

```
#include<iosys.h>       // Found in C:\Nburn\include
```

General File Descriptor Functions

- close --- Close open file descriptors
- read --- Read data from a file descriptor
- ReadWithTimeout --- Read from a FD with timeout
- dataavail --- Check to see if data is available for read
- charavail --- Check to see if data is available for read on stdin
- write --- Write data to a file descriptor
- writestring --- Write a string to the file descriptor
- writeall --- Write data to a file descriptor and block until complete

FD Set and Select Related Functions

- FD_ZERO --- Zero a file descriptor set
- FD_CLR --- Clear a specific fd in a fd_set
- FD_SET --- Set a specific fd in a fd_set
- FD_ISSET --- Test to see if a specific fd is set in an fd_set
- select --- ZeroWaitSelect
- ZeroWaitSelect --- ZeroWaitSelect

Standard I/O Modification Functions

- ioctl --- Control translation and formatting for stdio
- ReplaceStdio --- Replace (i.e. override) the stdio file descriptor with a new one

Miscellaneous Functions

Header File

```
#include<syslog.h>    // Found in C:\Nburn\include
```

- SysLog --- Sends output on UDP Port 514

11.1. close

Synopsis:

```
int close( int fd );
```

Description:

This function closes the resources associated with a file descriptor (fd). This can be a TCP socket or a Serial I/O port.

Parameters:

Type	Name	Description
int	fd	The file descriptor number

Returns:

0 (zero) --- On success
A resource specific error code --- On failure

See Also:

- read --- Read data from a file descriptor
- ReadWithTimeout --- Read from a FD with timeout
- write --- Write data to a file descriptor
- writestring --- Write a string to the file descriptor

11.2. read

Synopsis:

```
int read( int fd, char * buf, int nbytes );
```

Description:

This function reads data from a file descriptor (fd), and will block forever until at least one byte is available to be read (as opposed to the ReadWithTimeout function which reads data from a file descriptor with a specified time-out value). This function can be used to read from stdio, TCP sockets, or Serial ports.

Parameters:

Type	Name	Description
int	fd	The file descriptor number
char	*buf	A pointer to the read destination.
int	nbytes	Maximum number of bytes to read.

Returns:

The number of bytes read --- On success
A negative number (representing the resource specific error) --- On failure

See Also:

- close --- Close open file descriptors
- ReadWithTimeout --- Read from a FD with timeout
- write --- Write data to a file descriptor
- writestring --- Write a string to the file descriptor

11.3. ReadWithTimeout

Synopsis:

```
int ReadWithTimeout( int fd, char * buf, int nbytes,
                     unsigned long timeout );
```

Description:

This function reads data from a file descriptor (fd), with a specified time-out value (as opposed to the **read function which will block forever until at least one byte is available to be read**). This function will block until **either** the time-out expires **or** at least one byte is available to be read. This function can be used to read from stdio, TCP sockets, or Serial ports.

Important: This function operates like a read function in that it reads all available bytes and returns. The addition of a time-out does **not** cause the function to block until the maximum number of bytes specified in the function call is available. As with read, the application must use the return value of the ReadWithTimeout function to determine how many bytes were read, and call the function again if necessary.

Parameters:

Type	Name	Description
int	fd	The file descriptor number
char	*buf	A pointer to the read destination.
int	nbytes	Maximum number of bytes to read.
unsigned long	timeout	The number of timer ticks to wait for data.

Returns:

0 (zero) --- On timeout
The number of bytes read --- On success
A negative number (representing the resource specific error) --- On failure

See Also:

- close --- Close open file descriptors.
- read --- Read data from a file descriptor
- write --- Write data to a file descriptor
- writestring --- Write a string to the file descriptor

11.4. dataavail

Synopsis:

```
int dataavail( int fd );
```

Description:

This function checks to see if data is available for read.

Parameters:

Type	Name	Description
int	fd	The file descriptor number

Returns:

1 --- If data is available
0 --- If no data is available

See Also:

- charavail --- Is data is available for read on stdin?
- read --- Read data from a file descriptor

11.5. charavail

Synopsis:

```
int charavail( );
```

Description:

This function checks to see if data is available for read on stdin.

Parameters:

None

Returns:

1 --- If data is available
0 --- If no data is available

See Also:

- dataavail --- Is data is available for read?
- read --- Read data from a file descriptor

11.6. write

Synopsis:

```
int write( int fd, const char * buf, int nbytes );
```

Description:

This function writes data to the stream associated with a file descriptor (fd). This function can be used to write data to stdio, a TCP socket, or a Serial port. Note: The write function will block until at least one byte is written, but does **not** have to write all the bytes requested. For example, if you wanted to write 100 bytes, and there was only room in the buffer for 5, then the write function would return 5.

Parameters:

Type	Name	Description
int	fd	The file descriptor number
const char	*buf	A pointer to the byte to write.
int	nbytes	Maximum number of bytes to write.

Returns:

The number of bytes written (**Note:** This value can be less than the number of bytes requested)
0 (zero) --- If the write timed out
A negative number --- If an error occurred

See Also:

- close --- Close open file descriptors
- read --- Read data from a file descriptor
- ReadWithTimeout --- Read from a FD with timeout
- writestring --- Write a string to the file descriptor
- writesafestring --- Write out a string while escaping all special HTML characters
- writeall --- Write data to a file descriptor and block until complete

11.7. Writestring

Synopsis:

```
int writestring( int fd, const char * str );
```

Description:

This function writes null terminated string data to the stream associated with a file descriptor (fd). This function can be used to write data to stdio, a TCP socket, or a Serial port.

Parameters:

Type	Name	Description
int	fd	The file descriptor number
const char	*str	A pointer to the NULL terminated string to write.

Returns:

The number of bytes written (Note: This value can be less than the number of bytes requested.)
0 (zero) --- If the write timed out
A negative number --- If an error occurred

See Also:

- close --- Close open file descriptors
- read --- Read data from a file descriptor
- ReadWithTimeout --- Read from a FD with timeout
- write --- Write data to a file descriptor
- writesafestring --- Write out a string while escaping all special HTML characters

11.8. writeall

Synopsis:

```
int writeall( int fd, const char * buf, int nbytes );
```

Description:

This function writes data to the stream associated with a file descriptor (fd). This function can be used to write data to stdio, a TCP socket, or a Serial port. It will block and wait for the fd to either send the whole requested amount or to return an error.

Parameters:

Type	Name	Description
int	fd	The file descriptor number
const char	*buf	A pointer to the byte to write.
int	nbytes	Maximum number of bytes to write.

Returns:

The number of bytes written
A negative number --- If an error occurred

See Also:

- close --- Close open file descriptors
- read --- Read data from a file descriptor
- ReadWithTimeout --- Read from a FD with timeout
- write --- Write data to a file descriptor
- writestring --- Write a string to the file descriptor
- writesafestring --- Write out a string while escaping all special HTML characters

11.9. FD_ZERO

Synopsis:

```
void FD_ZERO( fd_set * pfds );
```

Description:

This function zero's a fd_set (file descriptor set) so that it has no file descriptors (fds) selected.

Parameters:

Type	Name	Description
fd_set	*pfds	A pointer to the fd_set

Returns:

Nothing --- This is a void function

See Also:

- FD_CLR --- Clear a specific fd in a fd_set
- FD_SET --- Set a specific fd in a fd_set
- FD_ISSET --- Test to see if a specific fd is set in an fd_set
- select --- Wait for I/O events

11.10. FD_CLR

Synopsis:

```
void FD_CLR( int fd, fd_set * pfds );
```

Description:

A fd_set (file descriptor set) holds a set of file descriptors (fds). This function clears or removes a specific file descriptor in an fd_set.

Parameters:

Type	Name	Description
int	fd	The file descriptor number.
fd_set	*pfds	A pointer to the fd_set to modify.

Returns:

Nothing --- This is a void function

See Also:

- FD_ZERO --- Zero a file descriptor set
- FD_SET --- Set a specific fd in a fd_set
- FD_ISSET --- Test to see if a specific fd is set in a fd_set
- select --- Wait for I/O events

11.11. FD_SET

Synopsis:

```
void FD_SET( int fd, fd_set * pfds );
```

Description:

A fd_set (file descriptor set) holds a set of file descriptors (fds). This function sets or adds a specific file descriptor to an fd_set.

Parameters:

Type	Name	Description
int	fd	The file descriptor number.
fd_set	*pfds	A pointer to the fd_set to modify.

Returns:

Nothing --- This is a void function

See Also:

- FD_ZERO --- Zero a file descriptor set
- FD_CLR --- Clear a specific fd in a fd_set
- FD_ISSET --- Test to see if a specific fd is set in an fd_set
- select --- Wait for I/O events

11.12. FD_ISSET

Synopsis:

```
int FD_ISSET( int fd, fd_set * pfds );
```

Description:

A fd_set (file descriptor set) holds a set of file descriptors (fds). This function indicates whether (or not) a specific fd is in a specific fd_set.

Parameters:

Type	Name	Description
int	fd	The file descriptor number.
fd_set	*pfds	A pointer to the fd_set to test.

Returns:

0 (zero) --- If the fd is not in the set
A non zero --- If the fd is in the set

See Also:

- FD_ZERO --- Zero a file descriptor set
- FD_CLR --- Clear a specific fd in a fd_set
- FD_SET --- Set a specific fd in a fd_set
- select --- Wait for I/O events

11.13. select

Synopsis:

```
int select( int nfds, fd_set * readfds, fd_set * writefds,
            fd_set * errorfds, unsigned long timeout );
```

Description:

This function waits for events to occur on one or more I/O resources associated with a set of file descriptors (fds). The user indicates his/her interest in specific fds by setting them in the fd_sets (file descriptor set) that are passed into the function. Note: This function will "unblock" when at least one byte is available for the file descriptor you add to the output set.

Parameters:

Type	Name	Description
int	nfds	The number of file descriptors to examine. **Note:** This parameter is currently ignored
fd_set	*readfds	A pointer to the fd_set to select for read events. **Note**: This parameter can be NULL. It is modified on exit to reflect the read availability of the selected fds in the set.
fd_set	*writefds	A pointer to the fd_set to select for write availability events. **Note:** This parameter can be NULL. It is modified on exit to reflect the write availability of the selected fds in the set.
fd_set	*errorfds	A pointer to the fd_set to select for error events. **Note:** This parameter can be NULL. It is modified on exit to reflect the error state of the selected fds in the set.
unsigned long	timeout	The number of time ticks to wait before timing out if no events occurred in the selected fd set.

Returns:

The number of fds in all of the non null fd_sets or 0 (zero) if the function timed out

See Also:

- FD_ZERO --- Zero a file descriptor set
- FD_CLR --- Clear a specific fd in a fd_set
- FD_SET --- Set a specific fd in a fd_set
- FD_ISSET --- Test to see if a specific fd is set in an fd_set

11.14. ZeroWaitSelect

Synopsis:

```
int ZeroWaitSelect( int nfds, fd_set * readfds, fd_set * writefds,
                    fd_set * errorfds )
```

Description:

This function waits for events to occur on one or more I/O resources associated with a set of file descriptors (fds). The user indicates his/her interest in specific fds by setting them in the fd_sets (file descriptor set) that are passed into the function.

Parameters:

Type	Name	Description
int	nfds	The number of file descriptors to examine. **Note:** This parameter is currently ignored
fd_set	*readfds	A pointer to the fd_set to select for read events. **Note**: This parameter can be NULL. It is modified on exit to reflect the read availability of the selected fds in the set.
fd_set	*writefds	A pointer to the fd_set to select for write availability events. **Note:** This parameter can be NULL. It is modified on exit to reflect the write availability of the selected fds in the set.
fd_set	*errorfds	A pointer to the fd_set to select for error events. **Note:** This parameter can be NULL. It is modified on exit to reflect the error state of the selected fds in the set.

Returns:

The number of fds in all of the non null fd_sets or 0 (zero) if there are no valid fds

See Also:

FD_ZERO --- Zero a file descriptor set
FD_CLR --- Clear a specific fd in a fd_set
FD_SET --- Set a specific fd in a fd_set
FD_ISSET --- Test to see if a specific fd is set in an fd_set

11.15. ioctl

Synopsis:

```
int ioctl( int fd, int cmd );
```

Description:

This function controls the selection of three options for stdio: stdin = 0, stdout = 1 and stderr = 2. The four legal options are:

IOCTL_TX_CHANGE_CRLF (1) /* When set transmitted char \n gets converted to \r\n */
IOCTL_RX_CHANGE_CRLF (2) /* When set received \r\n get turned into \n */
IOCTL_RX_PROCESS_EDITS (4) /* When set Process backspace and do simple line editing */
IOCTL_RX_ECHO (8) /* When set echo chars received to tx*/

Parameters:

Type	Name	Description
int	fd	The file descriptor number. The three options are: • 0 = stdin • 1 = stdout • 2 = stderr
int	cmd	The ioctl command consists of IOCTL_SET or IOCTL_CLR and the bit of the associated options.

Returns:

The old option value

See Also:

ReplaceStdio --- Replace the stdio file descriptor with a new one.

11.16. ReplaceStdio

Synopsis:

```
int ReplaceStdio( int stdio_fd, int new_fd );
```

Description:

This function allows you to map stdio to any file descriptor (fd). If the file descriptor generates an error (like a closed TCP connection), then stdio will be remapped to a negative fd (this will cause stdio to generate errors). When this function is used to remap an errored stdio channel, then the error will be cleared.

Parameters:

Type	Name	Optional	Description
int	stdio_fd	• No	• The stdio file descriptor to map to • (0 = stdin, 1 = stdout, and 2 = stderr).
int	new_fd	No	The file descriptor to replace stdio with. **Note:** A value of 0 returns stdio to the default debug monitor based traps

Returns:

The value of the fd for the previous stdio override
0 (zero) --- If stdio had not been mapped previously

See Also:

ioctl --- Control translation and formatting for stdio

11.17. SysLog

Header File:

```
#include<syslog.h>     // Found in C:\Nburn\include
```

Synopsis:

```
int SysLog( const char * format, ... );
```

Description:

This function works very similar to a standard printf function, in regards to input arguments, return values, and resulting output. The output is sent via UDP port 514, and it can be sent as either a broadcast or a unicast message. This function is useful for users who have no serial ports, are out of serial ports, or desire to send the debug output to a remote location.

If you do **not** specify an IP address to send to, then the message will be broadcasted. **Note:** If you are in crowded network, or if you desire to send a message to a particular IP address, then you will need to add the following line to your start-up code:

```
SysLogAddress = AsciiToIp( "<Destination IP Address>" );
```

For example:

```
SysLogAddress = AsciiToIp( "10.1.1.228" );
```

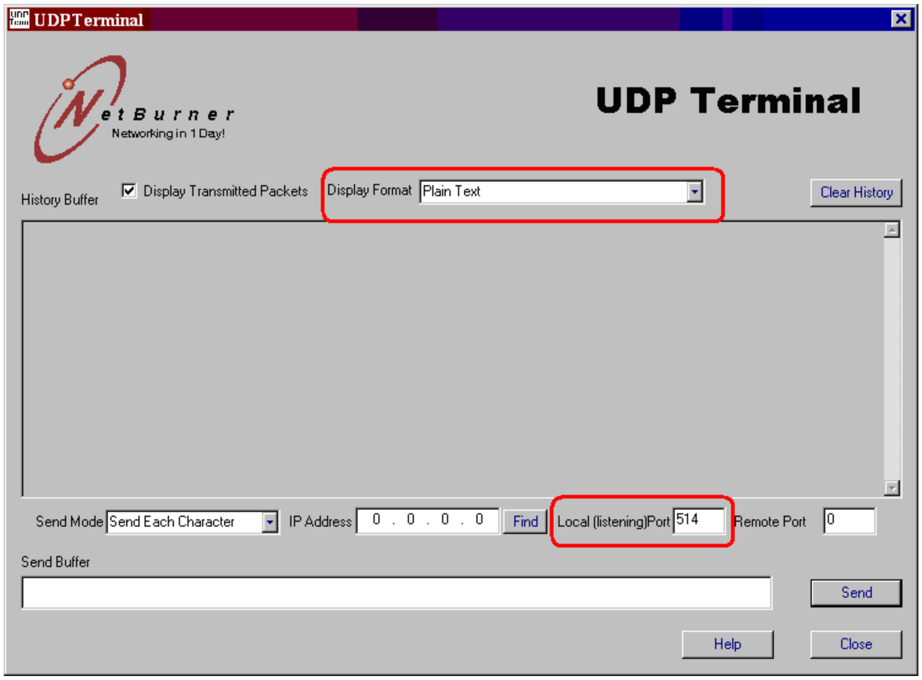
To make this function work in a normal project application, all you have to do is include the header file, and then in the program body, you use the SysLog() function as you would with an iprintf function. Some examples are:

```
SysLog( "Hello World!" );
SysLog( "This number of seconds have passed: %d\r\n", Secs );
SysLog( "%d plus %d equals %d.\r\n", num1, num2, sum );
```

To see the output generated by SysLog, open the **UDP Terminal Tool** application. From Windows: Start → Programs → Netburner NNDK → UDP Terminal Tool. By default this program is located in C:\Nburn\pcbin. Next, set the Display Format drop-down box to Plain Text and set the Local (listening) Port to 514 as shown on the next page.

If you have your NetBurner hardware connected to the network, and are periodically sending SysLog output, you will see the result in the UDP Terminal window. By default, it will broadcast whatever message is written to the network.

Warning: If a person is on a crowded network, sending broadcast messages to the SYSLOG port (i.e. Port 514) then using this function will increase traffic.



☑ Display Transmitted Packets

Display Format Plain Text

Send Mode Send Each Character

IP Address 0 . 0 . 0 . 0

Local (listening)Port 514

Remote Port 0

Parameters:

The message (output string) to send followed by any number of variables - it works similar to the printf function.

Returns:

The number of bytes in the output string, excluding the terminating NULL.

Example:

```
#include <syslog.h>

void UserMain( void *pd )
{
   // your start-up code here

   SysLogAddress = AsciiToIp( "10.1.1.228" ); // Only for unicasting
   while ( 1 )
   {
      OSTimeDly( TICKS_PER_SECOND );
      SysLog( "This is only a test! %d\r\n", Secs );
   }
}
```

12. I²C Library

12.1. Introduction

In the early 1980's, Philips Semiconductors developed a simple bidirectional 2-wire bus for efficient inter-IC control. This bus is called the Inter-IC or I²C-bus. Its name literally explains its purpose: to provide a communication link between Integrated Circuits. Its original purpose was to provide an easy way to connect a CPU to peripheral chips in a TV-set. All I²C-bus compatible devices incorporate an on-chip interface, which allows them to communicate directly with each other via the I²C-bus. This design concept solves the many interfacing problems encountered when designing digital control circuits. I²C has become a de facto world standard. The I²C-bus is patented by Philips.

The I²C-bus physically consists of two active wires and a ground connection. The active wires are called SDA and SCL. SDA is the Serial DAta line and SCL is the Serial CLock line. Every device hooked up to the bus has its own unique address. Each of these chips can act as a receiver and/or transmitter, depending on the functionality.

Both SDA and SCL are bi-directional signals, implemented in the following way : Each device on the I²C-bus can monitor the voltage or logic level on both signals. In addition, a device may connect the line to the system ground rail through an electronic switch or it may leave it floating. (For those of you who have done a bit of digital electronics, this is known as an `open collector' output.) External resistors (typically about 4.7k) are connected between each of the 2 signal lines and the +5V/3.3V power supply rail, so that if no device on the bus is connecting a line to ground, then that line appears to be in a logic 1 state.

The I²C-bus is a multi-master bus. This means that more than one IC capable of initiating a data transfer can be connected to it. The I²C protocol specification states that the IC that initiates a data transfer on the bus is considered the Bus Master (generally a microcontroller) and all the other ICs (at that time) are Bus Slaves. The most important thing to realize about data transfer on the I²C-bus is that the state of the SDA line can only change when the SCL line is in the logic low state. The reason for this is that the I²C protocol defines two special conditions to start and stop communications over the bus, they are:

A Start condition - defined as a change of SDA from logic 1 to logic 0 while SCL is high.
A Stop condition - defined as a change of SDA from logic 0 to logic 1 while SCL is high.

Prior to any transaction on the bus, a START condition needs to be issued on the bus by the Master. This start condition acts as a signal to all connected IC's that something is about to be transmitted on that bus. As a result, all connected chips will listen to the bus. The master controls the Clock line and always generates the Clock pulses.

Once a transmission is complete, the Master device can retain control of the bus by issuing a repeated start or RESTART condition. This gives the Master device the ability to immediately communicate with another device on the bus or to change transmission directions (read or write) with the current device.

After a message has been completed, a STOP condition is sent by the master. This is the signal for all devices on the bus that the bus is now available (i.e. idle). If a chip was accessed, and received data during the last transaction, it will now process that information (if it was not already processed during the reception of the message).

Devices on the I²C-bus are selected by an 8-bit address that is sent over the bus in the same way as data bytes. The least significant bit of this address acts as a read/write control signal and is set to 0 to make the Slave a Receiver and 1 to make the Slave a Transmitter. The address byte is the first byte transmitted after a Start condition. It is always transmitted by the master. By convention, if the slave is a receiver (and contains several registers), then the next byte transmitted after the address byte is an internal register address for that device. However, this is not required by the I²C specification.

12.2. The NetBurner I²C API

The NetBurner I²C API creates an easy interface to use interrupt driven I²C communication. The API will work only on those platforms that include the I2C hardware. The NetBurner I²C API comes in two flavors, I²C master and I²C multi.

The I²C master API allows you to configure the NetBurner device to act as the sole master device on an I²C bus while the I²C multi API configures the NetBurner device to be a multi-master device.

The I²C multi API should be used any time you wish to be able to have your NetBurner device act as both a bus master and slave device. This is very useful if you wish to have multiple smart-devices (e.g. NetBurner devices, Microcontrollers, etc.) on the same I²C bus. This API includes all the functions included in the I²C master API plus extra functions to handle slave mode transmissions and arbitration when attempting to become bus master.

The I²C master API is a limited functionality version of the I²C multi interface. Note: This mode will not work properly if there are other masters or multi-master devices on the same I²C bus. The master-only mode has the benefit of using less FLASH and RAM for space sensitive projects that only need to interface with slave devices. The space saved in FLASH is around 20 KB, and the space saved in RAM is dependent on the sizes configured for the slave mode RX/TX buffers.

Header Files:

```
#include <i2cmulti.h>     // Found in C:\Nburn\<HWPlatform>\include
#include <i2cmaster.h>    // Found in C:\Nburn\<HWPlatform>\include
```

Simple NetBurner I²C Functions

These functions are used in both I²C multi and master modes. They are simple in the fact that they require little configuration or code to send and receive buffers over I²C. Most devices that follow Philips I²C standard will work with these functions.

- I2CInit
- I2CSendBuf
- I2CReadBuf
- I2CRestart

Simple NetBurner Slave Mode I²C Functions

These functions can only be implemented when the I²C multi driver is being used. These functions provide both slave RX and TX ability.

- I2CRXAvail
- I2CTXAvail
- I2CGetByte
- I2CFillSlaveTXBuf

Advanced NetBurner I²C Functions

These functions are used in both I²C multi mode and master mode. They allow the user to control all aspects of I²C communication including start, stop, restart, and sending and receiving at single BYTE level. **Note:** These functions are useful when communicating with devices that do not follow Philips I²C standard exactly.

- I2CStart
- I2CStop
- I2CSend
- I2CRead

Note: An example I²C application can be found in C:\Nburn\examples\<HWPlatform>.

12.3. Simple I²C Functions

12.3.1. I2CInit

Synopsis:

```
void I2CInit( BYTE slave_Addr = 0x08, BYTE freqdiv = 0x11 );
```

Note: This version is used when including **i2cmulti.h**

Synopsis:

```
void I2CInit( BYTE freqdiv = 0x15 );
```

Note: This version is used when including **i2cmaster.h**

Description:

The I²C master and slave initialization routine must be called before performing any I²C functions.

Parameters:

Type	Name	Description
BYTE	slave_Addr	The 7-bit slave address assigned to NetBurner and is only used in i2cmulti API. **Note:** Phillips I²C Standard states that the two group addresses 0000XXX and 1111XXX are reserved for advanced purposes. The addresses 11110XX are also reserved for the 10-bit addressing I²C protocol.
BYTE	freqdiv	This value is used in the Coldfire I2FDR as a prescaler of the system clock to generate a max baud rate of the master mode I²C bus. Valid values for freqdiv are found in the I²C section of your Freescale MCF Manual (in C:\Nburn\docs). All the processors are set to be approximately 100Kbits by default, which is the max I²C standard speed.

Returns:

Nothing --- This is a void function

12.3.2. I2CSendBuf

Synopsis:

```
BYTE I2CSendBuf( BYTE addr, PBYTE buf, int num, bool stop = true );
```

Description:

This function sends a buffer to an address on the I²C bus in master mode without the need of a start and stop bit.

Parameters:

Type	Name	Description
BYTE	addr	The 7-bit address you wish to send the buffer to.
PBYTE	buf	A pointer to the BYTE buffer you wish to write from.
int	num	The number of bytes to write.
bool	stop	True (default): Terminate communication with stop. False: Do not terminate transmission. (This is useful if the user wishes to send a restart instead of a stop.)

Returns:

The standard NetBurner I²C return values

12.3.3. I2CReadBuf

Synopsis:

```
BYTE I2CReadBuf( BYTE addr, PBYTE buf, int num, bool stop = true );
```

Description:

This function allows a buffer to be read from an address on the I²C bus in master mode without the need of a start and stop bit.

Parameters:

Type	Name	Description
BYTE	addr	The 7-bit address you wish to read the buffer from.
PBYTE	buf	A pointer to the BYTE buffer you wish to read to.
int	num	The number of bytes to read.
bool	stop	True (default): Terminate communication with stop. False: Do not terminate transmission. (This is useful if the user wishes to send a restart instead of a stop.)

