Network Time Protocol (NTP)
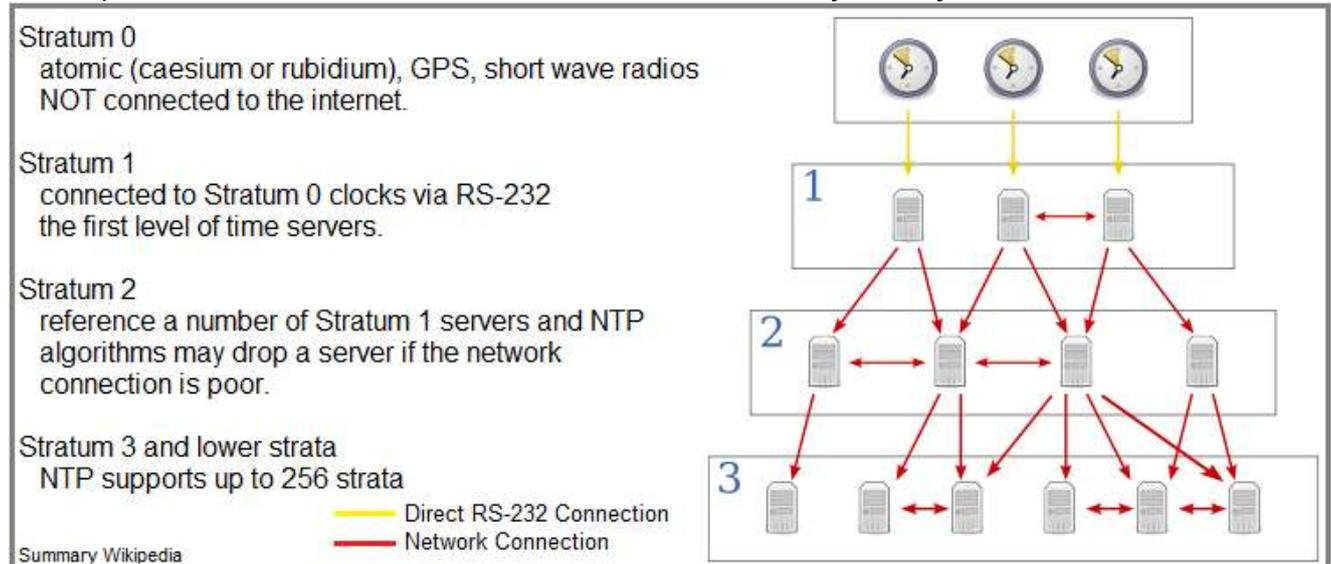## How accurate is it? Is it good enough for Occultation Observations?
by Dave Gault

NTP is of course the acronym for Network Time Protocol and is a method of synchronisation of clocks that have access to the internet. The computers and clock software sends synchronisation requests to time-servers maintained by various organisations around the world, and in response to the request, the time server sends packets of information that enable the clock to correct it's time display.

NTP Clock Strata (levels)
It is important to realise that NTP is a hierarchical, semi-layered system of levels of clocks.

Stratum 0
  atomic (caesium or rubidium), GPS, short wave radios NOT connected to the internet.

Stratum 1
  connected to Stratum 0 clocks via RS-232 the first level of time servers.

Stratum 2
  reference a number of Stratum 1 servers and NTP algorithms may drop a server if the network connection is poor.

Stratum 3 and lower strata
  NTP supports up to 256 strata

—— Direct RS-232 Connection
—— Network Connection

Summary Wikipedia

What can affect the accuracy of time synchronized by NTP?
There are many factors that can have a detrimental effect upon the quality of time displayed;
- Speed (latency) of the internet connection.
- Strata of the time server(s) chosen for synchronization.
- Signal distance from the servers (including to and from orbiting satellites).
- The quality and complexity of the software algorithm used.
    - Does it use more than one server?
    - Does it compute the round-trip delay?
    - Does it compensate for systematic bias?
    - Does it report on the accuracy of the synchronization?

All these factors can affect the quality of the synchronized time you receive, many of which are beyond your control, however some are within your control.

