



# NTP Client User Guide

Version 2.00

For use with Network Time Protocol (NTP) Client module versions 1.17 and above

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# 1 System Overview

This chapter contains the fundamental information for this module.

The component sections are as follows:

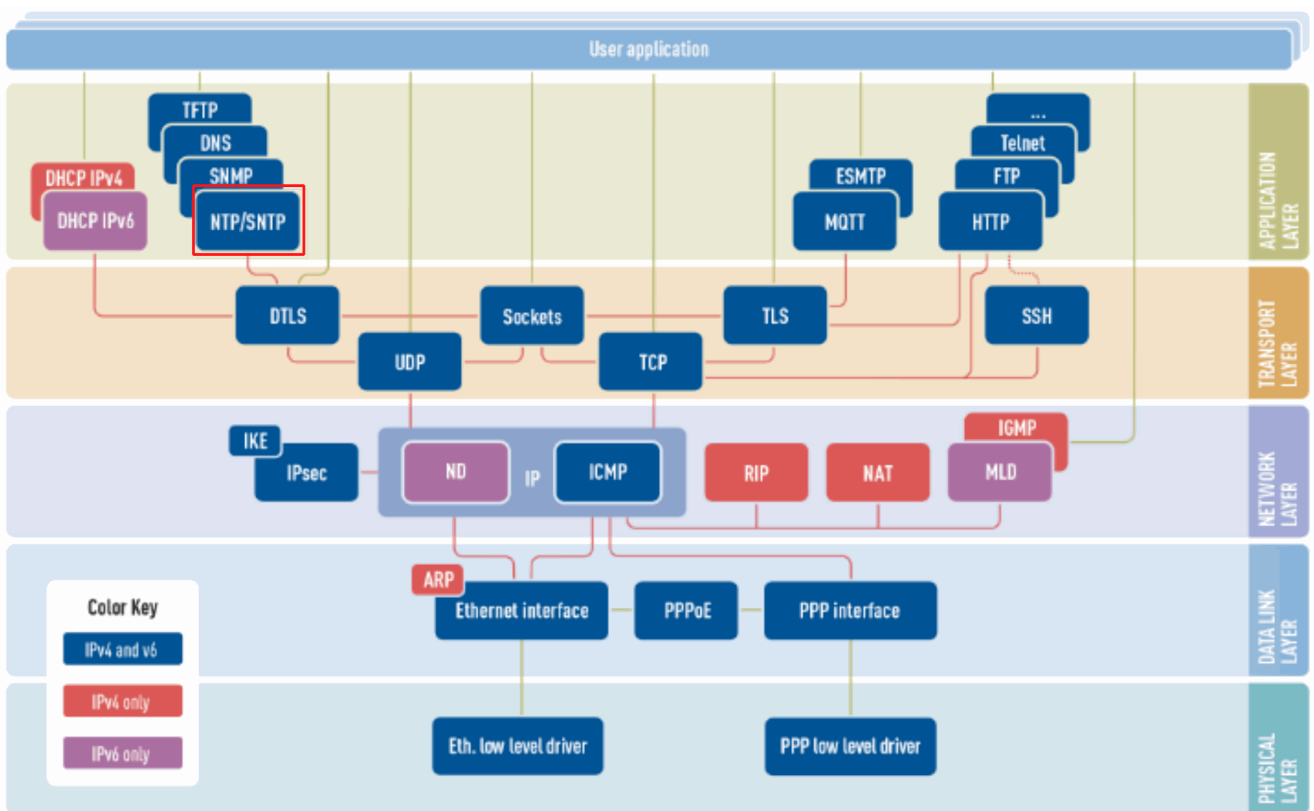
- [Introduction](#) – describes the main elements of the module. This section includes a diagram showing the position of this module within HCC's TCP/IP stack.
- [Feature Check](#) – summarizes the main features of the module as bullet points.
- [Overview of Operation](#) – presents a time sequence diagram that shows how the module operates.
- [Time Accuracy](#) – describes the two factors that influence the difference between the client time and the server time.
- [Packages and Documents](#) – the *Packages* section lists the packages that you need in order to use this module. The *Documents* section lists the relevant user guides.
- [Change History](#) – lists the earlier versions of this manual, giving the software version that each manual describes.

# 1.1 Introduction

This guide is for those who want to implement HCC Embedded's Network Time Protocol (NTP) client module. This client module comprises a single task which handles communication with NTP servers.

NTP is used to synchronize clocks on computer systems in packet-switched networks. An NTP client implements mitigation algorithms and authentication. NTP authentication uses keys with the Message Digest algorithm 5 (MD5).

