Network Time Protocol

Introduction and Demonstration of NTP Server

Source: The linux man : https://youtu.be/EkQPkQb2D3g

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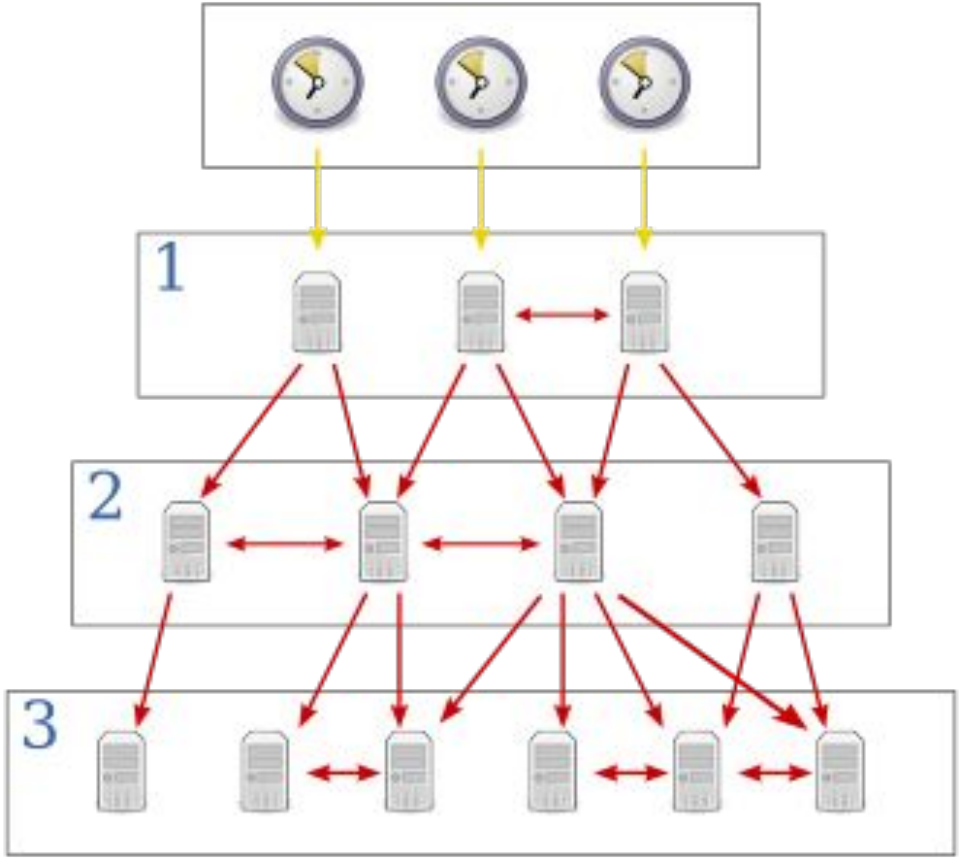
NTP was designed by David L. Mills [1979].

What is NTP ?

NTP stands for *Network Time Protocol*, and it is an *Internet* protocol used to synchronize the clocks of computers to some time reference.

NTP is an *Internet* standard protocol originally developed by Professor David L. Mills at the University of Delaware.

The U.S. Naval Observatory Alternate Master Clock at Schriever AFB (Colorado) is a stratum 0 source for NTP



Yellow arrows indicate a direct connection; red arrows indicate a network connection.

Clock Strata

NTP uses a hierarchical, semi-layered system of time sources. Each level of this hierarchy is termed a *stratum* and is assigned a number starting with zero for the reference clock at the top. A server synchronized to a stratum *n* server runs at stratum *n* + 1. The number represents the distance from the reference clock and is used to prevent cyclical dependencies in the hierarchy. Stratum is not always an indication of quality or reliability; it is common to find stratum 3 time sources that are higher quality than other stratum 2 time sources.[a] A brief description of strata 0, 1, 2 and 3 is provided below.

Stratum 0

These are high-precision timekeeping devices such as atomic clocks, GPS or other radio clocks. They generate a very accurate pulse per second signal that triggers an interrupt and timestamp on a connected computer. Stratum 0 devices are also known as reference clocks. NTP servers cannot advertise themselves as stratum 0. A stratum field set to 0 in NTP packet indicates an unspecified stratum.[25]

Stratum 1 and Stratum 2

Stratum 1

These are computers whose system time is synchronized to within a few microseconds of their attached stratum 0 devices. Stratum 1 servers may peer with other stratum 1 servers for sanity check and backup.[26] They are also referred to as primary time servers.[2][3]

Stratum 2

These are computers that are synchronized over a network to stratum 1 servers. Often a stratum 2 computer queries several stratum 1 servers. Stratum 2 computers may also peer with other stratum 2 computers to provide more stable and robust time for all devices in the peer group.

Stratum 3

Stratum 3

> These are computers that are synchronized to stratum 2 servers. They employ the same algorithms for peering and data sampling as stratum 2, and can themselves act as servers for stratum 4 computers, and so on.

The upper limit for stratum is 15; stratum 16 is used to indicate that a device is unsynchronized. The NTP algorithms on each computer interact to construct a Bellman-Ford shortest-path spanning tree, to minimize the accumulated round-trip delay to the stratum 1 servers for all the clients.

In addition to stratum, the protocol is able to identify the synchronization source for each server in terms of reference identifier (refid).

Why should Time be synchronized?

Time usually just advances. If you have communicating programs running on different computers, time still should even advance if you switch from one computer to another. Obviously if one system is ahead of the others, the others are behind that particular one. From the perspective of an external observer, switching between these systems would cause time to jump forward and back, a non-desirable effect.

As a consequence, isolated networks may run their own wrong time, but as soon as you connect to the *Internet*, effects will be visible. Just imagine some EMail message arrived five minutes before it was sent, and there even was a reply two minutes before the message was sent.

Even on a single computer some applications have trouble when the time jumps backwards. For example, database systems using transactions and crash recovery like to know the time of the last good state.

Therefore, air traffic control was one of the first applications for NTP.

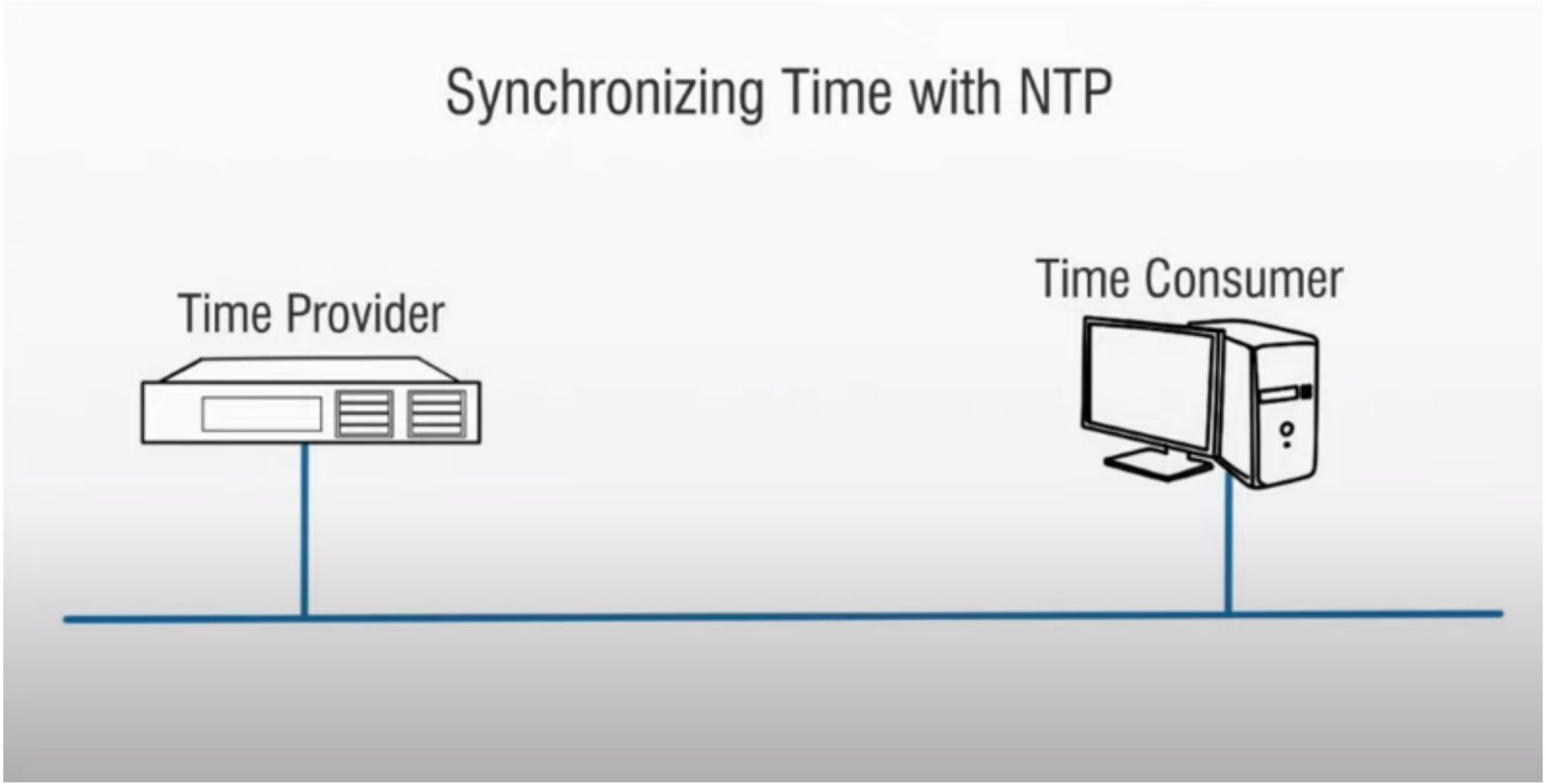
What are the basic features of NTP?

