Dynamic C TCP/IP

User's Manual

Volume 1

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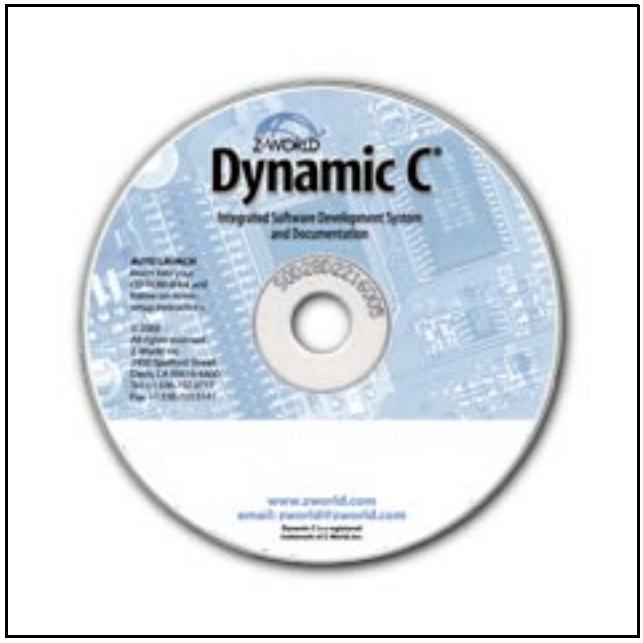

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Dynamic C TCP/IP User's Manual

Volume 1

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1. Introduction

This manual is intended for embedded system designers and support professionals who are using a Rabbit-based controller board. Most of the information contained here is meant for use with Ethernet-enabled boards, but using only serial communication is also an option. Knowledge of networks and TCP/IP (Transmission Control Protocol/Internet Protocol) is assumed. For an overview of these two topics a separate manual is provided, *An Introduction to TCP/IP.* A basic understanding of HTML (HyperText Markup Language) is also assumed. For information on this subject, there are numerous sources on the Web and in any major book store.

The Dynamic C implementation of TCP/IP comprises several libraries. The main library is DCRTCP.LIB. As of Dynamic C 7.05, this library is a light wrapper around DNS.LIB, IP.LIB, NET.LIB, TCP.LIB and UDP.LIB. These libraries implement DNS (Domain Name Server), IP, TCP, and UDP (User Datagram Protocol). This, along with the libraries ARP.LIB, ICMP.LIB, IGMP.LIB and PPP.LIB are the transport and network layers of the TCP/IP protocol stack.

The Dynamic C libraries:

- BOOTP.LIB
- FTP_SERVER.LIB
- FTP_CLIENT.LIB
- HTTP.LIB
- POP3.LIB
- SMNP.LIB
- SMTP.LIB
- TFTP.LIB
- VSERIAL.LIB

implement application-layer protocols. Except for BOOTP, which is described in volume 1 of the manual, these protocols are described in volume 2.

All user-callable functions are listed and described in their appropriate chapter. Example programs throughout the manual illustrate the use of all the different protocols. The sample code also provides templates for creating servers and clients of various types.

To address embedded system design needs, additional functionality has been included in Dynamic C's implementation of TCP/IP. There are step-by-step instructions on how to create HTML forms, allowing remote access and manipulation of information. There is also a serial-based console that can be used with TCP/IP to open up legacy systems for additional control and monitoring. The console may also be used for configuration when a serial port is available. The console and HTML forms are discussed in volume 2.

Multiple interfaces are supported starting with Dynamic C version 7.30.

2. TCP/IP Initialization

This chapter describes the configuration macros, data structures and functions used to configure and initialize the Dynamic C TCP/IP stack. Starting with Dynamic C version 7.30, the stack supports multiple interfaces. Interface configuration is described in Section 2.2.

The Dynamic C TCP/IP stack supports IP version 4. Although multiple interfaces are supported starting with 7.30, the TCP/IP stack does not support packet routing at the IP level.

2.1 TCP/IP Stack Configuration

You need to know certain things to configure the stack. You need to know which interfaces will be used and how many. You also need to determine the necessary software functionality. For example, will there be DNS lookups? Are TCP and UDP protocols both necessary? Will DHCP be used? The ability to remove unneeded features via conditional compilation has been enhanced starting with Dynamic C 7.30. This is accomplished with the configuration macros described in Section 2.5.1 and Section 2.5.2.

2.1.1 Multiple Interface Support

The supported interfaces are:

- Ethernet
- PPP (Point-to-Point Protocol) over a serial link
- PPP over Ethernet

The interfaces must be on distinct, non-overlapping subnets. In particular, each interface must be assigned a unique IP address, known as the “home IP address” for that interface.

The interfaces available to your application will depend on the hardware configuration of the target board. All Rabbit-based boards have at least 4 asynchronous serial ports, so PPP over serial is always available. Many boards have an Ethernet port. If an Ethernet port is available, then it may be used for normal Ethernet or PPP over Ethernet (PPPoE). No Z-World board has more than one Ethernet port, however Dynamic C 7.30 contains support for a second Ethernet if and when such a board becomes available.

Your application uses configuration macros to select the interface(s) to use for TCP/IP. Each hardware interface will have an interface number assigned. The interface number is not used directly; instead, your application should use the macros defined for this purpose. If you are writing general-purpose routines, then you should include `#ifdef` tests for the interface macro if you need to refer to it. This is because the macros are not necessarily defined for non-existent interfaces.

The macros are:

IF_ETH0, IF_ETH1

These macros represent Ethernet ports that are not using PPP. `IF_ETH0` refers to the first (and currently only) Ethernet port.

IF_PPPOE0, IF_PPPOE1

These macros represent Ethernet ports used for PPP over Ethernet. `IF_PPPOE0` refers to the first (and currently only) Ethernet port.

PPPoE and regular Ethernet can co-exist on the same Ethernet hardware. PPPoE effectively sets up a virtual point-to-point link between two devices on the same Ethernet LAN segment.

IF_PPP0, IF_PPP1, IF_PPP2, IF_PPP3, IF_PPP4, IF_PPP5

These macros represent asynchronous serial ports used for PPP. `IF_PPP0` always refers to serial port A, `IF_PPP1` refers to serial port B, etc. Most boards will avoid using serial port A, since it is most often used for Dynamic C debugging and program download.

IF_PPPX

This is an alias for the "first" PPP interface. The first PPP interface is selected as the first valid interface in the following order: `IF_PPPOE0`, `IF_PPPOE1`, `IF_PPP0`, `IF_PPP1`, etc. through to `IF_PPP5`.

IF_DEFAULT

This is an alias for the "default" interface. You can explicitly define this macro prior to including `dcrtcp.lib` to select a default interface. The Dynamic C TCP/IP libraries do not make use of `IF_DEFAULT` with the important exception of DHCP. DHCP only works on the default interface.

If you do not explicitly define `IF_DEFAULT`, it is chosen as the first valid interface in the following order: `IF_PPPX` (see above), `IF_ETH0`, `IF_ETH1`.

If you explicitly define `IF_DEFAULT`, then you must define it to a hard-coded integer value, not one of the `IF_*` macros, since the `IF_*` macros are not defined until `dcrtcp.lib` is included. Since the actual numbers assigned to each interface depend on the values of the `USE_*` macros, you must be careful when doing this. The only time you may want to explicitly define `IF_DEFAULT` is when you are using both PPP and non-PPPoE Ethernet, and you want to use DHCP on the Ethernet interface.

IF_ANY

This is not an interface as such. It is a special value used to denote “any” or “all” interfaces, where applicable. This macro should be used only where a function documents that its use is acceptable. For example, the `tcp_extlisten()` function accepts `IF_ANY` as an interface parameter, which tells it to listen for incoming connections on any available interface.

2.1.2 Interface Selection Macros

As each physical interface has its own macro, each type of interface has a corresponding macro. The macro value determines which physical interfaces of the same type will be supported by the stack. Setting the macro to zero disables support for that type of interface, i.e., no physical interfaces of that type will be supported. If the macros are not defined in the application program, they will be set to zero internally.

USE_ETHERNET

This macro allows support of non-PPPoE Ethernet. It can be set to 0x01, 0x02 or 0x03. Most boards only support 0x01, meaning the first non-PPPoE Ethernet device. Boards with two Ethernet devices can set this macro to 0x02, referring to the second Ethernet device, or 0x03 to allow use of both devices.

USE_PPP_SERIAL

This macro allows support of PPP over asynchronous serial. It can be set to

- 0x01 (serial port A)
- 0x02 (serial port B)
- 0x04 (serial port C)
- 0x08 (serial port D)
- or any bitwise combination of these 4 values

Serial port C is the default, but you may use any of the others. Please note that if you use serial port A (the programming port) Dynamic C will not be able to communicate with the target. You may also need to define other macros to allow correct functioning of the serial port hardware, e.g., hardware flow control.

USE_PPPOE

This macro allows support of PPP over Ethernet. It is set in the same way as `USE_ETHERNET`. The bitmask indicates which Ethernet devices are to be used for PPP over Ethernet.

2.1.2.1 Link Layer Drivers

The USE_* configuration macros described in Section 2.1.2 cause the appropriate link layer drivers to be included. If none of the USE_* macros are defined and the macro PKTDRV is also not defined, realtek.lib will be used. Some board types cause a driver other than realtek.lib to be used, e.g., if the board is a RCM 3200 or 3210, the packet driver library asix.lib will replace realtek.lib.

The following table tells which link layer drivers will be used when a USE_* macro is defined to a value greater than zero.

Table 2.1 Libraries included when USE_* macro value > zero

Configuration Macro	Realtek.lib*	Ppp.lib	Ppplink.lib	Pppoe.lib
USE_ETHERNET	yes	no	no	no
USE_PPP_SERIAL	no	yes	yes	no
USE_PPPOE	yes	yes	no	yes

* or a substitute packet driver library based on board type

As the table reveals, using PPP over Ethernet causes realtek.lib, ppp.lib and pppoe.lib to be included. Multiple drivers may also be included by defining multiple interfaces. For example, defining USE_PPP_SERIAL and USE_PPPOE to values greater than zero will also cause all libraries to be included.

If your application needs to perform conditional compilation that depends on the drivers actually included, then the following macros are defined:

- USING_ETHERNET
- USING_PPP_SERIAL
- USING_PPPOE

These macros are always defined, but will have a zero value if the driver was not included. Thus, the conditional compilation should use the #if operator, not #ifdef. For example,

```
#if USING_PPP_SERIAL
   // Do something special for PPP over serial
#endif
```

The value assigned to the USING_* macro is the number of hardware interfaces of that type that are available. On a Rabbit 2000 board, USING_PPP_SERIAL will be defined to 4 or 0. On a Rabbit 3000 board, the value will be 6 or 0.

An additional macro, USING_PPP, is also defined if any of the PPP-type interfaces are in use. Unlike the above macros, this macro is either defined or not defined, so the correct test is #ifdef.

2.1.3 Single Interface Support

Backwards compatibility exists for applications compiled with earlier versions of Dynamic C. If none of the USE_* macros are defined, then the old behavior (pre-Dynamic C 7.30) is used, which is to include one, and only one, link layer driver.

2.1.3.1 Configuration Macros for Link Layer Driver - Single Interface

Do not define either of these macros if any of the USE_* macros are defined.

PKTDRV

This macro specifies the packet driver to use. Include one of the following statements in your application.

```
#define PKTDRV "realtek.lib"      // To use Ethernet
#define PKTDRV "ppp.lib"          // To use PPP (serial or Ethernet)
```

PPPOE

This macro is defined to use PPP over Ethernet when PKTDRV is set to ppp.lib. For other packet drivers, this define has no effect (but should not be defined in order to avoid problems with future Dynamic C releases).

```
#define PPPOE
```

2.1.4 TCP/IP Stack Initialization

The function sock_init() must be called near the start of your main() function in order to initialize the TCP/IP stack. The return value from sock_init() must indicate success before calling any other TCP/IP functions, with the possible exception of ifconfig().

> **IMPORTANT:** If you are using µC/OS-II, then you must ensure that OSInit() is called before calling sock_init().

sock_init() performs the following actions, and does not return until complete (or an error was encountered):

- Calls subsystem initialization for ARP, TCP, UDP and DNS (if applicable).
- Tests to see whether sock_init() was run previously. If so, then it returns OK. Otherwise, the following steps are executed.
- Initialize the packet driver; basically this resets the hardware and clears out the packet receive buffer pool.
- Clears the router and other server tables.
- When using Ethernet, waits for approximately 1 second for the Ethernet hardware to initialize. This delay is required since some 10/100Mbit hubs take this long to negotiate.
- Interfaces are initialized using the settings specified in the IFCONFIG_* macros or predefined configurations.
- If USE_DHCP is specified, DHCP configuration is completed. This may take a second or so since network traffic needs to flow between the controller board and a DHCP server.

If all of the above completed successfully, the return code is set to 0. Otherwise, the return code will be non-zero, however you can still proceed if the return code is 2 since this indicates that DHCP failed but fallbacks were used. Other return codes indicate that the network is not usable.

After `sock_init()` returns OK, the non-PPPoE Ethernet interface should be ready for traffic if it is intended to be up initially. PPP interfaces may not be fully started even if requested to be up initially. PPP interfaces can take a substantial amount of time to come up, especially if modem dial-out is in use. You can wait for a particular interface to come up by polling the interface status using `ifstatus()` or, preferably, `ifpending()`.

2.2 Interface Configuration

Prior to Dynamic C version 7.30, only a single network interface was supported. Configuration of the interface was performed by defining a set of macros, such as `MY_IP_ADDRESS`, as well as by calling various configuration functions such as `sethostid()`. With version 7.30's support of multiple interfaces, the macro-style configuration becomes impractical, and the configuration functions generally would require an additional parameter, the interface number. Version 7.30 implements a slightly different method of configuration, but maintains compatibility with the old style of configuration for simple applications that require only a single interface.

It is recommended that new applications use the new style of configuration, even if multiple interface support is not required. This will ease the integration of future Dynamic C upgrades.

2.2.1 Configuration Overview

To run the TCP/IP stack, a host (i.e., the controller board) needs to know its unique home IP address for each interface. Interfaces that connect to broadcast networks (i.e., Ethernet) must also have a netmask assigned. The combination of IP address and netmask describes the so-called subnet which is addressable on that interface. The subnet basically describes the community of host addresses that can talk directly to this host, without requiring data to pass through a packet router. Point-to-point links only need an IP address, since there is only one other host by definition.

IP address and netmask are the most important configuration items; however, many other items are needed for successful networking. For anything but strictly local communication, a router or gateway host must be known. The router has the important task of forwarding messages between the local host and the outside world (i.e., hosts that are not on the local subnet). Routers are associated with particular interfaces. Each interface will generally require a different router; however, in the majority of cases only one interface will actually be used to talk to non-local hosts so only one router will be required to service all requests for non-local host addresses.

Some of the configuration items are not specific to any particular interface. For example, DNS (Domain Name System) servers are known by their IP address. DNS servers are used to translate human-readable domain names (e.g., www.zworld.com) into machine-readable IP addresses.

2.2.2 Sources of Configuration Information

The Dynamic C TCP/IP stack obtains configuration information from one or more of the following sources:

- Use one of the predefined configurations in `tcp_config.lib`; static or dynamic (new in version 7.30).
- Macro definitions before `#use "dcrtcp.lib"`; static configuration.
- Bootstrap network protocols such as BOOTP and DHCP; dynamic configuration.
- Runtime function calls such as `ifconfig()` (version 7.30) and `sethostid()` (previous versions).
- "Directed ping" IP address assignment (new in version 7.30).
- Console-based configuration, e.g., `zconsole.lib`.

As application designer, you have to decide which of these configuration techniques is applicable for your project. Entirely static configuration is typically used for initial application development and testing. Most of the TCP/IP sample programs use static configuration for simplicity in getting started. Applications which are intended for real-world use should allow at least one form of dynamic configuration. The particular form of configuration which is supported will depend on the complexity of the application, as well as the expected network or operational environment in which the application will run.

2.2.2.1 Predefined Configurations

Since networking configuration can be fairly complicated, Dynamic C version 7.30 has the concept of "canned" or predefined configurations. This has the advantage of reducing the number of macro definitions at the top of each TCP/IP program, as well as eliminating the need for copy/paste of a lot of settings from one program to the next.

Using the predefined configurations is very easy: simply `#define` a single macro (called `TCPCONFIG`) at the top of each program. The macro is defined to an integer, which selects one of the predefined configurations in `tcp_config.lib`. For example:

```
#define TCPCONFIG 1
#use "dcrtcp.lib"
```

causes the first predefined configuration to be used.

Most of the sample TCP/IP programs will refer to one of the predefined configurations. It is fairly likely (unfortunately) that none of the configurations will work with your network. For example, the default IP address of "10.10.6.100" may not be allowed on your LAN. If this is the case, you can modify `tcp_config.lib` to fix this so it works in your environment. Having fixed it once, all of the sample programs should work, since they all pull the same definitions out of `tcp_config.lib`.

The disadvantage of modifying `tcp_config.lib` is that any changes you make may be overwritten if you install a new release of Dynamic C. If this is a problem, then there is a solution: you can create a new library called `custom_config.lib`. In this library, you can place your own custom configurations which will not be overwritten by Dynamic C (since this is not a released library).

To create custom_config.lib, you can use tcp_config.lib as a template. Modify the definitions to suit your network environment. You must change the configuration numbers to be greater than or equal to 100. Numbers less than 100 are expected to be in tcp_config.lib; numbers over 99 cause custom_config.lib to be included.

The other thing you must do before using your own custom configurations is to add the library name (custom_config.lib) to the LIB.DIR file in the base Dynamic C installation directory. This is just a text file, which you can edit with the Dynamic C text editor. Locate the line that contains "tcp_config.lib." Repeat this line, and modify one of the line copies to point to your custom_config.lib file. You will not have to restart Dynamic C for this change to take effect.

A new release of Dynamic C will overwrite the LIB.DIR file, so you will need to perform this edit for each release.

To use custom configurations that you define, the only thing necessary in each sample program is to change the definition of the TCPCONFIG macro to indicate the appropriate configuration e.g.,

```
#define TCPCONFIG 100
#use "dcrtcp.lib"
```

2.2.2.2 Static Configuration

This is conceptually the easiest means of configuration; however it is primarily suitable for testing purposes (or possibly as a fallback in case other configuration techniques do not yield a result in a reasonable amount of time).

Prior to version 7.30, the (only) interface was configured by defining a fixed set of macros before including dcrtcp.lib. The most common definitions were limited to:

MY_IP_ADDRESS, MY_NETMASK, MY_GATEWAY and MY_NAMESERVER.

At runtime, the functions, tcp_config(), sethostid() and sethostname() override the configuration macros.

Version 7.30 still allows use of these macros for backwards compatibility, however, it is recommended that the new style of static configuration be used for new applications. The new configuration style uses macros called IFCONFIG_*, where '*' is replaced by the interface name e.g., IFCONFIG_ETH0 for the first Ethernet port. IFCONFIG_ALL contains configuration items which are not specific to any particular interface.

The value of the IFCONFIG_* macro is actually a list of items in the syntactic form of a C parameter list. For example, if the old style configuration (for Ethernet) was

```
#define MY_IP_ADDRESS "10.10.6.100"
#define MY_NETMASK "255.255.255.0"
#define MY_GATEWAY "10.10.6.1"
```

then the new replacement would be

```
#define IFCONFIG_ETH0 \
    IFS_IPADDR, aton("10.10.6.100"), \
    IFS_NETMASK, aton("255.255.255.0"), \
    IFS_ROUTER_SET, aton("10.10.6.1"), \
    IFS_UP
```

The replacement looks more complex, but this is because the macro value must be valid C syntax for a parameter list. The IFS_UP parameter at the end of the above example is a new feature for interfaces: they can be dynamically brought up and down. The default state for an interface is "down," which is why an explicit IFS_UP is required. The backslashes at the end of each line are used to continue the macro definition over more than one line.

The format of the static initialization macros will make more sense if you examine the documentation for the ifconfig() function. You will see that the macro definition is merely "plugged in" to the parameter list for an ifconfig() call.

2.2.2.3 Dynamic Configuration via the Network

The Dynamic C TCP/IP stack supports DHCP (Dynamic Host Configuration Protocol) or BOOTP (Bootstrap Protocol) for dynamic configuration. DHCP is a more modern replacement for BOOTP, which was originally designed to support bootstrap of diskless workstations. Use of these protocols can completely eliminate the need for static configuration.

The library BOOTP.LIB allows a target board to be a BOOTP or DHCP client. The protocol used depends on what type of server is installed on the local network. BOOTP and DHCP servers are usually centrally located on a local network and operated by the network administrator. Note that initialization may take longer when using DHCP as opposed to static configuration, but this depends on your server.

Both protocols allow a number of configuration parameters to be sent to the client, including:

- client's IP address.
- net mask.
- list of gateways.
- host and default domain names.
- list of name servers.

BOOTP assigns permanent IP addresses. DHCP can "lease" an IP address to a host, i.e., assign the IP address for a limited amount of time. There are two user-callable functions regarding IP address leases dhcp_release() and dhcp_acquire() (described in Chapter 7). In addition, there are a number of macros and global variables available for modifying behavior and obtaining information. Please see Section 2.5.3 and Section 2.5.4 for details.

As of 7.30, DHCP or BOOTP can be used only on the default interface i.e., the interface which is specified by the value of the IF_DEFAULT macro. If you are using more than one interface then you should ensure that IF_DEFAULT is set correctly.

To successfully use DHCP configuration, ensure all of the following conditions are met. (Only the first condition applies prior to 7.30.)

- #define USE_DHCP before including dcrtcp.lib.
- Ensure IF_DEFAULT is indicating the desired interface.
- Define an IFCONFIG_* macro to include the IFS_DHCP parameter ID.

For example, if the Ethernet interface is to be used for DHCP, the following code is required for DHCP:

```
#define USE_DHCP
#define IF_DEFAULT 0              // not necessary unless also using PPP
#define IFCONFIG_ETH0 IFS_DHCP, 1, IFS_UP
#use "dcrtcp.lib"
```

You may also use the predefined configuration number 3, which is DHCP:

```
#define TCPCONFIG 3
#use "dcrtcp.lib"
```

This configuration sets all required macros for DHCP (or BOOTP) to work. Naturally, there must be a DHCP server available on the interface. The DHCP server must be set up to contain all the required configuration options, however setting up the DHCP server is outside the scope of this document, since there are many different DHCP servers in use.

The sample program `Samples\tcpip\dhcp.c` uses dynamic configuration in a basic TCP/IP program that will initialize the TCP/IP interface, and allow the device to be 'pinged' from another computer on the network. It demonstrates DHCP features, such as releasing and re-acquiring IP addresses and downloading a configuration file.

2.2.2.4 Runtime Configuration using ifconfig()

`ifconfig()` is a function introduced in version 7.30. This function does many things, and is the recommended replacement for some of the functions marked as "deprecated" (including `tcp_config()`). `ifconfig()` performs most of the work for all the other configuration techniques. For example, static configuration (via the `IFCONFIG_*` macros) basically calls `ifconfig()` with the specified parameters substituted in.

`ifconfig()` takes a variable number of parameters, like `printf()`, however the parameter list is terminated with the special `IFS_END` symbol. For example, to use `ifconfig()` to set the same parameters as described above for the static configuration:

```
ifconfig(IF_ETH0, IFS_IPADDR, aton("10.10.6.100"),
         IFS_NETMASK, aton("255.255.255.0"),
         IFS_ROUTER_SET, aton("10.10.6.1"),
         IFS_UP,
         IFS_END);
```

Note that this is the same as substitution of the `IFCONFIG_*` macro e.g.,

```
ifconfig(IF_ETH0, IFCONFIG_ETH0, IFS_END);
```

`ifconfig()` is also used to obtain current configuration items at runtime e.g.,

```
longword ipaddr;
ifconfig(IF_ETH0, IFG_IPADDR, &ipaddr, IFS_END);
```

gets the current IP address of the first Ethernet interface into the variable `ipaddr`.

The first parameter of `ifconfig()` is the interface number. For certain settings, this can also be `IF_ANY`, which means apply the settings to all applicable interfaces. The parameters following

the first are an arbitrary number of tuples consisting of a parameter identifier followed by the value(s) for that parameter (if any). The list of parameters must be terminated by a special identifier, `IFS_END`. See the documentation for `ifconfig()` for a complete list of parameter identifiers with their expected values.

2.2.2.5 Directed Ping

This style of configuration, also known as ICMP configuration, is limited to setting the IP address of the interface. It only works on non-PPPoE Ethernet interfaces. To specify directed ping configuration, use the `IFS_ICMP_CONFIG` parameter ID in a call to `ifconfig()` or in the definition of the `IFCONFIG_*` macro for the interface. For example

```
#define IFCONFIG_ETH0 IFS_ICMP_PING, 1
```

for a static configuration, or

```
ifconfig(IF_ETH0, IFS_ICMP_CONFIG, 1, IFS_END);
```

at runtime. Note that you can use both directed ping and DHCP on the same interface, but directed ping is not limited to just the default interface. If both directed ping and DHCP are allowed on a particular interface, the first one “wins.”

Directed ping works as follows. The interface is brought up, but has no assigned IP address so it cannot be used for normal traffic. If the interface receives an ICMP echo request (i.e., ping) which is directed to the interface’s MAC address, then the destination IP address in the ICMP packet is assigned to the interface as its home IP address. After that point, the interface is configured and is available for normal traffic.

The weakness of directed ping is that only the IP address is provided. The netmask must be preconfigured or obtained by other means. Technically, directed ping violates some tenets of the Internet standards, however, it can be useful in controlled environments.

In order for directed ping to work, the MAC address of the board must be known (see below). The host which initiates the ICMP echo request must have its ARP table statically configured with the target MAC address. On Unix and Windows hosts, the appropriate command sequence is

```
arp -s <IP address> <MAC address>
```

followed by

```
ping <IP address>
```

The actual format of the MAC address depends on the operating system. Most hosts will recognize a format like “00-09-A0-20-00-99”. The IP address is in dotted decimal notation.

Once the interface is configured by directed ping (or DHCP), then further directed ping or DHCP configurations for that interface are not allowed. If desired, at runtime you can issue

```
ifconfig(IF_ETH0, IFS_ICMP_CONFIG_RESET, IFS_END);
```

to allow another directed ping configure.

2.2.2.6 Console Configuration via Zconsole.lib

The `zconsole.lib` library contains routines for allowing an external (serial or telnet) terminal to issue configuration commands. Basically, the commands call `ifconfig()` to perform the actual requests or obtain information.

Using a “dumb terminal” connection over a serial port presents no special difficulties for network configuration. Using telnet over the internet obviously requires a working TCP stack to begin with. This is still useful in the case that one of the other configuration techniques can at least get to a working state. For example, directed ping can assign an IP address. You could then use the same host to telnet into the new IP address in order to set other items like the netmask and router.

2.2.2.7 Media Access Control (MAC) address

Rarely, ISPs require that the user provide them with a MAC address for their device. Run the utility program, `Samples\tcpip\display_mac.c`, to display the MAC address of your controller board.

The MAC address is also required for directed PING configure, as well as some other bootstrap techniques. MAC addresses are often written as a sequence of six two-digit hexadecimal numbers, separated by colons e.g., 00:90:20:33:00:A3. This distinguishes them from IP addresses, which are written with dotted decimal numbers.

MAC addresses are completely unrelated to IP addresses. IP addresses uniquely identify each host on the global Internet. MAC addresses uniquely identify Ethernet hardware on a particular Ethernet LAN segment. Although only technically required to be unique on a LAN segment, in practice MAC addresses are globally unique and can thus be used to uniquely identify a particular Ethernet adapter.

The usual reason for an ISP requiring a MAC address is if the ISP uses DHCP to dynamically assign IP addresses. Most ISPs use PPP (Point to Point Protocol) which does not care about MAC addresses. DHCP can use the MAC address to determine that the same device is connecting, and assign it the same IP address as before.

2.3 Dynamically Starting and Stopping Interfaces

Dynamic C version 7.30 allows interfaces to be individually brought up and down by calling the `ifup()`, `ifdown()` or `ifconfig()` functions. The initial desired state of the interface is specified using the `IFCONFIG_*` macros. By default, interfaces are not brought up when `sock_init()` is called at boot time. Only if the `IFCONFIG_*` macro contains an `IFS_UP` directive will the interface will be brought up at boot time.

Most applications should not need to dynamically change the interface status. The exception to this may be PPP over serial interfaces, where a modem is used to dial out to an ISP on demand.

2.3.1 Testing Interface Status

There are two functions for testing the current status of an interface: `ifstatus()` and `ifpending()`. The function `ifstatus()` merely returns a boolean value indicating whether the interface is up. If the return value is true (non-zero), then the interface is ready for normal TCP/IP communications. Otherwise, the interface is not yet available; it may either be down, or in the process of coming up.

`ifpending()` gives more information: its return value indicates not only the current state, but also if the state is in the process of changing.

If your application needs to check the interface status, which is recommended for PPP over serial or PPPoE, then it can either poll the status using the above functions, or it can register a callback function which is automatically called whenever the interface changes status.

To register a callback function, you call `ifconfig()` with the `IFS_IF_CALLBACK` as the parameter identifier, and the address of your callback function as the parameter value.

2.3.2 Bringing an Interface Up

You can call `ifup()`, or `ifconfig()` with the `IFS_UP` parameter identifier. The advantage of using `ifconfig()` is that you can specify an interface number of `IF_ANY`, which brings all interfaces up together.

When the `ifup()` call returns, the interface may not have completed coming up. This is notably the case for PPP interfaces, which require a number of protocol negotiation packets to be sent and received. In addition, PPP over serial may require additional time to reset a modem, dial out to an ISP, and possibly respond to the ISP's login procedure. All this could take considerable time, so the `ifup()` function does not wait around for the process to complete, to allow the application to proceed with other work.

On return from the `ifup()` call, an application must test for completion using the functions described in the previous section.

In order for the interface to come up completely, your application must call `tcp_tick()` regularly while waiting for it. If you can afford to block until the interface is up, then use code similar to the following:

```
ifup(IF_PPP2);
// Wait for the interface to have any status other than "down coming up."
while (ifpending(IF_PPP2) == 1) tcp_tick();
if (ifstatus(IF_PPP2))
   printf("PPP2 is up now.\n");
else
   printf("PPP2 failed to come up.\n");
```

2.3.3 Bringing an Interface Down

You can call `ifdown()`, or `ifconfig()` with the `IFS_DOWN` parameter identifier. The advantage of using `ifconfig()` is that you can specify an interface number of `IF_ANY`, which brings all interfaces down together.

As for `ifup()`, `ifdown()` does not necessarily complete immediately on return. PPP requires link tear-down messages to be sent to the peer and acknowledged. Thus, similar considerations apply to bringing an interface down as they do for bringing it up.

`ifdown()` will always succeed eventually. Unlike `ifup()`, which can possibly fail to bring the interface up, `ifdown()` will always eventually return success i.e., it is not possible for an interface to be left "hanging up." If the PPP link tear-down does not get an acknowledgment from the peer, then the process times out and the link is forced down.

2.4 Setting up PPP Interfaces

PPP interfaces are slightly more complicated to configure than non-PPPoE Ethernet. They also generally take more time to become established. The advantage of PPP is that it can be made to run over a wide variety of physical layer hardware: on Rabbit-based boards this includes the asynchronous serial ports, as well as Ethernet (using PPPoE). Use of PPP over asynchronous serial allows boards with no Ethernet hardware to communicate using TCP/IP protocols.

Starting with Dynamic C version 7.30, the process of establishing a PPP link has been more tightly integrated into the library (using the `ifup()/ifdown()/ifconfig()` functions). Prior to 7.30, your application had to be hard-coded to use either Ethernet, PPP or PPPoE.

The Dynamic C Module document titled "PPP Driver" explains the details of establishing PPP interfaces. The following sections provide an overview.

2.4.1 PPP over Asynchronous Serial

There are two basic scenarios for use of PPP over asynchronous serial (shortened here to just PPP). The first is a direct, hard-wired, connection to another machine. The second is a connection to an ISP (Internet Service Provider) via a modem. Modem connections introduce another layer of complexity in that the modem itself must be instructed to connect to the desired peer's modem, most often via the PSTN (Public Switched Telephone Network). Most often, ISPs also have special requirements for establishing PPP links which are often unrelated to PPP itself. For example, many ISPs require navigation of "login scripts" which are basically intended for human users.

With hard-wired connections, e.g., RS232 cables with "null modems" or "crossed-over connections," the process of establishing a PPP link is relatively simple and reliable. Bringing such a PPP link up involves opening the serial port, sending and receiving PPP link negotiation messages (known as LCP; Link Control Protocol), sending and receiving authentication messages (PAP; Password Authentication Protocol) then finally sending and receiving Internet Protocol Control Messages (IPCP). If all negotiations are successful, the link is then ready for TCP/IP traffic.

If the link is established via a modem, then an extra layer of activity must precede the initial PPP negotiation. This is outside the scope of PPP, since it is really related to the establishment of a physical layer. The TCP/IP library gives you the option of incorporating the modem connection phase into the process of bringing the interface up and down. If preferred, the modem phase can be performed entirely separately from the `ifup()/ifdown()` process. This may be necessary if there are special requirements for connecting to the ISP.

2.4.2 PPP over Ethernet

PPPoE is often considered a "hack." It seems superfluous to define a protocol that establishes a logical "connection" between two peers on what is otherwise a broadcast (i.e., any-to-any) medium. Nevertheless, the existence of PPPoE was largely dictated by the needs of ISPs who wished to continue using their existing infrastructure, based on the earlier generation of dial-in connections. The advent of high speed (ADSL etc.) modems, that had an Ethernet connection to the user's network, made PPPoE an attractive proposition. If your application requires connection to an ISP via an ADSL modem, then you will most likely need to support PPPoE.

PPPoE also requires a physical layer negotiation to precede the normal PPP negotiations. This is known as the "access concentrator discovery" phase ("discovery" for short). PPPoE makes a dis-

tinction between PPPoE servers and PPPoE clients, however, PPP makes no distinction; you can think of PPP as also standing for Peer to Peer Protocol. The PPPoE server is known as the access concentrator. The Dynamic C TCP/IP libraries do not support acting as the access concentrator; only the PPPoE client mode is supported. This is the most common case, since the DSL modem is always configured as an access concentrator.

2.5 Configuration Macro Reference

This section categorizes the configuration macros by their purpose.

2.5.1 Removing Unnecessary Functions

The following macros default to being undefined (i.e., the functionality is included by default). You can define one or more of these macros to free up code and data memory space.