The NTP module is part of HCC's MISRA-compliant TCP/IP stack, as shown below, and is designed specifically for use with it. (In this diagram green lines show interfaces available to users of the stack, red lines show interfaces internal to the TCP/IP system.)



**Note:** This diagram shows both NTP and its alternative, the Simple Network Time Protocol (SNTP). These are mutually exclusive.

## 1.2 Feature Check

The main features of the system are the following:

- Conforms to the HCC Advanced Embedded Framework.
- Compliant with HCC's MISRA-compliant TCP/IP stack.
- Designed for integration with both RTOS and non-RTOS based systems.
- Compliant with [RFC 5905](#). It supports the the On-Wire Protocol (RFC 5905, Chapter 8).
- Backward-compatible with [RFC 1305](#).
- Supports NTP unicast ([RFC 1769](#)), NTP broadcast ([RFC 2030](#)), and NTP multicast ([RFC 4330](#)).
- Supports the NTP Authentication symmetric key (MD5; [RFC 1305](#), Appendix C).
- Demo package provides sample implementations to base your NTP client on.

The following NTP algorithms ([RFC 5905](#)) are supported:

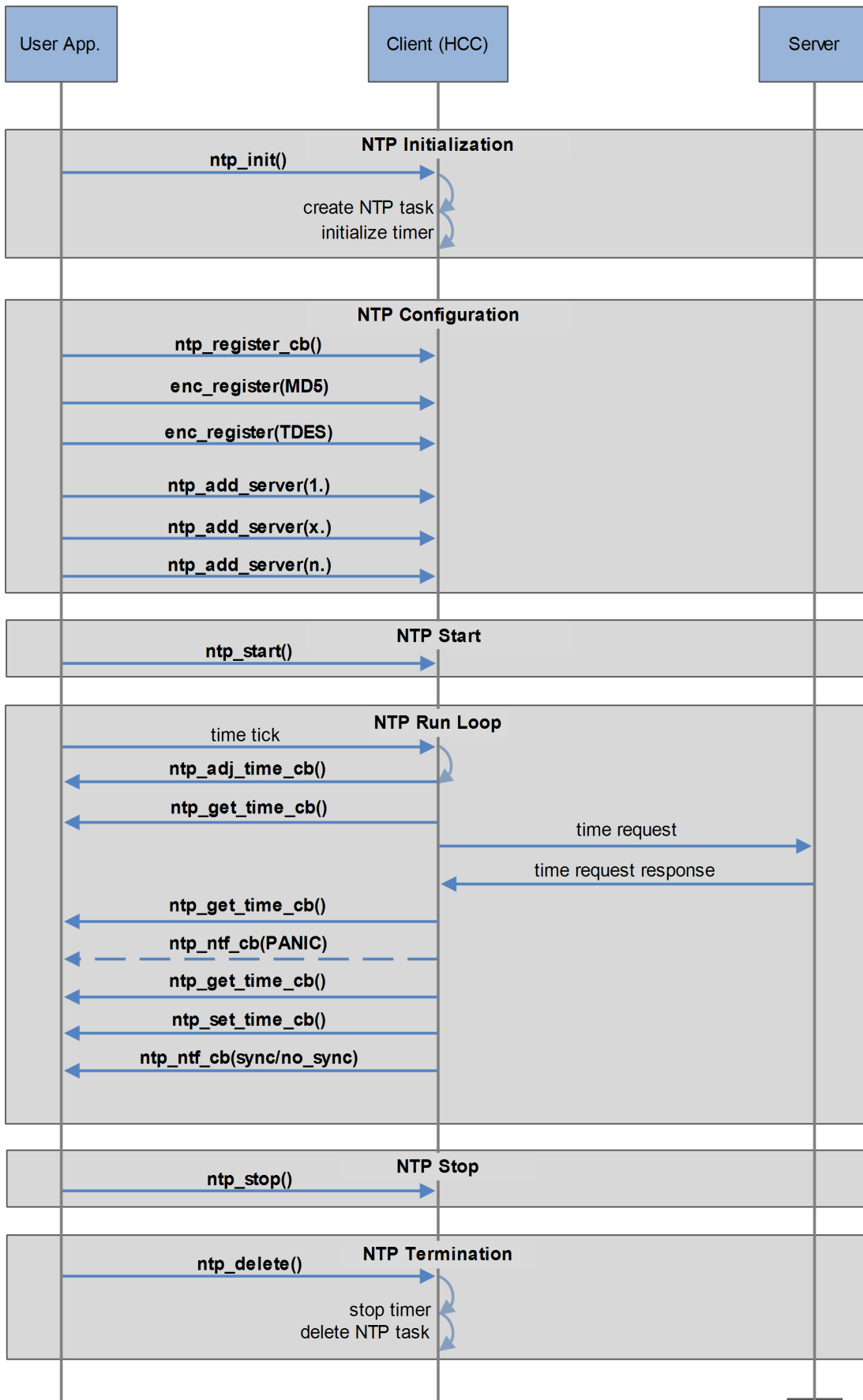
- Clock filter algorithm.
- Selection algorithms.
- Cluster algorithms.
- Combine algorithms.
- Clock Discipline Algorithm (CDA).
- Clock-adjust process.