There exist several protocols to synchronize computer clocks, each having distinguished features. Here is a list of NTP's features:

- NTP needs some *reference clock* that defines the *true time* to operate. All clocks are set towards that *true time*. (It will not just make all systems agree on *some* time, but will make them agree upon the *true time* as defined by some standard.)
  NTP uses UTC as reference time (See also *What is UTC?*).
- NTP is a fault-tolerant protocol that will automatically select the best of several available time sources to synchronize to. Multiple candidates can be combined to minimize the accumulated error. Temporarily or permanently insane time sources will be detected and avoided.
- NTP is highly scalable: A synchronization network may consist of several *reference clocks*. Each node of such a network can exchange time information either bidirectional or unidirectional. Propagating time from one node to another forms a hierarchical graph with *reference clocks* at the top.
- Having available several time sources, NTP can select the best candidates to build its estimate of the current time. The protocol is highly accurate, using a resolution of less than a nanosecond (about 2^-32 seconds). (The popular protocol used by `rdate` and defined in [RFC 868] only uses a resolution of one second).
- Even when a network connection is temporarily unavailable, NTP can use measurements from the past to estimate current time and error.
- For formal reasons NTP will also maintain estimates for the accuracy of the local time.

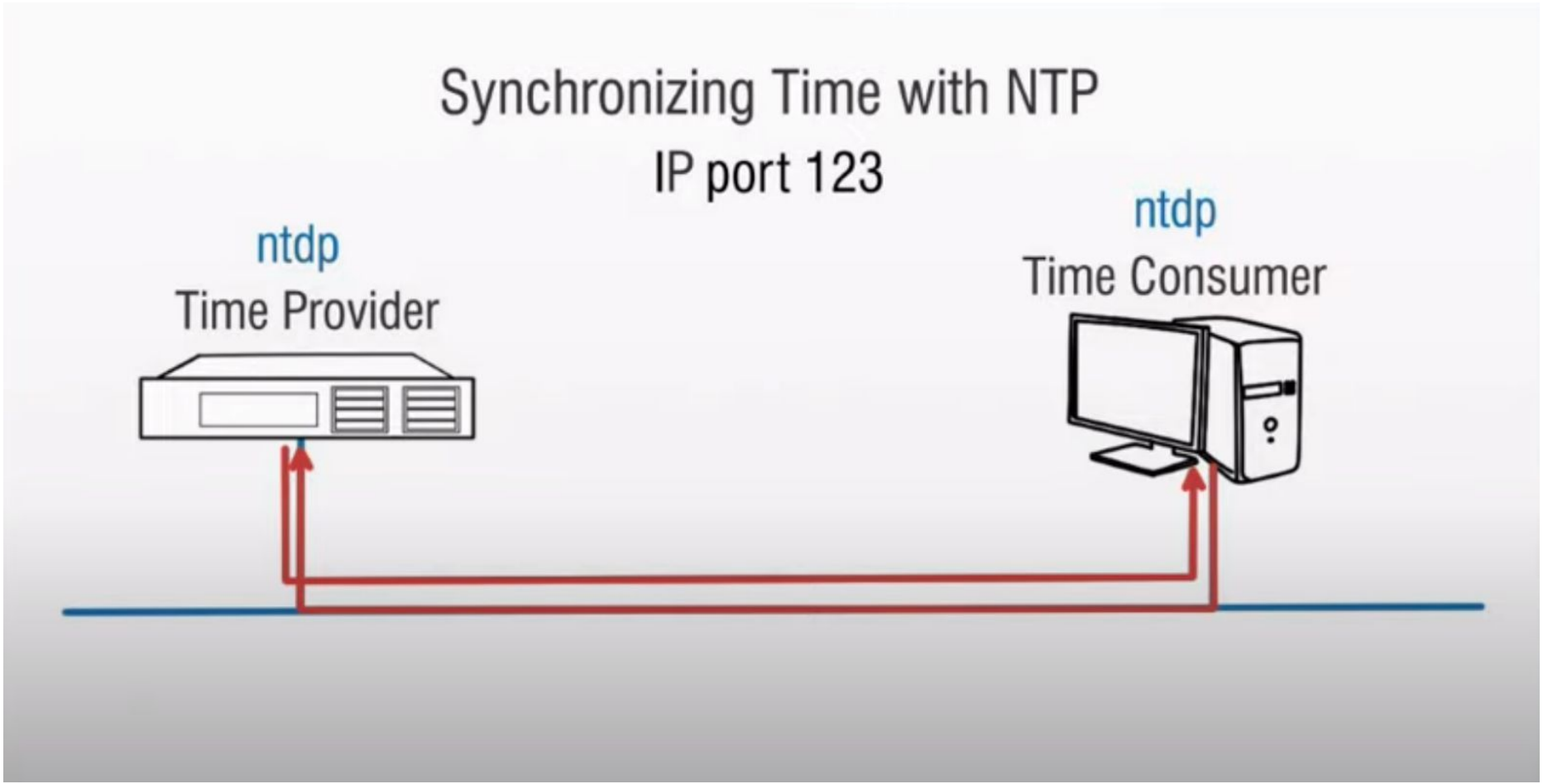
Demonstration [Installation of NTP server]

