A USER'S GUIDE TO THE NPL TELEPHONE TIME SERVICE

Contents

1. NPL's Computer Time Services
2. How to use the NPL Telephone Time Service
3. Additional information about the service
4. Contacting NPL

Appendix – Description of the time code

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1. NPL's Computer Time Services

How does a computer know the time and date? How does it know when the clocks are next due to go forward or back? Or when there will next be 61 seconds in the minute?

A computer can only refer to its internal clock, but this can drift by several seconds from one day to the next. For a computer to tell the time accurately it must set its internal clock regularly against a reliable source of time. NPL offers two services that provide access to just such a source: the national time scale located at NPL, which is based on an ensemble of atomic clocks.

- The Telephone Time Service (TTS) allows a computer to set its internal clock by direct telephone connection to a server at NPL. A call to the NPL TTS can be made at any time of the day or night, and it allows a computer equipped with a suitable modem and software to set its clock and to learn in advance about important time changes. It is particularly valuable in situations where the computer is not connected to the internet, for example in a security system where the equipment needs to be tamper-proof.
- The Internet Time Service (ITS) allows a computer to set its internal clock by connecting over the internet to a server at NPL that transmits a time code using the well-established Network Time Protocol (NTP). See the NPL web site for more information about this service.

The NPL Telephone Time Service provides access to a source of time that is accurate, reliable and traceable. This document explains how to obtain and install software that will allow a computer to use the service, and gives some additional information about the service. Anyone wishing to write their own software to access the service will find full details of the time code in the Appendix. If you have any questions about the Telephone Time Service, or indeed any aspect of time measurement, please contact the NPL – our contact details are given in Section 4.

2. How to use the NPL Telephone Time Service

To access the NPL TTS, a computer must be connected to the public telephone network using an internal or external modem, and needs to run software that will dial up the server, interpret the received code to extract the local time of day, and synchronise the internal clock to this time.

NPL has developed a demonstration program for use with the TTS, called ***Phoneclock***. It can be downloaded free of charge from the NPL Time web pages at this address:

www.npl.co.uk/time/research/computer_time_service/

Instructions for downloading and installing the program are given on the web page.

The *Phoneclock* software is intended for use with Windows 95, 98, NT and 2000, and will also run under 32-bit versions of Windows XP and Windows 7 (note: *Phoneclock* will not run on 64-bit systems). The software requires 1.7 Mb of disk space.

Once correctly installed, the *Phoneclock* window offers a drop-down help menu that provides detailed instructions for configuring and running the program. The Options menu provides a choice between setting the PC clock to UK local time, to UTC, or to a constant offset from UTC. One of the options in the menu is "`Use a high accuracy method (requires a longer call)`". This option is not currently enabled in the servers at NPL, and selecting it will have no effect.

An older version of the NPL TTS software intended for Windows 3.x operating systems, known as *Truetime*, can be supplied by NPL on request.

3. Additional information about the service

What time scale does the service synchronise to?
The time information within the code sent by the TTS server is derived from the UK national time scale, known as UTC(NPL), which is based on the ensemble of atomic clocks located at NPL. The reference clock is kept within 100 nanoseconds (one hundred billionths of a second) of the world time scale, Coordinated Universal Time (UTC). More information about UTC can be found on the NPL web site.

What time code does the service transmit?
The time code transmitted by the NPL TTS server conforms to a standard format known as the European Telephone Time Code. A line of up to 78 data bits is sent each second, providing a range of time and date information, and a time marker is incorporated at the end of each data line. A full description of the time code is given in the Appendix.

How accurate is the service?
The main limitation to the accuracy with which a computer's clock can be set using the NPL TTS is the delay of the telephone network between the server at NPL and the computer. The time code sent by the servers is advanced by 50 milliseconds (50 thousandths of a second) to compensate, but the actual delay might vary by a few tens of milliseconds from this value. However, the TTS will almost always set a computer's clock to within 50 milliseconds of the correct time, and will often do so to within 20 milliseconds.

How much does it cost?
The service uses a British Telecom premium rate telephone number – 0906 851 6333. As a complete line of information is sent by the TTS server every second, it is possible for a computer to receive and check the code within the time allowed for a single unit of telephone charge. Current call charges from a BT line are less than 70p per minute, the actual amount depending on the time of day, but other providers may charge different amounts. A typical call lasts around 20 seconds and costs less than 20p.

Can the service be accessed from outside the UK?
No, British Telecom's premium rate telephone numbers, including that used by the NPL TTS, cannot be called from outside the UK.

4. Contacting NPL

If you have any questions or comments regarding the NPL Telephone Time Service, please contact us by e-mail, telephone or letter. Our contact details are given below.

Time and Frequency Services
Time, Quantum & Electromagnetics Division
National Physical Laboratory
Hampton Road
Teddington
Middlesex TW11 0LW

Telephone: 020 8943 6796
E-mail: timefreq_enquiries@npl.co.uk

Web-site: www.npl.co.uk/time

Appendix – Description of the time code

The data are sent using the V22 1200 baud standard, with eight data bits, no parity, and one stop bit. One line of data is sent each second. The characters following each <carriage return> <line feed> are numbered 01-78 and are listed below.