## 1.3 Overview of Operation

The NTP module uses time servers on the internet to synchronize its own clock.

The following time sequence diagram shows how the module is used and specifically:

1. Module initialization.
2. How the module runs and interacts with NTP servers.
3. How the module uses user-defined callback functions to update the system time.
4. Module termination.



## 1.4 Time Accuracy

In general the time accuracy, the difference between the client time and the server time, depends on two factors:

- the transmission time between client and server; this is affected by network traffic. In NTP multiple servers are used and those that have the smallest transmission delays are chosen.
- the precision of the client's clock.

### Transmission time

Assuming that:

- T1 is the time needed to transmit a packet from client to server.
- T2 is the time needed to transmit a packet from server to client.

Then the time difference between the client and server time is equal to  $T2 - T1$ . For example, if time  $T2 - T1$  is 1 ms, the client clock has a 1 ms offset from the server clock. This means that time accuracy is greatest when the transmission times are equal.

### Local clock precision

The time accuracy cannot be greater than the local clock precision. The frequency jitter of the local clock is corrected but NTP needs 15 minutes to go into frequency adjustment state.



## 1.5 Packages and Documents

### Packages

The following table lists the packages that you need in order to use this module:

Package	Description
<b>hcc_base_doc</b>	This contains the two guides that will help you get started.
<b>ip_app_ntp</b>	The NTP client package described in this document.
<b>ip_app_ntp_demo</b>	The user demo for NTP, also described in this document. This is not mandatory but may be useful.
<b>ip_base_v4</b>	The TCP/IP Stack IPv4 package.
<b>mip_udp</b>	The UDP package, needed if NTP is used with HCC's native TCP/IP.
<b>ip_socket</b>	The IP Sockets package, needed if NTP is used with BSD sockets.
<b>psp_template_socket</b>	A wrapper to connect HCC modules that use sockets with the BSD-compliant socket implementation.
<b>psp_template_math</b>	The mathematics Platform Support Package (PSP).
<b>enc_base</b>	The encryption base package.

### Documents

For an overview of the HCC TCP/IP stack software, see [Product Information](#) on the main HCC website.

Readers should note the points in the [HCC Documentation Guidelines](#) on the HCC documentation website.

#### **HCC Firmware Quick Start Guide**

This document describes how to install packages provided by HCC in the target development environment. Also follow the *Quick Start Guide* when HCC provides package updates.

#### **HCC Source Tree Guide**

This document describes the HCC source tree. It gives an overview of the system to make clear the logic behind its organization.

#### **HCC TCP/IP Dual Stack System User Guide**

This is the core document that describes the complete TCP/IP stack. It covers both IPv4 and IPv6 systems.

#### **HCC UDP User Guide**

This document describes the UDP package.

**HCC Sockets Interface User Guide**

This document describes the Sockets package.

**HCC NTP Client User Guide**

This is this document.

## 1.6 Change History

This section describes past changes to this manual.

- To download this manual or a PDF describing an [earlier software version](#), see [TCP/IP PDFs](#).
- For the history of changes made to the package code itself, see [History: ip\\_app\\_ntp](#) and [History: ip\\_app\\_ntp\\_demo](#).

The current version of this manual is 2.00. The full list of versions is as follows:

Manual version	Date	Software version	Reason for change
2.00	2019-04-18	1.18	Added demo package to <i>Source Files</i> . Corrected NTP_PRECISION configuration option.
1.90	2018-10-05	1.18	Corrected <i>p_id</i> 's type in <b>ntp_add_server()</b> . Added note on NTP_SECURE_ENABLE to <b>ntp_register_md5()</b> . Improved some parts of <i>Types and Definitions</i> .
1.80	2017-11-13	1.17	Removed <b>NTP_STATIC_SRV_ADDR</b> option. Removed <b>psp_math</b> functions from <i>PSP Porting</i> .
1.70	2017-09-05	1.12	Corrected <i>Packages</i> list.
1.60	2017-06-20	1.12	New <i>Change History</i> format.
1.50	2017-03-28	1.09	Updated network diagram.
1.40	2017-01-16	1.06	Updated network diagram. Added function group tables.
1.30	2016-07-14	1.04	Added software <i>Change History</i> . Extended <i>Introduction</i> .
1.20	2015-11-02	1.02	Small changes.
1.10	2015-10-27	1.02	Reorganized <i>System Overview</i> section.
1.00	2015-05-08	1.02	First online version.

