Managing Accurate Date and Time

Avi Alkalay

Brad Knowles – Suggestion to use pool.ntp.org and NTP's stratum 2 public time servers

Kent Borg – Suggestion to use ntpq instead of ntpdc

Yura Moron – Good explanations on ntpq and ntpdc info

Takeo Nakano –

SHAKI –

Mihaly Gyulai –

Philippe Wautelet –

Kemal Ã–kmen –

2005−11−18

Revision History

Revision 2005−11−18	18 Nov 2005	Revised by: Avi
Included link to turkish translation		
Revision 2005−10−12	12 Oct 2005	Revised by: Avi
The Brazil zic file is now external and updated		
Revision 2005−05−03	03 May 2005	Revised by: Avi
Included link to french translation		
Revision 1.0.8	2004−10−29	Revised by: Mihaly Gyulai
Hungarian translation, the chorny section and the very first section		
Revision 1.0.7	9 Jul 2004	Revised by: avi
Disclaimer near to license, to let people know they can translate without asking permission.Small fixes in some phrases.		
Revision 1.0.6	25 Feb 2004	Revised by: avi
Included credits and link to russian translation.		
Revision 1.0.5	05 Jul 2003	Revised by: avi
Changed public time servers list URL. Added pool.ntp.org.		
Revision 1.0.4	21 Dec 2002	Revised by: avi

Added japanese translation link and credits.

Revision 1.0.3	24 Aug 2002	Revised by: avi
Fixed wrong screen and programlisting widths.		
Revision 1.0.2	04 Aug 2002	Revised by: avi
Link to public time servers page.		
Revision 1.0.1	07 May 2002	Revised by: avi
Final XML conversion. Files reorganization.		
Revision 1.0	28 Apr 2002	Revised by: avi
Finalized image.		
Revision 0.8	27 Apr 2002	Revised by: avi
Switched from ntpdc example to ntpq, based on contributions.		
Revision 0.8.1	20 Apr 2002	Revised by: avi
Improved graphic. Links to other doc locations.		
Revision 0.8	14 Apr 2002	Revised by: avi
Beter tunning of NTP graphic.		
Revision 0.76	13 Apr 2002	Revised by: avi
Inclusion of architecture graphic.		
Revision 0.75	10 Apr 2002	Revised by: avi
Spell checked. Using DocBook XSLT 1.50.		
Revision 0.65	31 Mar 2002	Revised by: avi
Upgraded to XML 4.1.2 DocBook format		
Revision 0.6	29 Mar 2002	Revised by: avi
Finished timezone mechanism on Linux. Created appendix. Now only drawings are needed.		
Revision 0.4	24 Mar 2002	Revised by: avi
All skeleton defined. All command examples written.		
Revision 0.2	19 Mar 2002	Revised by: avi
First DocBook version		

Table of Contents

1. Why do We Need a Precise Clock?

If our computer never connects to other computers (or other devices that use a clock), the precision of the clock is not critical itself, it depends on the need of the user. However, programs that some way use the net are dependent on a precise date and time. Some examples, when you may need precise clock:

- Softwares that deal with transactions
- Commercial applications (e.g. eBay)
- Mail and messaging−related client and servers
- Websites that use cookies
- Distributed web applications
- Web services
- Distributed component−based applications as J2EE, .NET, etc
- Advanced modern and paralel filesystems, as AFS, DFS, GFS, GPFS, etc

And of course, to use the computer to adjust our wristwatch clock.

1.1. On What Factors Does the Hardware−Clock Depend?

Here we talk a little about the hardware−clock precision.

In PCs we find quartz−oscillators maintaining the hardware clock. The frequency of the oscillator is divided, and at the end we get a counter stepping once in one second (in reality it is more complicated, but now it's enough for us). The clock−oscillator runs even if the computer is switched off, so after starting the computer (and starting Linux) the hardware clock can give the values of the actual time. The stability of this clock is mostly dependent on the temperature of its surroundings, but it is also dependent on the air−pressure and the stability of the power supply voltage. The hardware clock is inaccurate in short term, however in the long term it shows a certain difference from the exact time. As we continously can compare the frequency of our hardware clock and an exact clock, we can calculate the frequency of the hardware clock and so to create the exact time. If this exact clock is inside your LAN (local area network), the accuracy of your Linux machine clock is within 0.01 sec. If you use the internet for this purpose, the accuracy of your clock will be within 0.2 sec regarding to the exact time.