Speed of your internet connection
The speed of an internet connection can easily be measured and the effect of traffic load from other computers on the network can be seen, so that when synchronisation is required, steps can be taken to ensure the computer has the best chance to display good time. There are many tools that will measure internet speed. Simply load the URL and run the test. By having other computers that share the connection actively working (or not) you can see their effect.

http://www.auditmypc.com/broadband-speed-test.asp
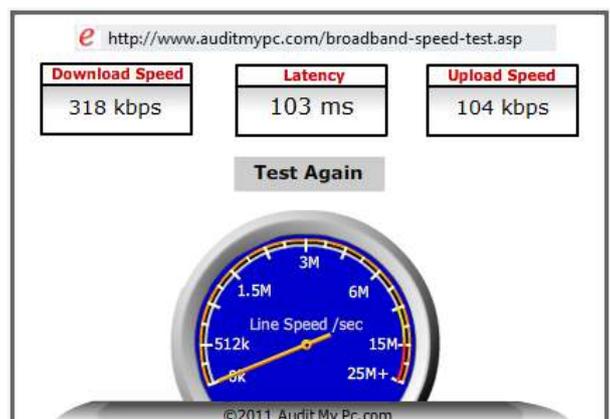
Strata of the time server
Try to choose a time server that is operated by a government institution.

Signal Distance
If you can, choose servers that are physically close to your synchronisation site. This will lessen the chance that the signal is not routed up to a geostationary satellite.
Here is a list of public time servers;
- Global; http://www.pool.ntp.org/zone/@
- Asia; http://www.pool.ntp.org/zone/asia
- Iran; http://www.pool.ntp.org/zone/ir
- Typically, the URL will be something like;
  - `x.asia.pool.ntp.org`
  - `where x = 0,1,2 or 3`

Quality of the software and time algorithms
The following programs were used to test the accuracy of the time displayed and the synchronisation achived was compared to 1ppsGPS time supplied by either IOTA-VTI or KIWI-PC.

1) Windows Control Panel - Date and Time
This program will synchronise the PC's system clock. This is not an easy task to do accurately, and you have little choice of the time server which is used. An indication that complex algorithms are <u>not</u> used is the speed the operation takes to complete, which on the author's machine is about 2 seconds. Here the program is shown to be 0.4442 seconds slow. <u>This is NOT good enough for any astronomical occultation observations.</u>

2) Web-Page (.html) -specifically http://www.asteroidoccultation.com/observations/NA/

Shown here is the recently synchronised web-clock that is displaying time that is;
0.090 seconds slow.

As stated in my article in IOTA-ME Newsletter No. 1, *"Universal Time For Occultation Observations"*
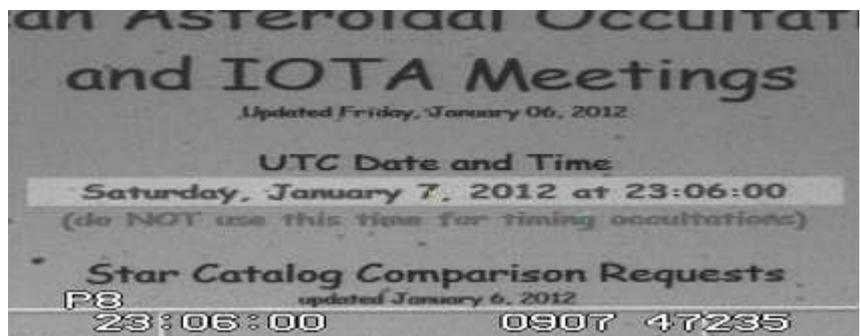
the timebase used for an occultation observation has to be 10 times more accurate than the observation itself, therefore if the accuracy of the timebase, as shown here is +/- 0.09 seconds, then the accuracy of the observation itself is +/- 0.9 seconds or simply round the accuracy to +/- 1 second.

3) Program:- Dimension4 http://www.thinkman.com/dimension4/

Dimension4 has a good reputation for synchronising to Universal Time, but at the time of writing, the author has failed to get it running on his PC (Win7/32 Core i7) so the author can only say that he believes Dimension4 is worth considering.