## 2 Source File List

The following sections describe all the source code files included in the system. These files follow the HCC Embedded standard source tree system, described in the [HCC Source Tree Guide](#). All references to file pathnames refer to locations within this standard source tree, not within the package you initially receive.

**Note:** Do not modify any files except the configuration file and PSP files.

### 2.1 API Header File

The file `src/api/api_ip_app_ntp.h` is the only file that should be included by an application using this module. For details of the API functions, see [Application Programming Interface](#).

### 2.2 Configuration File

The file `src/config/config_ip_app_ntp.h` contains all the configurable NTP parameters. Configure these as required. See [Configuration Options](#) for details.

### 2.3 System Files

The following files are in the directory `src/ip/apps/ntp`. **These files should only be modified by HCC.**

File	Description
<code>ntp.c</code>	Functions source code.
<code>ntp.h</code>	Header file.
<code>ntp_alg.c</code>	Clock and polling functions source code.
<code>ntp_alg.h</code>	Clock and polling functions header file.
<code>ntp_auth.c</code>	Authorization functions source code.
<code>ntp_auth.h</code>	Authorization functions header file.

### 2.4 Version

The file `src/version/ver_ip_app_ntp.h` contains the version number of this module. This version number is checked by all modules that use this module to ensure system consistency over upgrades.

## 2.5 Platform Support Package (PSP) Files

These files in **src/psp** provide the clock functions and math functions described in [PSP Porting](#).

**Note:** These are PSP implementations for the specific microcontroller and board; you may need to modify these to work with a different microcontroller and/or development board. See [PSP Porting](#) for details.

File	Description
<b>include/psp_math.h</b>	Math functions header file.
<b>include/psp_rtc.h</b>	Real time clock functions header file.
<b>target/psp_math.c</b>	Math functions source code.
<b>target/psp_rtc.c</b>	Real time clock functions source code.

## 2.6 Demo Package

The package **ip\_app\_ntp\_demo** holds these files in **psp/board/demo**:

File	Description
<b>ntp_user.h</b>	Header file defining the <b>ntp_user_init()</b> function for the demo.
<b>ntp_user.c</b>	Implements NTP callback functions that are used to set and get the system time. This demo uses RTC for storing the current time.

The demo also has its own version file, **ver\_ip\_app\_ntp\_user.h**.

## 3 Configuration Options

Set the configuration options in the file `src/config/config_ip_app_ntp.h`. This section lists the available options and their default values.

**Note:** Where stated, options use f64p32 format (using 32 bits to represent the fractional part).

### 3.1 NTP Task Configuration

#### **NTP\_CLIENT\_TASK\_STACK\_SIZE**

The size of the stack used by the module. The default is 512.

#### **NTP\_CLIENT\_PORT**

The NTP client port. The default is 1023; do not set a value lower than this.

### 3.2 General Configuration

These options control NTP client configuration.

#### **NTP\_PRECISION**

The system time precision. This is an exponent; the value is calculated as  $2^{(NTP\_PRECISION - 32)}$ . The default is (32-10).

#### **NTP\_MAX\_PEERS**

The maximum number of peers. The default is 6.

#### **NTP\_MAX\_SRV**

The number of servers in the configuration. The default is 6.

#### **NTP\_MAX\_DISP**

The maximum dispersion time. This is the maximum error of the local clock relative to the reference clock. This is 16s in f64p32 format. The default is (0x1000000000).

#### **NTP\_MIN\_DISP**

The minimum dispersion time. This is 0.01s in f64p32 format. The default is (0x028F5C28).

#### **NTP\_MAX\_DIST**

The maximum synchronization distance. This is 1s in f64p32 format. The default is (0x100000000).

**NTP\_MAX\_STRAT**

The maximum stratum number. The default is 16.

**NTP\_MIN\_POLL**

The minimum poll interval. This is an exponent; the minimum interval is  $2^n$  seconds. The default is 3.

**NTP\_MAX\_POLL**

The maximum poll interval. This is an exponent; the maximum interval is  $2^n$  seconds. The default is 12.