2. Computer Global Date and Time Concept

To determine the current time for some planet region, a computer needs exactly this two informations:

1. Correct UTC (universal time as in Greenwich, but not GMT) time
2. Region's current Time Zone

For computers, there is also the hardware clock, which is used as a base by the OS to set its time.

OS date and time (we'll use only date *or* time from now on) is set on boot, by some script that reads the hardware clock, makes Time Zone calculations (there is no time zone data stored in BIOS) and sets the OS. After this synchronization, BIOS and OS time are independent from each other. So after a while they may have some seconds of difference. Which one is correct? If you don't make special configurations, none of them.

We'll discuss here how to make them both *globally 100% accurate*.

---

3. What are Time Zones?

Time Zones are a geographical world globe division of 15º each, starting at Greenwich, in England, created to help people know what time is it now in another part of the world.

Nowadays it is much more a political division than geographical, because sometimes people needs to have the same time as other people in not−so−far locations. And for energy savings reasons, we have today the Daylight Savings Time, that are also a Time Zone variation.

Time Zones are usually defined by your country government or some astronomical institute, and is represented by 3 or 4 letters. See Section 3.2 for examples.

Use the timezoneconverter.com to know what time is it now at any part of the globe.

3.1. Daylight Savings Time

For energy savings reasons, governments created the Daylight Savings Time. Our clocks are forwarded one hour, and this makes our days look longer. In fact, what really happens is only a Time Zone change. The primitive time (UTC) is still, and will allways be, the same.

Later we'll see how to enable and disable DST automatically in Linux.

3.2. Time Zones Examples

There is nothing better than examples:

Table 1. Brazilian Time Zones. Shifts relative to UTC

Name and Shift	DST Name and Shift	Locations
BREST −2:00	BREDT −1:00	Fernando de Noronha
BRST −3:00	BRDT −2:00	São Paulo, Rio, Brasilia, Minas Gerais, North East Region, South Region,etc
BRWST −4:00	BRWDT −3:00	West Region
BRAST −5:00	BRADT −4:00	Acre

Please send me contributions like this table for US Time Zones.

3.3. Time Zone Mechanism on Linux

Linux systems uses the GLIBC dynamic Time Zones, based on `/etc/localtime`. This file is a link to (or a copy of) a zone information file, usually located under `/usr/share/zoneinfo` directory.

From a geophysical perspective, there is only 360º/15º=24 Time Zones in the world. But to make things easy to people, and to accommodate all the political variations (like Daylight Savings Time), you'll find hundreds of zoneinfo files in `/usr/share/zoneinfo`, each for every world city, country, etc.

Some countries, like Brazil, don't have a fixed day to start Daylight Savings Time. It is defined every year, a couple of months before summer, and you may end up in a situation you'll have to change your zoneinfo file, which was compiled by **zic** from a text file like this.

