SUMMARY

1 Prior to read this document, refer to www.ntp.org if you have no idea about the Network Time protocol.

2 The NTP isn’t that straightforward as it addressed in the website or document. The NTP is a kind of feedback control system. The target you want to pursue is the time of the time servers which you set in your ntp.conf file. The clock in your computer is the thing to be controlled, it will adjust the ‘frequency’ every updating time, then depending on the magnitude of errors, the time constant will be changed correspondingly. The time constant in NTP is the period of updating time, from 64 seconds to 1024 seconds.

3 Talking about the control system, first of all, if the objects to be controlled, it has to be in the loop bandwidth, another word, it has to be inside the capability of the control system. Oppositely, if the time in your computer is too far away as the time in the time servers, the NTP would not correct it, or be synchronized.

4 The dynamic range of the NTP is 500PPM, turns out 8.64* 5 = 43.2 seconds per day. That means if your clock in your computer is running 43.2 seconds faster than or slower than the time servers, the NTP can't do it job properly.

5 Unfortunately if it happen, manually adjust the tick of your computer's clock by :

[root@amibatcstp ntp]# /sbin/adjtimex –tick 10030

if your computer is behind than time server. Have tick smaller than 10000, if faster than time server.

6 After put all the time servers in your ntp.conf file:

[root@amibatcstp ntp]# /sbin/service ntpd start

If first time to run ntpd.

[root@amibatcstp ntp]# /sbin/service ntpd restart
7 Then place

```
[root@homin ntp]# /usr/sbin/ntpq -p
remote refid st t when poll reach delay offset jitter
LOCAL(0) LOCAL(0) 10 l 45 64 377 0.000 0.000 0.031
-ns.cc.sinica.edu time-b.nist.gov 2 u 883 1024 377 1.690 -45.910 1.820
+220-130-158-71. time.nist.gov 2 u 921 1024 377 110.299 5.466 8.385
```

and

```
[root@homin ntp]# /sbin/adjtimex -p
mode: 0
offset: -1776
frequency: -712773
maxerror: 440660
esterror: 8680
status: 1
time_constant: 6
precision: 1
tolerance: 33554432
tick: 10000
raw time: 1109646222s 36319us = 1109646222.036319
```

continuously about few ten minutes. Watching the numbers of frequency. If it saturated, that means the number go to the maximum values at 3554432 or minimum value at -3554432, and the offset between your computer and time server keep running to the divergent way, consequently, you have to stop the ntpd, adjust the tick manually, then restart the ntpd again.

8 Check the log file, /etc/ntp/ntp.log, if the ntpd reset every 10 minutes, it means your clock even too fast or too slow than the default setting, usually it should be less than 128 minisecond in about 10 minutes, put

```
tinker step 0
```

in your ntp.conf to disable the time reset function.

9 With disabling the time reset by ‘tinker step 0’, it could make the time offset pretty big if the network isn’t stable. It is better to remove it after the clock be synchronized, turns out the time will be reset whenever the network has problems. That will minimize the time offset. The TCS has experienced few time reset per night, that tells the network isn’t stable compare to the identical computer in Taipei has experienced none.

10 1 tick = 6553600 counts of frequency. Maximum count of freq. looks like 33554432. The adjusting capability of NTP is 500 PPM, or 8.64*5 = 43.2 seconds per day, or 5 ticks approximately. It refer to the maximum of frequency is 33554432, or the same number of the tolerance.

11 If you like to have ntpd running after every booting, place :
12 After you have a stable time, put the adjustment value into the /etc/rc.local file by:

/sbin/ hwclock –systohc

/sbin/adjtimex –tick 10031 or whatever value you have

13 A example as following:

At the beginning of NTP, the offset , is zero, frequency and tick as set by adjtimex. As:

ot@amibatcstp ntp]#/sbin/adjtimex --tick 10011 --frequency 0

[root@amibatcstp ntp]#/sbin/adjtimex -p
mode: 0
offset: 0
frequency: 0
maxerror: 39440
estaror: 16
status: 1
time_constant: 0
precision: 1
tolerance: 33554432
tick: 10011
raw time: 1109301818s 471654us = 1109301818.471654

few minutes later:

