

# NetX Duo™

## Simple Network Time Protocol (SNTP) Client

### User Guide

## Renesas Synergy™ Platform

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If you are using NetX Duo SNTP Client for the Renesas Synergy platform, please use the following information.

## Product Distribution

**Page 10:** The distribution of SNTP Client included with the Renesas Synergy SSP installation does not include the file `demo_netxdue_sntp_client.c`. Please ignore references to this file.

## Installation

**Page 10:** If you are using Renesas Synergy SSP and the e<sup>2</sup> studio ISDE, SNTP Client will already be installed. You can ignore the Installation and Use of NetX Duo SNTP Client section.

## IPv6 Support

Note that IPv6 support for NetX Duo SNTP has not been tested with SSP v1.5.0.



## **NetX Duo Simple Network Time Protocol (SNTP) Client User Guide**

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Part Number: 000-1052

Revision 5.11

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# Chapter 1

## Introduction to SNTP

The Simple Network Time Protocol (SNTP) is a protocol designed for synchronizing clocks over the Internet. SNTP Version 4 is a simplified protocol based on the Network Time Protocol (NTP). It utilizes User Datagram Protocol (UDP) services to perform time updates in a simple, stateless protocol. Though not as complex as NTP, SNTP is highly reliable and accurate. In most places of the Internet of today, SNTP provides accuracies of 1-50 milliseconds, depending on the characteristics of the synchronization source and network paths. SNTP has many options to provide reliability of receiving time updates. Ability to switch to alternative servers, applying back off polling algorithms and automatic time server discovery are just a few of the means for an SNTP client to handle a variable Internet time service environment. What it lacks in precision it makes up for in simplicity and ease of implementation. SNTP is intended primarily for providing comprehensive mechanisms to access national time and frequency dissemination (e.g. NTP server) services.

## NetX Duo SNTP Client Requirements

The NetX Duo SNTP Client requires that an IP instance has already been created. In addition, UDP must be enabled on that same IP instance and should have access to the *well-known* port 123 for sending time data to an SNTP Server, although alternative ports will work as well. Broadcast clients should bind the UDP port their broadcast server is sending on, usually 123. The NetX Duo SNTP Client application must have one or more IP SNTP Server addresses.

## NetX Duo SNTP Client Limitations

Precision in local time representation in NTP time updates handled by the SNTP Client API is limited to millisecond resolution.

The SNTP Client only holds a single SNTP Server address at any time. If that Server appears to be no longer valid, the application must stop the SNTP Client task, and reinitialize it with another SNTP server address, using either broadcast or unicast SNTP communication.

The SNTP Client does not support multicast.

NetX Duo SNTP Client does not support authentication mechanisms for verifying received packet data.

## NetX Duo SNTP Client Operation

RFC 4330 recommends that SNTP clients should operate only at the highest stratum of their local network and preferably in configurations where no NTP or SNTP client is dependent them for synchronization. Stratum level reflects the host position in the NTP time hierarchy where stratum 1 is the highest level (a root time server) and 15 is the lowest allowed level (e.g. Client). The SNTP Client default minimum stratum is 2.

The NetX Duo SNTP Client can operate in one of two basic modes, unicast or broadcast, to obtain time over the Internet. In unicast mode, the Client polls its SNTP Server on regular intervals and waits to receive a reply from that Server. When one is received, the Client verifies that the reply contains a valid time update by applying a set of 'sanity checks' recommended by RFC 4330. The Client then applies the time difference, if any, with the Server clock to its local clock. In broadcast mode, the Client merely listens for time update broadcasts and maintains its local clock after applying a similar set of sanity checks to verify the update time data. Sanity checks are described in detail in the **SNTP Sanity Checks** section below.

Before the Client can run in either mode, it must establish its operating parameters. This is done by calling either *nx\_sntp\_client\_initialize\_unicast* or *nx\_sntp\_client\_initialize\_broadcast* for unicast or broadcast modes, respectively. These serves set the time outs for maximum time lapse without a valid update, the limit on consecutive invalid updates received, a polling interval for unicast mode, operation mode e.g. unicast vs. broadcast, and SNTP Server.

If the maximum time lapse or maximum invalid updates received is exceeded, the SNTP Client continues to run but sets the current SNTP Server status to invalid. The application can poll the SNTP Client using the *nx\_sntp\_client\_receiving\_updates* service to verify the SNTP Server is still sending valid updates. If not, it should stop the SNTP Client thread using the *nx\_sntp\_client\_stop* service and call either of the two initialize services to set another SNTP Server address. To restart the SNTP Client, the application calls *nx\_sntp\_client\_run\_broadcast* or *nx\_sntp\_client\_run\_unicast*. Note that the application can change SNTP



Client operating mode in the initialize call to switch to unicast or broadcast as desired.

## Local Clock Operation

The SNTP time based on the number of seconds on the master NTP clock, or number of seconds elapsed in the first NTP epoch e.g. from Jan 1 **1900 00:00:00** to Jan 1 **1999 00:00:00**. The significance of 01-01-1999 was when the last leap second occurred. This value is defined as follows:

```
#define NTP_SECONDS_AT_01011999          0xBA368E80
```

Before the SNTP Client runs, the application can optionally initialize the SNTP Client local time for the Client to use as a baseline time. To do so, it must use the *nx\_sntp\_client\_set\_local\_time* service. This takes the time in NTP format, seconds and fraction, where fraction is the milliseconds in the NTP condensed time. Ideally the application can obtain an SNTP time from an independent source. There is no API for converting year, month, date and time to an NTP time in the NetX Duo SNTP Client. For a description of NTP time format, refer to *RFC4330 "Simple Network Time Protocol (SNTP) Version 4 for IPv4, IPv6 and OSI"*.

If no base local time is supplied when the SNTP Client starts up, the SNTP Client will accept the SNTP updates without comparing to its local time on the first update. Thereafter it will apply the maximum and minimum time update values to determine if it will modify its local time.

To obtain the SNTP Client local time, the application can use the *nx\_sntp\_client\_get\_local\_time* service.

## SNTP Sanity Checks

The Client examines the incoming packet for the following criteria:

- Source IP address must match the current server IP address.
- Sender source port must match with the current server source port.

- Packet length must be the minimum length to hold an SNTP time message.

Next, the time data is extracted from the packet buffer to which the Client then applies a set of specific 'sanity checks':

- The Leap Indicator set to 3 indicates the Server is not synchronized. The Client should attempt to find an alternative server.
- A stratum field set to zero is known as a Kiss of Death (KOD) packet. The SMTP Client KOD handler for this situation is a user defined callback. The small example demo file contains a simple KOD handler for this situation. The Reference ID field optionally contains a code indicating the reason for the KOD reply. At any rate, the KOD handler must indicate how to handle receiving a kiss of death from the SNTP Server. Typically it will want to reinitialize the SNTP Client with another SNTP Server.
- The Server SNTP version, stratum and mode of operation must be matched to the Client service.
- If the Client is configured with a server clock dispersion maximum, the Client checks the server clock dispersion on the first update received only, and if it exceeds the Client maximum, the Client rejects the Server.
- The Server time stamp fields must also pass specific checks. For the unicast Server, all time fields must be filled in and cannot be NULL. The Origination time stamp must equal the Transmit time stamp in the Client's SNTP time message request. This protects the Client from malicious intruders and rogue Server behavior. The broadcast Server need only fill in the Transmit time stamp. Since it does not receive anything from the Client it has no Receive or Origination fields to fill in.

A failed sanity check brands a time update as an invalid time update. The SNTP Client sanity check service tracks the number of consecutive invalid time updates received from the same Server.

If *nx\_sntp\_client\_apply\_sanity\_check* returns a unsuccessful status to the SNTP Client, the SNTP Client increments the invalid time update count.

If the Server time update passes the sanity checks, the Client then attempts to process the time data to its local time. If the Client is configured for round trip calculation, e.g. the time from sending an update request to the time one is received, the round trip time is calculated. This value is halved and then added to the Server's time.