DISABLE_DNS

This macro disables DNS lookup. This prevents a UDP socket for DNS from being allocated, thus saving memory. Users may still call `resolve()` with an IP address, provided that the address is in dotted decimal form i.e., does not require a real DNS lookup.

DISABLE_UDP

This macro disables all UDP functionality, including DNS, SNMP, TFTP and DHCP/BOOTP. You can define this to save a small amount of code if your application only needs to be a TCP server, or a TCP client that does not need to do name lookups.

This macro is available starting with Dynamic C 7.30.

DISABLE_TCP

This macro disables all TCP functionality, including HTTP (web server), SMTP (mail) and other TCP-based protocols. You can define this to save a substantial amount of code if your application only needs UDP.

This macro is available starting with Dynamic C 7.30.

2.5.2 Including Additional Functions

The following macros default to being undefined i.e., the functionality is not included by default.

USE_DHCP

This macro is required when DHCP or BOOTP functionality is desired.

USE_SNMP

Define this to be the version number of SNMP (Simple Network Management Protocol) to be supported. Currently, the only allowable value is ‘1’.

USE_MULTICAST

This macro will enable multicast support. In particular, the extra checks necessary for accepting multicast datagrams will be enabled and joining and leaving multicast groups (and informing the Ethernet hardware about it) will be added.

USE_IGMP

If this macro is defined, the USE_MULTICAST macro is automatically defined. This macro enables sending reports on joining multicast addresses and responding to IGMP queries by multicast routers. Unlike USE_MULTICAST, this macro must be defined to be 1 or 2. This indicates which version of IGMP will be supported. Note, however, that both version 1 and 2 IGMP clients will work with both version 1 and 2 IGMP routers. Most users should just choose version 2.

2.5.3 BOOTP/DHCP Control Macros

Various macros control the use of DHCP. Apart from setting these macros before '#use dcrtcp.lib', there is typically very little additional work that needs to be done to use DHCP/BOOTP services. Most of the work is done automatically when you call sock_init() to initialize TCP/IP. There are more control macros available than what are listed here. Please look at the beginning of the file lib\tcpip\bootp.lib for more information.

USE_DHCP

If this macro is defined, the target uses BOOTP and/or DHCP to configure the required parameters. This macro *must* be defined to use DHCP services.

DHCP_USE_BOOTP

If defined, the target uses the first BOOTP response it gets. If not defined, the target waits for the first DHCP offer and only if none comes in the time specified by _bootptimeout does it accept a BOOTP response (if any). Use of this macro speeds up the boot process, but at the expense of ignoring DHCP offers if there is an eager BOOTP server on the local subnet.

DHCP_CHECK

If defined, and USE_DHCP is defined, then the target will check for the existence of another host already using an offered IP address, using ARP. If the host exists, then the offer will be declined. If this happened most DHCP servers would log a message to the administrator, since it may represent a misconfiguration. If not defined, then the target will request the first offered address without checking.

DHCP_CLASS_ID "Rabbit2000-TCPIP:Z-World:Test:1.0.0"

This macro defines a class identifier by which the OEM can identify the type of configuration parameters expected. DHCP servers can use this information to direct the target to the appropriate configuration file. Z-World recommends the standard format: "hardware:vendor:product code:firmware version."

DHCP_USE_TFTP

If this and USE_DHCP are defined, the library will use the BOOTP filename and server to obtain an arbitrary configuration file that will be accessible in a buffer at physical address _bootpdata, with length, _bootpsize. The global variables, _bootpdone and _bootperror indicate the status of the boot file download. DHCP_USE_TFTP should be defined to the maximum file size that may be downloaded.

DHCP_CLIENT_ID clientid_char_ptr
DHCP_CLIENT_ID_LEN clientid_length

Define a client identifier string. Since the client ID can contain binary data, the length of this string must be specified as well. This string MUST be unique amongst all clients in an administrative domain, thus in practice the client ID must be individually set for each client e.g., via front-panel configuration. It is NOT recommended to program a hard-coded string (as for class ID). Note that RFC2132 recommends that the first byte of the string should be zero if the client ID is not actually the hardware type and address of the client (see next).

DHCP_CLIENT_ID_MAC

If defined, this overrides DHCP_CLIENT_ID, and automatically sets the client ID string to be the hardware type (1 for Ethernet) and MAC address, as suggested by RFC2132.

2.5.4 BOOTP/DHCP Global Variables

The following list of global variables may be accessed by application code to obtain information about DHCP or BOOTP. These variables are only accessible if USE_DHCP is defined. The variables marked "deprecated" should be accessed using ifconfig(IF_DEFAULT,...) as noted, rather than directly accessed.

_bootpon (Deprecated)

Runtime control of whether to perform DHCP/BOOTP. This is initially set to 'true.' It can be set to false before calling sock_init (the function that initializes the TCP/IP stack), causing static configuration to be used. Static configuration uses the values defined for the configuration macros, MY_IP_ADDRESS etc. If BOOTP fails during initialization, this will be reset to 0. If reset, then you can call dhcp_acquire() at some later time.

NOTE: Starting with Dynamic C 7.30, it is recommended that you do not manipulate this flag. Use ifconfig() instead to set the DHCP status for the default interface, using the IFS_DHCP/IFG_DHCP parameter.

_survivebootp (Deprecated)

Set to one of the following values:

0: If BOOTP/DHCP fails, then a runtime error occurs. This is the default.
1: If BOOTP fails, then use the values in MY_IP_ADDRESS etc. If those macros are not defined, a runtime error occurs.

NOTE: Starting with Dynamic C 7.30, it is recommended that you do not manipulate this flag. Use ifconfig() with the IFS_DHCP_FALLBACK parameter.

_dhcphost

IP address of last-used DHCP server (~0UL if none). If _survivebootp is true, then this variable should be checked to see if DHCP/BOOTP was actually used to obtain the lease. If _dhcphost is ~0UL, then the fallback parameters (MY_IP_ADDRESS etc.) were used since no DHCP server responded.

_bootphost

IP address of the last-used BOOTP/TFTP server (~0UL if none). Usually obtained from the siaddr field of the DHCP OFFER/ACK message. This is the default host used if NULL is given for the hostname in the call to tftp_exec(). This is the host that provides the boot file.

_dhcplife, _dhcpt1, _dhcpt2

These variables contain various absolute time values (referenced against SEC_TIMER) at which certain aspects of the DHCP protocol get activated. _dhcplife is when the current lease expires. If _dhcplife is ~0UL (i.e., 0xFFFFFFFF) then the lease is permanent and the other variables are not used. Otherwise, _dhcpt1 is when the current lease must be renewed by the current DHCP server. _dhcpt2 is when the lease must be re-bound to a possibly different server, if the current server does not respond. In general, _dhcpt1 < _dhcpt2 < _dhcplife. To work out the number of seconds remaining until the current lease expires, use code similar to

```
if (_dhcplife == ~0UL)
  printf("Lease is permanent\r\n");
else if (_dhcplife > SEC_TIMER)
  printf("Remaining lease %lu seconds\r\n",
   _dhcplife - SEC_TIMER);
else
  printf("Lease is expired\r\n");
```

_bootptimeout (Deprecated)

Number of seconds to wait for a BOOTP or DHCP offer. If there is no response within this time (default 30 seconds), then BOOTP is assumed to have failed, and the action specified by _survivebootp will be taken. You can set this variable to a different value before calling sock_init().

NOTE: Starting with Dynamic C 7.30, it is recommended that you do not manipulate this flag. Use ifconfig() with the IFS_DHCP_TIMEOUT parameter.

_bootpdone

Is set to a non-zero value when TFTP download of the boot file is complete. This variable only exists if DHCP_USE_TFTP is defined. It is set to one of the following values:

0: Download not complete, or boot file not yet known.
1: Boot file download completed (check _bootperror for status).
2: No boot file was specified by the server.

_bootpsize

Indicates how many bytes of the boot file have been downloaded. Only exists if DHCP_USE_TFTP is defined.

_bootpdata

Physical starting address of boot data. The length of this area will be DHCP_USE_TFTP bytes, however, the actual amount of data in the buffer is given by _bootpsize. This variable only exists if DHCP_USE_TFTP is defined and is only valid if _bootpdone is 1. You can access the data using xmem2root() and related functions.

_bootperror

Indicates any error which occurred in a TFTP process. This variable only exists if DHCP_USE_TFTP is defined and is only valid when _bootpdone is 1.

_bootperror is set to one of the following values (which are also documented with the tftp_tick() function):

- 0: No error.
- -1: Error from boot file server, transfer terminated. This usually occurs because the server is not configured properly, and has denied access to the nominated file.
- -2: Error, could not contact boot file server or lost contact.
- -3: Timed out, transfer terminated.
- -4: (not used)
- -5: Transfer complete, but truncated because buffer too small to receive the complete file.

_smtpsrv

IP address of mail server, or 0 if not obtained.

2.5.5 Buffer and Resource Sizing

MAX_SOCKETS (deprecated)

This macro defines the number of sockets that will be allocated, not including the socket for DNS lookups. It defaults to 4. If libraries such as HTTP.LIB or FTP_SERVER.LIB are used, you must provide enough sockets in MAX_SOCKETS for them also. This macro has been replaced by MAX_TCP_SOCKET_BUFFERS and MAX_UDP_SOCKET_BUFFERS.

MAX_SOCKET_LOCKS

For µC/OS-II support. This macro defines the number of socket locks to allocate. It defaults to MAX_TCP_SOCKET_BUFFERS + MAX_UDP_SOCKET_BUFFERS.

This macro is necessary because we can no longer calculate the number of socket locks needed based on the number of socket buffers, now that the user can manage their own socket buffers.

MAX_TCP_SOCKET_BUFFERS

Starting with Dynamic C version 7.05, this macro determines the maximum number of TCP sockets with preallocated buffers. If MAX_SOCKETS is defined, then MAX_TCP_SOCKET_BUFFERS will be assigned the value of MAX_SOCKETS for

backwards compatibility. If neither macro is defined, MAX_TCP_SOCKET_BUFFERS defaults to 4.

MAX_UDP_SOCKET_BUFFERS

Starting with Dynamic C version 7.05, this macro determines the maximum number of UDP sockets with preallocated buffers. It defaults to 0.

SOCK_BUF_SIZE (deprecated)

This macro determines the size of the socket buffers. A TCP socket will have two buffers of size SOCK_BUF_SIZE/2 for send and receive. A UDP socket will have a single buffer of size SOCK_BUF_SIZE. Both types of sockets take the same total amount of buffer space. This macro has been replaced by TCP_BUF_SIZE and UDP_BUF_SIZE.

TCP_BUF_SIZE

Starting with Dynamic C 7.05, TCP and UDP socket buffers are sized separately. TCP_BUF_SIZE defines the buffer sizes for TCP sockets. It defaults to 4096 bytes. Backwards compatibility exists with earlier version of Dynamic C: if SOCK_BUF_SIZE is defined, TCP_BUF_SIZE is assigned the value of SOCK_BUF_SIZE. If SOCK_BUF_SIZE is not defined, but tcp_MaxBufSize is, then TCP_BUF_SIZE will be assigned the value of tcp_MaxBufSize*2.

tcp_MaxBufSize (deprecated)

This use of this macro is deprecated in Dynamic C version 6.57 and higher; it has been replaced by SOCK_BUF_SIZE.

In Dynamic C versions 6.56 and earlier, tcp_MaxBufSize determines the size of the input and output buffers for TCP and UDP sockets. The sizeof(tcp_Socket) will be about 200 bytes more than double tcp_MaxBufSize. The optimum value for local Ethernet connections is greater than the Maximum Segment Size (MSS). The MSS is 1460 bytes. You may want to lower tcp_MaxBufSize, which defaults to 2048 bytes, to reduce RAM usage. It can be reduced to as little as 600 bytes.

tcp_MaxBufSize will work slightly differently in Dynamic C versions 6.57 and higher. In these later versions the buffer for the UDP socket will be tcp_MaxBufSize*2, which is twice as large as before.

UDP_BUF_SIZE

Starting with Dynamic C 7.05, TCP and UDP socket buffers are sized separately. UDP_BUF_SIZE defines the buffer sizes for UDP sockets. It defaults to 4096 bytes. Backwards compatibility exists with earlier version of Dynamic C: if SOCK_BUF_SIZE is defined, UDP_BUF_SIZE is assigned the value of SOCK_BUF_SIZE. If SOCK_BUF_SIZE is not defined, but tcp_MaxBufSize is, then UDP_BUF_SIZE will be assigned the value of tcp_MaxBufSize*2.

ETH_MTU

Define the Maximum Transmission Unit for Ethernet and PPPoE interfaces. The default is 600, but may be increased to a maximum of 1500 subject to root data memory limitations. PPPoE always uses a value that is 8 less than this figure. For maximum throughput on an Ethernet link, use the largest value (1500).

Note that, in DC version 7.30, a macro will be defined which is set to the larger of `ETH_MTU` and `PPP_MTU`. This macro is called `MAX_MTU`, and is used for sizing the receive buffer for incoming packets from all interfaces.

PPP_MTU

Define the maximum transmission/receive unit for PPP over serial links. This defaults to the same as `ETH_MTU` if it is defined, or 600. This macro is new for 7.30.

ETH_MAXBUFS

Define the maximum number of incoming packets that may be buffered. Defaults to 10. The buffers are shared between all interfaces (in spite of the name). The total amount of root data storage for incoming packets depends on the configured mix of interface types, but is (`MAX_MTU`+22)*`ETH_MAXBUFS` for just Ethernet without PPPoE. This will default to 6220 bytes if the defaults are selected.

ARP_TABLE_SIZE

Define to the number of ARP table entries. The default is set to the number of interfaces, plus 5 entries for every Ethernet interface (excluding PPPoE). The maximum allowable value is 200.

ARP_ROUTER_TABLE_SIZE

Define the maximum number of routers. Defaults to the number of interfaces, plus an extra entry for each Ethernet (excluding PPPoE) .

MAX_STRING

Define the maximum number of characters for a hostname or for a mail server when using the function `smtp_setserver()`. Defaults to 50.

MAX_NAMESERVERS

Define the maximum number of DNS servers. Defaults to 2.

MAX_COOKIES

Define the maximum number of cookies that a server can send to or receive from a client. Defaults to 1.

TCP_MAXPENDING

Define the maximum number of pending TCP connections allowed in the active list. Defaults to 20.

MAX_RESERVEPORTS

Defines the maximum number of TCP port numbers that may be reserved. Defaults to 5 if USE_RESERVEDPORTS is defined (which is defined by default). For more information about USE_RESERVEDPORTS and setting up a listen queue, please see Section 3.3.4.

DNS_MAX_RESOLVES

4 by default. This is the maximum number of concurrent DNS queries. It specifies the size of an internal table that is allocated in xmem.

DNS_MAX_NAME

64 by default. Specifies the maximum size in bytes of a host name that can be resolved. This number includes any appended default domain and the NULL-terminator. Backwards compatibility exists for the MAX_DOMAIN_LENGTH macro. Its value will be overridden with the value DNS_MAX_NAME if it is defined.

For temporary storage, a variable of this size must be placed on the stack in DNS processing. Normally, this is not a problem. However, for µC/OS-II with a small stack and a large value for DNS_MAX_NAME, this could be an issue.

DNS_MAX_DATAGRAM_SIZE

512 by default. Specifies the maximum length in bytes of a DNS datagram that can be sent or received. A root data buffer of this size is allocated for DNS support.

DNS_SOCK_BUF_SIZE

1024 by default. Specifies the size in bytes of an xmem buffer for the DNS socket. Note that this means that the DNS socket does not use a buffer from the socket buffer pool.

2.5.6 Pre Version 7.30 Network Configuration

These macros should only be used for releases of Dynamic C prior to version 7.30. They are supported in 7.30 for backward compatibility, however new applications should use the new style of configuration outlined in the next section. Use of the runtime functions mentioned in this section is deprecated in favor of ifconfig().

MY_DOMAIN

This macro is the initial value for the domain portion of the controller's address. At runtime, it can be overwritten by tcp_config() and setdomainname().

MAX_DOMAIN_LENGTH

Specify the maximum domain name length, including any concatenated host name. Defaults to 128.

MY_GATEWAY

This macro gives the default value for the controllers default gateway. At runtime, it can be overwritten by tcp_config().

MY_IP_ADDRESS

This macro is the default IP address for the controller. At runtime, it can be overwritten by `tcp_config()` and `sethostid()`.

MY_NAMESERVER

This macro is the default value for the primary name server. At runtime, it can be overwritten by `tcp_config()`.

MY_NETMASK

This macro is the default netmask for the controller. At runtime, it can be overwritten by `tcp_config()`.

2.5.7 Version 7.30 Interface Configuration

TCPCONFIG

Define to the number of a predefined configuration in `tcp_config.lib` (numbers less than 100) or `custom_config.lib` (numbers greater or equal to 100). Defaults to 0, which means no predefined configuration.

USE_ETHERNET

Define to 0 (or leave undefined) if Ethernet is not required. Define to 1 if the first Ethernet port is to be used. Defaults to 0. This macro does not include PPPoE interfaces.

USE_PPP_SERIAL

Define to a bitwise-OR combination of

- 0x01 - Serial port A (`IF_PPP0`)
- 0x02 - Serial port B (`IF_PPP1`)
- 0x04 - Serial port C (`IF_PPP2`)
- 0x08 - Serial port D (`IF_PPP3`)

Defaults to 0, i.e., no PPP over serial.

USE_PPPOE

Define in the same way as `USE_ETHERNET`, except that PPPoE is used on the specified Ethernet port. Defaults to 0 i.e., no PPPoE interfaces.

IFCONFIG_ALL
IFCONFIG_DEFAULT
IFCONFIG_ETH0
IFCONFIG_PPP0..5
IFCONFIG_PPPOE0

All the above IFCONFIG_* macros are defined in a similar manner. IFCONFIG_ALL is reserved for configuration items that are not specific to any particular interface number. IFCONFIG_DEFAULT is applied to the default interface (IF_DEFAULT) if there is no specific IFCONFIG_* for the default interface.

These macros must be defined as a C parameter list fragment. This is because the macro value is substituted into a call to ifconfig() at initialization time (sock_init()). For example, the fragment of code that initializes the non-PPPoE Ethernet interface looks somewhat like the following:

```
#ifdef IF_ETH0
  #ifdef IFCONFIG_ETH0
     ifconfig(IF_ETH0, IFCONFIG_ETH0, IFS_END);
  #else
     #if IF_DEFAULT == IF_ETH0
        ifconfig(IF_DEFAULT, IFCONFIG_DEFAULT, IFS_END);
     #endif
  #endif
#endif
```

The entire fragment is processed only if IF_ETH0 is defined, i.e., you have specified that the non-PPPoE Ethernet interface is to be used. Inside this, if the IFCONFIG_ETH0 macro has been defined, then it is substituted into an ifconfig() call for IF_ETH0. Otherwise, if IF_ETH0 is the default (i.e., equal to IF_DEFAULT) then the IFCONFIG_DEFAULT macro is substituted into the ifconfig() call.

Note that for backwards compatibility, IFCONFIG_DEFAULT is always defined to something if it was not explicitly defined prior to inclusion of dcrtcp.lib. It is defined using the given values of the pre version 7.30 macros: MY_IP_ADDRESS, MY_GATEWAY etc.

The IFCONFIG_* macros can be defined to be an arbitrary number of ifconfig() parameters. For example,

```
#define IFCONFIG_ETH0\
  IFS_IPADDR,aton("10.10.6.100"), \
  IFS_NETMASK,0xFFFFFF00uL, \
  IFS_ROUTER_ADD,aton("10.10.6.1"), \
  IFS_ROUTER_ADD_STATIC,aton("10.10.6.111"), \
    aton("10.10.6.0"),0xFFFFFF00uL, \
  IFS_DEBUG, 5, \
  IFS_ICMP_CONFIG, 1, \
  IFS_UP
```

which sets up local IP address and netmask, two routers, turns the verbose level all the

way up, allows ping configure, and finally specifies that the interface be brought up at boot time.

The final `IFS_UP` is important: if it is omitted, then the interface will not be brought up at boot time; you will need to call `ifup()` explicitly after `sock_init()`.

For a full list of the parameters that you can specify in an `IFCONFIG_*` macro, please see the documentation for the `ifconfig()` function in Table 7.1 on page 103.

2.5.8 Time-Outs and Retry Counters

`RETRAN_STRAT_TIME`

This is used for several purposes. It is the minimum time granularity (in milliseconds) of the retransmit process. No time-out is set less than this value. It defaults to 10 ms.

`TCP_OPENTIMEOUT`

Defines the time-out value (in milliseconds) for active open processing. Defaults to 31000 ms.

`TCP_CONNTIMEOUT`

Defines the time-out value (in milliseconds) during open or close negotiation. Defaults to 13000 ms.

`TCP_SYNQTIMEOUT`

Defines the time-out value (in milliseconds) for pending connection. Defaults to 90000 ms.

`TCP_TWTIMEOUT`

Define time to linger in `TIMEWAIT` state (milliseconds). It should be from .5 to 4 minutes (2MSL) but it's not really practical for us. Two seconds will hopefully handle the case where ACK must be retransmitted, but can't protect future connections on the same port from old packets. Defaults to 2000 ms.

`KEEPALIVE_NUMRETRYS`

Number of times to retry the TCP keepalive. Defaults to 4.

`KEEPALIVE_WAITTIME`

Time (in seconds) to wait for the response to a TCP keepalive. Defaults to 60 seconds.

`TCP_MAXRTO`

Set an overall upper bound for the retransmit timeout. This is in units of milliseconds. Defaults to 50,000 ms.

TCP_MINRTO

Set a lower bound for the retransmit timeout. This is in units of milliseconds. Default is 250 ms (¼ second). Beware of reducing this, since modern hosts try to ack only every second segment. If our RTO is too small, we will unnecessarily retransmit if we don't get the ack for the first of the two segments (especially on a fast LAN, where the RTT measurement will want to make us set a small time-out).

TCP_LAZYUPD

Set a delay time for "lazy update" (ms). This is used to slightly delay window updates and empty acknowledgments to the peer, in the hope of being able to tag extra data along with otherwise empty segments. This improves performance by allowing better interleaving of application processing with TCP activity, and sending fewer empty segments. This delay interval is also used when we need to retransmit owing to a temporary shortage of Ethernet transmit buffers. Defaults to 5 ms.

DNS_RETRY_TIMEOUT

2000 by default. Specifies the number of milliseconds to wait before retrying a DNS request. If a request to a nameserver times out, then the next nameserver is tried. If that times out, then the next one is tried, in order, until it wraps around to the first nameserver again (or runs out of retries).

DNS_NUMBER_RETRIES

2 by default. Specifies the number of times a request will be retried after an error or a timeout. The first attempt does not constitute a retry. A retry only occurs when a request has timed out, or when a nameserver returns an unintelligible response. That is, if a host name is looked up and the nameserver reports that it does not exist and then the DNS resolver tries the same host name with or without the default domain, that does not constitute a retry.

DNS_MIN_KEEP_COMPLETED

10000 by default. Specifies the number of milliseconds a completed request is guaranteed to be valid for `resolve_name_check()`. After this time, the entry in the internal table corresponding to this request can be reused for a subsequent request.

2.5.9 Program Debugging

TCP_STATS

Enable TCP socket statistics collection. This causes some additional fields to be defined in the TCP socket structure, which are updated with various counters. This is mainly for internal debugging.

DCRTCP_DEBUG

If defined, allow Dynamic C debugging in all TCP/IP libraries. This allows you to trace into library functions in case you are finding difficulty in solving a TCP/IP problem. Remember to remove this definition when compiling for a production environment.

DCRTCP_VERBOSE

If defined, enable debugging messages to be printed by the library to the Dynamic C stdout window. This can be very informative when you are trying to see how the TCP/IP libraries work. Unfortunately, the string messages take up a lot of root code space, so you may need to increase the DATAORG value in the BIOS. Otherwise, you can be more selective about which messages are printed by defining `*_VERBOSE` macros for individual libraries (`DCRTCP_VERBOSE` merely turns on all the individual library verbose definitions). See dcrtcp.lib source for a listing of the available debug and verbose macros.

Note that the number of messages printed depends on the value of a global variable, `debug_on`. If this variable is 0, only a few messages are printed. If set to higher numbers (up to 5), then successively more detailed messages are printed. You can set this variable directly at the start of your `main()` function, or preferably use

```
ifconfig(IF_ANY, IFS_DEBUG, 5, IFS_END);
```

2.5.10 Miscellaneous Macros

TCP_FASTSOCKETS

Define to '1' if sockets connected to "reserved" ports can be closed without the usual 2MSL delay. The default is set to '1', define to '0' to override this.

NET_ADD_ENTROPY

Define this macro to allow network packet arrival times (from any interface) to be a source of random number seeds. See `RAND.LIB` for further information.

NET_COARSELOCK

This macro is only used when µC/OS-II is active. It affects the definition of 2 other macros: `LOCK_SOCK(s)` and `UNLOCK_SOCK(s)`.

If `NET_COARSELOCK` is not defined, the lock/unlock macros are individual socket locks for use on socket transmit/receive buffers and the socket structure itself. If it is defined, the lock/unlock macros are global locks.

TCP_NO_CLOSE_ON_LAST_READ

If defined, then support half-close; i.e., `sock_close()` only closes the transmit side of the socket, but allows indefinite receives until the peer closes. This prevents the normal close timeout from being set. Also, when reading, if the socket is half-closed by the peer, then the socket will be automatically closed from this side if this define is *not* set.

2.5.10.1 TOS and TTL

TOS and TTL are fields in the IP header. TOS, short for "Type of Service," uses 4 bits to specify different types of service. For normal service all 4 bits are zero. Different applications will want different types of service. For example, SNMP might set the maximize reliability bit, whereas FTP would want maximize throughput.

- `IPTOS_DEFAULT` is normal service.
- `IPTOS_CHEAP` minimizes monetary cost.
- `IPTOS_RELIABLE` maximizes reliability.
- `IPTOS_CAPACIOUS` maximizes throughput
- `IPTOS_FAST` minimizes delay.
- `IPTOS_SECURE` maximizes security.

Note that you may not OR these values together. You must pick one only!

TTL, short for "Time to Live," specifies how many routers a packet may visit before it is discarded, or how many seconds it can remain in the network, whichever comes first.

`TCP_TTL`
: Default TTL of TCP segments. This value is from Internet STD0002. Defaults to 64.

`TCP_TOS`
: Default type of service for TCP. Defaults to `IPTOS_DEFAULT`.

`UDP_TTL`
: Default TTL of UDP datagrams. This value is from Internet STD0002. Defaults to 64.

`UDP_TOS`
: Default type of service for UDP. Defaults to `IPTOS_DEFAULT`.

`ICMP_TOS`
: Default type of service for ICMP. Defaults to `IPTOS_DEFAULT`.

3. TCP and UDP Socket Interface

TCP (Transmission Control Protocol) and UDP (User Datagram Protocol) are both transport layer protocols. TCP is used when a reliable, stream-oriented, transport is required for data flowing between two hosts on a network. UDP is a record-oriented protocol which is used when lower overhead is more important than reliability. The acronym UDP is sometimes expanded as “unreliable datagram protocol” although, in practice, UDP is quite reliable especially over a local Ethernet LAN segment.

The Dynamic C TCP/IP libraries implement TCP and UDP over IP (Internet Protocol). IP is a network layer protocol, that in turn uses lower levels known as “link layer” protocols, such as Ethernet and PPP (Point-to-Point Protocol). The link-layer protocols depend on a physical layer, such as 10BaseT for Ethernet, or asynchronous RS232 for PPP over serial.

In the other direction, various protocols use TCP. This includes the familiar protocols HTTP, SMTP (mail) and FTP. Other protocols use UDP: DNS and SNMP to name a couple. TCP handles a lot of messy details which are necessary to ensure reliable data flow in spite of possible deficiencies in the network, such as lost or re-ordered packets. For example, TCP will automatically retransmit data that was not acknowledged by the peer within a reasonable time. TCP also paces data transmission so that it does not overflow the peer’s receive buffers (which are always finite) and does not overload intermediate nodes (routers) in the network. UDP leaves all of these details to the application, however UDP has some benefits that TCP cannot provide: one benefit is that UDP can “broadcast” to more than one peer, and another is that UDP preserves the concept of “record boundaries” which can be useful for some applications.

TCP is a connection-oriented protocol. Two peers establish a TCP connection, which persists for the exclusive use of the two parties until it is mutually closed (in the usual case). UDP is connectionless. There is no special start-up or tear-down required for UDP communications. You can send a UDP packet at any time to any destination. Of course, the destination may not be ready to receive UDP packets, so the application has to handle this possibility. (In spite of being “connectionless,” we still sometimes refer to UDP “connections” or “sessions” with the understanding that the connection is a figment of your application’s imagination.)

This chapter describes how to implement your own application level protocols on top of TCP or UDP. The Dynamic C TCP/IP libraries can also be examined for further hints as to how to code your application. For example, `HTTP.LIB` contains the source for an HTTP web server.

3.1 What is a Socket?

Both TCP and UDP make extensive use of the term "socket." A TCP socket represents the connection state between the local host and the remote peer. When talking about TCP connections which traverse the Internet, a socket is globally unique because it is described by 4 numbers: the local and remote IP addresses (32 bits each), and the local and remote port numbers (16 bits each).

Connections that do not traverse the Internet (e.g., between two hosts on an isolated LAN) are still unique within the attached network.

UDP sockets do not have the global uniqueness property, since they are not connection-oriented. For UDP, a socket really refers to just the local side.

For practical purposes, a socket is a structure in RAM that contains all the necessary state information. TCP sockets are considerably larger than UDP sockets since there is more connection state information to maintain. TCP sockets also require both a receive and a transmit buffer, whereas UDP sockets require only a receive buffer.

With Dynamic C version 6.57, each socket must have an associated `tcp_Socket` structure of 145 bytes or a `udp_Socket` structure of 62 bytes. The I/O buffers are in extended memory. For Dynamic C 7.30 these sizes are 136 bytes and 44 bytes, respectively.

For earlier versions of Dynamic C (than 6.57), each socket must have a `tcp_Socket` data structure that holds the socket state and I/O buffers. These structures are, by default, around 4200 bytes each. The majority of this space is used by the input and output buffers.

3.1.1 Port Numbers

Both TCP and UDP sockets make use of port numbers. Port numbers are a convenient method of allowing several simultaneous connections to exist between the same two hosts. Port numbers are also used to provide "well-known" starting points for common protocols. For example, TCP port number 23 is used for standard telnet connections. In general, port numbers below 1024 are used for standard services. Numbers between 1024 and 65535 are used for connections of a temporary nature. Often, the originator of a connection will select one of the temporary port numbers for its end of the connection, with the well-known number for the other end (which is often some sort of "server").

TCP and UDP port numbers are not related and operate in an independent "space." However, the well-known port numbers for TCP and UDP services often match if the same sort of protocol can be made to run over TCP or UDP.

When you open a socket using the TCP/IP libraries, you can specify a particular port number to use, or you can allow the library to pick a temporary port number for an "ephemeral" connection.

3.2 Allocating TCP and UDP Sockets

In all versions of Dynamic C, TCP and UDP socket structures *must* be allocated in static data storage. This is simply accomplished by declaring a static variable of type tcp_Socket or udp_Socket:

```
static tcp_Socket my_sock;
static udp_Socket my_udp_sock_array[20];
```

3.2.1 Allocating Socket Buffers

Starting with Dynamic C version 7.05, there are two macros that define the number of sockets available. These macros do not determine how many sockets you can allocate, but they do limit how many sockets you can successfully use. Each socket requires some resources which are not automatically available just because you declare a tcp_Socket structure. The additional resources are receive/transmit buffers (which are allocated in extended memory), and also socket semaphores if you are using µC-OS/II. The relevant macros are:

MAX_TCP_SOCKET_BUFFERS

Determines the maximum number of TCP sockets with preallocated buffers. The default is 4. A buffer is tied to a socket with the first call to `tcp_open()` or `tcp_listen()`. If you use `tcp_extopen()` or `tcp_extlisten()` then these buffer resources are not used up, but only if you allocate your own buffers using `xalloc()`.

MAX_UDP_SOCKET_BUFFERS

Determines the maximum number of UDP sockets with preallocated buffers. The default is 0. A buffer is tied to a socket with the first call to `udp_open()`. If you use `udp_extopen()` then these buffer resources are not used up, but only if you allocate your own buffers using `xalloc()`.

Note that DNS does not need a UDP socket buffer since it manages its own buffer. Prior to version 7.30, DHCP and `TFTP.LIB` each need one UDP socket buffer. Starting with version 7.30, DHCP manages its own socket buffers.

Prior to Dynamic C version 7.05, `MAX_SOCKETS (deprecated)` defined the number of sockets that could be allocated, not including the socket for DNS lookups. If you use libraries such as `HTTP.LIB` or `FTP_SERVER.LIB`, you must provide enough sockets in `MAX_SOCKETS` for them also.

In Dynamic C 7.05 (and later), if `MAX_SOCKETS` is defined in an application program, `MAX_TCP_SOCKET_BUFFERS` will be assigned the value of `MAX_SOCKETS`.

If you are using µC-OS/II then there is a further macro which must be set to the correct value: `MAX_SOCKET_LOCKS`. This must count every socket (TCP plus UDP), including those used internally by the libraries. If you cannot calculate this exactly, then it is best to err on the side of caution by overestimating. The actual socket semaphore structure is not all that big (less than 70 bytes).

The default value for `MAX_SOCKET_LOCKS` is the sum of `MAX_TCP_SOCKET_BUFFERS` and `MAX_UDP_SOCKET_BUFFERS` (plus 1 if DNS is being used).

3.2.2 Socket Buffer Sizes

Starting with Dynamic C version 7.05, TCP and UDP I/O buffers are sized separately using:

TCP_BUF_SIZE

Determines the TCP buffer size. Defaults to 4096 bytes.

UDP_BUF_SIZE

Determines the UDP buffer size. Defaults to 4096 bytes.

Compatibility is maintained with earlier versions of Dynamic C. If SOCK_BUF_SIZE is defined, TCP_BUF_SIZE and UDP_BUF_SIZE will be assigned the value of SOCK_BUF_SIZE. If SOCK_BUF_SIZE is not defined, but tcp_MaxBufSize is, then TCP_BUF_SIZE and UDP_BUF_SIZE will be assigned the value of tcp_MaxBufSize * 2.