Returns:

The standard NetBurner I²C return values

12.3.4. I2CRestart

Synopsis:

```
int I2CRestart( BYTE addr, BOOL Read_Not_Write,
                DWORD ticks_to_wait = I2C_RX_TX_TIMEOUT );
```

Description:

This function will send a restart signal on the I²C bus instead of a stop. **Note:** This function should **only** be used when in master mode and you have control of the bus.

Parameters:

Type	Name	Description
BYTE	addr	The 7-bit address you wish to send the restart to.
BOOL	Read_Not_Write	True to read. False to write. **Note:** You can use I2C_START_READ or I2C_START_WRITE as values.
DWORD	ticks_to_wait	The number of ticks to wait on restart before failing. **Note:** The default value in i2cmaster/multi.h = I2C_RX_TX_TIMEOUT.

Returns:

The standard NetBurner I²C return values

12.4. Slave I²C Functions

12.4.1. I2CRXAvail

Synopsis:

```
bool I2CRXAvail( );
```

Description:

This function determines if there is data available in the I²C slave receive buffer.

Parameters:

None

Returns:

True --- If there is data in slave RX buffer
False --- If slave RX buffer is empty

12.4.2. I2CTXAvail

Synopsis:

```
DWORD I2CTXAvail( );
```

Description:

This function determines the free space available in the I²C slave TX buffer.

Parameters:

None

Returns:

The number of bytes remaining in the I²C slave TX buffer

12.4.3. I2CGetByte

Synopsis:

```
BYTE I2CGetByte( );
```

Description:

This function will pend on a slave receive I²C semaphore.

Parameters:

None

Returns:

The oldest unread byte in the I²C slave RX buffer

12.4.4. I2CFillSlaveTXBuf

Synopsis:

```
BYTE I2CFillSlaveTXBuf( PBYTE buf, DWORD num, bool restart = true );
```

Description:

This function is used to fill the I²C slave TX buffer.

Parameters:

Type	Name	Description
PBYTE	buf	A pointer to the BYTE buffer that contains data for the slave TX buffer.
DWORD	num	The number of BYTE to send from buf to TX buffer.
BOOL	restart	If true then restart next TX from beginning TX buffer. (A new slave fill replaces buffer.) If false then continue next TX from last slave TX. (A new slave fill adds to buffer at last unread byte.)

Returns:

Returns false if it failed to copy data

12.5. Advanced I²C Functions

12.5.1. I2CRead

Synopsis:

```
int I2CRead( PBYTE val, DWORD ticks_to_wait = I2C_RX_TX_TIMEOUT );
```

Description:

This function reads a single byte in master mode from the I²C bus.

Parameters:

Type	Name	Description
PBYTE	val	A pointer to byte location to store read value.
DWORD	ticks_to_wait	The number of system time ticks before a timeout occurs.

Returns:

The standard NetBurner I²C return values

12.5.2. I2CSend

Synopsis:

```
int I2CSend( BYTE val, DWORD ticks_to_wait = 5 );
```

Description:

This function sends a single byte in master mode on the I²C bus.

Parameters:

Type	Name	Description
BYTE	val	The byte to send.
DWORD	ticks_to_wait	The number of system time ticks before a timeout occurs.

Returns:

The standard NetBurner I²C return values

12.5.3. I2CStart

Synopsis:

```
int I2CStart( BYTE addr, BOOL Read_Not_Write,
              DWORD ticks_to_wait = I2C_START_TIMEOUT );
```

Description:

This function is used to obtain an I²C bus and start communication in master mode.

Parameters:

Type	Name	Description
BYTE	addr	The 7-bit address you wish to send the start to.
BOOL	Read_Not_Write	True to read. False to write. **Note:** You can use I2C_START_READ or I2C_START_WRITE as values
DWORD	ticks_to_wait	The number of ticks to wait on restart before failing. **Note:** The default value in i2cmaster/multi.h = I2C_RX_TX_TIMEOUT

Returns:

The standard NetBurner I²C return values

12.5.4. I2CStop

Synopsis:

```
void I2CStop( );
```

Description:

This function ends communication and releases control of the I²C bus. This function puts your NetBurner board into idle/slave mode.

Parameters:

None

Returns:

Nothing --- This is a void function

13. Multicast Library

13.1. Introduction

This Module provides code for joining multicast groups. This module uses the IGMP protocol defined in RFC1112 and RFC 2236. IGMP Multicast is a method for distributing UDP packets within a group of hosts and servers.

The NetBurner Multicast functions extend the NetBurner UDP interface. Instead of using the RegisterUDPFifo function, you would use the RegisterMulticastFifo function to listen for Multicast UDP packets. **Note**: To transmit Multicast packets, just use the normal UDP Send with a multicast IP Address.

Header File

```
#include <multicast.h>    // Found in C:\Nburn\include
```

Multicast Group Functions

- RegisterMulticastFifo --- Register to join a Multicast group
- UnregisterMulticastFifo --- Register to leave a Multicast group

Multicast Example

See Multicast example in c:\nburn\examples

13.2. RegisterMulticastFifo

Synopsis:

```
void RegisterMulticastFifo( IPADDR group, WORD dest_port,
                            OS_FIFO *pfifo );
```

Description:

This call initializes the Multicast system. Register to join a Multicast group. **Note:** It is **not** active until at least **one** join has taken place.

Parameters:

Type	Name	Description
IPADDR	group	The IP Address of the group to join.
WORD	dest_port	The UDP Port to listen on.
OS_FIFO	*pfifo	The fifo to put incoming packets into.

Returns:

Nothing --- This is a void function

13.3. UnregisterMulticastFifo

Synopsis:

```
void UnregisterMulticastFifo( IPADDR group, WORD destination_port );
```

Description:

This call removes the NetBurner device from the specified multicast group.

Parameters:

Type	Name	Description
IPADDR	group	The IP Address of the group to leave
WORD	dest_port	The UDP Port to listen on.

Returns:

Nothing --- This is a void function

14. NBTime Library

14.1. Introduction

The NBTime library allows users to set and read the system time manually, or by using an NTP server to set the system time. The system time runs internally to a core module and will be lost whenever it loses power or is reset.

For information on how to keep time running when the module loses power or is reset, refer to the section on the RTC library (the real-time clock library is only supported with modules mounted on MOD-DEV-40, -70, and -100 development boards).

Header File

```
#include <nbtime.h>   // Found in \Nburn\include
```

Functions

- `time` --- Reads the system time.
- `set_time` --- Sets the system time.
- `GetNTPTime` --- Reads time from an NTP server.
- `SetNTPTime` --- Sets the system time using time read from an NTP server.

14.2. time

Synopsis:

```
time_t time( time_t *pt )
```

Description:

This function reads the system time and returns it as type time_t. If `pt` is not null, then it will also write the system time to its pointed location.

Parameters:

Type	Name	Description
time_t	`*pt`	A pointer to a location of type time_t that will be written with the read system time. It can be null if the user wishes not to store the read time.

Returns:

The read system time in time_t format.

14.3. set_time

Synopsis:

```
time_t set_time( time_t time_to_set )
```

Description:

This function sets the system time with the value given by `time_to_set`.

Parameters:

Type	Name	Description
time_t	`time_to_set`	A value of type time_t that will be used to set the system time.

Returns:

The set system time in time_t format.

14.4. GetNTPTime

Synopsis:

```
DWORD GetNTPTime( IPADDR NTP_server_ip )
```

Description:

This function gets time from an NTP server.

Parameters:

Type	Name	Description
IPADDR	NTP_server_ip	The IP address of the NTP server.

Returns:

The NTP time to the nearest second of type DWORD if successful, zero (0) if it fails.

14.5. SetNTPTime

Synopsis:

```
BOOL SetNTPTime( IPADDR ntpserver )
```

Description:

This function gets time from an NTP Server and uses it to set the system time.

Parameters:

Type	Name	Description
IPADDR	`ntpserver`	The IP address of the NTP server.

Returns:

TRUE --- Succeeds in getting time from an NTP server.
FALSE --- Fails to get time from an NTP server.

15. The POP3 Client Library

15.1. Introduction

This module provides functions for receiving and managing mail from a Post Office Protocol version 3 (POP3) server. POP3 is defined in RFC1939. For sending mail, please see the SendMail section.

Header Files

```
#include<pop3.h>              // Found in C:\Nburn\include
```

POP3 Client Functions

POP3_InitializeSession --- Initialize the POP3 network connection
POP3_CloseSession --- Close the POP3 network connection
POP3_StatCmd --- Get the status of the Mailstore on the POP3 server
POP3_ListCmd --- Get the size of the specified message
POP3_DeleteCmd --- Delete a specific message on the server
POP3_RetrieveMessage --- Retrieve a specific message from the server
GetPOPErrorString --- Returns the Error text for a specific code

POP3 Example

```
#include <pop3.h>
#include <dns.h>
#define USERID "username"
#define USERPASS "password"
#define SERVERNAME "pop.yourserver.com"
#define POP_PORT (110)

int StartSession()
{
    IPADDR srvr_addr;
    if (GetHostByName(SERVERNAME,&srvr_addr,0,TICKS_PER_SECOND*10)==DNS_OK)
    {
        iprintf("Got Server IP = ");
        ShowIP(srvr_addr);
        printf("\r\n");
        // Create the POP 3 session with the server
        int session = POP3_InitializeSession( srvr_addr, POP_PORT, USERID,
                                              USERPASS, TICKS_PER_SECOND*10 );
        return session;
    }
    else
    {
        iprintf("Failed to get Server IP Address\n");
        return 0;
    }
}

#define MSG_BUF_SIZ (16000)
static char messagebuffer[MSG_BUF_SIZ];
void GetMessages()
{
    DWORD num_mess;
    DWORD num_bytes;
    int session = StartSession();
    if ( session > 0 )
    {
        int rv = POP3_StatCmd(session, &num_mess, &num_bytes,
                              10*TICKS_PER_SECOND);
        if ( rv == POP_OK )
        {
            iprintf( "The server has %ld messages and %ld bytes\r\n",
                     num_mess, num_bytes );
            if ( num_mess == 0 )
                return;

            for ( DWORD nmsg = 1; nmsg <= num_mess; nmsg++ )
            {
                char * psub;
                char * pbody;
                DWORD predict_size;
                rv = POP3_ListCmd(session,nmsg, &predict_size,
                                  TICKS_PER_SECOND*10);
                iprintf( "Predicted message size is %ld\r\n", predict_size );
                rv = POP3_RetrieveMessage(session,nmsg,messagebuffer,
                                          &psub, &pbody,MSG_BUF_SIZ-1,
                                          TICKS_PER_SECOND*20 );
                if ( rv > 0 )
                {
                    iprintf( "Received a message of %d bytes\r\n", rv );
                    messagebuffer[rv] = 0;
                    if ( pbody )
                    {
                       iprintf("Body Size %ld\r\n, <Start of Message:>\r\n
                               %s\r\n<End of Message>\r\n", strlen(pbody), pbody );
                    }
                    else
                    {

                        iprintf("Unable to locate body.\r\nPrinting the entire
                                 message\r\n<Start of Message:>\r\n %s\r\n<End
                                 of Message>\r\n",pbody);
                    }
                    char c;
                    do
                    {
                        iprintf( "Delete this message (Y/N?)" );
                        c = toupper(getchar());
                    }

                    while ( (c != 'N') && (c != 'Y') );

                    if ( c == 'Y' )
                    {
                        rv = POP3_DeleteCmd( session,nmsg, TICKS_PER_SECOND*10 );
                        if (rv == POP_OK)
                            iprintf("Message deleted\r\n");
                        else
                            iprintf("Delete command processing failed with
                                     error:%s\r\n", GetPOPErrorString(rv));
                    }
                    else
                        iprintf("Message not deleted\r\n");
                }
                else
                    iprintf("Retrieve command processing failed with error:%s\r\n",
                            GetPOPErrorString(rv));
            }
        }
        else
        {
            iprintf("STAT command processing failed with error:%s\r\n",
                    GetPOPErrorString(rv));
        }
        POP3_CloseSession(session);
    }
    else
    {
        iprintf("Failed to create session with error:%s\r\n",
                GetPOPErrorString(session));
    }
}
```

15.2. POP3_InitializeSession

Synopsis:

```
int POP3_InitializeSession( IPADDR server_address, WORD port,
                           PCSTR UserName, PCSTR PassWord, DWORD time_out )
```

Description:

This function initializes the POP3 network connection. This call makes the connection to the POP Server and logs in with the Username and Password.

Parameters:

Type	Name	Description
IPADDR	server_address	The IP Address of the Server.
WORD	port	The port to connect to on the Server.
PCSTR	UserName	The account Username.
PCSTR	PassWord	The account Password.
DWORD	time_out	The number of ticks to wait.

Return Values:

int --- The command success code
> 0 --- Mail session
POP_TIMEOUT --- Time out
POP_PASSWORDERROR --- Network error
POP_CONNECTFAIL--- Password error
POP_NETWORKERROR --- Network error

15.3. POP3_CloseSession

Synopsis:

```
Int POP3_CloseSession( int session );
```

Description:

This function closes the POP3 network connection. This function also flushes deleted messages. (See RFC1939 for additional information.)

Parameters:

Type	Name	Description
int	session	The POP3 session

Return Values:

int --- The command success code
POP_OK --- Closed successfully
POP_TIMEOUT --- Time out
POP_COMMANDFAIL --- Command error
POP_NETWORKERROR --- Network error
POP_BADSESSION--- Bad session number

15.4. POP3_StatCmd

Synopsis:

```
int POP3_StatCmd( int session, DWORD * num_messages,
                  DWORD * total_bytes, DWORD time_out );
```

Description:

This function gets the status of the Mailstore on the POP3 server and retrieves the state of the mail store associated with this session.

Parameters:

Type	Name	Description
int	session	The POP3 session.
DWORD	*num_messages	The DWORD variable to hold the number of pending messages.
DWORD	*total_bytes	The DWORD variable to hold the total number of bytes in the pending messages.
DWORD	time_out	The number of ticks to wait.

Return Values:

int --- The command success code
POP_OK --- Command OK
POP_TIMEOUT --- Time out
POP_COMMANDFAIL --- Command error
POP_NETWORKERROR --- Network error
POP_BADSESSION--- Bad session number

15.5. POP3_ListCmd

Synopsis:

```
int POP3_ListCmd( int session, DWORD message_number, DWORD * total_bytes,
                  DWORD time_out );
```

Description:

This function gets the size of the specified message and retrieves the size of the message.

Parameters:

Type	Name	Description
int	session	The POP3 session.
DWORD	message_number	Retrieves the size of the message.
DWORD	*total_bytes	The DWORD variable to hold the total number of bytes in the pending messages.
DWORD	time_out	The number of ticks to wait.

Return Values:

int --- The command success code
POP_OK --- Command OK
POP_TIMEOUT --- Time out
POP_COMMANDFAIL --- Command error
POP_NETWORKERROR --- Network error
POP_BADSESSION--- Bad session number

15.6. POP3_DeleteCmd

Synopsis:

```
int POP3_DeleteCmd( int session, DWORD message_number,
                    DWORD time_out )
```

Description:

This function deletes a specific message on the server. **Note:** The message is **not** actually deleted until the session is closed.

Parameters:

Type	Name	Description
int	session	The POP3 session.
DWORD	message_number	The message to delete.
DWORD	time_out	The number of ticks to wait.

Return Values:

int --- The command success code
POP_OK --- Command OK
POP_TIMEOUT --- Time out
POP_COMMANDFAIL --- Command error
POP_NETWORKERROR --- Network error
POP_BADSESSION--- Bad session number

15.7. POP3_RetrieveMessage

Synopsis:

```
int POP3_RetrieveMessage( int session, DWORD message_number, char * buffer,
                          char ** subject_ptr, char ** body_ptr,
                          int max_bufferlen, DWORD time_out );
```

Description:

This function retrieves a specific message from the server. The message is retrieved as a large block with all of the headers first. Note: The message is left on the server and will not be deleted until you call POP3_DeleteCmd.

Parameters:

Type	Name	Description
int	session	The POP3 session.
DWORD	message_number	The message to retrieve.
char	*buffer	The buffer to hold the message.
char	**subject_ptr	If not NULL, the char pointer will be left pointing at the message subject.
char	**body_ptr	If not NULL, the char pointer will be left pointing at the message body.
int	max_bufferlen	The maximum size of the retrieved message.
DWORD	time_out	The number of ticks to wait.

Return Values:

int --- The command success code
> 0 --- The length of the message retrieved
POP_TIMEOUT --- Time out
POP_COMMANDFAIL --- Command error
POP_NETWORKERROR --- Network error
POP_BADSESSION --- Bad session number

15.8. GetPOPErrorString

Synopsis:

```
PCSTR GetPOPErrorString( int err );
```

Description:

This function returns the error text for a specific code.

Parameters:

Type	Name	Description
int	err	The error code

Return Value:

The text string

16. The SendMail SMTP Library

16.1. Introduction

This Module provides code for sending email using Simple Mail Transfer Protocol (SMTP). You can send mail with or without plain text password authentication. Attachments can be sent in MIME format as plain text or binary.

Header Files

```
#include <mailto.h>           // Found in C:\Nburn\include
```

SendMail Functions

SendMail ---Send a message without authentication
SendMailEx --- Send an E-Mail using the selected POP server
SendMailAuth --- Send an E-Mail using the selected POP server and a password
SendMailAuthStartMIME --- Initiate a MIME session
SendMailAuthAddMIME --- Call one or more times to add MIME parts
SendMailAuthEndMIME --- Send the MIME message and close session

16.2. SendMail

Synopsis:

```
int SendMail( IPADDR smtp_server, PCSTR userid, PCSTR from_addr,
              PCSTR to_addr, PCSTR subject, PCSTR textbody );
```

Description:

Send an email message. The function will open a TCP connection to the specified SMTP server, create a message based on the parameters, and send the message.

Parameters:

Type	Name	Description
IPADDR	smtp_server	Name or IP Address of the SMTP Server
PCSTR	userid	The ASCII string to provide for RFC931 Identification.
PCSTR	from_addr	The "from" E-Mail address.
PCSTR	to_addr	The "to" E-Mail address (i.e. where to send the E-Mail).
PCSTR	subject	The E-Mail subject.
PCSTR	textbody	The body of the E-Mail.

Return Values:

0 --- If it fails
1 --- If successful

16.3. SendMailEx

Synopsis:

```
int SendMailEx( IPADDR smtp_server, PCSTR userid, PCSTR from_addr_rev_path,
                PCSTR from_addr_memo_hdr, PCSTR to_addr, PCSTR subject,
                PCSTR textbody );
```

Description:

Send an email message with extended parameters. The function will open a TCP connection to the specified SMTP server, create a message based on the parameters, and send the message. This function is identical to SendMail( ), with the addition of the from_addr_rev_path and from_addr_memo_hdr parameters.

Parameters:

Type	Name	Description
IPADDR	pop_server	Name or IP Address of the SMTP Server
PCSTR	userid	The ASCII string to provide for RFC931 Identification.
PCSTR	from_addr_rev_path	The "from" E-Mail address - RFC 821 - <reverse-path>.
PCSTR	from_addr_memo_hdr	The "from” E-Mail address - RFC 821- memo header.
PCSTR	to_addr	“Send To” E-Mail address
PCSTR	subject	The E-Mail subject.
PCSTR	textbody	The body of the E-Mail.

Return Values:

0 --- If it fails
1 --- If successful

16.4. SendMailAuth

Synopsis:

```
int SendMailAuth( IPADDR smtp_server, PCSTR userid, PCSTR pass,
                  PCSTR from_addr, PCSTR to_addr, PCSTR subject,
                  PCSTR textbody );
```

Description:

Send an email message with SMTP plain text authentication per RFC 931. The function will open a TCP connection to the specified SMTP server, authenticate the connection with the specified user name and password, create a message based on the parameters, and send the message.

Parameters:

Type	Name	Description
IPADDR	pop_server	Name or IP Address of the SMTP Server
PCSTR	userid	The ASCII string to provide for RFC931 Identification.
PCSTR	pass	The ASCII String to provide for AUTH Identification.
PCSTR	from_addr	The "from" E-Mail
PCSTR	to_addr	The "to" E-Mail address (i.e. where to send the E-Mail).
PCSTR	subject	The E-Mail subject.
PCSTR	textbody	The body of the E-Mail.

Return Values:

0 --- If it fails
1 --- If successful

16.5. Sending MIME Attachments

Sending an E-Mail message with Multipurpose Internet Mail Extensions (MIME) is a multi step process:

- Call SendMailAuthStartMIME( ) to begin a Session with the SMTP server
- Call SendMailAuthAddMIME( ) for each MIME attachment you want to add
- Call SendMailAuthEndMIME( ) to send the email message and close the Session

The following MIME types are supported by default. The binary attachment should cover most types such as jpg, gif, etc. The type are defined in \nburn\include\mailto.h, and the functions are implemented in \nburn\system\mailto.cpp.

```
// MIME Content Types defined in mailto.h
extern enum CONTENT_TYPE_ENUM
{
        CONTENT_TYPE_PLAIN_TEXT,                // for message body
        CONTENT_TYPE_PLAIN_TEXT_ATTACH,
        CONTENT_TYPE_BINARY_ATTACH,
        // Add additional types above CONTENT_TYPE_END
        CONTENT_TYPE_END
} CONTENT_TYPE;
```

16.5.1. SendMailAuthStartMIME

Synopsis:

```
int SendMailAuthStartMIME( IPADDR smtp_server, PCSTR userid, PCSTR pass,
                           PCSTR from_addr, PCSTR to_addr, PCSTR subject,
                           int &fd )
```

Description:

Start a MIME session with plain text password authentication. This function will open a TCP connection to the SMTP server, authenticate, then return while leaving the TCP connection open. The Session file descriptor is returned in the “int &fd” reference variable. This function must be called before any other SendMail MIME function.

Parameters:

Type	Name	Description
IPADDR	pop_server	Name or IP Address of the SMTP Server
PCSTR	userid	The ASCII string to provide for RFC931 Identification.
PCSTR	pass	The ASCII String to provide for AUTH Identification.
PCSTR	from_addr	The "from" E-Mail
PCSTR	to_addr	The "to" E-Mail address (i.e. where to send the E-Mail).
PCSTR	subject	The E-Mail subject.
Int	& fd	A “reference” (or pointer) to an integer value of the calling function. The value of fd is modified by this function and will contain the file descriptor for the open SMTP Session. This value must always be checked to be greater than 0 for a valid Session. The fd is passed to other MIME functions to identify the open Session.

Return Values:

0 --- If it fails
1 --- If successful

16.5.2. SendMailAuthAddMIME

Synopsis:

```
int SendMailAuthAddMIME( int fd, int ContentType, const char *pContent,
                         const char *FileName )
```

Description:

Add a MIME part or attachment to an open MIME Session. This function should be called for each part/attachment you wish to add to the email message.

Parameters:

Type	Name	Description
int	fd	The file descriptor of the open MIME Session returned by SendMailAuthStartMIME( ).
int	ContentType	MIME Content Type, such as : CONTENT_TYPE_PLAIN_TEXT, CONTENT_TYPE_PLAIN_TEXT_ATTACH, CONTENT_TYPE_BINARY_ATTACH
const char *	pContent	A pointer to the MIME content
const char *	FileName	File name for the attachment

Return Values:

0 --- If it fails
1 --- If successful

16.5.3. SendMailAuthEndMIME

Synopsis:

```
int SendMailAuthEndMIME( int fd, PCSTR userid )
```

Description:

Send a MIME email message and close the SMTP Session.

Parameters:

Type	Name	Description
int	fd	The file descriptor of the open MIME Session returned by SendMailAuthStartMIME( ).
PCSTR	Userid	The user id used to open the Session in SendMailAuthStartMIME( )

Return Values:

0 --- If it fails
1 --- If successful

17. RTC Library

17.1. Introduction

The RTC (real-time clock) library allows users to set and read the real-time clock manually, or use the current system time to set the RTC time or use the current RTC time to set the system time. The RTC is external to the core module and is located on the MOD-DEV-40, -70, and -100 development boards. While the system time inside a core module can be lost when it loses power or is reset, the RTC is sustained by a supercapacitor which is also located on the development boards. This library acts as an interface between the system and RTC time clocks.

Header File

```
#include <rtc.h>   // Found in \Nburn\<HardwarePlatform>\include
```

Parameters

The following chart defines the contents of struct tm, as it is utilized by the RTCGetTime and RTCSetTime functions.

Type	Name	Description
int	`tm_sec`	Seconds (0-59).
int	`tm_min`	Minutes (0-59).
int	`tm_hour`	Hour (0-23).
int	`tm_mday`	Day of the month (1-31).
int	`tm_mon`	Month of the year: January (0) to December (11).
int	`tm_year`	Years since 1900.
int	`tm_wday`	Day of the week: Sunday (0) to Saturday (6).
int	`tm_yday`	Days since January 1st (0-365).
int	`tm_isdst`	Daylight Saving Time flag (greater than zero if in effect; zero if not in effect; less than zero if information not available).

Functions

- RTCGetTime --- Gets the current RTC time.
- RTCSetTime --- Sets the RTC time with a given `tm` structure.
- RTCSetSystemFromtRTCTime --- Sets the system time with the current RTC time.
- RTCSetRTCfromSystemTime --- Sets the RTC time using the current system time.

17.2. RTCGetTime

Synopsis:

```
int RTCGetTime( struct tm &bts )
```

Description:

This function gets the current RTC time.

Parameters:

Type	Name	Description
struct tm	&bts	The basic time structure used to store the current time read from the RTC clock.

Returns:

0 if successful, 1 if failed.

17.3. RTCSetTime

Synopsis:

```
int RTCSetTime( struct tm &bts )
```

Description:

This function sets the RTC time with a given time structure.

Parameters:

Type	Name	Description
struct tm	&bts	The basic time structure used to set the RTC time.

Returns:

0 if successful, 1 if failed.