Example 1. Brazilian Zone Info text file

```
# Brazil Time Zones
#
# Brazilian Time Zones are:
# BREST: East of Brasilia. Fernando de Noronha.
# BRST:  Brasilia, SÃ£o Paulo, Rio, Northeast, South etc
# BRWST: West of Brasilia. Mato Grosso, Manaus
# BRAST: Acre.
#
# In daylight saving time, letter 'S' changes to 'D'.
# All the brazilian daylight changes can be found here:
#   http://pcdsh01.on.br/
#   http://pcdsh01.on.br/verao1.html
#
# To install, make:
#
# # zic Brazil.txt
#
# Zone files will be installed in /usr/share/zoneinfo (depends on your
# distribution). Then, make a symbolic link from your zone to /etc/localtime:
#
# # cd /etc; ln -sf /usr/share/zoneinfo/Brazil/Brasilia localtime
#
#
# If you have updates and new standards to this file please send to
# Avi Alkalay (avi @ unix.sh)
# Fred Neves (fneves @ registro.br)
#
# Last update: 12 Oct 2005
#
#
# This file is available at
#
# http://avi.alkalay.net/software/zoneinfo/
#

# Rule  NAME    FROM    TO      TYPE    IN     ON      AT      SAVE    LETTER/S
Rule    Brazil  1931    1932    -       Oct     3      00:00   1:00    D
Rule    Brazil  1932    1933    -       Mar    31      00:00   0       S
Rule    Brazil  1949    only    -       Dec     1      00:00   1:00    D
Rule    Brazil  1950    only    -       Apr    30      00:00   0       S
Rule    Brazil  1950    1952    -       Dec     1      00:00   1:00    D
Rule    Brazil  1951    only    -       Apr    16      00:00   0       S
Rule    Brazil  1952    only    -       Mar    31      00:00   0       S
Rule    Brazil  1953    only    -       Feb    28      00:00   0       S
Rule    Brazil  1963    only    -       Oct    23      00:00   1:00    D
Rule    Brazil  1964    only    -       Mar     1      00:00   0       S
Rule    Brazil  1965    only    -       Jan    31      00:00   1:00    D
Rule    Brazil  1965    only    -       Mar    31      00:00   0       S
Rule    Brazil  1965    only    -       Dec     1      00:00   1:00    D
Rule    Brazil  1966    1968    -       Mar     1      00:00   0       S
Rule    Brazil  1966    1967    -       Nov     1      00:00   1:00    D
Rule    Brazil  1984    only    -       Nov     2      00:00   1:00    D
Rule    Brazil  1985    only    -       Mar    15      00:00   0       S
```

```
Rule    Brazil  1985    only    -       Nov    2      00:00   1:00    D
Rule    Brazil  1986    only    -       Mar   15      00:00   0       S
Rule    Brazil  1986    only    -       Oct   25      00:00   1:00    D
Rule    Brazil  1987    only    -       Feb   14      00:00   0       S
Rule    Brazil  1987    only    -       Oct   25      00:00   1:00    D
Rule    Brazil  1988    only    -       Feb    7      00:00   0       S
Rule    Brazil  1988    only    -       Oct   16      00:00   1:00    D
Rule    Brazil  1989    only    -       Jan   29      00:00   0       S
Rule    Brazil  1989    only    -       Oct   15      00:00   1:00    D
Rule    Brazil  1990    only    -       Feb   11      00:00   0       S
Rule    Brazil  1990    only    -       Oct   21      00:00   1:00    D
Rule    Brazil  1991    only    -       Feb   17      00:00   0       S
Rule    Brazil  1991    only    -       Oct   20      00:00   1:00    D
Rule    Brazil  1992    only    -       Feb    9      00:00   0       S
Rule    Brazil  1992    only    -       Oct   25      00:00   1:00    D
Rule    Brazil  1993    only    -       Jan   31      00:00   0       S
Rule    Brazil  1993    only    -       Oct   17      00:00   1:00    D
Rule    Brazil  1994    only    -       Feb   20      00:00   0       S
Rule    Brazil  1994    only    -       Oct   16      00:00   1:00    D
Rule    Brazil  1995    only    -       Feb   19      00:00   0       S
Rule    Brazil  1995    only    -       Oct   15      00:00   1:00    D
Rule    Brazil  1996    only    -       Feb   11      00:00   0       S
Rule    Brazil  1996    only    -       Oct   06      00:00   1:00    D
Rule    Brazil  1997    only    -       Feb   16      00:00   0       S
Rule    Brazil  1997    only    -       Oct   06      00:00   1:00    D
Rule    Brazil  1998    only    -       Mar   01      00:00   0       S