[root@amibatcstp ntp]#/usr/sbin/ntpq -p
remote refid st t when poll reach delay offset jitter
==============================================================================
LOCAL(0) LOCAL(0) 10 l 9 64 177 0.000 0.000 0.031
*ns.cc.sinica.ed time-b.nist.gov 2 u 9 64 177 0.974 676.366 3.428
+homin.asiaa.sin 220-130-158-51. 3 u 62 64 77 0.373 787.870 101.579
[root@amibatcstp ntp]#/sbin/adjtimex -p
mode: 0
offset: 482805
frequency: 6079987
maxerror: 409175
estaror: 90473
status: 1
time_constant: 2
precision: 1
tolerance: 33554432
tick: 10011
raw time: 1109302148s 93504us = 1109302148.0935

10 minutes later:

[root@amibatcstp ntp]#/usr/sbin/ntpq -p
remote refid st t when poll reach delay offset jitter
==============================================================================
LOCAL(0) LOCAL(0) 10 l 33 64 377 0.000 0.000 0.031
*ns.cc.sinica.ed time-b.nist.gov 2 u 28 64 377 1.035 743.723 17.575
+homin.asiaa.sin 220-130-158-51. 3 u 19 64 377 0.382 867.060 17.347
This show that the clock was running too slow, out of the controllable range, make time synchronization impossible. The tick has to be increased again.

14 This show the NTPD running in TCS, GPS has been referring as time server.

15 Refer to appendix to have statistic files. Employing gnuplot, to have the statistic curves plotted as:

```
> plot "~/homin/amiba/pointing/ntpstatsTCS/loopstats.20050301_2" using (($1-53430)*86400+$2):3:5 with yerrorbars
```

it should generate the time offset with estimated error and

```
> plot "~/homin/amiba/pointing/ntpstatsTCS/loopstats.20050301_2" using (($1-53430)*86400+$2):4:6 with yerrorbars
```

it should pop up the frequency offset to the standard one with allen varience.

After having statistic data plotted by Gnuplot, you can print it out hust follow the procedure below:

```
> set terminal postscript eps color lw 15 "Helvetica" 20
```
For easier porting the statistic graphics to Open Office. Use the png format by:

```
gnuplot> set terminal png small

# specify the filename
```

The graphics below is generated by png.
It didn't work of the following.

First, issue command in the computer which want to use the GPS as:

```
linux> /sbin/service vsftpd start
```

Then issue:

```
linux> /sbin/chkconfig –level 35 vsftpd on
```

to enable this function permanently.

For the Truetime GPS, it is design for Windows users, it set up the ntp files via the anonymous, so this function has to be enable in the computer by editing the `/ etc/vsftpd/vsftpd.conf`, adding a line as:

```
anon_upload_enable=YES
```

change the attribute of directory in the anonymous area, which is in `/var/ftp` for Linux.
Change it to writable by:

```
/var/ftp> chmod 733 pub
```

to make the pub subdirectory writable.

After updated all above, strongly recommend to reboot the system, I have been suffered about not to do that.

Remote login into GPS by:

```
linux> telnet 4 23.196.50
```

Use operator user and password.

Follow the proceeded as addressed in Xli's manual:

```
Xli> f100 config ntp host:4.23.196.121 dir:./pub
```

The GPS terminal should has message as:

```
PREVIOUS CONFIG HOST config IP 140.109.177.215 DELETED!
HOST config IP 4.23.196.121 CONFIGURED SUCCESSFULLY!
SOURCE FILE /etc/ntp.conf BYTES READ: 1113
DEST FILE ./pub/ntp.conf BYTES WRITTEN: 1113!
SOURCE FILE /etc/ntp.keys BYTES READ: 39
DEST FILE ./pub/ntp.keys BYTES WRITTEN: 39!
```

3/1/05
31  Modify the server IP to 4.23.196.121 in the ntp.conf file in /var/ftp/pub.

32  Upload the ntp.conf to GPS by:
> f100 config ntp set host:4.23.196.121 dir:./pub

the message should likes this:

    HOST config IP 4.23.196.121 ALREADY CONFIGURED!
    SOURCE FILE ./pub/ntp.conf BYTES READ: 1112

    >DEST FILE /etc/ntp.conf BYTES WRITTEN: 1112!
    SOURCE FILE ./pub/ntp.keys BYTES READ: 39
    DEST FILE /etc/ntp.keys BYTES WRITTEN: 39!
    CONFIGURATION FILES TRANSFERRED SUCCESSFULLY!
    OK

    RESETING...