17.4. RTCSetSystemFromRTCTime

Synopsis:

```
int RTCSetSystemFromRTCTime()
```

Description:

This function sets the system time with the current RTC time.

Parameters:

None.

Returns:

0 if successful, 1 if failed.

17.5. RTCSetRTCfromSystemTime

Synopsis:

```
int RTCSetRTCfromSystemTime()
```

Description:

This function sets the RTC time with the current system time.

Parameters:

None.

Returns:

0 if successful, 1 if failed.

18. Serial Library

18.1. Introduction

All available I/O functions in the NetBurner I/O system library work with serial ports. When the NetBurner device boots up, the serial ports are running in a polled mode. Calling either the `OpenSerial()` or `SimpleOpenSerial()` function will open the serial port in an interrupt-driven and buffered mode that will result in an increase in performance.

In order to enable the interrupt-driven mode for the default debug port (UART 0), `SerialClose()` needs to be called, followed by either `OpenSerial()` or `SimpleOpenSerial()`. Once the serial port is closed, UART 0 will no longer be connected to stdio (stdin, stdout, stderr). If stdio calls such as `iprintf()`, `printf()`, `siprintf()`, and `sprintf()` are used, then stdio must be reconnected to the appropriate serial port with `ReplaceStdio()`. For example, assuming "fdSerial" is the return value from `OpenSerial()`:

```
SerialClose( 0 );
fdSerial = OpenSerial( 0, 115200, 1, 8, eParityNone );
ReplaceStdio( 0, fdSerial );   // stdin via UART 0
ReplaceStdio( 1, fdSerial );   // stdout via UART 0
ReplaceStdio( 2, fdSerial );   // stderr via UART 0
```

Header File:

```
#include <serial.h>        // Found in C:\Nburn\include
```

Applicable to All NetBurner Platforms

- `OpenSerial` – Opens a serial port
- `SimpleOpenSerial` – Shortcut macro to open a serial port
- `SerialClose` – Closes a serial port [using `close()` works as well]
- `SerialEnableTxFlow` – Enables software flow control on transmit (XON/XOFF)
- `SerialEnableRxFlow` – Enables software flow control on receive (XON/XOFF)
- `SerialEnableHwTxFlow` – Enables hardware flow control on transmit (RTS/CTS)
- `SerialEnableHwRxFlow` – Enables hardware flow control on receive (RTS/CTS)
- `Serial485HalfDupMode` – Configures for RS-485 half- or full-duplex mode
- `SendBreak` – Sets a break in the transmission for a given period of time
- `serwriteaddress` – Writes address values (used only with multidrop parity setting)
- `GetUartErrorReg` – Reads the status of the UART error register

Applicable to the CB34EX and SB72EX Platforms

- `GetCD` – Reads the state of the Carrier Detect (CD) pin of a serial port
- `GetRI` – Reads the state of the Ring Indicator (RI) pin of a serial port
- `GetDSR` – Reads the state of the Data Set Ready (DSR) pin of a serial port
- `SetDTR` – Writes the state of the Data Terminal Ready (DTR) pin of a serial port

18.2. OpenSerial

Synopsis:

```
int OpenSerial( int portnum, unsigned int baudrate, int stop_bits,
                int data_bits, parity_mode parity );
```

Description:

This function opens a serial port.

Parameters:

Type	Name	Description
int	portnum	The UART to open; valid values are ‘0’, ‘1’, and ‘2’ (not available on all platforms).
unsigned int	baudrate	The speed of the serial port in bits per second.
int	stop_bits	The number of stop bits to append to character data; valid values are ‘1’ and ‘2’.
int	data_bits	The number of data bits sent per character or frame; valid values are 5, 6, 7, and 8.
parity_mode	parity	The type of parity checking to use; valid values are eParityNone, eParityEven, eParityOdd, and eParityMulti.

Returns:

The file descriptor of the initialized port if successful; otherwise, one of the error codes is returned:

- SERIAL_ERR_NOSUCH_PORT (-1)
- SERIAL_ERR_PORT_ALREADYOPEN (-3)
- SERIAL_ERR_PARAM_ERROR (-4) – This error will be returned if either the number of stop bits or data bits are outside a valid range.

18.3. SimpleOpenSerial

Synopsis:

```
int SimpleOpenSerial( int portnum, unsigned int baudrate );
```

Description:

This is a macro that opens a serial port with the most common default values for the stop bit (1), data bits (8), and parity (no parity) already provided; all that is required in the call is the UART to open and the configuring baud rate.

The following provides an example between calling the normal `OpenSerial()` function and the `SimpleOpenSerial()` function:

```
int fd = OpenSerial( 0, 115200, 1, 8, eParityNone );
int fd = SimpleOpenSerial( 0, 115200 );
```

Both statements above perform the same operation in configuring UART 0 to operate at 115,200 bps, 1 stop bit, 8 data bits, and no parity, with the difference being that the `SimpleOpenSerial()` already provides the last three parameters by default.

If one needs to use different parameters other than what the last three input parameters provide by default, then the `OpenSerial()` function must be used.

Parameters:

Type	Name	Description
int	`port`	The UART to open; valid values are ‘0’, ‘1’, and ‘2’ (not available on all platforms).
unsigned int	`baudrate`	The speed of the serial port in bits per second.

Returns:

The file descriptor of the initialized port if successful; otherwise, one of the error codes is returned:

- SERIAL_ERR_NOSUCH_PORT (-1)
- SERIAL_ERR_PORT_ALREADYOPEN (-3)

18.4. SerialClose

Synopsis:

```
int SerialClose( int portnum );
```

Description:

This function closes a UART serial port. It is valid to close a serial port that is not open, and allows a port in an unknown state to be closed. Port settings can be changed by closing and reopening the port. The `close`() function can also be used in place of this function.

Parameters:

Type	Name	Description
int	`portnum`	The UART port to close; valid values are ‘0’, ‘1’, and ‘2’ (not available on all platforms).

Returns:

‘0’ if successful; otherwise, one of the following error codes is returned:

- SERIAL_ERR_NOSUCH_PORT (-1)
- SERIAL_ERR_PORT_NOTOPEN (-2)

18.5. SerialEnableTxFlow

Synopsis:

```
void SerialEnableTxFlow( int port, int enab );
```

Description:

Enables or disables software flow control (XON/XOFF) on transmit. The NetBurner device will recognize the special XON and XOFF characters being sent from another device in order to throttle the output when enabled.

Parameters:

Type	Name	Description
int	`port`	The UART whose flow control will be toggled; valid values are ‘0’, ‘1’, and ‘2’ (not available on all platforms).
int	`enab`	‘0’ disables flow control; ‘1’ (or any non-zero number) will enable it.

Returns:

Nothing --- This is a void function.

18.6. SerialEnableRxFlow

Synopsis:

```
void SerialEnableRxFlow( int port, int enab );
```

Description:

Enables or disables software flow control (XON/XOFF) on receive. The NetBurner device will send special XON and XOFF characters to another device in order to control the flow of incoming data when enabled.

Parameters:

Type	Name	Description
int	`port`	The UART whose flow control will be toggled; valid values are ‘0’, ‘1’, and ‘2’ (not available on all platforms).
int	`enab`	‘0’ disables flow control; ‘1’ (or any non-zero number) will enable it.

Returns:

Nothing --- This is a void function.

18.7. SerialEnableHwTxFlow

Synopsis:

```
void SerialEnableHwTxFlow( int port, int enab );
```

Description:

This function enables or disables transmitter hardware flow control for the specified serial port number. The transmitter is throttled via the CTS (Clear-to-Send) input signal line, which would be linked to the RTS (Request-to-Send) output line on the receiver. The transmitter starts sending data to the receiver when it receives a request on its CTS line from the receiver.

Note: Calling this function to disable Tx hardware flow control after enabling RS-485 full-duplex mode configures the port for RS-422 mode (Tx stays actively driven).

Parameters:

Type	Name	Description
int	`port`	The UART whose flow control will be toggled; valid values are ‘0’, ‘1’, and ‘2’ (not available on all platforms).
int	`enab`	‘0’ disables flow control; ‘1’ (or any non-zero number) will enable it.

Returns:

Nothing --- This is a void function.

18.8. SerialEnableHwRxFlow

Synopsis:

```
void SerialEnableHwRxFlow( int port, int enab );
```

Description:

This function enables or disables receiver hardware flow control for the specified serial port number. The receiver controls the flow of incoming data via the RTS (Request-to-Send) output signal line, which would be linked to the CTS (Clear-to-Send) input line on the transmitter. The receiver sets RTS when it is ready to receive data, thereby enabling the transmitter to start sending information to the receiver.

Parameters:

Type	Name	Description
int	`port`	The UART whose flow control will be toggled; valid values are ‘0’, ‘1’, and ‘2’ (not available on all platforms).
int	`enab`	‘0’ disables flow control; ‘1’ (or any non-zero number) will enable it.

Returns:

Nothing --- This is a void function.

18.9. Serial485HalfDupMode

Synopsis:

```
void Serial485HalfDupMode( int port, int enab );
```

Description:

Enables or disables RS-485 half-duplex mode. Full-duplex mode is automatically enabled when half-duplex mode is disabled. This must be explicitly called before RS-485 functionality can be used.

Parameters:

Type	Name	Description
int	port	The UART port to use; the UART that can only be used for RS-485 depends on the platform.
int	enab	‘0’ disables half-duplex (enables full-duplex); ‘1’ enables half-duplex (disables full-duplex).

Returns:

Nothing --- This is a void function.

18.10. SendBreak

Synopsis:

```
void SendBreak( int port, DWORD time );
```

Description:

Sets a break in the UART transmission for a given period of time. The break starts when character transmission completes. The break is delayed until any character in the transmitter shift register is sent. Any character in the transmitter holding register is sent after the break.

Parameters:

Type	Name	Description
int	`port`	The UART whose transmitter will be forced low (start break).
DWORD	`time`	Specifies the amount of time in ticks that the break will hold; when time expires, the break will be stopped; 20 ticks equal 1 second by default.

Returns:

Nothing --- This is a void function.

18.11. serwriteaddress

Synopsis:

```
int serwriteaddress( int fd, const char c );
```

Description:

Sends an address character via the UART port number associated with the given file descriptor. This function can only be utilized if the UART is initialized in multidrop mode.

Parameters:

Type	Name	Description
int	fd	The file descriptor associated with the UART serial port that will be used.
const char	c	The address character to be sent.

Returns:

‘1’ if successful; otherwise, one of the following error codes is returned (note that SERIAL_ERR_PORT_NOTOPEN is also returned if UART is not initialized to be in multidrop mode):

- SERIAL_ERR_NOSUCH_PORT (-1) – The file descriptor is associated with a serial port that does not exist, therefore the file descriptor is invalid.
- SERIAL_ERR_PORT_NOTOPEN (-2) – The file descriptor is associated with a closed serial port.

18.12. GetUartErrorReg

Synopsis:

```
int GetUartErrorReg( int fd );
```

Description:

Gets the UART error register. Any errors are added to this register in a logical OR operation. Calling this function to read the error status will clear the register. The meaning of each bit in the error status register is shown in the table below.

Bit	Description
3	Received break
2	Framing error
1	Parity error
0	Overrun error

Parameters:

Type	Name	Description
int	`fd`	The file descriptor associated with the UART serial port whose error register is to be retrieved.

Returns:

The value of the read error register if successful; otherwise, one of the error codes is returned:

- SERIAL_ERR_NOSUCH_PORT (-1) – The file descriptor is associated with a serial port that does not exist, therefore the file descriptor is invalid.
- SERIAL_ERR_PORT_NOTOPEN (-2) – The file descriptor is associated with a closed serial port.

18.13. GetCD

Synopsis:

```
BOOL GetCD( int port );
```

Description:

This function gets the current state of the Carrier Detect signal from the specified serial port (CB34EX and SB72EX platforms only).

Parameters:

Type	Name	Description
int	port	The UART port whose CD signal will be read.

Returns:

‘TRUE’ if set, ‘FALSE’ if cleared; ‘0’ is returned if port number is invalid.

18.14. GetRI

Synopsis:

```
BOOL GetRI( int port );
```

Description:

This function gets the current state of the Ring Indicator signal from the specified serial port (CB34EX and SB72EX platforms only).

Parameters:

Type	Name	Description
int	port	The UART port whose RI signal will be read.

Returns:

‘TRUE’ if set, ‘FALSE’ if cleared; ‘0’ is returned if port number is invalid.

18.15. GetDSR

Synopsis:

```
BOOL GetDSR( int port );
```

Description:

This function gets the current state of the Data Set Ready signal from the specified serial port (CB34EX and SB72EX platforms only).

Parameters:

Type	Name	Description
int	port	The UART port whose DSR signal will be read.

Returns:

‘TRUE’ if set, ‘FALSE’ if cleared; ‘0’ is returned if port number is invalid.

18.16. SetDTR

Synopsis:

```
void SetDTR( int port, BOOL val );
```

Description:

Sets or clears the Data Terminal Ready signal for the specified serial port.

Parameters:

Type	Name	Description
int	port	The UART port whose DTR signal will be set or cleared.
BOOL	val	The Boolean value to configure the signal; ‘TRUE’ sets it, while ‘FALSE’ clears it.

Returns:

Nothing --- This is a void function.

19. SNMP Library

19.1. Introduction

Simple Network Management Protocol (SNMP) is a system for exposing a number of variables to a Network Management System. These variables are grouped together into SNMP MIB's (Management Information Bases). It is common to underestimate the complexity and time required to implement SNMP for a product. The purpose of this section is to provide a general idea of the complexity and effort required to implement SNMP, and to describe the provisions of the NetBurner SNMP package.

The NetBurner SNMP package is sold as a licensed option only, and is not part of the standard development kit package. Please contact our **Sales** Department to purchase the SNMP package.

SNMP is complex, and the standard NetBurner SNMP package is intended for customers that have a SNMP expert on staff. If you do not know how to use and configure SNMP tools such as SNMPWALK, SNMPGET, and SNMPSET, you **must** acquire that capability before you attempt to implement SNMP on your system. If you do not know what a MIB is and do not know how to write one, you must acquire that capability before you attempt to implement a custom SNMP MIB. For additional information, please read the SNMP FAQ (http://www.faqs.org/faqs/snmpfaq/).

Implementation Requirements

- The Provisions of the NetBurner SNMP Package
- Items Not Included in the NetBurner SNMP Package
- Additional Support for SNMP

A Short Startup Guide for using NetBurner's SNMP Library

- Level 0 - Basic instructions on using the SNMP tools provided with the NetBurner SNMP package
- Level 1 - Enable SNMP at the absolute minimum level without custom MIBs
- Level 2 - A simple custom MIB to set/clear community names and trap destinations

Notes

- Note 1 - Custom tables (no external example code provided)
- Note 2 - Custom community name parsing and protection
- Note 3 - Traps and custom traps

Header File

```
#include <snmp.h>     // Found in C:\Nburn\include
```

Functions

- Snmpget - Get a single SNMP variable
- Snmpgetnext - Get the next variable following the specified variable
- Snmpset - Set a single SNMP variable
- Snmpwalk - Walk the SNMP tree

19.2. SNMP Implementation Requirements

Provisions of the NetBurner SNMP Package

MIB-II (RFC 1213) implementation reports network usage variables from MIB-II. MIB-II is supported 100% with the following exceptions:

- The PPP interface does not support SNMP.
- The ipForwarding variable is read only and set to non-forwarding.
- The ipRouteTable - since the forwarding gateway is fixed; the route table is read only and set to a single value. The table will reflect the current state of the IP connections and routes stored in the ARP table, but it is not writable.
- The egp table and values are not applicable because NetBurner hardware is not a router and does not do egp.

SNMP requires the maintenance and storage of a number of persistent variables

- The methods to set or modify variables such as SysLocation are defined in the MIB-II specification. The mechanisms to set or modify other variables (such as community names and trap destination IP addresses) are not defined and require the implementation of a custom mechanism. NetBurner provides a trivial NetBurner custom MIB to accomplish this task, but it should be part of your custom MIB. You will also have to write code that will take a structure containing this information and store it in nonvolatile memory so the names will be persistent (otherwise the SNMP community names will be hard coded to default values and traps will not be sent.).

Tools for implementing a custom MIB on the NetBurner platform

- The tools provided will parse a custom MIB input file and produce a .CPP output file that implements the MIB. You will be responsible for hand editing this source file to populate the data in the MIB.

Items NOT Included in the NetBurner SNMP Package

The NetBurner SNMP License Package explicitly does **not** provide:

Education on the SNMP protocol and how to use it
Technical support for writing your own custom MIB

Additional Support for SNMP

NetBurner can provide this support on an hourly consulting basis. Given a group of experienced embedded developers with no SNMP knowledge or experience, the effort required to implement a custom SNMP MIB and learn to use the SNMP tools can easily exceed 100 hours of consulting time. In the extreme case of a complex implementation, it can exceed 300 hours. For more information on purchasing this support option, please contact our **Sales** Department.

19.3. Level 0 --- Basic Instructions Using the SNMP Tools

NetBurner provides a set of SNMP tools with its SNMP package. They are intended to assist in your SNMP development, but we consider them to be a convenience and not part of the core SNMP package. It is expected that anyone needing to develop SNMP application will already have some basic SNMP tools in-house. The four functions provided are:

- Snmpget --- Get a single SNMP variable
- Snmpgetnext --- GetNext a single SNMP variable
- Snmpset --- Set a single SNMP variable
- Snmpwalk --- Walk the SNMP tree

The SNMP protocol knows nothing about human readable names. The protocol only knows about variables identified by OIDs (Object Identifiers). For instance, the variable commonly referred to as sysDescr is really the OID 1.3.6.1.2.1.1.1.0.

The protocol on the wire will never know that .1.3.6.1.2.1.1.1.0 is usually called sysDescr. The SNMP tools do all of the translation from OID to human readable names by parsing MIB text files. Important: The NetBurner tools assume that these MIB's are stored in the C:\Nburn\mibs directory.

Caution: By convention, MIBS are never supposed to change. If you change the data stored in a MIB, then you are supposed to release a new MIB with a different OID. The meaning of a single OID and the contents of a specific MIB file, are never supposed to change. This is what the tools expect. This is completely unrealistic for a development environment, and hence developers typically use the following workaround: If you ever change the contents in any of the textual MIB files in the C:\Nburn\mibs directory, you must erase the file .index as that keeps a parsed and cached copy of the MIB information. Otherwise, the changes you made will seem to have no effect.

19.4. Level 1 --- Enable SNMP at the Absolute Minimum Level without Custom MIBs

To enable SNMP at the absolute minimum level (without custom MIBs), you need to do two things:

- Provide system identification information
- Provide storage and recall for the SYSInfo structure

You will find an example of this in your C:\Nburn\examples\snmp\simplesnmp directory.

Providing System Identification Information

Every model of SNMP device is supposed to have a unique system identifier or OID. It is also supposed to have a human readable name. These are reported in the SNMP MIB-II standard variables sysDescr and sysObjectID. To define these constants you must define the following two variables in your application:

```
const char * SYSDESC="NetBurner SNMP Test application";

const char * SYSOID="1.3.6.1.4.1.8174.2.40";
```

The number sequence 1.3.6.1.4.1 is the SNMP tree pointing to the custom MIB area. **Warning: The number sequence 8174 is the Private Enterprise Number uniquely issued to NetBurner.** You should create a SYSOID that starts with 1.3.6.1.4 followed by your own company identifier. **You can obtain an identifier from the Internet Assigned Numbers Authority (http://www.iana.org/protocols/forms.htm).**

Providing Storage and Recall for the SYSInfo Structure

The SNMP system needs to store and recall information that will be nonvolatile. This will usually be done by storing data in the UserFlash area. However, this was not done by default, as it is expected that the Users will probably be using this data area for their own storage structures. This SNMP storage is encapsulated in a SysInfo structure defined in snmp.h (found in C:\Nburn\include):

```
struct SysInfo
 {
   char SysContact[256];
   char SysName[256];
   char SysLocation[256];
   unsigned char ReadCommunity[40];
   unsigned char WriteCommunity[40];
   IPADDR trap_destination;
   DWORD trap_enable_flags;
   DWORD valid;
 };
```

This data is accessed and stored using two user written functions:

```
const SysInfo * GetSysInfo( );    /* Returns a SysInfo structure */

void SetSysInfo( SysInfo si );    /* Saves a SysInfo structure */
```

Note: Simple examples of these functions can be found in C:\Nburn\examples\snmp\main.cpp. If this structure has never been initialized it is suggested that SysContact, SysName, and SysLocation default to either the empty string or to Not Set. The two community names should default to what ever you want your default read and write SNMP community names to be. (Think of community names as passwords.)

19.5. Level 2 --- A Simple Custom MIB to Set/Clear Community Names

SNMP specifies that community names are to be used for access control, but it does **not** specify how they are to be changed. The typical solution is to change them as part of your custom MIB. The example below will create an absolutely trivial custom MIB, and implement the ability to change the community name settings using this MIB. You **will** find a completed version of this project in your C:\Nburn\examples\snmp\nburnmib directory. There are five parts to this process.

1. Writing your Custom MIB

For this example we are going to implement the absolute minimal MIB. You can copy this text into a text file. We will assume that this is named NburnCnameMib.txt for the purposes of this discussion. The full text is shown below.

Beginning of MIB file

```
NBURNSAMPLE-MIB DEFINITIONS ::= BEGIN
IMPORTS
     mgmt, enterprises, IpAddress
        FROM RFC1155-SMI
     OBJECT-TYPE
           FROM RFC-1212;
netburner   OBJECT IDENTIFIER ::= { enterprises 8174 }
READCOMMUNITY OBJECT-TYPE
SYNTAX OCTET STRING (SIZE(1..255))
ACCESS read-write
STATUS mandatory
DESCRIPTION
"Description: ReadCommunity name"
::= {netburner 1}
WRITECOMMUNITY OBJECT-TYPE
SYNTAX OCTET STRING (SIZE(1..255))
ACCESS read-write
STATUS mandatory
DESCRIPTION
"Description: ReadCommunity name"
::= {netburner 2}
TRAPDESTINATION OBJECT-TYPE
SYNTAX IpAddress
ACCESS read-write
STATUS mandatory
DESCRIPTION
"Description: The Trap destination IP address”
::= {netburner 3 }
END
```

End of MIB file

2. Compiling your Custom MIB

The NetBurner SNMP tools provide a utility SNMPTRANSLATE that will convert a custom MIB into a cpp source file to implement the MIB. Important: The MIB requires several inputs, specifically RFC1155-SMI and RFC-1212. Just copy these files from the C:\Nburn\mibs directory to the directory where your custom MIB is located. To do this (copy) from the command line:

```
snmptranslate -M yourmibdir -Tn > yourmibfile.cpp
```

Therefore, the example below generates the cpp file that will be the new custom MIB.

```
snmptranslate -M ./ -Tn > Nburn_Cname_Mib.cpp
```

3. Implementing your Custom MIB Functions

This auto generated file only has the outline for what you want to do, you will need to go everyplace there is a #warning in the file and add your custom code for implementing the actual SNMP variables. In this case there are six functions to fill in:

```
/* Read function prototypes */
     snmp_typeString ReadFuncREADCOMMUNITY();
     snmp_typeString ReadFuncWRITECOMMUNITY();
     snmp_typeIpAddr ReadFuncTRAPDESTINATION();

/* Write function prototypes */
     int WriteFuncREADCOMMUNITY(snmp_typeString var, int bTest);
     int WriteFuncWRITECOMMUNITY(snmp_typeString var, int bTest);
     int WriteFuncTRAPDESTINATION(snmp_typeIpAddr var, int bTest);
```

We want these functions to report and set the variables we have defined. The bodies of these functions can be found in C:\Nburn\examples\snmp\Nburn_Cname_Mib.cpp

Special Note: We normally allow you to read SNMP variables with the read community name, and set them with the write community name. (Think passwords.) However, it would be a bit stupid if we could read the value of the write community name using only a READCOMMUNITY name; so one additional modification is made to the auto generated cpp file. We must change the read permissions of the WRITECOMMUNITY variable from READ_COMMUNITY_MASK to WRITE_COMMUNITY_MASK

4. Add your Custom MIB file to your Project

Now edit your makefile to add the mib cpp file (adding Nburn_Cname_Mib.cpp in the example case.).

5. Add your Custom MIB File to the MIB Tools

The MIB text file you created must be located where the MIB tools can find it. Copy the MIB text file you just created to your C:\Nburn\mibs directory, and delete the .index file (so a new index will automatically be created by the MIB tools). Your new MIB is now ready to be used.

19.6. Note 1 --- Custom Tables

Implementing Tables

The general process for implementing your own custom MIB closely follows the steps outlined in the Level 2. One area that is somewhat different is tables. If you do not already know what an SNMP table is, you need to research the topic before reading this section. When the SNMP translate utility parses a MIB definition for a table, it generates a different set of functions. This will be illustrated with the udpEntry table from MIB-II.

```
/* Function definitions for udpEntry */
void AddTableElementudpEntry( void * data_el, snmp_typeIpAddr
udpLclAddress, snmp_typeINTEGER, udpLocalPort );
void RemoveTableElementudpEntry( void * data_el );
void PutTableElementsudpEntry( SNMP_Request & req, void * data_el, int
subid );
```

These three functions allow you to do three things:

- Add a table entry/element
- Remove a table entry/element
- Provide the values for a table entry/element

The first two functions are completely written by the snmptranslate utility. The final function needs to be filled in by the programmer. The programmer has three responsibilities:

- Call AddTableElementudpEntry when a new UDP table element is created. This **must** include a **(void *) data_el** that encapsulates whatever data is needed to access this element.
- Call RemoveTableElementudpEntry when ever a UDP table element is to be destroyed. **Important:** This **must** include the same **(void *) data_el** passed in when the table was **created**.
- Fill in the code to convert the **(void *) data_el** into the specific MIB variables that make up the table element.