Next, if this is the first update received from the current SNTP Server, the SNTP Client determines if it should ignore the difference between the Server and Client local time. Thereafter all updates from the SNTP Server are evaluated for the difference with the Client local time. The difference between Client and Server time is compared with `NX_SNTP_CLIENT_MAX_TIME_ADJUSTMENT`. If it exceeds this value, the data is thrown out. If the difference is less than the `NX_SNTP_CLIENT_MIN_TIME_ADJUSTMENT` the difference is considered too small to require adjustment.

Passing all these checks, the time update is then applied to the SNTP Client with some corrections for delays in internal SNTP Client processing.

## SNTP Asynchronous Unicast Requests

The SNTP Client allows the host application to asynchronously send a unicast request for the current time from the NTP server.

```
UINT _nx_sntp_client_request_unicast_time(
    NX_SNTP_CLIENT *client_ptr,
    UINT wait_option)
```

The wait option is the expiration to wait for a response.

If the NTP Server responds, the packet is subjected to the same processing and sanity checks as described in the previous section before updating the SNTP Client local time.

If the call returns successful completion, the application can call *`nx_sntp_client_utility_display_date_time`* or *`nx_sntp_client_get_local_time`* for the updated local time.

These unicast requests do not interfere with the normal SNTP Client schedule for sending the next unicast request, or if in broadcast mode, when to expect the next NTP broadcast.

## Periodic Local Time Updates

The maximum adjustment to the local time is set in the `NX_SNTP_CLIENT_MAX_TIME_ADJUSTMENT` option (in milliseconds). The polling update interval for unicast SNTP Client operations is set in the `NX_SNTP_CLIENT_UNICAST_POLL_INTERVAL` option (in seconds). If the polling interval is greater than the maximum adjustment, then subsequent server updates after the first server update will be rejected. To prevent this, the SNTP Client application can update the local time periodically to keep the local time reasonably close to the server time. A simple example follows:

```
for (;;)
{
    tx_thread_sleep(NX_IP_PERIODIC_RATE);
    if (seconds)
    {
        seconds++;
        nx_sntp_client_set_local_time(&demo_client, seconds, 0);
    }
}
```

Alternatively, the maximum adjustment can be set to a multiple of (greater than) the unicast polling update (or anticipated broadcast intervals).

## Multiple Network Interfaces

NetX Duo SNTP Client supports devices with multiple network interfaces.

## SNTP and NTP RFCs

NetX Duo SNTP client is compliant with RFC4330 “Simple Network Time Protocol (SNTP) Version 4 for IPv4, IPv6 and OSI” and related RFCs.

## Chapter 2

# Installation and Use of NetX Duo SNTP Client

This chapter contains a description of various issues related to installation, setup, and usage of the NetX Duo SNTP Client.

## Product Distribution

SNTP for NetX Duo is shipped on a single CD-ROM compatible disk. The package includes two source files and a PDF file that contains this document, as follows:

<b><code>nxd_sntp_client.c</code></b>	SNTP Client C source file
<b><code>nxd_sntp_client.h</code></b>	SNTP Client Header file
<b><code>demo_netxd_sntp_client.c</code></b>	Demonstration SNTP Client application
<b><code>nxd_sntp_client.pdf</code></b>	NetX Duo SNTP Client User Guide

## NetX Duo SNTP Client Installation

In order to use SNTP for NetX Duo, the entire distribution mentioned previously should be copied to the same directory where NetX Duo is installed. For example, if NetX Duo is installed in the directory “*\threadx\arm7\green*” then the NetX Duo SNTP Client files *nxd\_sntp\_client.c* and *nxd\_sntp\_client.h* (*nx\_sntp\_client.c* and *nx\_sntp\_client.h* in NetX) should be copied into this directory.

## Using NetX Duo SNTP Client

Using NetX Duo SNTP Client is easy. Basically, the application code must include *nxd\_sntp\_client.h* after it includes *tx\_api.h*, *fx\_api.h*, and *nx\_api.h*, in order to use ThreadX and NetX Duo, respectively. Once *nxd\_sntp\_client.h* is included, the application code is then able to make the SNTP function calls specified later in this guide. The application must also include *nxd\_sntp\_client.c* in the build process. These files must be compiled in the same manner as other application files and its object form must be linked along with the files of the application. This is all that is required to use NetX Duo SNTP Client.

Note that since the NetX Duo SNTP Client utilizes NetX Duo UDP services, UDP must be enabled with the *nx\_udp\_enable* call prior to using SNTP services.

## Small Example System

An example of how to use NetX Duo SNTP is shown below. In this example, the SNTP include file *nxd\_sntp\_client.h* is brought in at line 13. The SNTP Client is created in “*tx\_application\_define*” on line 155. Note that the kiss of death and leap second handler functions are optional when creating the SNTP Client.

This demo can be used with IPv6 or IPv4. To run the SNTP Client over IPv6, define *USE\_IPV6*. IPv6 must be enabled in NetX Duo as well. In lines 205-243, the SNTP Client host is set up for IPv6 address validation and ICMPv6 and IPv6 services in NetX Duo. See the NetX Duo User Guide for more details on IPv6 support in NetX Duo.

Then the SNTP Client must be initialized for either unicast or broadcast mode.

SNTP Client initially writes Server time updates to its own internal data structure. This is not the same as the device local time. The device local time can be set as a baseline time in the SNTP Client before starting the SNTP Client thread. This is useful if the SNTP Client is configured (*NX\_Sntp\_Client\_Ignore\_Max\_Adjust\_Startup* set to *NX\_FALSE*) to compare the first Server update to the *NX\_Sntp\_Client\_Max\_Adjustment* (default value 180 milliseconds). Otherwise the SNTP Client will set the initial local time directly when it gets the first update from the Server.

A baseline time is applied to the SNTP Client on line 297 using the *nx\_sntp\_client\_set\_local\_time* service.

The SNTP Client is started on started at line 309 and 311 for unicast and broadcast mode respectively. The application then periodically checks for updates. The *nx\_sntp\_client\_receiving\_updates* service verifies that the SNTP Client is currently receiving valid updates. If so, it will retrieve the latest update time using the *nx\_sntp\_client\_get\_local\_time* service on line 334.

The SNTP Client can be stopped at any time using the *nx\_sntp\_client\_stop* service (line 355) if for example it detects the SNTP Client is no longer receiving valid updates.. To restart the Client, the application must call either the unicast or broadcast initialize service and

then call either unicast or broadcast run services. Note that the SNTP Client can switch SNTP servers and modes (unicast or broadcast) while stopped.

```

1  /*
2     This is a small demo of the NetX SNTP Client on the high-performance NetX TCP/IP stack.
3     This demo relies on Thread, NetX and NetX SNTP Client API to execute the Simple Network Time
4     Protocol in unicast and broadcast modes.
5
6  */
7
8
9  #include <stdio.h>
10 #include "nx_api.h"
11 #include "nx_ip.h"
12 #include "nx_ipv6.h"
13 #include "nxd_sntp_client.h"
14
15 /* Set up generic network driver for demo program. */
16 void _nx_ram_network_driver(struct NX_IP_DRIVER_STRUCT *driver_req);
17
18 /* Application defined services of the NetX SNTP Client. */
19
20 UINT leap_second_handler(NX_SNTP_CLIENT *client_ptr, UINT leap_indicator);
21 UINT kiss_of_death_handler(NX_SNTP_CLIENT *client_ptr, UINT KOD_code);
22
23
24 /* Set up client thread and network resources. */
25
26 NX_PACKET_POOL   client_packet_pool;
27 NX_IP             client_ip;
28 TX_THREAD        demo_client_thread;
29 NX_SNTP_CLIENT    demo_client;
30
31 /* Configure the SNTP Client to use IPv6. If not enabled, the
32    Client will use IPv4. Note: IPv6 must be enabled in NetX Duo
33    for the Client to communicate over IPv6. */
34 #ifdef FEATURE_NX_IPV6
35 #define USE_IPV6
36 #endif /* FEATURE_NX_IPV6 */
37
38
39 /* Configure the SNTP Client to use unicast SNTP. */
40 #define USE_UNICAST
41
42
43 #define CLIENT_IP_ADDRESS    IP_ADDRESS(192,2,2,66)
44 #define SERVER_IP_ADDRESS    IP_ADDRESS(192,2,2,92)
45 #define SERVER_IP_ADDRESS_2  SERVER_IP_ADDRESS
46
47 /* Set up the SNTP network and address index; */
48 UINT   iface_index = 0;
49 UINT   prefix = 64;
50 UINT   address_index;
51