33  That will make the GPS rebooted.

34  For access the GPS in Mauna Loa:

    34.1 Linux> telnet 4.23.196.50

34.2 Key in the user as guest, password as truetime.

34.3 Hit enter to have command prompt.

34.4 Xli> F8    -to have continuous time stamp at one second interval.

34.5 Xli> F50 B3 LLA   -to show the position of where the GPS is.

34.6
Appendix I

NTP.conf file works in RedHat:

# Permit time synchronization with our time source, but do not
# permit the source to query or modify the service on this system.

restrict default nomodify notrap noquery

# Permit all access over the loopback interface. This could
# be tightened as well, but to do so would effect some of
# the administrative functions.
restrict 127.0.0.1

# -- CLIENT NETWORK -------
# Permit systems on this network to synchronize with this
# time service. Do not permit those systems to modify the
# configuration of this service. Also, do not use those
# systems as peers for synchronization.
# restrict 192.168.1.0 mask 255.255.255.0 nomodify notrap

# --- OUR TIMESERVERS ------
#server 213.134.172.184
#server 217.114.97.97
#server 193.170.141.4

# --- NTP MULTICASTCLIENT ---
#multicastclient     # listen on default 224.0.1.1
# restrict 224.0.1.1 mask 255.255.255.255 nomodify notrap
# restrict 192.168.1.0 mask 255.255.255.0 nomodify notrap

# --- GENERAL CONFIGURATION ---
#
# Undisciplined Local Clock. This is a fake driver intended for backup
# and when no outside source of synchronized time is available. The
# default stratum is usually 3, but in this case we elect to use stratum
# 0. Since the server line does not have the prefer keyword, this driver
# is never used for synchronization, unless no other other
# synchronization source is available. In case the local host is
# controlled by some external source, such as an external oscillator or
# another protocol, the prefer keyword would cause the local host to
# disregard all other synchronization sources, unless the kernel
# modifications are in use and declare an unsynchronized condition.
#
#server 127.127.1.0
peer 127.127.1.0
fudge 127.127.1.0 stratum 10

#
# Drift file. Put this in a directory which the daemon can write to.
# No symbolic links allowed, either, since the daemon updates the file
# by creating a temporary in the same directory and then rename("")ing
# it to the file.
#
driftfile /etc/ntp/drift
broadcastdelay 0.008
logfile /var/log/ntp.log
#
# Keys file. If you want to diddle your server at run time, make a
# keys file (mode 600 for sure) and define the key number to be
# used for making requests.
#
# PLEASE DO NOT USE THE DEFAULT VALUES HERE. Pick your own, or remote
# systems might be able to reset your clock at will. Note also that
# ntpd is started with a -A flag, disabling authentication, that
# will have to be removed as well.
#
keys /etc/ntp/keys
# restrict 213.134.172.184 mask 255.255.255.255 nomodify notrap noquery
# restrict 217.114.97.97 mask 255.255.255.255 nomodify notrap noquery
# restrict 193.170.141.4 mask 255.255.255.255 nomodify notrap noquery
server 140.109.1.4
restrict 140.109.1.4 mask 255.255.255.255 nomodify notrap noquery

server time.stdtime.gov.tw prefer
restrict time.stdtime.gov.tw mask 255.255.255.255 nomodify notrap noquery
server tock.stdtime.gov.tw prefer
restrict tock.stdtime.gov.tw mask 255.255.255.255 nomodify notrap noquery
server watch.stdtime.gov.tw prefer
restrict watch.stdtime.gov.tw mask 255.255.255.255 nomodify notrap noquery

server tick.stdtime.gov.tw prefer
restrict tick.stdtime.gov.tw mask 255.255.255.255 nomodify notrap noquery
statsdir /var/log/ntpstats/
statistics loopstats peerstats clockstats
filegen loopstats file loopstats type day enable
filegen peerstats file peerstats type day enable
filegen clockstats file clockstats type day enable
Appendix II

8.1. MONITORING

Without any doubt, troubleshooting requires monitoring. Somehow you must find out that something is wrong before you wonder how to fix it.

8.1.1. If I think my NTP server is working fine, what could I do to confirm this?

8.1.2. How do I use peerstats and loopstats?

8.1.3. How can I see the Time Difference between Client and Server?

8.1.4. What does 257 mean as value for reach?

8.1.5. What can I use these statistics files for?

8.1.1. If I think my NTP server is working fine, what could I do to confirm this?

One of the quickest commands to verify that ntpd is still up and running as desired is ntpq -p. That command will show all peers used and configured together with their corner performance data.

As the above command requires periodic invocation to monitor the performance, it is also recommended to enable statistic files in ntpd. See also Q: 8.1.2. and Q: 8.1.3.