Rule    Brazil  1998    only    -       Oct   11      00:00   1:00    D
Rule    Brazil  1999    only    -       Feb   21      00:00   0       S
Rule    Brazil  1999    only    -       Oct    3      00:00   1:00    D
Rule    Brazil  2000    only    -       Feb   27      00:00   0       S
Rule    Brazil  2000    only    -       Oct    8      00:00   1:00    D
Rule    Brazil  2001    only    -       Feb   18      00:00   0       S
Rule    Brazil  2001    only    -       Oct   14      00:00   1:00    D
Rule    Brazil  2002    only    -       Feb   17      00:00   0       S
Rule    Brazil  2002    only    -       Nov    3      00:00   1:00    D
Rule    Brazil  2003    only    -       Feb   16      00:00   0       S
Rule    Brazil  2003    only    -       Oct   19      00:00   1       D
Rule    Brazil  2004    only    -       Feb   15      00:00   0       S
Rule    Brazil  2004    only    -       Nov    2      00:00   1       D
Rule    Brazil  2005    only    -       Feb   20      00:00   0       S
Rule    Brazil  2005    only    -       Oct   16      00:00   1       D
Rule    Brazil  2006    only    -       Feb   19      00:00   0       S



# Zone  NAME                           GMTOFF  RULES/SAVE    FORMAT  [UNTIL]
Zone    Brazil/DeNoronha               -2:00   Brazil        BRE%sT
Zone    posix/Brazil/DeNoronha         -2:00   Brazil        BRE%sT
Zone    right/Brazil/DeNoronha         -2:00   Brazil        BRE%sT

Zone    America/Sao_Paulo              -3:00   Brazil        BR%sT
Zone    America/Rio_de_Janeiro         -3:00   Brazil        BR%sT
Zone    America/Brasilia               -3:00   Brazil        BR%sT
Zone    posix/America/Sao_Paulo        -3:00   Brazil        BR%sT
Zone    posix/America/Rio_de_Janeiro   -3:00   Brazil        BR%sT
Zone    posix/America/Salvador         -3:00   Brazil        BR%sT
Zone    posix/America/Brasilia         -3:00   Brazil        BR%sT
Zone    posix/Brazil/Central           -3:00   Brazil        BR%sT
Zone    posix/Brazil/Brasilia          -3:00   Brazil        BR%sT
Zone    posix/Brazil/Sao_Paulo         -3:00   Brazil        BR%sT
Zone    posix/Brazil/Salvador          -3:00   Brazil        BR%sT
Zone    posix/Brazil/Rio_de_Janeiro    -3:00   Brazil        BR%sT
```

```
Zone    right/America/Sao_Paulo        -3:00   Brazil        BR%sT
Zone    right/America/Rio_de_Janeiro   -3:00   Brazil        BR%sT
Zone    right/America/Salvador         -3:00   Brazil        BR%sT
Zone    right/America/Brasilia         -3:00   Brazil        BR%sT
Zone    right/Brazil/Central           -3:00   Brazil        BR%sT
Zone    right/Brazil/Brasilia          -3:00   Brazil        BR%sT
Zone    right/Brazil/Sao_Paulo         -3:00   Brazil        BR%sT
Zone    right/Brazil/Salvador          -3:00   Brazil        BR%sT
Zone    right/Brazil/Rio_de_Janeiro    -3:00   Brazil        BR%sT
Zone    Brazil/Central                 -3:00   Brazil        BR%sT
Zone    Brazil/Brasilia                -3:00   Brazil        BR%sT
Zone    Brazil/Sao_Paulo               -3:00   Brazil        BR%sT
Zone    Brazil/Rio_de_Janeiro          -3:00   Brazil        BR%sT
Zone    Brazil/Salvador                -3:00   Brazil        BR%sT
Zone    Brazil/East                    -3:00   Brazil        BR%sT
Zone    posix/Brazil/East              -3:00   Brazil        BR%sT
Zone    right/Brazil/East              -3:00   Brazil        BR%sT

Zone    Brazil/West                    -4:00   Brazil        BRW%sT
Zone    Brazil/Manaus                  -4:00   Brazil        BRW%sT
Zone    Brazil/Rondonia                -4:00   Brazil        BRW%sT
Zone    Brazil/Roraima                 -4:00   Brazil        BRW%sT
Zone    Brazil/Mato_Grosso             -4:00   Brazil        BRW%sT
Zone    posix/Brazil/Manaus            -4:00   Brazil        BRW%sT
Zone    posix/Brazil/Mato_Grosso       -4:00   Brazil        BRW%sT
Zone    right/Brazil/Manaus            -4:00   Brazil        BRW%sT
Zone    right/Brazil/Mato_Grosso       -4:00   Brazil        BRW%sT
Zone    posix/America/Manaus           -4:00   Brazil        BRW%sT
Zone    right/America/Manaus           -4:00   Brazil        BRW%sT

Zone    Brazil/Acre                    -5:00   Brazil        BRA%sT
```