This function as generated by **SNMPTRANSLATE** is shown below:

```
void PutTableElementsudpEntry( SNMP_Request & req, void * data_el, int
subid )
{
switch(subid)
{
case 1: req.put_asn.PutIPAddr ( /* You must provide a conversion
from the data_el for udpLocalAddress */ );
break;
case 2: req.put_asn.PutInt ( /* You must provide a conversion from
the data_el for udpLocalPort */ );
break;
default: req.put_asn.PutNullObject();
}
}
```

The example on the previous page is implemented in the C:\Nburn\system\bcls.cpp and C:\Nburn\system\udp.cpp code set.

Important: At this time, the NetBurner SNMP system does not implement writing to dynamically created table elements. However, table elements can be created using the standard SNMP write variable definitions. If you have a specific need for dynamic writable tables, please contact NetBurner **Support** and we will assist you.

19.7. Note 2 --- Custom Community Name Parsing and Protection

The default NetBurner implementation provides two community names: read and write. It is often desirable to have multiple community names providing multiple levels of access and object visibility.

The NetBurner SNMP implementation can support 32 different access classes. All visibility and access decisions are based on a 32 bit mask. Each SNMP element includes a mask parameter. This is the last element in the variable definitions:

```
SNMPREADFUNC( sysDescr, "1.3.6.1.2.1.1.1.0", ASN_typeString,
ReadFuncsysDescr, READ_COMMUNITY_MASK );
```

The present code defines:

```
     #define READ_COMMUNITY_MASK (0x0001)
     #define WRITE_COMMUNITY_MASK (0x0002)
```

You could easily define an additional mask:

```
     #define CUSTOM_COMMUNITY_MASK (0x0004)
```

To connect these mask values to the community name you would have to write a function to convert community names to mask values, and to place a pointer to that function in the function pointer:

```
     DWORD (*SnmpCommunityDecodeFunc) (const unsigned char * name);
```

Example Code

```
DWORD MyCustomCommunityDecode( const unsigned char cname )
{
if ( strcmp ( cname,”MySecretW0rd” )==0 ) return
CUSTOM_COMMUNITY_MASK;
/* Otherwise return the default community name mask stuff */
return DefaultCommunityDecode( cname );
}
```

Then someplace in your system initialization you will need to setup the function pointer:

```
     SnmpCommunityDecodeFunc=MyCustomCommunityDecode;
```

19.8. Note 3 --- Traps and Custom Traps

The NetBurner SNMP system provides for three types of traps

- Auto generated traps within the SNMP system - The Authentication fail trap and warm start traps are auto generated within the SNMP system at the appropriate times. These traps are sent to the destination defined in the trap_destination variable in the SysInfo structure (the same structure that maintains community names).

- Basic predefined traps without additional variables as generated by the application code - If you pass in a destination of 0; it uses the value stored in the SysInfo structure for trap_destination. This is done with the following function:

  ```
  SnmpBasicTrap( IPADDR dest, const char * community_name,
                 int generic_trap, int specific_trap );
  ```

- Custom traps with additional OID values attached - This feature uses the function:

```
void SnmpTrapWithData       /* As defined in snmp.h */
```

Important: This requires that you write a call-back function that will actually put the variables into the trap.

Example Code

```
/* The callback function that fills in extra varbind defined in
your custom trap variables */
void TrapVarFunction(ASN * put_asn)
{
  put_asn->PutHeader(0x30); /* Var Bind */
  put_asn->PutOidFromString("1.3.6.1.4.1.8174.1");
  put_asn->PutOctetString("This is test message number 1");
  put_asn->FixUpHeader(); /* Var Bind */
  put_asn->PutHeader(0x30); /* Var Bind */
  put_asn->PutOidFromString("1.3.6.1.4.1.8174.2");
  put_asn->PutOctetString("This is test message number 2");
  put_asn->FixUpHeader(); /* Var Bind */
}
/* The function that actually sends the trap */
void SendTestTrap()
{
   SnmpTrapWithData(0, "public", SNMP_ENTERPRISE_TRAP, 1, TrapVarFunction);
}
```

19.9. Snmpget

Usage:

```
Snmpget device_address community_name object_name
```

Description:

This function gets a single SNMP variable.

Parameters:

Name	Description
device_address	The device IP Address (e.g. 10.1.1.77) or DNS name.
community_name	The community name used to access the device. (The rough equivalent of a password.)
object_name	The textual or OID name of the object to be retrieved.

Examples:

```
Snmpget 10.1.1.77 public sysDescr.0
Snmpget 10.1.1.77 public .1.3.1.2.1.1.1.0
```

19.10. Snmpgetnext

Usage:

```
Snmpgetnext device_address community_name object_name
```

Description:

This function gets the **next** variable **following** the **specified** variable. The entire MIB of a device could be obtained by executing a getnext on .1.3.1 followed by a getnext on each returned variable. Essentially, this would walk down the entire MIB tree the same way as Snmpwalk.

Parameters:

Name	Description
device_address	The device IP Address (e.g. 10.1.1.77) or DNS name.
community_name	The community name used to access the device. (The rough equivalent of a password.)
object_name	The textual or OID name of the object preceding the object to be retrieved.

Examples:

```
Snmpgetnext 10.1.1.77 public sysDescr
Snmpgetnext 10.1.1.77 public .1.3.1.2.1.1.1
```

19.11. Snmpset

Usage:

```
Snmpset device_address community_name object_name object_type
```

Description:

This function sets a single SNMP variable.

Parameters:

Name	Description
device_address	The device IP Address (e.g. 10.1.1.77) or DNS name.
community_name	The community name used to access the device. (The rough equivalent of a password.)
object_name	The textual or OID name of the object to be set.
object_type	The type of the object. (See the “Types” description below.)

Types:

One of: i, u, t, a, o, s, x, d, n

i --- INTEGER
u --- unsigned INTEGER
t --- TIMETICKS
a --- IPADDRESS
o --- OBJID
s --- STRING
x --- HEX STRING
d --- DECIMAL STRING
U --- unsigned int64
I --- signed int64
F --- float
D --- double

Example:

```
Snmpset 10.1.1.77 public sysLocation.0 s “At NetBurner HQ”
```

19.12. Snmpwalk

Usage:

```
Snmpwalk device_address community_name
```

Description:

This function walks the SNMP tree. Essentially it does a repetitive getnext until it runs out of SNMP variables to retrieve.

Parameters:

Name	Description
device_address	The device IP Address (e.g. 10.1.1.77) or DNS name.
community_name	The community name used to access the device. (The rough equivalent of a password.)

Example:

```
Snmpwalk 10.1.1.77 public
```

20. SSL Library

20.1. Introduction

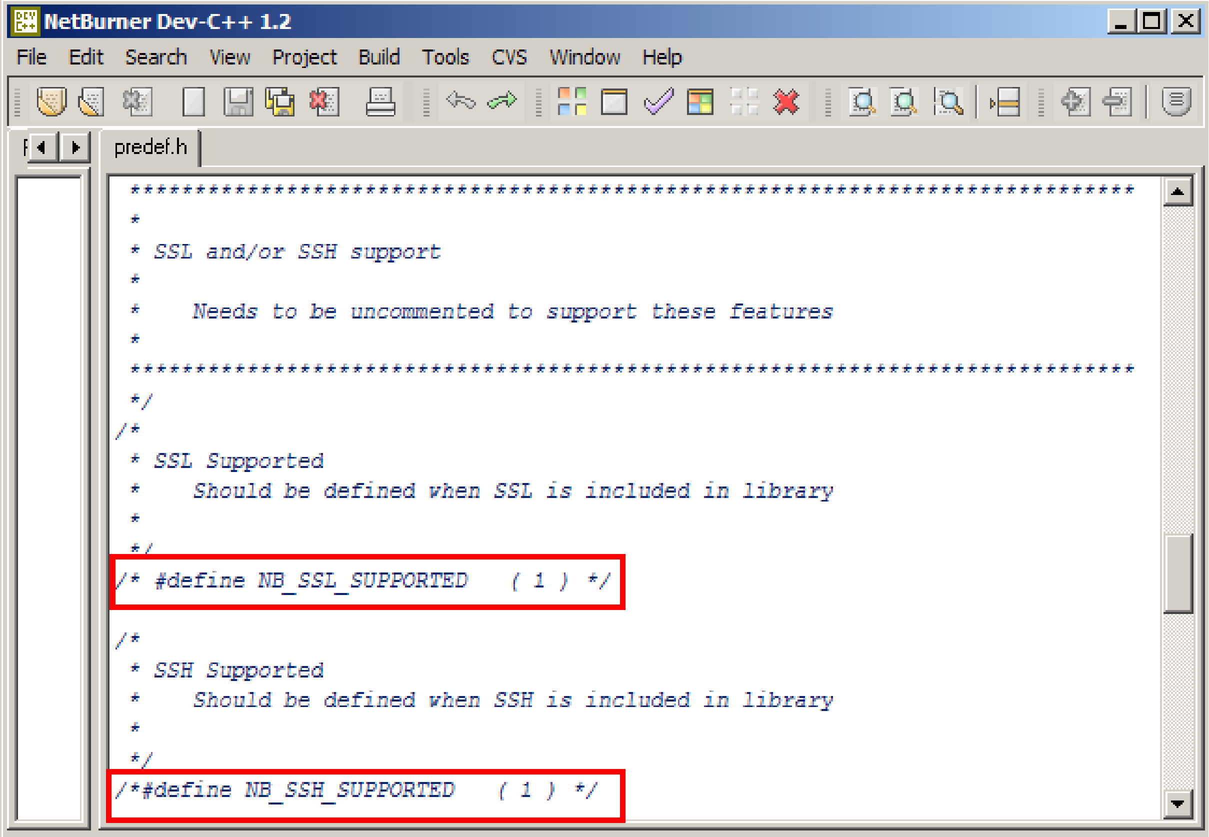
The NetBurner SSL package is sold as a licensed option only, and is not part of the standard development kit package. Please contact our **Sales** Department to purchase the SSL package.

Implementing SSL in an embedded system will require some knowledge of SSL certificates. Please read the following four SSL sections:

- Easy SSL overview
- Creating SSL server certificates
- Diagram: Creating a code module - SSL Server Key and Certificates
- Creating the list of acceptable client certificates

You cannot skip these documents. Before you can use the SSL accept function, you will need to add a Server certificate to your project. Before you can use the SSL connect function, you will need to add a list of Client certificates to your project.

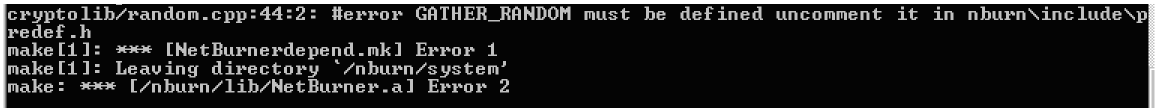
Important: Before you compile any programs, open up predef.h (located in C:\Nburn\include) with any text editor, and uncomment “#define NB_SSL_SUPPORTED and “#define NB_SSH_SUPPORTED” to get your applications to compile when using the NetBurner SSL Module. After editing predef.h (i.e. uncomment the mentioned lines), you must execute the make clean command (at the command line) in your C:\Nburn\system directory.



```
 *****************************************************************************
 *
 * SSL and/or SSH support
 *
 *    Needs to be uncommented to support these features
 *
 *****************************************************************************
 */
/*
 * SSL Supported
 *    Should be defined when SSL is included in library
 *
 */
/* #define NB_SSL_SUPPORTED    ( 1 ) */

/*
 * SSH Supported
 *    Should be defined when SSH is included in library
 *
 */
/*#define NB_SSH_SUPPORTED    ( 1 ) */
```

Warning: If you do not edit predef.h, your applications will not compile – you will get a make error as shown below (DOS Command line compilation).



```
cryptolib/random.cpp:44:2: #error GATHER_RANDOM must be defined uncomment it in nburn\include\p
redef.h
make[1]: *** [NetBurnerdepend.mk] Error 1
make[1]: Leaving directory `/nburn/system'
make: *** [/nburn/lib/NetBurner.a] Error 2
```

Header File

```
#include <ssl.h>        // Found in C:\Nburn\include\crypto
```

SSL Server Functions

-
- StartHTTPs --- Starts the secure Web Server
-
- SSL_accept --- SSL mirror of the TCP accept function
-
-

File Descriptor (fd) Information Functions

- IsSSLfd --- Is the file descriptor an SSL file descriptor or some other kind
-
- SSL_GetSocketRemoteAddr --- Returns the remote address of this connected socket
-
- SSL_GetSocketRemotePort --- Returns the remote port of this connected socket
-
- SSL_GetSocketLocalAddr --- Returns the local address of this connected socket
-
- SSL_GetSocketLocalPort --- Returns the local port of this connected socket
-

Socket Option Functions

-
- SSL_setsockoption --- Set the socket option
-
- SSL_clrsockoption --- Clear the socket option
-
- SSL_getsockoption --- Get the socket option

SSL Client Function

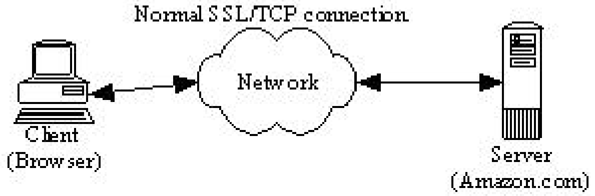
- SSL_connect --- SSL mirror of the TCP connect call

20.2. SSL Overview

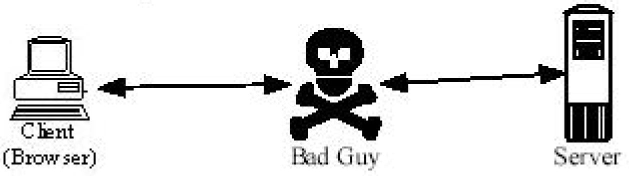
The NetBurner SSL library makes SSL as easy as it can be, but SSL requires a system of trusted certificates. The NetBurner SSL package is sold as a licensed option only, and is not part of the standard development kit package. Please contact our Sales Department if you want to purchase the SSL package.

When you use SSL to connect to http://www.amazon.com (for example) with a normal web browser, you will not need to know anything about certificates. This is because Amazon purchased a certificate from Verisign and your browser vendor preinstalled Verisign, as an entity that can sign trusted certificates.

If you know all there is to know about the whys and hows of certificates you can skip ahead to the section on installing certificates in your NetBurner based product. For the vast majority of the embedded developers, certificates will need a bit more explanation.



Above, is a picture of a perfectly normal TCP or SSL connection; the client (most often a browser) has connected through the network to a server. If we do **not** have any entities doing bad things on our network then there is **no** need for SSL. However, if the data we are sending is worth stealing, we might have a very different network picture (below).



If our connection is routed through a third party (a normal TCP connection), we have no guarantee that this third party is not a "bad guy" trying to steal or modify our data. The SSL protocol was designed to eliminate this man in the middle attack. SSL is designed not only to make sure that the data we send over the network is hidden from snooping eyes, but it is also designed to make sure we are connected to the proper server without any "bad guys" in the middle. This verification is done with Public Key (PK) Cryptography and a hierarchy of trust.

Why do we trust a doctor when we go to the emergency room? We trust the doctor we have never met because we trust the hospital to employ qualified doctors. The hospital vouches for his skills and we trust the hospital. His medical school also vouches for him by giving him a diploma with his name and the schools seal or signature. We trust the school, we trust the hospital, and thus we trust the doctor.

SSL works in a very similar way. When a client connects to the server the server sends the client a certificate. This certificate has three major elements:

A name (i.e. who is this server)

A public key (e.g. think of an open padlock)
A signature (by a trusted third party that vouches for the name and the public key)

A doctor's diploma is very similar; it also has three major elements: The doctor's name, the type of degree and the medical school (that vouches for the doctor). For example, Bob and George both graduate from Harvard Medical School. They both have Harvard diplomas. However, the diplomas are unique to each doctor. The diplomas are not interchangeable. Bob's diploma would be of no use to George and vice versa. This illustrates the first key point about SSL.

Key Point # 1: Each and every SSL server must have a unique certificate. Note: You cannot reuse an SSL server certificate. The certificates are distinguished by the "common name" or "CN" on the certificate.

If you went into a new doctor's office and saw a diploma from Harvard medical school, you would feel comfortable with the doctor's skills. You trust Harvard and Harvard will vouch for this doctor. If instead, the diploma were from the Medical School of Zaire, you would probably be more skeptical. We do not have the same inherent trust of this school as we did with Harvard.

In SSL as a client, we have to decide who we will trust to sign our certificates. This list of trusted certificate authorities must be explicitly configured into the client. When the web browser or OS was installed on your PC, it probably installed a list of trusted certificate authorities. With the NetBurner SSL library, we have to explicitly decide whom we are going to trust to sign server certificates. This leads to key point #2.

Key Point # 2: An SSL client must be pre-configured with a list of Certificate Authorities (CAs) that it will trust to sign server certificates. This list can be common across all the clients and does not have to be unique.

What do I need to do to make SSL work?

- You **must** create or choose a certificate authority. **Note:** If you **create** a certificate authority, you **will** also have to create a set of public/private keys for this authority.
- You **must** create public/private keys and a certificate for **each** SSL server and have the certificate **signed** by the certificate authority you have chosen.
- You **must** configure the clients with the **list** of certificate authorities it should **trus**t.

How do I find or create a certificate authority?

Using the medical school example, you can go to Harvard pay lots of $$$ and get a diploma that is trusted by everyone. You can also choose to start your own medical school and issue diplomas. Almost everyone in the world would trust a Harvard diploma. Almost no one will trust a "Bob's Medical School" diploma, unless you spend the time convincing them that it is a quality medical school. In the end, you will likely only be able to convince your family, and then only for non-life threatening needs.

SSL certificates are a lot like medical schools; you can go and purchase server certificates. To see what a certificate looks like, open your web browser (e.g. Internet Explorer), and connect to https://www.NetBurner.com (notice the s on the end of https). On Internet Explorer's menu, choose File then Properties. Now, click the Certificates button, and look at all the tabs shown in this section.

How do I know whom my browser trusts?

On your (Internet Explorer) browser's menu - choose Tools then Internet Options. Open the Content tab, click the Certificates button, and open the Trusted Root Certificate Authorities tab. Add Verisign or Thawte and every browser in the world will trust your certificate and your server.

If you want to save some money and create your own certificate authority then you can do so. However, none of the clients will accept your certificate until you convince them to add "Bob’s Certificate Authority" to their list of trusted certificate authorities. If, the users using the embedded SSL system you are deploying are all in one business entity, then it is relatively simple to add your own certificate authority to the list of trusted authorities. If you are responsible for both the client and server end of the connection, it is even easier; you can configure the clients to accept a single server authority - yours.

SSL is based on Public Key Cryptography (PK) and a little bit of background on PK is necessary in order to deploy a secure SSL solution. Public Key Cryptography is different from Symmetric Key Cryptography. In PK, the keys used for encryption are broken into two parts, much like a padlock (the public part) and a key (the private part). If you give someone an open padlock and a steel box, they can put things into the box, close the lid, and lock the lock. Unless they have the key to the lock, they cannot open the box. They can be confident that if they mail you the box, none of the mailmen along the way can look inside. Only the person who holds the (private) key to the padlock can open the box. For additional information on Public Key Cryptography, please read the Cryptography FAQ (http://isc.faqs.org/faqs/cryptography-faq)

When the SSL client connects to a server, the server sends back a certificate with a public key (open padlock). This certificate also includes the name of the server and a signature vouching for both the public key and the name. If any part of the certificate is changed, the signature will compute to be invalid.

So, if we have a "bad guy" in the middle, he can watch the padlock going from the server to the client. But, when the client puts his secret information into the box and locks it, the "bad guy" cannot see inside. He only knows that the client sent something in the box to the server. The secrets in the box are safe from the prying eyes of the "bad guy". This safety only exists if the server has done a good job of protecting the private key. If the "bad guy" sneaks into the server room, logs on the server console, and makes a copy of the private key, he can intercept all of the traffic. He can also change the content at will. This leads to key point #3.

Key Point # 3: When using Public Key Cryptography (as SSL does), the system is only as secure as the security of the private key. Since a server needs access to the private key to unlock the data from the client, the private key must exist on the server.

Key Point # 3 Corollary: If the private key exists on the server, then the system is only as secure as the physical security of the server. If the server is not physically secure, then someone (i.e. the “bad guy”) can attach an emulator or other hardware to the server and read out the private key.

For example, suppose the "bad guy" wants to intercept your credit card number when you send it to Amazon to order a book. We have already shown that he cannot read the data unless he has Amazon's private key. However, he has one other option - he can pretend to be Amazon and offer his own certificate to you, the client. If this certificate is properly signed by a Certificate Authority the client trusts, then client will accept the connection. If any "Certificate Authority" in the list of trusted authorities is compromised, then the system is insecure. If the "bad guy" has the ability to add a new "Certificate Authority" to the client, then he can completely compromise the system. This leads to key point #4.

Key Point # 4: If the ability to add a "Certificate Authority" to the client’s list of trusted authorities is not secure, then system is not secure.

Key Point # 4 Corollary: If the list of trusted "Certificate Authorities" exists on the client, then the system is only as secure as the physical security of the client. If the client is not physically secure, then someone (i.e. the “bad guy”) can attach an emulator or other hardware to the client and add a "trusted" authority.

These last two key points imply that it is not possible to build a system that is more secure than the physical security of the device being secured. Important: All the cryptography in the world will not help if someone can gain access to your computer and hide a bug inside the keyboard; or even easier, add or modify a system file to record your keystrokes and periodically send them over the internet to some nefarious foe. Note: If your data is valuable enough to be attractive to a skilled adversary, then you must learn to be truly paranoid.

Recommended Reading

For an excellent overview of computer security

- Secrets and Lies by Bruce Schneier (ISBN 0-471-25311-1)

For a detailed review of cryptography

- Applied Cryptography by Bruce Schneier (ISBN 0-471-11709-9)

For a detailed description of the SSL protocol

- SSL and TLS by Eric Rescorla (ISBN 0-201-61598-3)

For a reference on the math and methods in cryptography (this is a heavy duty book):

- Handbook of Applied Cryptography by Menezes, Oorschot and Vanstone (ISBN 0-8493-8523-7)

20.3. Creating a Code Module for SSL Server Certificates

Introduction

The NetBurner SSL library provides some open source tools for the generation and maintenance of SSL keys and certificates. These key and certificate management tools are based on the fine openssl package available from http://www.openssl.org. These tools are subject to the openssl License. The embedded SSL library code is derived from other sources and is subject to the standard NetBurner License (located by default in C:\Nburn\docs)

Setting up the Environment

Important: Before you can perform any of these steps, you **must** set up the environment.

- Make sure the **openssl.exe** provided with the NetBurner SSL Library is in your path (by default it installs in **C:\Nburn\pcbin**)
-
- Make sure you have **edited the openssl.cnf file in C:\Nburn\ssl\config** to have the appropriate entries for your business
-
- Make sure that your system environment has the variable OPENSSL_CONF= <your path >\openssl.cnf

Creating a Certificate Authority (CA)

This step creates a CA you can use to sign SSL server certificates. **Important**: You should only have to do this step once. The key file created in this step should be protected as the security of all your SSL Certificates depends on it. You have two choices to protect this key file.

You can use a pass phrase to encode it

You can leave it unencoded to protect the computer it is stored on

Note: If you want the key to **not** be **protected** by a pass phrase then **leave** the **–des off** the **genrsa** command.

- Open a command prompt/DOS window
- Navigate to the directory you want to house your CA files
- To make a CA Key file, execute the command (and press the Enter key when finished):

```
openssl genrsa –out CA.key –des
```

- Create a CA Certificate, by executing the command (and press the Enter key when finished):
-

```
openssl req -new -key CA.key -x509 -days 3650 -out CA.crt
```

You will be prompted to answer some identification questions. How you answer them is up to you, but when creating a NetBurner CA we answered these questions as follows:

Country Name: US
State or Province: California
Locality: San Diego
Organization Name: NetBurner
Organizational Unit Name: Certificate Authority
Common Name: NetBurner CA

If you are going to be accessing the embedded SSL device via a web browser you will need to add this Certificate to your web browser's list of trusted certificate authorities. To do this for Internet Explorer:

- Open up your Internet Explorer web browser
- From the Tools menu go into the Internet Options section
- Select the Content tab
- Press the Certificates button
- Select the Trusted Root Certification Authorities tab
- Press the Import button
- Select the CA.crt file to import. (Note: It will not show up via the browse button unless you change the file type combo box at the bottom of the window to look for X509 certificate files.)

Creating a Server Key

You will need to create a server key for each SSL Server you intend to deploy. If you are deploying many SSL servers, the bookkeeping associated with this will not be trivial.

- Open a command prompt/DOS window
-
- Navigate to the directory you want to house your device files
-
- To make a Device Key file, execute the command (and press the Enter key when finished):

```
openssl genrsa –out devicename.key
```

You will need to keep track of this key file while you make a server certificate, as the two have to be matched. If you are creating your own certificates, you can create a big batch file that does all of the steps in a single execution. See the batch file in Appendix I.

Creating a Server Certificate with your CA

You will need to create a server certificate for each SSL Server you intend to deploy. If you are deploying many SSL Servers, the bookkeeping associated with this will not be trivial. The common name you enter in this step must match the deployed DNS name or the IP Address of the Server it will be used on.

- Open a command prompt/DOS window
-
- Navigate to the directory that you want to house your device files
-
- To make a Device Certificate Request file, execute the command (and press the Enter key when finished):

```
openssl req -new -key devicename.key -out devicename.csr
```

- To make a Device Certificate, execute the command (**all on one line**) and press the "Enter" key when finished:

```
openssl x509 -req -days 365 -in devicename.csr –CA CA.crt -CAkey CA.key -
CAcreateserial -out device.crt
```

You can combine the creation of server keys, certificates, and code by running the batch file shown in Appendix I (at the end of this section).

Converting a Certificate and Key to Code

This step takes both the private Server Key and the Server Certificate and converts them into a CPP source code module that can be linked into your application. This implies that you need to generate a different application image for each of your servers.