The ISO-7-UK code table (in effect, ASCII) is used. The seconds time reference is the leading edge of the start bit of the <line feed>. The information in each line relates to the following second, not that in which the line is transmitted.

01-10	Date, changing at local midnight *YYYY-MM-DD*
11	Space
12-19	Local time in the format *hh:mm:ss* except when 'putting the clocks back' when hhAmm:ss is used for the first hour and hhBmm:ss for the second, repeated, hour. Note that, in the case of a positive leap second, *ss* can take the value 60.
20	Space
21-25	A name for the local time, currently 'UTC+0' during GMT and 'UTC+1' during BST
26	Day of week, from 1=Monday to 7=Sunday
27-28	Week of the year, from 01 to 52 or 53 (week 01 contains the first Thursday of the year)
29-31	Day of year, from 001 to 365 or 366
32-37	Month, day and hour (in current local time) of next one-hour time change (*MMDDhh*)
38-49	Year, month, day, hour and minute in UTC time scale (*YYYYMMDDhhmm*)
50-54	Modified Julian Date (MJD), a five-digit decimal day count incrementing at 0000 UTC. As a current example, 1997 January 01 corresponds to MJD 50449
55-56	DUT1, the difference in tenths of a second between UT1 (in effect, GMT) and UTC in the range *+8* through *+0* to *-8*. A positive figure means GMT is 'ahead' of UTC.
57-59	A currently announced positive or negative leap second, at the end of the UTC month MM, is indicated by *+MM* or *-MM*. *000* indicates 'no announcement'.
60-62	The number of milliseconds by which the next time reference is advanced with respect to UTC seconds markers.
63	Message sequence number (see below) in the range 0-9.
64-77	A 14-character field for a message line. Up to ten different lines may be used in sequence, labelled by the message sequence number *transmission pause*
78	This character is usually *, but it changes to # if the code is deliberately advanced in order to anticipate an estimated delay
79	<carriage return>
00	<line feed> - the leading edge of the start bit is the reference time for the second just described *transmission pause*

Example of the Time Code

The following two lines are to help in identifying the character numbers, and are not part of the time code:

```
0         1         2         3         4         5         6         7
12345678901234567890123456789012345678901234567890123456789012345678901234567 8

2005-02-22 11:59:50 UTC+02080530327012005022211595342 3-50000501CKLS 22       *
2005-02-22 11:59:51 UTC+02080530327012005022211595342 3-50000502              *
2005-02-22 11:59:52 UTC+02080530327012005022211595342 3-50000503              *
2005-02-22 11:59:53 UTC+02080530327012005022211595342 3-50000500NPL TDS 1     *
2005-02-22 11:59:54 UTC+02080530327012005022211595342 3-50000501CKLS 22       *
2005-02-22 11:59:55 UTC+02080530327012005022211595342 3-50000502              *
2005-02-22 11:59:56 UTC+02080530327012005022211595342 3-50000503              *
2005-02-22 11:59:57 UTC+02080530327012005022211595342 3-50000500NPL TDS 1     *
2005-02-22 11:59:58 UTC+02080530327012005022211595342 3-50000501CKLS 22       *
2005-02-22 11:59:59 UTC+02080530327012005022211595342 3-50000502              *
2005-02-22 12:00:00 UTC+02080530327012005022212005342 3-50000503              *
2005-02-22 12:00:01 UTC+02080530327012005022212005342 3-50000500NPL TDS 1     *
2005-02-22 12:00:02 UTC+02080530327012005022212005342 3-50000501CKLS 22       *
2005-02-22 12:00:03 UTC+02080530327012005022212005342 3-50000502              *
2005-02-22 12:00:04 UTC+02080530327012005022212005342 3-50000503              *
2005-02-22 12:00:05 UTC+02080530327012005022212005342 3-50000500NPL TDS 1     *
2005-02-22 12:00:06 UTC+02080530327012005022212005342 3-50000501CKLS 22       *
2005-02-22 12:00:07 UTC+02080530327012005022212005342 3-50000502              *
2005-02-22 12:00:08 UTC+02080530327012005022212005342 3-50000503              *
2005-02-22 12:00:09 UTC+02080530327012005022212005342 3-50000500NPL TDS 1     *
2005-02-22 12:00:10 UTC+02080530327012005022212005342 3-50000501CKLS 22       *
```

The message contained in characters 64-77 repeats every four seconds. It is normally used to provide two pieces of information:

- "NPL TDS 1" indicates which of the three servers at NPL is currently online;
- "CKLS22" specifies the number of **C**umulative **K**nown **L**eap **S**econds since leap seconds were first introduced into UTC in January 1972. The difference between TAI and UTC was then 10 s, so the current value can be found using [TAI = UTC +10 +CKLS]. The CKLS number figure changes when a new leap second is announced in the time code. It can be used to account for leap seconds when dates are subtracted to give time intervals.