3.2.2.1 User-Supplied Buffers

Starting with Dynamic C version 7.05, a user can associate his own buffer with a TCP or UDP socket. The memory for the buffer must be allocated by the user. This can be done with xalloc(), which returns a pointer to the buffer. This buffer will be tied to a socket by a call to an extended open function: tcp_extlisten(), tcp_extopen() or udp_extopen(). Each function requires a long pointer to the buffer and its length be passed as parameters.

3.3 Opening TCP Sockets

There are two ways to open a TCP socket, passive and active. Passive open means that the socket is made available for connections originated from another host. This type of open is commonly used for Internet servers that listen on a well-known port, like 80 for HTTP (Hypertext Transfer Protocol) servers. Active open is used when the controller board is establishing a connection with another host which is (hopefully) listening on the specified port. This is typically used when the controller board is to be a "client" for some other server.

The distinction between passive and active open is lost as soon as the connection is fully established. When the connection is established, both hosts operate on a peer-to-peer basis. The distinction between who is "client" and who is "server" is entirely up to the application. TCP itself does not make a distinction.

3.3.1 Passive Open

To passively open a socket, call tcp_listen() or tcp_extlisten(); then wait for someone to contact your device. You supply the listen function with a pointer to a tcp_Socket data structure, the local port number others will be contacting on your device, and possibly the IP address and port number that will be acceptable for the peer. If you want to be able to accept connections from any IP address or any port number, set one or both to zero.

To handle multiple simultaneous connections, each new connection will require its own tcp_Socket and a separate call to one of the listen functions, but using the same local port number (lport value). The listen function will immediately return, and you must poll for the incoming connection. You can manually poll the socket using sock_established(). The proper procedure for fielding incoming connections is described below.

3.3.2 Active Open

When your Web browser retrieves a page, it actively opens one or more connections to the server's passively opened sockets. To actively open a connection, call `tcp_open()` or `tcp_extopen()`, which use parameters that are similar to the ones used in the listen functions. Supply exact parameters for `remip` and `port`, which are the IP address and port number you want to connect to; the `lport` parameter can be zero, causing an unused local port between 1024 and 65535 to be selected.

If the open function returns zero, no connection was made. This could be due to routing difficulties, such as an inability to resolve the remote computer's hardware address with ARP. Even if non-zero is returned, the connection will not be immediately established. You will need to check the socket status as described in the next section.

3.3.3 Waiting for Connection Establishment

When you open a TCP socket either passively or actively, you must wait for a complete TCP connection to be established. This is technically known as the "3-way handshake." As the name implies, at least 3 packets must be exchanged between the peers. Only after completion of this process, which takes at least one round-trip time, does the connection become fully established such that application data transfer can proceed.

Unfortunately, the 3-way handshake may not always succeed: the network may get disconnected; the peer may cancel the connection; or the peer might even crash. The handshake may also complete, but the peer could immediately close or cancel the connection. These possibilities need to be correctly handled in a robust application. The consequences of not doing this right include locked-up sockets (i.e., inability to accept further connections) or protocol failures.

The following code outlines the correct way to accept connections, and to recover in case of errors.

```
if (!tcp_open(&my_socket, ...))
   printf("Failed to open\n");
else while(!sock_established(&my_socket)) {
   if (!tcp_tick(&my_socket)) {
      printf("Failed to establish\n");
      break;
   }
}
if (sock_established(&my_socket)) {
   printf("Established OK!\n");
   // do whatever needs to be done...
}
```

Notice the `tcp_tick(&my_socket)` call inside the while loop. This is necessary in order to test whether the handshake was aborted by the peer, or timed out. At the end of the loop, `sock_established()` tests whether the handshake did indeed complete. If so, then the socket is ready for data flow. Otherwise, the socket should be re-opened. The same basic procedure applies for passively opened sockets (i.e., `tcp_listen()`).

3.3.4 Specifying a Listen Queue

A `tcp_Socket` structure can handle only a single connection at any one time. However, a passively opened socket may be required to handle many incoming connection requests without undue delay. To help smoothly process successive connection requests with a single listening socket, you can specify that certain TCP port numbers have an associated "pending connection" queue. If there is no queue, then incoming requests will be cancelled if the socket is in use. If there is a queue, then the new connections will be queued until the current active connection is terminated.

To accept new connection requests when the passively opened socket is currently connected, use the function `tcp_reserveport()`. It takes one parameter, the port number where you want to accept connections. When a connection to that port number is requested, the 3-way handshaking is done even if there is not yet a socket available. When replying to the connection request, the window parameter in the TCP header is set to zero, meaning, "I can take no bytes of data at this time." The other side of the connection will wait until the value in the window parameter indicates that data can be sent. Using the companion function, `tcp_clearreserve(port number)`, causes TCP/IP to treat a connection request to the port in the conventional way. The macro `USE_RESERVEDPORTS` is defined by default. It allows the use of these two functions.

When using `tcp_reserveport`, the 2MSL (Maximum Segment Lifetime) waiting period for closing a socket is avoided.

3.4 TCP Socket Functions

There are many functions that can be applied to an open TCP socket. They fall into three main categories: Control, Status, and I/O.

3.4.1 Control Functions for TCP Sockets

These functions change the status of the socket or its I/O buffer.

- sock_abort
- sock_close
- sock_flush
- sock_flushnext
- tcp_extlisten
- tcp_extopen
- tcp_listen
- tcp_open

The open and listen functions have been explained in previous sections.

Call `sock_close()` to end a connection. This call may not immediately close the connection because it may take some time to send the request to end the connection and receive the acknowledgements. If you want to be sure that the connection is completely closed before continuing, call `tcp_tick()` with the socket structure's address. When `tcp_tick()` returns zero, then the socket is completely closed. Please note that if there is data left to be read on the socket, the socket will not completely close.

Call `sock_abort()` to cancel an open connection. This function will cause a TCP reset to be sent to the other end, and all future packets received on this connection will be ignored.

For performance reasons, data may not be immediately sent from a socket to its destination. If your application requires the data to be sent immediately, you can call `sock_flush()`. This

function will try sending any pending data immediately. If you know ahead of time that data needs to be sent immediately, call `sock_flushnext()` on the socket. This function will cause the next set of data written to the socket to be sent immediately, and is more efficient than `sock_flush()`.

3.4.2 Status Functions for TCP Sockets

These functions return useful information about the status of either a socket or its I/O buffers.

- sock_alive
- sock_bytesready
- sock_dataready
- sock_established
- sock_iface
- sock_rbleft
- sock_rbsize
- sock_rbused
- sock_tbleft
- sock_tbsize
- sock_tbused
- tcp_tick

`tcp_tick()` is the daemon that drives the TCP/IP stack, but it also returns status information. When you supply `tcp_tick()` with a pointer to a `tcp_Socket` (a structure that identifies a particular socket), it will first process packets and then check the indicated socket for an established connection. `tcp_tick()` returns zero when the socket is completely closed. You can use this return value after calling `sock_close()` to determine if the socket is completely closed.

```
sock_close(&my_socket);
while(tcp_tick(&my_socket)) {
 // you can do other things here while waiting for the socket to be completely closed
}
```

The status functions can be used to avoid blocking when using `sock_write()` and some of the other I/O functions. As illustrated in the following code, you can make sure that there is enough room in the buffer before adding data with a blocking function.

```
if(sock_tbleft(&my_socket,size)) {
    sock_write(&my_socket,buffer,size);
}
```

The following block of code ensures that there is a string terminated with a new line in the buffer, or that the buffer is full before calling `sock_gets()`:

```
sock_mode(&my_socket,TCP_MODE_ASCII);
if(sock_bytesready(&my_socket) != -1) {
    sock_gets(buffer,MAX_BUFFER);
}
```

3.4.3 I/O Functions for TCP Sockets

These functions handle all I/O for a TCP socket.

- sock_aread
- sock_awrite
- sock_axread
- sock_axwrite
- sock_fastread
- sock_fastwrite
- sock_getc
- sock_gets
- sock_preread
- sock_putc
- sock_puts
- sock_read
- sock_write
- sock_xfastread
- sock_xfastwrite

There are two modes of reading and writing to TCP sockets: ASCII and binary. By default, a socket is opened in binary mode, but you can change the mode with a call to `sock_mode()`.

When a socket is in ASCII mode, it is assumed that the data is an ASCII stream with record boundaries on the newline characters for some of the functions. This behavior means `sock_bytesready()` will return ≥0 only when a complete newline-terminated string is in the buffer or the buffer is full. The `sock_puts()` function will automatically place a newline character at the end of a string, and the `sock_gets()` function will strip the newline character.

Do not use `sock_gets()` in binary mode.

3.5 UDP Socket Overview

The UDP protocol is useful when sending messages where either a lost message does not cause a system failure or is handled by the application. Since UDP is a simple protocol and you have control over the retransmissions, you can decide if you can trade low latency for high reliability.

Broadcast Packets

UDP can send broadcast packets (i.e., to send a packet to a number of computers on the same network). This is accomplished by setting the remote IP address to -1, in either a call to `udp_open()` or a call to `udp_sendto()`. When used properly, broadcasts can reduce overall network traffic because information does not have to be duplicated when there are multiple destinations.

Checksums

There is an optional checksum field inside the UDP header. This field verifies the header and the data. This feature can be disabled on a reliable network where the application has the ability to detect transmission errors. Disabling the UDP checksum can increase the performance of UDP packets moving through the TCP/IP stack. This feature can be modified by:

```
sock_mode(s, UDP_MODE_CHK);     // enable checksums
sock_mode(s, UDP_MODE_NOCHK);   // disable checksums
```

The first parameter is a pointer to the socket's data structure, either `tcp_Socket` or `udp_Socket`.

In Dynamic C version 7.20, some convenient macros offer a safer, faster alternative to using `sock_mode()`. They are `udp_set_chk(s)` and `udp_set_nochk(s)`.

Improved Interface

With Dynamic C version 7.05 there is a redesigned UDP API. The new interface is incompatible with the previous one. Section 3.6 covers the new interface and Section 3.7 covers the previous one. See Section 3.7.5 for information on porting an older program to the new UDP interface.

3.6 UDP Socket Functions (7.05 and later)

Starting with Dynamic C 7.05, the UDP implementation is a true record service. It receives distinct datagrams and passes them as such to the user program. The socket I/O functions available for TCP sockets will no longer work for UDP sockets.

3.6.1 Control Functions for UDP Sockets

These functions change the status of the socket or its I/O buffer.

- udp_close
- udp_extopen
- udp_open

3.6.2 Status Function for UDP Sockets

These functions return useful information about the status of either a socket or its I/O buffers.

- sock_bytesready
- sock_dataready
- sock_rbleft
- sock_rbsize
- sock_rbused
- udp_peek

For a UDP socket, `sock_bytesready()` returns the number of bytes in the next datagram in the socket buffer, or -1 if no datagrams are waiting. Note that a return of 0 is valid, since a datagram can have 0 bytes of data.

3.6.3 I/O Functions for UDP Sockets

These functions handle datagram-at-a-time I/O:

- udp_recv
- udp_recvfrom
- udp_send
- udp_sendto

The write function, `udp_sendto()`, allows the remote IP address and port number to be specified. The read function, `udp_recvfrom()`, identifies the IP address and port number of the host that sent the datagram. There is no longer a UDP read function that blocks until data is ready.

3.7 UDP Socket Functions (pre 7.05)

This interface is basically the TCP socket interface with some additional functions for simulating a record service. Some of the TCP socket functions work differently for UDP because of its connectionless state. The descriptions for the applicable functions detail these differences.

3.7.1 I/O Functions for UDP Sockets

Prior to Dynamic C 7.05, the functions that handle UDP socket I/O are mostly the same functions that handle TCP socket I/O.

- sock_fastread
- sock_fastwrite
- sock_getc
- sock_gets
- sock_preread
- sock_putc
- sock_puts
- sock_read
- sock_recv
- sock_recv_from
- sock_recv_init
- sock_write
- udp_close
- udp_open

Notice that there are three additional I/O functions that are only available for use with UDP sockets: `sock_recv()`, `sock_recv_from()` and `sock_recv_init()`. The status and control functions that are available for TCP sockets also work for UDP sockets, with the exception of the open functions, `tcp_listen()` and `tcp_open()`.

3.7.2 Opening and Closing a UDP Socket

`udp_open()` takes a remote IP address and a remote port number. If they are set to a specific value, all incoming and outgoing packets are filtered on that value (i.e., you talk only to the one remote address).

If the remote IP address is set to -1, the UDP socket receives packets from any valid remote address, and outgoing packets are broadcast. If the remote IP address is set to 0, no outgoing packets may be sent until a packet has been received. This first packet completes the socket, filling in the remote IP address and port number with the return address of the incoming packet. Multiple sockets can be opened on the same local port, with the remote address set to 0, to accept multiple incoming connections from separate remote hosts. When you are done communicating on a socket that was started with a 0 IP address, you can close it with `sock_close()` and reopen to make it ready for another source.

3.7.3 Writing to a UDP Socket

Prior to Dynamic C 7.05, the normal socket functions used for writing to a TCP socket will work for a UDP socket, but since UDP is a significantly different service, the result could be different. Each atomic write—`sock_putc()`, `sock_puts()`, `sock_write()`, or `sock_fastwrite()`—places its data into a single UDP packet. Since UDP does not guarantee delivery or ordering of packets, the data received may be different either in order or content than the data sent. Packets may also be duplicated if they cross any gateways. A duplicate packet may be received well after the original.

3.7.4 Reading From a UDP Socket

There are two ways to read UDP packets prior to Dynamic C 7.05. The first method uses the same read functions that are used for TCP: `sock_getc()`, `sock_gets()`, `sock_read()`, and `sock_fastread()`. These functions will read the data as it came into the socket, which is not necessarily the data that was written to the socket.

The second mode of operation for reading uses the `sock_recv_init()`, `sock_recv()`, and `sock_recv_from()` functions. The `sock_recv_init()` function installs a large buffer area that gets divided into smaller buffers. Whenever a datagram arrives, it is stuffed into one of these new buffers. The `sock_recv()` and `sock_recv_from()` functions scan these buffers. After calling `sock_recv_init` on the socket, you should not use `sock_getc()`, `sock_read()`, or `sock_fastread()`.

The `sock_recv()` function scans the buffers for any datagrams received by that socket. If there is a datagram, the length is returned and the user buffer is filled, otherwise `sock_recv()` returns zero.

The `sock_recv_from()` function works like `sock_recv()`, but it allows you to record the IP address where the datagram originated. If you want to reply, you can open a new UDP socket with the IP address modified by `sock_recv_from()`.

3.7.5 Porting Programs from the older UDP API to the new UDP API

To update applications written with the older-style UDP API, use the mapping information in the following table.

UDP API prior to Dynamic C 7.05	UDP API starting with Dynamic C 7.05
MAX_SOCKETS	MAX_UDP_SOCKET_BUFFERS and MAX_TCP_SOCKET_BUFFERS
SOCK_BUF_SIZE	UDP_BUF_SIZE and TCP_BUF_SIZE
udp_open()	udp_open()
sock_write(), sock_fastwrite()	udp_send() or udp_sendto()
sock_read()(blocking function)	udp_recv() or udp_recvfrom() (nonblocking functions)
sock_fastread()	udp_recv() or udp_recvfrom()
sock_recv_init()	udp_extopen() (to specify your own buffer)
sock_recv()	udp_recv()
sock_recv_from()	udp_recvfrom()
sock_close()	sock_close() or udp_close()
sock_bytesready()	sock_bytesready()
sock_dataready()	sock_dataready()

3.8 Skeleton Program

The following program is a general outline for a Dynamic C TCP/IP program. The first couple of defines set up the default IP configuration information. The "memmap" line causes the program to compile as much code as it can in the extended code window. The "use" line causes the compiler to compile in the Dynamic C TCP/IP code using the configuration data provided above it.

Program Name: Samples\tcpip\icmp\pingme.c

```
/*
 * Starting with Dynamic C 7.30, the network addresses are initialized by defining the
 * following macro to identify the desired configuration in the file tcp_config.lib.
 */
#define TCPCONFIG 1      // static configuration of single Ethernet interface.
/*
 * Prior to Dynamic C 7.30, you must change the following values to whatever
 * your local IP address, netmask, and gateway are. Contact your network
 * administrator for these numbers.
 */
// #define MY_IP_ADDRESS "10.10.6.101"
// #define MY_NETMASK "255.255.255.0"
// #define MY_GATEWAY "10.10.6.19"
#memmap xmem
#use dcrtcp.lib
main()
{
   sock_init();
   for (;;) {
      tcp_tick(NULL);
   }
}
```

To run this program, start Dynamic C and open the `Samples\TCPIP\ICMP\PINGME.C` file. If you are using a Dynamic C version prior to 7.30, edit the `MY_IP_ADDRESS`, `MY_NETMASK`, and `MY_GATEWAY` macros to reflect the appropriate values for your device. Otherwise, edit your `tcpconfig.lib` (or `custom_config.lib`) file with appropriate network addresses for your device and define `TCPCONFIG` to access the desired configuration information.

Run the program and try to run `ping 10.10.6.101` from a command line on a computer on the same physical network, replacing `10.10.6.101` with your value for `MY_IP_ADDRESS`.

3.8.1 TCP/IP Stack Initialization

The `main()` function first initializes the TCP/IP stack with a call to `sock_init()`. This call initializes internal data structures and enables the Ethernet chip, which will take a couple of seconds with the RealTek chip. At this point, the TCP/IP stack is ready to handle incoming packets.

3.8.2 Packet Processing

Incoming packets are processed whenever `tcp_tick()` is called. The user-callable functions that call `tcp_tick()` are: `tcp_open`, `udp_open`, `sock_read`, `sock_write`, `sock_close`, and `sock_abort`. Some of the higher-level protocols, e.g., `HTTP.LIB` will call `tcp_tick()` automatically.

Call `tcp_tick()` periodically in your program to ensure that the TCP/IP stack has had a chance to process packets. A rule of thumb is to call `tcp_tick()` around 10 times per second, although slower or faster call rates should also work. The Ethernet interface chip has a large buffer memory, and TCP/IP is adaptive to the data rates that both ends of the connection can handle; thus the system will generally keep working over a wide variety of tick rates.

3.9 TCP/IP Daemon: tcp_tick()

`tcp_tick()` is a fundamental function for the TCP/IP library. It has two uses: it drives the "background" processing necessary to maintain up-to-date information; and it may also be used to test TCP socket state. The latter use is described in the next section.

Note that `tcp_tick()` does more than just TCP processing: it is also necessary for UDP and other internal protocols such as ARP and ICMP. It also (as of Dynamic C 7.30) controls interface status.

The computing time consumed by each call to `tcp_tick()` varies. Rough numbers are less than a millisecond if there is nothing to do, tens of milliseconds for typical packet processing, and hundreds of milliseconds under exceptional circumstances. In general, the more active sockets that are in use simultaneously, the longer it will take for `tcp_tick()` to complete, however there is not much increase for reasonable numbers of sockets.

It is recommended that you call `tcp_tick()` at the head of the main application processing loop. If you have any other busy-wait loops in your application, you should arrange for `tcp_tick()` to be called in each such loop. TCP/IP library functions that are documented as "blocking" will always include calls to `tcp_tick()`, so you do not have to worry about it. Library functions which are documented as "non-blocking" (e.g., `sock_fastread()`) do not in general call `tcp_tick()`, so your application will need to do it.

Some of the provided application protocols (such as HTTP and FTP) have their own "tick" functions (e.g., `http_handler()` and `ftp_tick()`). When you call such a function, there is no need to call `tcp_tick()` since the other tick function will always do this for you.

3.9.1 tcp_tick() for Robust Applications

It goes without saying that your application should be designed to be robust. You should be aware that an open TCP socket may become disconnected at any time. The disconnection can arise because of a time-out (caused by network problems), or because the peer application sent a RST (reset) flag to abort the connection, the interface went down, or even because another part of your application called `sock_abort()`. Your application should check for this condition, preferably in the main socket processing loop, by calling `tcp_tick()` with the socket address. Since `tcp_tick()` needs to be called regularly, this does not add much overhead if you have a single socket. For applications which manage multiple sockets, you can use the `sock_alive()` function (new for Dynamic C 7.30). If `tcp_tick()` or `sock_alive()` returns zero for a socket, then the socket may be re-opened after your application recovers.

Regular checking of socket status is also convenient in that it can simplify the rest of your application. In effect, checking socket status in your main application loop concentrates socket error handling at a single point in the code. There is less need to perform error handling after other calls to TCP/IP functions. For example, the `sock_fastread()` function normally returns a non-negative value, but it can return -1 if there is a problem with the socket. An application function which calls `sock_fastread()` needs to check for this code, however it can choose to merely return to the caller (the main loop) if this code is detected, rather than handling the error at the point where it was first detected. This works because if `sock_fastread()` returns -1, `tcp_tick()` will return zero for that socket.

3.9.2 Global Timer Variables

The TCP/IP stack depends on the values for `MS_TIMER`, and `SEC_TIMER`. Problems may be encountered if the application program changes these values during execution.

3.10 State-Based Program Design

An efficient design strategy is to create a state machine within a function and pass the socket's data structure as a function parameter. This method allows you to handle multiple sockets without the services of a multitasking kernel. This is the way the `HTTP.LIB` functions are organized. Many of the common Internet protocols fit well into this state machine model.

The general states are:

- Waiting to be initialized.
- Waiting for a connection.
- Connected states that perform the real work.
- Waiting for the socket to be closed.

An example of state-based programming is `SAMPLES\TCPIP\STATE.C`. This program is a basic Web server that should work with most browsers. It allows a single connection at a time, but can be extended to allow multiple connections.

In general, when defining the set of states for a socket connection, you will need to define a state for each point where the application needs to wait for some external event. At a minimum, this will include states when waiting for

- session establishment
- new received data
- space in the transmit buffer for write data
- session termination

For non-trivial application protocols, the states in-between session establishment and session termination may need to be embellished into a set of sub-states which reflect the stage of processing of input or output. Sometimes, input and output states may need to overlap. If they do not, then you typically have a step-by-step protocol. Otherwise, you have an application that uses receive and transmit independently. Step-by-step protocols are easier to implement, since there is no need to be able to overlap two (or more) sets of state.

For read states, which are waiting for some data to come in from the peer, you will typically call one of the non-blocking socket read functions to see if there is any data available. If you are expecting a fixed length of data (e.g., a C structure encoded in the TCP data stream), then it is most convenient to use the `sock_aread()` function which was introduced in Dynamic C 7.30. Otherwise, if you cannot tell how much data will be required to go to the next state, then you will have to call `sock_preread()` to check the current data, without prematurely extracting it from the socket receive buffer.

For write states, you can just keep calling `sock_fastwrite()` until all the data for this state is written. If you have a fixed amount of data, `sock_awrite()` is more convenient since you do not have to keep track of partially written data.

3.10.1 Blocking vs. Non-Blocking

There is a choice between blocking and non-blocking functions when doing socket I/O.

3.10.1.1 Non-Blocking Functions

The `sock_fastread()` and `sock_preread()` functions read all available data in the buffers, and return immediately. Similarly, the `sock_fastwrite()` function fills the buffers and returns the number of characters that were written. When using these functions, you must ensure that all of the data were written completely.

```
offset=0;
while(offset<len) {
   bytes_written = sock_fastwrite(&s, buf+offset, len-offset);
   if(bytes_written < 0) {
      // error handling
   }
   offset += bytes_written;
}
```

3.10.1.2 Blocking Functions

The other functions (`sock_getc()`, `sock_gets()`, `sock_putc()`, `sock_puts()`, `sock_read()` and `sock_write()`) do not return until they have completed or there is an error. If it is important to avoid blocking, you can check the conditions of an operation to ensure that it will not block.

```
sock_mode(socket,TCP_MODE_ASCII);
// ...
if (sock_bytesready(&my_socket) != -1){
    sock_gets(buffer, MAX_BUFFER);
}
```

In this case `sock_gets()` will not block because it will be called only when there is a complete new line terminated record to read.

3.11 TCP and UDP Data Handlers

Starting with Dynamic C 7.30[1], your application can specify data handler callback functions for TCP and UDP sockets. The data handler callback may be specified as a parameter to the `tcp_open()`, `tcp_extopen()`, `tcp_listen()`, `tcp_extlisten()`, `udp_open()`, `udp_extopen()` and `udp_waitopen()` functions.

The UDP data handler callback is always available. The TCP handler is only available if you `#define TCP_DATAHANDLER` before including `dcrtcp.lib`. Both types of callback use the same function prototype, however, the parameters are interpreted slightly differently.

The prototype for a suitable callback function is:

```
int my_data_handler(
   int event,
   void * socket,
   ll_Gather * g,
   void * info
   );
```

“event” indicates the type of callback. It is one of a predefined set of constants specified in the table below.

“socket” is a pointer to the socket structure (TCP or UDP). “g” contains a number of fields which may be accessed to find additional information, including the data stream or packet. “info” points to a structure which depends on the type of socket: `_udp_datagram_info` if the socket is UDP, or `NULL` for TCP sockets.

1. Data handler pointers were provided to the tcp_open etc. functions prior to this release, however the interface was not documented, and does not work in the way described herein.

The ll_Gather structure is defined and documented in NET.LIB. It is printed here for reference:

```
typedef struct {
   byte iface;             // Destination interface
   byte spare;
   word len1;              // Length of root data section
   void * data1;           // Root data (e.g., link, IP, transport headers)
   word len2;              // Length of first xmem section
   long data2;             // First xmem data extent (physical address)
   word len3;              // Length of second xmem section
   long data3;             // Second xmem data extent (physical address)
} ll_Gather;
```

The _udp_datagram_info is defined in UDP.LIB. It is documented with the udp_peek() function.

For UDP sockets, the callback is invoked for each packet received by the socket. For TCP sockets, the callback is invoked whenever *new* data is available that could otherwise be returned by sock_fastread().

The advantages of using the data handler callback are

- Less application overhead calling sock_dataready() or sock_fastread().
- Data copy to root buffers can be avoided.
- Ability to transform data in the socket buffer (e.g., decryption).
- For UDP, may avoid the need to copy incoming data into the socket receive buffer.
- Minimizes latency between tcp_tick() receive processing, and application processing.
- Allows event-driven programming style.

The following table lists the parameters to the callback for each event type.

Table 3. Parameters for each type of callback

event	s	g	info	notes
UDP_DH_INDATA	udp_Socket	pkt data	UDI	Normal received data
UDP_DH_ICMPMSG	udp_Socket	pkt data	UDI	ICMP message received for this socket
TCP_DH_LISTEN	tcp_Socket	NULL	NULL	Passive open call (e.g., tcp_extlisten())
TCP_DH_OPEN	tcp_Socket	NULL	NULL	Active open call (e.g., tcp_extopen())
TCP_DH_ESTAB	tcp_Socket	NULL	NULL	3-way handshake complete, ready for data transfer
TCP_DH_INDATA	tcp_Socket	seg data	NULL	Incoming stream data
TCP_DH_OUTBUF	tcp_Socket	NULL	NULL	New space in transmit buffer (data acknowledged by peer)

Table 3. Parameters for each type of callback

event	s	g	info	notes
TCP_DH_INCLOSE	tcp_Socket	NULL	NULL	No further incoming data (peer sent FIN)
TCP_DH_OUTCLOSE	tcp_Socket	NULL	NULL	No further outgoing data (application closed socket, sent FIN)
TCP_DH_CLOSED	tcp_Socket	NULL	NULL	Socket completely closed
TCP_DH_ABORT	tcp_Socket	NULL	NULL	Application called sock_abort
TCP_DH_RESET	tcp_Socket	NULL	NULL	Peer sent RST flag
TCP_DH_ICMPMSG	tcp_Socket	pkt data	NULL	ICMP message associated with this socket
other	?	?	?	Reserved for future use. Callback should always return zero.

3.11.1 UDP Data Handler

For UDP sockets, the callback is invoked as soon as a new datagram is demultiplexed to the socket. For event type `UDP_DH_INDATA`,the `ll_Gather` struct is set up with the interface number and pointers to the data in the receive buffers (not the UDP socket receive buffer, since the data has not yet been copied there). The info structure is a pointer to `_udp_datagram_info (UDI)`, which is set up with the usual `udp_peek` information such as the host IP address and port number, and whether the datagram is in fact an ICMP error message. If an ICMP message is received, the event type is set to `UDP_DH_ICMPMSG`. The callback should return 0 to continue with normal processing (i.e., add the datagram to the socket buffer), or 1 to indicate that the datagram has been processed and should not be added to the socket buffer

The data pointers in the `ll_Gather` structure are the physical address (and length) of one or two datagram fragments in the main network receive buffers. (Currently, only one address will be provided, since datagrams are reassembled before passing to the UDP handler). There is also a root data pointer in the `ll_Gather` structure, that is set to point to the IP and UDP headers of the datagram.

3.11.2 TCP Data Handler

The TCP data handler is only available if you #define `TCP_DATAHANDLER`. It is invoked with a large number of different event types. Most of the events are for significant changes in the TCP socket state. You can use these events to perform customized handling of socket open and close. Apart from `TCP_DH_INDATA` and `TCP_DH_ICMPMSG`, the `ll_Gather` structure is not passed (g is set to `NULL`). Currently, the info parameter is always null for TCP sockets.

If your callback function does not understand a particular event type, or is not interested, it should return zero. This will allow for upward compatibility if new callback events are introduced.

For convenience in coding the callback, you can use the user_data field in the tcp_Socket structure to hold some application-specific data which is to be associated with a socket instance. There is no

API for accessing this field; just use `s->user_data`. This field is only available if you have defined `TCP_DATAHANDLER`, and only for TCP sockets (not UDP).

There is no guarantee on the order in which events will arrive for a socket. The exceptions are that `TCP_DH_LISTEN` or `TCP_DH_OPEN` will always be first, and `TCP_DH_CLOSED` will always be last. There is no guarantee that the callback will be invoked with `TCP_DH_INCLOSE` or `TCP_DH_OUTCLOSE` before `TCP_DH_CLOSED`.

`TCP_DH_OUTBUF` indicates that some previously transmitted data has been acknowleged by the peer. Generally, this means that there is more space available in the transmit buffer. The callback can write data to the socket using `sock_fastwrite()` and other non-blocking write functions. The available transmit buffer space may be determined by `sock_tbleft()` function. When `TCP_DH_ESTAB` is invoked, the transmit buffer is normally completely empty, so the callback can write a reasonable amount of data to start with.

The `TCP_DH_INDATA` event callback is invoked after the incoming data has been stored in the socket buffer. It is only invoked if there is *new* data available from the peer. The `ll_Gather` structure is set up with one or two physical address pointers to the new data, and the logical pointer points to the IP header of the most recent datagram which provided the new data. Usually there will be only one physical address, however there may be two if the socket buffer happens to wrap around at that point. The callback will need to be coded to handle this possibility if it is accessing the data directly out of the xmem buffer.

The `TCP_DH_INDATA` callback is allowed to modify the new data in-place, if desired. This may be used to provide “transparent decryption” or similar services.

There are some restrictions which apply to callback code. Primarily, it is not allowed to invoke `tcp_tick()` directly or indirectly, since that will cause recursion into `tcp_tick()`. It will be possible to call `sock_fastwrite()` or `udp_sendto()` e.g., to generate some sort of response. Since `sock_fastwrite()` needs to buffer data, there is a possibility that there may be insufficient room in the transmit buffer for the generated response. Thus the callback will need to be carefully coded to avoid getting into a buffer deadlock situation if it generates responses. It will also need to co-ordinate with the rest of the application, since the application will otherwise have to contend with the possibility of arbitrary data being inserted in the write stream by the callback.

> **NOTE:** The application must call `sock_fastread()` or other read functions to actually remove data from the TCP socket receive buffer unless the data handler callback is coded to call `sock_fastread()` itself. If neither the data handler nor the rest of the application actually read the received data, then the TCP connection will become “blocked” in the read direction.

3.12 Multitasking and TCP/IP

Dynamic C's TCP/IP implementation is compatible with both µC/OS-II and with the language constructs that implement cooperative multitasking: costatements and cofunctions. Note that TCP/IP is not compatible with the slice statement.

3.12.1 µC/OS-II

The TCP/IP stack may be used with the µC/OS-II real-time kernel. The line

```
#use ucos2.lib
```

must appear before the line

```
#use dcrtcp.lib
```

in the application program. Also be sure to call `OSInit()` before calling `sock_init()`.

Dynamic C version 7.05 and later requires the macro `MAX_SOCKET_LOCKS` for µC/OS-II support. If it is not defined, it will default to `MAX_TCP_SOCKET_BUFFERS` + `TOTAL_UDP_SOCKET_BUFFERS` (which is `MAX_UDP_SOCKET_BUFFERS` + 1 if there are DNS lookups).

Buffers `xalloc`'d for socket I/O should be accounted for in `MAX_SOCKET_LOCKS`.

3.12.2 Cooperative Multitasking

The following program demonstrates the use of multiple TCP sockets with costatements.

Program Name: costate_tcp.c

```
// #define MY_IP_ADDRESS "10.10.6.11"
// #define MY_NETMASK "255.255.255.0"
// #define MY_GATEWAY "10.10.6.1"

#define TCPCONFIG 1

#define PORT1 8888
#define PORT2 8889

#define SOCK_BUF_SIZE 2048
#define MAX_SOCKETS 2

#memmap xmem
#use "dcrtcp.lib"

tcp_Socket Socket_1;
tcp_Socket Socket_2;

#define MAX_BUFSIZE 512
char buf1[MAX_BUFSIZE], buf2[MAX_BUFSIZE];


// The function that actually does the TCP work
cofunc int basic_tcp[2](tcp_Socket *s, int port, char *buf){
   auto int length, space_avaliable;

   tcp_listen(s, port, 0, 0, NULL, 0);

   // wait for a connection
   while((-1 == sock_bytesready(s)) && (0 == sock_established(s)))
      // give other tasks time to do things while we are waiting
      yield;

   while(sock_established(s)) {
      space_avaliable = sock_tbleft(s);

      // limit transfer size to MAX_BUFSIZE, leave room for '\0'
      if(space_avaliable > (MAX_BUFSIZE-1))
         space_avaliable = (MAX_BUFSIZE-1);

      // get some data
      length = sock_fastread(s, buf, space_avaliable);
      if(length > 0) {          // did we receive any data?
         buf[length] = '\0';    // print it to the Stdio window
         printf("%s",buf);

         // send it back out to the user's telnet session
         // sock_fastwrite will work-we verified the space beforehand
         sock_fastwrite(s, buf, length);
      }
      yield;                   // give other tasks time to run
   }
   sock_close(s);
   return 1;
}
```

Program Name: costate_tcp.c (continued)

```
main() {
   sock_init();
   while (1) {
      costate {
         // Go do the TCP/IP part, on the first socket
         wfd basic_tcp[0](&Socket_1, PORT1, buf1);
      }
      costate {
         // Go do the TCP/IP part, on the second socket
         wfd basic_tcp[1](&Socket_2, PORT2, buf2);
      }
      costate {
         // drive the tcp stack
         tcp_tick(NULL);
      }
      costate {
         // Can insert application code here!
         waitfor(DelayMs(100));
      }
   }
}
```

4. Optimizing TCP/IP Performance

Once you have a TCP/IP application coded and working, it is worthwhile to tune the application to get the best possible performance. There is usually a trade-off between performance and memory usage. If more memory is available, you can specify larger data buffers to improve overall performance. Conversely, if performance is already adequate, you can reduce buffer sizes to make room for more application functionality.