4) Program:- BeeperSync http://www.hristopavlov.net/BeeperSync/

BeeperSync is a program designed specifically to synchronise a device called a BeeperBox and it does this by emitting an electronic signal, sent via the Parallel or Serial ports of the computer. The author is Hristo Pavlov of Sydney, Australia.

Once installed and given a URL for a nearby timeserver, BeeperSync will measure the latency of the internet connection and will compensate for the delay and it will present the user with accuracy estimates. Shown here are two screen-shots of BeeperSync where the screen-shot on the left is using a timeserver a long way away from the author's home (near Sydney) and the screenshot on the right is using a nearby timeserver.
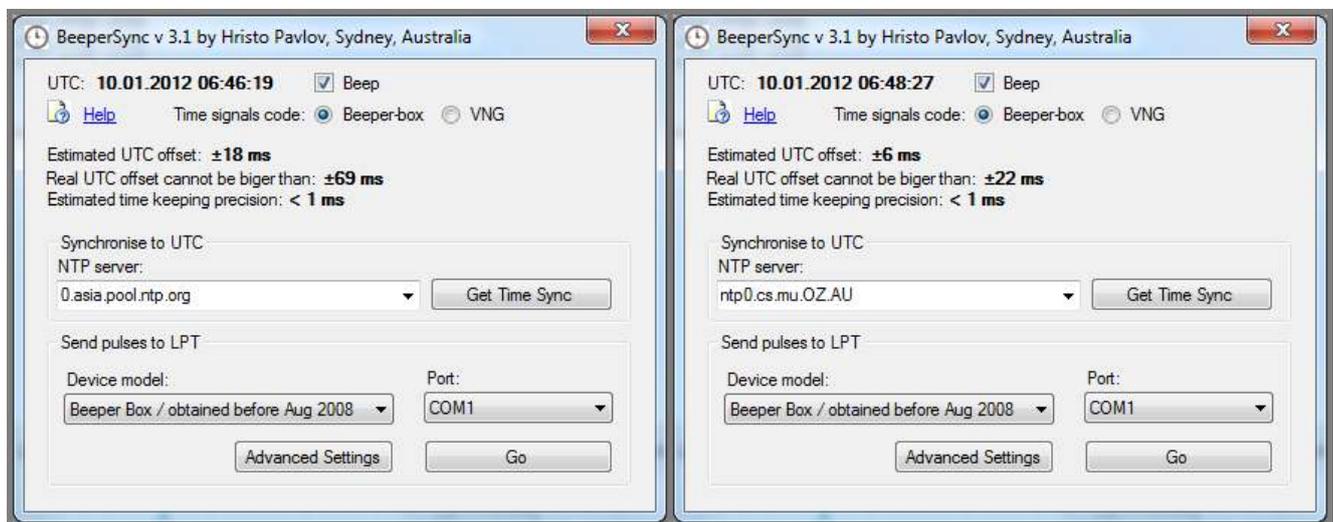
Note:
   -   the left (distant) Estimated UTC accuracy   = +/- 18 milliseconds
   -   the right (nearby) Estimated UTC accuracy = +/-   6 milliseconds
So the effect of timeserver distance can be readily seen.

I have tested the claimed accuracy of BeeperSync while performing the task it was designed for, namely synchronisation of BeeperBoxes, and found that the stated accuracy values were correct. However Hristo does not guarantee the On Screen Display time (OSD-time) or the sound of beeps made by the PC's speaker, so I decided to test the accuracy of both;

   1) The OSD-time which could be used to set a stop-watch.
   2) The audio beeps which could be used as a timebase for the observation directly.

Sadly the test of the accuracy of the OSD-time was spoilt by the nature of the program – the tick at the beginning of the minute was delayed due to the program re-syncing with the timeserver and this made it impossible to set a stopwatch accurately.

However the audio beeps emitted by the PC's speaker were found to be consistently delayed by 40 milliseconds. The photo below is of a LiMovie analysis of a Video.avi file with a sound track.
- The blue dots at the top of the plot is when the KIWI-PC LED flashes, indicating precise (Stratum 0) UT.
- The light blue vertical line represents the LED flash frame in the sound plot.
- The red vertical line is a visual indication of the audio beep.