```

```

52  /* Set up client thread entry point. */
53  void demo_client_thread_entry(ULONG info);
54
55  /* Define main entry point. */
56  int main()
57  {
58      /* Enter the ThreadX kernel. */
59      tx_kernel_enter();
60      return 0;
61  }
62
63  /* Define what the initial system looks like. */
64  void tx_application_define(void *first_unused_memory)
65  {
66
67      UINT status;
68      UCHAR *free_memory_pointer;
69
70
71      free_memory_pointer = (UCHAR *)first_unused_memory;
72
73      /* Create client packet pool. */
74      status = nx_packet_pool_create(&client_packet_pool, "SNTP Client Packet Pool",
75                                     NX_SNTP_CLIENT_PACKET_SIZE, free_memory_pointer,
76                                     NX_SNTP_CLIENT_PACKET_POOL_SIZE);
77
78      /* Check for errors. */
79      if (status != NX_SUCCESS)
80      {
81
82          return;
83      }
84
85      /* Initialize the NetX system. */
86      nx_system_initialize();
87
88      /* Update pointer to unallocated (free) memory. */
89      free_memory_pointer = free_memory_pointer + NX_SNTP_CLIENT_PACKET_POOL_SIZE;
90
91      /* Create Client IP instances */
92      status = nx_ip_create(&client_ip, "SNTP IP Instance", CLIENT_IP_ADDRESS,
93                           0xFFFFFFFFUL, &client_packet_pool, _nx_ram_network_driver,
94                           free_memory_pointer, 2048, 1);
95
96      /* Check for error. */
97      if (status != NX_SUCCESS)
98      {
99
100         return;
101     }
102
103     free_memory_pointer = free_memory_pointer + 2048;
104
105     /* Enable ARP and supply ARP cache memory. */
106     status = nx_arp_enable(&client_ip, (void **) free_memory_pointer, 2048);
107

```



```

108     /* Check for error. */
109     if (status != NX_SUCCESS)
110     {
111
112         return;
113     }
114
115     /* Update pointer to unallocated (free) memory. */
116     free_memory_pointer = free_memory_pointer + 2048;
117
118     /* Enable UDP for client. */
119     status = nx_udp_enable(&client_ip);
120
121     /* Check for error. */
122     if (status != NX_SUCCESS)
123     {
124
125         return;
126     }
127
128     status = nx_icmp_enable(&client_ip);
129
130     /* Check for error. */
131     if (status != NX_SUCCESS)
132     {
133
134         return;
135     }
136     /* Create the client thread */
137     status = tx_thread_create(&demo_client_thread, "SNTP Client Thread", demo_client_thread_entry,
138                             (ULONG)&demo_client, free_memory_pointer, 2048,
139                             4, 4, TX_NO_TIME_SLICE, TX_DONT_START);
140
141     /* Check for errors */
142     if (status != TX_SUCCESS)
143     {
144
145         return;
146     }
147
148     /* Update pointer to unallocated (free) memory. */
149     free_memory_pointer = free_memory_pointer + 2048;
150
151     /* set the SNTP network interface to the primary interface. */
152     iface_index = 0;
153
154     /* Create the SNTP Client to run in broadcast mode.. */
155     status = nx_snmp_client_create(&demo_client, &client_ip, iface_index, &client_packet_pool,
156                                  leap_second_handler,
157                                  kiss_of_death_handler,
158                                  NULL /* no random_number_generator callback */);
159
160     /* Check for error. */
161     if (status != NX_SUCCESS)
162     {
163

```

```

164     /* Bail out! */
165     return;
166 }
167
168 tx_thread_resume(&demo_client_thread);
169
170 return;
171 }
172
173 /* Define size of buffer to display client's local time. */
174 #define BUFSIZE 50
175
176 /* Define the client thread. */
177 void demo_client_thread_entry(ULONG info)
178 {
179
180     UINT status;
181     UINT spin;
182     UINT server_status;
183     CHAR buffer[BUFSIZE];
184     ULONG base_seconds;
185     ULONG base_fraction;
186     ULONG seconds, milliseconds;
187     #ifdef USE_IPV6
188     NXD_ADDRESS sntp_server_address, sntp_server_address2;
189     NXD_ADDRESS client_ip_address;
190     #endif
191
192
193     /* Give other threads (IP instance) a chance to initialize. */
194     tx_thread_sleep(100);
195
196     #ifdef USE_IPV6
197     /* Set up IPv6 services. */
198     status = nxd_ipv6_enable(&client_ip);
199
200     status += nxd_icmp_enable(&client_ip);
201
202     if (status != NX_SUCCESS)
203         return;
204
205     client_ip_address.nxd_ip_address.v6[0] = 0x20010db8;
206     client_ip_address.nxd_ip_address.v6[1] = 0x0000f101;
207     client_ip_address.nxd_ip_address.v6[2] = 0x0;
208     client_ip_address.nxd_ip_address.v6[3] = 0x101;
209     client_ip_address.nxd_ip_version = NX_IP_VERSION_V6;
210
211     /* Set the IPv6 server address. */
212     sntp_server_address.nxd_ip_address.v6[0] = 0x20010db8;
213     sntp_server_address.nxd_ip_address.v6[1] = 0x0000f101;
214     sntp_server_address.nxd_ip_address.v6[2] = 0x0;
215     sntp_server_address.nxd_ip_address.v6[3] = 0x00000106;
216     sntp_server_address.nxd_ip_version = NX_IP_VERSION_V6;
217
218     /* Set up our 'alternative' time server. Actually we'll just copy over the server above
219        and present it as an alternative server when we restart the SNTP Client below. */

```

```

220     COPY_NXD_ADDRESS(&sntp_server_address, &sntp_server_address2);
221
222     /* Establish the link local address for the host. The RAM driver creates
223        a virtual MAC address. */
224     status = nxd_ipv6_address_set(&client_ip, iface_index, NX_NULL, 10, NULL);
225
226     /* Check for link local address set error. */
227     if (status != NX_SUCCESS)
228     {
229         return;
230     }
231
232     /* Set the host global IP address. We are assuming a 64
233        bit prefix here but this can be any value (< 128). */
234     status = nxd_ipv6_address_set(&client_ip, iface_index, &client_ip_address, prefix, &address_index);
235
236     /* Check for global address set error. */
237     if (status != NX_SUCCESS)
238     {
239         return;
240     }
241
242     /* Wait while NetX Duo validates the global and link local addresses. */
243     tx_thread_sleep(400);
244
245 #endif
246
247
248     /* Set up client time updates depending on mode. */
249 #ifdef USE_UNICAST
250
251     /* Initialize the Client for unicast mode to poll the SNTP server once an hour. */
252 #ifdef USE_IPV6
253     /* Use the duo service to set up the Client and set the IPv6 SNTP server. Note: this
254        can take either an IPv4 or IPv6 address. */
255     status = nxd_sntp_client_initialize_unicast(&demo_client, &sntp_server_address);
256 #else
257     /* Use the IPv4 service to set up the Client and set the IPv4 SNTP server. */
258     status = nx_sntp_client_initialize_unicast(&demo_client, SERVER_IP_ADDRESS);
259 #endif /* USE_IPV6 */
260
261 #else /* Broadcast mode */
262
263     /* Initialize the Client for broadcast mode, no roundtrip calculation required and a broadcast SNTP service.
264        */
265 #ifdef USE_IPV6
266     /* Use the duo service to initialize the Client and set IPv6 SNTP all hosts multicast address.
267        (Note: This can take either an IPv4 or IPv6 address.) */
268     status = nxd_sntp_client_initialize_broadcast(&demo_client, &sntp_server_address, NX_NULL);
269 #else
270
271     /* Use the IPv4 service to initialize the Client and set IPv4 SNTP broadcast address. */
272     status = nx_sntp_client_initialize_broadcast(&demo_client, NX_NULL, SERVER_IP_ADDRESS);
273 #endif /* USE_IPV6 */
274 #endif /* USE_UNICAST */