**NTP\_NSANE**

The minimum number of intersection survivors. The default is 3.

**NTP\_NMIN**

The minimum number of cluster survivors. The default is 2.

**NTP\_SGATE**

The spike gate used in the clock filter. The default is 3.

### 3.3 Clock Discipline Algorithm (CDA) Options

**NTP\_PANICT**

The threshold used to determine when the time difference between host and server is too large. This is termed the "panic threshold". The default is (0x10003E800000000).

**NTP\_CLKD\_STEPT**

The step threshold (0.128s) in f64p32 format. The default is ( 0x20C49BA5 ).

**NTP\_CLKD\_WATCH**

The stepout threshold in seconds. The default is ( 900 \* 0x100000000 )

**NTP\_CLKD\_PLL\_SHIFT**

The PLL loop gain shift value. This is an exponent value; the gain is  $2^{\text{NTP\_CLKD\_PLL\_SHIFT}}$ . The default is 4.

**NTP\_CLKD\_FLL**

The FLL loop gain. The default is (NTP\_MAX\_POLL + 1).

**NTP\_CLKD\_AVG**

The CDA averaging constant. The default is 4.

**NTP\_CLKD\_ALLAN\_SHIFT**

The compromise Allan intercept value in seconds. This is an exponent; it should be equal to  $\log_2(\text{NTP\_CLKD\_ALLAN})$ . The default is 10.

**NTP\_CLKD\_ALLAN**

The compromise Allan intercept value in f64p32 format. The default is ( 1500 \* 0x100000000 ).

**NTP\_CLKD\_LIMIT**

The poll-adjust limit. The default is 30.

**NTP\_CLKD\_MAXFREQ**

The frequency tolerance (500 ppm). The default is ( 0x20C49B ).

**NTP\_CLKD\_PGATE**

The poll-adjust gate value. The default is 4.

**NTP\_UNREACH\_MAX**

The number of polls to increase the poll value by in case of an unreachable server. The default is 12.

**NTP\_BROADCAST\_DELAY**

The broadcast delay in f64p32 format (0.004s). The default is ( 0x10624DD ).

**NTP\_LONG\_JUMP\_ENABLE**

Keep the default of 1 to enable a long time jump when synchronizing for the first time. This suppresses the PANIC notify when synchronizing to a server whose time is significantly different to the device's system time.

**Note:** If NTP\_LONG\_JUMP\_ENABLE is not set, NTP may never synchronize if the system clock time is much different from that of NTP servers.



## 3.4 Implementation Options

### **NTP\_USE\_SOCKET**

Keep this at the default of 0 to use the native HCC implementation. Set it to 1 to use the BSD Sockets implementation.

### **NTP\_USE\_IP\_V6\_SOCKET**

Keep this at the default of 0 to use the IPv4 implementation. Set it to 1 to use the IPv6 implementation.

### **NTP\_USE\_STD\_SOCKET**

Keep this at the default of 0 to use the HCC Sockets implementation. Set it to 1 to use the standard Sockets implementation.

### **NTP\_SECURE\_ENABLE**

Keep this at the default of 0 to disable the NTP authorization mechanism. Set it to 1 to use the authorization mechanism.

# 4 Application Programming Interface

This section describes the Application Programming Interface (API) functions. It includes all the functions that are available to an application program.

## 4.1 Module Management

The functions are the following:

Function	Description
<b>ntp_init()</b>	Initializes the module and allocates the required resources.
<b>ntp_start()</b>	Starts the module.
<b>ntp_stop()</b>	Stops the module.
<b>ntp_delete()</b>	Deletes the module and releases the resources it used.

## ntp\_init

Use this function to initialize the client module and allocate the required resources.

**Note:** Call this before any other NTP function.

### Format

```
t_ntp_ret ntp_init ( void )
```

### Arguments

Argument
None.

### Return Values

Return value	Description
NTP_SUCCESS	Successful execution.
NTP_ERROR	Operation failed.

## ntp\_start

Use this function to start the client module.

If one of the configured servers uses a key identifier that is not in the list of authorization keys, this function returns NTP\_KEY\_MISSING. If the user configures less than [NTP\\_NSANE](#) NTP servers, the function returns NTP\_NOT\_EN\_SERVERS.

**Note:** Call `ntp_init()` before this function.

### Format

```
t_ntp_ret ntp_start ( void )
```

### Arguments

Argument
None.

### Return Values

Return value	Description
NTP_SUCCESS	Successful execution.
NTP_ERROR	Operation failed.
NTP_NOT_EN_SERVERS	Too few servers are configured to allow the mitigation algorithm to pass.