- Open a command prompt/DOS window
-
- Navigate to the directory that you want to house your device files
-
- To make a Device CPP file with the key in it, execute the command (and press the Enter key when finished):

```
openssl rsa -in devicename.key -nburn –out devicename.cpp
```

- To add the Certificate to the CPP file, execute the command (and press the Enter key when finished):

```
openssl x509 -nburn -in devicename.crt –append devicename.cpp
```

Adding the Module to your Code Set

Take the devicename.cpp file previously created and add it to your makefile.

Create a Server Certificate for External CA

If you are going to have your certificates signed by an external entity, they will **need** a Certificate Request file. **Note:** The common name you enter in this step **must** match the deployed DNS name or IP Address of the Server it will be used on.

- Open a command prompt/DOS window
-
- Navigate to the directory that you want to house your device files
-
- To make a Device Certificate Request file, execute the command (and press the Enter key when finished):

```
openssl req -new -key devicename.key -out devicename.csr
```

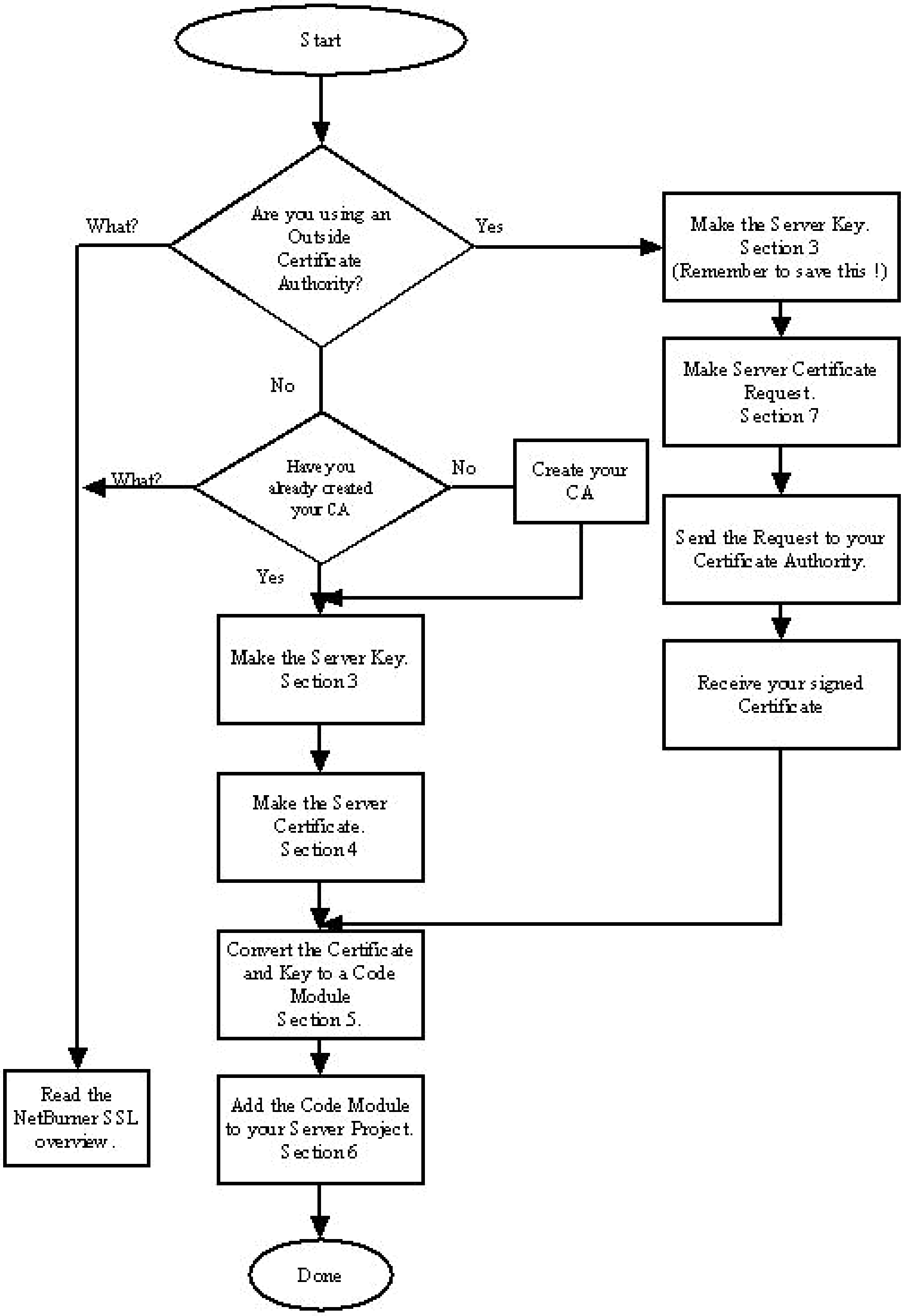
- Send this devicename.csr to the CA that will create your certificate.

Warning: If you lose the devicename.key file associated with this particular device, then you will not be able to use the certificate file they send back.

Appendix I - A Device Creation DOS Batch File

```
REM contents of makedev.bat
REM usage is makedev devicename
openssl genrsa -out %1.key
openssl req -new -key %1.key -out %1.csr
openssl x509 -req -days 365 -in %1.csr -CA CA.crt -CAkey CA.key -
CAcreateserial -out %1.crt
openssl rsa -in %1.key -nburn -out %1.cpp
openssl x509 -nburn -in %1.crt -append %1.cpp
```

20.4. Creating a Code Module - SSL Server Key & Certificate - Diagram


Start
Are you using an Outside Certificate Authority?
What?
Yes
No
Make the Server Key. Section 3 (Remember to save this !)
Make Server Certificate Request. Section 7
Send the Request to your Certificate Authority.
Receive your signed Certificate
Have you already created your CA
What?
No
Yes
Create your CA
Make the Server Key. Section 3
Make the Server Certificate. Section 4
Convert the Certificate and Key to a Code Module Section 5.
Add the Code Module to your Server Project. Section 6
Read the NetBurner SSL overview .
Done

20.5. Creating a Code Module for SSL Client Certificates

Introduction

The NetBurner SSL library provides some open source tools for the generation and maintenance of SSL Keys and Certificates. These key and certificate management tools are based on the fine **openssl package** available from **http://www.openssl.org**. These tools are subject to the **openssl License**.

The **embedded SSL Library code** is derived from other sources and is subject to the standard **NetBurner license** (a copy is in your **C:\Nburn\docs** directory) that holds a list of certificate authorities that will be acceptable signers for SSL client connections.

Determining what Certificates you need

If you do not know what certificates are needed you should read the Easy SSL Overview document in this section. You want to include the certificates from the CA(s) that will be signing the server certificates that your SSL client will be connecting to.

Testing your Certificates

For each CA you want to trust you **need** to obtain a certificate. These certificates should be in the **X509 format** with the extension .crt (see RFC 3280). General purpose **openssl documents** can be found at: **http://www.openssl.org**. To test your certificate:

- Make sure the **openssl.exe** provided with the NetBurner SSL library is in your path (by default it installs in **C:\Nburn\pcbin**)
-
- Open a command prompt/DOS window in your project directory
-
-
- Execute the command (and press the Enter key when finished):
-
- **`openssl x509 –in yourcert.crt –text`**
-
- This command should dump the cert contents
-
- If this command **fails** then you **will** need to **convert** the format. **Note:** One way to do this is to use the **openssl tools**
-
- Certificates can be in DER, NET and/or PEM formats. **Warning:** **We need the Certificates to be in the PEM format.** To convert a Certificate **from DER to PEM**, just execute the following command (and press the Enter key when finished):

```
openssl x509 -inform der -in server_cert.crt –out server_cert_in_pem.crt
```

Creating a CA List file

This step creates a cpp file that holds all of the CA certificates you will accept. To create a CA List file:

- Open a command prompt/DOS window in your project directory
-
- Execute the command (and press the Enter key when finished):
-
-
  ```
  openssl x509 –out ccerts.cpp -nburnccerts cerfile1 cerfile2
  ...lastcertfile
  ```
-
- This command should build the file ccerts.cpp (Important: Make sure that this file (ccerts.cpp) has all of your certs in it.)
-
- Add this file to your project's makefile

20.6. StartHTTPs

Synopsis:

```
void StartHTTPs( WORD ssl_port=443, WORD http_port=80 );
```

Description:

This function starts the secure web server.

Parameters:

Type	Name	Description
Word	ssl_port=443	Port 443 is the standard HTTPS port.
Word	http_port=80	Port 80 is the standard HTTP Server port.

Returns:

Nothing --- This is a void function

20.7. SSL_accept

Synopsis:

```
int SSL_accept( int fdListen, IPADDR * address, WORD * port,
                WORD timeout );
```

Description:

This call is a mirror of the TCP accept call.

Parameters:

Type	Name	Description
int	fdListen	The file descriptor of the TCP listening socket.
IPADDR	*address	The IPADDR variable to hold the address of the connecting computer.
WORD	*port	The WORD variable to receive the remote port of this connection.
WORD	timeout	The number of ticks to wait for a connection.

Return Values:

> 0 --- The file descriptor of the connected SSL socket
TCP_ERR_TIMEOUT --- Underlying TCP system timed out
TCP_ERR_NOCON --- The underlying TCP connection failed to negotiate
TCP_ERR_CLOSING --- The underlying TCP fd was closing
TCP_ERR_NOSUCH_SOCKET --- The fd listen socket was invalid
TCP_ERR_NONE_AVAIL --- No free sockets to return
TCP_ERR_CON_RESET --- The connection was reset by the remote device
TCP_ERR_CON_ABORT --- The connection was aborted by the remote device
SSL_ERROR_FAILED_NEGOTIATION --- The SSL system failed to successfully negotiate a connection
SSL_ERROR_HASH_FAILED --- The connection failed the startup hash test
SSL_ERROR_WRITE_FAIL --- The connection failed to write out a full record

20.8. IsSSLfd

Synopsis:

```
BOOL IsSSLfd( int fd );
```

Description:

This Boolean function is used to determine if the fd (file descriptor) is an SSL connection (i.e. Is the file descriptor an SSL FD or some other kind?). It can be used by things like the callback functions of the web server to determine how secure the fd is before sending sensitive information over it.

Parameters:

Type	Name	Description
int	fd	The file descriptor to test.

Return Values:

TRUE --- If it is an SSL file descriptor
FALSE --- If it is not an SSL file descriptor, or on error

20.9. SSL_GetSocketRemoteAddr

Synopsis:

```
IPADDR SSL_GetSocketRemoteAddr( int fd );
```

Description:

This function returns the remote address of this connected socket. This function is used to retrieve the remote address of an SSL fd. This function will also work correctly if you pass in a fd that is a TCP connection. This allows you to use one set of code for both normal TCP and SSL connections.

Parameters:

Type	Name	Description
int	fd	The file descriptor to test.

Return Values:

remote ---The IP Address of the TCP or SSL connection
0 --- Otherwise

20.10. SSL_GetSocketRemotePort

Synopsis:

```
WORD SSL_GetSocketRemotePort( int fd );
```

Description:

This function returns the remote port of this connected socket. This function is used to retrieve the remote port of an SSL fd. This function will also work correctly if you pass in a fd that is a TCP connection. This allows you to use one set of code for both normal TCP and SSL connections.

Parameters:

Type	Name	Description
int	fd	The file descriptor to test.

Return Values:

remote --- The port number of the TCP or SSL connection
0 --- Otherwise

20.11. SSL_GetSocketLocalAddr

Synopsis:

```
IPADDR SSL_GetSocketLocalAddr( int fd );
```

Description:

This function returns the local address of this connected socket. This function is used to retrieve the local address of an SSL fd. This function will also work correctly if you pass in a fd that is a TCP connection. This allows you to use one set of code for both normal TCP and SSL connections.

Parameters:

Type	Name	Description
int	fd	The file descriptor to test.

Return Values:

local --- The IP address of the TCP or SSL connection
0 --- Otherwise

20.12. SSL_GetSocketLocalPort

Synopsis:

```
WORD SSL_GetSocketLocalPort( int fd );
```

Description:

This function returns the local port of this connected socket. This function is used to retrieve the local port of an SSL fd. This function will also work correctly if you pass in an fd that is a TCP connection. This allows you to use one set of code for both normal TCP and SSL connections.

Parameters:

Type	Name	Description
int	fd	The file descriptor to test.

Return Values:

local ---The port number of the TCP or SSL connection
0 --- Otherwise

20.13. SSL_setsockoption

Synopsis:

```
int SSL_setsockoption( int fd, int option );
```

Description:

This function will set the socket option.

Parameters:

Type	Name	Description
int	fd	The file descriptor to test.
int	option	The socket option.

Returns:

> 0 --- The file descriptor of the connected SSL socket
TCP_ERR_TIMEOUT --- Underlying TCP system timed out
TCP_ERR_NOCON --- The underlying TCP connection failed to negotiate
TCP_ERR_CLOSING --- The underlying TCP fd was closing
TCP_ERR_NOSUCH_SOCKET --- The fd listen socket was invalid
TCP_ERR_NONE_AVAIL --- No free sockets to return
TCP_ERR_CON_RESET --- The connection was reset by the remote device
TCP_ERR_CON_ABORT --- The connection was aborted by the remote device
SSL_ERROR_FAILED_NEGOTIATION --- The SSL system failed to successfully negotiate a connection
SSL_ERROR_HASH_FAILED --- The connection failed the startup hash test
SSL_ERROR_WRITE_FAIL --- The connection failed to write out a full record
SSL_ERROR_CERTIFICATE_UNKNOWN SSL --- Received a certificate it could not decode
SSL_ERROR_CERTIFICATE_NAME_FAILED The connected name did not match common_name
SSL_ERROR_CERTIFICATE_VERIFY_FAILED --- The server returned a certificate that we did not trust

20.14. SSL_clrsockoption

Synopsis:

```
int SSL_clrsockoption( int fd, int option );
```

Description:

This function will clear the socket option.

Parameters:

Type	Name	Description
int	fd	The file descriptor to test.
int	option	The socket option.

Returns:

> 0 ---The file descriptor of the connected SSL socket
TCP_ERR_TIMEOUT --- Underlying TCP system timed out
TCP_ERR_NOCON --- The underlying TCP connection failed to negotiate
TCP_ERR_CLOSING --- The underlying TCP fd was closing
TCP_ERR_NOSUCH_SOCKET --- The fd listen socket was invalid
TCP_ERR_NONE_AVAIL --- No free sockets to return
TCP_ERR_CON_RESET --- The connection was reset by the remote device
TCP_ERR_CON_ABORT --- The connection was aborted by the remote device
SSL_ERROR_FAILED_NEGOTIATION --- The SSL system failed to successfully negotiate a connection
SSL_ERROR_HASH_FAILED The connection failed the startup hash test
SSL_ERROR_WRITE_FAIL The connection failed to write out a full record
SSL_ERROR_CERTIFICATE_UNKNOWN SSL --- Received a certificate it could not decode
SSL_ERROR_CERTIFICATE_NAME_FAILED --- The connected name did not match common_name
SSL_ERROR_CERTIFICATE_VERIFY_FAILED --- The server returned a certificate that we did not trust.

20.15. SSL_getsockoption

Synopsis:

```
int SSL_getsockoption( int fd );
```

Description:

This function will get the socket option.

Parameters:

Type	Name	Description
int	fd	The file descriptor to test.

Returns:

> 0 --- The file descriptor of the connected SSL socket
TCP_ERR_TIMEOUT --- Underlying TCP system timed out
TCP_ERR_NOCON --- The underlying TCP connection failed to negotiate
TCP_ERR_CLOSING --- The underlying TCP fd was closing
TCP_ERR_NOSUCH_SOCKET --- The fd listen socket was invalid
TCP_ERR_NONE_AVAIL --- No free sockets to return
TCP_ERR_CON_RESET --- The connection was reset by the remote device
TCP_ERR_CON_ABORT --- The connection was aborted by the remote device
SSL_ERROR_FAILED_NEGOTIATION --- The SSL system failed to successfully negotiate a connection
SSL_ERROR_HASH_FAILED --- The connection failed the startup hash test
SSL_ERROR_WRITE_FAIL --- The connection failed to write out a full record
SSL_ERROR_CERTIFICATE_UNKNOWN SSL --- Received a certificate it could not decode
SSL_ERROR_CERTIFICATE_NAME_FAILED --- The connected name did not match common_name
SSL_ERROR_CERTIFICATE_VERIFY_FAILED --- The server returned a certificate that we did not trust

20.16. SSL_connect

Synopsis:

```
int SSL_connect( IPADDR ip, WORD local_port, WORD remote_port,
                 DWORD timeout, const char * common_name );
```

Description:

This call is a mirror of the TCP connect call.

Parameters:

Type	Name	Description
IPADDR	ip	The address to connect to.
WORD	local_port	The local port to use. **Note:** 0 will pick a local port.
WORD	remote_port	The port to connect to.
DWORD	timeout	The number of ticks to wait for a connection.
const char	*common_name	The command name to use for checking certificate validity. **Note:** Passing in NULL will accept any connection.

Return Values:

> 0 ---The file descriptor of the connected SSL socket
TCP_ERR_TIMEOUT --- Underlying TCP system timed out
TCP_ERR_NOCON --- The underlying TCP connection failed to negotiate
TCP_ERR_CLOSING --- The underlying TCP fd was closing
TCP_ERR_NOSUCH_SOCKET --- The fd listen socket was invalid
TCP_ERR_NONE_AVAIL --- No free sockets to return
TCP_ERR_CON_RESET --- The connection was reset by the remote device
TCP_ERR_CON_ABORT --- The connection was aborted by the remote device
SSL_ERROR_FAILED_NEGOTIATION --- The SSL system failed to successfully negotiate a connection
SSL_ERROR_HASH_FAILED --- The connection failed the startup hash test
SSL_ERROR_WRITE_FAIL --- The connection failed to write out a full record
SSL_ERROR_CERTIFICATE_UNKNOWN SSL --- Received a certificate it could not decode
SSL_ERROR_CERTIFICATE_NAME_FAILED --- The connected name did not match common_name
SSL_ERROR_CERTIFICATE_VERIFY_FAILED --- The server returned a certificate that we did not trust

21. Stream Update Library

21.1. Introduction

The functions supplied in this module are intended to be used in conjunction with FTP Server and FTP Client implementations. Functions are provided to access the user parameter storage area of the flash memory, and to update the application code in flash memory.

Header File

```
#include <StreamUpdate.h>        // Found in C:\Nburn\include
```

User Parameter Flash Data Functions

- SendUserFlashToStreamAsBinary --- Send User Parameter Flash data as a binary output stream
-
- SendUserFlashToStreamAsS19 --- Send User Parameter Flash data as a S19 ASCII record to an output stream
-
- ReadS19UserFlashFromStream --- Read User Parameter Flash data from a S19 ASCII input stream
-
- ReadBinaryUserFlashFromStream --- Read User Parameter Flash data from a binary input stream

Application Code Function

- ReadS19ApplicationCodeFromStream --- Read a new application in _APP.S19 format from an ASCII input stream

Example Application

- ftpd_code_update (found in C:\Nburn\examples)

21.2. SendUserFlashToStreamAsBinary

Synopsis:

```
int SendUserFlashToStreamAsBinary( int fd );
```

Description:

This function sends User Parameter Flash data as a binary output stream. This function sends the User Parameter Flash data to the specified fd output stream as a binary record.

Parameters:

Type	Name	Description
int	fd	The socket file descriptor (fd) to send the data to.

Return Values:

STREAM_UP_OK --- The system was able to send the data
STREAM_UP_FAIL --- The system failed to send the data

21.3. SendUserFlashToStreamAsS19

Synopsis:

```
int SendUserFlashToStreamAsS19( int fd );
```

Description:

This function sends User Parameter Flash data as a S19 ASCII record to an output stream. This function sends the User Parameter Flash data to the specified fd output stream as a S19 text record.

Parameters:

Type	Name	Description
int	fd	The socket file descriptor (fd) to send the data to.

Return Values:

STREAM_UP_OK --- The system was able to send the data
STREAM_UP_FAIL --- The system failed to send the data

21.4. ReadS19UserFlashFromStream

Synopsis:

```
int ReadS19UserFlashFromStream( int fd );
```

Description:

This function reads User Parameter Flash data from a S19 ASCII input stream. This function reads ASCII S19 records from the specified fd input stream and programs the data in the User Parameter Flash area.

Parameters:

Type	Name	Description
int	fd	The socket file descriptor (fd) to read data from.

Return Values:

STREAM_UP_OK --- The system was able to read the data and update flash
STREAM_UP_FAIL ---The system failed to read or update

21.5. ReadBinaryUserFlashFromStream

Synopsis:

```
int ReadBinaryUserFlashFromStream( int fd );
```

Description:

This function reads User Parameter Flash data from a binary input stream. This function reads binary data from the specified input stream and programs the data into the User Parameter Flash area.

Parameters:

Type	Name	Description
int	fd	The socket file descriptor (fd) to read data from.

Return Values:

STREAM_UP_OK --- The system was able to read the data and update flash
STREAM_UP_FAIL --- The system failed to read or update

21.6. ReadS19ApplicationCodeFromStream

Synopsis:

```
int ReadS19ApplicationCodeFromStream( int fd );
```

Description:

This function reads a new application in _APP.S19 format from an ASCII input stream. This function reads ASCII S19 records from a _APP.s19 format application file and reprograms the Flash memory with the new application. **Note:** The Flash memory will **not** be modified unless the **entire** application is received **without** error.

Since applications are run from RAM, your NetBurner device **must** be rebooted **before** the new application code becomes active. One way to accomplish a reboot is to use the **ForceReboot** function (located in the NetBurner System Library section of this manual).

Note: The items that you **will** need to clean up and/or close before a reboot are dependant on your particular application. At a minimum, you should clean up and/or close any FTP Client or Server sessions **before** calling this function.

Parameters:

Type	Name	Description
int	fd	The socket file descriptor (fd) to read data from.

Return Values:

STREAM_UP_OK --- The system was able to read the data and update the Flash
STREAM_UP_FAIL --- The system failed to read or update Flash

Example Application:

- ftpd_code_update --- Located (by default) in C:\Nburn\examples

22. System Library

Header Files

```
#include <system.h>        // Found in C:\Nburn\include
#include <utils.h>         // Found in C:\Nburn\include
```

System Constants

```
#include <constants.h>     // Found in C:\Nburn\include
```

ConfigRecord --- The configuration storage structure

Global Variables

- gConfigRec --- The global configuration record
- Secs --- Seconds since the board booted
- TimeTick --- Time ticks since the board booted

Code Update Functions/Capabilities

- Code Update Overview
- EnableAutoUpdate
- UpdateShutdown Hook
- UpdatePassword Hook

Configuration Functions

- UpdateConfigRecord --- Change the configuration record stored in Flash
- SetupDialog --- Change system configuration by prompting the user over stdio

User Flash Parameter Functions

- SaveUserParameters --- Save a blob of data to Flash
- GetUserParameters --- Get a read only pointer to the user defined data blob stored in Flash

LED and Switch Functions

- putleds --- Set the system board LEDs
- getdipsw --- Read the DIP switches on the board

Utility I/O Functions

- ShowData --- Show a data block in ASCII and hex
- ShowMac --- Show a MAC address on stdio
- outbyte --- Output a byte on stdio
- print --- Output a zero terminated string
- putnum --- Output a hexadecimal number to stdio
- AsciiToIp --- Convert a dotted decimal IP string to an IP address
- ShowIP --- Show an IP address as dotted decimal on stdio
- itoa --- An integer to ASCII function

Diagnostic Function

- ShowCounters --- Show all system counters on stdio

Counter Function

- GetPreciseTime --- Gets time ticks at a smaller resolution since the board booted

Reboot Function

Header File

```
#include <bsp.h>           // Found in C:\Nburn\include
```

- ForceReboot --- Reboot your NetBurner device

Ethernet Functions

```
#include <ethernet.h>      // Found in C:\Nburn\include
```

- EtherLink --- Reports the status of the Ethernet link
- EtherSpeed100 --- Reports if the Ethernet link is operating at 100 MB
- EtherDuplex --- Reports if the Ethernet link is in Full Duplex mode
- ManualEthernetConfig --- Controls the speed and duplex of the Ethernet connection

22.1. Constants

Synopsis:

These constants control the system configuration.

Warning: If you change these constants, you must rebuild the System directory.