The **Rule** block defines the date and time we change the Time Zone, while in the **Zone** block we reference the **Rule** will manage it. Note that the **Zone** name is actually the file name under `/usr/share/zoneinfo` directory, and here we defined several different names for the same Time Zone, just to be easyer for people to find their zone.

This file's comments explains how to install these time zones, using the **zic** zoneinfo compiler (which already installs them also). To make it effective, you only have to link (or copy) the zoneinfo file to `/etc/localtime`. In some distributions, there is a higher level (and preferred) way to set the Time Zone, described in Section 4.1.

After making `/etc/localtime` pointing to the correct zoneinfo file, you are already under that zone rules and DST changes are automatic −− you don't have to change time manually.

The following command sequence shows Linux Time Zone mechanics dynamism. Note they were all issued in less than one minute:

```
bash$ ls -al /etc/localtime
lrwxrwxrwx  1 root root 35 May 22  2001 /etc/localtime -> /usr/share/zoneinfo/Brazil/Brasilia
bash$ date
Fri Mar 29 20:13:38 BRST 2002
bash# ln -sf /usr/share/zoneinfo/GMT /etc/localtime
bash$ date
Fri Mar 29 23:13:47 GMT 2002
bash# ln -sf /usr/share/zoneinfo/Brazil/Brasilia /etc/localtime
bash$ date
```

```
Fri Mar 29 20:14:03 BRST 2002
```

At 20:13, I was in my default brazilian Time Zone (BRST), then I switched to GMT and my system time changed to 23:13! When your Time Zone enters DST, you'll see a similar effect, but the rules are all inside your Time Zone (`/etc/localtime` link doesn't change like this example).

An application running in this machine (eg. web−server generating access logs) will feel this change, so it is very important for developers to remember that the full Time Concept is the current *time* plus current *Time Zone*, as described in Section 2.

In the end, I switched back to my correct Time Zone.

---

4. The Correct Settings for Your Linux Box

For any OS installation, you must know your Time Zone. This is expressed in terms of a city, a state or a country. You must also decide how to set BIOS time, and we may follow two strategies here:

Linux Only Machine
: In this case you should set BIOS time to UTC time. DST changes will be dynamically managed by Time Zone configurations.

Dual Boot Linux and MS Windows Machine
: Windows handles time in a more primitive way than Linux. For Windows, BIOS time is allways your local time, so DST changes are more aggressive because they directly change hardware clock. And since both Linux and Windows initially get and set time from the hardware, when they are together, Linux must handle it in the same way. So set BIOS time to your localtime.

4.1. Setting Time Zone

On Red Hat Linux and derived systems, you can set the hardware clock strategy and Time Zone using the **timeconfig** command, that shows a user−friendly dialog. You can also use it non−interactively:

Example 2. Time Configuration Tool

```
bash# timeconfig "Brasil/East"   # set HC to localtime, and TZ to "Brazil/East"
bash# timeconfig --utc "Brasil/East"   # set HC to UTC, and TZ to "Brazil/East"
```

Anyway, it changes `/etc/sysconfig/clock` file that is read at boot time. You can edit it by hand, and that is how it looks:

Example 3. `/etc/sysconfig/clock` file

```
ZONE="Brazil/East"
UTC=true
ARC=false
```

4.2. Setting the Hardware Clock

I encourage you to set your hardware clock only after understanding how to get accurate time, described on Section 5.

The **hwclock** command reads and sets the hardware clock, based on several options you give to it, documented in its man page. But you don't have to use it if you have a modern Linux distribution. After defining your hardware clock strategy and Time Zone, you can use the high level **setclock** command to correctly set your hardware clock. You don't need to pass any parameters because **setclock** intelligently calls **hwclock** to set the BIOS based on your OS current date and time. *So you should always use the **setclock** command.*

But if you are a minimalist and prefer hard work, here are some **hwclock** examples:

Example 4. setclock and hwclock usage

```
bash# setclock                                  # The easy way to set HC
bash# hwclock                                   # reads HC
bash# hwclock --systohc --utc                   # set HC with UTC time based on OS current time
bash# hwclock --systohc                         # set HC with local time based on OS current time
bash# hwclock --set --date "21 Oct 2004 21:17"  # set HC with time specified on string
```

Since the OS time is independent from the hardware clock, any BIOS change we make will take place in the next boot.