## ntp\_stop

Use this function to stop the client module.

This clears connection data and closes all open NTP connections.

### Format

```
t_ntp_ret ntp_stop ( void )
```

### Arguments

Argument
None.

### Return Values

Return value	Description
NTP_SUCCESS	Successful execution.
NTP_ERROR	Operation failed.

## ntp\_delete

Use this function to delete the client module and release the associated resources.

### Format

```
t_ntp_ret ntp_delete ( void )
```

### Arguments

Argument
None.

### Return Values

Return value	Description
NTP_SUCCESS	Successful execution.
NTP_ERROR	Operation failed.

## 4.2 Client Functions

The functions are the following:

Function	Description
<b>ntp_add_server()</b>	Adds the NTP server configuration to the NTP server list.
<b>ntp_del_server()</b>	Deletes an NTP server configuration from the NTP servers list.
<b>ntp_register_md5()</b>	Registers the MD5 hash algorithm handle with the NTP module.
<b>ntp_register_cb()</b>	Registers the time synchronization interface callback functions, if these are used, with the NTP module.

## ntp\_add\_server

Use this function to add the NTP server configuration to the NTP server list.

**Note:** This function can only be called in the stopped state. The system is in this state between calls of **ntp\_init()** and **ntp\_start()**, and also after a call of **ntp\_stop()**.

### Format

```
t_ntp_ret ntp_add_server (
    t_ip_port *   p_port,
    uint8_t      ver,
    uint8_t      mode,
    t_ntp_key *   p_key,
    uint8_t *     p_id )
```

### Arguments

Argument	Description	Type
p_port	A pointer to the server IP address and port number.	t_ip_port *
ver	The <a href="#">NTP protocol version</a> to use when communicating with the server.	uint8_t
mode	The <a href="#">client operating mode</a> (NTP_MODE_*).	uint8_t
p_key	A pointer to a structure containing key data to be used for authorization.  If authorization is disabled, this parameter is discarded. Key identifier 0 is reserved by the NTP protocol.	t_ntp_key *
p_id	On return, a pointer to the server configuration's identifier.	uint8_t *

### Return Values

Return value	Description
NTP_SUCCESS	Successful execution.
NTP_PARAM_ERR	A parameter passed to this function is invalid. This is returned if <a href="#">NTP_FLAGS_AUTH_NEEDED</a> is set and <i>p_key</i> is NULL.
NTP_NO_FREE_SPACE	Cannot add the server/key because there is no free slot in the configuration table.
NTP_ERROR	The function was called when not in the stopped state.



## ntp\_del\_server

Use this function to delete an NTP server configuration from the NTP servers list.

**Note:** This function can only be called in the stopped state. The system is in this state between calls of **ntp\_init()** and **ntp\_start()**, and also after a call of **ntp\_stop()**.

### Format

```
t_ntp_ret ntp_del_server ( uint8_t p_id )
```

### Arguments

Argument	Description	Type
p_id	The server configuration's identifier.	uint8_t

### Return Values

Return value	Description
NTP_SUCCESS	Successful execution.
NTP_PARAM_ERR	The parameter passed to this function is invalid.
NTP_ERROR	The function was called when not in the stopped state.

## ntp\_register\_md5

Use this function to register the MD5 hash algorithm handle with the NTP module.

This handle is obtained from the Embedded Encryption Manager.

**Note:**

- This is only available if configuration option `NTP_SECURE_ENABLE` is set.
- This function can only be called in the stopped state. The system is in this state between calls of `ntp_init()` and `ntp_start()`, and also after a call of `ntp_stop()`.

**Format**

```
t_ntp_ret ntp_register_md5( t_enc_ifc_hdl hdl )
```

**Arguments**

Argument	Description	Type
hdl	The handle of the MD5 driver.	t_enc_ifc_hdl

**Return Values**

Return value	Description
NTP_SUCCESS	Successful execution.
NTP_PARAM_ERR	The handle is already registered.
NTP_ERROR	The function was called when not in the stopped state.

## ntp\_register\_cb

Use this function to register the time synchronization interface callback functions, if these are used, with the NTP module.

**Note:** This function can only be called in the stopped state. The system is in this state between calls of **ntp\_init()** and **ntp\_start()**, and also after a call of **ntp\_stop()**.

### Format

```
t_ntp_ret ntp_register_cb ( const t_ntp_cb_dsc * const p_cb )
```

### Arguments

Argument	Description	Type
p_cb	A pointer to the time interface descriptor. This structure describes the callback functions to the time interface.	t_ntp_cb_dsc *

### Return Values

Return value	Description
NTP_SUCCESS	Successful execution.
NTP_PARAM_ERROR	One of the callback function pointers is NULL.
NTP_ERROR	The function was called when not in the stopped state.