Synchronizing Time with NTP

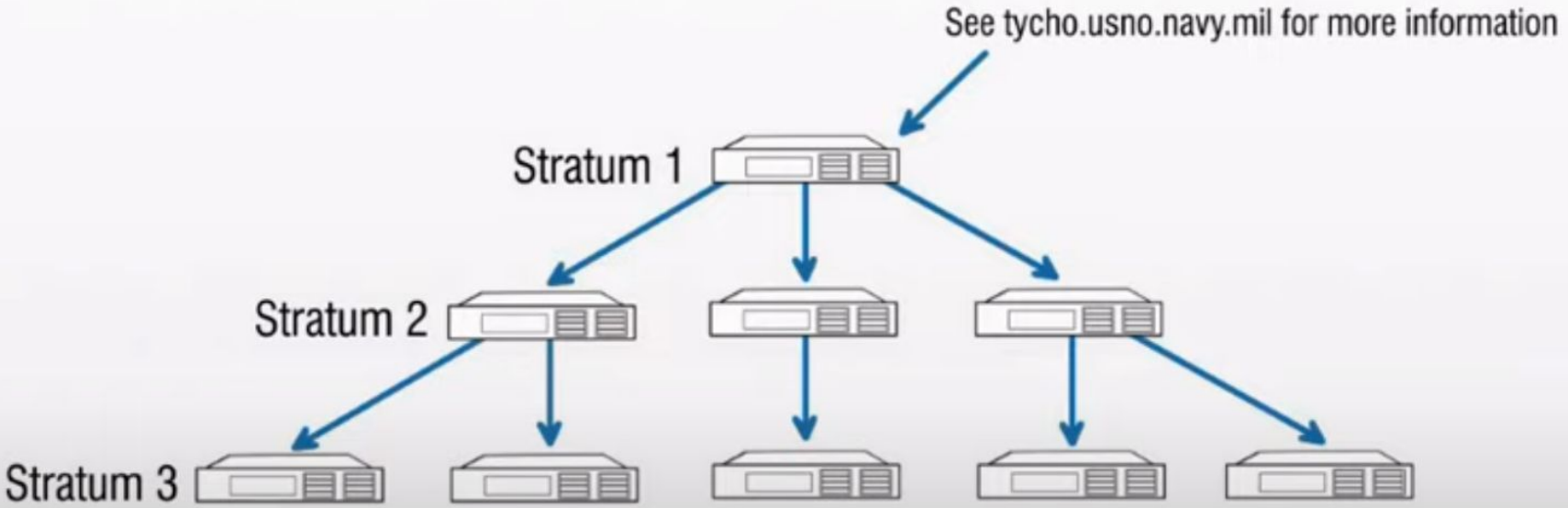


Synchronizing Time with NTP

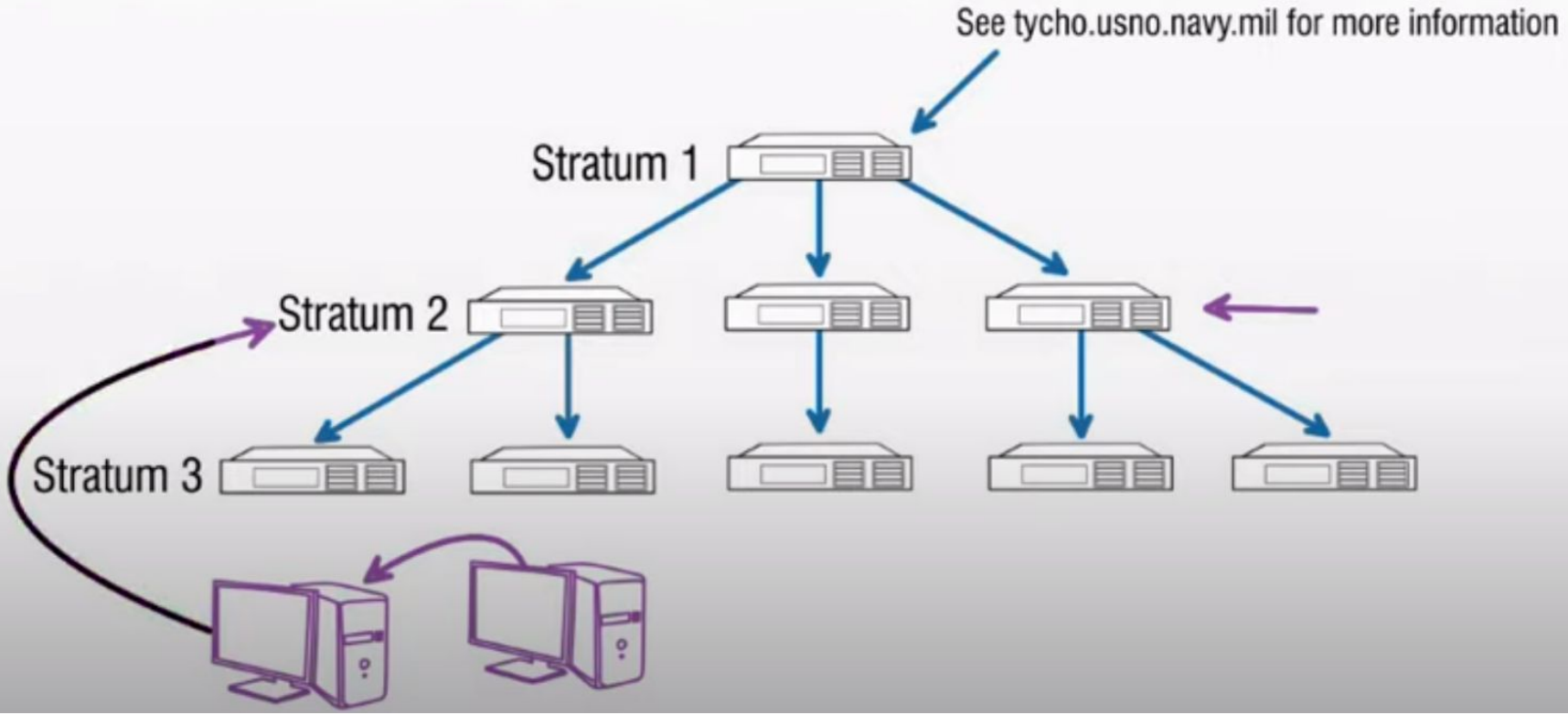
IP port 123



NTP Stratum


See tycho.usno.navy.mil for more information
Stratum 1
Stratum 2
Stratum 3

NTP Stratum


See tycho.usno.navy.mil for more information
Stratum 1
Stratum 2
Stratum 3

NTP Concepts

- Stepping
- Slewing

Initially: Once every minute
Later: Once every 17 minutes

128 ms

- Insane time > 17 minutes
- Drift ←
- Jitter ←

/etc/ntp.conf

- Syntax: server time_server_address
- Example: server pool.ntp.org

Initial Time Synchronization

- Syntax: ntpdate time_provider_address

```
[root@fs5 etc]# ntpdate pool.ntp.org
27 Oct 09:18:00 ntpdate[3053]: adjust time server 129.6.15.30 offset 0.002459 sec
```

Monitoring Time Synchronization

```
[root@fs5 etc]# ntpq -p
     remote           refid      st t when poll reach   delay   offset  jitter
==============================================================================
+vimo.dorui.net  209.51.161.238   2 u   10   64  377   65.341  -13.123   4.908
*time-b.timefreq .ACTS.           1 u   11   64  377   27.818  -12.278   5.287
+clock1.alb1.ino .CDMA.           1 u    7   64  377   68.468  -12.429   3.845
-mirror          173.230.149.23   3 u    8   64  377   84.308  -11.351   2.707
```

Monitoring Time Synchronization

```
[root@fs5 etc]# ntptrace
localhost.localdomain: stratum 2, offset 0.000000, synch distance 0.013909
```