Another option to change HC is rebooting and accessing your computer BIOS screens. On IBM e−server zSeries platforms you'll have to do it on z/VM level, because Linux here runs on virtual machines created by z/VM.

5. Accurate Global Time Synchronization

To have accurate time in all your systems is as important as having a solid network security strategy (achieved by much more than simple firewall boxes). It is one of the primary components of a system administration based on good practices, which leads to organization and security. Specially when administering distributed applications, web−services, or even a distributed security monitoring tool, accurate time is a must.

5.1. NTP: The Network Time Protocol

We won't discuss here the protocol, but how this wonderful invention, added to the pervasivenes of the Internet, can be useful for us. You can find more about it at www.ntp.org.

Once your system is properly setup, NTP will manage to keep its time accurate, making very small adjustments to not impact the running applications.

People can get exact time using hardware based on atom's electrons frequency. There is also a method based on GPS (Global Positioning System). The first is more accurate, but the second is pretty good also. Atomic clocks require very special and expensive equipment, but their maintainers (usually universities and research labs) connect them to computers, that run an NTP daemon, and some of them are connected to the Internet, that finally let us access them for free. And this is how we'll synchronize our systems.

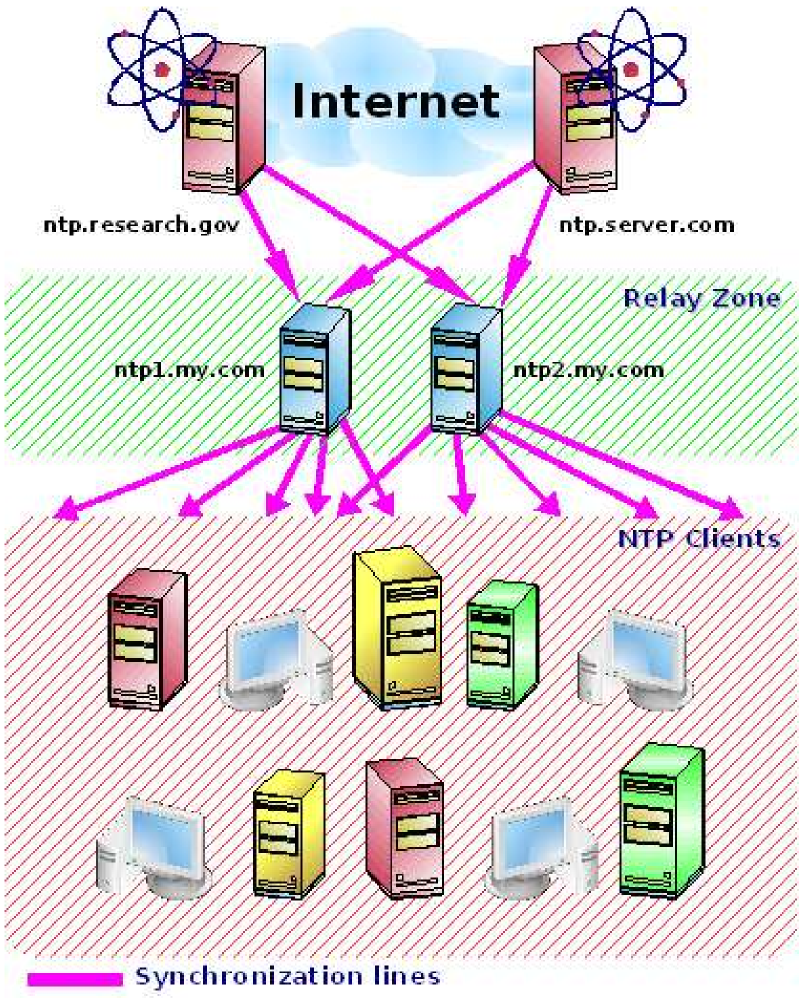
5.2. Building a Simple Time Synchronization Architecture

You will need:

1. A direct or indirect (through a firewall) connection to the Internet.
2. Choose some NTP servers. You can use the public server pool.ntp.org, or choose some from the stratum 2 public time servers on NTP website. If you don't have an Internet access, your WAN administrator (must be a clever guy) can provide you some internal addresses.
3. Have the NTP package installed in all systems you want to synchronize. You can find RPMs in your favorite Linux distribution CD, or make a search on rpmfind.net.