The beep is exactly and consistently 40 milliseconds behind Universal time.
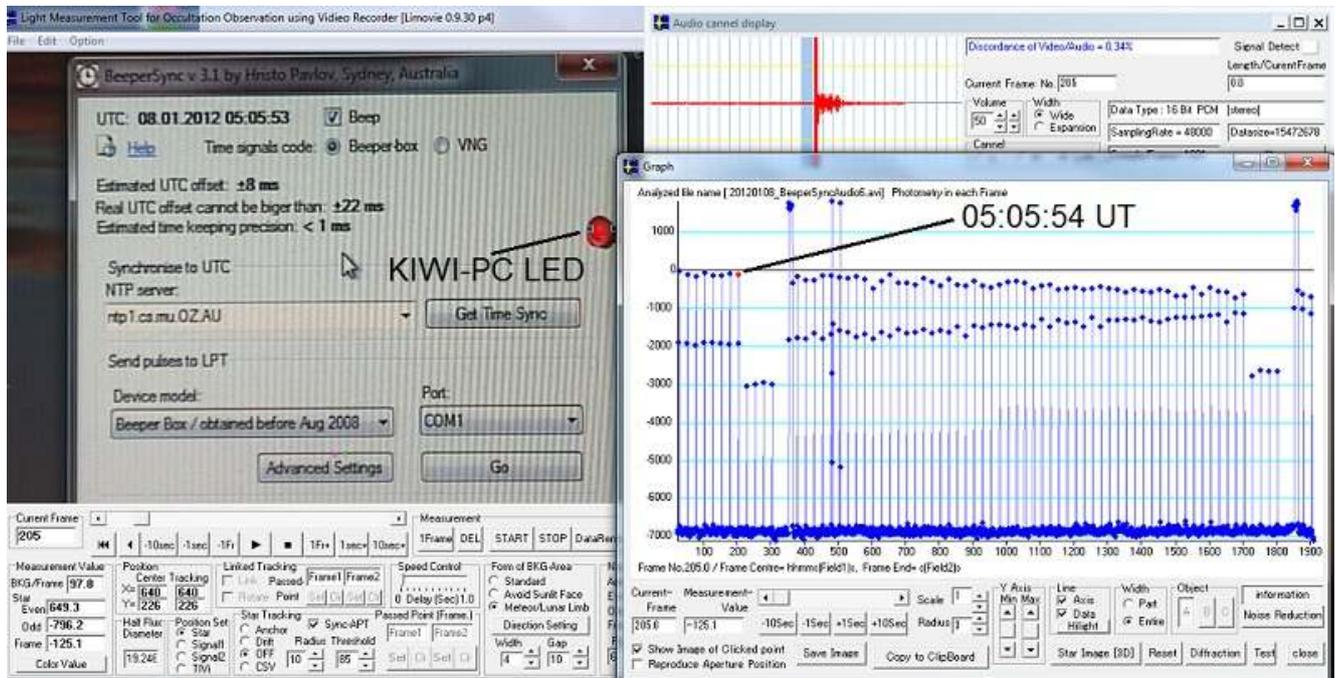
Summary

If a Web-page timebase is used the accuracy should be reported as +/- 1 second.

However, provided the observer;
1) Uses the audio beeps of BeeperSync as a timebase.
2) Notes that the timebase was supplied by BeeperSync and gives the Estimated UTC Offset value as part of their observation.
3) The Estimated UTC Offset value is 0.010 seconds or less.
4) Maintains constant internet connection so that BeeperSync will compensate for time drift.
5) Adds a value of 40 milliseconds to their value of PE and notes that this was added to the PE value reported.
6) The observation was analysed as detailed in the article "**Analysis of Occultation Events Using Audio Techniques**

A visual accuracy of +/- 0.1 seconds is achievable for an occultation observation.

1ppsGPS time
I wish to point out that 1ppsGPS time is Stratum 0 (the most accurate) and is the preferred timebase if available.

Regards
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