Interrupt Priorities:

- `#define TICK_IRQ_LEVEL (5)`
- `#define SERIAL_IRQ_LEVEL (4)`
- `#define SERIAL_VECTOR_BASE (64)`

Time Related Functions:

- `#define TICKS_PER_SECOND (20)`
- `#define XTAL_FREQ 40000000`

Ethernet Buffer Definitions:

- `#define ETHER_BUFFER_SIZE 1548`
- `#define ETH_MAX_SIZE (1500)`
- `#define ETH_MIN_SIZE (64)`
- `#define MAX_UDPDATA (ETHER_BUFFER_SIZE-(20+8+14))`

uCOS OS Setting:

- `#define OS_MAX_TASKS 20    // Max number of system tasks`

System Task Priorities:

- `#define MAIN_PRIO (50)`
- `#define HTTP_PRIO (45)`

Any User Tasks that call I/O should have a Priority Number higher than the TCP_PRIO:

- `#define TCP_PRIO (40)`
- `#define IP_PRIO (39)`
- `#define ETHER_SEND_PRIO (38)`

Stack Size Definitions:

`// If you add big structures in user functions you should`
`// increase the value of the USER_TASK_STK_SIZE`

- `#define USER_TASK_STK_SIZE (2048)`

`// If you add big structures in your dynamic HTML code`
`// you need to increase the value of HTTP_STK_SIZE`

- `#define HTTP_STK_SIZE (2048)`
- `#define IP_STK_SIZE (2048)`
- `#define TCP_STK_SIZE (2048)`
- `#define IDLE_STK_SIZE (2048)`
- `#define ETHER_SEND_STK_SIZE (2048)`

TCP Constants:

- `#define DEFAULT_TCP_MSS (512)`
- `// See RFC 1122 for a 50msec tick 60 ticks=3 sec 4*15=60`
- `#define DEFAULT_TCP_RTTVAR ((TICKS_PER_SECOND*3)/4)`
- `(Note: The 4 comes from Stevens Vol. 1 page 300)`
- `// 75 seconds Min`
- `#define TCP_CONN_TO (75 * TICKS_PER_SECOND)`
- `// 200 msec delayed ACK timer`
- `#define TCP_ACK_TICK_DLY (TICKS_PER_SECOND /5)`
- `#define DEFAULT_INITAL_RTO (TICKS_PER_SECOND*3)`
- `#define TCP_MAX_RTO (64 * TICKS_PER_SECOND)`
- `#define TCP_MIN_RTO (1 * TICKS_PER_SECOND)`
- `#define TCP_2MSL_WAIT (60 * TICKS_PER_SECOND)`
- `#define MAX_TCP_RETRY (12)`
- `#define TCP_WRITE_TIMEOUT (TICKS_PER_SECOND*10)`
- `// Store 3 segments max in tx and rx buffers`
- `#define TCP_BUFFER_SEGMENTS (3)`
- `// 10 idle Seconds and a partially received request is abandoned`
- `#define HTTP_TIMEOUT (TICKS_PER_SECOND*10)`

FD Offset Values:

- `#define SERIAL_SOCKET_OFFSET (3)`
- `#define TCP_SOCKET_OFFSET (5)`
- `#define MAX_IP_ERRS 3`
- `#define BUFFER_POOL_SIZE (64)`
- `#define UDP_DISPATCH_SIZE (10)`
- `#define ARP_ENTRY_SIZE (256)`
- `#define TCP_SOCKET_STRUCTS (32)`
- `#define UDP_NETBURNERID_PORT (0x4E42) /*NB*/`
- `#define TFTP_RX_PORT (1414)`

22.2. ConfigRecord

Synopsis:

```
typedef struct
{
unsigned long recordsize; /* The stored size of the struct*/
unsigned long ip_Addr; /* The device IP Address */
unsigned long ip_Mask; /* The IP Address Mask */
unsigned long ip_GateWay; /* The address of the IP Gateway */
unsigned long ip_TftpServer;/* The address of the TFTP server to load
data from for debugging */
unsigned long baud_rate; /* The initial system baud rate */
unsigned char wait_seconds; /* The number of seconds to wait before
booting */
unsigned char bBoot_To_Application; /* True - if we boot to the
application, not the monitor */
unsigned char bException_Action; /* What should we do when we have an
exception? */
unsigned char m_FileName[80]; /* The file name of the TFTP file to
load */
unsigned char mac_address[6]; /* The Ethernet MAC address */
unsigned long ip_DNS_server; /* The DNS Server address */
unsigned long m_Unused[7];
unsigned short checksum; /* A Checksum for this structure */
} ConfigRecord;
```

Description:

This structure is stored in the system FLASH and records default values for the system operation.
Note: This structure can be manipulated with the **IP Setup** program and the **Debug monitor**.

22.3. gConfigRec

Synopsis:

```
extern ConfigRecord gConfigRec;
```

Description:

This is a **read only copy** of the system configuration record.

22.4. Secs

Synopsis:

```
extern VDWORD Secs;
```

Description:

The number of seconds since the device rebooted.

22.5. TimeTick

Synopsis:

```
extern VDWORD TimeTick;
```

Description:

The number of time ticks since the device booted. There are TICKS_PER_SECOND ticks in each second. **Note:** At the time this document was written, this value is 20.

22.6. Code Update Overview

Description:

It is **not** necessary to access the serial port to update the application code on your NetBurner device. With AutoUpdate capability, it is possible to update the application code running on your NetBurner device from **any** computer (with the AutoUpdate application running) with network access to that NetBurner device.

Important: AutoUpdate **must** be enabled in your application **before** it can be used. This is done by calling the **EnableAutoUpdate** function (see the example code below).

Note: If you want the update to **automatically** shutdown the running application **before** it updates the application then you need to add a function to the **UpdateShutdown Hook**. If you want the update to be **password protected**, you must also install a password checking function in the **UpdatePassword Hook**.

Example Code:

```
#include <autoupdate.h> /* Required for AutoUpdate capability */

int MyPasswordTest(const char * user, const char * pass)
{
  /* Check password and user here */
  if (/*passwordok*/)
     return 1;
  else
     return 0;
}

int MyShutdownTest( void )
{
  if (/* It is OK to shutdown */)
  {
      /* Do your shutdown processing here */
      return 1;
   }
   else
      return 0;
 }

void UserMain(void * pd)
{
   update_authenticate_func = MyPasswordTest;
   update_shutdown_func = MyShutdownTest;
   EnableAutoUpdate(); /* Required for AutoUpdate capability */
}
```

22.7. Enable AutoUpdate

Synopsis:

```
void EnableAutoUpdate( );
```

Description:

Calling this function enables the remote network AutoUpdate function. Important: This functionality can only be turned on. However, if you need to turn the capability on and off dynamically, then you will need to use the UpdateShutdown Hook functionality.

Parameters:

None

Returns:

Nothing --- This is a void function

22.8. Update Shutdown Hook

Synopsis:

`extern int ( *update_shutdown_func )( void );`

Description:

By pointing this function pointer to a function that function will be called before AutoUpdate takes place. It also allows the function to reject any update attempt.

Your function must be of the form:

```
int YourShutdownTest(void)
{
   if (/* It is OK to shutdown */)
   {
      /* Do your shutdown processing here */
      return 1;
   }
   return 0; /* If you want to abort AutoUpdate */
}
```

22.9. Update Password Hook

Synopsis:

```
extern int ( *update_authenticate_func )( const char *name,
             const char *passwd );
```

Description:

Pointing this function pointer at a password checking function requires that the updating program provide a password that this routine approves of.

Your password function must be of the form:

```
int MyPasswordTest(const char * user, const char * pass)
  {
     /* Check password and user here */
     if (/* password ok */) return 1;
     else return 0;
  }
```

You assign the function to the password hook by:

```
update_authenticate_func=MyPasswordTest;
```

22.10. UpdateConfigRecord

Synopsis:

```
void UpdateConfigRecord( ConfigRecord *pNewRec );
```

Description:

This updates the stored configuration record. It can be used to change system configurations settings. Note: The mac_address and checksum values are ignored in the passed-in structure, and the proper system values are used before storing the record.

Returns:

Nothing --- This is a void function

22.11. SetupDialog

Synopsis:

```
void SetupDialog( );
```

Description:

This function will cause an interactive exchange on stdio. Note: This exchange will allow the user to change both the IP Address and Baudrate values.

Parameters:

None

Returns:

Nothing --- This is a void function

22.12. SaveUserParameters

Synopsis:

```
int SaveUserParameters( void *pCopyFrom, int len );
```

Description:

This function stores up to 8kB of arbitrary data in the user configuration space. The type and format of the stored data is entirely up to the individual developer. The system stores this as a blob, and provides no protection from uninitialized data. Note: The developer needs to add some uninitialized data protection to his stored structure.

Parameters:

Type	Name	Description
void	*pCopyFrom	A pointer to the data to store.
int	len	The length in bytes of the data to store. **Note:** This value must be less than or equal to 8192.

Returns:

0 (zero) --- Failure
len --- Returns the length in bytes of the data stored on success.

22.13. GetUserParameters

Synopsis:

```
void * GetUserParameters( );
```

Description:

This function returns a pointer to the user parameter area. This area is intended for storage of non-volatile configuration parameters. The type and format of the stored data is entirely up to the individual developer. The system stores this as a blob, and provides no protection from uninitialized data. Note: The developer needs to add some uninitialized data protection to his stored structure.

Parameters:

None

Returns:

A read only pointer to the user parameter area

Example Application:

FlashForm --- Found in C:\Nburn\examples

22.14. putleds

Synopsis:

```
void putleds( unsigned char b );
```

Description:

This function is specific to the NetBurner development boards and turns the LEDs on or off. The function is located in the c:\nburn\<platform>\system\iobard.c file, where <platform> represents the NetBurner hardware platform you are using (eg Mod5270). You may modify this function to support any external hardware you design for your product. Depending on the development board, the hardware interface can be GPIO signals or use a Xylinx FPGA.

Note: The Mod-Dev-70 that is part of the Mod5270LC development kit, requires that a function called BOOL OnModDev70() be called before using the LEDs. This function is located in the ioboard.c platform system file.

- 0x00 = all OFF
- 0xFF = all ON
- 0x01 = LED 1
- 0x02 = LED 2
- 0x04 = LED 3
- 0x08 = LED 4
- 0x10 = LED 5
- 0x20 = LED 6
- 0x40 = LED 7
- 0x80 = LED 8

Returns:

Nothing --- This is a void function

Example Application:

TicTacToe --- Found in C:\Nburn\examples

22.15. getdipsw

Synopsis:

```
unsigned char getdipsw( );
```

Description:

This function reads the dip switches.

Parameters:

None

Returns:

The bit of the DIP switches:

- SW1 = 1
- SW2 = 2
- SW3 = 4
- SW4 = 8

Example Application:

TicTacToe --- Found in C:\Nburn\examples

22.16. ShowData

Synopsis:

```
void ShowData( PBYTE fromptr, WORD len );
```

Description:

This function dumps a block of memory to stdio. It displays this block as hexadecimal and ASCII where appropriate.

Returns:

Nothing --- This is a void function

22.17. ShowMac

Synopsis:

```
void ShowMac( MACADR * ma );
```

Description:

This function displays the MAC Address on stdout, which is UART 0 by default.

Returns:

Nothing --- This is a void function

22.18. outbyte

Synopsis:

```
void outbyte( char c );
```

Description:

This function outputs a single character on stdout. **Note:** This is a very low overhead call.

Returns:

Nothing --- This is a void function

22.19. print

Synopsis:

```
void print( char * );
```

Description:

The output of print is a NULL terminated string to stdout. **Note:** This is a much lower overhead call than printf.

Returns:

Nothing --- This is a void function

22.20. putnum

Synopsis:

```
void putnum( int i );
```

Description:

The output of putnum is a hexadecimal number of stdout. **Note:** This is a much lower overhead call than printf.

Returns:

Nothing --- This is a void function

22.21. AsciiToIp

Synopsis:

`IPADDR AsciiToIp( char * p );`

Description:

This function converts an ASCII representation of an IP Address to type IPADDR.

Returns:

An IP address of type IPADDR.

Example:

```
IPADDR IpAddr = AsciiToIp("10.1.1.12");
```

22.22. ShowIP

Synopsis:

```
void ShowIP( IPADDR ia );
```

Description:

This function displays an IP address variable of type IPADDR in ASCII text (eg 10.1.1.1) and sends it to stdout, which is the debug serial port 0 by default.

Parameters:

Type	Name	Description
IPADDR	ia	IPADDR variable to be displayed

Returns:

Nothing --- This is a void function

Examples:

```
IPADDR IpAddr = AsciiToIp("10.1.1.12");

ShowIP( IpAddr ); // Sends ASCII "10.1.1.12" to stdio
```

22.23. itoa

Synopsis:

```
char * itoa ( int value, char * buffer, int radix )
```

Description:

This function converts an integer value to a null-terminated string using the specified radix and stores the result in the given buffer. If the radix is 10 and the value is negative, the string is preceded by the minus sign (-). With any other radix, the value is always considered unsigned.

Note: The buffer should be large enough to contain the largest possible value used in your application: (sizeof(int)*8+1) for radix=2, i.e. 33 bits.

Parameters:

Type	Name	Description
int	value	The value to be represented as a string.
char	*buffer	The buffer - where to store the resulting string.
int	radix	The numeral radix in which the value has to be represented, between 2 and 36.

Returns

A pointer to the string

22.24. ShowCounters

Synopsis:

```
void ShowCounters( );
```

Description:

This diagnostic function will dump all of the system counters to stdout.

Parameters:

None

Returns:

Nothing --- This is a void function

22.25. GetPreciseTime

Synopsis:

```
DWORD GetPreciseTime( void );
```

Description:

Gets the number of time ticks since the system booted at a smaller resolution in comparison to using the global variable TimeTick (TimeTick has a resolution of about 50 milliseconds when TICKS_PER_SECOND = 20). This function is only accessible for the MOD5234, MOD5270, and MOD5282 platforms. The number of ticks returned by this function has a resolution of about 0.868 microseconds for the MOD5234 and MOD5270, and 1.929 microseconds for the MOD5282.

Note: This function is used to get a more precise time from the system clock; it is not intended to work as a time delay function like OSTimeDly().

Parameters:

None.

Returns:

The number of higher precision time ticks since system start.

22.26. ForceReboot

Header File:

```
#include <bsp.h>          // Found in C:\Nburn\include
```

Synopsis:

```
void ForceReboot( );
```

Description:

This function will reboot your NetBurner device.

Parameters:

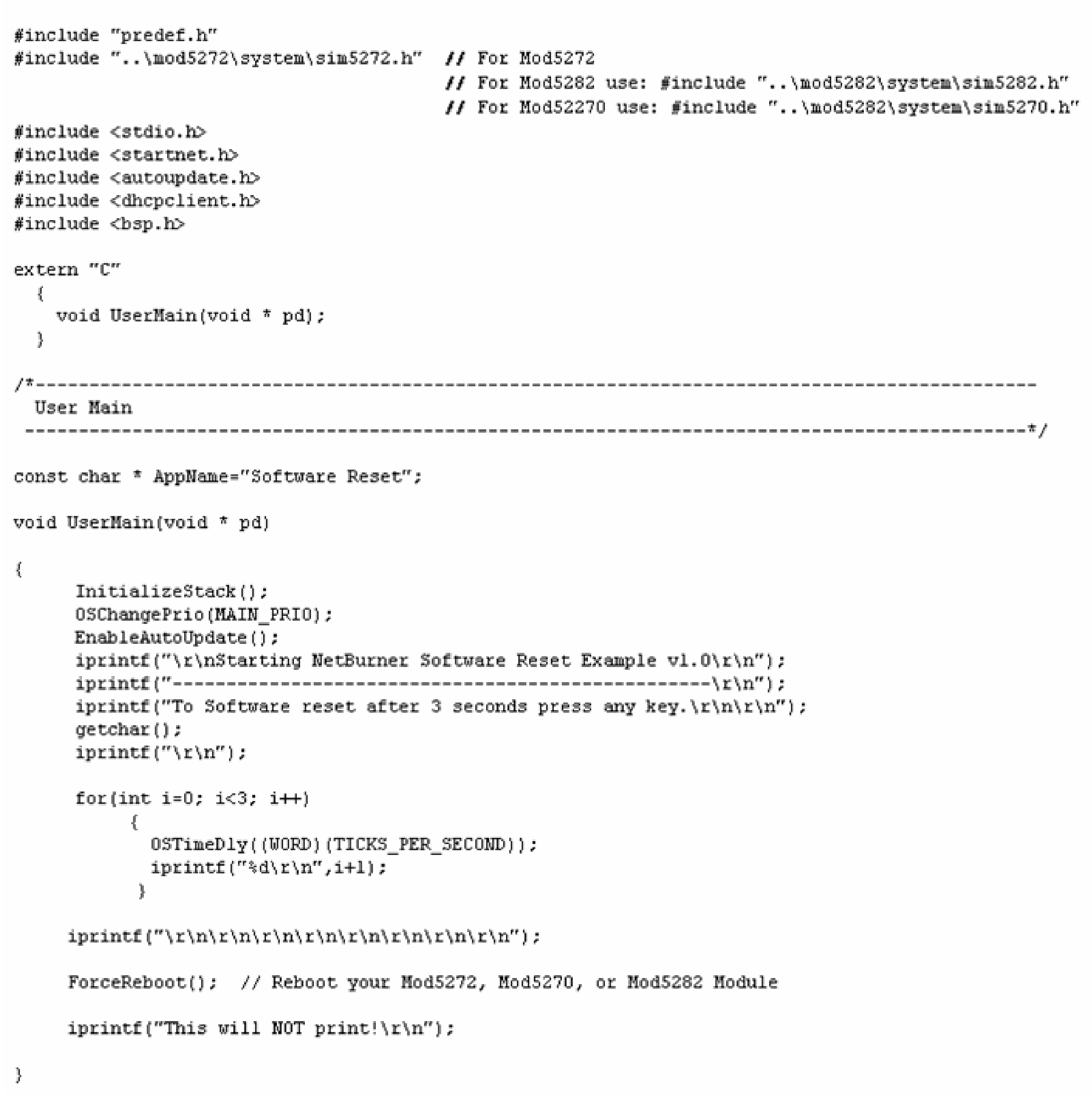
None

Returns:

Nothing --- This is a void function

22.26.1. Example

Mod5270, Mod5272, and/or Mod5282 only



```
#include "predef.h"
#include "..\mod5272\system\sim5272.h"  // For Mod5272
                                        // For Mod5282 use: #include "..\mod5282\system\sim5282.h"
                                        // For Mod52270 use: #include "..\mod5282\system\sim5270.h"
#include <stdio.h>
#include <startnet.h>
#include <autoupdate.h>
#include <dhcpclient.h>
#include <bsp.h>

extern "C"
  {
    void UserMain(void * pd);
  }

/*---------------------------------------------------------------------------------------------
  User Main
 ---------------------------------------------------------------------------------------------*/

const char * AppName="Software Reset";

void UserMain(void * pd)

{
      InitializeStack();
      OSChangePrio(MAIN_PRIO);
      EnableAutoUpdate();
      iprintf("\r\nStarting NetBurner Software Reset Example v1.0\r\n");
      iprintf("---------------------------------------------------\r\n");
      iprintf("To Software reset after 3 seconds press any key.\r\n\r\n");
      getchar();
      iprintf("\r\n");

      for(int i=0; i<3; i++)
           {
             OSTimeDly((WORD)(TICKS_PER_SECOND));
             iprintf("%d\r\n",i+1);
            }

     iprintf("\r\n\r\n\r\n\r\n\r\n\r\n\r\n\r\n");

     ForceReboot();  // Reboot your Mod5272, Mod5270, or Mod5282 Module

     iprintf("This will NOT print!\r\n");

}
```

22.27. EtherLink

Header File:

```
#include <ethernet.h>     // Found in C:\Nburn\include
```

Synopsis:

```
BOOL EtherLink( );
```

Description:

This function reports the status of the Ethernet link.

Parameters:

None

Returns:

True --- If the Ethernet link is valid
False --- If there is no Ethernet connection

22.28. EtherSpeed100

Header File:

```
#include <ethernet.h>      // Found in C:\Nburn\include
```

Synopsis:

```
BOOL EtherSpeed100( );
```

Description:

This function reports if the Ethernet link is operating at 100 MB.

Parameters:

None

Returns:

True --- If the Ethernet link is operating at 100 Mbps
Flase – 10Mbps mode.
Important: The EtherLink function must return true for this value to be valid.

22.29. EtherDuplex

Header File:

```
#include <ethernet.h>     // Found in C:\Nburn\include
```

Synopsis:

```
BOOL EtherDuplex( );
```

Description:

This function reports if the Ethernet link is in Full Duplex mode.

Parameters:

None

Returns:

True --- If the Ethernet link is in full duplex mode
False – Half duplex mode
Important: The EtherLink function **must** return **true** for this value to be **valid**.

22.30. ManualEthernetConfig

Header File:

```
#include <ethernet.h> // Found in C:\Nburn\include
```

Synopsis:

```
void ManualEthernetConfig ( BOOL FullSpeed, BOOL FullDuplex,
                            BOOL AutoNegotiate )
```

Description:

This function controls the speed and duplex of the Ethernet connection. The default connection at boot will be auto-negotiated.

If this function is called with AutoNegotiate=**TRUE**, then the other two parameters (i.e. FullSpeed and FullDuplex) do not care, and the connection will re-establish itself as an auto-negotiation link.

If this function is called with AutoNegotiate=**FALSE** then set:

- FullSpeed=TRUE for 100BaseTX or FullSpeed=FALSE for 10BaseT
- 2FullDuplex=TRUE for Full Duplex or FullDuplex=FALSE for Half Duplex

Note: Setting both speed and duplex is usually required for establishing a connection to a device that does not support auto-negotiation.

Parameters:

Type	Name	Description
BOOL	FullSpeed	Connection speed -- select if auto-negotiate disabled
BOOL	FullDuplex	Connection duplex -- select if auto-negotiate disabled.
BOOL	AutoNegotiate	Connect with auto-negotiate.

Returns:

Nothing --- This is a void function

23. TCP/IP Library

23.1. Introduction

The TCP/IP Stack is a high performance TCP/IP Stack for embedded applications. The TCP/IP Stack is integrated with the RTOS, Web Server, and I/O System providing easy development of network applications. The NetBurner Web Server is integrated with the TCP/IP Stack and RTOS, enabling you to quickly develop dynamic web pages and content.

This section covers the TCP/IP specific functions (i.e. the creation and setup of sockets) in the NetBurner system. **Important:** This section does not cover the **read/write operations** on these sockets. The read/write operations are covered in the **I/O System Library**. For **UDP** specific functions please refer to the **UDP Library**.

Header Files

```
#include <ip.h>              // Found in C:\Nburn\include
#include <tcp.h>             // Found in C:\Nburn\include
#include <udp.h>             // Found in C:\Nburn\include
#include <multihome.h>       // Found in C:\Nburn\include
```

Functions

IP Stack Start, Stop, and Add Functions

- InitializeStack --- Start the IP and TCP stack
- KillStack --- Shutdown the IP stack
- AddInterface --- (MULTIHOME) Add an additional IP interface to the system

Socket Creation Functions

- listen --- Start listening to accept connections
- accept --- Accept a connection on a listening socket
- connect --- Connect initiate a connection to another host
- connectvia --- Connect initiate a connection to another host via a specific interface (**Warning: This only works with MULTIHOME**)

Socket Option Functions

- setsockoption --- Set a socket option
- clrsockoption --- Clear a socket option
- getsockoption --- Get a socket option

Get Socket Information Functions

- GetSocketRemoteAddr --- Get the IP address of the remote host associated with a socket
- GetSocketLocalAddr --- Get the IP address of local interface associated with a socket (Warning: This only works with MULTIHOME)
- GetSocketRemotePort --- Get the remote port associated with a socket
- GetSocketLocalPort --- Get the local port associated with a socket

Get Host by Name Function

- GetHostByName --- Look up an IP address using DNS

Ping Functions

-
- Ping --- Sends an ICMP echo to an address and waits for a response
- PingViaInterface --- Sends an ICMP echo through a specified interface and waits for a response

TFTP Functions

- GetTFTP --- Read a file from a TFTP server
- SendTFTP --- Send a file to a TFTP server

Diagnostic Functions

- ShowArp --- Dump the ARP cache to stdio
- DumpTcpDebug --- Dump the TCP debugging log to stdio
- EnableTcpDebug --- Enable the TCP debug log
- ShowIPBuffer --- Dump a pool pointer to stdio, interpreting it as a packet
- GetFreeCount --- Get number of free buffer available
- ShowBuffer --- Show the raw data in a poolptr

Byte Order Translation (not needed on Coldfire) Functions

- HTONS --- Translate a WORD from host order to network order
- HTONL --- Translate a DWORD from host order to network order
- NTOHS --- Translate a WORD from network order to host order
- NTOHL --- Translate a DWORD from network order to host order

23.2. InitializeStack

Synopsis:

```
void InitializeStack( IPADDR ipaddr=0, IPADDR ipMask=0, IPADDR ipGate=0 );
```

Description:

This function initializes the IP stack.

Parameters:

Type	Name	Description
IPADDR	ipaddr=0	The IP Address
IPADDR	ipMask=0	The IP (Network) Mask
IPADDR	ipGate=0	The IP Gateway

Important: If **no** values are passed in for the addresses, the **default** values are **copied** from the **system configuration** record.

Returns:

Nothing --- This is a void function

See Also:

KillStack --- Shut down the IP stack (used very rarely)
ConfigRecord --- The configuration storage structure

Example Applications:

Simple Html --- Located by default in C:\Nburn\examples
tcp2Serial --- Located by default in C:\Nburn\examples

23.3. KillStack

Synopsis:

```
void KillStack( );
```

Description:

This function shuts down the IP stack.

Parameters:

None

Returns:

Nothing --- This is a void function

See Also:

InitializeStack --- Start the IP and TCP stack

23.4. AddInterface (Multihome)

Header File:

```
#include<multihome.h>     // Found in C:\Nburn\include
```

Synopsis:

```
int AddInterface( IPADDR addr, IPADDR mask, IPADDR gateway );
```

Description:

This function creates/initializes a new IP interface. This call adds a new interface to the system.

Warning: This call only works if you have defined the variable MULTIHOME in C:\Nburn\include\predef.h and rebuilt all of the system libraries.

Parameters:

Type	Name	Description
IPADDR	addr	The IP Address of the new interface.
IPADDR	mask	The IP (Network) Mask of the new interface
IPADDR	gateway	The IP Gateway of the new interface.

Returns:

Any value greater than 0 --- Equals the interface number
-1 --- Failed too many interfaces

23.5. listen

Synopsis:

```
int listen( IPADDR addr, WORD port, BYTE maxpend=5 );
```

Description:

This function starts listening for connections on a TCP port. You must accept connections from this socket before you can use them. **Note:** You may use select to wait for connections on multiple listening sockets, by putting a listening socket in the readfds.

Parameters:

Type	Name	Description
IPADDR	addr	The address from which to accept connections. **Note:** If you want to accept connections from anywhere pass in the value INADDR_ANY.
WORD	port	The port to listen to.
BYTE	maxpend	The maximum number of pending connections to store on this listening socket.

Returns:

A file descriptor for the listening socket

A negative number if there was an error:

- TCP_ERR_NOCON (-2) --- Indicates that you have attempted to read/write from a socket that does not have a connection established yet.
- TCP_ERR_NONE_AVAIL (-5) --- Indicates that you have attempted to allocate a socket, but no socket it currently available.