Here is an example of good architecture:

Figure 1. Local Relay Servers for NTP



If you have several machines to synchronize, *do not* make them all access the remote NTP servers you chose. Only 2 of your server farm's machines must access remote NTP servers, and the other machines will sync with these 2. We will call them the *Relay Servers*.

Your Relay Servers can be any machine already available in your network. NTP consumes low memory and CPU. You don't need a dedicated machine for it.

It is a good idea to create hostname aliases for your local Relay Servers like ntp1.my.com and ntp2.my.com, and use only these names when configuring the client machines. This way you can move the NTP functionality to a new Relay Server (with a different IP and hostname), without having to reconfigure the clients. Ask your DNS administrator to create such aliases.

5.3. NTP Configurations

For Your Relay Servers

Edit `/etc/ntp.conf` and add the remote servers you chose:

Example 5. Relay machines' `/etc/ntp.conf`

```
.
.
server  otherntp.server.org     # A stratum 1 server at server.org
server  ntp.research.gov        # A stratum 2 server at research.gov
.
.
```

Again, you can use the public server pool.ntp.org, or get a list of public stratum 2 time servers from NTP website.

For Your Clients

Edit `/etc/ntp.conf` and add your Relay Servers with a standard name:

Example 6. Client machines' `/etc/ntp.conf`

```
.
.
server  ntp1.my.com             # My first local relay
server  ntp2.my.com             # My second local relay
.
.
```

If your machine has a UTC time difference bigger than some minutes comparing to the NTP servers, NTP will not work. So you must do a first full sync, and I recommend you to do it in a non–production hour. You need to do it only when you are making the initial NTP setup. Never more:

Example 7. First sync

```
bash# ntpdate otherntp.research.gov❶
24 Mar 18:16:36 ntpdate[10254]: step time server 200.100.20.10 offset -15.266188 sec
bash# ntpdate otherntp.research.gov❷
24 Mar 18:16:43 ntpdate[10255]: adjust time server 200.100.20.10 offset -0.000267 sec
```

❶ First full sync. We were 15 seconds late.

❷ Second full sync, just to be sure. Now we are virtually 0 seconds late, which is good.

The last step is to start or restart the NTP daemons in each machine:

```
bash# service ntpd restart
```

5.4. Watching Your Box Synchronizing

Now you have everything setup. NTP will softly keep your machine time synchronized. You can watch this process using the NTP Query (**ntpq** command):

Example 8. A time synchronization status

```
bash# ntpq -p
     remote           refid      st t when poll reach   delay   offset  jitter
==============================================================================
```

```
-jj.cs.umb.edu   gandalf.sigmaso  3 u   95 1024  377   31.681  -18.549   1.572
 milo.mcs.anl.go ntp0.mcs.anl.go  2 u  818 1024  125   41.993  -15.264   1.392
-mailer1.psc.edu ntp1.usno.navy.  2 u  972 1024  377   38.206   19.589  28.028
-dr-zaius.cs.wis ben.cs.wisc.edu  2 u  502 1024  357   55.098    3.979   0.333
+taylor.cs.wisc. ben.cs.wisc.edu  2 u  454 1024  347   54.127    3.379   0.047
-ntp0.cis.strath harris.cc.strat  3 u  507 1024  377  115.274   -5.025   1.642
*clock.via.net   .GPS.            1 u  426 1024  377  107.424   -3.018   2.534
 ntp1.conectiv.c 0.0.0.0         16 u    - 1024    0    0.000    0.000 4000.00
+bonehed.lcs.mit .GPS.            1 u  984 1024  377   25.126    0.131  30.939
-world.std.com   204.34.198.40    2 u  119 1024  377   24.229   -6.884   0.421
```