Some performance improvements can be made without large increases in memory usage. To make these improvements, you will need to understand how TCP, IP and the properties of the network work and interact. This is a complex subject, which is well covered in various texts. This section concentrates on the characteristics of the Dynamic C TCP/IP stack. Most of the discussion is centered around Dynamic C version 7.30, but many of the principles apply to earlier releases. The discussion also concentrates on TCP. UDP is also mentioned where appropriate, however UDP performance is mainly determined by the application so there are not as many tuning controls available in the Dynamic C libraries for tuning UDP performance.

The type of application has a large bearing on the performance tuning options which will be most appropriate. Here are some basic types of application which have different performance requirements:

- "bulk loader": an application which periodically uploads large amounts of data (such as a log) to a server
- "casual server": one which just needs to process occasional commands which come in from the network. This includes "interactive" servers such as telnet.
- "master controller": one which sends short data bursts to a number of "slave" controllers, which must be sent and processed in a timely manner
- "web server": a web-enabled appliance
- "protocol translator": accepts stream of data, perhaps serial, and converts to a TCP data stream, or vice-versa

All these application types have different requirements for the basic properties of a communications channel, namely bandwidth, throughput and latency.

The bandwidth of a channel is the maximum sustained rate of end-to-end data transmission, in bytes per second. A full-duplex channel has the same bandwidth in each direction, independent of data traffic flowing in the opposite direction. In a half-duplex channel, the total bandwidth is divided between both directions. Ethernet is usually half-duplex in that an Ethernet chip cannot send and receive at the same time, however some types of Ethernet can run full-duplex.

The throughput of a channel is related to bandwidth, but is used to express the amount of useful data that can be transmitted through the channel in a fixed (specified) amount of time, using a practical transport protocol (i.e., a protocol which adds some overhead to each message). Throughput generally improves as the bandwidth rises, and as the time interval increases. Throughput is always less than bandwidth for finite time intervals or practical protocols, since there is usually some overhead to establish the connection in the first place, as well as overhead during the transmission itself.

The latency of a channel can have several definitions. For our purposes, it is the minimum possible time delay between sending of a message, its receipt by the other end, and the reception of a reply; in other words, the round-trip-time (RTT). On electrical and radio channels, the latency is related to the physical length of the link and the speed of light. On channels which are more complex than a simple electrical connection, there may also be intermediate nodes which buffer the data being transmitted: this can add delays which are much larger than the speed of light between the end nodes.

Note that round-trip times are important for most communications protocols: not only do we want to send data, but we also want to receive an acknowledgment that the other end received the data.

Some examples of real networks may be helpful here. Note that the values given for RTT are approximations since they depend on the length of the connection, the sizes of packets sent, or intermediate nodes. Throughput is specified for an infinite time interval, assuming TCP over IP with 600 bytes of data per packet, and no data in the acknowledgment The RTT figure assumes the same size packets.

Table 4. Channel characteristics for selected networks

Type	Bandwidth (Byte/sec)	RTT (msec)	Throughput (Byte/sec)
Local 10Base-T Ethernet	1.25M	0.6	1M
PPP over 8N1 serial (57.6k)	5760	120	5000
PPPoE over 1.5Mbit DSL	187k	4	150k

The above table does not count any delay in the host which generates the response, nor any delay passing through the Internet. These represent minimum possible RTTs.

4.1 DBP and Sizing of TCP Buffers

An important quantity derived from the above is known as Delay-Bandwidth Product (DBP). As the name suggests, this is the product of bandwidth and RTT, and has units of bytes. It represents the maximum amount of data (and overhead) that can exist “in the network” at any point in time. This number has implications for sizing of TCP socket buffers. The DBP for local 10Base-T Ethernet is about 750 bytes. For local Ethernet connections, the DBP is about the same as the packet size of the transmitted data. For wider area networks that have significant propagation delays, the DBP can increase substantially. For example, satellite links can add several 100’s of milliseconds to the RTT. If the bandwidth is high enough, the DBP can exceed the packet size by orders of magnitude. This means that several packets may be in transit at the same time.

The DBP is important for TCP connections. This is because TCP is able to transmit a large number of packets into the network without having to wait for an acknowledgement for each one. Similarly, a TCP can receive a large number of packets without necessarily acknowledging them all. In fact, TCP only has to acknowledge the most recent packet; the sender can assume that all earlier packets are implicitly acknowledged.

How does all this apply to sizing of TCP socket buffers? It basically means that there is little point in making the buffers (both transmit and receive) larger than the expected maximum DBP of the communications channel. For connections which are expected to traverse the Internet, you may need quite large buffers. For local Ethernet only, the buffers need not be larger than, say, two packets.

The maximum packet size is a compromise between performance and memory usage. The largest packet supported by `dcrtcp.lib` is 1500 bytes, which is dictated by the limits of Ethernet. Dynamic C's default packet size is 600 bytes. Using large packet sizes improves performance for bulk data transfer, but has little effect for interactive traffic. Performance is improved for large packet sizes mainly because there is less CPU overhead per byte. There is a roughly fixed amount of CPU time required to process each packet. This is obviously better utilized if there are a large number of bytes per packet.

When using Ethernet, the Rabbit processor is limited in its overall TCP/IP throughput by CPU power. 10Base-T Ethernet is capable of 1MB/sec for TCP sockets[1], however the Rabbit 2000 running at 21MHz will only be able to transmit at about 270kB/sec when sending 1500 byte packets. Receive rate is slightly slower at about 220kB/sec. This scales approximately linearly with respect to CPU clock speed as well as application use of the CPU. In short, current Rabbit-based boards cannot use the full bandwidth of a local Ethernet link.

The situation changes for PPP over serial. In this case, the serial port bandwidth is less than the rate at which packets can be generated or received. Also, PPP is typically used to access peers over the Internet, so there may be a much larger DBP than for a pure point-to-point link. For PPP serial links, smaller packet sizes, e.g. 256 bytes, are satisfactory for bulk data transfers without impacting interactive traffic, should that be required. Socket buffer sizes should be determined based on the expected Internet RTTs, which may be 1 second or more. For a 57.6kbps serial link, the DBP is 5000 bytes for 1 second RTT, thus the socket buffers should be about this size for receive and transmit.

TCP is adaptive to changing network conditions. For example, the RTT can vary considerably at different times of day, and communication channels can become congested. TCP is designed to cope with these conditions without exacerbating any existing problems, however socket buffer and packet sizes are usually constants for the application so they need to be selected with due consideration to the most common conditions.

1. Assuming there is no other traffic on the Ethernet, and that collisions are rare. This is rarely the case, so a 50-80% utilization of bandwidth is considered the maximum desirable Ethernet load.

4.2 TCP Performance Tuning

TCP is a well-designed protocol, and provides nearly optimum performance over a wide range of conditions. Obtaining the best possible performance requires the application to co-operate with TCP by setting the correct options if the defaults are not optimal, making the most efficient use of the socket API functions, and providing appropriate memory and CPU resources.

The available performance-related options are:

- whether to use the Nagle algorithm
- settings for time-out values
- whether to define a pending connection queue (“reserved port”)
- setting the IP Type Of Service field
- packet, buffer and MTU sizes
- ARP cache size (for Ethernet).

Sizing of buffers was discussed in the previous section. The following sections discuss the other performance controls.

4.2.1 The Nagle Algorithm

The Nagle algorithm is an option for TCP sockets. It modifies the transmit processing for a socket, but has no effect on receive processing. The TCP/IP library allows Nagle to be applied on a per-socket basis.

Most applications should leave the Nagle algorithm enabled for each TCP socket, which is the default. This provides the best utilization of bandwidth, since it prevents many small packets from being sent where one big packet would be preferable.

The main reason to override the default, and disable the Nagle algorithm, is for applications that require the least possible delay between writing data to the socket, and its receipt by the peer application. This comes at the expense of efficiency, so you should carefully consider whether the application really requires the slight reduction in delay.

When Nagle is turned off, using the macro `tcp_set_nonagle(&socket)`, transmit processing is changed so that TCP tries to transmit a packet for each call of a socket write function such as `sock_fastwrite()`.

If Nagle is on (which is the default state or can be set using `tcp_set_nagle(&socket)`) a new packet will only be sent if there is no outstanding unacknowledged data. Thus, on a slow network where acknowledgements from the peer take a substantial amount of time to arrive, fewer packets will be sent because there is a greater chance that there is some unacknowledged data.

The difference may be illustrated by the following example: suppose that a TCP socket connection is currently established and quiescent (i.e., there is no outstanding data to be acknowledged; everything is up-to-date). The network round-trip-time is 550ms. The application writes ten single characters to the socket, at 100ms intervals each. With Nagle turned off, ten packets will be sent at approximately 100ms intervals. Each packet will contain a 40-byte header (IP and TCP) with a single byte of data. A total of 410 bytes will be sent. With Nagle on, the first character written at time zero will cause a 41-byte packet to be sent. The acknowledgment of this first packet will not arrive for another 550ms. In the meantime, the application writes an additional 5 characters at 100ms intervals. Since there is outstanding unacknowledged data (the first character) these charac-

ters are not sent immediately. They are buffered, waiting for an acknowledgment from the peer. When the first character's acknowledgment comes in at 550ms, there is no outstanding unack'ed data; the additional 5 characters have not yet been sent so they do not count as unack'ed data. Now the TCP stack will send the 5 additional characters in a single packet at approximately t=550ms. While that packet is in transit, 4 more characters are written by the application. Again, these characters will be buffered since characters 2 through 6 have not been acknowledged. Only when the next acknowledgment is received will these 4 characters be sent. The total number of packets sent is 3, with 1, 5 and 4 bytes of data. This translates to 130 bytes in total.

Obviously, the total number of bytes transmitted, including overhead, is far less when Nagle is used (130 compared with 410 bytes). One can also examine how this looks from the point of view of the peer.

In the non-Nagle case, each character is received 275ms after it was transmitted (we assume that the one-way trip is half of the RTT). The last character is received at t=1175ms (with the reference t=0 taken as the first character transmission time). The acknowledgment of the last character, which completes the transaction, is received at t=1400ms.

In the Nagle case, the last character is received at t=1375 and the final acknowledgment at t=1650. In this example, the peer received all 10 characters 200ms later when Nagle was used.

It can be seen that at a slight cost in increased delay, a great saving in total data transmission was made. If the above example was extended to hundreds or thousands of characters, then the additional delay would remain constant at a few hundred ms, whereas the network bandwidth would be better utilized by a factor approaching five!

In conclusion, leave Nagle on unless you absolutely must have the lowest delay between transmission and reception of data. If you turn Nagle off, ensure that your application is disciplined enough to write the largest blocks it can. For example, if you have to send an 8-byte value (as a unit), construct the full 8 bytes as a single block then write them all in a single `sock_fastwrite()` call, rather than calling `sock_fastwrite()` with two 4-byte calls or, worse, 8 single byte calls.

A useful alternative to turning Nagle off is to control packetization using calls to `sock_flush()`, `sock_noflush()` and `sock_flushnext()`. These functions allow the application fairly fine control over when TCP sends packets. Basically, `sock_noflush()` is used to set a "lock" on the socket that prevents TCP from sending packets containing new data. After `sock_noflush()`, you can call `sock_fastwrite()` or other write functions. The new data will not be sent until the socket is "unlocked" with a call to `sock_flush()`. `sock_flushnext()` unlocks the socket, but TCP does not send any data until the next write function is called.

4.2.2 Time-Out Settings

There are many time-out settings in TCP. These are necessary because the TCP socket needs to be able to take meaningful actions when things take longer than expected. For good performance, it is also sometimes necessary for the socket to delay slightly some action that it could otherwise perform immediately.

The time-out settings currently apply to all sockets; they cannot be applied selectively because they are in the form of macro constants.

In general, you can improve overall TCP performance by reducing some of the time-out settings, however there is a law of diminishing returns, and you can also start to reduce overall efficiency.

What may be good settings for a local Ethernet connection may be very poor for an Internet connection. Note that if you optimize time-out settings for a particular network environment, you will need to document this so that your end-users do not inadvertently use your application in the wrong sort of environment. For this reason, it is best to use the default settings for general-purpose applications, since the defaults work well in worst-case settings without affecting best-case performance unduly.

TCP is internally adaptive to network bandwidth and RTT, which are the main variables. Some of the time-out settings only apply to an initial "guess" of the network characteristics; TCP will converge to the correct values in a short time. Specifying a good initial guess will help TCP in the initial stages of establishing a socket connection.

4.2.2.1 Time-Out Setting Constants

The following constants can be #defined before including `dcrtcp.lib`. They specify various time intervals that have a bearing on connection performance.

`RETRAN_STRAT_TIME`

This defaults to 10ms. It specifies the minimum time interval between testing for retransmissions of data for a particular TCP socket. This not only provides an upper bound for packet transmission rate, but also cuts down on CPU overhead. Since retransmissions are basically driven from `tcp_tick()`, the less time used in `tcp_tick()` processing the more time is left for your application. Note that the actual minimum retransmit interval is defined by `TCP_MINRTO`; this setting only affects the testing interval.

Retransmissions are only required when there is an unexpected surge in network congestion, which causes packets to be delayed well beyond the average or even dropped.

It is not recommended to reduce this setting, but you could increase it to about 100ms to cut down on `tcp_tick()` overhead without materially affecting most applications.

`TCP_MINRTO`

Defaults to 250ms. This specifies the actual minimum time between TCP retransmissions. Reducing this will not affect performance in a properly functioning network, and may in fact worsen efficiency. Only in a network that is dropping a high percentage of packets will this setting have any real effect. On local Ethernet connections, genuine packet drops will be practically non-existent. The most likely cause of delays is if a host CPU is tied up and unable to perform network processing. On Internet connections, setting a retransmit time shorter than 250ms is just as likely to worsen the congestion which is causing packets to be dropped in the first place.

The only case where this value might be profitably reduced is the case of a point-to-point link where there is a lot of packet loss (maybe because the RS232 wiring is routed near an industrial welder). In this case, any packet loss may be assumed to be because of noise or interference, not because of router congestion. In the Internet, most packet loss is because of router congestion, in which case there is nothing to be gained by reducing `TCP_MINRTO`.

Another reason for not reducing this setting is that modern TCP/IP implementations

only acknowledge every 2nd packet received (or after a short time-out - see TCP_LAZYUPD). Normally, this will happen within the 250ms time interval, so there will be no unnecessary retransmission.

TCP_TWTIMEOUT

This defaults to 2000ms (2 seconds). This is one area where embedded system requirements conflict somewhat with recommendations in the standards documents. The "time-wait" time-out is a waiting period that is necessary when a socket is closed. This waiting period is supposed to be twice the maximum lifetime of any packet in the network. The maximum packet lifetime is 255 seconds, so the time-wait time-out should be about 8 minutes. The purpose of the waiting time is to allow both ends of the connection to be satisfied that their respective peer has agreed to the close and acknowledged it.

This wait time only affects the closed socket i.e., the unique socket combination of IP addresses and port numbers. It means that when a socket is closed, the same socket cannot be re-opened until at least 8 minutes have passed.

This is usually no problem for systems that have large memories to hold the state of recently closed sockets. For an embedded system, which has a limited pool of sockets and limited memory for storing connection states, this wait time is inconvenient since the socket structure cannot be re-used until the time-wait period has expired.

The default time-wait period is thus set to 2 seconds in the Dynamic C TCP/IP libraries. This will work perfectly well for local Ethernet connections, where the maximum packet lifetime is of the order of milliseconds. For Internet connections, this may be a bit short, but will generally be satisfactory.

If in fact the time-wait period is too short, the worst that will happen is that one of the peers will be unsure about whether the other end got the last segment of data, and confusion may happen if old packets (from this connection) happen to arrive after the close. This latter case is unlikely to happen, but if it does then it will eventually be resolved when the socket connection process times out.

If you want your application to be more robust, you can increase this value. 8 minutes is an extremely conservative value. Most implementations shorten this to 2 minutes or 30 seconds, since packets are extremely unlikely to survive more than 15 seconds.

Note that this value is only used if you do *not* specify the `tcp_reserveport()` option for the local port of a passively opened connection. If you specify reserveport, then the time-wait period is set to zero.

TCP_LAZYUPD

This defaults to 5ms, and is used for several purposes. The first use is to reschedule transmission attempts that could not be processed owing to local resource shortages. For example, if a previous packet is still being transmitted via a slow PPP interface, the current packet may need to be delayed. Similarly, the Ethernet hardware can be busy. In these cases, the TCP stack needs to try again a short time later.

The second use is to allow time for further information to come in from the network before transmitting otherwise empty packets. TCP has two main reasons for transmitting packets with no data content. The first is acknowledgement of incoming data when we have nothing to send, and the other is to update our receive window to the peer. The receive window tells the peer how much data it can transmit which we can store in our socket receive buffer. This window needs to be updated not only when we receive data, but also when the application reads data out of the receive buffer.

Rather than send these empty packets as soon as possible, it is often profitable to wait a short time. In the case of window updates, this can allow the application to write some data after the read which updated the window. The data can be sent with the window update, which improves efficiency because one packet can do the work of two. For receive data acknowledgements, the same trick can be applied i.e., piggy-backing on some additional data.

These optimizations can be taken advantage of quite often with most applications, so it is worth while specifying the lazy update time-out to be at least a few ms. Lowering the lazy update interval can slightly improve latency and throughput on high-speed (i.e., local Ethernet) connections.

4.2.3 Reserved Ports

As mentioned in the `TCP_TWTIMEOUT` description, you can specify that certain TCP port numbers have the special property of being “reserved.” If a port is reserved, it has two effects:

- A number of pending connections can be queued while a socket connection is established. The pending connections form a FIFO queue, with the longest-outstanding pending connection becoming active after the current connection is closed.
- The time-wait time-out is truncated when the current connection is closed.

Together, these increase the performance of passively-opened sockets, which are designed to implement server functions such as FTP and HTTP servers. Reserving a port has no effect on actively opened sockets (i.e., “clients”), and does not affect its performance during the life of each connection.

The functions `tcp_reserveport()` and `tcp_clearreserve()` respectively enable and disable a TCP port number from being treated in this manner.

4.2.4 Type of Service (TOS)

Type Of Service is an IP (Internet Protocol) header field that causes routers in the Internet to handle packets according to the specified service level. TOS has not been widely deployed in the past, but recently Internet routers have been able to take advantage of the TOS field.

TOS generally takes one (and only one) of a pre-specified number of values. The currently available values are:

- `IPTOS_DEFAULT` - the default, used when none of the following are obviously applicable.
- `IPTOS_CHEAP` - minimize monetary cost. Used for bulk transfers where speed or reliability are not of concern, and you are paying by the packet.
- `IPTOS_RELIABLE` - maximize reliability.
- `IPTOS_CAPACIOUS` - maximize throughput.
- `IPTOS_FAST` - minimize delay.
- `IPTOS_SECURE` - maximize security.

IP does not guarantee that the TOS setting will improve the objective performance, however, it at least guarantees that performance will not be any worse than if the default TOS was selected. In other words, it doesn't hurt to specify TOS, and it may even help!

TOS can be set on a packet-by-packet basis; however, the TCP stack only allows a TOS to be set for a socket (TCP or UDP) which is used for all packets until changed. The function `sock_set_tos()` is used to set the TOS field.

4.2.5 ARP Cache Considerations

ARP (Address Resolution Protocol) is only relevant for non-PPPoE Ethernet, not PPP interfaces. Although it works in the background, mainly to translate IP addresses into Ethernet MAC addresses, there are some considerations which apply to TCP (and UDP) performance.

There is a limited size cache of address mapping entries, known as the ARP Table. The cache is necessary in order to avoid network traffic each time a socket connection is established. It must be sized appropriately to avoid "cache misses" as much as possible.

If the controller board is to be used exclusively in "server mode," i.e., TCP sockets opened passively, then the cache does not have to be very big. If, on the other hand, the controller is going to actively establish sessions with a number of hosts, then the cache should be big enough to contain an entry for each host such that entries do not get pushed out for at least a few minutes.

The ARP Table also contains special entries for routers that are on the local Ethernet. These entries are important, since they represent entries for all hosts that are not on the local LAN segment subnet.

The default sizing rule for the ARP Table allocates an entry for each interface (including point-to-point) plus 5 entries for each Ethernet interface in use. The single entry for each interface is basically reserved for routers, on the assumption that each interface will probably require a router to allow connections to hosts which are farther afield. The additional 5 entries (for Ethernet) are for non-router hosts that the controller board will need to talk to.

This implies that 5 connections to hosts on the Ethernet subnet can be supported simultaneously, without any of the entries being pushed out. If the table is full, connection to a 6th host can be made, with the least-recently-used host entry being pushed out to make room.

If your application connects with, say, ten hosts in random order, it is likely that the ARP Table will need to be increased in size. If in doubt, increase the table size, since each entry only takes up about 32 bytes.

4.3 Writing a Fast UDP Request/Response Server

UDP is a lightweight protocol wrapper that adds port number "multiplexing" and checksums to basic IP packets. Being lightweight, it is capable of being very fast, with low CPU overhead. UDP is often selected for custom application protocols that do not need the reliable, stream-oriented, connections of TCP.

UDP is connectionless, however, application designers can think in terms of client-server or transaction-based programming. A popular design for UDP servers is to have the controller board listen for incoming datagrams. Each incoming message is processed and an immediate reply is sent. It is left up to the client to retransmit messages if it did not receive a reply in the expected time frame. The server, however, is extremely simple to implement, which allows it to serve more clients than a TCP-based server could manage.

Starting with Dynamic C 7.30, a data handler facility has been added to UDP (as well as TCP) sockets. The data handler is especially efficient for UDP, since it allows the datagram to be processed without any copying to the socket buffer.

The UDP data handler is a callback function whose address is supplied on the `udp_extopen()` call. For simple request/response applications, the only application requirements are to define the data handler, and call `tcp_tick()` repeatedly in a loop after setting up the TCP/IP stack and opening the UDP socket.

The sample program `Samples\tcpip\udp\udp_echo_dh.c` shows how to implement a simple UDP echo server using the technique described in this section.

4.4 Tips and Tricks for TCP Applications

This section contains miscellaneous suggestions for getting the most out of your TCP-based applications.

Application design requirements that affect TCP performance include:

- the responsiveness and throughput requirements of the application
- how often `tcp_tick()` can be called
- whether socket is used in ASCII or binary mode
- whether multitasking or "big loop" programming style.

The list of application types on page 57 is used as a basis for discussion. Your application may neatly fit into one of these categories, or it may be a combination of several. In either case, you should try to follow the programming guidelines unless you are fairly experienced with the Dynamic C TCP/IP libraries.

4.4.1 Bulk Loader Applications

This type of application is idle (from the TCP/IP point of view) most of the time, but this is punctuated by periods of intensive data transfer. Applications which exhibit this characteristic include data loggers and file transfer agents e.g. FTP server or client. Sending email via SMTP also comes under this category.

The main application requirement is good utilization of the available bandwidth i.e., highest throughput. This is achieved by using the largest practical buffer sizes, processing data in the largest possible chunks, and minimizing data copying. Since the Rabbit processor is CPU-bound when dealing with high speed transfers (over Ethernet), every time the data is "handled" it reduces the ultimate throughput.

The Nagle algorithm should be left ON. Time-outs should be set to generously high values to avoid unnecessary retransmissions. The TOS should be set to IPTOS_CAPACIOUS.

Bulk TCP transfers are most efficient when the packet size is the largest possible. The largest packet size is limited to the MTU size of the network connection. You can assume that 600 bytes is a reasonable MTU for Internet connections. You can use up to 1500 for all supported interface types (except PPPoE, which is limited to 1492), however it is best to use 600 if Internet connections are expected. If the Internet MTU is in fact less than the expected value, then packets may become fragmented, which lowers efficiency. You cannot do much about this except reduce the MTU.

When the MTU is determined, the maximum TCP packet data length will usually be the MTU minus 40. The 40 bytes are for the IP and TCP header overhead. For a 600 byte MTU, the maximum TCP data segment size will be 560. Thus, TCP performance will be best if data is handled in multiples of 560 bytes.

It is not quite this simple, however. When a TCP connection is opened, both sides can agree to use different data segment sizes than the default. Generally, whichever side has the smallest MTU will place a limit on the segment size. This is negotiated via the TCP MSS (Maximum Segment Size) option.

In your program, rather than hard-coding the optimum chunk size, you can define a symbol as follows:

```
#define TCP_CHUNK_SIZE (MAX_MTU - 40)
```

where `MAX_MTU` is a symbol defined by the library to be the actual MTU in effect. For multiple interfaces, it is probably better to use the minimum value of any interface. You can find out the current MTU for an interface using `ifconfig(iface, IFG_MTU, &mtu, IFS_END)` which will read the MTU for interface "iface" into the integer variable "mtu".

Most of the time, the TCP socket MSS will be equal to the fixed value above. In cases where it is smaller, there will not be a noticeable decrease in efficiency.

Once you have determined the appropriate chunk size, use `sock_awrite()` or `sock_axwrite()` (for extended memory data) with the specified chunk size, except possibly for the last chunk. `sock_awrite()` and friends are available starting with Dynamic C 7.30. They have the advantage that the data is completely buffered, or not at all. `sock_fastwrite()` may buffer less than the requested amount, which means that your application needs to keep track of the current position in the data being sent. `sock_awrite()` does not do things "by halves," so it is easier to keep track in the application. Because it will not do small data moves, it is also slightly more efficient in terms of CPU time.

4.4.2 Casual Server Applications

A casual server is a term we use for applications that need to respond to occasional requests for information, or commands, without large data transfers. Although the amount of data transfer is limited, the application still needs to be as responsive as possible. Example applications of this type include machine, building and power controllers. Interactive servers are also included, such as telnet.

The main goal here is to achieve low latency.

4.4.3 Master Controller Applications

Master controllers are responsible for coordinating access to a number of other devices (via TCP/IP or other types of communication) or acting as an “access concentrator”. Data transfer may be low to moderate. Latency should be minimized.

4.4.4 Web Server Applications

The TCP/IP libraries include web server software. `HTTP.LIB` takes advantage of the TCP library to get good performance. Your application can still affect web server performance, since it may be responsible for generating content via CGI callback functions. Web servers have much the same characteristics as “bulk loaders,” however, they are such a common case that they deserve special treatment.

4.4.5 Protocol Translator Applications

A protocol translator basically converts between a TCP data stream and some other type of data stream, for example asynchronous serial data. The data may flow in either or both directions.

This type of application has the most stringent requirements on both throughput and latency. This is because the incoming stream may not be amenable to any sort of flow control: it is necessary for TCP to keep up with a possibly high data rate. Also, the more timely the transmission of data, the more useful the protocol translator.

5. Network Addressing: ARP & DNS

ARP (Address Resolution Protocol) and DNS (Domain Name System) perform translations between various network address formats. ARP converts between IP addresses and (usually) Ethernet hardware addresses. DNS converts between human-readable domain names such as "ftp.mydomain.org" and IP addresses.

ARP and DNS are not closely related protocols, but they are lumped together in this chapter for convenience. In the Dynamic C TCP/IP libraries, `ARP.LIB` handles ARP proper, as well as router (gateway) functionality.

5.1 ARP Functions

ARP (Address Resolution Protocol) is used on non-PPPoE Ethernet interfaces. ARP is used to determine the hardware address of network interface adapters. Most of the ARP functionality operates in the background and is handled by the TCP/IP libraries. Most applications should not need to deal with ARP, and indeed some of the ARP functions are quite complex to use correctly.

Nevertheless, there are some useful debugging functions included in `ARP.LIB`.

Starting with Dynamic C 7.20, the internal ARP processing was converted to non-blocking style. This has no direct impact on applications, except that there will be lower maximum latency in tcp_tick() calls.

The ARP functions are all named starting with _arp, arpcache, arpresolve, or router.

`router_printall()` is a useful function for debugging router table problems, for example in the case where connections to hosts which are not on local subnets appear to be failing.

5.2 Configuration Macros for ARP

`ARP_LONG_EXPIRY`

Number of seconds that a normal entry stays current. Defaults to 1200.

`ARP_SHORT_EXPIRY`

Number of seconds that a volatile entry stays current. Defaults to 300.

`ARP_PURGE_TIME`

Number of seconds until a flushed entry is actually deleted. Defaults to 7200.

ARP_PERSISTENCE

Number of retries allowed for an active ARP resolve request to come to fruition. Default s to 4. If no response is received after this many requests, then the host is assumed to be dead. Set to a number between 0 and 7. This number relates to the total time spent waiting for a response as follows:

```
timeout = 2(ARP_PERSISTENCE+1) - 1
```

For example, for 0 the time-out is 1 second. For 4 it is 31 seconds. For 7 it is 255 seconds. If you set this to 8 or higher, then ARP will persist forever, retrying at 128 second intervals.

ARP_NO_ANNOUNCE

Configuration items not defined by default. Do not announce our hardware address at `sock_init()`.

This macro is undefined by default. Do not uncomment it in `NET.LIB`. Instead, define it in your mainline C program before including the networking libraries.

ARP_CONFLICT_CALLBACK

Define a function to call in case of IP address conflict. This function takes a arp_Header pointer as the first and only parameter. It should return one of

- 0: do not take any action
- 0xFFFFFFFF : abort all open sockets with `NETERR_IPADDR_CONFLICT`
- other: new IP address to use. Open sockets are aborted with `NETERR_IPADDR_CHANGE`.

This macro is undefined by default. Do not uncomment it in `NET.LIB`. Instead, define it in your mainline C program before including the networking libraries.

ARP_TABLE_SIZE

Define to the number of ARP table entries. The default is set to the number of interfaces, plus 5 entries for every non-PPPoE Ethernet interface. The maximum allowable value is 200.

ARP_ROUTER_TABLE_SIZE

Define the maximum number of routers. Defaults to the number of interfaces, plus an extra entry for each non-PPPoE Ethernet.

5.3 DNS Functions

Starting with Dynamic C 7.05, non-blocking DNS lookups are supported. Prior to DC 7.05, there was only the blocking function, `resolve()`. Compatibility has been preserved for `resolve()`, `MAX_DOMAIN_LENGTH`, and `DISABLE_DNS`.

The application program has to do two things to resolve a host name:

1. Call `resolve_name_start()` to start the process.
2. Call `resolve_name_check()` to check for a response.

Call `resolve_cancel()` to cancel a pending lookup.

5.4 Configuration Macros for DNS Lookups

`DISABLE_DNS`

If this macro is defined, DNS lookups will not be done. The DNS subsystem will not be compiled in, saving some code space and memory.

`DNS_MAX_RESOLVES`

4 by default. This is the maximum number of concurrent DNS queries. It specifies the size of an internal table that is allocated in xmem.

`DNS_MAX_NAME`

64 by default. Specifies the maximum size in bytes of a host name that can be resolved. This number includes any appended default domain and the `NULL`-terminator. Backwards compatibility exists for the `MAX_DOMAIN_LENGTH` macro. Its value will be overridden with the value `DNS_MAX_NAME` if it is defined.

For temporary storage, a variable of this size must be placed on the stack in DNS processing. Normally, this is not a problem. However, for µC/OS-II with a small stack and a large value for `DNS_MAX_NAME`, this could be an issue.

`DNS_MAX_DATAGRAM_SIZE`

512 by default. Specifies the maximum length in bytes of a DNS datagram that can be sent or received. A root data buffer of this size is allocated for DNS support.

`DNS_RETRY_TIMEOUT`

2000 by default. Specifies the number of milliseconds to wait before retrying a DNS request. If a request to a nameserver times out, then the next nameserver is tried. If that times out, then the next one is tried, in order, until it wraps around to the first nameserver again (or runs out of retries).

DNS_NUMBER_RETRIES

2 by default. Specifies the number of times a request will be retried after an error or a time-out. The first attempt does not constitute a retry. A retry only occurs when a request has timed out, or when a nameserver returns an unintelligible response. That is, if a host name is looked up and the nameserver reports that it does not exist and then the DNS resolver tries the same host name with or without the default domain, that does not constitute a retry.

DNS_MIN_KEEP_COMPLETED

10000 by default. Specifies the number of milliseconds a completed request is guaranteed to be valid for `resolve_name_check()`. After this time, the entry in the internal table corresponding to this request can be reused for a subsequent request.

DNS_SOCK_BUF_SIZE

1024 by default. Specifies the size in bytes of an xmem buffer for the DNS socket. Note that this means that the DNS socket does not use a buffer from the socket buffer pool.

6. IGMP and Multicasting

The Internet Group Management Protocol (IGMP) and multicasting are supported by the Dynamic C TCP/IP stack starting with version 7.30.

6.1 Multicasting

Multicasting is a form of limited broadcast. UDP is used to send datagrams to all hosts that belong to what is called a "host group." A host group is a set of zero or more hosts identified by the same destination IP address. The following statements apply to host groups.

- Anyone can join or leave a host group at will.
- There are no restrictions on a host's location.
- There are no restrictions on the number of members that may belong to a host group.
- A host may belong to multiple host groups.
- Non-group members may send UDP datagrams to the host group.

Multicasting is useful when data needs to be sent to more than one other device. For instance, if one device is responsible for acquiring data that many other devices need, then multicasting is a natural fit. Note that using multicasting as opposed to sending the same data to individual devices uses less network bandwidth.

6.1.1 Multicast Addresses

A multicast address is a class D IP address, i.e., the high-order four bits are "1110." Addresses range from 224.0.0.0 to 239.255.255.255. The address 224.0.0.0 is guaranteed not to be assigned to any group, and 224.0.0.1 is assigned to the permanent group of all IP hosts (including gateways). This is used to address all multicast hosts on a directly connected network.