See Also:

accept --- Accept a connection on a listening socket
close --- Close open file descriptors (In the I/O section of this manual)

Example Application:

tcp2serial --- Located by default in C:\Nburn\examples

23.6. accept

Synopsis:

```
int accept( int listening_socket, IPADDR * address, WORD * port,
            WORD timeout );
```

Description:

This function accepts a connection from a listening socket.

Parameters:

Type	Name	Description
int	listening_socket	The listening socket to accept from.
IPADDR	*address	A pointer to the IPADDR that will receive the IPADDR of the connection. **Note:** This parameter can be NULL.
WORD	*port	A pointer to the WORD that will receive the port number of the connection. **Note:** This parameter can be NULL
WORD	timeout	The number of time ticks to wait for a connecting socket. **Note:** 0 waits forever.

Returns:

The file descriptor of the connected socket

A negative number if there was an error:

- TCP_ERR_TIMEOUT (-1) --- Indicates that the connection has timed out.
- TCP_ERR_NOCON (-2) --- Indicates that you have attempted to read/write from a socket that does not have a connection established yet.
- TCP_ERR_CLOSING (-3) --- Indicates that you have attempted to read/write from a socket that has already been closed.
- TCP_ERR_NOSUCH_SOCKET (-4) --- Indicates that you have attempted to allocate a socket that does not exist.
- TCP_ERR_NONE_AVAIL (-5) --- Indicates that you have attempted to allocate a socket, but no socket it currently available.
- TCP_ERR_CON_RESET (-6) --- Indicates that you have attempted to read/write from a connection that has been reset by the other side.
- TCP_ERR_CON_ABORT (-7) --- This is an internal error that the client won't usually see.

See Also:

listen ---Start listening to accept connections.
close ---Close open file descriptors (In the I/O section of this manual)

23.7. connect

Synopsis:

```
int connect( IPADDR addr, WORD localport, WORD remoteport,
             DWORD timeout );
```

Description:

This function connects to another host.

Parameters:

Type	Name	Description
IPADDR	addr	The address to connect to.
WORD	localport	The local port to use for the connection. **Note:** A value of 0 causes the stack to select an unused port.
WORD	remoteport	The remote port to connect to.
DWORD	timeout	The number of time ticks to wait for a connecting socket. **Note:** A value of 0 waits forever.

Returns:

The file descriptor of the connected socket

A negative number if there was an error:

- TCP_ERR_TIMEOUT (-1) --- Indicates that the connection has timed out.
- TCP_ERR_NOCON (-2) --- Indicates that you have attempted to read/write from socket that does not have a connection established yet.
- TCP_ERR_CLOSING (-3) --- Indicates that you have attempted to read/write from a socket that has already been closed.
- TCP_ERR_NONE_AVAIL (-5) --- Indicates that you have attempted to allocate a socket, but no socket it currently available.
- TCP_ERR_CON_RESET (-6) --- Indicates that you have attempted to read/write from a connection that has been reset by the other side.
- TCP_ERR_CON_ABORT (-7) --- This is an internal error that the client won't usually see.

See Also:

connectvia --- Initiate a connection to another host via a specific MULTIHOME interface
accept --- Accept a connection on a listening socket
listen --- Start listening to accept connections
close --- Close open file descriptors (In the I/O section of this manual)

23.8. connectvia

Synopsis:

```
int connectvia( IPADDR addr, WORD localport, WORD remoteport,
                DWORD timeout, IPADDR ipa );
```

Description:

This function connects to another host via a specific IP interface.

Parameters:

Type	Name	Description
IPADDR	addr	The address to connect to.
WORD	localport	The local port to use for the connection. **Note:** A value of 0 causes the stack to select an unused port.
WORD	remoteport	The remote port to connect to.
DWORD	timeout	The number of time ticks to wait for a connecting socket. **Note:** A value of 0 waits forever.
IPADDR	ipa	The IP address of the interface to use for making this connection.

Returns:

The file descriptor of the connected socket

A negative number if there was an error:

- TCP_ERR_TIMEOUT (-1) --- Indicates that the connection has timed out.
- TCP_ERR_NOCON (-2) --- Indicates that you have attempted to read/write from socket that does not have a connection established yet.
- TCP_ERR_CLOSING (-3) --- Indicates that you have attempted to read/write from a socket that has already been closed.
- TCP_ERR_NONE_AVAIL (-5) --- Indicates that you have attempted to allocate a socket, but no socket it currently available.
- TCP_ERR_CON_RESET (-6) --- Indicates that you have attempted to read/write from a connection that has been reset by the other side.
- TCP_ERR_CON_ABORT (-7) --- This is an internal error that the client will not (usually) see.

See Also:

connect --- Initiate a connection to another host via default interface
accept --- Accept a connection on a listening socket
listen --- Start listening to accept connections
close --- Close open file descriptors (In the I/O section of this manual)

23.9. setsockoption

Synopsis:

```
int setsockoption( int fd, int option );
```

Description:

This function sets a socket option.

Parameters:

Type	Name	Description
int	fd	The socket file descriptor.
int	option	The option to set.

Options:

SO_NONAGLE --- Disables the NAGLE algorithm for this socket.
SO_NOPUSH --- Does not send packets with every write. It holds the data for larger packets.

Returns:

The bitmask of all the options for this socket

See Also:

clrsockoption --- Clears a specific socket option
getsockoption --- Get a socket option

23.10. clrsockoption

Synopsis:

```
int clrsockoption( int fd, int option );
```

Description:

This function clears a specific socket option.

Parameters:

Type	Name	Description
int	fd	The socket file descriptor.
int	option	The option to clear.

Options:

SO_NONAGLE --- Disables the NAGLE algorithm for this socket
SO_NOPUSH --- Does not send packets with every write. It holds the data for larger packets

Returns:

The bit of all enabled options

See Also:

setsockoption --- Set a socket option
getsockoption --- Get a socket option

23.11. getsockoption

Synopsis:

```
int getsockoption( int fd );
```

Description:

This function gets the current options for this socket.

Parameters:

Type	Name	Description
int	fd	The socket file descriptor.

Options:

SO_NONAGLE --- Disables the NAGLE algorithm for this socket.
SO_NOPUSH --- Does not send packets with every write. It holds the data for larger packets.

Returns:

The bit of all enabled options for the selected socket

See Also:

setsockoption --- Set a socket option
clrsockoption --- Clear a socket option

23.12. GetSocketRemoteAddr

Synopsis:

```
IPADDR GetSocketRemoteAddr( int fd );
```

Description:

This function gets the IP address of the remote host associated with this socket.

Parameters:

Type	Name	Description
int	fd	The socket file descriptor.

Returns:

The IP Address of the remote host

See Also:

GetSocketLocalAddr --- Get the IP address of local interface associated with a socket
GetSocketRemotePort --- Get the remote port associated with a socket
GetSocketLocalPort --- Get the local port associated with a socket

23.13. GetSocketLocalAddr

Synopsis:

```
IPADDR GetSocketLocalAddr( int fd );
```

Description:

This function gets the IP address of the interface associated with this socket.

Warning: This call only works if you have defined the variable MULTIHOME in C:\Nburn\include\predef.h and rebuilt all of the system libraries

Parameters:

Type	Name	Description
int	fd	The socket file descriptor.

Returns:

The IP Address of the associated interface

See Also:

GetSocketRemoteAddr --- Get the IP address of the remote host associated with a socket
GetSocketRemotePort --- Get the remote port associated with a socket
GetSocketLocalPort --- Get the local port associated with a socket

23.14. GetSocketRemotePort

Synopsis:

```
WORD GetSocketRemotePort( int fd )
```

Description:

This function gets the remote port associated with this socket.

Parameters:

Type	Name	Description
int	fd	The socket file descriptor.

Returns:

This function returns the (WORD) remote port of the remote host.

See Also:

GetSocketRemoteAddr --- Get the IP address of the remote host associated with a socket
GetSocketLocalAddr --- Get the IP address of local interface associated with a socket
GetSocketLocalPort --- Get the local port associated with a socket

23.15. GetSocketLocalPort

Synopsis:

```
WORD GetSocketLocalPort( int fd );
```

Description:

This function gets the local port associated with this socket.

Parameters:

Type	Name	Description
int	fd	The socket file descriptor.

Returns:

This function returns the (WORD) local port of the remote host.

See Also:

GetSocketRemoteAddr --- Get the IP address of the remote host associated with a socket
GetSocketLocalAddr --- Get the IP address of local interface associated with a socket
GetSocketRemotePort --- Get the remote port associated with a socket

23.16. GetHostByName

Header File:

```
#include <dns.h>          // Found in C:\Nburn\include
```

Synopsis:

```
int GetHostByName( const char * name, IPADDR * pIpaddr,
                   IPADDR dns_server, DWORD timeout );
```

Description:

This function looks up the IP address of the named host. Note that you will need to configure the NetBurner device to have a valid DNS IP address and Gateway IP address.

Parameters:

Type	Name	Description
const char	*name	The name to resolve (e.g. www.netburner.com).
IPADDR	*pIpaddr	A pointer to the IPADDR variable. (Used to store the retrieved address.)
IPADDR	dns_server	The IPADDR of the DNS server to query. **Note:** 0 uses the stored system default.
WORD	timeout	The number of time ticks to wait for a response. **Note:** A value of 0 waits forever.

Returns:

DNS_OK --- On Success
DNS_TIMEOUT --- If the DNS Server does not respond
DNS_NOSUCHNAME --- If the DNS Server can not find the name
DNS_ERR --- If the received DNS response has errors

See Also:

AsciiToIp --- Convert a dotted decimal IP string to an IP address
ShowIP --- Show an IP address as dotted decimal on stdio

23.17. Ping

Synopsis:

`int Ping( IPADDR to, WORD id, WORD seq, WORD maxwaitticks );`

Description:

This function "pings" the selected address and waits for a response. Ping (i.e. **P**acket **IN**ternet **G**roper) is an Internet utility used to determine whether a particular IP address is online by sending out a packet and waiting for a response. Ping is also used to test and debug a network as well as see if a user is online. Ping can also function like a DNS (Domain Name Server) because "pinging" a domain name will return its IP address. The Ping function is used for the primary ethernet interface. **Note:** If you need to ping through another specified interface, you **must** use the **PingViaInterface** function.

Returns:

The number of ticks the response took
-1 --- If it timed out

See Also:

PingViaInterface --- Sends an ICMP echo through a specified interface and waits for a response
SendPing --- Sends an ICMP echo to an address

Example:

```
/* This function pings the address given in buffer */
void ProcessPing(char * buffer)
{
   IPADDR addr_to_ping;
   char * cp = buffer; /* Trim leading white space */

   /* Get the address or use the default */
   while ((*cp) && (isspace(*cp))) cp++;
   if ( cp[0] )
      addr_to_ping = AsciiToIp(cp);
   else
      addr_to_ping = IpGate;
   iprintf( "\nPinging :" );
   ShowIP( addr_to_ping );
   iprintf("\n");
   int rv = Ping( addr_to_ping, 1/*Id */, 1 /*Seq */, 100/*Max Ticks*/ );
   if ( rv == -1 )
      iprintf(" Failed! \n" );
   else
      iprintf(" Response Took %d ticks\n", rv );
}
```

23.18. PingViaInterface

Synopsis:

```
int PingViaInterface( IPADDR to, WORD id, WORD seq, WORD maxwaitticks,
                      int interface );
```

Description:

This function "pings" the selected address through a specified interface and waits for a response. Ping (i.e. **P**acket **IN**ternet **G**roper) is an Internet utility used to determine whether a particular IP address is online by sending out a packet and waiting for a response. Ping is also used to test and debug a network as well as see if a user is online. Ping can also function like a DNS (Domain Name Server) because "pinging" a domain name will return its IP address. **Note:** If pinging over WiFi (or if any other alternate IP interface is desired), then this function is required in lieu of the Ping function.

Returns:

The number of ticks the response took
-1 --- If it timed out

See Also:

Ping --- Sends an ICMP echo to an address and waits for a response
SendPing --- Sends an ICMP echo to an address

23.19. SendPing

Synopsis:

```
void SendPing( IPADDR to, WORD id, WORD seq, int interface );
```

Description:

This function "pings" the selected address. Ping (i.e. **P**acket **IN**ternet **G**roper) is an Internet utility used to determine whether a particular IP address is online by sending out a packet and waiting for a response. Ping is also used to test and debug a network as well as see if a user is online. Ping can also function like a DNS (Domain Name Server) because "pinging" a domain name will return its IP address. The Ping function is used for the primary ethernet interface. **Note:** If you need to ping through another specified interface, you must use the **PingViaInterface** function.

Returns:

Nothing --- This is a void function

See Also:

Ping --- Sends an ICMP echo to an address and waits for a response
PingViaInterface --- Sends an ICMP echo through a specified interface and waits for a response

23.20. GetTFTP

Synopsis:

```
int GetTFTP( PCSTR fname, PCSTR mode, PBYTE buffer, int & len,
             DWORD timeout, IPADDR server, WORD opening_port );
```

Description:

This function reads a file from a TFTP Server and put it in the passed in buffer. Important: TFTP (i.e. Trivial File Transfer Protocol) is a version of the TCP/IP FTP protocol that has no directory or password capability.

Parameters:

Type	Name	Description
PCSTR	fname	The name of the file to retrieve.
PCSTR	mode	The opening mode: b (binary) or t (text).
PBYTE	buffer	A pointer to the memory area to hold the received file.
int	&len	A reference to the buffer length. It holds the maximum length when the function is called and holds the number of bytes actually copied on return.
DWORD	timeout	The number of ticks to wait for the operation to complete.
IPADDR	server	The IP Address to send the TFTP request to.
WORD	opening_port	The port to send the TFTP request to.

Returns:

TFTP_OK (0)
TFTP_TIMEOUT (1)
TFTP_ERROR (2)

See Also:

SendTFTP --- Send a file to a TFTP server
NBTFTP --- A TFTP Server for Win32

23.21. SendTFTP

Synopsis:

```
int SendTFTP( PCSTR fname, PCSTR mode, PBYTE buffer, int & len,
      DWORD timeout, DWORD pkttimeout, IPADDR server, WORD opening_port );
```

Description:

This function sends a file to a TFTP server. Important: TFTP (i.e. Trivial File Transfer Protocol) is a version of the TCP/IP FTP protocol that has no directory or password capability.

Parameters:

Type	Name	Description
PCSTR	fname	The name of the file to put on the TFTP Server.
PCSTR	mode	The opening mode: b (binary) or t (text).
PBYTE	buffer	A pointer to the memory area that holds the file to be sent.
int	&len	A reference to the buffer length. It holds the maximum length when the function is called, and holds the number of bytes actually copied on return.
DWORD	timeout	The total number of ticks to wait for the operation to complete.
DWORD	pkttimeout	The number of ticks to wait for timeout on each packet sent.
IPADDR	server	The IP Address to send the TFTP request to.
WORD	opening_port	The port to send the TFTP request to.

Returns:

TFTP_OK (0)
TFTP_TIMEOUT (1)
TFTP_ERROR (2)

See Also:

NBTFTP --- A TFTP Server for Win32
GetTFTP --- Read a file from a TFTP server

23.22. ShowArp

Synopsis:

```
void ShowArp( );
```

Description:

This function dumps the ARP cache to stdio. ARP (**A**ddress **R**esolution **P**rotocol) is a protocol for mapping an Internet Protocol address (IP address) to a physical machine address that is recognized in the local network. The physical machine address is also known as a Media Access Control (MAC) address. A table, usually called the ARP cache, is used to maintain a correlation between each MAC address and its corresponding IP address. ARP provides the protocol rules for making this correlation and providing address conversion in both directions.

When an incoming packet destined for a host machine on a particular local area network arrives at a gateway, the gateway asks the ARP program to find a physical host or MAC address that matches the IP address. The ARP program looks in the ARP cache and, if it finds the address, provides it so that the packet can be converted to the right packet length and format and sent to the machine. If no entry is found for the IP address, ARP broadcasts a request packet in a special format to all the machines on the LAN to see if one machine knows that it has that IP address associated with it. A machine that recognizes the IP address as its own returns a reply so indicating. ARP updates the ARP cache for future reference and then sends the packet to the MAC address that replied.

Since protocol details differ for each type of local area network, there are separate ARP Requests for Comments (RFC) for Ethernet, ATM, Fiber Distributed-Data Interface, High-Performance Parallel Interface (HIPPI), and other protocols. There is also a Reverse ARP (RARP) for host machines that do not know their IP address. RARP enables them to request their IP address from the gateway's ARP cache.

Parameters:

None

Returns:

Nothing --- This is a void function

See Also:

ShowIPBuffer --- Dump a pool pointer to stdio, interpreting it as a packet

23.23. DumpTcpDebug

Synopsis:

```
void DumpTcpDebug( );
```

Description:

This function dumps the TCP debugging log to stdio.

Parameters:

None

Returns:

Nothing ---This is a void function

See Also:

EnableTcpDebug --- Enable the TCP debug log

23.24. EnableTcpDebug

Synopsis:

```
void EnableTcpDebug( WORD db );
```

Description:

This function enables the TCP debug log.

Returns:

Nothing --- This is a void function

See Also:

DumpTcpDebug --- Dump the TCP debugging log to stdio

23.25. ShowIPBuffer

Synopsis:

```
void ShowIPBuffer( PoolPtr rp );
```

Description:

This function dumps a pool pointer to stdio, interpreting it as a packet.

Returns:

Nothing --- This is a void function.

See Also:

ShowBuffer --- Show the raw data in a pool pointer
GetFreeCount --- Get number of free buffer available
ShowArp --- Dump the ARP cache to stdio

23.26. GetFreeCount

Synopsis:

```
#include <buffers.h>

WORD GetFreeCount( );
```

Description:

This function returns the number of free pool buffers, which are used for network and serial communication. The buffers.h include file is normally already included, so you do not usually need to add it yourself. The maximum number of buffers is defined in \nburn\include\constants.h as:
#define BUFFER_POOL_SIZE (256).
The size of each buffer is defined as: #define ETHER_BUFFER_SIZE 1548.

A number of buffers must be allocated to the Ethernet driver for receiving packets. The number will vary by platform, but is typically 10 buffers. If your number of free buffers reaches zero, then no further network communication will be possible until some buffers are freed.

Serial port buffers are defined as a number of buffers allocated from this buffer pool for serial use only. In constants.h the default definitions are:

#define SERIAL_TX_BUFFERS (2)
#define SERIAL_RX_BUFFERS (2)

Each serial port buffer is equal in size to an Ethernet buffer.

Parameters:

None

Returns:

Number of free buffers.

See Also:

ShowIPBuffer --- Dump a pool pointer to stdio, interpreting it as a packet
ShowBuffer --- Show the raw data in a pool pointer

23.27. ShowBuffer

Synopsis:

```
void ShowBuffer( PoolPtr p );
```

Description:

This function shows the raw data in a buffer referenced by a pool pointer.

Returns:

Nothing --- This is a void function

See Also:

ShowIPBuffer --- Dump a pool pointer to stdio, interpreting it as a packet
GetFreeCount --- Get number of free buffer available

23.28. TcpGetLastRxTime

Synopsis:

```
DWORD TcpGetLastRxTime(int fd);
```

Description:

Each TCP connection has a corresponding Socket_struct. One of the elements of this struct is a variable called LastRxTime, which stores the current time tick every time a packet is received. This function allows you to find out when the last packet was received by returning this variable.

- This function, along with TcpSendKeepAlive, is used to implement keepalive.
- If LastRxTime is the same before and after a keepalive packet is sent, the client has not responded to the keepalive packet and it can be assumed that connection is lost.
- Make sure to allow time for the client to respond to the keep alive packet
- Do not call TcpGetLastRxTime more often than once every second.

Parameters:

Type	Name	Description
int	fd	The socket file descriptor.

Returns:

Time (in ticks) of last TCP packet received on the corresponding socket.

See Also:

TcpSendKeepAlive --- Send KeepAlive packet

23.29. TcpSendKeepAlive

Synopsis:

```
void TcpSendKeepAlive (int fd);
```

Description:

This function checks to see if the other end of a TCP connection is still responding by sending it an empty packet with a decremented sequence number (the sequence number of the last packet it sent). This causes the other end to send an ACK even though the packet was empty.

Parameters:

Type	Name	Description
int	fd	The socket file descriptor.

Returns:

Nothing

See Also:

TcpGetLastRxTime --- get time of last packet received

23.30. HTONS

Synopsis:

```
WORD HTONS( WORD x );
```

Description:

This function translates a WORD from host order to network order.

See Also:

HTONL --- Translate a DWORD from host order to network order
NTOHS --- Translate a WORD from network order to host order
NTOHL --- Translate a DWORD from network order to host order

23.31. HTONL

Synopsis:

```
DWORD HTONL( DWORD x );
```

Description:

This function translates a DWORD from host order to network order.

See Also:

HTONS --- Translate a WORD from host order to network order
NTOHS --- Translate a WORD from network order to host order
NTOHL --- Translate a DWORD from network order to host order

23.32. NTOHS

Synopsis:

```
WORD NTOHS( WORD x );
```

Description:

This function translates a WORD from network order to host order.

See Also:

HTONL --- Translate a DWORD from host order to network order
HTONS --- Translate a WORD from host order to network order
NTOHL --- Translate a DWORD from network order to host order

23.33. NTOHL

Synopsis:

```
DWORD NTOHL( DWORD x );
```

Description:

This function translates a DWORD from network order to host order.

See Also:

HTONL --- Translate a DWORD from host order to network order
HTONS --- Translate a WORD from host order to network order
NTOHS --- Translate a WORD from network order to host order

24. UDP Library

The UDP protocol is implemented as a C++ class. You can implement UDP functionality in your application using the C++ class interface, or you can use wrapper functions that implement a UDP sockets type interface. For background on UDP and example programs, please refer to the NetBurner Network Programming Guide.

Header File

```
#include <udp.h>        // Found in C:\Nburn\include
```

24.1. UPD C++ Class API

Constructors and Destructor

- UDPPacket --- Construct a UDP object by waiting on a FIFO
- UDPPacket --- Make a UDP packet from a pool buffer
- UDPPacket --- Make an empty UDP packet
- ~UDPPacket --- UDP packet destructor

Check Packet Validity

- Validate --- Returns true if the packet is valid

Packet Element Access

- SetSourcePort --- Set the source port for the packet
- GetSourcePort --- Read source port
- SetDestinationPort --- Set the destination port
- GetDestinationPort --- Get the destination port

Data Access Functions

- GetDataBuffer --- Get a pointer to the data buffer
- SetDataSize --- Set the size of the data section
- GetDataSize ---Get the size of the data section
- ResetData --- Zero the data buffer length

Append Data Functions

- AddData --- Add data on the end
- AddData --- Add a zero terminated string
- AddDataWord --- Add a WORD
- AddDataByte --- Add a Byte

Pool Pointer Access Functions

- ReleaseBuffer --- Release the UDP objects captive buffer
- GetPoolPtr --- Get a handle to the UDP objects captive buffer

Send Functions

- SendAndKeep --- Send a copy of the attached pool pointer
- SendAndKeepVia --- Send a copy of the attached pool ptr via a specific interface
- Send --- Send and free the attached pool buffer
- SendVia --- Send and free the attached pool buffer via a specific interface

Related Class Functions

- RegisterUDPFifo --- Register to listen to a specific UDP port
- UnregisterUDPFifo --- Unregister a listening UDP Fifo

24.1.1. UDP Class Example

The following example is taken from the NetBurner Network Programmers Guide, which provides detailed information on UDP.

```
/******************************************************************************
 UDP Packet C++ Class Example
 This application will send/receive UDP packets with another host on a network,
 such as a PC. Use the MTTTY serial port program to access the menu and
 prompts to specify the destination IP address and port number.

 NetBurner supplies an API for handling UDP as a C++ Class using UDPPacket, or
 you can use a UDP sockets API (see UDP socket example).

 For an external UDP host you can use the NetBurner java example, or the
 NetBurner UDP terminal program.
*****************************************************************************/
#include "predef.h"
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>
#include <startnet.h>
#include <ucos.h>
#include <udp.h>
#include <autoupdate.h>
#include <string.h>
#include <taskmon.h>
#include <dhcpclient.h>
#include <networkdebug.h>

const char *AppName = "UDP C++ Packet Class Example";

extern "C"
{
   void UserMain( void *pd );
}


// Declare a task stack for the UDP Reader task
DWORD UdpReaderStack[USER_TASK_STK_SIZE];


/*-------------------------------------------------------------------
 * This task will wait for incoming UDP packets and process them.
 -------------------------------------------------------------------*/
void UdpReaderTask( void *pd )
{
   int port = ( int ) pd;
   iprintf( "UdpReaderTask monitoring port %d\r\n", port );

   // Create FIFO to store incoming packets and initialize it
   OS_FIFO fifo;
   OSFifoInit( &fifo );

   // Register to listen for UDP packets on port number 'port'
   RegisterUDPFifo( port, &fifo );

   while ( 1 )
   {
      // We construct a UDP packet object using the FIFO.
      // This constructor will only return when we have received a packet
      UDPPacket upkt( &fifo,
                      0 /* Replace this 0 with a tick count to have a time out
delat */ );

      // Did we get a valid packet or just time out?
      if ( upkt.Validate() )
      {
         WORD len = upkt.GetDataSize();
         iprintf( "\r\nReceived a UDP packet with %d bytes from :", ( int ) len );
         ShowIP( upkt.GetSourceAddress() );
         iprintf( "\r\n" );
         ShowData( upkt.GetDataBuffer(), len );
         iprintf( "\r\n" );
      }
   }
}


/********************************************************************
 * UserMain Task
 * This is the first task to be executed and will create the UDP
 * Reader Task.
 *******************************************************************/
void UserMain( void *pd )
{
   int              portnum;
   IPADDR    ipaddr;
   char      buffer[80];

   InitializeStack();
   EnableAutoUpdate();
   EnableTaskMonitor();

   if ( EthernetIP == 0 )
   {
      iprintf( "Trying DHCP\r\n" );
      GetDHCPAddress();
      iprintf( "DHCP assigned the IP address of :" );
      ShowIP( EthernetIP );
      iprintf( "\r\n" );
   }

   OSChangePrio( MAIN_PRIO );

   #ifdef _DEBUG
   InitializeNetworkGDB();
   #endif

   iprintf( "Starting UDP Packet C++ Class Example\r\n" );

   // Get desination IP address
   iprintf( "Enter the destination IP address: " );
   buffer[0] = '\0';
   while ( buffer[0] == '\0' )  // Keep looping until something is entered
   {
      gets( buffer );
   }
   ipaddr = AsciiToIp( buffer );
   iprintf("\r\n");

   /* Get the port number. This application uses the same
    * port number for send and receive.
    */
   iprintf( "Enter the source/destination port number: " );
   gets( buffer );
   portnum = atoi( buffer );
   iprintf("\r\n");

   // Display informational message
   iprintf( "Sending/Recieving with host ");
   ShowIP( ipaddr );
   iprintf( ": %d\r\n", portnum );

   /* Create task to recieve UDP packets. We will pass the destination
    * port number in the optional second parameter field, and set the
    * priority to 1 less than the UserMain priority so packets get
    * processed as they are received.
    */
   OSTaskCreate( UdpReaderTask,
                 ( void * ) portnum,
                 &UdpReaderStack[USER_TASK_STK_SIZE],
                 UdpReaderStack,
                 MAIN_PRIO - 1 );

   // Loop forever displaying UDP data
   while ( 1 )
   {
      iprintf( "Enter a string to send: " );
      gets( buffer );
      iprintf("\r\n");
      iprintf( "Sending \"%s\" using UDP to ", buffer );
      ShowIP( ipaddr );
      iprintf(" : %d\r\n", portnum );

      // Note that the UDPPacket instance below is enclosed by '{'
      // braces to handle the scope of the data buffers used by
      // the C++ class instance.
      {
         UDPPacket pkt;
         pkt.SetSourcePort( portnum );
         pkt.SetDestinationPort( portnum );
         pkt.AddData( buffer );
         pkt.AddDataByte( 0 );
         pkt.Send( ipaddr );
      }
      iprintf( "\r\n" );
   };
}
```

24.1.2. UDPPacket

Synopsis:

```
UDPPacket( );
```

Description:

This function creates a UDP packet with no data. Member functions are then used to configure the packet and send it.

