

A USER'S GUIDE TO THE NPL INTERNET TIME SERVICE

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1. NPL's Computer Time Services

A computer time-stamps every event, such as an e-mail being sent or a file saved, by taking the time from its internal clock. This clock is usually an inexpensive quartz oscillator that can drift by several seconds over a day and gradually build up an error of many minutes. If the computer is to tell the time accurately it must set its internal clock regularly against a trusted external source of time, which must be both accurate and reliable. NPL offers two services that provide access to just such a source - the UK national time scale located at NPL, which is based on a group of atomic clocks.

- 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). The NPL ITS 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 provides instructions for accessing the NPL ITS.
- 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 allows a computer equipped with a suitable modem and software to set its clock to UK local time 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, or where a reliable source of UK local time is required. See the NPL web site for more information about this service.

If you have any questions about the NPL Computer Time Services, or indeed any aspect of time measurement, please get in touch with NPL – our contact details are given in Section 4.

2. The Network Time Protocol (NTP)

The Network Time Protocol, or NTP, is the most widely used method for transmitting time information across the Internet. NTP version 3 is defined formally in an Internet draft standard, RFC 1305 (RFC means Request For Comments), and NTP version 4 is under development. NTP takes as its time reference the international atomic time scale, Coordinated Universal Time (UTC), which is kept within 0.9 seconds of the astronomical time scale Greenwich Mean Time by the insertion of leap seconds when necessary. NTP aims to provide the best attainable synchronisation to UTC by using a hierarchy of time servers. At the top are those servers, known as stratum 1, that obtain their time from an external source of UTC

such as an off-air receiver for GPS or radio time signals. Servers synchronised to one or more stratum 1 servers are known as stratum 2, and so on.

A computer can be synchronised using NTP by running client software, which may be a small program running in the background or built into other software such as the operating system. The client sends periodic time requests across the Internet or an internal network to one or more (up to five) specified servers. Each call to a server results in an exchange of time-stamped packets of data that allow the client software to estimate the network delay and the rate offset between the client computer's clock and the server, and uses this information to adjust the clock. Repeated calls to a number of servers allow the client software to ignore responses from those that send a time significantly different from the others, and to average the results from those that appear to be correct.

Much of the available NTP software makes use of a simplified version of the protocol known as SNTP (Simple Network Time Protocol), version 4 of which is defined in the internet draft standard RFC 2030. SNTP client software sets its computer clock by making a single timing request to just one specified server, so it does not perform any averaging and is unable to judge the accuracy of the selected server by comparison with others.

The accuracy of synchronisation that can be achieved using NTP varies from better than one millisecond (one thousandth of a second) over an internal company Local Area Network to 30 milliseconds or more for calls to a server located in another continent. The result is highly dependent on the symmetry and speed of the network path between the client and the server. In general, the best performance is obtained using two or three servers that synchronise to different sources, and which are geographically not too distant so that they can be accessed without too many switches between public networks.

Further information about the Network Time Protocol can be obtained from a wide range of web sites. A small selection of the more useful sites is listed below.

The "official home" of NTP at the University of Delaware:

www.ntp.org/

The official NTP Frequently Asked Questions list:

www.ntp.org/ntpfaq/NTP-a-faq.htm

An "Executive Summary" about network time synchronisation:

www.eecis.udel.edu/~mills/exec.html

3. Using the NPL Internet Time Service

NPL operates two NTP servers that provide Internet Time Service to users outside NPL. The servers are synchronised using NTP over the NPL local area network to two other servers, which are themselves synchronised to 1 pulse-per-second signals derived from NPL's atomic clocks. The public servers are therefore classed as stratum 2, but they are controlled by a highly reliable source of time – the UK national time scale UTC(NPL) - that is traceable directly to UTC and independent of GPS.

The NPL Internet Time Servers can be accessed by specifying their host name or IP address. These addresses are given in the table below.

Name	Host (DNS) Name	IP Address
NTP Server 1	ntp1.npl.co.uk	139.143.5.30
NTP Server 2	ntp2.npl.co.uk	139.143.5.31

Any computer with Internet access and running a suitable NTP client program should be able to call the NPL ITS servers. NPL does not provide such a program as there is already a wide range of NTP software available from many different sources, including a number of freeware programs that can be downloaded over the internet. However, the following guidance may be of help.

- If your PC is running Windows XP Home Edition, SNTP capability is already built-in. It can be set up easily by following these instructions:
 - a. Click on the “Start” button at the bottom left of the screen and select “Control Panel”.
 - b. If you have chosen to use the Classic View, click on “Date and Time” and select the “Internet Time” tab, or if you are using the Category View, click on “Date, Time, Language & Regional Options” then “Change Date and Time”, then “Internet Time”.
 - c. The address of the selected NTP server, such as ntp1.npl.co.uk, can then be entered, and if desired tested using the “Update Now” button.
 - d. Make sure that the “Automatically synchronize with an Internet time server” box is checked.
 - e. Click on the “OK” button to implement the changes.

The software will then synchronise the PC clock to the server weekly. NTP capability is also included in Windows 2000 and Windows XP Professional, but it is aimed primarily at synchronising a number of computers within a “domain” and is more complex to set up. If you would like more detailed instructions, there is a document on the web site of the US National Institute of Standards and Technology (NIST) that

explains how to set up and use the SNTP facility in various versions of Windows, which can be found at this address:

www.boulder.nist.gov/timefreq/service/pdf/win2000xp.pdf

- This web page has a list of links to web sites offering free software for use with Windows PCs:
<http://geodsoft.com/howto/timesync/wininstall.htm>
- The NIST web site also maintains a list of web addresses of all companies known to publish NTP software. The list can be found here:
www.boulder.nist.gov/timefreq/general/softwarelist.htm

Note that many of these suppliers do not offer NTP client software as freeware.

It is important to note that NTP provides synchronisation to UTC, and not to UK civil time. However, Windows and other operating systems incorporate an option to change the PC clock automatically to and from summer time. Leap seconds are inserted into UTC and should be correctly taken into account by NTP servers, although your computer may not apply the leap second until the next time it synchronises over the Internet.

4. Contacting NPL

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

Time and Frequency Services
National Physical Laboratory
Hampton Road
Teddington
Middlesex TW11 0LW

Telephone: 020 8943 6880
Facsimile: 020 8943 6458
E-mail: time@npl.co.uk
Web-site: www.npl.co.uk/time