6.1.2 Host Group Membership

Any datagram sent to a multicast address is received by all hosts that have joined the multicast group associated with that address. A host group is joined automatically when the remote IP address passed to `udp_open()` is a valid multicast address. A host group may also be joined by a call to `multicast_joingroup`(). Leaving a host group is done automatically when `udp_close`() is called. Like joining, leaving a group may be done explicitly by an application by calling an API function, in this case: `multicast_leavegroup`().

6.2 IGMP

As long as all multicast traffic is local (i.e., on the same LAN) IGMP is not needed. IGMP is used for reporting host group memberships to any routers in the neighborhood. The library `IGMP.LIB` conforms to RFC 2236 for IGMPv2 hosts.

6.3 Multicast Macros

As mentioned above, the use of IGMP is not required for multicast support on a LAN. You may select only multicast support by defining `USE_MULTICAST`.

`USE_MULTICAST`

This macro will enable multicast support. In particular, the extra checks necessary for accepting multicast datagrams will be enabled and joining and leaving multicast groups (and informing the Ethernet hardware about it) will be added.

`USE_IGMP`

If this macro is defined, the `USE_MULTICAST` macro is automatically defined. This macro enables sending reports on joining multicast addresses and responding to IGMP queries by multicast routers. Unlike `USE_MULTICAST`, this macro must be defined to be 1 or 2. This indicates which version of IGMP will be supported. Note, however, that both version 1 and 2 IGMP clients will work with both version 1 and 2 IGMP routers. Most users should just choose version 2.

`IGMP_V1_ROUTER_PRESENT_TIMEOUT`

Defaults to 400. When IGMPv2 is supported, a timer is set to this many seconds every time the board sees an IGMPv1 message from an IGMP router. As long as there is time left on the timer, the board acts as an IGMPv1 host. If the timer expires, the board returns to acting as an IGMPv2 host.

`IGMP_UNSOLICITED_REPORT_INTERVAL`

Defaults to 100 deciseconds (10 seconds). This value is specified in deciseconds. It determines the maximum random interval between the initial join report for a multicast group and the second join report.

7. Function Reference

This section contains descriptions for all user-callable functions in DCRTCP.LIB. Starting with Dynamic C 7.05, DCRTCP.LIB is a light wrapper around

- DNS.LIB
- IP.LIB
- NET.LIB
- TCP.LIB
- UDP.LIB.

This update requires no changes to existing code.

Descriptions for select user-callable functions in:

- ARP.LIB
- ICMP.LIB
- BSDNAME.LIB
- IGMP.LIB
- XMEM.LIB

are also included here. Note that ARP.LIB, ICMP.LIB and BSDNAME.LIB are automatically #use'd from DCRTCP.LIB.

Functions are listed alphabetically and by category grouped by the task performed.

_abort_socks

```
int _abort_socks( byte reason, byte iface );
```

DESCRIPTION

Abort all open TCP and UDP sockets. This routine may be called if the network becomes unavailable, for example because a DHCP address lease expired or because an IP address conflict was encountered.

This function is generally intended for internal library use, but may be invoked by applications in special circumstances.

PARAMETERS

reason	Reason code. A suitable NETERR_* constant as defined in NETERRNO.LIB. This code is set as the error code for each socket that was affected.
iface	Specific interface on which active connections are to be aborted, or pass IF_ANY to abort connections on all active interfaces.

RETURN VALUE

0

SEE ALSO

sock_abort, sock_error

arpcache_create

```
ATHandle arpcache_create( longword ipaddr );
```

DESCRIPTION

Create a new entry in the ARP cache table for the specified IP address. If a matching entry for that address already exists, then that entry is returned. Otherwise, a new entry is initialized and returned. If a new entry is created, then an old entry may need to be purged. If this is not possible, then ATH_NOENTRIES is returned.

PARAMETER

ipaddr IP address of entry.

RETURN VALUE

Positive value: Success.

ATH_NOENTRIES: No space is available in the table, and none of the entries could be purged because they were all marked as permanent or router entries.

LIBRARY

ARP.LIB

arpcache_flush

```
ATHandle arpcache_flush( ATHandle ath );
```

DESCRIPTION

Mark an ARP cache table entry for flushing. This means that the given table entry will be the first entry to be re-used for a different IP address, if necessary. Any entry (including permanent and router entries) may be flushed except for the broadcast entry.

PARAMETER

ath ARP table handle obtained from e.g., `arpcache_search()`.

RETURN VALUE

Positive value: Success.

`ATH_UNUSED`: The table entry was unused.

`ATH_INVALID`: the `ath` parameter was not a valid handle.

`ATH_OBSOLETE`: The given handle was valid, but obsoleted by a more recent entry. No change made.

LIBRARY

`ARP.LIB`

arpcache_hwa

```
ATHandle arpcache_hwa( ATHandle ath, byte *hwa );
```

DESCRIPTION

Copy the Ethernet (hardware) address from the given ARP cache table entry into the specified area.

PARAMETERS

ath	ARP cache table entry.
hwa	Address of where to store the hardware address (6 bytes).

RETURN VALUE

Positive value: Handle to the entry.

ATH_UNUSED: The table entry was unused.

ATH_INVALID: The ath parameter was not a valid handle.

ATH_OBSOLETE: The given handle was valid, but obsoleted by a more recent entry. No change made.

LIBRARY

ARP.LIB

arpcache_iface

```
ATHandle arpcache_iface( ATHandle ath, byte *iface );
```

DESCRIPTION

Copy the interface number from the given ARP cache table entry into the specified area.

If the ath parameter refers to a broadcast or loopback entry, then `*iface` is set to `IF_DEFAULT` (and `ATH_INVALID` is returned, since we can't really determine which of the interfaces to broadcast from).

PARAMETERS

ath	ARP cache table entry.
iface	Address of where to store the interface number (1 byte).

RETURN VALUE

Positive value: Handle to the entry.

`ATH_UNUSED`: The table entry was unused.

`ATH_INVALID`: The ath parameter was not a valid handle, or was a broadcast, multicast or loopback handle.

`ATH_OBSOLETE`: The given handle was valid, but obsoleted by a more recent entry.

LIBRARY

`ARP.LIB`

arpcache_ipaddr

```
ATHandle arpcache_ipaddr( ATHandle ath, longword *ipaddr );
```

DESCRIPTION

Copy the IP address from the given ARP cache table entry into the specified area. If the `ath` parameter refers to a broadcast entry, then the subnet broadcast IP is returned.

PARAMETERS

ath	ARP cache table entry.
ipaddr	Address of where to store the IP address (4 bytes).

RETURN VALUE

Positive value: Handle to the entry.

`ATH_UNUSED`: The table entry was unused.

`ATH_INVALID`: The ath parameter was not a valid handle, or was a point-point, broadcast, multicast or loopback handle.

`ATH_OBSOLETE`: The given handle was valid, but obsoleted by a more recent entry.

LIBRARY

`ARP.LIB`

arpcache_load

```
ATHandle arpcache_load( ATHandle ath, byte *hwa, byte iface,
   word flags, byte router_used );
```

DESCRIPTION

Load an entry in the ARP cache table. The entry must have been created using `arpcache_create()`, or be an existing valid entry located via `arpcache_search()`.

This function is primarily intended for internal use by the ARP library, although advanced applications could also use it. Most applications should not need to call this function directly.

PARAMETERS

`ath` Handle for the entry.

`hwa` Hardware (Ethernet) address, or `NULL`. Pass `NULL` if the current hardware address is not to be changed.

`iface` Interface to use (`IF_DEFAULT` to use default, or not change current setting).

`flags` Flags for entry: one or more of the following values, OR'd together:

- `ATE_PERMANENT`: permanent entry
- `ATE_RESOLVING`: initiate network resolve for this entry (`hwa` is ignored if this flag is set)
- `ATE_RESOLVED`: this entry now resolved
- `ATE_ROUTER_ENT`: this is a router entry
- `ATE_FLUSH`: mark this entry for flush
- `ATE_VOLATILE`: set short timeout for this entry
- `ATE_ROUTER_HOP`: this entry uses the specified router as the first hop. `hwa` ignored.
- `ATE_REDIRECTED`: this entry redirected by ICMP.

Only one of `ATE_ROUTER_ENT` or `ATE_ROUTER_HOP` should be set. For either of these, the next parameter indicates the router table entry to use.

Only one of `ATE_RESOLVING` or `ATE_RESOLVED` should be set.

`router_used` Router table entry. Only used if one of `ATE_ROUTER_ENT` or `ATE_ROUTER_HOP` is set in the flags parameter.

RETURN VALUE

Positive value: Success.

ATH_NOROUTER: The specified router entry number is invalid. This can be because the router_used parameter is bad, or because the router entry has a mismatching ATH.

ATH_INVALID: Invalid table handle passed (or unused entry).

ATH_OBSOLETE: The given handle was valid, but obsoleted by a more recent entry. No change made.

LIBRARY

ARP.LIB

arpcache_search

```
ATHandle arpcache_search( longword ipaddr, int virt );
```

DESCRIPTION

Return handle that refers to the ARP cache table entry for the given IP address. This does not do any resolving. It only consults the existing cache entries. The returned handle is guaranteed to be valid at least until the next call to `tcp_tick()`. Usually the handle will be valid for considerably longer, however it is possible for the handle to become obsolete if the cache entry is re-used for a different address. The caller should be able to deal with this possibility. The entry returned for the broadcast address is guaranteed to be permanent.

PARAMETERS

ipaddr	IP address to locate in the cache. This may be -1L to locate the broadcast entry or our own IP address to return the "loopback" entry.
virt	`0`: Do not return the broadcast or loopback entries. `1`: Allow the broadcast or loopback entries.

RETURN VALUE

Positive value: Handle to the entry.

`ATH_NOTFOUND`: No entry exists for the given IP address.

LIBRARY

`ARP.LIB`

_arp_resolve

```
int _arp_resolve( longword ina, eth_address *ethap,
   int nowait );
```

DESCRIPTION

Gets the Ethernet address for the given IP address. This function is deprecated starting in Dynamic C 7.20.

PARAMETERS

ina	The IP address to resolve to an Ethernet address.
ethap	The buffer to hold the Ethernet address.
nowait	If 0, return within 750 ms; else if !0 wait up to 5 seconds trying to resolve the address.

RETURN VALUE

1: Success.

0: Failure.

LIBRARY

ARP.LIB

arpresolve_check

```
ATHandle arpresolve_check( ATHandle ath, longword ipaddr );
```

DESCRIPTION

Check up on status of resolve process initiated by `arpresolve_start()`. This function should be called regularly to ensure that an ARP table handle is pointing to the correct entry, and that the entry is still current.

This caller must call `tcp_tick()` if spinning on this function.

PARAMETERS

ath	ARP Table Handle obtained from `arpresolve_start()`.
ipaddr	IP address specified to `arpresolve_start()`. If this is zero, no check is performed. Otherwise, the ARP table entry is checked to see that it is the correct entry for the specified IP address.

RETURN VALUE

Positive value: Completed successfully. The return value will be the same as the ath parameter.

`ATH_AGAIN`: Not yet completed, try again later.

`ATH_FAILED`: Completed in error. Address cannot be resolved because of a network configuration problem.

`ATH_TIMEDOUT`: Resolve timed out. No response from addressee within the configured time limit.

`ATH_INVALID`: The `ath` parameter was not a valid handle|.

`ATH_OBSOLETE`: The given handle was valid, but obsoleted by a more recent entry. Restart using `arpresolve_start()`.

`ATH_MISMATCH`: The `ipaddr` parameter was not zero, and the IP address does not match the table entry.

LIBRARY

`ARP.LIB`

arpresolve_ipaddr

```
longword arpresolve_ipaddr( ATHandle ath );
```

DESCRIPTION

Given an ARP table handle, return the IP address of the corresponding table entry.

PARAMETER

ath ARP Table Handle obtained from e.g., `router_for()`.

RETURN VALUE

`0`: An error occurred, such as an invalid or obsolete handle.

`0xFFFFFFFF`: The handle refers to either the broadcast address, or to a point-to-point entry whose IP address is not defined.

Else: An IP address. This may be 127.0.0.1 for the loopback entry.

LIBRARY

`ARP.LIB`

arpresolve_start

```
ATHandle arpresolve_start( longword ipaddr );
```

DESCRIPTION

Start resolve process for the given IP address. This may return immediately if the IP address is in the ARP cache table and still valid. Otherwise, if the IP address is on the local subnet then an ARP resolve request is issued through the appropriate interface. If the address is not on the local subnet, then a router table entry is used and no network activity is necessary (unless the router itself is not resolved, in which case its resolution commences).

PARAMETER

ipaddr IP address of host whose hardware address is to be resolved.

RETURN VALUE

Positive value: Success. The value is actually the ATH of the ARP cache table entry which is (or will be) used. This value should be passed to subsequent calls to `arpresolve_check()`.

`ATH_NOENTRIES`: No space is available in the table, and none of the entries could be purged, because they were all marked as permanent or router entries.

`ATH_NOROUTER`: No router ("gateway") is configured for the specified address, which is not on the local subnet.

LIBRARY

`ARP.LIB`

aton

```
longword aton( char *text );
```

DESCRIPTION

Converts [a.b.c.d] or a.b.c.d to a 32 bit long value.

PARAMETER

text	Pointer to string that holds the IP address to convert.

RETURN VALUE

0: Error, string has invalid format.
>0: Success, long value of IP address.

LIBRARY

IP.LIB

_chk_ping

```
longword _chk_ping( longword host_ip, longword *sequence_number );
```

DESCRIPTION

Checks for any outstanding ping replies from host. `_chk_ping` should be called frequently with a host IP address. If an appropriate packet is found from that host IP address, the sequence number is returned through `*sequence_number.` The time difference between our request and their response is returned in milliseconds.

PARAMETERS

`host_ip` IP address to receive ping reply from.

`sequence_number` Sequence number of reply.

RETURN VALUE

Time in milliseconds from the ping request to the host's ping reply.

If `_chk_ping` returns `0xffffffffL`, there were no ping receipts on this current call.

LIBRARY

`ICMP.LIB`

SEE ALSO

_ping, _send_ping

dhcp_acquire

```
int dhcp_acquire( void );
```

DESCRIPTION

This function acquires a DHCP lease that has not yet been obtained, or has expired, or was relinquished using `dhcp_release()`. Normally, DHCP leases are renewed automatically, however if the DHCP server is down for an extended period then it might not be possible to renew the lease in time, in which case the lease expires and TCP/IP should not be used. When the lease expires, `tcp_tick()` will return 0, and the global variable for the IP address will be reset to 0. At some later time, this function can be called to try to obtain an IP address.

This function blocks until the lease is renewed, or the process times out.

RETURN VALUE

`0`: OK, lease was not expired, or an IP address lease was acquired with the same IP address as previously obtained.

`-1`: An error occurred, no IP address is available. TCP/IP functionality is thus not available. Usual causes of an error are timeouts because a DHCP or BOOTP server is not available within the timeout specified by the global variable `_bootptimeout` (default 30 seconds).

`1`: Lease was re-acquired, however the IP address differs from the one previously obtained. All existing sockets must be re-opened. Normally, DHCP servers are careful to reassign the same IP address previously used by the client, however this is sometimes not possible.

LIBRARY

`BOOTP.LIB`

dhcp_get_timezone

```
int dhcp_get_timezone( long *seconds );
```

DESCRIPTION

This function returns the time zone offset provided by the DHCP server, if any, or uses the fallback time zone defined by the TIMEZONE macro. Note that TIMEZONE is expressed in hours, whereas the return result is in seconds.

PARAMETERS

seconds Pointer to result longword. If the return value is 0 (OK), then this will be set to the number of seconds offset from Coordinated Universal Time (UTC). The value will be negative for west; positive for east of Greenwich. If the return value is -1, then the result will be set using the hard-coded value from the macro TIMEZONE (converted to seconds by multiplying by 3600), or zero if this macro is not defined.

RETURN VALUE

0: Time zone obtained from DHCP.

-1: Time zone not valid, or not yet obtained, or not using DHCP.

LIBRARY

BOOTP.LIB

dhcp_release

```
int dhcp_release( void );
```

DESCRIPTION

This function relinquishes a lease obtained from a DHCP server. This allows the server to re-use the IP address that was allocated to this target. After calling this function, the global variable for the IP address is set to 0, and it is not possible to call any other TCP/IP function which requires a valid IP address. Normally, `dhcp_release()` would be used on networks where only a small number of IP addresses are available, but there are a large number of hosts which need sporadic network access.

This function is non-blocking since it only sends one packet to the DHCP server and expects no response.

RETURN VALUE

`0`: OK, lease was relinquished.

`1`: Not released, because an address is currently being acquired, or because a boot file (from the BOOTP or DHCP server) is being downloaded, or because some other network resource is in use e.g., open TCP socket. Call `dhcp_release()` again after the resource is freed.

`-1`: Not released, because DHCP was not used to obtain a lease, or no lease was acquired.

LIBRARY

`BOOTP.LIB`

getdomainname

```
char *getdomainname( char *name, int length );
```

DESCRIPTION

Gets the current domain name. For example, if the controller's internet address is "test.mynetwork.com" then "mynetwork" is the domain portion of the name.

The domain name can be changed by the `setdomainname()` function.

PARAMETERS

name	Buffer to place the name.
length	Maximum length of the name, or zero to get a pointer to the internal domain name string. Do not modify this string!

RETURN VALUE

If `length` ≥1: Pointer to `name`. If `length` is not long enough to hold the domain name, a `NULL` string is written to `name`.

If `length` = 0: Pointer to internal string containing the domain name. Do not modify this string!

LIBRARY

`BSDNAME.LIB`

SEE ALSO

`setdomainname, gethostname, sethostname, getpeername, getsockname`

EXAMPLE

```
main() {
   sock_init();
   printf("Using %s for a domain\n", getdomainname(NULL, 0));
}
```

gethostid

```
longword gethostid( void );
```

DESCRIPTION

Return the IP address of the controller in host format.

RETURN VALUE

IP address in host format, or zero if not assigned or not valid.

LIBRARY

IP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sethostid

EXAMPLE

```
main() {
   char buffer[ 512 ];
   sock_init();
   printf("My IP address is %s\n", inet_ntoa( buffer,
     gethostid()));
}
```

gethostname

```
char *gethostname( char *name, int length );
```

DESCRIPTION

Gets the host portion of our name. For example if the controller's internet address is "test.mynetwork.com" the host portion of the name would be "test."

The host name can be changed by the `sethostname()` function.

PARAMETERS

name	Buffer to place the name.
length	Maximum length of the name, or zero for the internal host name buffer. Do not modify this buffer.

RETURN VALUE

`length` ≥1: Return name.

`length` = 0: Return internal host name buffer (do not modify!).

LIBRARY

BSDNAME.LIB

getpeername

```
int getpeername( sock_type *s, void *dest, int *len );
```

DESCRIPTION

Gets the peer's IP address and port information for the specified socket.

PARAMETERS

s Pointer to the socket.

dest Pointer to `sockaddr` to hold the socket information for the remote end of the socket. The data structure is:

```
typedef struct sockaddr {
   word      s_type;   // reserved
   word      s_port;   // port #, or 0 if not connected
   longword  s_ip;     // IP addr, or 0 if not connected
   byte  s_spares[6]; // not used for tcp/ip connections
};
```

len Pointer to the length of `sockaddr`. A `NULL` pointer can be used to represent the `sizeof(struct sockaddr)`.

RETURN VALUE

`0`: Success.

`-1`: Failure.

LIBRARY

`BSDNAME.LIB`

SEE ALSO

`getsockname`

getsockname

```
int getsockname( sock_type *s, void *dest, int *len );
```

DESCRIPTION

Gets the controller's IP address and port information for a particular socket.

PARAMETERS

s Pointer to the socket.

dest Pointer to `sockaddr` to hold the socket information for the local end of the socket. The data structure is:

```
typedef struct sockaddr {
   word      s_type;  // reserved
   word      s_port;  // port #, or 0 if not connected
   longword  s_ip;    // IP addr, or 0 if not connected
   byte  s_spares[6]; // not used for tcp/ip connections
};
```

len Pointer to the length of `sockaddr`. A `NULL` pointer can be used to represent the `sizeof(struct sockaddr)`. `BSDNAME.LIB` will assume 14 bytes if a `NULL` pointer is passed.

RETURN VALUE

`0`: Success.

`-1`: Failure.

LIBRARY

`BSDNAME.LIB`

SEE ALSO

`getpeername`

htonl

```
longword htonl( longword value );
```

DESCRIPTION

This function converts a host-ordered double word to a network-ordered double word. This function is necessary if you are implementing standard internet protocols because the Rabbit does not use the standard for network-byte ordering. The network orders bytes with the most significant byte first and the least significant byte last. On the Rabbit, the bytes are in the opposite order.

PARAMETERS

value Host-ordered double word.

RETURN VALUE

Host word in network format, e.g., `htonl(0x44332211)` returns 0x11223344.

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

htons, ntohl, ntohs

htons

```
word htons( word value );
```

DESCRIPTION

Converts host-ordered word to a network-ordered word. This function is necessary if you are implementing standard internet protocols because the Rabbit does not use the standard for network-byte ordering. The network orders bytes with the most significant byte first and the least significant byte last. On the Rabbit, the bytes are in the opposite order within each 16-bit section.

PARAMETERS

value Host-ordered word.

RETURN VALUE

Host-ordered word in network-ordered format, e.g., `htons(0x1122)` returns 0x2211.

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

htonl, ntohl, ntohs

ifconfig

```
int ifconfig( int iface,... );
```

DESCRIPTION

This function replaces `tcp_config()` for setting network parameters at runtime. In addition, it allows retrieval of parameters and supports multiple interfaces. An arbitrary number of parameters may be set or retrieved in one call.

Example:

```
ifconfig( IF_ETH0,
            IFS_DOWN,
            IFS_IPADDR, aton("10.10.6.100"),
            IFS_NETMASK, 0xFFFFFF00uL,
            IFS_ROUTER_SET, aton("10.10.6.1"),
            IFS_NAMESERVER_SET, aton("192.68.1.123"),
            IFS_NAMESERVER_ADD, aton("192.68.1.124"),
            IFS_UP,
            IFS_END);
```

This call to `ifconfig()` brings the first Ethernet interface down if it is not already inactive, then it configures the home IP address, netmask, router (gateway), and two nameservers. Finally, the interface is made active (`IFS_UP`). `IFS_END` is required to terminate the parameter list.

PARAMETERS

`iface` Interface number. Use one of the definitions:

- `IF_ETH0`
- `IF_ETH1`
- `IF_PPPOE0`
- `IF_PPPOE1`
- `IF_PPPX (X = 0|1|2|3|4|5)`
- `IF_ANY`

If the interface does not exist, then you will get a compile time error. `IF_ANY` may be used only for the parameters which are not specific to any particular interface. It can also be used, where applicable, to mean "all interfaces" if the operation would make sense when applied to all interfaces.

`...` Parameters 2 through n are polymorphic (like `printf()` parameters). Parameters are provided in groups (usually pairs) with the first parm in the group being one of a documented set of identifiers, and subsequent parms in the group being the value specific to that identifier. The list of parm groups MUST be terminated using the identifier `IFS_END`. The parameter identifiers are:

Table 7.1 Parameter Identifiers for ifconfig()

Macro Name	Macro Description	Data Type(s) for Macro Parms
IFS_END	Marks the end of the parameter list.	none
IFS_IPADDR[a,b]	Set IP address.	longword
IFG_IPADDR	Get IP address.	longword *
IFS_NETMASK	Set netmask.	longword
IFG_NETMASK	Get netmask.	longword *
IFS_MTU	Set maximum transmission unit (MTU).	word
IFG_MTU	Get MTU.	word *
IFS_UP	Bring up interface.	none
IFS_DOWN	Bring down interface	none
IFS_HWA[a]	Set the hardware address.	byte[6]
IFG_HWA	Get the hardware address.	byte[6]
IFS_NAMESERVER_SET[c]	Delete all nameservers, then set this one.	longword
IFS_NAMESERVER_ADD[c]	Add nameserver.	longword
IFS_NAMESERVER_DEL[c]	Delete nameserver.	longword
IFS_ICMP_CONFIG	Use "arp -s" ping to configure IP address, or not. If DHCP and ping configure are both set, then the completion of DHCP will automatically turn off ping configure. If DHCP fails, then ping configure will be allowed after the set time-out for DHCP. Ping config cannot override DHCP until DHCP has timed out. This is the case whenever a DHCP lease is obtained, whether or not at `sock_init()` time. This parameter may be set for `IF_ANY` i.e., all interfaces.	bool
IFG_ICMP_CONFIG	Get whether or not ping configure is allowed.	bool *
IFS_ICMP_CONFIG_RESET	After ping configured okay, allow new ping configure.	none
IFG_ICMP_CONFIG_OK	Get whether ping configured successfully.	bool *
IFS_ROUTER_SET[c]	Delete all routers, then set this one.	longword

Table 7.1 Parameter Identifiers for ifconfig()

Macro Name	Macro Description	Data Type(s) for Macro Parms
IFS_ROUTER_SET_STATIC[c,d]	Set restricted router.	longword, longword, longword
IFS_DEBUG[c]	Set debug level.	int
IFG_DEBUG[c]	Get debug level.	int *
IFS_RESTORE[c,e]	Set network interfaces according to saved configuration.	NetConfSave *
IFG_SAVE[c]	Get current network configuration.	NetConfSave *
IFS_ROUTER_ADD[c]	Add router.	longword
IFS_ROUTER_ADD_STATIC[c,d]	Add restricted router.	longword, longword, longword
IFS_ROUTER_DEL[c]	Delete router If macro parameter = 0, delete all routers.	longword
IFG_ROUTER_DEFAULT	Get default router. The interface parameter may be either a specific interface number (to get the default router for that interface), or IF_ANY which will retrieve an overall default router.	longword *
IFS_DHCP[f]	Use DHCP to configure this interface, or not.	bool[g]
IFG_DHCP[f]	Get whether DHCP to be used.	bool *
IFS_DHCP_DOMAIN[f]	Set DHCP host/domain flag; that is, set whether to use domain and/or hostname info.	bool
IFG_DHCP_DOMAIN[f]	Get DHCP host/domain flag setting.	bool *
IFG_DHCP_OK[f]	Get whether DHCP actually configured okay.	bool *
IFS_DHCP_TIMEOUT[f]	Set DHCP time-out seconds.	int
IFG_DHCP_TIMEOUT[f]	Get DHCP time-out seconds.	int *
IFS_DHCP_FALLBACK[f]	Set whether DHCP allows fallback to static configuration.	bool
IFG_DHCP_FALLBACK[f]	Get whether DHCP allows fallback to static configuration.	bool *
IFG_DHCP_FELLBACK[f]	Get whether DHCP actually had to use fallbacks.	bool *

Table 7.1 Parameter Identifiers for ifconfig()

Macro Name	Macro Description	Data Type(s) for Macro Parms
IFS_DHCP_FB_IPADDR[f,h]	Set the DHCP fallback IP address.	longword
IFG_DHCP_FB_IPADDR[f,h]	Get the DHCP fallback IP address.	longword
IFS_DHCP_QUERY[f,i]	Set whether DHCP uses INFORM.	bool
IFG_DHCP_QUERY[f]	Get whether DHCP uses INFORM	bool *
IFS_DHCP_OPTIONS[f,j]	Set DHCP custom options.	int, char*, int(*)()
IFG_DHCP_OPTIONS[f]	Get DHCP custom options.	int*, char**
IFG_DHCP_INFO	Get DHCP information, or NULL if not qualified.	DHCPInfo**
IFS_PPP_ACCEPTIP	Accept peer's idea of our local IP address.	bool
IFG_PPP_ACCEPTIP	Get peer’s idea of our local IP address.	bool *
IFS_PPP_REMOTEIP	Try to set peer's IP address.	longword
IFG_PPP_REMOTEIP	Get peer’s IP address.	longword *
IFS_PPP_SETREMOTEIP	Try to set peer's IP address.	longword
IFS_PPP_ACCEPTDNS	Accept a DNS server IP address from peer.	bool
IFG_PPP_ACCEPTDNS	Find out if we are accepting a DNS server IP address from peer.	bool *
IFS_PPP_REMOTEDNS	Set DNS server IP addresses (primary, secondary) for peer .	longword, longword
IFG_PPP_REMOTEDNS	Get DNS server IP addresses (primary, secondary) for peer.	longword *, longword *
IFS_PPP_SETREMOTEDNS	Set DNS server IP address for peer (primary, secondary).	longword, longword

IFS_PPP_AUTHCALLBACK	Called when a peer attempts to authenticate. The authentication callback is invoked with the following parameters:
	`int auth_cb(char *user,`
	`int userlen, char *passwd,`
	`int passwdlen)`
	The parameters indicate userid, password and their lengths (not NULL terminated). The callback should return 1 if OK, 0 if not authorized.
		int (*)()

IFS_PPP_INIT	Sets up PPP with default parameters.	none

Table 7.1 Parameter Identifiers for ifconfig()

Macro Name	Macro Description	Data Type(s) for Macro Parms
IFS_PPP_REMOTEAUTH	Sets username and password to give to peer.	char *, char *
IFG_PPP_REMOTEAUTH	Gets username and password to give to peer.	char **, char **
IFS_PPP_LOCALAUTH	Required username and password for incoming peer.	char *, char *
IFG_PPP_LOCALAUTH	Get username and password required for incoming peer.	char **, char **
IFS_PPP_RTSPIN[k]	Define the RTS pin.	int, char *, int
IFG_PPP_RTSPIN	Get the definition for the RTS pin.	int *, char **, int *
IFS_PPP_CTSPIN[k]	Define the CTS pin.	int, int
IFG_PPP_CTSPIN	Get the definition for the CTS pin.	int *, int *
IFS_PPP_FLOWCONTROL	Turn hardware flow control on/off (1/0).	bool
IFG_PPP_FLOWCONTROL	Determine if hardware flow control is on (1) or off (0).	bool *
IFS_PPP_SPEED	Set serial PPP speed in bits/sec.	longword
IFG_PPP_SPEED	Get serial PPP speed in bits/sec.	longword *
IFS_PPP_SENDEXPECT	A series of strings to send and then expect, each separated by a carriage return('\r'). Setting send/expect automatically turns on IF_PPP_USEMODEM.	char *
IFG_PPP_SENDEXPECT	Get the series of strings to send and then expect, each separated by '\r.'	char **
IFS_PPP_USEMODEM	Specify whether or not to use modem dialout string.	bool
IFG_PPP_USEMODEM	Determine whether modem dialout string may be used.	bool *
IFS_PPP_MODEMESCAPE	Specify whether or not to add the escape sequence <delay>+++<delay> before sending send/expect or hangup strings.	bool
IFG_PPP_MODEMESCAPE	Determine whether or not the escape sequence <delay>+++<delay> is added before sending send/expect or hangup strings.	bool *

Table 7.1 Parameter Identifiers for ifconfig()

Macro Name	Macro Description	Data Type(s) for Macro Parms
IFS_PPP_USEPORTD	Use parallel port D instead of parallel port C for serial ports A and B.	bool
IFG_PPP_USEPORTD	Determine if parallel port D is being used.	bool *
IFG_PPP_PEERADDR	Get the PPP peer address. Returns 0 if no connection.	longword *
IFS_PPP_HANGUP	Set optional string to send to modem to shut it down.	char *
IFG_PPP_HANGUP	Get optional string to send to modem to shut it down.	char **
IFS_IF_CALLBACK	Set interface up/down callback, or NULL. The interface up/down callback function is called with two parameters: ifcallback(int iface, int up) where “iface” is the interface number, and “up” is non-zero if the interface has just come up, or zero if it has just come down. You must #define USE_IF_CALLBACK before #use "dcrtcp.lib" to use this functionality.	void (*)()

a. Setting the value of these parameters may require the interface(s) to be brought down temporarily. If this is necessary it will be brought up again before return, however any sockets that were open on that interface will have been aborted.

b. The action of IFS_IPADDR depends on the current interface state. If the i/f has the IFS_DHCP flag set, then this parameter sets only the fallback IP address without changing the current i/f status. Otherwise, the i/f is reconfigured with the new address immediately, which may require it to be brought down then up. IFS_IPADDR always sets the DHCP fallback address, but you can also use the IFS_DHCP_FB_IPADDR parameter to set the fallback address without ever changing the i/f status.

c. These parameters do not care about the value of iface because they are not specific to an interface.

d. "Static router" means a router that handles routing to a specified subnet destination. When a router is selected for a given IP address, the most specific static router will be used. For example, given the following setup:

Router	Subnet	Mask
10.10.6.1	0	0
10.10.6.2	10.99.0.0	255.255.0.0
10.10.6.3	10.99.57.0	255.255.255.0

then, given a destination IP address (which is not on the local subnet 10.10.6.0), the router will be selected according to the following algorithm:

if address is 10.99.57.*, use 10.10.6.3
else if address is 10.99.*.*, use 10.10.6.2
else use 10.10.6.1

Note that `IFS_ROUTER_SET` is basically the same as `IFS_ROUTER_SET_STATIC`, except that the subnet and mask parameters are automatically set to zero. Most simple networks with a single router to non-local subnets will use a single `IFS_ROUTER_SET`.

e. The saved configuration does not remember whether the interface is currently active. When restored, all interfaces are set to the inactive state. This facility is intended to allow saving network configuration to non-volatile storage, such as the User block. When restoring a configuration, all interfaces are brought down prior to restoral.

f. The DHCP parameters are only available if `USE_DHCP` is defined, and will only work if the interface parameter is `IF_DEFAULT`, since DHCP can only be used on the default interface. The `IFS_DHCP` parameter will cause acquisition or release of the default interface.

g. The bool parameter really means an integer, whose value is 0 for false, or non-zero for true.

h. The DHCP fallback address parameters are used in preference to `IFS_IPADDR` (the “current” address). This indicates the static IP address to use in case DHCP could not be used to configure the interface. See also the following note.

i. This parameter specifies that DHCP INFORM message is used for Ethernet interfaces, and is applicable if the IP address is configured other than by DHCP. The parameter is always TRUE for PPP interfaces.

j. DHCP custom options processing: First parameter (`int`) is length of options list. 2nd parameter (`char *`) points to options list. This is a byte array containing values from the `DHCP_VN_*` definitions in `BOOTP.LIB` (these are taken from the list in RFC2132). Also, option "0"is used to indicate the boot file name. If the boot file name is provided, then the TFTP server IP address can be obtained from the `di->bootp_host` field of the structure provided to the callback (see the function prototype below). This options list must be in static storage, since only the pointer is saved.