Parameters:

None

Returns:

No value returned

24.1.3. UDPPacket (FIFO)

Synopsis:

```
UDPPacket( OS_FIFO * fifo, DWORD wait );
```

Description:

UDP packets are received in a OS_FIFO. Once received, this function can be used to create a UDP packet from the FIFO entry, which removes the entry from the FIFO. This function will block until a FIFO entry is available, or the specified timeout occurs. If the FIFO times out, then an invalid UDP packet will be created. The UDP Validate( ) function must always be called after this function to verify a valid UDP packet has been received.

Returns:

A UDP Packet, which then must be verified Validate( ) function

24.1.4. UDPPacket (Pool Buffer)

Synopsis:

```
UDPPacket( PoolPtr p );
```

Description:

This creates a UDP packet from a pool buffer. This is a reserved function for internal use.

Returns:

A UDP Packet, which then must be verified Validate( ) function

24.1.5. ~UDPPacket

Synopsis:

```
~UDPPacket( );
```

Description:

This function is the UDPPacket destructor, which will be called automatically when an instance of UDPPacket goes out of scope.

Parameters:

None

Returns:

No value returned

24.1.6. Validate

Synopsis:

```
BOOL Validate( );
```

Description:

Verifies a received UDP packet has data and validates the checksum. This function should only be called when receiving a UDP packet.

Parameters:

None

Returns:

True --- If the packet is valid
False --- If you try to validate a packet before it has been sent

24.1.7. SetSourcePort

Synopsis:

```
void SetSourcePort( WORD );
```

Description:

Sets the UDP Packet source port number.

Returns:

Nothing --- This is a void function

24.1.8. GetSourcePort

Synopsis:

```
WORD GetSourcePort( );
```

Description:

Returns a received UDP packet's source port number.

Parameters:

None

Returns:

The 16-bit source port number

24.1.9. SetDestinationPort

Synopsis:

```
void SetDestinationPort( WORD );
```

Description:

Sets the UDP Packet destination port number.

Returns:

Nothing --- This is a void function

24.1.10. GetDestinationPort

Synopsis:

```
WORD GetDestinationPort( );
```

Description:

Returns a UDP packet's destination port number.

Parameters:

None

Returns:

The 16-Bit destination port number

24.1.11. GetDataBuffer

Synopsis:

```
PBYTE GetDataBuffer( );
```

Description:

This function gets a pointer to the UDP packet’s data buffer.

Parameters:

None

24.1.12. SetDataSize

Synopsis:

```
void SetDataSize( WORD );
```

Description:

Specifies the UDP Packet’s data size as a number of bytes.

Returns:

Nothing --- This is a void function

24.1.13. GetDataSize

Synopsis:

```
WORD GetDataSize( );
```

Description:

Returns the number of data bytes in a UDP packet.

Returns:

Number of data bytes.

24.1.14. ResetData

Synopsis:

```
void ResetData( );
```

Description:

This function zero's the data buffer length.

Parameters:

None

Returns:

Nothing --- This is a void function

24.1.15. AddData

Synopsis:

```
void AddData( PBYTE pData, WORD len );
```

Description:

This function appends data to an existing UDP packet.

Returns:

Nothing --- This is a void function

24.1.16. AddData (Add a Zero Terminated String)

Synopsis:

```
void AddData( PCSTR pData );
```

Description:

Appends data to an existing UDP packet. The length is determined by the null character at the end of the parameter string.

Returns:

Nothing --- This is a void function

24.1.17. AddDataWord

Synopsis:

```
void AddDataWord( WORD w );
```

Description:

Appends a 16-bit unsigned value to an existing UDP packet.

Returns:

Nothing --- This is a void function

24.1.18. AddDataByte

Synopsis:

```
void AddDataByte( BYTE b );
```

Description:

Appends a byte of data to an existing UDP packet.

Returns:

Nothing --- This is a void function

24.1.19. ReleaseBuffer

Synopsis:

```
void ReleaseBuffer( );
```

Description:

Releases UDP objects captive buffer (a pool pointer). This function is for internal use only.

Parameters:

None

Returns:

Nothing --- This is a void function

24.1.20. GetPoolPtr

Synopsis:

```
PoolPtr GetPoolPtr( );
```

Description:

This function gets a handle to the UDP objects captive buffer. This function is for internal use only.

Parameters:

None

24.1.21. SendAndKeep

Synopsis:

```
void SendAndKeep( IPADDR to, BYTE ttl );
```

Description:

This function sends a copy of the attached pool pointer.

Returns:

Nothing --- This is a void function

24.1.22. SendAndKeepVia

Synopsis:

```
void SendAndKeepVia( IPADDR to, IPADDR from_ip, BYTE ttl );
```

Description:

This function sends a copy of the attached pool pointer via a specified interface.

Returns:

Nothing --- This is a void function

24.1.23. Send

Synopsis:

```
void Send( IPADDR to, BYTE ttl=0 );
```

Description:

This function sends the UDP packet and frees the attached pool buffer.

Returns:

Nothing --- This is a void function

24.1.24. SendVia

Synopsis:

```
void SendVia( IPADDR to, IPADDR from_ip, BYTE ttl );
```

Description:

This function sends and frees the attached pool buffer via the specified interface.

Returns:

Nothing --- This is a void function

24.1.25. RegisterUDPFifo

Synopsis:

```
void RegisterUDPFifo( WORD dest_port, OS_FIFO *pfifo );
```

Description:

A OS_FIFO is used to receive incoming UDP Packets. This function registers a OS_FIFO to listen to a specific UDP port.

Returns:

Nothing --- This is a void function

24.1.26. UnregisterUDPFifo

Synopsis:

```
void UnregisterUDPFifo( WORD destination_port );
```

Description:

This function will unregister a listening UDP FIFO.

Returns:

Nothing --- This is a void function

24.2. UDP Socket Interface

Definitions

```
#define  UDP_ERR_NOSUCH_SOCKET    (-1)
#define  UDP_ERR_NOTOPEN_TO_WRITE (-2)
#define  UDP_ERR_NOTOPEN_TO_READ  (-3)
```

Open a UDP Socket

```
int CreateRxUdpSocket(WORD listening_port )
```

Open a UDP socket that can be used by the select( ) function to receive UDP datagrams.

```
int CreateTxUdpSocket(IPADDR send_to_addr, WORD remote_port,
                      WORD local_port)
```

Open a UDP socket that can use write functions such as: write( ), writestring( ), etc. to send data.

```
int CreateRxTxUdpSocket(IPADDR send_to_addr, WORD send_to_remote_port,
                        WORD local_port)
```

Open a UDP socket that can send and receive.

These functions return a standard file descriptor, or a negative number if a socket cannot be created.

Send a UDP Packet

```
int sendto(int sock, PBYTE what_to_send, int len_to_send,IPADDR to_addr,
           WORD  remote_port)
```

Returns the number of bytes sent or error as defined above

```
int sendtovia(int sock, PBYTE what_to_send, int len_to_send,IPADDR to_addr,
              WORD remote_port, int intfnum)
```

This is the same function as above, but specifies the interface as the last parameter. It returns the number of bytes sent, or an error as defined above.

Receive a UDP Packet

```
int recvfrom(int sock, PBYTE buffer, int len, IPADDR * pAddr,
             WORD * pLocal_port, WORD * pRemote_port)
```

Returns the number of bytes read, or UDP_ERR_NOSUCH_SOCKET (-1)

24.2.1. UDP Sockets Example

The following example is taken from the NetBurner Network Programmers Guide, which provides detailed information on UDP.

```
/******************************************************************************
 UDP Sockets Example
 This application will send/receive UDP packets with another host on a network,
 such as a PC. Use the MTTTY serial port program to access the menu and
 prompts to specify the destination IP address and port number.

 NetBurner supplies an API for handling UDP as a C++ Class using UDPPacket, or
 you can use a UDP sockets API (see UDP socket example).

 For an external UDP host you can use the NetBurner java example, or the
 NetBurner UDP terminal program.
*****************************************************************************/
#include "predef.h"
#include <stdio.h>
#include <stdlib.h>
#include <ctype.h>
#include <startnet.h>
#include <ucos.h>
#include <udp.h>
#include <autoupdate.h>
#include <string.h>
#include <taskmon.h>
#include <dhcpclient.h>
#include <networkdebug.h>

const char *AppName = "UDP Sockets Example";

extern "C"
{
   void UserMain( void *pd );
}


// Declare a task stack for the UDP Reader task
DWORD UdpReaderStack[USER_TASK_STK_SIZE];


/*-------------------------------------------------------------------
 * This task will wait for incoming UDP packets and process them.
 ------------------------------------------------------------------*/
void UdpReaderTask( void *pd )
{
   int port = ( int ) pd;
   iprintf( "UdpReaderTask monitoring port %d\r\n", port );

   // Create a UDP socket for receiving
   int UdpFd = CreateRxUdpSocket( port );
   if ( UdpFd <= 0 )
   {
      iprintf("Error Creating UDP Listen Socket: %d\r\n", UdpFd);
      while (1)
         OSTimeDly(TICKS_PER_SECOND);
   }
   else
   {
      iprintf( "Listening for UDP packets on port %d\r\n", port );
   }

   while (1)
   {
      IPADDR SrcIpAddr;  // UDP packet source IP address
      WORD   LocalPort;  // Port number UDP packet was sent to
      WORD   SrcPort;    // UDP packet source port number
      char   buffer[80];

      int len = recvfrom( UdpFd, (BYTE *)buffer, 80, &SrcIpAddr, &LocalPort,
&SrcPort );
      buffer[len] = '\0';

      iprintf( "\r\nReceived a UDP packet with %d bytes from :", len );
      ShowIP( SrcIpAddr );
      iprintf( "\r\n%s\r\n", buffer );
   }
}





/*-------------------------------------------------------------------
 * UserMain Task
 * This is the first task to be executed and will create the UDP
 * Reader Task.
 -------------------------------------------------------------------*/
void UserMain( void *pd )
{
   int              portnum;
   IPADDR    ipaddr;
   char      buffer[80];

   InitializeStack();
   EnableAutoUpdate();
   EnableTaskMonitor();

   if ( EthernetIP == 0 )
   {
      iprintf( "Trying DHCP\r\n" );
      GetDHCPAddress();
      iprintf( "DHCP assigned the IP address of :" );
      ShowIP( EthernetIP );
      iprintf( "\r\n" );
   }

   OSChangePrio( MAIN_PRIO );

   #ifdef _DEBUG
   InitializeNetworkGDB();
   #endif

   iprintf( "Starting UDP Sockets Example\r\n" );

   // Get desination IP address
   iprintf( "Enter the UDP Server destination IP address: " );
   buffer[0] = '\0';
   while ( buffer[0] == '\0' )  // Keep looping until something is entered
   {
      gets( buffer );
   }
   ipaddr = AsciiToIp( buffer );
   iprintf("\r\n");

   // Get the port number. This application uses the same
   // port number for send and receive.
   iprintf( "Enter the source/destination port number: " );
   gets( buffer );
   portnum = atoi( buffer );
   iprintf("\r\n");

   // Create a UDP socket for sending/receiving
   int UdpFd = CreateTxUdpSocket( ipaddr, portnum, portnum );
   if ( UdpFd <= 0 )
   {
      iprintf("Error Creating UDP Socket: %d\r\n", UdpFd);
      while (1)
         OSTimeDly(TICKS_PER_SECOND);
   }
   else
   {
      iprintf( "Sending/Recieving with host ");
      ShowIP( ipaddr );
      iprintf( ": %d\r\n", portnum );
   }

   // Create task to receive UDP packets. We will pass the destination
   // port number in the optional second parameter field, and set the
   // priority to 1 less than the UserMain priority so packets get
   // processed as they are received.
   OSTaskCreate( UdpReaderTask,
                 ( void * ) portnum,
                 &UdpReaderStack[USER_TASK_STK_SIZE],
                 UdpReaderStack,
                 MAIN_PRIO - 1 );

   // Loop forever displaying UDP data
   while ( 1 )
   {
      iprintf( "Enter a string to send: " );
      gets(buffer);
      iprintf("\r\n");
      iprintf( "Sending \"%s\" using UDP to ", buffer );
      ShowIP( ipaddr );
      iprintf(" : %d\r\n", portnum );

      sendto( UdpFd, (BYTE *)buffer, strlen(buffer), ipaddr, portnum );
      iprintf( "\r\n" );
   };
}
```

24.2.2. CreateRxUdpSocket

Synopsis:

int CreateRxUdpSocket(WORD listening_port)

Description:

Open a UDP socket that can be used by the select( ) function to receive UDP datagrams.

Parameters:

listening_port	16-bit unsigned value of UDP port to listen to for incoming packets

Returns:

A file descriptor, or negative number on error.

24.2.3. CreateTxUdpSocket

Synopsis:

```
int CreateTxUdpSocket(IPADDR send_to_addr, WORD remote_port,
                      WORD local_port).
```

Description:

Open a UDP socket that can use write functions such as: write( ), writestring, etc. to send data.

Parameters:

send_to_addr	Destination IP address
remote_port:	Destination port number
local_port :	Local port number to use. A value of 0 will automatically select a random port number.

Returns:

A file descriptor, or negative number on error.

24.2.4. CreateRxTxUdpSocket

Synopsis:

```
int CreateRxTxUdpSocket(IPADDR send_to_addr, WORD send_to_remote_port,
                    WORD local_port)
```

Description:

Open a UDP socket that can send and receive.

Parameters:

send_to_addr	Destination IP address
send_to_remote_port:	Destination port number
local_port :	Local port number to use. A value of 0 will automatically select a random port number.

Returns:

A file descriptor, or negative number on error.

24.2.5. sendto

Synopsis:

int sendto(int sock, PBYTE what_to_send, int len_to_send,IPADDR to_addr, WORD remote_port)

Description:

Send a UDP packet

Parameters:

sock	File descriptor from a previous call to CreateTxUdpSocket( ) or CreateRxTxSocket( )
what_to_send	BYTE array pointer to data to send in packet
len_to_send :	Number of bytes of data to send
to_addr:	Destination IP address
remote_port:	Destination port number

Returns:

Number of bytes sent negative number on error.

24.2.6. sendtovia

Synopsis:

```
int sendtovia(int sock, PBYTE what_to_send, int len_to_send,IPADDR to_addr,
              WORD remote_port, int intfnum)
```

Description:

Send a UDP packet using the specified network interface.

Parameters:

sock	File descriptor from a previous call to CreateTxUdpSocket( ) or CreateRxTxSocket( )
what_to_send	BYTE array pointer to data to send in packet
len_to_send :	Number of bytes of data to send
to_addr:	Destination IP address
remote_port:	Destination port number
intfnum:	Local network interface to use from previous call to RegisterInterface( )

Returns:

Number of bytes sent or a negative number on error.

24.2.7. receivefrom

Synopsis:

```
int recvfrom(int sock, PBYTE buffer, int len, IPADDR *pAddr,
               WORD *pLocal_port, WORD *pRemote_port)
```

Description:

Receive a UDP packet.

Parameters:

sock File descriptor from a previous call to CreateRxUdpSocket( ) or CreateRxTxSocket( )
buffer: Pointer to BYTE array buffer to store received UDP packet data
len: Maximum number of bytes to receive
pAddr: Pointer to an IPADDR variable to store the sender’s IP address of the packet
pLocal_port: Pointer to WORD variable to store the local port number of the packet
pRemote_port: Pointer to WORD variable to store the sender’s port number of the packet

Returns:

Number of bytes received or a negative number on error.

25. PPP Library

Like Ethernet, Point to Point Protocol (PPP) is a data link layer which transfers data between nodes on a network. The main difference is that PPP is used between only two network nodes. PPP can be used over many types of physical networks, including: fiber, phone line, serial cable and cellular telephone. Once you have created a PPP connection to or from your NetBurner device you can use it with all the standard network applications such as the web server, tcp, udp, ftp, email, etc.

Internet Service Providers (ISP) can implement PPP with many different options that vary from ISP to ISP. The PPP example program included in the development kit examples directory specifies the most common ISP options and can be used as a code example to specify any specific options you may need in your application.

Header File

```
#include <ppp.h>        // Found in C:\Nburn\include
```

25.1. PPP Structure and Definitions

pppoptions	PPP options structure
enum_PPPState	PPP state definitions

25.2. PPP Functions

StartPPPDameon	Starts the PPP daemon and initialized a modem
StartPPPDirect	Starts the PPP daemon for a direct connection on a Serial port
DialPPP	Dials out (via a modem) to create a PPP connection.
DirectConnectPPP	Initiates a client PPP direct connection on a Serial port.
GetPPPState	Reports the connection state of the PPP system.
StopPPPDameon	Stops listening for a PPP connection.
ClosePPPSesion	Stops any current PPP connection.
GetThatPPP_IP	Get the IP address of the other device on the PPP connection.
GetThisPPP_IP	Get the IP address of the NetBurner device on the PPP connection.
SendCHAPChallenge	Send CHAP challenge packet to PPP host

25.3. PPP Options Structure

The PPP options structure is used to configure the PPP link, specify whether or not authentication is required, and supply an optional user name and password. The code below is an example of the options in tools release 2.3 rc7. Please refer to c:\nburn\include\ppp.h for the latest option structure.

```
struct pppoptions {
BYTE Restart_Interval; // The restart interval for PPP negotiations in seconds
BYTE Max_Terminate;    // The Maximum number of times to send terminate
BYTE Max_Configure;    // The Maximum number of times to send config requests
BYTE Max_Failure;      // The Maximum number of config failures (for retries)
BOOL CHAPenable;       // If TRUE then CHAP will be required for connection
BOOL Chat_Login_disable;  //If TRUE, PPP will not allow Chat_Login mode


// Callback function used for incoming connections. If you require authentication
// from the peer, crate your own authentication function that takes a user name and
// password, and set the authenticate_func pointer to it. A non-zero return value
// means the authentication was successful.
int  ( *authenticate_func )( const char *name, const char *passwd );


// Username and password used for outgoing connections during PAP or CHAP
// authentication.
const char *pUserName;
const char *pPassword;


// Set to zero to request that the other side to provide our IP address
IPADDR SetThisInterfaceAddress;

// Set to non-zero to request an IP address for the peer
IPADDR SetThatInterfaceAddress;

// The actual values after negotiation
IPADDR ActualThisInterfaceAddress;
IPADDR ActualThatInterfaceAddress;

DWORD dwflags;  // Reserved for system use

// The negotiated Maximum Receive Unit (MRU). Read only. Usually 1500 bytes.
WORD MRU;

/* Asynchronous Control Character Map (ACCM) is used to specify escape sequences
for control characters in the data stream. */
DWORD TX_DESIRED_ACCM; /* Set to any additional ACCM vaues you want to use */
DWORD RX_DESIRED_ACCM; /* Set to any additional ACCM vaues you want to use */

// The agreed-upon values after negotiation
DWORD TX_ACCM;
DWORD RX_ACCM;

};
```

25.4. StartPPPDameon

Synopsis:

int StartPPPDameon(int serial_port, pppoptions * popt);

Description:

When this function is called, the PPP system initializes the modem and prepares it to receive calls.

Parameters:

serial_port	The serial port to use for communication, 0, 1 or 2.
popt *pppoptions	Structure containing the PPP options.

Returns:

ERR_PPP_SUCESS
ERR_PPP_ALREADY_OPEN
ERR_PPP_NO_DIALTONE
ERR_PPP_NO_ANSWER
ERR_PPP_BUSY
ERR_PPP_FAIL
ERR_PPP_PASSFAIL
ERR_PPP_LOSTCARRIER

25.5. StartPPPDirect

Synopsis:

```
int StartPPPDirect( int serial_port, pppoptions *popt );
```

Description:

This function will initiate a host PPP direct connection on a serial port. StartPPPDirect is similar to StartPPPDameon, but it does not require a modem.

Parameters:

serial_port	The serial port to use for communication, 0, 1 or 2.
popt *pppoptions	Structure containing the PPP options.

Returns:

ERR_PPP_SUCCESS
ERR_PPP_ALREADY_OPEN
ERR_PPP_NO_DIALTONE
ERR_PPP_NO_ANSWER
ERR_PPP_BUSY
ERR_PPP_FAIL
ERR_PPP_PASSFAIL
ERR_PPP_LOSTCARRIER
ERR_PPP_NO_MODEM
ERR_PPP_LCP_FAILED

25.6. DialPPP

Synopsis:

int DialPPP(int serial_port, pppoptions * popt, const char * dial_string);

Description:

This function dials the provided number and attempts to establish a PPP session.

Parameters:

serial_port	The serial port to use for communication, 0, 1 or 2.
popt *pppoptions	Structure containing the PPP options.
dial_string const char *	The dial string to send to the modem. For example "ATD555-1212".

Returns:

ERR_PPP_SUCESS (0)
ERR_PPP_ALREADY_OPEN
ERR_PPP_NO_DIALTONE
ERR_PPP_NO_ANSWER
ERR_PPP_BUSY
ERR_PPP_FAIL
ERR_PPP_PASSFAIL
ERR_PPP_LOSTCARRIER

25.7. DirectConnectPPP

Synopsis:

int DirectConnectPPP(int serial_port, pppoptions *popt, const char *dial_string);

Description:

This function will initiate a client PPP direct connection on a serial port. DirectConnectPPP similar to DialPPP, but it does not require a modem.

Parameters:

serial_port	The serial port to use for communication, 0, 1 or 2.
popt *pppoptions	Structure containing the PPP options.
dial_string const char *	The dial string to send to the modem. For example "ATD555-1212".

Returns:

ERR_PPP_SUCCESS
ERR_PPP_ALREADY_OPEN
ERR_PPP_NO_DIALTONE
ERR_PPP_NO_ANSWER
ERR_PPP_BUSY
ERR_PPP_FAIL
ERR_PPP_PASSFAIL
ERR_PPP_LOSTCARRIER
ERR_PPP_NO_MODEM
ERR_PPP_LCP_FAILED

25.8. GetPPPState

Synopsis:

enum_PPPState GetPPPState( );

Description:

This function returns the current state of the PPP system as defined by the PPPState structure in ppp.h:

```
typedef enum {
   eClosed,
   eInitializingModem,
   eDialing,
   eWait4Ring,
   eAnswering,
   eWaitForTrain,
   eLCPNegotiate,
   ePAPAuthenticate,
   eCHAPAuthenticate,
   eNCPNegotiate,
   eOpen,
   eClosing
}enum_PPPState;
```

Parameters:

None

Returns:

The current state of the PPP system.

25.9. StopPPPDameon

Synopsis:

void StopPPPDameon();

Description:

This function stops the PPP receive daemon started with the StartPPPDameon.

Parameters:

None

Returns:

Nothing.

25.10. ClosePPPSesion

Synopsis:

void ClosePPPSesion( );

Description:

This function closes any active PPP sessions.

Parameters:

None

Returns:

Nothing. This is a void function.

25.11. GetThatPPP_IP

Synopsis:

IPADDR GetThatPPP_IP( );

Description:

Returns the IP address of the other end of the PPP connection.

Parameters:

None

Returns:

An IP address of type IPADDR.

25.12. GetThisPPP_IP

Synopsis:

IPADDR GetThisPPP_IP( );

Description:

Returns the IP address of the NetBurner device used in the PPP connection.

Parameters:

None

Returns:

An IP address of type IPADDR.

25.13. SendCHAPChallenge

Synopsis:

void SendCHAPChallenge( );

Description:

Sends a CHAP packet to the PPP connected device. Note that the #define GATHER_RANDOM must be enabled in \nburn\include\predef.h.

Parameters:

None

Returns:

Nothing.