```

```

275
276
277     /* Check for error. */
278     if (status != NX_SUCCESS)
279     {
280
281         return;
282     }
283
284     /* Set the base time which is approximately the number of seconds since the turn of the last century.
285        If this is not available in SNTP format, the nx_sntp_client_utility_add_msecs_to_ntp_time service
286        can convert milliseconds to fraction. For how to compute NTP seconds from real time, read the
287        NetX SNTP User Guide.
288
289        Otherwise set the base time to zero and set NX_SNTP_CLIENT_IGNORE_MAX_ADJUST_STARTUP to
290        NX_TRUE for
291        the SNTP CLient to accept the first time update without applying a minimum or maximum adjustment
292        parameters (NX_SNTP_CLIENT_MIN_TIME_ADJUSTMENT and
293        NX_SNTP_CLIENT_MAX_TIME_ADJUSTMENT). */
294
295     base_seconds = 0xd2c96b90; /* Jan 24, 2012 UTC */
296     base_fraction = 0xa132db1e;
297
298     /* Apply to the SNTP Client local time. */
299     status = nx_sntp_client_set_local_time(&demo_client, base_seconds, base_fraction);
300
301     /* Check for error. */
302     if (status != NX_SUCCESS)
303     {
304
305         return;
306     }
307
308     /* Run whichever service the client is configured for. */
309     #ifdef USE_UNICAST
310
311     status = nx_sntp_client_run_unicast(&demo_client);
312     #else
313     status = nx_sntp_client_run_broadcast(&demo_client);
314     #endif /* USE_UNICAST */
315
316     if (status != NX_SUCCESS)
317     {
318
319         return;
320     }
321
322     spin = NX_TRUE;
323
324     /* Now check periodically for time changes. */
325     while(spin)
326     {
327
328         /* First verify we have a valid SNTP service running. */
329         status = nx_sntp_client_receiving_updates(&demo_client, &server_status);
330
331         if ((status == NX_SUCCESS) && (server_status == NX_TRUE))

```

```

329     {
330
331         /* Server status is good. Now get the Client local time. */
332
333         /* Display the local time in years, months, date format. */
334         status = nx_sntp_client_get_local_time(&demo_client, &seconds, &milliseconds, &buffer[0]);
335
336         if (status == NX_SUCCESS)
337         {
338             printf("Date: %s\n", &buffer[0]);
339         }
340
341         /* Wait a while before the next update. */
342         tx_thread_sleep(300);
343
344         memset(&buffer[0], 0, BUFSIZE);
345     }
346     else
347     {
348
349         /* Wait a short bit to check again. */
350         tx_thread_sleep(100);
351     }
352 }
353
354 /* We can stop the SNTP service if for example we think the SNTP service has stopped. */
355 status = nx_sntp_client_stop(&demo_client);
356
357 if (status != NX_SUCCESS)
358 {
359     return;;
360 }
361
362 /* Set up another server and reinitialize the SNTP Client. */
363 #ifndef USE_UNICAST
364 #ifndef USE_IPV6
365
366     status = nxd_sntp_client_initialize_unicast(&demo_client, &sntp_server_address);
367
368 #else
369     /* Initialize the Client for unicast mode to poll the SNTP server once an hour. */
370     status = nx_sntp_client_initialize_unicast(&demo_client, SERVER_IP_ADDRESS_2);
371 #endif
372
373     /* Check for error. */
374     if (status != NX_SUCCESS)
375     {
376         return;
377     }
378
379     /* Now start the SNTP Client task back up. */
380     status = nx_sntp_client_run_unicast(&demo_client);
381
382     if (status != NX_SUCCESS)
383     {
384         return;

```

```

385
386     }
387 #else /* Start Client in broadcast */
388
389 #ifdef USE_IPV6
390
391     /* Initialize the Client for broadcast mode (multicast in IPv6) and set up an alternative server. */
392     status = nxd_sntp_client_initialize_broadcast(&demo_client, &sntp_server_address2, NX_NULL);
393 #else
394
395     status = nx_sntp_client_initialize_broadcast(&demo_client, NX_NULL, SERVER_IP_ADDRESS_2);
396 #endif /* USE_IPV6 */
397
398     if (status != NX_SUCCESS)
399     {
400         return;
401     }
402
403     /* Now start the SNTP Client task back up. */
404     status = nx_sntp_client_run_broadcast(&demo_client);
405
406     /* Check for error. */
407     if (status != NX_SUCCESS)
408     {
409         return;
410     }
411 #endif
412
413     spin = NX_TRUE;
414
415     /* Now check periodically for time changes. */
416     while(spin)
417     {
418
419         /* First verify we have a valid SNTP service running. */
420         status = nx_sntp_client_receiving_updates(&demo_client, &server_status);
421
422         if ((status == NX_SUCCESS) && (server_status == NX_TRUE))
423         {
424
425             /* Server status is good. Now retrieve the Client local time. */
426
427             /* Display the local time in years, months, date format. */
428             status = nx_sntp_client_get_local_time(&demo_client, &seconds, &milliseconds, &buffer[0]);
429             if (status == NX_SUCCESS)
430             {
431                 printf("Date: %s\n", &buffer[0]);
432             }
433
434             /* It will be a bit longer till the next update. */
435             tx_thread_sleep(200);
436
437             memset(&buffer[0], 0, BUFSIZE);
438         }
439
440         /* Wait a short bit and try again. */

```

```

441     tx_thread_sleep(100);
442 }
443
444 /* To return resources to NetX and ThreadX stop the SNTP client and delete the client instance. */
445 status = nx_sntp_client_delete(&demo_client);
446
447 return;
448 }
449
450
451 /* This application defined handler for handling an impending leap second is not
452    required by the SNTP Client. The default handler below only logs the event for
453    every time stamp received with the leap indicator set. */
454
455 UINT leap_second_handler(NX_SNTP_CLIENT *client_ptr, UINT leap_indicator)
456 {
457
458     /* Handle the leap second handler... */
459
460     return NX_SUCCESS;
461 }
462
463 /* This application defined handler for handling a Kiss of Death packet is not
464    required by the SNTP Client. A KOD handler should determine
465    if the Client task should continue vs. abort sending/receiving time data
466    from its current time server, and if aborting if it should remove
467    the server from its active server list.
468
469    Note that the KOD list of codes is subject to change. The list
470    below is current at the time of this software release. */
471
472 UINT kiss_of_death_handler(NX_SNTP_CLIENT *client_ptr, UINT KOD_code)
473 {
474
475     UINT remove_server_from_list = NX_FALSE;
476     UINT status = NX_SUCCESS;
477
478
479     /* Handle kiss of death by code group. */
480     switch (KOD_code)
481     {
482
483         case NX_SNTP_KOD_RATE:
484         case NX_SNTP_KOD_NOT_INIT:
485         case NX_SNTP_KOD_STEP:
486
487             /* Find another server while this one is temporarily out of service. */
488             status = NX_SNTP_KOD_SERVER_NOT_AVAILABLE;
489
490             break;
491
492         case NX_SNTP_KOD_AUTH_FAIL:
493         case NX_SNTP_KOD_NO_KEY:
494         case NX_SNTP_KOD_CRYPT_FAIL:
495
496             /* These indicate the server will not service client with time updates

```

```

497         without successful authentication. */
498
499
500         remove_server_from_list = NX_TRUE;
501
502         break;
503
504
505         default:
506
507             /* All other codes. Remove server before resuming time updates. */
508
509             remove_server_from_list = NX_TRUE;
510             break;
511     }
512
513     /* Removing the server from the active server list? */
514     if (remove_server_from_list)
515     {
516
517         /* Let the caller know it has to bail on this server before resuming service. */
518         status = NX_SNTP_KOD_REMOVE_SERVER;
519     }
520
521     return status;
522 }

```

Figure 1 Example of using SNTP Client with NetX Duo

## Configuration Options

There are several configuration options for defining the NetX Duo SNTP Client. The following list describes each in detail:

Define	Meaning
<b>NX_SNTP_CLIENT_THREAD_STACK_SIZE</b>	This option sets the size of the Client thread stack. The default NetX Duo SNTP Client size is 2048.
<b>NX_SNTP_CLIENT_THREAD_TIME_SLICE</b>	This option sets the time slice of the scheduler allows for Client thread execution. The default NetX Duo SNTP Client size is TX_NO_TIME_SLICE.