## 4.3 Callback Functions

These functions provide the interface to the NTP server. You can implement these as required.

**Note:**

- It is the user's responsibility to provide any callback functions the application requires. Providing such functions is optional. Use the demo for guidance.
- All callback functions are called from the same task context and are protected against concurrent calls; no callback function can interrupt another callback function.

The callbacks are the following:

Function	Description
<b>t_ntp_get_time_cb()</b>	Specifies the format of a callback function you may call to obtain a new time after synchronization with the NTP server.
<b>t_ntp_set_time_cb()</b>	Specifies the format of a callback function you may call to set a new system time after synchronization with the NTP server.
<b>t_ntp_adj_time_cb()</b>	Specifies the format of a callback function you may call to adjust the system time clock frequency.
<b>t_ntp_ntf_cb()</b>	Specifies the format of a callback function you may call to notify a user about NTP events.

## t\_ntp\_get\_time\_cb

The **t\_ntp\_get\_time\_cb()** definition specifies the format of a callback function you may call to obtain a new time after synchronization with the NTP server.

NTP 64 bit timestamps comprise a 32 bit part for seconds and a 32 bit part for fractional seconds. The returned parameters contain these two components.

### Format

```
typedef void ( * t_ntp_get_time_cb ) (  
    uint32_t *   p_seconds,  
    uint32_t *   p_fraction )
```

### Arguments

Argument	Description	Type
p_seconds	A pointer to the number of seconds.	uint32_t *
p_fraction	A pointer to the number of fractional seconds.	uint32_t *

### Return Codes

Code	Description
NTP_SUCCESS	Successful execution.
NTP_ERROR	Operation failed.

## t\_ntp\_set\_time\_cb

The **t\_ntp\_set\_time\_cb()** definition specifies the format of the callback function you may call to set a new system time after synchronization with the NTP server.

NTP 64 bit timestamps comprise a 32 bit part for seconds and a 32 bit part for fractional seconds. The parameters contain these two components.

### Format

```
typedef void ( * t_ntp_set_time_cb ) (  
    uint32_t  seconds,  
    uint32_t  fraction )
```

### Arguments

Argument	Description	Type
seconds	The number of seconds.	uint32_t
fraction	The number of fractional seconds.	uint32_t

### Return Codes

Code	Description
NTP_SUCCESS	Successful execution.
NTP_ERROR	Operation failed.

## t\_ntp\_adj\_time\_cb

The **t\_ntp\_adj\_time\_cb()** definition specifies the format of the callback function you may call to adjust the system time clock frequency.

NTP 64 bit timestamps comprise a 32 bit part for seconds and a 32 bit part for fractional seconds. The *delta* parameter contains these two components.

### Format

```
typedef void ( * t_ntp_adj_time_cb ) ( int64_t delta )
```

### Arguments

Argument	Description	Type
delta	The time to adjust the system clock by (32 bit seconds, 32 fractional bits).	int64_t

### Return Codes

Code	Description
NTP_SUCCESS	Successful execution.
NTP_ERROR	Operation failed.

## t\_ntp\_ntf\_cb

The **t\_ntp\_ntf\_cb()** definition specifies the format of a callback function you may call to notify a user about NTP events.

### Format

```
typedef void ( * t_ntp_ntf_cb ) ( uint32_t ntf )
```

### Arguments

Argument	Description	Type
ntf	The <a href="#">notification type</a> .	uint32_t

### Return Codes

Code	Description
NTP_SUCCESS	Successful execution.
NTP_ERROR	Operation failed.



## 4.4 Error Codes

If a function executes successfully, it returns with NTP\_SUCCESS, a value of 0. The following table shows the meaning of the NTP error codes.

**Note:** Also check error code values in the base system by using the *HCC TCP/IP Dual Stack System User Guide*.

Return Value	Value	Description
NTP_SUCCESS	0	Successful execution.
NTP_ERROR	1	Operation failed.
NTP_PARAM_ERR	2	A parameter passed to this function is invalid.
NTP_NO_FREE_SPACE	3	Cannot add the server/key because there is no free slot in the configuration table.
NTP_NOT_EN_SERVERS	4	Too few servers are configured to allow the mitigation algorithm to pass.

## 4.5 Types and Definitions

This section describes the main elements that are defined in the API Header file.