   The 3rd parameter may be NULL, or is a pointer to a callback function to process the custom options.The callback function has the following prototype:

```
int my_callback(int iface, DHCPInfo * di, int opt, int len,
  char * data)
```

   where

   iface: interface number.

   di: DHCP information struct. Read only, except you can modify the `data` field if desired. See the definition of this struct in `NET.LIB` for details.

   opt: DHCP option number (`DHCP_VN_*`); or 0 for the boot file name.

   len: length of option data in bytes

   data: pointer to data for this option. Read only.

   The callback is only invoked for options that were requested and that were not handled internally (such as `DHCP_VN_SUBNET`). The return value from the callback should be zero, for future compatibility. The callback should not make any long computations, blocking calls, or call any other tcp/ip functions, since it would delay the main application. If uC/OS is in use, it should also be re-entrant and definitely not call any tcp/ip functions.

   Note that the following options are always retrieved and MUST NOT be provided in the options list:

   All DHCP protocol options (50-61)
   DHCP_VN_SUBNET
   DHCP_VN_TIMEOFF
   DHCP_VN_ROUTER*
   DHCP_VN_DNS*
   DHCP_VN_SMTPSRV*
   DHCP_VN_NTPSRV*
   DHCP_VN_COOKIE*

   (* - only forbidden if `DHCP_NUM_ROUTERS` etc. are defined to be non-zero).

k. The parameters for the RTS/CTS pin assignments are:

RTS: int port_address, char *shadow_reg, int port_pin
CTS: int port_address, int port_pin

where `port_address` is the parallel port internal I/O address e.g., PEDR for port E. `shadow_reg` is the appropriate shadow register for the parallel port data register e.g., &PEDRShadow for port E. `port_pin` is a number from 0-7 indicating the pin number of the port.

RETURN VALUE

`0`: Success.
`>0`: identifer of first parameter group that encountered an error.
`-1`: `iface` parameter is invalid.

An exception (runtime error) is raised if the parameter list contains an invalid parameter number.

LIBRARY

`NET.LIB`

SEE ALSO

`sock_init, tcp_config, ip_print_ifs, ifstatus, ifpending`

ifdown

```
int ifdown( int iface );
```

DESCRIPTION

This function attempts to deactivate the specified interface.

PARAMETER

iface Interface number. Use one of the definitions

- IF_ETH0
- IF_ETH1
- IF_PPPOE0
- IF_PPPOE1
- IF_PPPX (X = 0|1|2|3|4|5)

If the interface does not exist, then you will get a compile time error.

RETURN VALUE

IFCTL_OK: if OK.

IFCTL_FAIL: if error.

IFCTL_PEND: if OK but not complete.

LIBRARY

NET.LIB

SEE ALSO

ifconfig, ifup, ifstatus, ifpending

ifpending

```
int ifpending( int iface );
```

DESCRIPTION

Returns indication of whether the specified interface is up, down, pending up or pending down. This reveals more information than `ifstatus()`, which only indicates the current state (up or down).

NOTE: ANDing the return value with 0x01 indicates a pending condition; ANDing with 0x02 is equivalent to the return from `ifstatus()`.

PARAMETERS

`iface` Interface number. Use one of the definitions:

- `IF_ETH0`
- `IF_ETH1`
- `IF_PPPOE0`
- `IF_PPPOE1`
- `IF_PPPX (X = 0|1|2|3|4|5)`

If the interface does not exist, you will get a compile time error.

RETURN VALUE

`0`: If interface is currently down and not pending up.

`1`: If interface is currently down and pending up.

`2`: If interface is currently up and not pending down.

`3`: If interface is currently up and pending down.

LIBRARY

`NET.LIB`

SEE ALSO

`ifconfig, ifdown, ifup, ifstatus`

ifstatus

```
int ifstatus( int iface );
```

DESCRIPTION

This macro returns the status of the specified interface.

PARAMETER

iface Interface number. Use one of the definitions

- IF_ETH0
- IF_ETH1
- IF_PPPOE0
- IF_PPPOE1
- IF_PPPX (X = 0|1|2|3|4|5)

If the interface does not exist, then you will get a compile time error.

RETURN VALUE

0: if interface is currently down.

Non-zero if interface is currently up (active).

LIBRARY

NET.LIB

SEE ALSO

ifconfig, ifup, ifdown, ifpending

ifup

```
int ifup( int iface );
```

DESCRIPTION

This function attempts to activate the specified interface.

PARAMETER

iface Interface number. Use one of the definitions

- IF_ETH0
- IF_ETH1
- IF_PPPOE0
- IF_PPPOE1
- IF_PPPX (X = 0|1|2|3|4|5)

If the interface does not exist, then you will get a compile time error.

RETURN VALUE

IFCTL_OK: if OK.

IFCTL_FAIL: if error.

IFCTL_PEND: if OK but not complete.

LIBRARY

NET.LIB

SEE ALSO

ifconfig, ifdown, ifstatus

inet_addr

```
longword inet_addr( char *dotted_ip_string );
```

DESCRIPTION

Converts an IP address from dotted decimal IP format to its binary representation. No check is made as to the validity of the address.

PARAMETERS

dotted_ip_string Dotted decimal IP string, e.g., "10.10.6.100".

RETURN VALUE

`0`: Failure.

Binary representation of `dotted_ip_string`: Success.

LIBRARY

`IP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)`

SEE ALSO

`inet_ntoa`

inet_ntoa

```
char *inet_ntoa( char *s, longword ip );
```

DESCRIPTION

Converts a binary IP address to its dotted decimal format, e.g., `inet_ntoa(s,0x0a0a0664)` returns a pointer to "10.10.6.100".

PARAMETERS

s	Location to place the dotted decimal string. A sufficient buffer size would be 16 bytes.
ip	The IP address to convert.

RETURN VALUE

Pointer to the dotted decimal string pointed to by `s`.

LIBRARY

`IP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)`

SEE ALSO

`inet_addr`

ip_iface

```
byte ip_iface( longword ipaddr, int local_only );
```

DESCRIPTION

Given an IP address, this function return the interface number for that address. If `ipaddr` is an address on one of the local subnets, then the interface to that subnet is returned.

If the address is not local, then the `local_only` parameter determines the result:

If `local_only` is 1, then `IF_ANY` will be returned for a non-local address.

Otherwise, the `router_for()` function is invoked to find the correct router -- the interface for the router is returned.

PARAMETERS

ipaddr	IP address of an external host.
local_only	0: allow non-local addresses (returns interface for router). 1: return `IF_ANY` for non-local addresses.

RETURN VALUE

Interface number (0..`IF_MAX`-1), of possibly `IF_ANY` (0xFF).

LIBRARY

`IP.LIB`

SEE ALSO

`router_for`

ip_print_ifs

```
void ip_print_ifs( void );
```

DESCRIPTION

Print all interface table entries. This is for debugging only, since the results are printed to the Dynamic C Stdio window.

There are 8 fields for each interface entry:

The interface number

IP addr The local ("home") IP address of this interface. May be 0.0.0.0 if interface is not currently active.

Mask Local subnet mask.

Up Indicates status; one of

- `Yes`: interface currently active
- `No`: currently inactive
- `NYU`: Not Yet Up i.e., coming up
- `NYD`: Not Yet Down i.e., coming down

Type: Interface type; one of

- `eth`: normal Ethernet
- `ppp`: PPP over serial port
- `pppoe`: PPP over Ethernet

MTU: Maximum transmission unit.

Flags: A list of the following characters:

- `*`: this is the default interface (`IF_DEFAULT`)
- `D`: Use DHCP
- `DD`: Currently configured via DHCP
- `S`: allow IP addr configuration via directed ping (ICMP echo).
- `SS`: IP address currently set via directed ping
- `1`: IGMP version 1 router present on this interface

Peer/router IP address of peer node (for PPP or PPPoE), or address of default router on this interface (for Ethernet type). May be blank or 0.0.0.0 if no peer or router is available.

LIBRARY

IP.LIB

ip_timer_expired

```
word ip_timer_expired( void *s );
```

DESCRIPTION

Check the timer inside the socket structure that was set by `ip_timer_init()`.

PARAMETER

s Pointer to a socket.

RETURN VALUE

`0`: If not expired.

`1`: If expired.

LIBRARY

`NET.LIB`

SEE ALSO

`ip_timer_init`

ip_timer_init

```
void ip_timer_init( void *s, word seconds );
```

DESCRIPTION

Set a timer inside the socket structure.

PARAMETER

s	Pointer to a socket.
seconds	Number of seconds for the time-out; if `seconds` is zero never time-out.

RETURN VALUE

None.

LIBRARY

NET.LIB

SEE ALSO

ip_timer_expired

is_valid_iface

```
int is_valid_iface( int iface );
```

DESCRIPTION

This function returns a boolean indicator of whether the given interface number is valid for the configuration.

PARAMETER

iface Interface number. Use one of the definitions

- IF_ETH0
- IF_ETH1
- IF_PPPOE0
- IF_PPPOE1
- IF_PPPX (X = 0|1|2|3|4|5)

RETURN VALUE

!0: Interface is valid.

0: Interface does not exist.

LIBRARY

NET.LIB

SEE ALSO

ifconfig, ifup, ifdown, ifstatus

multicast_joingroup

```
int multicast_joingroup( int iface, longword ipaddr );
```

DESCRIPTION

This function joins the specified multicast group (class D IP address--from 224.0.0.0 to 239.255.255.255) on the specified interface. For an Ethernet interface, it configures the hardware to accept multicast packets for the specified address.

Note that this function is called automatically when `udp_open()` is used to open a multicast address.

PARAMETER

`iface` Interface on which to join the group. Use one of the definitions

- `IF_ETH0`
- `IF_ETH1`
- `IF_DEFAULT`

`ipaddr` Multicast group to join.

RETURN VALUE

`0`: Success.

`1`: Failure (e.g., `ipaddr` is not a multicast address; or not enough available ARP entries to hold the group).

LIBRARY

`IGMP.LIB`

multicast_leavegroup

```
int multicast_leavegroup( int iface, longword ipaddr );
```

DESCRIPTION

This function leaves the specified multicast group (class D IP address--from 224.0.0.0 to 239.255.255.255) on the specified interface. For an Ethernet interface, it configures the hardware to no longer accept multicast packets for the specified address. This function will leave the group no matter how many `multicast_joingroup()` calls were made on that group. However, note that this function will not actually leave a group for which there are UDP sockets. However, when those UDP sockets close, the group will be left.

Note that this function is called automatically when a multicast UDP socket is closed.

PARAMETER

`iface` Interface on which to leave the group. Use one of the definitions

- `IF_ETH0`
- `IF_ETH1`
- `IF_DEFAULT`

`ipaddr` Multicast group to leave.

RETURN VALUE

`0`: Success.

`1`: Failure (e.g., `ipaddr` is not a multicast address).

LIBRARY

`IGMP.LIB`

ntohl

```
longword ntohl( longword value );
```

DESCRIPTION

Converts network-ordered long word to host-ordered long word. This function is necessary if you are implementing standard internet protocols because the Rabbit does not use the standard for network byte ordering. The network orders bytes with the most significant byte first and the least significant byte last. On the Rabbit, the bytes are in the opposite order.

PARAMETERS

value Network-ordered long word.

RETURN VALUE

Network-ordered long word in host-ordered format,
e.g., `ntohl(0x44332211)` returns `0x11223344`

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

htons, ntohs, htonl

ntohs

```
word ntohs( word value );
```

DESCRIPTION

Converts network-ordered word to host-ordered word. This function is necessary if you are implementing standard internet protocols because the Rabbit does not use the standard for network byte ordering. The network orders bytes with the most significant byte first and the least significant byte last. On the Rabbit, the bytes are in the opposite order.

PARAMETERS

value Network-ordered word.

RETURN VALUE

Network-ordered word in host-ordered format,
e.g., `ntohs(0x2211)` returns 0x1122

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

htonl, ntohl, htons

paddr

```
unsigned long paddr( void *pointer );
```

DESCRIPTION

Converts a logical pointer into its physical address. Use caution when converting address in the E000-FFFF range. This function will return the address based on the XPC on entry.

PARAMETERS

pointer Pointer to convert.

RETURN VALUE

Physical address of pointer.

LIBRARY

XMEM.LIB

pd_getaddress

```
void pd_getaddress( int nic, void *buffer );
```

DESCRIPTION

This function copies the Ethernet address (aka the MAC address) into the buffer.

PARAMETERS

nic	Starting with Dynamic C 7.30, this parameter identifies an Ethernet interface. Use a value of 0 if only one NIC is present
buffer	Place to copy address to. Must be at least 6 byes.

RETURN VALUE

None.

LIBRARY

PKTDRV.LIB

EXAMPLE

```
main() {
   char buf[6];
   sock_init();
   pd_getaddress(0,buf);
   printf("Your Link Address is:%02x%02x:%02x%02x:%02x%02x
      \n", buf[0], buf[1], buf[2], buf[3], buf[4], buf[5]);
}
```

pd_havelink

```
int pd_havelink( int nic );
```

DESCRIPTION

Determines if the physical-layer link is established for the specified NIC.

PARAMETERS

nic The NIC to check. Use a value of 0 if only one NIC is present.

RETURN VALUE

0: There is no link.

!0: The link is established.

LIBRARY

REALTEK.LIB | ASIX.LIB | SMSC.LIB

pd_powerdown

```
int pd_powerdown( int nic );
```

DESCRIPTION

Power down the NIC, by turning off as many services as possible. When the NIC is in powerdown mode, it is very important to *not* call any TCP/IP, ethernet, etc. functions, as they will obviously fail, and the results will be undefined. `pd_powerup()` should be the very next network function called, to re-enable the NIC.

PARAMETERS

nic	The NIC to powerdown. Use a value of 0 if only one NIC is present.

RETURN VALUE

`0`: Success.

`!0`: Error.

LIBRARY

`REALTEK.LIB | ASIX.LIB | SMSC.LIB`

SEE ALSO

`pd_powerup`

pd_powerup

```
int pd_powerup( int nic );
```

DESCRIPTION

Power up the NIC, undoing the sleepy-mode changes made by `pd_powerdown`. After this function has returned success, Ethernet and TCP/IP function may be called again.

NOTE: This function will block for 10 ms, to let the chip start up.

PARAMETERS

`nic` The NIC to power up. Use a value of 0 if only one NIC is present.

RETURN VALUE

`0`: Success.

`!0`: Error.

LIBRARY

`REALTEK.LIB | ASIX.LIB | SMSC.LIB`

SEE ALSO

`pd_powerdown`

_ping

```
int _ping( longword host_ip, longword sequence_number );
```

DESCRIPTION

Generates an ICMP request for host. NOTE: this is a macro that calls `_send_ping`.

PARAMETERS

`host_ip` IP address to send ping.

`sequence_number` User-defined sequence number.

RETURN VALUE

`0`: Success.

`1`: Failure, unable to resolve hardware address.

`-1`: Failure, unable to transmit ICMP request.

LIBRARY

`ICMP.LIB`

SEE ALSO

`_chk_ping, _send_ping`

psocket

```
void psocket( void *s );
```

DESCRIPTION

Given an open UDP or TCP socket, the IP address of the remote host is printed out to the Stdio window in dotted IP format followed by a colon and the decimal port number on that machine. This routine can be useful for debugging your programs.

PARAMETERS

s	Pointer to a socket.

RETURN VALUE

None.

LIBRARY

BSDNAME.LIB

resolve

```
longword resolve( char *host_string );
```

DESCRIPTION

Converts a text string, which contains either the dotted IP address or host name, into the longword containing the IP address. In the case of dotted IP, no validity check is made for the address. NOTE: this function blocks. Names are currently limited to 64 characters. If it is necessary to lookup larger names include the following line in the application program:

```
#define DNS_MAX_NAME <len in chars>
```

If `DISABLE_DNS` has been defined, `resolve()` will not do DNS lookup.

If you are trying to resolve a host name, you must set up at least one name server. You can set the default name server by defining the `MY_NAMESERVER` macro at the top of your program. When you call `resolve()`, it will contact the name server and request the IP address. If there is an error, `resolve()` will return 0L.

To simply convert dotted IP to longword, see `inet_addr()`.

For a sample program, see the Example Using tcp_open() listed under `tcp_open()`.

PARAMETERS

`host_string` Pointer to text string to convert.

RETURN VALUE

`0`: Failure.

`!0`: The IP address `*host_string` resolves to.

LIBRARY

`DNS.LIB (Prior to DC 7.05, this was DCRTCP.LIB)`

SEE ALSO

`_arp_resolve, inet_addr, inet_ntoa`

resolve_cancel

```
int resolve_cancel( int handle );
```

DESCRIPTION

Cancels the resolve request represented by the given handle. If the handle is 0, then this function cancels all outstanding resolve requests.

PARAMETERS

handle Handle that represents a DNS lookup process, or 0 to cancel all outstanding resolve requests.

RETURN VALUE

RESOLVE_SUCCESS: The resolve request has been cancelled and is no longer valid.

RESOLVE_HANDLENOTVALID: There is no request for the given handle.

RESOLVE_NONAMESERVER: No nameserver has been defined.

LIBRARY

DNS.LIB

SEE ALSO

resolve_name_start, resolve_name_check, resolve

resolve_name_check

```
int resolve_name_check( int handle, longword *resolved_ip );
```

DESCRIPTION

Checks if the DNS lookup represented by the given handle has completed. On success, it fills in the resolved IP address in the space pointed to by `resolved_ip`.

PARAMETERS

`handle` Handle that represents a DNS lookup process.

`resolved_ip` A pointer to a user-supplied `longword` where the resolved IP address will be placed.

RETURN VALUE

`RESOLVE_SUCCESS`: The address was resolved. The given handle will no longer be valid after this value is returned.

`RESOLVE_AGAIN`: The resolve process has not completed, call this function again.

`RESOLVE_FAILED`: The DNS server responded that the given host name does not exist. The given handle will no longer be valid if `RESOLVE_FAILED` is returned.

`RESOLVE_TIMEDOUT`: The request has been cancelled because a response from the DNS server was not received before the last time-out expired. The given handle will no longer be valid after this value is returned.

`RESOLVE_HANDLENOTVALID`: There is no DNS lookup occurring for the given handle.

`RESOLVE_NONAMESERVER`: No nameserver has been defined.

LIBRARY

`DNS.LIB`

SEE ALSO

resolve_name_start, resolve_cancel, resolve

resolve_name_start

```
int resolve_name_start( char *hostname );
```

DESCRIPTION

Starts the process of resolving a host name into an IP address. The given host name is limited to DNS_MAX_NAME characters, which is 64 by default (63 characters + the NULL terminator). If a default domain is to be added, then the two strings together are limited to DNS_MAX_NAME.

If hostname does not contain a '.' then the default domain (MY_DOMAIN) , if provided, is appended to hostname. If hostname with the appended default domain does not exist, hostname is tried by itself. If that also fails, the lookup fails.

If hostname does contain a '.' then hostname is looked up by itself. If it does not exist, the default domain is appended, and that combination is tried. If that also fails, the lookup fails.

If hostname ends with a '.', then the default domain is not appended. The host name is considered "fully qualified." The lookup is attempted without the ending '.' and if that fails no other combinations are attempted.

This function returns a handle that must be used in the subsequent resolve_name_check() and resolve_cancel() functions.

PARAMETERS

hostname Host name to convert to an IP address

RETURN VALUE

>0: Handle for calls to resolve_name_check() and resolve_cancel().

RESOLVE_NOENTRIES: Could not start the resolve process because there were no resolve entries free.

RESOLVE_LONGHOSTNAME: The given hostname was too large.

RESOLVE_NONAMESERVER: No nameserver has been defined.

LIBRARY

DNS.LIB

SEE ALSO

resolve_name_check, resolve_cancel, resolve

rip

```
char *rip( char *string );
```

DESCRIPTION

Strips newline (\n) and/or carriage return (\r) from a string. Only the first \n and \r characters are replaced with \0s. The resulting string beyond the first \0 character is undefined.

PARAMETERS

string Pointer to a string.

RETURN VALUE

Pointer to the modified string.

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

EXAMPLE

```
setmode( s, TCP_MODE_ASCII );
...
sock_puts( s, rip( questionable_string ));
```

NOTE: In ASCII mode `sock_puts()` adds \n; `rip` is used to make certain the string does not already have a newline character. Remember, `rip` modifies the source string, not a copy!

router_add

```
ATHandle router_add( longword ipaddr, byte iface,
   longword subnet, longword mask, word flags );
```

DESCRIPTION

Add a router to the router table. The same router can be added multiple times, with different subnet and mask. Normally, only one entry is needed in order to access non-local subnets: this entry should be specified with a zero mask. The hardware address of the router is not immediately resolved, however this can be done explicitly by calling `arpresolve_start()` with the same IP address. Otherwise, the router will be resolved only when it first becomes necessary.

PARAMETERS

ipaddr	IP address of the router. This address should be on the local subnet, since non-local routers are not supported.
iface	Interface to use to access this router, or `IF_DEFAULT`.
subnet	Subnet accessible through this entry.
mask	Subnet mask for this entry.
flags	Flags word: set to zero (non-zero reserved for internal use).

RETURN VALUE

Positive value: completed successfully. The return value is the ARP cache table entry for this router.

`ATH_NOENTRIES`: insufficient space in either the router or ARP cache tables.

LIBRARY

`ARP.LIB`

router_del_all

```
void router_del_all( void );
```

DESCRIPTION

Delete all router table entries. This will make any host that is not on the local subnet inaccessible. This function is usually called in preparation for adding a new router entry.

LIBRARY

`ARP.LIB`

router_delete

```
ATHandle router_delete( longword ipaddr );
```

DESCRIPTION

Delete a router from the router table. All instances of the router's IP address are deleted, and the ARP cache table entry is flushed.

PARAMETER

ipaddr IP address of the router. This address should be on the local subnet, since non-local routers are not supported.

RETURN VALUE

Positive value: completed successfully.

ATH_NOTFOUND: specified entry did not exist.

LIBRARY

ARP.LIB

router_for

```
ATHandle router_for( longword ipaddr, byte *router_used,
   byte *r_iface );
```

DESCRIPTION

Return the ARP cache table entry corresponding to the router that handles the given IP address. If there is a pre configured router for the given address, it is selected. Otherwise, routers discovered via DHCP or ICMP router discovery are searched, with the highest preference being selected. Failing this, if there is a point-to-point interface, this is selected as the default.

An alternative mode of calling this function is invoked if `ipaddr` is zero. In this case, the default router for the specified interface (`*r_iface`) is returned. If `r_iface` is `NULL`, then the default interface is assumed:`IF_DEFAULT`, the only interface supported at present. `IF_DEFAULT` may refer to the primary Ethernet NIC or a PPP connection that uses a serial port or the primary Ethernet NIC.

PARAMETERS

ipaddr	IP address of the host which is not on the local subnet.
router_used	If not `NULL`, the byte at this location is set to the index of the router in the router table.
r_iface	If not `NULL`, the byte at this location is set to the interface number that can access the router.

RETURN VALUE

Positive value: completed successfully.

`ATH_NOROUTER`: no suitable router found. Either no router is configured, or the given IP address is on the local subnet.

LIBRARY

`ARP.LIB`

router_print

```
int router_print( byte r );
```

DESCRIPTION

Print a router table entry, indexed by 'r.' This is for debugging only, since the results are printed to the Dynamic C stdio window. 'r' may be obtained from the router_for() function, by passing &r as the router_used parameter to that function.

If the specified router entry is not in use, nothing is printed and the return value is non-zero. Otherwise, the information is printed and zero returned.

See router_printall() for a description of the output fields printed.

PARAMETER

r	Router table index. A number from 0 through (ARP_ROUTER_TABLE_SIZE-1).

RETURN VALUE

0: Success, information printed to stdio window.

!0: Entry is not in use.

LIBRARY

ARP.LIB

SEE ALSO

router_printall

router_printall

```
int router_printall( void );
```

DESCRIPTION

Print all router table entries. This is for debugging only, since the results are printed to the Dynamic C stdio window. If no routers exist in the table, nothing is printed and the return value is non-zero.

There are 6 fields for each router entry:

Router Table Entry Field	Description of Field
#	The entry number.
Flags	A list of the following characters: P = this entry pre configured T = transient entry D = added by DHCP/BOOTP R = added by ICMP redirect ? = router not reachable H = router's hardware address resolved
Address	Either the router's IP address or an indication that the entry is a point-to-point link.
i/f	Interface number.
Net/preference	For pre configured entries, indicates the network(s) which are served by this entry (the Mask indicates which bits of the IP address are used to match with the network address). For non-pre configured entries, this is the "preference value" assigned.
Mask/exp(sec)	For pre configured entries, the bitmask to apply to IP addresses when matching against the above network. Otherwise, is the expiry time from the present, in seconds, of a transient entry.

RETURN VALUE

0: Success, information printed to stdio window.

!0: No routers in the table.

LIBRARY

ARP.LIB

_send_ping

```
int _send_ping( longword host, longword countnum, byte ttl,
   byte tos, longword *theid );
```

DESCRIPTION

Generates an ICMP request for host.

PARAMETERS

host	IP address to send ping.
countnum	User-defined count number.
ttl	Time to live for the packets (hop count). 255 is a standard value for this field. See `sock_set_ttl()` for details.
tos	Type of service on the packets. See `sock_set_tos()` for details.
theid	The identifier that was sent out.

RETURN VALUE

`0`: Success.

`1`: Failure: unable to resolve hardware address.

`-1`: Failure: unable to transmit ICMP request.

LIBRARY

`ICMP.LIB`

SEE ALSO

`_chk_ping, _ping, sock_set_ttl, sock_set_tos`

setdomainname

```
char *setdomainname( char *name );
```

DESCRIPTION

The domain name returned by `getdomainname()` and used for `resolve()` is set to the value in the string pointed to by `name`. Changing the contents of the string after a `setdomainname()` will change the value of the system domain string. It is not recommended. Instead dedicate a static location for holding the domain name.

`setdomainname( NULL )` is an acceptable way to remove any domain name and subsequent `resolve` calls will not attempt to append a domain name.

PARAMETERS

`name` Pointer to string.

RETURN VALUE

Pointer to string that was passed in.

LIBRARY

`BSDNAME.LIB`

SEE ALSO

`getdomainname, sethostname, gethostname, getpeername, getsockname`

sethostid

```
longword sethostid( longword ip );
```

DESCRIPTION

This function changes the system's current IP address. Changing this address will disrupt existing TCP or UDP sessions. You should close all sockets before calling this function.

Normally there is no need to call this function. The macro `MY_IP_ADDRESS` defines an initial IP address for this host, or you can define `USE_DHCP` to obtain a dynamically assigned address. In either case, it is not recommended to use this function to change the address.

PARAMETERS

ip New IP address.

RETURN VALUE

New IP address.

LIBRARY

IP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

gethostid

sethostname

```
char *sethostname( char *name );
```

DESCRIPTION

Sets the host portion of our name.

PARAMETERS

name Pointer to the new host name.

RETURN VALUE

Pointer to internal hostname buffer on success.

NULL on error (if hostname is too long).

LIBRARY

BSDNAME.LIB

sock_abort

```
void sock_abort( void *s );
```

DESCRIPTION

Close a connection immediately. Under TCP this is done by sending a RST (reset).

Under UDP there is no difference between `sock_close()` and `sock_abort()`.

PARAMETERS

s Pointer to a socket.

RETURN VALUE

None.

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sock_close, tcp_open

sock_alive

```
int sock_alive( tcp_Socket *s );
```

DESCRIPTION

This function performs the same test as `tcp_tick(s)` i.e., it checks the status of the socket and returns 0 if the socket is fully closed.

The processing overhead of `tcp_tick()` is avoided for cases where several sockets need to be checked in succession.

When this function returns zero for a socket, the socket is then ready for a new call to `tcp_open()` or `tcp_listen()` and friends.

PARAMETER

s TCP socket pointer.

RETURN VALUE

`0`: Connection reset or fully closed. Socket ready for re-use in another connection.

`!0`: Connection is opening, established, listening, or in the process of closing.

LIBRARY

NET.LIB

SEE ALSO

tcp_open, tcp_listen, sock_close, sock_abort, tcp_tick

sock_aread

```
int sock_aread( tcp_Socket *s, byte *dp, int len );
```

DESCRIPTION

Read exactly `len` bytes from the socket or, if that amount of data is not yet available, do not read anything. Unlike `sock_fastread()`, this function will never return less than the requested amount of data. This can be useful when the application knows that it will be receiving a fixed amount of data, but does not wish to handle the arrival of only part of the data, as it would have to do if `sock_fastread()` was used.

`len` must be less than or equal to the socket receive buffer size, otherwise `sock_fastread()` must be used.

This function is only valid for TCP sockets. It is available starting with DC 7.30.

PARAMETERS

s	Pointer to a TCP socket.
dp	Buffer to place bytes that are read.
len	Number of bytes to copy to the buffer.

RETURN VALUE

`-1`: `len` is greater than the total socket receive buffer size, hence this request could never be satisfied in one call.

`-2`: The socket is closed or closing, but insufficient data is in the buffer to satisfy the request.

`-3`: `len` < 0 or the socket parameter was invalid.

`0`: Insufficient data is in the buffer to satisfy the request, or `len` was zero. Try again later since the socket is still able to receive data from the peer.

`len`: The `len` parameter is returned if there was sufficient data in the socket buffer to satisfy the request.

LIBRARY

TCP.LIB

SEE ALSO

sock_fastread, sock_xfastread, sock_fastwrite, sock_xfastwrite, sock_axread, sock_awrite, sock_axwrite

sock_awrite

```
int sock_awrite( tcp_Socket *s, byte *dp, int len );
```

DESCRIPTION

Write exactly `len` bytes to the socket or, if that amount of data can not be written, do not write anything. Unlike `sock_fastwrite()`, this function will never return less than the requested amount of data. This can be useful when the application needs to write a fixed amount of data, but does not wish to handle the transmission of only part of the data, as it would have to do if `sock_fastwrite()` was used.

`len` must be less than or equal to the socket transmit buffer size, otherwise `sock_fastwrite()` must be used.

This function is only valid for TCP sockets. It is available starting with DC 7.30.

Parameters

s	Pointer to a TCP socket.
dp	Buffer containing data to write.
len	Number of bytes to write to the socket buffer.

RETURN VALUE

`-1`: `len` is greater than the total socket receive buffer size, hence this request could never be satisfied in one call.

`-2`: The socket has been closed for further transmissions, e.g., because `sock_close()` has already been called.

`-3`: `len` < 0 or the socket parameter was invalid.

`0`: Insufficient free space in the transmit buffer to satisfy the request, or `len` was zero. Try again later since the peer will eventually acknowledge the receipt of previous data, freeing up transmit buffer space.

`len`: The `len` parameter is returned if there was sufficient data in the socket transmit buffer to satisfy the request.

LIBRARY

TCP.LIB

SEE ALSO

sock_fastread, sock_xfastread, sock_fastwrite, sock_xfastwrite, sock_axread, sock_aread, sock_axwrite

sock_axread

```
int sock_axread( tcp_Socket *s, long dp, int len );
```

DESCRIPTION

Reads exactly `len` bytes from the socket or, if that amount of data is not yet available, do not read anything.

This function is available starting with DC 7.30. It is identical to `sock_aread()` except that the destination buffer is in xmem.

PARAMETERS

s	Pointer to a TCP socket.
dp	Buffer to place bytes that are read.
len	Number of bytes to copy to the buffer.

RETURN VALUE

`-1`: `len` is greater than the total socket receive buffer size, hence this request could never be satisfied in one call.

`-2`: The socket is closed or closing, but insufficient data is in the buffer to satisfy the request.

`-3`: `len` < 0 or the socket parameter was invalid.

`0`: Insufficient data is in the buffer to satisfy the request, or `len` was zero. Try again later since the socket is still able to receive data from the peer.

`len`: The `len` parameter is returned if there was sufficient data in the socket buffer to satisfy the request.

LIBRARY

TCP.LIB

SEE ALSO

sock_fastread, sock_xfastread, sock_fastwrite, sock_xfastwrite, sock_aread, sock_awrite, sock_axwrite

sock_axwrite

```
int sock_axwrite( tcp_Socket *s, long dp, int len );
```

DESCRIPTION

Write exactly `len` bytes to the socket or, if that amount of data can not be written, do not write anything. This function is available starting with DC 7.30. It is identical to `sock_awrite()` except that the source buffer is in xmem.

Parameters

s	Pointer to a TCP socket.
dp	Buffer containing data to write.
len	Number of bytes to write to the socket buffer.

RETURN VALUE

`-1`: `len` is greater than the total socket receive buffer size, hence this request could never be satisfied in one call.

`-2`: The socket has been closed for further transmissions, e.g., because `sock_close()` has already been called.

`-3`: `len` < 0 or the socket parameter was invalid.

`0`: Insufficient free space in the transmit buffer to satisfy the request, or `len` was zero. Try again later since the peer will eventually acknowledge the receipt of previous data, freeing up transmit buffer space.

`len`: The `len` parameter is returned if there was sufficient data in the socket transmit buffer to satisfy the request.

LIBRARY

TCP.LIB

SEE ALSO

sock_fastread, sock_xfastread, sock_fastwrite, sock_xfastwrite, sock_axread, sock_aread, sock_awrite

sock_bytesready

```
int sock_bytesready( void *s );
```

DESCRIPTION

For TCP sockets:

If the socket is in binary mode, `sock_bytesready()` returns the number of bytes waiting to be read. If there are no bytes waiting, it returns -1.

In ASCII mode, `sock_bytesready()` returns -1 if there are no bytes waiting to be read or the line that is waiting is incomplete (no line terminating character has been read). The number of bytes waiting to be read will be returned given one of the following conditions:

- the buffer is full
- the socket has been closed (no line terminating character can be sent)
- a complete line is waiting

In ASCII mode, a blank line will be read as a complete line with length 0, which will be the value returned. `sock_bytesready()` handles ASCII mode sockets better than `sock_dataready()`, since it can distinguish between an empty line on the socket and an empty buffer.

For UDP sockets:

Returns the number of bytes in the next datagram to be read. If it is a datagram with no data (an empty datagram), then it will return 0. If there are no datagrams waiting, then it returns -1.

PARAMETERS

s	Pointer to a socket.

RETURN VALUE

`-1`: No bytes waiting to be read.

`0`: If in ASCII mode and a blank line is waiting to be read;
for DC 7.05 and later, a UDP datagram with 0 bytes of data is waiting to be read.

`>0`: The number of bytes waiting to be read.

LIBRARY

`NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)`

SEE ALSO

`sock_established, sockstate`

sock_close

```
void sock_close( void *s );
```

DESCRIPTION

Close an open socket. The socket cannot be reused until it is completely closed.