<b>NX_SNTP_CLIENT_THREAD_PRIORITY</b>	This option sets the Client thread priority. The NetX Duo SNTP Client default value is 2.
<b>NX_SNTP_CLIENT_PREEMPTION_THRESHOLD</b>	This option sets the sets the level of priority at which the Client thread allows preemption. The default NetX Duo SNTP Client value is set to <code>NX_SNTP_CLIENT_THREAD_PRIORITY</code> .
<b>NX_SNTP_CLIENT_UDP_SOCKET_NAME</b>	This option sets the UDP socket name. The NetX Duo SNTP Client UDP socket name default is "SNTP Client socket."
<b>NX_SNTP_CLIENT_UDP_PORT</b>	This sets the port which the Client socket is bound to. The default NetX Duo SNTP Client port is 123.
<b>NX_SNTP_SERVER_UDP_PORT</b>	This is port which the Client sends SNTP messages to the SNTP Server on. The default NetX SNTP Server port is 123.
<b>NX_SNTP_CLIENT_TIME_TO_LIVE</b>	Specifies the number of routers a Client packet can pass before it is discarded. The default NetX Duo SNTP Client is set to 0x80.
<b>NX_SNTP_CLIENT_MAX_QUEUE_DEPTH</b>	Maximum number of UDP packets (datagrams) that can be queued in the NetX Duo SNTP Client socket. Additional packets received mean the oldest packets are released. The default NetX Duo SNTP Client is set to 5.
<b>NX_SNTP_CLIENT_PACKET_TIMEOUT</b>	Time out for NetX Duo packet allocation. The default NetX Duo SNTP Client packet timeout is 1 second.

<b>NX_SNTP_CLIENT_NTP_VERSION</b>	SNTP version used by the Client The NetX Duo SNTP Client API was based on Version 4. The default value is 3.
<b>NX_SNTP_CLIENT_MIN_NTP_VERSION</b>	Oldest SNTP version the Client will be able to work with. The NetX Duo SNTP Client default is Version 3.
<b>NX_SNTP_CLIENT_MIN_SERVER_STRATUM</b>	The lowest level (highest numeric stratum level) SNTP Server stratum the Client will accept. The NetX Duo SNTP Client default is 2.
<b>NX_SNTP_CLIENT_MIN_TIME_ADJUSTMENT</b>	The minimum time adjustment in milliseconds the Client will make to its local clock time. Time adjustments below this will be ignored. The NetX Duo SNTP Client default is 10.
<b>NX_SNTP_CLIENT_MAX_TIME_ADJUSTMENT</b>	The maximum time adjustment in milliseconds the Client will make to its local clock time. For time adjustments above this amount, the local clock adjustment is limited to the maximum time adjustment. The NetX Duo SNTP Client default is 180000 (3 minutes).
<b>NX_SNTP_CLIENT_IGNORE_MAX_ADJUST_STARTUP</b>	This enables the maximum time adjustment to be waived when the Client receives the first update from its time server. Thereafter, the maximum time adjustment is enforced. The intention is to get the Client in synch with the server clock as soon as possible. The NetX Duo SNTP Client default is NX_TRUE.

**NX\_SNTP\_CLIENT\_MAX\_TIME\_LAPSE** Maximum allowable amount of time (seconds) elapsed without a valid time update received by the SNTP Client. The SNTP Client will continue in operation but the SNTP Server status is set to NX\_FALSE. The default value is 7200.

**NX\_SNTP\_UPDATE\_TIMEOUT\_INTERVAL** The interval (seconds) at which the SNTP Client timer updates the SNTP Client time remaining since the last valid update received, and the unicast Client updates the poll interval time remaining before sending the next SNTP update request. The default value is 1.

**NX\_SNTP\_CLIENT\_UNICAST\_POLL\_INTERVAL** The starting poll interval (seconds) on which the Client sends a unicast request to its SNTP server. The NetX Duo SNTP Client default is 3600.

**NX\_SNTP\_CLIENT\_EXP\_BACKOFF\_RATE** The factor by which the current Client unicast poll interval is increased. When the Client fails to receive a server time update, or receiving indications from the server that it is temporarily unavailable (e.g. not synchronized yet) for time update service, it will increase the current poll interval by this rate up to but not exceeding NX\_SNTP\_CLIENT\_MAX\_TIME\_LAPSE. The default is 2.

**NX\_SNTP\_CLIENT\_RTT\_REQUIRED** This option if enabled requires that the SNTP Client calculate round trip time of SNTP messages when applying Server updates to the local clock. The default value is NX\_FALSE (disabled).

**NX\_SNTP\_CLIENT\_MAX\_ROOT\_DISPERSION**

The maximum server clock dispersion (microseconds), which is a measure of server clock precision, the Client will accept. To disable this requirement, set the maximum root dispersion to 0x0. The NetX Duo SNTP Client default is set to 50000.

**NX\_SNTP\_CLIENT\_INVALID\_UPDATE\_LIMIT**

The limit on the number of consecutive invalid updates received from the Client server in either broadcast or unicast mode. When this limit is reached, the Client sets the current SNTP Server status to invalid (NX\_FALSE) although it will continue to try to receive updates from the Server. The NetX Duo SNTP Client default is 3.

**NX\_SNTP\_CLIENT\_RANDOMIZE\_ON\_STARTUP**

This determines if the SNTP Client in unicast mode should send its first SNTP request with the current SNTP server after a random wait interval. It is used in cases where significant numbers of SNTP Clients are starting up simultaneously to limit traffic congestion on the SNTP Server. The default value is NX\_FALSE.

**NX\_SNTP\_CLIENT\_SLEEP\_INTERVAL**

The time interval during which the SNTP Client task sleeps. This allows the application API calls to be executed by the SNTP Client. The default value is 1 timer tick.

**NX\_SNTP\_CURRENT\_YEAR**

To display date in year/month/date format, set this value to equal or less than current year (need not be same year as in NTP time being

**NTP\_SECONDS\_AT\_01011999**

evaluated). The default value is 2015.

This is the number of seconds into the first NTP Epoch on the master NTP clock. It is defined as 0xBA368E80. To disable display of NTP seconds into date and time, set to zero.

## Chapter 3

# Description of NetX Duo SNTP Client Services

This chapter contains a description of all NetX Duo SNTP Client services (listed below) in alphabetic order.

In the “Return Values” section in the following API descriptions, values in **BOLD** are not affected by the **NX\_DISABLE\_ERROR\_CHECKING** define that is used to disable API error checking, while non-bold values are completely disabled.

`nx_sntp_client_create`  
*Create the SNTP Client*

`nx_sntp_client_delete`  
*Delete the SNTP Client*

`nx_sntp_client_get_local_time`  
*Get SNTP Client local time*

`nx_sntp_client_initialize_broadcast`  
*Initialize Client for IPv4 broadcast operation*

`nxd_sntp_client_initialize_broadcast`  
*Initialize Client for IPv6 or IPv4 broadcast operation*

`nx_sntp_client_initialize_unicast`  
*Initialize Client for IPv4 unicast operation*

`nxd_sntp_client_initialize_unicast`  
*Initialize Client for IPv4 or IPv6 unicast operation*

`nx_sntp_client_receiving_updates`  
*Client is currently receiving valid SNTP updates*

`nx_sntp_client_request_unicast_time`  
*Send a request asynchronously to NTP server*

`nx_sntp_client_run_broadcast`  
*Receive time updates from server*

`nx_sntp_client_run_unicast`  
*Send requests and receive time updates from server*

`nx_sntp_client_set_local_time`  
*Set SNTP Client initial local time*

`nx_sntp_client_stop`  
*Stop the SNTP Client thread*

`nx_sntp_client_utility_display_date_and_time`  
*Display NTP time in seconds*

`nx_sntp_client_utility_msecs_to_fraction`  
*Convert milliseconds to NTP fraction component*

## nx\_sntp\_client\_create

---

Create an SNTP Client

### Prototype

```
UINT nx_sntp_client_create(NX_SNTP_CLIENT *client_ptr, NX_IP *ip_ptr,
    UINT iface_index, NX_PACKET_POOL *packet_pool_ptr,
    UINT (*leap_second_handler)(NX_SNTP_CLIENT *client_ptr, UINT
        indicator),
    UINT (*kiss_of_death_handler)(NX_SNTP_CLIENT *client_ptr,
        NX_SNTP_TIME_MESSAGE *server_time_msg),
    VOID (random_number_generator)(struct NX_SNTP_CLIENT_STRUCT
        *client_ptr, ULONG *rand));
```

### Description

This service creates an SNTP Client instance.