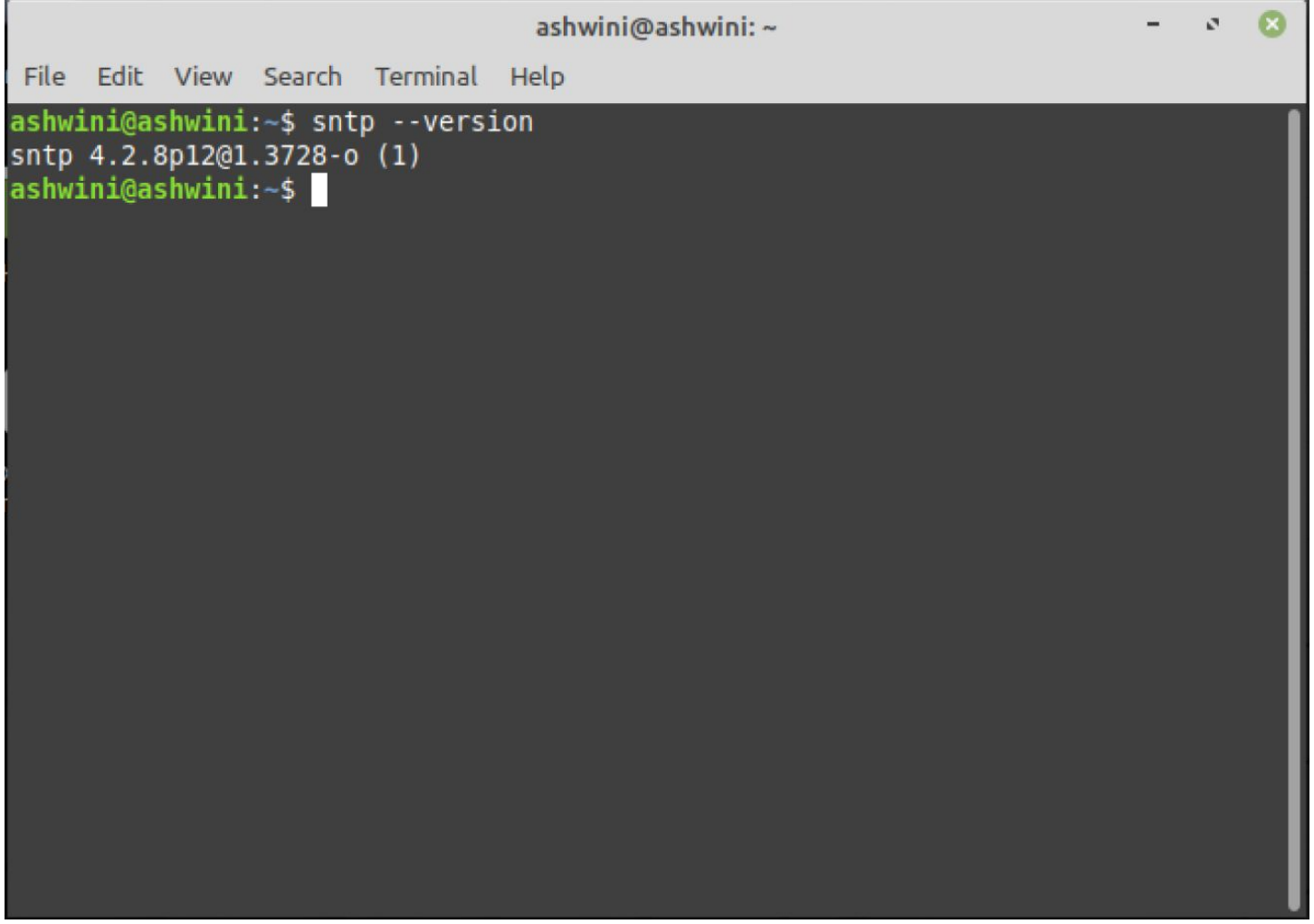
Demonstration in Ubuntu Machine

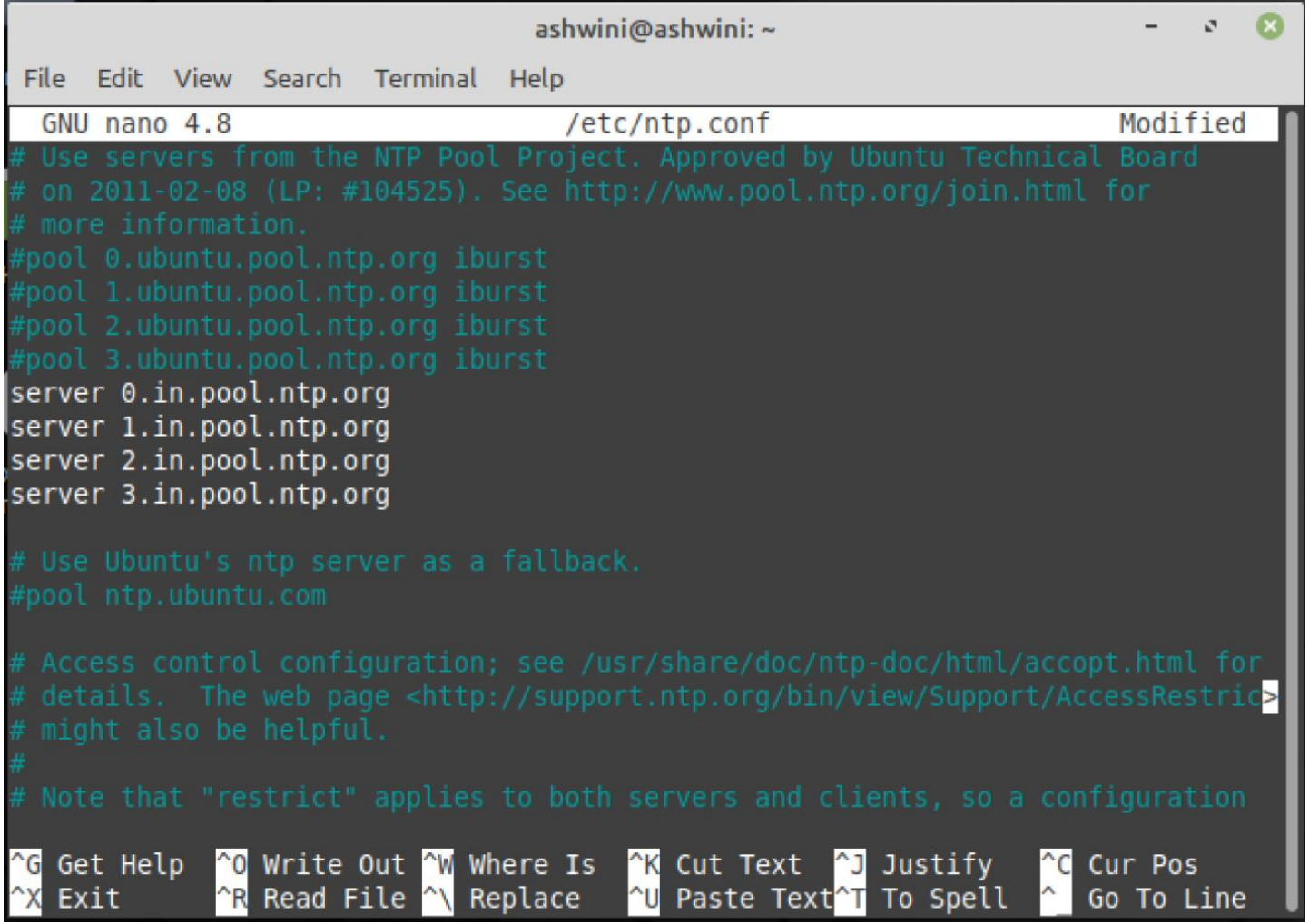
Installation of NTP package

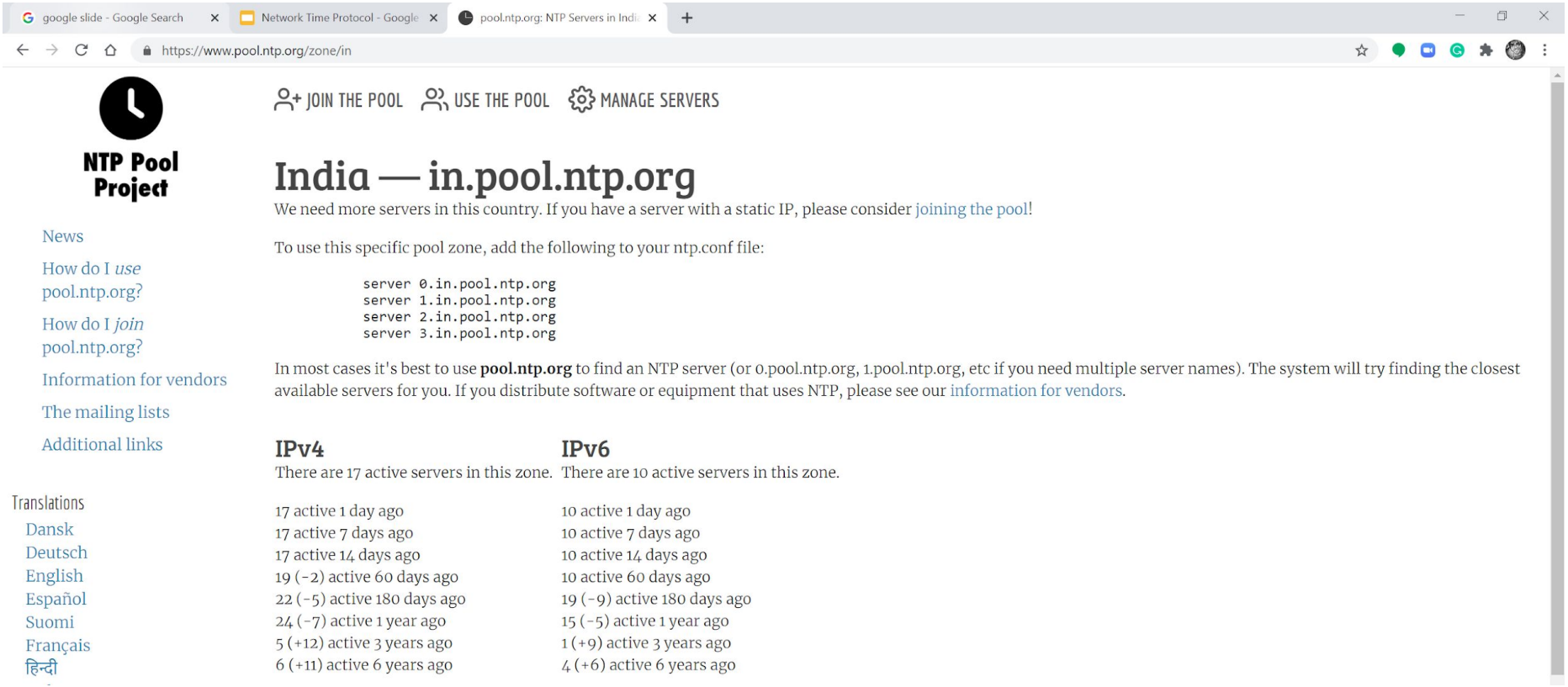