In the case of UDP, the socket is closed immediately. TCP, being a connection-oriented protocol, must negotiate the close with the remote computer. You can tell a TCP socket is closed by `tcp_tick(s)==NULL` or by running `sock_wait_closed(s)`.

In emergency cases, it is possible to abort the TCP connection rather than close it. Although not recommended for normal transactions, this service is available and is used by all TCP/IP systems.

PARAMETERS

s Pointer to a socket.

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sock_abort, sock_tick, sock_wait_closed, tcp_open, udp_open

sock_dataready

```
int sock_dataready( void *s );
```

DESCRIPTION

Returns the number of bytes waiting to be read. If the socket is in ASCII mode, this function returns zero if a newline character has not been read or the buffer is not full. For UDP sockets, the function returns the number of bytes in the next datagram.

This function cannot tell the difference between no bytes to read and either a blank line or a UDP datagram with no data. For this reason, use `sock_bytesready()` instead.

PARAMETERS

s Pointer to a socket.

RETURN VALUE

`0`: No bytes to read;
or newline not yet read if the socket is in ASCII mode;
or (for DC 7.05 and later) if a UDP datagram has 0 bytes of data waiting to be read.

`>0`: Number of bytes ready to read.

LIBRARY

`NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)`

SEE ALSO

`sock_bytesready`

sockerr

```
char *sockerr( void *s );
```

DESCRIPTION

Gets the last ASCII error message recorded for the specified socket. Use of this function will introduce a lot of string constants in root memory. For production programs, it is better to use error numbers (without translation to strings).

PARAMETERS

s Pointer to a socket.

RETURN VALUE

Pointer to the string that represents the last error message for the socket.

NULL pointer if there have been no errors.

If the symbol SOCKERR_NO_RETURN_NULL is defined, then if no error occurred the string "OK" will be returned instead of a NULL pointer.

The error messages are read-only; do not modify them!

LIBRARY

NETERRNO.LIB

SEE ALSO

sock_error, sock_perror

EXAMPLE

```
char *p;
...
if ( p = sockerr( s ))
   printf("Socket closed with error '%s'\n\r", p );
```

sock_error

```
int sock_error( void *s, int clear );
```

DESCRIPTION

Return the most recent error number for the specified socket, which may be a TCP or UDP socket. Up to two error codes may be queued to a socket.

PARAMETERS

s	socket
clear	0: do not clear the returned error condition. 1: clear the returned error from the socket. You can call this function again to get the next older error code (if any).

RETURN VALUE

0: No error.

!0: One of the NETERR_* constants defined in NETERRNO.LIB.

LIBRARY

NETERRNO.LIB

SEE ALSO

sockerr, sock_perror

sock_established

```
int sock_established( void *s );
```

DESCRIPTION

TCP connections require a handshaked open to ensure that both sides recognize a connection. Whether the connection was initiated with `tcp_open()` or `tcp_listen()`, `sock_established()` will continue to return 0 until the connection is established, at which time it will return 1. It is not enough to spin on this after a listen because it is possible for the socket to be opened, written to and closed between two checks. `sock_bytesready()` can be called with `sock_established()` to handle this case.

UDP is a connectionless protocol, hence `sock_established()` always returns 1 for UDP sockets.

PARAMETERS

s Pointer to a socket.

RETURN VALUE

`0`: Not established.

`1`: Established.

LIBRARY

`TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)`

SEE ALSO

`sock_bytesready, sockstate`

sock_fastread

```
int sock_fastread( tcp_Socket *s, byte *dp, int len );
```

DESCRIPTION

Reads up to `len` bytes from `dp` on socket `s`. If possible this function fills the buffer, otherwise only the number of bytes immediately available, if any, are returned.

Starting with Dynamic C 7.05, this function is only valid for TCP sockets. For UDP sockets, use `udp_recv()` or `udp_recvfrom()`. Prior to 7.05, this function cannot be used on UDP sockets after `sock_recv_init()` is called.

PARAMETERS

s	Pointer to a socket.
dp	Buffer to put bytes that are read.
len	Maximum number of bytes to write to the buffer.

RETURN VALUE

≥0: Success, number of bytes read.

-1: Error.

LIBRARY

TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sock_read, sock_fastwrite, sock_write, sockerr, udp_recv, udp_recvfrom, sock_xfastwrite, sock_aread, sock_axread

EXAMPLE

Note that `sock_fastread()` and `sock_read()` do not necessarily return a complete or single line—they return blocks of bytes. In comparison, `sock_getc()` returns a single byte at a time and thus yields poor performance.

```
do {
   /* this function does not block */
   len = sock_fastread( s, buffer, sizeof(buffer)-1 );
   if (len>0) {
      buffer[ len ] = 0;
      printf( "%s", buffer );
   }
} while(tcp_tick(s));
```

sock_fastwrite

```
int sock_fastwrite( tcp_Socket *s, byte *dp, int len );
```

DESCRIPTION

Writes up to `len` bytes from `dp` to socket `s`. This function writes as many bytes as possible to the socket and returns that number of bytes. Starting with Dynamic C 7.05, this function is only valid for TCP sockets. For UDP sockets, use `udp_send()` or `udp_sendto()`.

When using a UDP socket prior to DC 7.05, `sock_fastwrite()` will send one record if

```
len <= ETH_MTU - 20 - 8
```

`ETH_MTU` is the Ethernet Maximum Transmission Unit; 20 is the IP header size and 8 is the UDP header size. By default, this is 572 bytes. If `len` is greater than this number, then the function does not send the data and returns -1. Otherwise, the UDP datagram would need to be fragmented.

For TCP, the new data is queued for sending and `sock_fastwrite()` returns the number of bytes that will be sent. The data may be transmitted immediately if enough data is in the buffer, or sufficient time has expired, or the user has explicitly used `sock_flushnext()` to indicate this data should be flushed immediately. In either case, no guarantee of acceptance at the other end is possible.

PARAMETERS

s	Pointer to a socket.
dp	Buffer to be written.
len	Maximum number of bytes to write to the socket.

RETURN VALUE

`≥0`: Success, number of bytes written.

`-1`: Error.

LIBRARY

`TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)`

SEE ALSO

`sock_write, sock_fastread, sock_read, sockerr, sock_flush, sock_flushnext, udp_send, udp_sendto, sock_xfastwrite`

sock_flush

```
void sock_flush( tcp_Socket *s );
```

DESCRIPTION

`sock_flush()` will flush the unwritten portion of the TCP buffer to the network. No guarantee is given that the data was actually delivered. In the case of a UDP socket, no action is taken.

`sock_flushnext()` is recommended over `sock_flush()`.

PARAMETERS

s Pointer to a socket.

RETURN VALUE

None.

LIBRARY

TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sock_flushnext, sock_fastwrite, sock_write, sockerr

sock_flushnext

```
void sock_flushnext( tcp_Socket *s );
```

DESCRIPTION

Writing to TCP sockets does not guarantee that the data are actually transmitted or that the remote computer will pass that data to the other client in a timely fashion. Using a flush function will guarantee that DCRTCP.LIB places the data onto the network. No guarantee is made that the remote client will receive that data.

`sock_flushnext()` is the most efficient of the flush functions. It causes the next function that sends data to the socket to flush, meaning the data will be transmitted immediately.

Several functions imply a flush and do not require an additional flush: `sock_puts()`, and sometimes `sock_putc()` (when passed a \n).

PARAMETERS

s Pointer to a socket.

RETURN VALUE

None.

LIBRARY

TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sock_write, sock_fastread, sock_read, sockerr, sock_flush, sock_flushnext

sock_getc

```
int sock_getc( tcp_Socket *s );
```

DESCRIPTION

Gets the next character from the socket. NOTE: This function blocks. Starting with Dynamic C 7.05, this function is only valid with TCP sockets. Prior to 7.05, this function could not be used on UDP sockets after `sock_recv_init()` was called.

PARAMETERS

s Pointer to a socket.

RETURN VALUE

Character read or `-1` if error.

LIBRARY

TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sock_putc, sock_gets, sock_puts, sock_read, sock_write

EXAMPLE

```
do {
   if (sock_bytesready( s ) > 0)
      putchar( sock_getc( s ));
} while (tcp_tick(s));
```

sock_gets

```
int sock_gets( tcp_Socket *s, char *text, int len );
```

DESCRIPTION

Reads a string from a socket and replaces the CR or LF with a '\0'. If the string is longer than `len`, the string is null terminated and the remaining characters in the string are discarded.

To use `sock_gets()`, you must first set ASCII mode using the function `sock_mode()` or the macro `tcp_set_ascii()`.

Starting with Dynamic C 7.05, this function is only valid for TCP sockets. Prior to 7.05, this function could not be used on UDP sockets after `sock_recv_init()` was called.

PARAMETERS

s	Pointer to a socket
text	Buffer to put the string.
len	Max length of buffer.

RETURN VALUE

`0`: Either the buffer is empty or the buffer has room and the connection can get more data, but no '\r' or '\n' was read.

`>0`: The length of the string.

`-1`: Function was called with a UDP socket (valid for Dynamic C 7.05 and later).

LIBRARY

`TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)`

SEE ALSO

`sock_puts, sock_putc, sock_getc, sock_read, sock_write`

EXAMPLE

```
sock_mode( s, TCP_MODE_ASCII );
do {
   if (sock_bytesready( s ) > 0) {
      sock_gets( s, buffer, sizeof(buffer)-1 );
      puts( buffer );
   }
} while (tcp_tick( s );
```

sock_iface

```
byte sock_iface( void *s );
```

DESCRIPTION

Retrieve the interface number of an open socket. May return `IF_ANY` for unbound sockets.

PARAMETER

s Pointer to open TCP or UDP socket.

RETURN VALUE

Interface number (0..`IF_MAX`-1).

`IF_ANY`: If the socket is unbound.

LIBRARY

`NET.LIB`

SEE ALSO

`tcp_extopen, udp_extopen, tcp_extlisten`

sock_init

```
int sock_init( void );
```

DESCRIPTION

This function initializes the packet driver and DCRTCP using the compiler defaults for configuration. This function should be called before using other DCRTCP functions.

The return value indicates if `sock_init()` was successful. If it returns 0, then everything was successful. If it returns 1, then the packet driver initialization failed.

Note that the network interface will not necessarily be available immediately after `sock_init()` is called, even if you are simply using an Ethernet interface with a static configuration. This is especially true if you are using DHCP. If you need to make a network connection directly after calling `sock_init()`, then you will probably want to use code like the following:

```
sock_init();
while (ifpending(IF_DEFAULT) == IF_COMING_UP) {
  tcp_tick(NULL);
}
```

The `while` loop will not finish until the interface has either completely come up or has failed (see the documentation for `ifpending()` for more information).

If you use `ucos2.lib`, be sure to call `OSInit()` before calling `sock_init()`.

RETURN VALUE

`0`: OK.
`1`: Ethernet packet driver initialization failed.
Other: reserved.

LIBRARY

`NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)`

sock_mode

```
word sock_mode( void *s, word mode );
```

DESCRIPTION

Change some of the socket options. Depending on whether `s` is a TCP or UDP socket, you may pass OR'd combinations of the following flags in the mode parameter. For a TCP socket, only the `TCP_MODE_*` flags are relevant. For a UDP socket, only the `UDP_MODE_*` flags are relevant. Do not use the wrong flags for the given socket type.

It is more convenient, faster, and safer to use the macro equivalent, if it is only desired to change one mode at a time. If you use this function, then you must specify the setting of all relevant flags (TCP or UDP). The macros do not do socket locking so, strictly speaking, µC/OS users should call this function.

TCP MODES:

`TCP_MODE_ASCII` | `TCP_MODE_BINARY (default)`

TCP and UDP sockets are usually in binary mode which means an arbitrary stream of bytes is allowed (TCP is treated as a byte stream and UDP is treated as records filled with bytes.) The default is `TCP_MODE_BINARY`. By changing the mode to `TCP_MODE_ASCII`, some of the `DCRTCP.LIB` functions will see a stream of records terminated with a newline character.

In ASCII mode, `sock_bytesready()` will return -1 until a newline-terminated string is in the buffer or the buffer is full. `sock_puts()` will append a newline to any output. `sock_gets()` (which should only be used in ASCII mode) removes the newline and null terminates the string.

Equivalent Macros: `tcp_set_binary(s)` and `tcp_set_ascii(s)`

`TCP_MODE_NAGLE (default)` | `TCP_MODE_NONAGLE`

The Nagle algorithm may substantially reduce network traffic with little negative effect on a user (In some situations, the Nagle algorithm even improves application performance.) The default is `TCP_MODE_NAGLE`. This mode only affects TCP connections.

Equivalent Macros: `tcp_set_nagle(s)` and `tcp_set_nonagle(s)`

UDP MODES:

UDP_MODE_CHK | UDP_MODE_NOCHK

Checksums are required for TCP, but not for UDP. The default is UDP_MODE_CHK. If you are providing a checksum at a higher level, the low-level checksum may be redundant. The checksum for UDP can be disabled by selecting the UDP_MODE_NOCHK flag. Note that you do not control whether the remote computer will send checksums. If that computer does checksum its outbound data, DCRTCP.LIB will check the received packet's checksum.

Equivalent Macros: udp_set_chk(s) and udp_set_nochk(s)

UDP_MODE_NOICMP (default) | UDP_MODE_ICMP

Marks this socket for receipt of ICMP error messages. The messages are queued like normal received datagrams, and read using udp_recvfrom(), which returns -3 when ICMP messages are returned instead of normal datagrams. Only ICMP messages which are relevant to the current binding of the socket are queued.

Equivalent Macros: udp_set_noicmp(s) and udp_set_icmp(s)

UDP_MODE_NODICMP (default) | UDP_MODE_DICMP

Marks this socket as the default receiver of ICMP messages which cannot be assigned to a particular UDP socket. This would be used for UDP sockets that are used with many different sendto addresses, since the ICMP message may refer to a message sent some time ago (with different destination address than the most recent). Only one UDP socket should be set with this mode.

Equivalent Macros: udp_set_nodicmp(s) and udp_set_dicmp(s)

PARAMETERS

s	Pointer to a socket.
mode	New mode for specified socket.

RETURN VALUE

Resulting mode flags.

SEE ALSO

inet_addr

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

sock_noflush

```
void sock_noflush( tcp_Socket *s );
```

DESCRIPTION

This function prevents the next write to the socket from transmitting a data segment. It needs to be issued before each write function in which it is desired not to transmit. It can be used to make more efficient use of network bandwidth when the Nagle algorithm is turned off for the socket. If Nagle is on, then there is not much benefit to using this function.

PARAMETERS

s Pointer to a socket.

RETURN VALUE

None.

SEE ALSO

sock_flush, sock_flushnext, sock_fastwrite, sock_write

LIBRARY

TCP.LIB

sock_perror

```
void sock_perror( void *s, const char *prefix );
```

DESCRIPTION

Prints out the most recent error messages for a socket, and clear the errors. This calls `sockerr()` and `printf()`, so it should only be called for debugging a new application. The output is in the format:

```
[TCP|UDP] socket (ipaddr:port -> ipaddr:port) msg1; msg2
```

where `msg1` and, possibly, `msg2` are the most recent error messages. The initial string is "TCP" or "UDP" for open sockets, or may be "Closed" if the socket is currently closed (either TCP or UDP). Up to two error codes may be queued to a socket.

If there are no errors, nothing is printed.

PARAMETERS

s	Pointer to TCP or UDP socket.
prefix	Pointer to text to add to generated messages, or `NULL`.

LIBRARY

`NETERRNO.LIB`

SEE ALSO

`sock_error, sockerr`

sock_preread

```
int sock_preread( tcp_Socket *s, byte *dp, int len );
```

DESCRIPTION

This function reads up to `len` bytes from the socket into the buffer `dp`. The bytes are not removed from the socket's buffer. This function is only valid with TCP sockets.

PARAMETERS

s	Pointer to a socket structure.
dp	Buffer to preread into.
len	Maximum number of bytes to preread.

RETURN VALUE

`0`: No data waiting.

`-1`: Error.

`>0`: Number of preread bytes.

LIBRARY

`TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)`

SEE ALSO

`sock_fastread, sock_fastwrite, sock_read, sock_write`

sock_putc

```
byte sock_putc( tcp_Socket *s, byte c );
```

DESCRIPTION

A single character is placed on the output buffer. In the case of '\n', the buffer is flushed as described under `sock_flushnext`. No other ASCII character expansion is performed.

Note that `sock_putc` uses `sock_write`, and thus may block if the output buffer is full. See `sock_write` for more details.

Starting with Dynamic C 7.05, this function is only valid with TCP sockets.

PARAMETERS

s	Pointer to a socket.
c	Character to send.

RETURN VALUE

The character `c`.

LIBRARY

`TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)`

SEE ALSO

`sock_read, sock_write, sock_fastread, sock_fastwrite, sock_mode`

sock_puts

```
int sock_puts( tcp_Socket *s, byte *dp );
```

DESCRIPTION

A string is placed on the output buffer and flushed as described under `sock_flushnext()`. If the socket is in ASCII mode, CR and LF are appended to the string. No other ASCII character expansion is performed. In binary mode, the string is sent as is.

Note that `sock_puts()` uses `sock_write()`, and thus may block if the output buffer is full. See `sock_write()` for more details.

Starting with Dynamic C 7.05, this function is only valid with TCP sockets.

PARAMETERS

s	Pointer to a socket.
dp	Buffer to read the string from.

RETURN VALUE

≥0: Length of string in dp.

-1: Function was called with a UDP socket (valid for Dynamic C 7.05 and later).

LIBRARY

TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sock_gets, sock_putc, sock_getc, sock_read, sock_write

sock_rbleft

```
int sock_rbleft( void *s );
```

DESCRIPTION

Determines the number of bytes available in the receive buffer.

PARAMETERS

s Pointer to a socket.

RETURN VALUE

Number of bytes available in the receive buffer.

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sock_rbsize, sock_rbused, sock_tbsize, sock_tbused, sock_tbleft

sock_rbsize

```
int sock_rbsize( void *s );
```

DESCRIPTION

Determines the size of the receive buffer for the specified socket.

PARAMETERS

s Pointer to a socket.

RETURN VALUE

The size of the receive buffer.

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sock_rbleft, sock_rbused, sock_tbsize, sock_tbused, sock_tbleft

sock_rbused

```
int sock_rbused( void *s );
```

DESCRIPTION

Returns the number of bytes in use in the receive buffer for the specified socket.

PARAMETERS

s Pointer to a socket.

RETURN VALUE

Number of bytes in use.

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sock_rbleft, sock_tbsize, sock_tbused, sock_tbleft

sock_read

```
int sock_read( tcp_Socket *s, byte *dp, int len );
```

DESCRIPTION

Reads up to `len` bytes from `dp` on socket `s`. This function will busy wait until either `len` bytes are read or there is an error condition. If `sock_yield()` has been called, the user-defined function that is passed to it will be called in a tight loop while `sock_read()` is busy waiting.

Starting with Dynamic C 7.05, this function is only valid for TCP sockets. For UDP sockets, use `udp_recv()` or `udp_recvfrom()`. Prior to 7.05, this function cannot be used on UDP sockets after `sock_recv_init()` is called.

PARAMETERS

s	Pointer to a socket.
dp	Buffer to store bytes that are read.
len	Maximum number of bytes to write to the buffer.

RETURN VALUE

≥0: Success, number of bytes read..

-1: Error.

LIBRARY

TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sock_fastread, sock_fastwrite, sock_write, sockerr, udp_recv, udp_recvfrom

EXAMPLE

Note that `sock_fastread()` and `sock_read()` do not necessarily return a complete or single line—they return blocks of bytes. In comparison, `sock_getc()` returns a single byte at a time and thus yields poor performance.

```
do {
   len = sock_bytesready( s );
   if (len > 0) {
      if (len > sizeof( buffer) - 1)  // If too many bytes, read some
         len = sizeof( buffer ) - 1;  //  now, read the rest next time.
      sock_read( s, buffer, len );
      buffer[ len ] = 0;
      printf( "%s", buffer );
   }
} while ( tcp_tick( s ));
```

sock_readable

```
int sock_readable(void * s);
```

DESCRIPTION

This function determines whether a socket may have data read from it using, for example, `sock_fastread()` or `udp_recvfrom()`.

The parameter may be either a TCP socket or a UDP socket.

The return value is more than a simple boolean: it also indicates the amount of data the socket is guaranteed to deliver with a `sock_fastread()` call that immediately follows (provided that the buffer length is at least that long).

Note: a TCP socket may be readable after it is closed, since there may be pending data in the buffer that has not been read by the application, and it is also possible for the peer to keep sending data.

PARAMETERS

s TCP or UDP socket pointer.

RETURN VALUE

If parameter is a TCP socket (`tcp_Socket *`):

`0`: socket is not readable. It was aborted by the application or the peer has closed the socket and all pending data has been read by the application. This can be used as a definitive EOF indication for a receive stream.

non-zero: the socket is readable. The amount of data that the socket would deliver is this value minus 1; which may turn out to be zero if the socket's buffer is temporarily empty, or the socket is not yet connected to a peer.

If parameter is a UDP socket (`udp_Socket *`):

`0`: socket is not open.

non-zero: socket is open. This value minus 1 equals the size of the next datagram in the receive buffer, that would be returned by `udp_recvfrom()` etc. Note that ICMP error messages are also considered if the socket is set up to receive ICMP messages.

LIBRARY

NET.LIB

SEE ALSO

tcp_open, tcp_listen, sock_close, sock_abort, tcp_tick, sock_established, sock_alive, sock_waiting, sock_writable, udp_open, udp_recvfrom

sock_recv

```
int sock_recv( sock_type *s, char *buffer, int len );
```

DESCRIPTION

After a UDP socket is initialized with `udp_open()` and `sock_recv_init()`, `sock_recv()` scans the buffers for any datagram received by that socket.

This function is not available starting with Dynamic C 7.05 (see Section 3.5).

PARAMETERS

s	Pointer to a UDP socket.
buffer	Buffer to put datagram.
maxlength	Length of buffer.

RETURN VALUE

`>0`: Length of datagram.

`0`: No datagram found.

`-1`: Receive buffer not initialized with `sock_recv_init()`.

LIBRARY

DCRTCP.LIB

SEE ALSO

sock_recv_from, sock_recv_init

EXAMPLE USING SOCK_RECV()

```
// Old way of setting network addresses are commented out
//#define MY_IP_ADDRESS "10.10.6.100"
//#define MY_NETMASK "255.255.255.0"
// New way of setting network addresses.
#define TCPCONFIG 1
#memmap xmem

#use "dcrtcp.lib"
#define SAMPLE 401
udp_Socket data;
char bigbuf[ 8192 ];
main() {
   word templen;
   char spare[ 1500 ];
   sock_init();
   if ( !udp_open( &data, SAMPLE, 0xffffffff, SAMPLE, NULL)
   {
      puts("Could not open broadcast socket");
      exit( 3 );
   }
   /* set large buffer mode */
   if ( sock_recv_init( &data, bigbuf, sizeof( bigbuf ))) {
      puts("Could not enable large buffers");
      exit( 3 );
   }
   sock_mode( &data, UDP_MODE_NOCHK );     // turn off checksums
   while (1) {
      tcp_tick( NULL );
      if (templen = sock_recv(&data, spare, sizeof(spare )))
      {
         /* something received */
         printf("Got %u byte packet\n", templen );
      }
   }
}
```

sock_recv_from

```
int sock_recv_from( sock_type *s, long *hisip, word *hisport,
   char *buffer, int len );
```

DESCRIPTION

After a UDP socket is initialized with `udp_open()` and `sock_recv_init()`, `sock_recv_from()` scans the buffers for any datagram received by that socket and identifies the remote host's address.

This function is not available starting with Dynamic C 7.05 (see Section 3.5).

PARAMETERS

s	Pointer to UDP socket.
hisip	IP of remote host, according to UDP header.
hisport	Port of remote host.
buffer	Buffer to put datagram in.
len	Length of buffer.

RETURN VALUE

`>0`: Length of datagram received.

`0`: No datagram.

`-1`: Receive buffer was not initialized with `sock_recv_init()`.

LIBRARY

DCRTCP.LIB

SEE ALSO

sock_recv, sock_recv_init

sock_recv_init

```
int sock_recv_init( sock_type *s, void *space, word len );
```

DESCRIPTION

This function is not available starting with Dynamic C 7.05 (see Section 3.5).

The basic socket reading functions (`sock_read()`, `sock_fastread()`, etc.) are not adequate for all your UDP needs. The most basic limitation is their inability to treat UDP as a record service.

A record service must receive distinct datagrams and pass them to the user program as such. You must know the length of the received datagram and the sender (if you opened in broadcast mode). You may also receive the datagrams very quickly, so you must have a mechanism to buffer them.

Once a socket is opened with `udp_open()`, you can use `sock_recv_init()` to initialize that socket for `sock_recv()` and `sock_recv_from()`. Note that `sock_recv()` and related functions are *incompatible* with `sock_read()`, `sock_fastread()`, `sock_gets()` and `sock_getc()`. Once you have used `sock_recv_init()`, you can no longer use the older-style calls.

`sock_recv_init()` installs a large buffer area which gets segmented into smaller buffers. Whenever a UDP datagram arrives, `DCRTCP.LIB` stuffs that datagram into one of these new buffers. The new functions scan those buffers. You must select the size of the buffer you submit to `sock_recv_init()`; make it as large as possible, say 4K, 8K or 16K.

For a sample program, see Example using sock_recv() listed under `sock_recv()`.

PARAMETERS

s	Pointer to a UDP socket.
space	Buffer of temporary storage space to store newly received packets.
len	Size of the buffer.

RETURN VALUE

`0`

LIBRARY

`DCRTCP.LIB`

SEE ALSO

`sock_recv_from, sock_recv`

sock_resolved

```
int sock_resolved( void *s );
```

DESCRIPTION

Check whether the socket has a valid destination hardware address. This is typically used for UDP sockets, but may also be used for TCP sockets. If this function returns zero (FALSE), then any datagrams you send using `udp_send()` or `udp_sendto()` may not be transmitted because the destination hardware address is not known.

If the current destination IP address of the socket is zero (i.e., the socket is passively opened), this function returns zero, since datagrams cannot be transmitted from a passively opened socket.

If `udp_bypass_arp()` is in effect, the return value from this function is unaffected, however datagrams will still be sent to the specified hardware address (since the normal resolve process is bypassed).

Note that a hardware address may become invalid after being valid, since the underlying ARP table may need to purge the entry. This would be rare, but if any UDP application needs to ensure that all packets are actually transmitted, which is a questionable goal since UDP is unreliable, then this function should be consulted before each send. If this function returns 0, then the UDP socket should be re-opened.

The hardware address may also be invalidated if `udp_sendto()` is called with a different destination IP address, that has not been determined based on an incoming datagram.

This function is not required for TCP sockets, since the TCP library handles these details internally.

PARAMETER

s	Pointer to open TCP or UDP socket

RETURN VALUE:

`0`: Destination hardware address not valid.

`!0`: Destination hardware address resolved OK.

LIBRARY

`NET.LIB`

SEE ALSO

`udp_extopen, arpresolve_start, arpresolve_check, udp_waitopen, udp_sendto, udp_bypass_arp`

sock_set_tos

```
void sock_set_tos( void *s, byte tos );
```

DESCRIPTION

Set the IP "Type Of Service" field in outgoing packets for this socket. The given TOS will be in effect until the socket is closed. When a socket is opened (or re-opened), the TOS will be set to the default (`TCP_TOS` or `UDP_TOS` as appropriate). If not overridden, the defaults are zero (`IPTOS_DEFAULT`) in both cases.

PARAMETERS

s Pointer to open TCP or UDP socket.

tos Type Of Service. This should be one of the following values:

- `IPTOS_DEFAULT` - Default service
- `IPTOS_CHEAP` - Minimize monetary cost
- `IPTOS_RELIABLE` - Maximize reliability
- `IPTOS_CAPACIOUS` - Maximize throughput
- `IPTOS_FAST` - Minimize delay
- `IPTOS_SECURE` - Maximize security.

Other value may be used (since TOS is just a number between 0 and 255), but this should only be done for experimental purposes.

LIBRARY

`NET.LIB`

SEE ALSO

`sock_set_ttl`

sock_set_ttl

```
void sock_set_ttl( void *s, byte ttl );
```

DESCRIPTION

Set the IP "Time To Live" field in outgoing packets for this socket. The given TTL will be in effect until the socket is closed. When a socket is opened (or re-opened), the TTL will be set to the default (TCP_TTL or UDP_TTL as appropriate). If not overridden, the defaults are 64 in both cases.

PARAMETERS

s	Pointer to open TCP or UDP socket.
ttl	Time To Live. This is a value between 1 and 255. A value of zero is also accepted, but will have undesirable consequences.

LIBRARY

NET.LIB

SEE ALSO

sock_set_tos

sockstate

```
char *sockstate( void *s );
```

DESCRIPTION

Returns a string that gives the current state for a socket.

PARAMETERS

s Pointer to a socket.

RETURN VALUE

An ASCII message which represents the current state of the socket. These strings should not be modified.

“Listen" indicates a passively opened socket that is waiting for a connection.

"SynSent" and "SynRcvd" are connection phase intermediate states.

"Established" states that the connection is complete.

"EstClosing" "FinWait1" "FinWait2" "CloseWait" "Closing" "LastAck" "TimeWait" and "CloseMSL" are connection termination intermediate states.

"Closed" indicates that the connection is completely closed.

"UDP Socket" is always returned for UDP sockets because they are stateless.

"Not an active socket" is a default value used when the socket is not recognized as UDP or TCP.

"BAD" more than one bit set.

LIBRARY

TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sock_established, sock_dataready

EXAMPLE

```
char *p;
...
#ifdef DEBUG
if ( p = sockstate( s ))
   printf("Socket state is '%s'\n\r", p );
#endif DEBUG
```

sock_tbleft

```
int sock_tbleft( void *s );
```

DESCRIPTION

Gets the number of bytes left in the transmit buffer. If you do not wish to block, you may first query how much space is available for writing by calling this function before generating data that must be transmitted. This removes the need for your application to also buffer data.

PARAMETERS

s Pointer to a socket.

RETURN VALUE

Number of bytes left in the transmit buffer.

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sock_rbsize, sock_rbused, sock_rbleft, sock_tbsize, sock_tbused

```
if ( sock_tbleft( s ) > 10 ) {
   /* we can send up to 10 bytes without blocking or overflowing */
   ...
}
```

sock_tbsize

```
int sock_tbsize( void *s );
```

DESCRIPTION

Determines the size of the transmit buffer for the specified socket.

PARAMETERS

s Pointer to a socket.

RETURN VALUE

The size of the transmit buffer.

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sock_rbsize, sock_rbused, sock_rbleft, sock_tbleft, sock_tbused

sock_tbused

```
int sock_tbused( void *s );
```

DESCRIPTION

Gets the number of bytes in use in the transmit buffer for the specified socket.

PARAMETERS

s Pointer to a socket.

RETURN VALUE

Number of bytes in use.

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sock_rbsize, sock_rbused, sock_rbleft, sock_tbsize, sock_tbleft

sock_tick

```
void sock_tick( void *s, int *optional_status_ptr );
```

DESCRIPTION

This macro calls `tcp_tick()` to quickly check incoming and outgoing data and to manage all the open sockets. If our particular socket, `s`, is either closed or made inoperative due to an error condition, `sock_tick()` sets the value of `*optional_status_ptr` (if the pointer is not `NULL`) to 1, then jumps to a local, user-supplied label, `sock_err`. If the socket connection is fine and the pointer is not `NULL` `*optional_status_ptr` is set to 0.

PARAMETERS

s	Pointer to a socket.
optional_status_ptr	Pointer to status word.

RETURN VALUE

None.

LIBRARY

`NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)`

sock_wait_closed

```
void sock_wait_closed( void *s, int seconds, int (*fptr)(),
   int *status );
```

DESCRIPTION

This macro waits until a TCP connection is fully closed. Returns immediately for UDP sockets. On an error, the macro jumps to a local, user-supplied `sock_err` label. If `fptr` returns non-zero the macro returns with the status word set to the value of `fptr`'s return value.

This macro has been deprecated in Dynamic C version 7.20.

PARAMETERS

s	Pointer to a socket.
seconds	Number of seconds to wait before timing out. A value of zero indicates the macro should never time-out. A good value to use is `sock_delay`, a system variable set on configuration. Typically `sock_delay` is about 20 seconds, but can be set to something else in `main()`.
fptr	Function to call repeatedly while waiting. This is a user-supplied function.
status	Pointer to a status word.

RETURN VALUE

None.

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

sock_wait_established

```
void sock_wait_established( void *s, int seconds,
   int (*fptr)(), int *status );
```

DESCRIPTION

This macro waits until a connection is established for the specified TCP socket, or aborts if a time-out occurs. It returns immediately for UDP sockets. On an error, the macro jumps to the local, user-supplied `sock_err` label. If `fptr` returns non-zero, the macro returns.

This macro has been deprecated in Dynamic C version 7.20.

PARAMETERS

s	Pointer to a socket.
seconds	Number of seconds to wait before timing out. A value of zero indicates the macro should never time-out. A good value to use is `sock_delay`, a system variable set on configuration. Typically `sock_delay` is about 20 seconds, but can be set to something else in `main()`.
fptr	Function to call repeatedly while waiting. This is a user-supplied function.
status	Pointer to a status word.

RETURN VALUE

None.

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

sock_waiting

```
int sock_waiting(tcp_Socket * s);
```

DESCRIPTION

This function determines whether a TCP socket is waiting for a connection establishment. It returns TRUE (non-zero) if and only if the socket is open, but not YET established.

The purpose of this function is to simplify the application logic in programs which interleave TCP/IP functions with other processing i.e., "non-blocking" style.

NOTE: it is an error to pass a UDP socket to this function. UDP sockets are connectionless, so there is no concept of “waiting for a connection.”

PARAMETER

s TCP socket pointer. This should be a TCP socket which was opened using `tcp_listen()`, `tcp_extlisten()`, `tcp_open()` or `tcp_extopen()`.

RETURN VALUE

0: socket is not waiting. In this case, then next tests that the application should perform are:

a. `sock_established()`: if this returns TRUE, a connection is currently established. The application can now communicate using `sock_read()`, `sock_write()` etc., then finally call `sock_close()`.

b. `sock_alive()`: if this returns FALSE, then the socket was aborted by the peer. The application may re-open or re-listen the socket.

c. Otherwise, the socket was established, but is now closing because the peer closed its side of the connection. The application MAY be able to read and/or write to the socket (depending on protocol) however the amount of readable data will be limited. The application should call `sock_close()` or `sock_abort()`.