The meaning of each column

remote
: Is the name of the remote NTP server. If you use the `-n` switch, you will see the IP addresses of these servers instead of their hostnames.

refid
: Indicates where each server is getting its time right now. It can be a server hostname or something like .GPS., indicating a Global Positioning System source.

st
: *Stratum* is a number from 1 to 16, to indicate the remote server precision. 1 is the most accurate, 16 means 'server unreachable'. Your Stratum will be equal to the accurate remote server plus 1. Never connect to a Stratum 1 server, use Stratum 2 servers! Stratum 2 servers are also good for our purposes, and this policy is good for reducing the traffic to the Stratum 1 servers.

poll
: The polling interval (in seconds) between time requests. The value will range between the minimum and maximum allowed polling values. Initially the value will be smaller to allow synchronization to occur quickly. After the clocks are 'in sync' the polling value will increase to reduce network traffic and load on popular time servers.

reach
: This is an octal representation of an array of 8 bits, representing the last 8 times the local machine tried to reach the server. The bit is set if the remote server was reached.

delay
: The amount of time (seconds) needed to receive a response for a "what time is it" request.

offset
: The most important value. The difference of time between the local and remote server. In the course of synchronization, the offset time lowers down, indicating that the local machine time is getting more accurate.

jitter
: Dispersion, also called Jitter, is a measure of the statistical variance of the offset across several successive request/response pairs. Lower dispersion values are preferred over higher dispersion values. Lower dispersions allow more accurate time synchronization.

The meaning of the signs before server hostname

–
: Means the local NTP service doesn't like this server very much

+
: Means the local NTP service likes this server

x
: Marks a bad host

*

Indicates the current favorite

5.5. Configure to Automatically Run NTP at Boot

You may want to have NTP running all the time even if you reboot your machine. On each machine, do the following:

```
bash# chkconfig --level 2345 ntpd on
```

This will ensure autostart.

If your machine is up and running for a long time (months, years) without rebooting, you'll find a big discrepancy between the inaccurate hardware clock and the (now very accurate) system time. Modern Linux distributions copy OS time to the HC everytime the system is shutdown, using a mechanism similar to the **setclock** command. This way, in the next OS boot, you'll get date and time almost as accurate as it was when you shutdown the machine.

6. Precise Time with the chrony Program

6.1. How chrony Differs from the ntp Suite?

chrony also uses the NTP protocol, and is also designed to make Linux clock more accurate. It is also suitable for systems that do not have an Internet connection. Then the source of the exact time can be any accurate clock, from which we can read the time and type it to the program. In addition, it is also capable of calculating the inaccuracy of the hardware clock, and based on that, adjust the hardware clock at boot time.

chrony 1.20 does not support built−in hardware clocks like GPS and DCF receivers, but the structure of the program makes such development possible.

6.2. How to Use chrony?

chrony consists of two parts: **chronyd** daemon and a user interface **chronyc**.

You can find **chrony** at chrony.sunsite.dk/index.php

A. About this Document

This document is published in the following locations:

- Official site [XML (DocBook) Source]
- TLDP, as a HOWTO [single page] [PDF]
- Philippe Wautelet <p.wautelet fractalzone.be> french translation [XML (DocBook) Source]
- Takeo Nakano <nakano at apm.seikei.ac.jp> japanese translation [txt version]
- SHAKI <sha−ki at narod.ru> russian translation
- Mihaly Gyulai <gyulai kukac fbi pont hu> Hungarian translation − magyar forditas
- Kemal Ã–kmen <kemal AT comu edu tr> Turkish translation − TÃ¼rkÃ§e Ã§eviri

When translating, feel free to change all brazilian−related configuration examples to your country's. And please send me an e−mail containing the translator's name, e−mail address, the language that this doc was translated to, the phrase "[YOUR LANGUAGE] translation" in your language, all UTF−8 encoded. This way I can put, in the original document, in your language, a link to your translation. Also, please let the TLDP folks be aware of your translation, so they can add it to the collection of HOWTOs in your language.