1 . sudo apt-get update

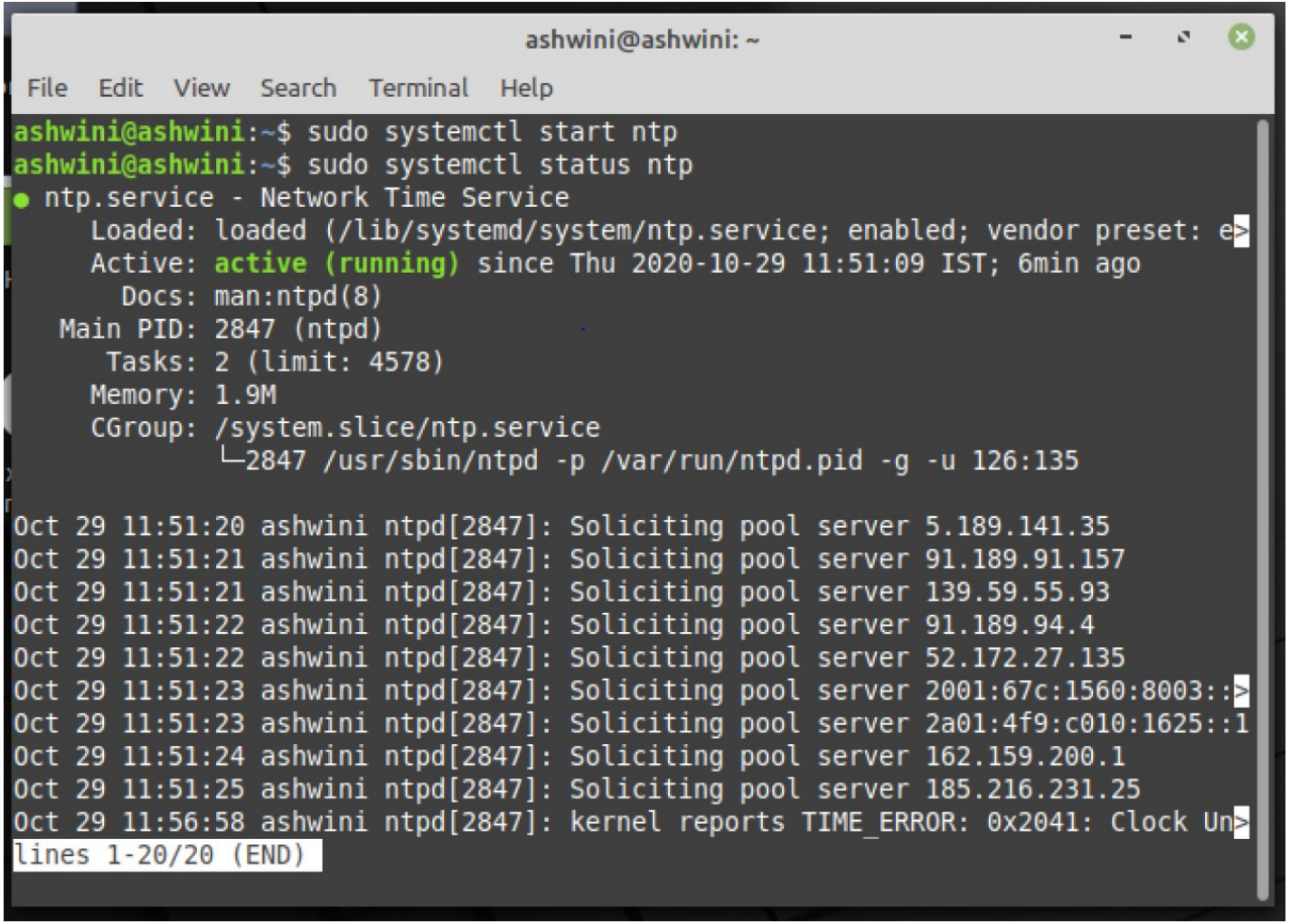
2. sudo apt-get install ntp

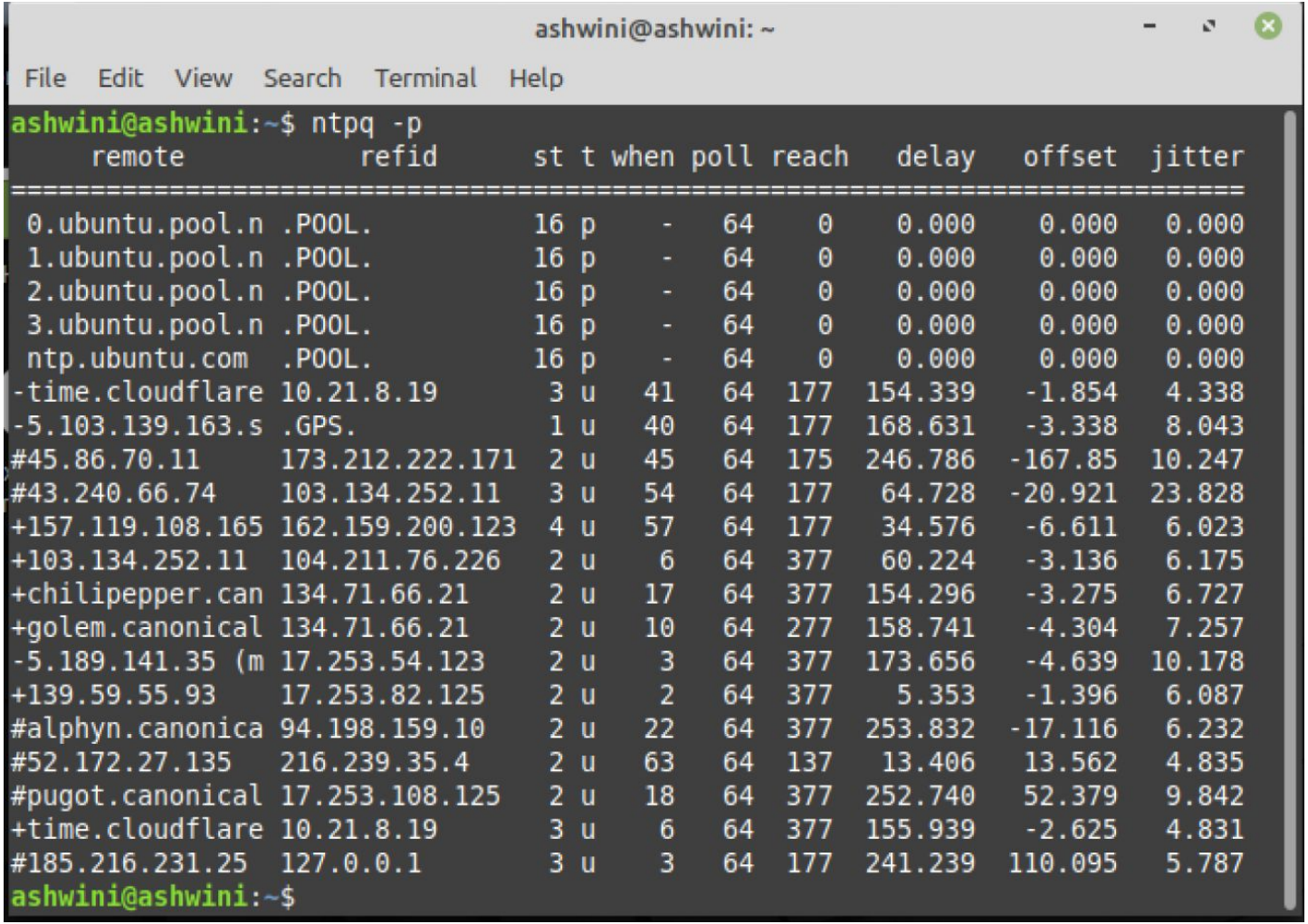
3. Sntp --version