### Notification Types

The following notifications may be sent by the client:

Element	Value	Description
NTP_NTF_NO_SYNCH	0	The time is not synchronised with the server.
NTP_NTF_SYNCH	1	The time is synchronised with the server.
NTP_NTF_SRV_NO_RESP	2	An attempt to get the time from the server failed.
NTP_NTF_PANIC	3	Time unsynchronization is larger than <a href="#">NTP_PANICT</a> . You must set the system clock manually.

### Client Operating Modes

The following client operating modes may be used:

Element	Value	Description
NTP_MODE_UNICAST	0	Unicast mode.
NTP_MODE_BROADCAST	1	Broadcast mode.
NTP_MODE_MANYCAST	2	Manycast mode.

### Flags

The following flags may be used:

Element	Value	Description
NTP_FLAGS_BURST_EN	4	Enables burst mode on every poll to a server.
NTP_FLAGS_INIT_BURST_EN	8	Enables burst mode on connection initialization.
NTP_FLAGS_AUTH_NEEDED	10	Shows that this server requires authorization. This is only available if configuration option <a href="#">NTP_SECURE_ENABLE</a> is set.

## NTP Protocol Versions

The following protocol versions may be used:

Element	Value	Description
NTP_HDR_VN_1	0x08	NTP protocol version 1.
NTP_HDR_VN_2	0x10	NTP protocol version 2.
NTP_HDR_VN_3	0x18	NTP protocol version 3.
NTP_HDR_VN_4	0x20	NTP protocol version 4.

## t\_ntp\_cb\_dsc

The *t\_ntp\_cb\_dsc* structure defines the time synchronization interface.

Its elements are as follows:

Element	Type	Description
ntpc_get_time_cb	t_ntp_get_time_cb	The <a href="#">get current time callback</a> .
ntpc_set_time_cb	t_ntp_set_time_cb	The <a href="#">set current time callback</a> .
ntpc_adj_time_cb	t_ntp_adj_time_cb	The <a href="#">adjust time callback</a> .
ntpc_ntf_cb	t_ntp_ntf_cb	The <a href="#">notify callback</a> .

## t\_ntp\_key

The *t\_ntp\_key* structure describes the key used for authentication.

Its elements are as follows:

Element	Type	Description
ntpk_id	uint32_t	The authentication identifier that is used during communication with the server. Value 0 is reserved.
ntpk_type	uint8_t	The key type: 1 = MD5.
ntpk_key [NTP_KEY_LENGTH]	uint8_t	Each key is constructed as in the Berkeley Unix distributions.

## t\_ntp\_srv\_conf

The *t\_ntp\_srv\_conf* structure describes port settings that are used to connect to the NTP server.

Its elements are as follows:

Element	Type	Description
ntpk_id	t_ip_port	The NTP server address and IP port.
ntsc_ver	uint8_t	The NTP protocol version.
ntsc_mode	uint8_t	The NTP <a href="#">client operating mode</a> .
ntsc_key	uint16_t	The key authorization identifier.

## 5 Integration

This section describes all aspects of the NTP Client module that require integration with your target project. This includes porting and configuration of external resources.

### 5.1 OS Abstraction Layer

All HCC modules use the OS Abstraction Layer (OAL). This allows modules to run seamlessly with a wide variety of RTOSes, or without an RTOS.

This module uses the following OAL components:

OAL Resource	Number Required
Tasks	1
Mutexes	1
Events	1

### 5.2 Utilities

The code creates and uses a single timer in the **hcc\_timer** module.

The **hcc\_timer** module is included in your system when you install the base TCP/IP modules.

## 5.3 PSP Porting

The Platform Support Package (PSP) is designed to hold all platform-specific functionality, either because it relies on specific features of a target system, or because this provides the most efficient or flexible solution for the developer. For full details of its functions and macros, see the *HCC Base Platform Support Package User Guide*.

The module makes use of the following standard PSP functions:

Function	Package	Element	Description
<b>psp_memcmp()</b>	psp_base	psp_string	Compares two blocks of memory.
<b>psp_memcpy()</b>	psp_base	psp_string	Copies a block of memory. The result is a binary copy of the data.
<b>psp_memset()</b>	psp_base	psp_string	Sets the specified area of memory to the defined value.

The module makes use of the following standard PSP macros:

Macro	Package	Element	Description
PSP_RD_BE32	psp_base	psp_endianness	Reads a 32 bit value stored as big-endian from a memory location.
PSP_RD_LE32	psp_base	psp_endianness	Reads a 32 bit value stored as little-endian from a memory location.
PSP_WR_BE32	psp_base	psp_endianness	Writes a 32 bit value to be stored as big-endian to a memory location.