8.1.2. How do I use peerstats and loopstats?

I use the following lines in /etc/ntp.conf to enable loopfilter statistics (See the line starting with statistics). New files are created every day, and the current files are available as /var/log/ntp/peers and /var/log/ntp/loops. Older files are archived as /var/log/ntp.peers.YYYYMMDD and /var/log/ntp.loops.YYYYMMDD:

```
statistics loopstats
statsdir /var/log/ntp/
filegen peerstats file peers type day link enable
filegen loopstats file loops type day link enable
```

Usually I only monitor the loops file. Table 3 lists the individual fields of each file. I'll show examples for peerstats and loopstats for version 3 and 4 in the following screens.

Table 3. Statistic Files

<table>
<thead>
<tr>
<th>File Type</th>
<th>Version</th>
<th>List of Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>loopstats</td>
<td>3</td>
<td>day, second, offset, drift compensation, polling interval</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>day, second, offset, drift compensation, estimated error, stability, polling interval</td>
</tr>
<tr>
<td>peerstats</td>
<td>3</td>
<td>day, second, address, status, offset, delay, dispersion</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>day, second, address, status, offset, delay, dispersion, skew (variance)</td>
</tr>
</tbody>
</table>

Offset=time offset(seconds)
drift compensation=frequency offset(PPM), refer to standard frequency:14.318MHz, no unit.
estimated error=jitter RMS(seconds)
stability=Allen deviation(PPM)
8.1.3. How can I see the Time Difference between Client and Server?

(By Terje Mathisen) Normally ntpd maintains an estimate of the time offset. To inspect these offsets, you can use the following commands:

- `ntpq -p` will display the offsets for each reachable server in milliseconds (ntpdc -p uses seconds instead).
- `ntpd -c loopinfo` will display the combined offset in seconds, as seen at the last poll. If supported, `ntpd -c kerninfo` will display the current remaining correction, just as ntptime does.

The first can be used to check what ntpd thinks the offset and jitter is currently, relative to the preferred/current server, the second can tell you something about the estimated offset/error all the way to the stratum 1 source. Q: 8.1.2. describes a way to collect such data automatically.

If a PPS source is active (see Q: 5.2.4.1. and Section 6.2.4), the offset displayed with the second choice is updated periodically, maybe every second.

Sometimes things are wrong and you may want to compare time offsets directly. An easy way is to use ntpdate -d server to compare the local system time with the time taken from server.

8.1.4. What does 257 mean as value for reach?

(inspired by Martin Burnicki) The value displayed in column reach is octal, and it represents the reachability register. One digit in the range of 0 to 7 represents three bits. The initial value of that register is 0, and after every poll that register is shifted left by one position. If the corresponding time source sent a valid response, the rightmost bit is set.

During a normal startup the registers values are these: 0, 1, 3, 7, 17, 37, 77, 177

Thus 257 in the dual system is 10101111, saying that two valid responses were not received during the last eight polls. However, the last four polls worked fine.

8.1.5. What can I use these statistics files for?

You can do a lot of useful things with statistic files before you remove them. For example there is a utility named summary.pl written in Perl to compute mean values and standard deviation (RMS) from the loopfilter and peer statistics. It will also show exceptional conditions found in these files. Here's a short example output (you could have used summary.pl --dir=/var/log/ntp --start=19990518 --end=19990604):

```
loops.19990518
loop 110, -30+/-36.5, rms 6.7, freq 14.95+/-1.149, var 0.612
loops.19990519
loop 113, -26+/-40.3, rms 6.9, freq 12.95+/-3.240, var 1.378
loops.19990520
loop 107, -7+/-32.0, rms 5.7, freq 13.04+/-3.253, var 1.579
loops.19990522
loop 190, 3+/-18.5, rms 2.9, freq 15.48+/-3.715, var 0.604
loops.19990523
loop 146, -5+/-9.2, rms 1.9, freq 15.77+/-0.716, var 0.305
loops.19990604
loop 73, -27+/-9.2, rms 6.9, freq 16.81+/-0.327, var 0.140
```

Still another utility named plot_summary.pl can be used to make plots with these summary data. As an alternative you could plot the loopfilter file directly with gnuplot[1] using the command plot "/var/log/ntp/loops" using 2:3 with linespoints. Figure 6 had been produced with a little more complicated command. It shows yerrorbars with the estimated errors for offset and frequency respectively.
Reference

1. True Time users manual and Reference, Xii Inc.