In cases (a) and (c), a socket should not be re-opened until `tcp_tick()` on that socket returns 0.

Note that '0' is returned for invalid sockets (e.g., UDP sockets or sockets that are closed).

non-zero: the socket is waiting for a connection. The application should keep calling `tcp_tick()` until this function returns 0.

LIBRARY

`net.lib`

SEE ALSO

`tcp_open, tcp_listen, sock_close, sock_abort, tcp_tick, sock_established, sock_alive`

sock_wait_input

```
void sock_wait_input( void *s, int seconds, int (*fptr)(),
   int *status );
```

DESCRIPTION

Waits until input exists for functions such as `sock_read()` and `sock_gets()`. As described under `sock_mode()`, if in ASCII mode, `sock_wait_input` only returns when a complete string exists or the buffer is full. It returns immediately for UDP sockets.

On an error, the macro jumps to a local, user-supplied `sock_err` label. If `fptr` returns non-zero, the macro returns.

This macro has been deprecated in Dynamic C version 7.20.

PARAMETERS

s	Pointer to a socket.
seconds	Number of seconds to wait before timing out. A value of zero indicates the macro should never time-out. A good value to use is `sock_delay`, a system variable set on configuration. Typically `sock_delay` is about 20 seconds, but can be set to something else in `main()`.
fptr	Function to call repeatedly while waiting.
status	A pointer to the status word. If this parameter is `NULL`, no status number will be available, but the macro will otherwise function normally. Typically the pointer will point to a local signed integer that is used only for status. `status` may be tested to determine how the socket was ended. A value of 1 means a proper close while a -1 value indicates a reset or abort.

RETURN VALUE

None.

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

sock_writable

```
int sock_writable(void * s);
```

DESCRIPTION

This function determines whether a socket may have data written to it using (e.g.) `sock_fastwrite()` or `udp_sendto()`.

The parameter may be either a TCP socket or a UDP socket.

The return value is more than a simple boolean: it also indicates the amount of data the socket is guaranteed to accept with a `sock_fastwrite()` call that immediately follows.

NOTE: a TCP socket may be writable before it is established. In this case, any written data is transferred as soon as the connection is established.

PARAMETER

s TCP or UDP socket pointer.

RETURN VALUE

If parameter is a TCP socket (tcp_Socket *):

0: socket is not writable. It was closed by theapplication or it may have been aborted by the peer.

non-zero: the socket is writable. The amount of data that the socket would accept is this value minus 1; which may turn out to be zero if the socket's buffer is temporarily full. On a freshly-established socket, and at any other time when all data has been acknowledged by the peer, the return value (minus one) indicates the maximum socket transmit buffer size.

If parameter is a UDP socket (udp_Socket *):

0: socket is not open.

non-zero: socket is open. This value minus 1 equals the maximum size datagram payload that would be sent without fragmentation at the IP level.

Note: the maximum payload depends on the interface that is selected. Since this is not known a-priori, the interface with the largest MTU is arbitrarily selected.

LIBRARY

`net.lib`

SEE ALSO

`tcp_open, tcp_listen, sock_close, sock_abort, tcp_tick, sock_established, sock_alive, sock_waiting, sock_readable, udp_open, udp_sendto`

sock_write

```
int sock_write( tcp_Socket *s, byte *dp, int len );
```

DESCRIPTION

Writes up to `len` bytes from `dp` to socket `s`. This function busy waits until either the buffer is completely written or a socket error occurs. If `sock_yield()` has been called, the user-defined function that is passed to it will be called in a tight loop while `sock_write()` is busywaiting.

For UDP, `sock_write()` will send one (or more) records. For TCP, the new data may be transmitted if enough data is in the buffer or sufficient time has expired or the user has explicitly used `sock_flushnext()` to indicate this data should be flushed immediately. In either case, there is no guarantee of acceptance at the other end.

Starting with Dynamic C 7.05, this function is only valid for TCP sockets. For UDP sockets, use `udp_send()` or `udp_sendto()`.

PARAMETERS

s	Pointer to a socket.
dp	Pointer to a buffer.
len	Maximum number of bytes to write to the buffer.

RETURN VALUE

Number of bytes written or `-1` on an error.

LIBRARY

TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

sock_read, sock_fastwrite, sock_fastread, sockerr, sock_flush, sock_flushnext, udp_send, udp_sendto

sock_xfastread

```
int sock_xfastread( tcp_Socket *s, long dp, long len );
```

DESCRIPTION

Reads up to `len` bytes from `dp` on socket `s`. If possible this function fills the buffer, otherwise only the number of bytes immediately available if any are returned. This function is only valid for TCP sockets. For UDP sockets, use `udp_recv()` or `udp_recvfrom()`.

This function is identical to `sock_fastread()`, except that it reads into an extended memory buffer.

PARAMETERS

s	Pointer to socket.
dp	Buffer to place bytes that are read, as an xmem address obtained from, for example, `xalloc()`.
len	Maximum number of bytes to write to the buffer.

RETURN VALUE

Number of bytes read or -1 if there was an error.

LIBRARY

TCP.LIB

SEE ALSO

sock_read, sock_fastwrite, sock_write, sockerr, udp_recv, udp_recvfrom, sock_fastread

sock_xfastwrite

```
int sock_xfastwrite( tcp_Socket *s, long dp, long len );
```

DESCRIPTION

Writes up to `len` bytes from `dp` to socket `s`. This function writes as many bytes possible to the socket and returns that number of bytes. This function is only valid for TCP sockets. For UDP sockets, use `udp_send()` or `udp_sendto()`.

This function is identical to `sock_fastwrite()`, except that an extended memory data source is used.

PARAMETERS

s	Pointer to socket.
dp	Buffer containing data to be written, as an xmem address obtained from, for example, `xalloc()`.
len	Maximum number of bytes to write to the socket.

RETURN VALUE

Number of bytes written or -1 if there was an error.

LIBRARY

TCP.LIB

SEE ALSO

sock_write, sock_fastread, sock_read, sockerr, sock_flush, sock_flushnext, udp_send, udp_sendto, sock_fastwrite

sock_yield

```
int sock_yield( tcp_Socket *s, void (*fn)() );
```

DESCRIPTION

This function, if called prior to one of the blocking functions, will cause `fn`, the user-defined function that is passed in as the second parameter, to be called repeatedly while the blocking function is in a busywait state.

PARAMETERS

s	Pointer to a TCP socket.
fn	User-defined function.

RETURN VALUE

0

LIBRARY

NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

tcp_clearreserve

```
void tcp_clearreserve( word port );
```

DESCRIPTION

This function causes DCRTCP to handle a socket connection to the specified port normally. This undoes the action taken by `tcp_reserveport()`.

PARAMETERS

port Port to use.

RETURN VALUE

None.

LIBRARY

TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

tcp_open, tcp_listen, tcp_reserveport

tcp_config

```
void tcp_config( char *name, char *value );
```

DESCRIPTION

Sets TCP/IP stack parameters at runtime. It should not be called with open sockets.

Note that there are specific (and safer) functions for modifying some of the common parameters.

This function is deprecated. It is highly recommended that you do NOT use it, since it uses strings, hence taking up lots of root data storage.

PARAMETERS

name Setting to be changed. The possible parameters are:

`MY_IP_ADDRESS`: host IP address (use `sethostid()` instead)
`MY_NETMASK`
`MY_GATEWAY`: host's default gateway
`MY_NAMESERVER`: host's default nameserver
`MY_HOSTNAME`
`MY_DOMAINNAME`: host's domain name (use `setdomainname()` instead)

value The value to assign to `name`.

RETURN VALUE

None.

LIBRARY

`NET.LIB (Prior to DC 7.05, this was DCRTCP.LIB)`

SEE ALSO

`tcp_open, sock_close, sock_abort, sethostid, setdomainname, sethostname`

tcp_extlisten

```
int tcp_extlisten( tcp_Socket *s, int iface, word lport,
   longword remip, word port, dataHandler_t datahandler,
   word reserved, long buffer, int buflen );
```

DESCRIPTION

This function tells DCRTCP that an incoming session for a particular port will be accepted. The `buffer` and `buflen` parameters allow a user to supply a socket buffer, instead of using a socket buffer from the pool. `tcp_extlisten()` is an extended version of `tcp_listen()`.

PARAMETERS

s	Pointer to the socket's data structure.
iface	Local interface on which to open the socket. Use `IF_ANY` if the socket is to accept connections from any interface. Otherwise, connections will be accepted only from the specified interface. Prior to Dynamic C 7.30 this parameter was not implemented and should be `IF_DEFAULT`.
lport	Port to listen on.
remip	IP address to accept connections from or 0 for all.
port	Port to accept connections from or 0 for all.
datahandler	Function to call when data is received, `NULL` for placing data in the socket's receive buffer. Prior to Dynamic C 7.30, some details for implementation of this service had not been finalized. Insert a value of `NULL` if you are using a version of Dynamic C prior to 7.30.
reserved	Set to 0 for now. This parameter is for compatibility and possible future use.
buffer	Address of user-supplied socket buffer in xmem. This is the return value of `xalloc()`. If `buffer` is 0, the socket buffer for this socket is pulled from the buffer pool defined by the macro `MAX_TCP_SOCKET_BUFFERS`.
buflen	Length of user-supplied socket buffer.

RETURN VALUE

`0`: Failure.

`1`: Success.

LIBRARY

`TCP.LIB`

tcp_extopen

```
int tcp_extopen( tcp_Socket *s, int iface, word lport,
   longword remip, word port, dataHandler_t datahandler,
   long buffer, int buflen );
```

DESCRIPTION

Actively creates a session with another machine. The `buffer` and `buflen` parameters allow a user to supply a socket buffer, instead of using a socket buffer from the pool. `tcp_extopen()` is an extended version of `tcp_open()`.

s Pointer to socket's data structure.

iface Local interface on which to open the socket. Use `IF_ANY` if interface is to be selected automatically based on the destination IP address.

lport Our port, zero for the next one available in the range 1025-65536.

remip IP address to connect to.

port Port to connect to.

datahandler Function to call when data is received, `NULL` for placing data in the socket's receive buffer. Prior to Dynamic C 7.30, some details for implementation of this service had not been finalized. Insert a value of `NULL` if you are using a version of Dynamic C prior to 7.30.

buffer Address of user-supplied socket buffer in xmem. This is the return value of `xalloc()`. If `buffer` is 0, the socket buffer for this socket is pulled from the buffer pool defined by the macro `MAX_TCP_SOCKET_BUFFERS`.

buflen Length of user-supplied socket buffer.

RETURN VALUE

`0`:Error, unable to resolve the remote computer's hardware address.

`!0`: Success.

LIBRARY

`TCP.LIB`

SEE ALSO

`tcp_open`

tcp_keepalive

```
int tcp_keepalive( tcp_Socket *s, long timeout );
```

DESCRIPTION

Enable or disable TCP keepalives on a specified socket. The socket must already be open. Keepalives will then be sent after `timeout` seconds of inactivity. It is highly recommended to keep `timeout` as long as possible, to reduce the load on the network. Ideally, it should be no shorter than 2 hours. After the timeout is sent, and `KEEPALIVE_WAITTIME` seconds pass, another keepalive will be sent, in case the first was lost. This will be retried `KEEPALIVE_NUMRETRYS` times. Both of these macros can be defined at the top of your program, overriding the defaults of 60 seconds, and 4 retries.

Using keepalives is not a recommended procedure. Ideally, the application using the socket should send its own keepalives. `tcp_keepalive()` is provided because telnet and a few other network protocols do not have a method of sending keepalives at the application level.

PARAMETERS

s	Pointer to a socket.
timeout	Period of inactivity, in seconds, before sending a keepalive or 0 to turn off keepalives.

RETURN VALUE

`0`: Success.

`1`: Failure.

LIBRARY

`TCP.LIB`

SEE ALSO

sock_fastread, sock_fastwrite, sock_write, sockerr

tcp_listen

```
int tcp_listen( tcp_Socket *s, word lport, longword remip,
   word port, dataHandler_t datahandler, word reserved );
```

DESCRIPTION

This function tells DCRTCP.LIB that an incoming session for a particular port will be accepted. After a call to tcp_listen(), the function sock_established() (or the macro sock_wait_established) must be called to poll the connection until a session is fully established.

It is possible for a connection to be opened, written to and closed between two calls to the function sock_established(). To handle this case, call sock_bytesready() to determine if there is data to be read from the buffer.

Multiple calls to tcp_listen() to the same local port (lport) are acceptable and constitute the mechanism for supporting multiple incoming connections to the same local port. Each time another host attempts to open a session on that particular port, another one of the listens will be consumed until such time as all listens have become established sessions and subsequent remote host attempts will receive a reset.

PARAMETERS

s	Pointer to a socket.
lport	Port to listen on (the local port number).
remip	IP address of the remote host to accept connections from or 0 for all.
port	Port to accept connections from or 0 for all.
datahandler	Function to call when data is received; NULL for placing data in the socket's receive buffer. Prior to Dynamic C 7.30, some details for implementation of this service had not been finalized. Insert a value of NULL if you are using a version of Dynamic C prior to 7.30.
reserved	Set to 0 for now. This parameter is for compatibility and possible future use.

RETURN VALUE

0: Failure.

1: Success.

LIBRARY

TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

tcp_extlisten

EXAMPLE USING TCP_LISTEN()

```
// Old way of setting network addresses is commented out.
//#define MY_IP_ADDRESS "10.10.6.100"
//#define MY_NETMASK "255.255.255.0"
// New method of setting network addresses
#define TCPCONFIG 1
#memmap xmem
#use "dcrtcp.lib"

#define TELNET_PORT 23

static tcp_Socket *s;
char *userid;

telnets(int port) {
   tcp_Socket telnetsock;
   char buffer[ 512 ];
   int status;
   s = &telnetsock;
   tcp_listen( s, port, 0L, 0, NULL, 0);
   while (!sock_established(s) && sock_bytesready(s)==-1){
      tcp_tick(NULL);
   }
   puts("Receiving incoming connection");
   sock_mode( s, TCP_MODE_ASCII );
   sock_puts( s, "Welcome to a sample telnet server.");
   sock_puts( s, "Each line you type will be printed on"\
   " this screen once you hit return.");
   /* other guy closes connection except if we timeout ... */
   do {
      if (sock_bytesready(s) >= 0) {
         sock_gets(s, buffer, sizeof(buffer)-1);
         puts ( buffer);
      }
   } while (tcp_tick(s));
}
main() {
   sock_init();
   telnets( TELNET_PORT);
   exit( 0 );
}
```

tcp_open

```
int tcp_open( tcp_Socket *s, word lport, longword remip,
   word port, dataHandler_t datahandler );
```

DESCRIPTION

This function actively creates a session with another machine. After a call to `tcp_open()`, the function `sock_established()` (or the macro `sock_wait_established`) must be called to poll the connection until a session is fully established.

It is possible for a connection to be opened, written to and closed between two calls to the function `sock_established()`. To handle this case, call `sock_bytesready()` to determine if there is data to be read from the buffer.

PARAMETERS

s	Pointer to a socket structure.
lport	Our local port. Use zero for the next available port in the range 1025-65536. A few applications will require you to use a particular local port number, but most network applications let you use almost any port with a certain set of restrictions. For example, FINGER or TELNET clients can use any local port value, so pass the value of zero for `lport` and let `DCRTCP.LIB` pick one for you.
remip	IP address to connect to.
port	Port to connect to.
datahandler	Function to call when data is received; `NULL` for placing data in the socket's receive buffer. Prior to Dynamic C 7.30, some details for implementation of this service had not been finalized. Insert a value of `NULL` if you are using a version of Dynamic C prior to 7.30.

RETURN VALUE

`0`: Unable to resolve the remote computer's hardware address.

`!0` otherwise.

LIBRARY

`TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)`

SEE ALSO

`tcp_listen`

EXAMPLE USING TCP_OPEN()

```
// Old way of setting network addresses is commented out.
//#define MY_IP_ADDRESS "10.10.6.100"
//#define MY_NETMASK "255.255.255.0"
// New of setting network addresses
#define TCPCONFIG 1
#memmap xmem
#use "dcrtcp.lib"
#define ADDRESS "10.10.6.19"
#define PORT "200"
main() {
   word status;
   word port;
   longword host;
   tcp_Socket tsock;
   sock_init();
   if (!(host = resolve(ADDRESS))) {
      puts("Could not resolve host");
      exit( 3 );
   }
   port = atoi( PORT );
   printf("Attempting to open '%s' on port %u\n\r", ADDRESS,
       port );
   if ( !tcp_open( &tsock, 0, host, port , NULL )) {
      puts("Unable to open TCP session");
      exit( 3 );
   }
   printf("Waiting a maximum of %u seconds for connection"\
       " to be established\n\r", sock_delay );
   while (!sock_established(&tsock) &&
       sock_bytesready(&tsock)== -1){
      tcp_tick(NULL);
   }
   puts("Socket is established");
   sock_close( &tsock );
   exit( 0 );
}
```

tcp_reserveport

```
void tcp_reserveport( word port );
```

DESCRIPTION

This function allows a connection to be established even if there is not yet a socket available. This is done by setting a parameter in the TCP header during the connection setup phase that indicates 0 bytes of data can be received at the present time. The requesting end of the connection will wait until the TCP header parameter indicates that data will be accepted.

The 2MSL waiting period for closing a socket is avoided by using this function.

The penalty of slower connection times on a controller that is processing a large number of connections is offset by allowing the program to have less sockets and consequently less RAM usage.

PARAMETERS

port Port to use.

RETURN VALUE

None.

LIBRARY

TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)

SEE ALSO

tcp_open, tcp_listen, tcp_clearreserve

tcp_tick

```
int tcp_tick( void *s );
```

DESCRIPTION

This function is a single kernel routine designed to quickly process packets and return as soon as possible. `tcp_tick()` performs processing on all sockets upon each invocation: checking for new packets, processing those packets, and performing retransmissions on lost data. On most other computer systems and other kernels, performing these required operations in the background is often done by a task switch. `DCRTCP.LIB` does not use a tasker for its basic operation, although it can adopt one for the user-level services.

Although you may ignore the returned value of `tcp_tick()`, it is the easiest method to determine the status of the given socket.

PARAMETERS

s Pointer to a socket. If a `NULL` pointer is passed in the returned value should be ignored.

RETURN VALUE

`0`: Connection reset or closed by other host or `NULL` was passed in.

`!0`: Connection is fine.

LIBRARY

`TCP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)`

SEE ALSO

`tcp_open, sock_close, sock_abort`

udp_bypass_arp

```
void udp_bypass_arp( udp_Socket *s, eth_address *eth );
```

DESCRIPTION

Override the normal Address Resolution Protocol for this UDP socket. This is sometimes necessary for special purposes such as if the Ethernet address is to remain fixed, or if the Ethernet address is not obtainable using ARP. The great majority of applications should not use this function.

If ARP bypass is in effect for a UDP socket, then `udp_sendto()` will never return the -2 return code.

The destination interface is also forced to be `IF_DEFAULT`. If the supplied hardware address is accessible from a non-default interface only, then you will need to manually set the `s->iface` field.

PARAMETERS

s	UDP socket
eth	Pointer to override address. If `NULL`, then resume normal operation i.e., use ARP to resolve Ethernet addresses. Note that the specified Ethernet address must be in static storage, since only the pointer is stored.

LIBRARY

`UDP.LIB`

SEE ALSO

`udp_sendto, udp_waitsend, sock_resolved`

udp_close

```
void udp_close( udp_Socket *ds );
```

DESCRIPTION

This function closes a UDP connection. Starting with Dynamic C 7.30, this function performs the actions necessary to leave a host group when closing a multicast socket. It is IGMPv2 compliant.

PARAMETERS

ds Pointer to socket's data structure.

LIBRARY

UDP.LIB

udp_extopen

```
int udp_extopen( udp_Socket *s, int iface, word lport,
   longword remip, word port, dataHandler_t datahandler,
   long buffer, int buflen );
```

DESCRIPTION

This function is an extended version of `udp_open()`. It opens a socket on a given network interface (`iface`) on a given local port (`lport`). If the remote IP address is specified (`remip`), then only UDP datagrams from that host will be accepted.

The remote end of the connection is specified by `remip` and `port`. The following table explains the possible combinations and what they mean.

REMIP	Effect of REMIP value
0	The connection completes when the first datagram is received, supplying both the remote IP address and the remote port number. Only datagrams received from that IP/port address will be accepted.
-1	All remote hosts can send datagrams to the socket. All outgoing datagrams will be sent to the broadcast address unless `udp_sendto()` specifies otherwise.
>0	If the remote IP address is a valid IP address and the remote port is 0, the connection will complete when the first datagram is received, supplying the remote port number. If the remote IP address and the remote port are both specified when the function is called, the connection is complete at that point.

The `buffer` and `buflen` parameters allow a user to supply a socket buffer, instead of using a socket buffer from the pool.

If `remip` is non-zero, then the process of resolving the correct destination hardware address is started. Datagrams cannot be sent until `sock_resolved()` returns TRUE. If you attempt to send datagrams before this, then the datagrams may not get sent. The exception to this is if `remip` is -1 (broadcast) in which case datagrams may be sent immediately after calling this function.

This function also works with multicast addresses. If `remip` is a multicast address, then packets sent with this function will go to the multicast address, and packets received will also be from that multicast address. Also, if enabled, IGMP will be used to join the multicast groups. The group will be left when the socket is closed. Note that if port is 0 and `remip` is a multicast address, the port will not be filled in on the first received datagram (that is, the socket is non-binding to the port).

PARAMETERS

s	Pointer to socket.
iface	Local interface on which to open the socket. Use IF_ANY if the socket is to accept datagrams from any interface. Otherwise, datagrams will be accepted only from the specified interface. This parameter is supported as of Dynamic C 7.30. With earlier version of DC, this parameter should be IF_DEFAULT.
lport	Local port.
remip	Acceptable remote IP, or 0 for all.
port	Acceptable remote port, or 0 for all.
datahandler	Function to call when data is received, NULL for placing data in the socket's receive buffer.
buffer	Address of user-supplied socket buffer in xmem. If buffer is 0, the socket buffer for this socket is pulled from the buffer pool defined by the macro MAX_UDP_SOCKET_BUFFERS.
buflen	Length of user-supplied socket buffer.

RETURN VALUE:

!0: Success.

0: Failure; error opening socket, e.g., a buffer could not be allocated.

LIBRARY

UDP.LIB

SEE ALSO

udp_open, sock_resolved

udp_open

```
int udp_open( udp_Socket *s, word lport, longword remip,
   word port, dataHandler_t datahandler );
```

DESCRIPTION

This function opens a UDP socket on the given local port (`lport`). If the remote IP address is specified (`remip`), then only UDP datagrams from that host will be accepted. The remote end of the connection is specified by `remip` and `port`. The following table explains the possible combinations and what they mean.

REMIP	Effect of REMIP value
`0`	The connection completes when the first datagram is received, supplying both the remote IP address and the remote port number. Only datagrams received from that IP/port address will be accepted.
`-1`	All remote hosts can send datagrams to the socket. All outgoing datagrams will be sent to the broadcast address on the specified port. The `port` parameter is ignored.
`>0`	If the remote IP address is a valid IP address and the remote port is 0, the connection will complete when the first datagram is received, supplying the remote port number. If the remote IP address and the remote port are both specified when the function is called, the connection is complete at that point.

If the remote host is set to a particular address, either host may initiate traffic. Multiple calls to `udp_open()` with `remip` set to zero is a useful way of accepting multiple incoming sessions.

Although multiple calls to `udp_open()` may normally be made with the same `lport` number, only one `udp_open()` should be made on a particular `lport` if the `remip` is set to -1. Essentially, the broadcast and nonbroadcast protocols cannot coexist.

Be sure that you have allocated enough UDP socket buffers with `MAX_UDP_SOCKET_BUFFERS`. Note that this macro defaults to 0, so any usage of `udp_open()` requires a definition of `MAX_UDP_SOCKET_BUFFERS` in your program.

This function also works with multicast addresses. If `remip` is a multicast address, then packets sent with this function will go to the multicast address, and packets received will also be from that multicast address. Also, if enabled, IGMP will be used to join the multicast groups. The group will be left when the socket is closed. Note that if `port` is 0 and `remip` is a multicast address, the port will not be filled in on the first received datagram (that is, the socket is non-binding to the port).

PARAMETERS

s	Pointer to a UDP socket.
lport	Local port
remip	Acceptable remote IP, 0 to connect on first datagram, or -1 for broadcast.
port	Acceptable remote port, or 0 to connect on first datagram.
datahandler	Function to call when data is received. `NULL` for placing data in the socket's receive buffer.

RETURN VALUE

`0`: Failure (e.g., a buffer could not be allocated).

`!0`: Success.

LIBRARY

`UDP.LIB (Prior to DC 7.05, this was DCRTCP.LIB)`

SEE ALSO

`udp_extopen`

udp_peek

```
int udp_peek( udp_Socket *s, _udp_datagram_info *udi );
```

DESCRIPTION

Look into the UDP socket receive buffer to see if there is a datagram ready to be read using `udp_recvfrom()`. This function does not remove the datagram from the buffer, but it allows the application to determine the full details about the next datagram, including whether the datagram was broadcast.

The returned data is put in `*udi`. `udi` must point to a valid data structure, or be `NULL`. The data structure is:

```
typedef struct {
  longword remip;     // Remote host IP address
  word     remport;   // Remote host port number
  int      len;       // Length of datagram
  byte     flags;     // Bit mask (defined below)
  byte     iface;     // Interface number
} _udp_datagram_info;
```

The `flags` field may have one of the following values:

```
UDI_ICMP_ERROR    - This is an ICMP error entry.
UDI_TOS_MASK      - Type-of-service bit mask.
UDI_BROADCAST_LL  - Received on broadcast link layer address.
UDI_BROADCAST_IP  - Received on broadcast network (IP) address.
```

PARAMETERS

s	UDP socket to check
udi	Where to store the returned information.

RETURN VALUE

`1`: A normal datagram is in the receive buffer.

`0`: No datagram waiting.

`-3`: ICMP error message in receive buffer - will only be returned if `udi` is not `NULL`.

LIBRARY

`UDP.LIB`

SEE ALSO

`udp_recvfrom`

udp_recv

```
int udp_recv( udp_Socket *s, char *buffer, int len );
```

DESCRIPTION

Receives a single UDP datagram on a UDP socket. If the buffer is not large enough for the datagram, the datagram is truncated, and the remainder discarded.

PARAMETERS

s	Pointer to socket's data structure.
buffer	Buffer where the UDP datagram will be stored.
len	Maximum length of the buffer.

RETURN VALUE

≥0: Number of bytes received.

-1: No datagram waiting.

<-1: Error.

LIBRARY

UDP.LIB

SEE ALSO

udp_recvfrom, udp_send, udp_sendto, udp_open

udp_recvfrom

```
int udp_recvfrom( udp_Socket *s, char *buffer, int len,
   longword *remip, word *remport );
```

DESCRIPTION

Receive a single UDP datagram on a UDP socket. remip and remport should be pointers to the locations where the remote IP address and remote port from which the datagram originated are placed. If the buffer is not large enough for the datagram, then the datagram will be truncated, with the remainder being discarded.

If and only if the UDP_MODE_ICMP or UDP_MODE_DICMP modes are set for this socket, then a return code of -3 indicates that an ICMP error message is being returned in the buffer instead of a normal datagram. In this case, buffer will contain fixed data in the form of a structure of type _udp_icmp_message. The definition of this structure is:

```
typedef struct {
word myport;          // Originating port on this host
byte icmp_type;       // One of the ICMPTYPE_* values
byte icmp_code;       // The corresponding ICMP code
} _udp_icmp_message;
```

Please see sock_mode for more information about the modes UDP_MODE_ICMP and UDP_MODE_DICMP.

PARAMETERS

s	Pointer to socket's data structure.
buffer	Buffer where the UDP datagram will be stored.
len	Maximum length of the buffer.
remip	IP address of the remote host of the received datagram.
remport	Port number of the remote host of the received datagram.

RETURN VALUE

≥0: Number of bytes received.

-1: No datagram waiting.

-2: Error - not a UDP socket.

-3: The returned buffer contains an ICMP error which was queued previously.

LIBRARY

UDP.LIB

SEE ALSO

udp_recv, udp_send, udp_sendto, udp_open, udp_peek

udp_send

```
int udp_send( udp_Socket *s, char *buffer, int len );
```

DESCRIPTION

Sends a single UDP datagram on a UDP socket. It will not work for a socket for which the `remip` parameter to `udp_open()` was 0, unless a datagram has first been received on the socket. If the `remip` parameter to `udp_open()` was -1, the datagram will be send to the broadcast address.

PARAMETERS

s	Pointer to socket's data structure.
buffer	Buffer that contains the UDP datagram
len	Length of the UDP datagram.

RETURN VALUE

≥0: Number of bytes sent.

-1: Failure.

-2: Failed because hardware address not resolved.

LIBRARY

UDP.LIB

SEE ALSO

udp_sendto, udp_recv, udp_recvfrom, udp_open

udp_sendto

```
int udp_sendto( udp_Socket *s, char *buffer, int len,
   longword remip, word remport );
```

DESCRIPTION

Sends a single UDP datagram on a UDP socket. It will send the datagram to the IP address and port specified by `remip` and `remport`. Note that this function can be used on a socket that has been "connected" to a different remote host and port.

PARAMETERS

s	Pointer to socket's data structure.
buffer	Buffer that contains the UDP datagram.
len	Length of the UDP datagram.
remip	IP address of the remote host.
remport	Port number of the remote host.

RETURN VALUE

≥0: Success, number of bytes sent.

-1: Failure.

-2: Failed because hardware address not resolved.

LIBRARY

UDP.LIB

SEE ALSO

udp_send, udp_xsendto, udp_recv, udp_recvfrom, udp_open

udp_waitopen

```
int udp_waitopen( udp_Socket *s, int iface, word lport,
   longword remip, word port, dataHandler_t datahandler,
   long buffer, int buflen, longword millisecs );
```

DESCRIPTION

This function is identical to `udp_extopen()`, except that it waits a specified amount of time for the hardware address of the destination to be resolved.

While waiting, this function calls `tcp_tick()`.

PARAMETERS

s	Pointer to socket.
iface	Local interface on which to open the socket. This parameter is supported as of Dynamic C 7.30. With earlier version of DC, this parameter should be `IF_DEFAULT`.
lport	Local port.
remip	Acceptable remote ip, or 0 for all.
port	Acceptable remote port, or 0 for all.
datahandler	Function to call when data is received, `NULL` for placing data in the sockets receive buffer.
buffer	Address of user-supplied socket buffer in xmem, 0 to use a buffer from the socket buffer pool.
buflen	Length of user-supplied socket buffer.
millisecs	Maximum milliseconds to wait for the hardware address to be resolved.

RETURN VALUE

`>0`: Successfully opened socket.

`0`: Timed out without resolving address.

`-1`: Error opening socket (e.g., buffer could not be allocated).

LIBRARY

UDP.LIB

SEE ALSO

udp_extopen, sock_resolved

udp_waitsend

```
int udp_waitsend( udp_Socket *s, char *buffer, int len,
   longword remip, word remport, word millisecs );
```

DESCRIPTION

This is identical to `udp_sendto()`, except that it will block for up to the specified amount of time waiting for the hardware address to be resolved. Normally, you should not have to specify more than 100ms for the time out. If it takes longer than this, the destination is probably unavailable.

PARAMETERS

s	UDP socket on which to send the datagram.
buffer	Buffer that contains the UDP datagram.
len	Length of the UDP datagram.
remip	IP address of the remote host.
remport	Port number of the remote host.
millisecs	Number of milliseconds to wait for hardware address resolution. Reasonable values are between 50 and 750 milliseconds.

RETURN VALUE

≥0: Number of bytes sent.

-1: Failure (invalid UDP socket etc.).

-2: Failure (timed out, no datagram sent).

LIBRARY

UDP.LIB

SEE ALSO

udp_sendto, udp_recvfrom, udp_bypass_arp

udp_xsendto

```
int udp_xsendto( udp_Socket *s, long buffer, int len,
   longword remip, word remport );
```

DESCRIPTION

Send a single UDP datagram on a UDP socket. It will send the datagram to the IP address specified by remip, and the port specified by remport. Note that this function can be used even on a socket that has been "connected" to a remote host and port.

This function is identical to `udp_sendto()` except that the data address is specified as a physical address.

PARAMETERS

s	UDP socket on which to send the datagram.
buffer	Buffer that contains the UDP datagram.
len	Length of the UDP datagram.
remip	IP address of the remote host.
remport	Port number of the remote host.

RETURN VALUE

≥0: Number of bytes sent.

-1: Failure.

-2: Failure (hardware address not resolved).

LIBRARY

UDP.LIB

SEE ALSO

udp_send, udp_recv, udp_recvfrom, udp_open, udp_sendto

virtual_eth

```
int virtual_eth( word real_iface, longword ipaddr, longword
   netmask, void * resv );
```

DESCRIPTION

Create a new virtual ethernet interface. You must #define VIRTUAL_ETH to a positive number (1-6) for this function to work. The macro VIRTUAL_ETH gives the maximum number of virtual interfaces.

Virtual ethernet interfaces have some restrictions:

- You cannot use DHCP.
- Broadcast/multicast packets are not received.
- Some ifconfig() settings (such as MTU size) are not settable.
- Once a virtual interface is created, it cannot be destroyed. In practice, this means that all virtual interfaces should be created at boot time (after sock_init()).

The virtual interface will be created in the same up/down state as the real interface. Changes to the up/down state of the real interface will affect all virtual interfaces tied to that interface.

The callback function for a virtual interface is set to NULL.

PARAMETERS

real_iface The real interface to use. This must be IF_ETH0, or may be IF_ETH1 for boards with two ethernet chips.

ipaddr The IP address to assign this interface. This must not be the same as the IP address of any other interface.

netmask Netmask to use. If zero, then the netmask of the real interface will be used.

resv Pointer reserved for future use. Pass as NULL.

RETURN VALUE

-1: Failed because VIRTUAL_ETH was not defined, or the number of virtual interfaces exceeds the value specified by VIRTUAL_ETH, or the real_iface parameter was not valid.

Otherwise: returns the interface number to use for this virtual interface. This should be passed to any other function that requires the interface number to be specified.

LIBRARY

NET.LIB

SEE ALSO

ifconfig

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The Dynamic C TCP/IP software is designed for use only with Rabbit Semiconductor chips.

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