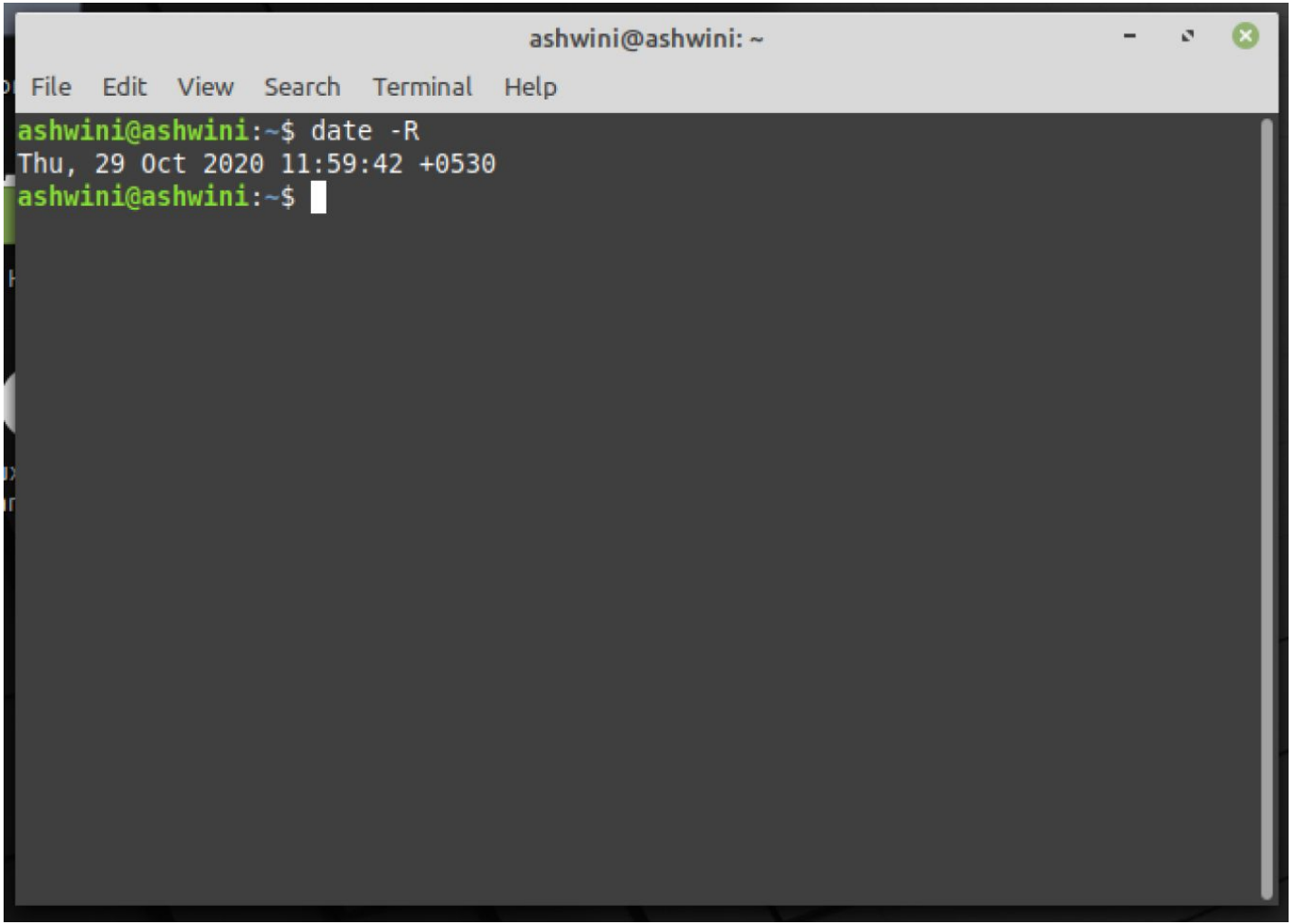

ashwini@ashwini: ~
File Edit View Search Terminal Help
ashwini@ashwini:~$ sntp --version
sntp 4.2.8p12@1.3728-o (1)
ashwini@ashwini:~$