### Input Parameters

<b>client_ptr</b>	Pointer to SNTP Client control block
<b>ip_ptr</b>	Pointer to Client IP instance
<b>iface_index</b>	Index to SNTP network interface
<b>packet_pool_ptr</b>	Pointer to Client packet pool
<b>leap_second_handler</b>	Callback for application response to impending leap second
<b>kiss_of_death_handler</b>	Callback for application response to receiving Kiss of Death packet
<b>random_number_generator</b>	Callback to random number generator service

### Return Values

<b>NX_SUCCESS</b>	(0x00) Successful Client creation
<b>NX_SNTP_INSUFFICIENT_PACKET_PAYLOAD</b>	(0xD2A) Invalid non pointer input
<b>NX_PTR_ERROR</b>	(0x07) Invalid pointer input
<b>NX_INVALID_INTERFACE</b>	(0x4C) Invalid network interface



## Allowed From

Initialization, Threads

## Example

```
/* Create the SNTP Client on the primary interface. */
UINT iface_index = 0;
status = nx_sntp_client_create(&demo_client, iface_index, &client_ip,
                               &client_packet_pool, leap_second_handler,
                               kiss_of_death_handler,
                               NULL /* no random_number_generator callback */);

/* If status is NX_SUCCESS an SNTP Client instance was successfully
   created. */
```

## nx\_sntp\_client\_delete

---

Delete an SNTP Client

### Prototype

```
UINT nx_sntp_client_delete(NX_SNTP_CLIENT *client_ptr);
```

### Description

This service deletes an SNTP Client instance.

### Input Parameters

<b>client_ptr</b>	Pointer to SNTP Client control block
-------------------	--------------------------------------

### Return Values

<b>NX_SUCCESS</b>	(0x00) Successful Client creation
<b>NX_PTR_ERROR</b>	(0x07) Invalid pointer input
<b>NX_CALLER_ERROR</b>	(0x11) Invalid caller of service

### Allowed From

Threads

### Example

```
/* Delete the SNTP Client. */
status = nx_sntp_client_delete(&demo_client);

/* If status is NX_SUCCESS an SNTP Client instance was successfully
   deleted. */
```

## nx\_sntp\_client\_get\_local\_time

---

Get the SNTP Client local time

### Prototype

```
UINT nx_sntp_client_get_local_time(NX_SNTP_CLIENT *client_ptr ,
                                   ULONG *seconds,
                                   ULONG *milliseconds,
                                   CHAR *buffer);
```

### Description

This service gets the SNTP Client local time with an option buffer pointer input to receive the data in string message format.

### Input Parameters

<b>client_ptr</b>	Pointer to SNTP Client control block
<b>seconds</b>	Pointer to local time seconds
<b>milliseconds</b>	Pointer to milliseconds component
<b>buffer</b>	Pointer to buffer to write time data

### Return Values

<b>NX_SUCCESS</b>	(0x00) Successful Client creation
<b>NX_PTR_ERROR</b>	(0x07) Invalid pointer input
<b>NX_CALLER_ERROR</b>	(0x11) Invalid caller of service

### Allowed From

Threads

### Example

```
/* Get the SNTP Client local time without the string message option. */
ULONG base_seconds;
ULONG base_milliseconds;

status = nx_sntp_client_get_local_time(&demo_client, &base_seconds,
                                       &base_milliseconds, NX_NULL);

/* If status is NX_SUCCESS an SNTP Client time was successfully
   retrieved. */
```

## **nx\_sntp\_client\_initialize\_broadcast**

---

Initialize the Client for broadcast operation

### **Prototype**

```
UINT nx_sntp_client_initialize_broadcast(NX_SNTP_CLIENT *client_ptr,
                                       ULONG multicast_server_address,
                                       ULONG broadcast_time_servers);
```

### **Description**

This service initializes the Client for broadcast operation by setting the the SNTP Server IP address and initializing SNTP startup parameters and timeouts. If both multicast and broadcast addresses are non-null, the multicast address is selected. If both addresses are null an error is returned. Note this supports IPv4 server addresses only.

### **Input Parameters**

<b>client_ptr</b>	Pointer to SNTP Client control block
<b>multicast_server_address</b>	SNTP multicast address
<b>broadcast_time_server</b>	SNTP server broadcast address

### **Return Values**

<b>NX_SUCCESS</b>	(0x00)	Successful Client Creation
<b>NX_INVALID_PARAMETERS</b>	(0x4D)	Invalid non pointer input
<b>NX_PTR_ERROR</b>	(0x07)	Invalid pointer input
<b>NX_CALLER_ERROR</b>	(0x11)	Invalid caller of service

### **Allowed From**

Initialization, Threads

### **Example**

```
/* Initialize the client for broadcast operation. */
status = nx_sntp_client_initialize_broadcast(client_ptr, 0x0,
                                           NX_NULL, IP_ADDRESS(192,2,2,255));

/* If status is NX_SUCCESS the Client was successfully initialized. */
```

# nxd\_sntp\_client\_initialize\_broadcast

Initialize the Client for IPv4 or IPv6 broadcast operation

## Prototype

```
UINT nxd_sntp_client_initialize_broadcast(NX_SNTP_CLIENT *client_ptr,
                                         NXD_ADDRESS *multicast_server_address,
                                         NXD_ADDRESS *broadcast_server_address);
```

## Description

This service initializes the Client for broadcast operation by setting up the SNTP Server IP address and initializing SNTP startup parameters and timeouts. If both broadcast and multicast address pointers are non null, the multicast address is selected. If both address pointers are null, an error is returned. This supports both IPv4 and IPv6 address types. Note that IPv6 does not support broadcast, so the broadcast address pointer is set to IPv6, an error is returned.

## Input Parameters

<b>client_ptr</b>	Pointer to SNTP Client control block
<b>multicast_server_address</b>	SNTP server multicast address
<b>broadcast_server_address</b>	SNTP server broadcast address

## Return Values

<b>NX_SUCCESS</b>	(0x00)	Client successfully initialized
<b>NX_SNTP_PARAM_ERROR</b>	(0xD0D)	Invalid non pointer input
<b>NX_PTR_ERROR</b>	(0x07)	Invalid pointer input
<b>NX_CALLER_ERROR</b>	(0x11)	Invalid caller of service

## Allowed From

Initialization, Threads

## Example

```
/* Initialize the client for broadcast operation. */
NXD_ADDRESS broadcast_server;

Broadcast_server.nxd_ip_address = NX_IP_VERSION_V6;
Broadcast_server.nxd_ip_address.v6[0] = 0x20010db1;
Broadcast_server.nxd_ip_address.v6[1] = 0x0f101;
Broadcast_server.nxd_ip_address.v6[2] = 0x0;
Broadcast_server.nxd_ip_address.v6[3] = 0x101;

status = nxd_sntp_client_initialize_broadcast(client_ptr, 0x0,
                                              NX_NULL, &broadcast_server)

/* If status is NX_SUCCESS the Client was successfully initialized. */
```

## **nx\_sntp\_client\_initialize\_unicast**

---

Set up the SNTP Client to run in unicast

### **Prototype**

```
UINT nx_sntp_client_initialize_unicast(NX_SNTP_CLIENT * client_ptr,
                                       ULONG unicast_time_server);
```

### **Description**

This service initializes the Client for unicast operation by setting the SNTP Server IP address and initializing SNTP startup parameters and timeouts. Note this supports IPv4 server addresses only.

### **Input Parameters**

<b>client_ptr</b>	Pointer to SNTP Client control block
<b>unicast_time_server</b>	SNTP server IP address

### **Return Values**

<b>NX_SUCCESS</b>	(0x00)	Client successfully initialized
<b>NX_INVALID_PARAMETERS</b>	(0x4D)	Invalid non pointer input
<b>NX_PTR_ERROR</b>	(0x07)	Invalid pointer input
<b>NX_CALLER_ERROR</b>	(0x11)	Invalid caller of service

### **Allowed From**

Initialization, Threads

### **Example**

```
/* Initialize the Client for unicast operation. */
status = nx_sntp_client_initialize_unicast(&client_ptr, IP_ADDRESS(192,2,2,1));

/* If status is NX_SUCCESS the Client is initialized for unicast operation. */
```

## nxd\_sntp\_client\_initialize\_unicast

---

Set up the SNTP Client to run in IPv4 or IPv6 unicast

### Prototype

```
UINT nxd_sntp_client_initialize_unicast(NX_SNTP_CLIENT * client_ptr,
                                       NXD_ADDRESS *unicast_time_server);
```

### Description

This service initializes the Client for unicast operation by setting up the SNTP Server IP address and initializing SNTP startup parameters and timeouts. This supports both IPv4 and IPv6 address types.

### Input Parameters

<b>client_ptr</b>	Pointer to SNTP Client control block
<b>unicast_time_server</b>	SNTP server IP address

### Return Values

<b>NX_SUCCESS</b>	(0x00) Client successfully initialized
<b>NX_INVALID_PARAMETERS</b>	(0x4D) Invalid non pointer input
<b>NX_PTR_ERROR</b>	(0x07) Invalid pointer input
<b>NX_CALLER_ERROR</b>	(0x11) Invalid caller of service

### Allowed From

Initialization, Threads

### Example

```
/* Initialize the Client for unicast operation. */
NXD_ADDRESS unicast_server;

unicast_server.nxd_ip_address = NX_IP_VERSION_V6;
unicast_server.nxd_ip_address.v6[0] = 0x20010db1;
unicast_server.nxd_ip_address.v6[1] = 0x0f101;
unicast_server.nxd_ip_address.v6[2] = 0x0;
unicast_server.nxd_ip_address.v6[3] = 0x101;

status = nxd_sntp_client_initialize_unicast(&client_ptr, *unicast_server);

/* If status is NX_SUCCESS the Client is initialized for unicast operation. */
```



## **nx\_sntp\_client\_receiving\_updates**

---

Indicate if Client is receiving valid updates

### **Prototype**

```
UINT nx_sntp_client_receiving_updates(NX_SNTP_CLIENT *client_ptr,
                                       UINT *receive_status);
```

### **Description**

This service indicates if the Client is receiving valid SNTP updates. If the maximum time lapse without a valid update or limit on consecutive invalid updates is exceeded, the receive status is returned as false. Note that the SNTP Client is still running and if the application wishes to restart the SNTP Client with another unicast or broadcast/multicast server it must stop the SNTP Client using the *nx\_sntp\_client\_stop* service, reinitialize the Client using one of the initialize services with another server.

### **Input Parameters**

<b>client_ptr</b>	Pointer to SNTP Client control block.
<b>receive_status</b>	Pointer to indicator if Client is receiving valid updates.

### **Return Values**

<b>NX_SUCCESS</b>	(0x00) Client successfully received update status
<b>NX_PTR_ERROR</b>	(0x07) Invalid pointer input

### **Allowed From**

Initialization, Threads

### **Example**

```
/* Determine if the SNTP Client is receiving valid updates. */
UINT receive_status;

status = nx_sntp_client_receiving_updates(client_ptr, &receive_status);

/* If status is NX_SUCCESS and receive_status is NX_TRUE, the client is
   currently receiving valid updates. */
```

## nx\_sntp\_client\_request\_unicast\_time

---

Send a unicast request directly to the NTP Server

### Prototype

```
UINT nx_sntp_client_request_unicast_time(NX_SNTP_CLIENT *client_ptr,
                                         UINT wait_option);
```

### Description

This service allows the application to directly send a unicast request to the NTP server asynchronously from the SNTP Client thread task. The wait option specifies how long to wait for a response. If successful, the application can use other SNTP Client services to obtain the latest time. See section **SNTP Asynchronous Unicast Requests** for more details.

### Input Parameters

<b>client_ptr</b>	Pointer to SNTP Client control block.
<b>Wait_option</b>	Wait option for NTP response in timer ticks.

### Return Values

<b>NX_SUCCESS</b>	(0x00)	Client successfully sends and receives unicast update
<b>NX_SNTP_CLIENT_NOT_STARTED</b>	(0xD0B)	Client thread not started
<b>NX_PTR_ERROR</b>	(0x07)	Invalid pointer input
<b>NX_CALLER_ERROR</b>	(0x11)	Invalid caller of service

### Allowed From

Threads

### Example

```
/* Determine if the SNTP Client is receiving valid updates. */
UINT receive_status;

status = nx_sntp_client_request_unicast_time(client_ptr, 400);

/* If status is NX_SUCCESS and receive_status is NX_TRUE, the client is received
   a valid response to the unicast request. */
```

## **nx\_sntp\_client\_run\_broadcast**

---

Run the Client in broadcast mode

### **Prototype**

```
UINT nx_sntp_client_run_broadcast(NX_SNTP_CLIENT *client_ptr);
```

### **Description**

This service starts the Client in broadcast mode where it will wait to receive broadcasts from the SNTP server. If a valid broadcast SNTP message is received, the SNTP client timeout for maximum lapse without an update and count of consecutive invalid messages received are reset. If the either of these limits are exceeded, the SNTP Client sets the server status to invalid although it will still wait to receive updates. The application can poll the SNTP Client task for server status, and if invalid stop the SNTP Client and reinitialize it with another SNTP broadcast address. It can also switch to a unicast SNTP server.

### **Input Parameters**

<b>client_ptr</b>	Pointer to SNTP Client control block.
-------------------	---------------------------------------

### **Return Values**

<b>status</b>	----- Actual completion status
<b>NX_SNTP_CLIENT_ALREADY_STARTED</b>	(0xD0C) Client already started
<b>NX_SNTP_CLIENT_NOT_INITIALIZED</b>	(0xD01) Client not initialized
<b>NX_PTR_ERROR</b>	(0x07) Invalid pointer input
<b>NX_CALLER_ERROR</b>	(0x11) Invalid caller of service

### **Allowed From**

Threads

### **Example**

```
/* Start Client running in broadcast mode. */
status = nx_sntp_client_run_broadcast(client_ptr);

/* If status is NX_SUCCESS, the client is successfully started. */
```

## **nx\_sntp\_client\_run\_unicast**

---

Run the Client in unicast mode

### **Prototype**

```
UINT nx_sntp_client_run_unicast(NX_SNTP_CLIENT *client_ptr);
```

### **Description**

This service starts the Client in unicast mode where it periodically sends a unicast request to its SNTP Server for a time update. If a valid SNTP message is received, the SNTP client timeout for maximum lapse without an update, initial polling interval and count of consecutive invalid messages received are reset. If the either of these limits are exceeded, the SNTP Client sets the Server status to invalid although it will still poll and wait to receive updates. The application can poll the SNTP Client task for server status, and if invalid stop the SNTP Client and reinitialize it with another SNTP unicast address. It can also switch to a broadcast SNTP server.

.

### **Input Parameters**

<b>client_ptr</b>	Pointer to SNTP Client control block.
-------------------	---------------------------------------

### **Return Values**

<b>NX_SUCCESS</b>	(0x00)	Successfully started Client in unicast mode
<b>NX_SNTP_CLIENT_ALREADY_STARTED</b>	(0xD0C)	Client already started
<b>NX_SNTP_CLIENT_NOT_INITIALIZED</b>	(0xD01)	Client not initialized
<b>NX_PTR_ERROR</b>	(0x07)	Invalid pointer input
<b>NX_CALLER_ERROR</b>	(0x11)	Invalid caller of service

## Allowed From

Threads

## Example

```
/* Start the Client in unicast mode. */  
status = nx_snmp_client_run_unicast(client_ptr);  
/* If status = NX_SUCCESS, the Client was successfully started. */
```

## nx\_sntp\_client\_set\_local\_time

---

Set the SNTP Client local time

### Prototype

```
UINT nx_sntp_client_set_local_time(NX_SNTP_CLIENT *client_ptr,
                                   ULONG seconds, ULONG fraction);
```

### Description

This service sets the SNTP Client local time with the input time, in SNTP format e.g. seconds and 'fraction' which is the format for putting fractions of a second in hexadecimal format. It is intended for use when starting up the SNTP Client to give it a base time upon which to compare received updates for valid time data. This is optional; the SNTP Client can run without a starting local time. Input time candidates can be obtained from existing SNTP time values (on the Internet) and are computed as the number of seconds since January 1, 1900 (until 2036 when a new 'epoch' will be started).