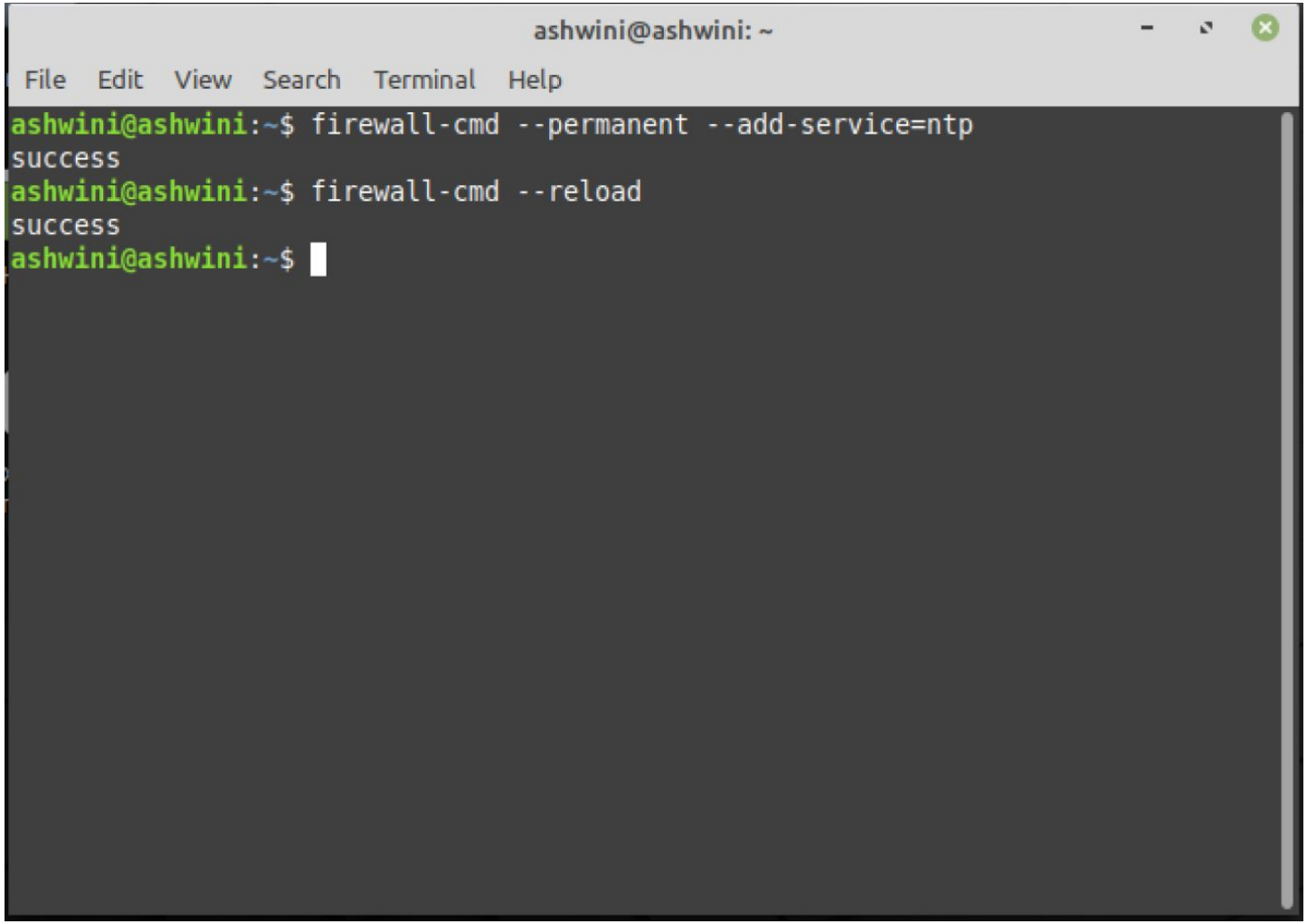

ashwini@ashwini: ~
File Edit View Search Terminal Help
GNU nano 4.8 /etc/ntp.conf Modified
Use servers from the NTP Pool Project. Approved by Ubuntu Technical Board
on 2011-02-08 (LP: #104525). See http://www.pool.ntp.org/join.html for
more information.
#pool 0.ubuntu.pool.ntp.org iburst
#pool 1.ubuntu.pool.ntp.org iburst
#pool 2.ubuntu.pool.ntp.org iburst
#pool 3.ubuntu.pool.ntp.org iburst
server 0.in.pool.ntp.org
server 1.in.pool.ntp.org
server 2.in.pool.ntp.org
server 3.in.pool.ntp.org
Use Ubuntu's ntp server as a fallback.
#pool ntp.ubuntu.com
Access control configuration; see /usr/share/doc/ntp-doc/html/accopt.html for
details. The web page <http://support.ntp.org/bin/view/Support/AccessRestric>
might also be helpful.
#
Note that "restrict" applies to both servers and clients, so a configuration
^G Get Help ^O Write Out ^W Where Is ^K Cut Text ^J Justify ^C Cur Pos
^X Exit ^R Read File ^\ Replace ^U Paste Text ^T To Spell ^_ Go To Line

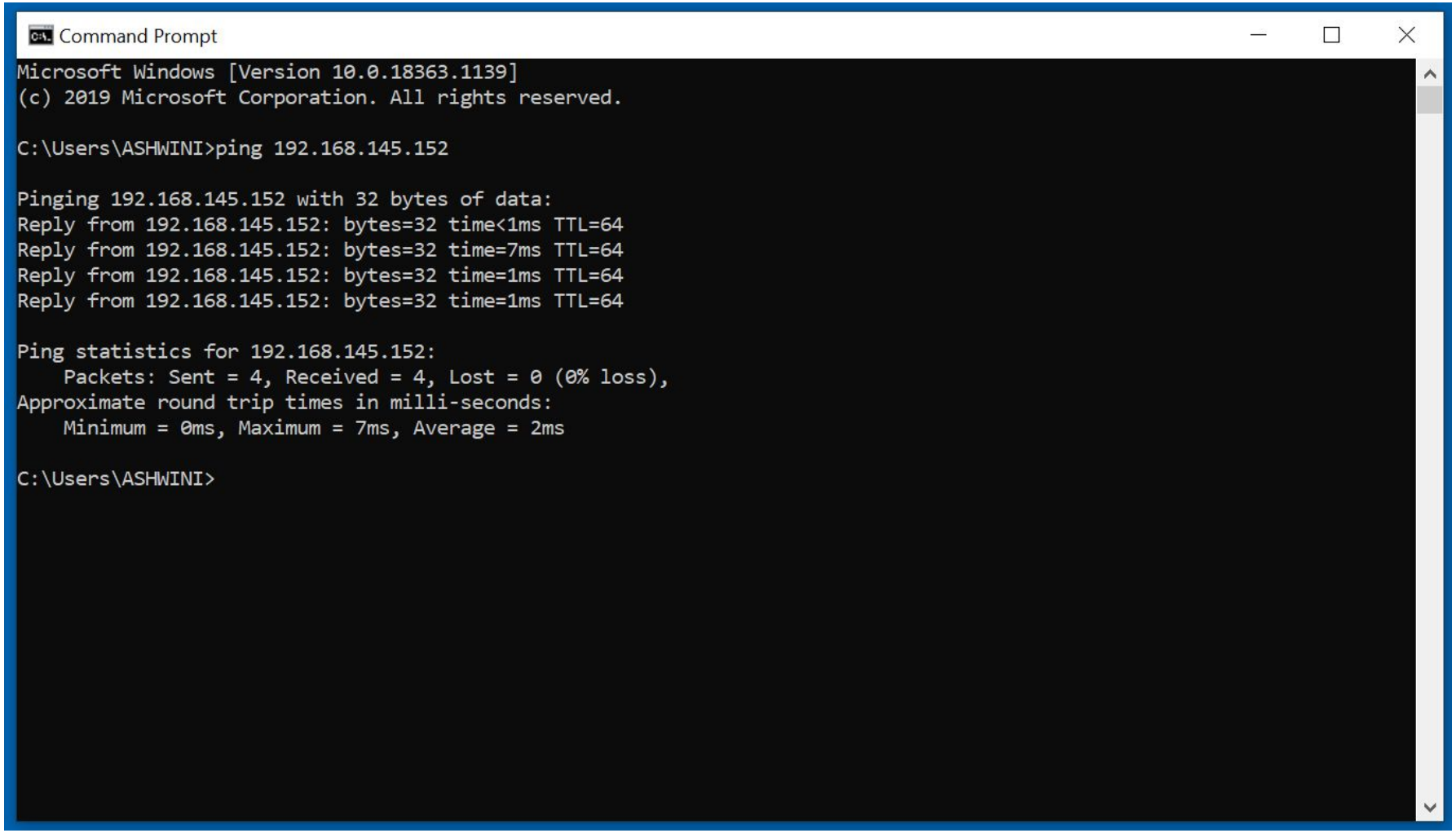

google slide - Google Search
Network Time Protocol - Google
pool.ntp.org: NTP Servers in Indi
https://www.pool.ntp.org/zone/in
JOIN THE POOL
USE THE POOL
MANAGE SERVERS
NTP Pool Project
News
How do I use pool.ntp.org?
How do I join pool.ntp.org?
Information for vendors
The mailing lists
Additional links
Translations
Dansk
Deutsch
English
Español
Suomi
Français
हिन्दी
India — in.pool.ntp.org
We need more servers in this country. If you have a server with a static IP, please consider joining the pool!
To use this specific pool zone, add the following to your ntp.conf file:
server 0.in.pool.ntp.org
server 1.in.pool.ntp.org
server 2.in.pool.ntp.org
server 3.in.pool.ntp.org
In most cases it's best to use pool.ntp.org to find an NTP server (or 0.pool.ntp.org, 1.pool.ntp.org, etc if you need multiple server names). The system will try finding the closest available servers for you. If you distribute software or equipment that uses NTP, please see our information for vendors.
IPv4
There are 17 active servers in this zone.
17 active 1 day ago
17 active 7 days ago
17 active 14 days ago
19 (-2) active 60 days ago
22 (-5) active 180 days ago
24 (-7) active 1 year ago
5 (+12) active 3 years ago
6 (+11) active 6 years ago
IPv6
There are 10 active servers in this zone.
10 active 1 day ago
10 active 7 days ago
10 active 14 days ago
10 active 60 days ago
19 (-9) active 180 days ago
15 (-5) active 1 year ago
1 (+9) active 3 years ago
4 (+6) active 6 years ago

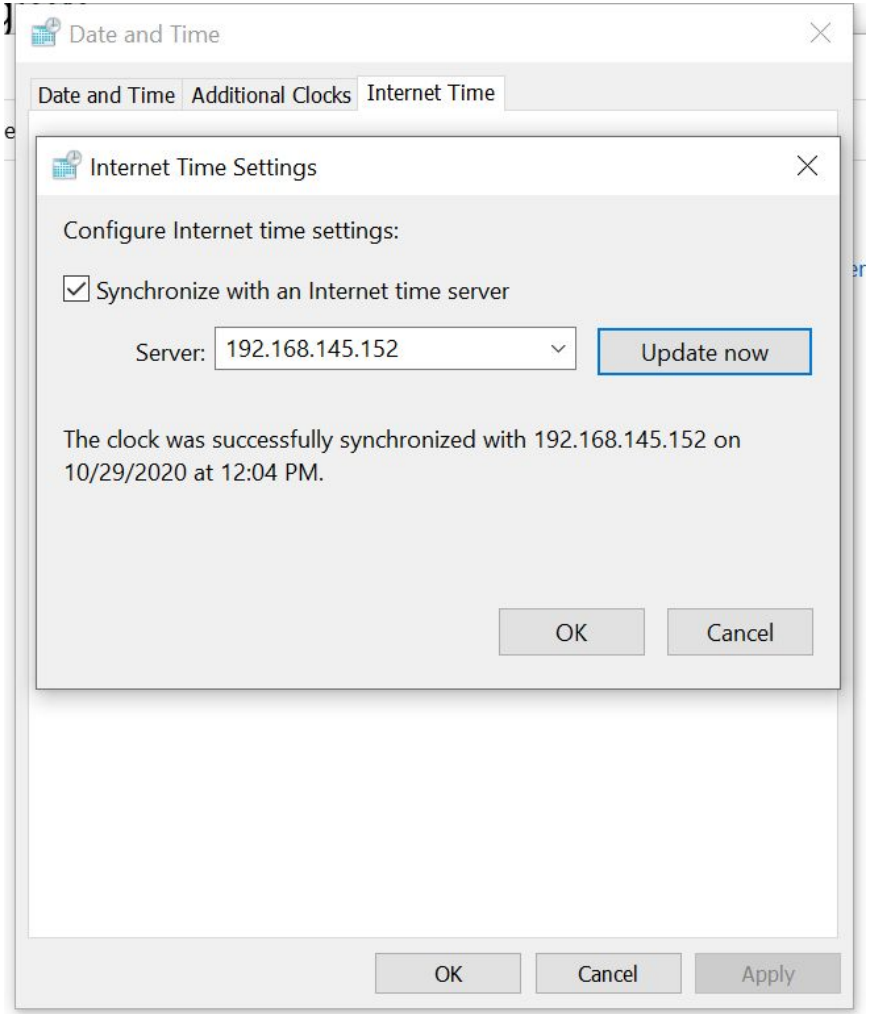

ashwini@ashwini: ~
File Edit View Search Terminal Help
ashwini@ashwini:~$ sudo systemctl start ntp
ashwini@ashwini:~$ sudo systemctl status ntp
● ntp.service - Network Time Service
Loaded: loaded (/lib/systemd/system/ntp.service; enabled; vendor preset: e>
Active: active (running) since Thu 2020-10-29 11:51:09 IST; 6min ago
Docs: man:ntpd(8)
Main PID: 2847 (ntpd)
Tasks: 2 (limit: 4578)
Memory: 1.9M
CGroup: /system.slice/ntp.service
└─2847 /usr/sbin/ntpd -p /var/run/ntpd.pid -g -u 126:135
Oct 29 11:51:20 ashwini ntpd[2847]: Soliciting pool server 5.189.141.35
Oct 29 11:51:21 ashwini ntpd[2847]: Soliciting pool server 91.189.91.157
Oct 29 11:51:21 ashwini ntpd[2847]: Soliciting pool server 139.59.55.93
Oct 29 11:51:22 ashwini ntpd[2847]: Soliciting pool server 91.189.94.4
Oct 29 11:51:22 ashwini ntpd[2847]: Soliciting pool server 52.172.27.135
Oct 29 11:51:23 ashwini ntpd[2847]: Soliciting pool server 2001:67c:1560:8003::>
Oct 29 11:51:23 ashwini ntpd[2847]: Soliciting pool server 2a01:4f9:c010:1625::1
Oct 29 11:51:24 ashwini ntpd[2847]: Soliciting pool server 162.159.200.1
Oct 29 11:51:25 ashwini ntpd[2847]: Soliciting pool server 185.216.231.25
Oct 29 11:56:58 ashwini ntpd[2847]: kernel reports TIME_ERROR: 0x2041: Clock Un>
lines 1-20/20 (END)


ashwini@ashwini: ~
File Edit View Search Terminal Help
ashwini@ashwini:~$ ntpq -p
remote refid st t when poll reach delay offset jitter
0.ubuntu.pool.n .POOL. 16 p - 64 0 0.000 0.000 0.000
1.ubuntu.pool.n .POOL. 16 p - 64 0 0.000 0.000 0.000
2.ubuntu.pool.n .POOL. 16 p - 64 0 0.000 0.000 0.000
3.ubuntu.pool.n .POOL. 16 p - 64 0 0.000 0.000 0.000
ntp.ubuntu.com .POOL. 16 p - 64 0 0.000 0.000 0.000
-time.cloudflare 10.21.8.19 3 u 41 64 177 154.339 -1.854 4.338
-5.103.139.163.s .GPS. 1 u 40 64 177 168.631 -3.338 8.043
#45.86.70.11 173.212.222.171 2 u 45 64 175 246.786 -167.85 10.247
#43.240.66.74 103.134.252.11 3 u 54 64 177 64.728 -20.921 23.828
+157.119.108.165 162.159.200.123 4 u 57 64 177 34.576 -6.611 6.023
+103.134.252.11 104.211.76.226 2 u 6 64 377 60.224 -3.136 6.175
+chilipepper.can 134.71.66.21 2 u 17 64 377 154.296 -3.275 6.727
+golem.canonical 134.71.66.21 2 u 10 64 277 158.741 -4.304 7.257
-5.189.141.35 (m 17.253.54.123 2 u 3 64 377 173.656 -4.639 10.178
+139.59.55.93 17.253.82.125 2 u 2 64 377 5.353 -1.396 6.087
#alphyn.canonica 94.198.159.10 2 u 22 64 377 253.832 -17.116 6.232
#52.172.27.135 216.239.35.4 2 u 63 64 137 13.406 13.562 4.835
#pugot.canonical 17.253.108.125 2 u 18 64 377 252.740 52.379 9.842
+time.cloudflare 10.21.8.19 3 u 6 64 377 155.939 -2.625 4.831
#185.216.231.25 127.0.0.1 3 u 3 64 177 241.239 110.095 5.787
ashwini@ashwini:~$


ashwini@ashwini: ~
File Edit View Search Terminal Help
ashwini@ashwini:~$ date -R
Thu, 29 Oct 2020 11:59:42 +0530
ashwini@ashwini:~$


ashwini@ashwini: ~
File Edit View Search Terminal Help
ashwini@ashwini:~$ firewall-cmd --permanent --add-service=ntp
success
ashwini@ashwini:~$ firewall-cmd --reload
success
ashwini@ashwini:~$


Command Prompt
Microsoft Windows [Version 10.0.18363.1139]
(c) 2019 Microsoft Corporation. All rights reserved.
C:\Users\ASHWINI>ping 192.168.145.152
Pinging 192.168.145.152 with 32 bytes of data:
Reply from 192.168.145.152: bytes=32 time<1ms TTL=64
Reply from 192.168.145.152: bytes=32 time=7ms TTL=64
Reply from 192.168.145.152: bytes=32 time=1ms TTL=64
Reply from 192.168.145.152: bytes=32 time=1ms TTL=64
Ping statistics for 192.168.145.152:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 7ms, Average = 2ms
C:\Users\ASHWINI>


Date and Time
Date and Time
Additional Clocks
Internet Time
Internet Time Settings
Configure Internet time settings:
Synchronize with an Internet time server
Server:
192.168.145.152
Update now
The clock was successfully synchronized with 192.168.145.152 on 10/29/2020 at 12:04 PM.
OK
Cancel
OK
Cancel
Apply