### Input Parameters

<b>client_ptr</b>	Pointer to SNTP Client control block
<b>seconds</b>	Seconds component of the time input
<b>fraction</b>	Subseconds component in the SNTP fraction format

### Return Values

<b>NX_SUCCESS</b>	(0x00) Successfully set local time
<b>NX_PTR_ERROR</b>	(0x07) Invalid pointer input

### Allowed From

Initialization

### Example

```
/* Set the SNTP Client local time. */
base_seconds = 0xd2c50b71;
base_fraction = 0xa132db1e;

status = nx_sntp_client_set_local_time(&demo_client, base_seconds,
                                       base_fraction);

/* If status is NX_SUCCESS an SNTP Client time was successfully
   set. */
```

## nx\_sntp\_client\_set\_time\_update\_notify

---

Set the SNTP update callback

### Prototype

```
UINT nx_sntp_client_set_time_update_notify(NX_SNTP_CLIENT *client_ptr,
      VOID (time_update_cb)(NX_SNTP_TIME_MESSAGE
                           *time_update_ptr, NX_SNTP_TIME *local_time)));
```

### Description

This service sets callback to notify the application when the SNTP Client receives a valid time update. It supplies the actual SNTP message and the SNTP Client's local time (usually the same) in NTP format. The application can use the NTP data directly or call the *nx\_sntp\_client\_utility\_display\_date\_time service* to convert the time to human readable format.

### Input Parameters

<b>client_ptr</b>	Pointer to SNTP Client control block
<b>time_update_cb</b>	Pointer to callback function

### Return Values

<b>NX_SUCCESS</b>	(0x00) Successfully set callback
<b>NX_PTR_ERROR</b>	(0x07) Invalid pointer input

### Allowed From

Initialization

### Example

```
/* Set the SNTP Client time update callback. */
VOID client_time_update_notify(NX_SNTP_TIME_MESSAGE *time_update_ptr,
                              NX_SNTP_TIME *local_time);

NX_SNTP_CLIENT demo_client;

status = nx_sntp_client_set_time_update_notify(&demo_client, time_update_cb);

/* If status is NX_SUCCESS an SNTP Client time update callback was successfully
   set. */
```

## nx\_sntp\_client\_stop

---

Stop the SNTP Client thread

### Prototype

```
UINT nx_sntp_client_stop(NX_SNTP_CLIENT *client_ptr);
```

### Description

This service stops the SNTP Client thread. The SNTP Client thread tasks, which runs in an infinite loop, pauses on every iteration to release control of the SNTP Client state and allow applications to make API calls on the SNTP Client.

### Input Parameters

<b>client_ptr</b>	Pointer to SNTP Client control block
-------------------	--------------------------------------

### Return Values

<b>NX_SUCCESS</b>	(0x00) Successful stopped Client thread
<b>NX_SNTP_CLIENT_NOT_STARTED</b>	(0xDB) SNTP Client thread not started
<b>NX_PTR_ERROR</b>	(0x07) Invalid pointer input

### Allowed From

Initialization, Threads

### Example

```
/* Stop the SNTP Client. */
status = nx_sntp_client_stop(&demo_client);

/* If status is NX_SUCCESS an SNTP Client instance was successfully
   stopped. */
```



## **nx\_sntp\_client\_utility\_display\_date\_time**

---

Convert an NTP Time to Date and Time string

### **Prototype**

```
UINT nx_sntp_client_utility_display_date_time (NX_SNTP_CLIENT
                                              *client_ptr, CHAR *buffer, UINT length);
```

### **Description**

This service converts the SNTP Client local time to a year month date format and returns the date in the supplied buffer. The NX\_SNTP\_CURRENT\_YEAR need not be the same year as the current Client time but it must be defined.

### **Input Parameters**

<code>client_ptr</code>	Pointer to SNTP Client
<code>buffer</code>	Pointer to buffer to store date
<code>length</code>	Size of input buffer

### **Return Values**

<b>NX_SUCCESS</b>	(0x00)	Successful conversion
<b>NX_SNTP_ERROR_CONVERTING_DATETIME</b>	(0xD08)	NX_SNTP_CURRENT_YEAR not defined or no local client time established
<b>NX_SNTP_INVALID_DATETIME_BUFFER</b>	(0xD07)	Insufficient buffer length

## Allowed From

Initialization, Threads

## Example

```
/* Convert and display the Client's local time. */  
status = nx_sntp_client_utility_display_date_time(client_ptr, buffer,  
                                                  sizeof(buffer));  
/* If status is NX_SUCCESS, date was successfully written to buffer. */
```

## **nx\_sntp\_client\_utility\_msecs\_to\_fraction**

---

Convert milliseconds to an NTP fraction component

### **Prototype**

```
UINT nx_sntp_client_utility_msecs_to_fraction (ULONG milliseconds,
                                              ULONG *fraction);
```

### **Description**

This service converts the input milliseconds to the NTP fraction component. It is intended for use with applications that have a starting base time for the SNTP Client but not in NTP seconds/fraction format. The number of milliseconds must be less than 1000 to make a valid fraction.

### **Input Parameters**

<b>milliseconds</b>	Milliseconds to convert
<b>fraction</b>	Pointer to milliseconds converted to fraction

### **Return Values**

<b>NX_SUCCESS</b>	(0x00)	Successful conversion
<b>NX_SNTP_OVERFLOW_ERROR</b>	(0xD32)	Error converting time to a date
<b>NX_SNTP_INVALID_TIME</b>	(0xD30)	Invalid SNTP data input

### **Allowed From**

Initialization, Threads

### **Example**

```
/* Convert the milliseconds to a fraction. */

status = nx_sntp_client_utility_msecs_to_fraction(milliseconds, &fraction);

/* If status is NX_SUCCESS, data was successfully converted. */
```

## Appendix A: SNTP Fatal Error Codes

The following error codes will result in the SNTP Client aborting time updates with the current server. It is up to the application to decide if the server should be removed from the SNTP Client list of available servers, or simply switch to the next available server on the list. The definition of each error status is defined in *nxd\_sntp\_client.h*.

When the SNTP Client returns an error from the list below to the application, the Server should probably be replaced with another Server. Note that the `NX_Sntp_Kod_Remove_Server` error status is left to the SNTP Client kiss of death handler (callback function) to set:

<code>NX_Sntp_Kod_Remove_Server</code>	<code>0xD0C</code>
<code>NX_Sntp_Server_Auth_Fail</code>	<code>0xD0D</code>
<code>NX_Sntp_Invalid_Ntp_Version</code>	<code>0xD11</code>
<code>NX_Sntp_Invalid_Server_Mode</code>	<code>0xD12</code>
<code>NX_Sntp_Invalid_Server_Stratum</code>	<code>0xD15</code>

When the SNTP Client returns an error from the list below to the application, the Server may only temporarily be unable to provide valid time updates and need not be removed:

<code>NX_Sntp_No_Unicast_From_Server</code>	<code>0xD09</code>
<code>NX_Sntp_Server_Clock_Not_Sync</code>	<code>0xD0A</code>
<code>NX_Sntp_Kod_Server_Not_Available</code>	<code>0xD0B</code>
<code>NX_Sntp_Over_Bad_Update_Limit</code>	<code>0xD17</code>
<code>NX_Sntp_Bad_Server_Root_Dispersion</code>	<code>0xD16</code>
<code>NX_Sntp_Invalid_Rtt_Time</code>	<code>0xD21</code>
<code>NX_Sntp_Kod_Server_Not_Available</code>	<code>0xD24</code>

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NetX Duo Simple Network Time Protocol (SNTP) Client  
User Guide

Publication Date: Rev.5.12 Nov 8, 2018

Published by: Renesas Electronics Corporation

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# NetX Duo Simple Network Time Protocol (SNTP) Client User Guide



Renesas Electronics Corporation

R11UM0038EU0512