Waiting Room

Concept of DHCP

Along with the Demonstration in Linux

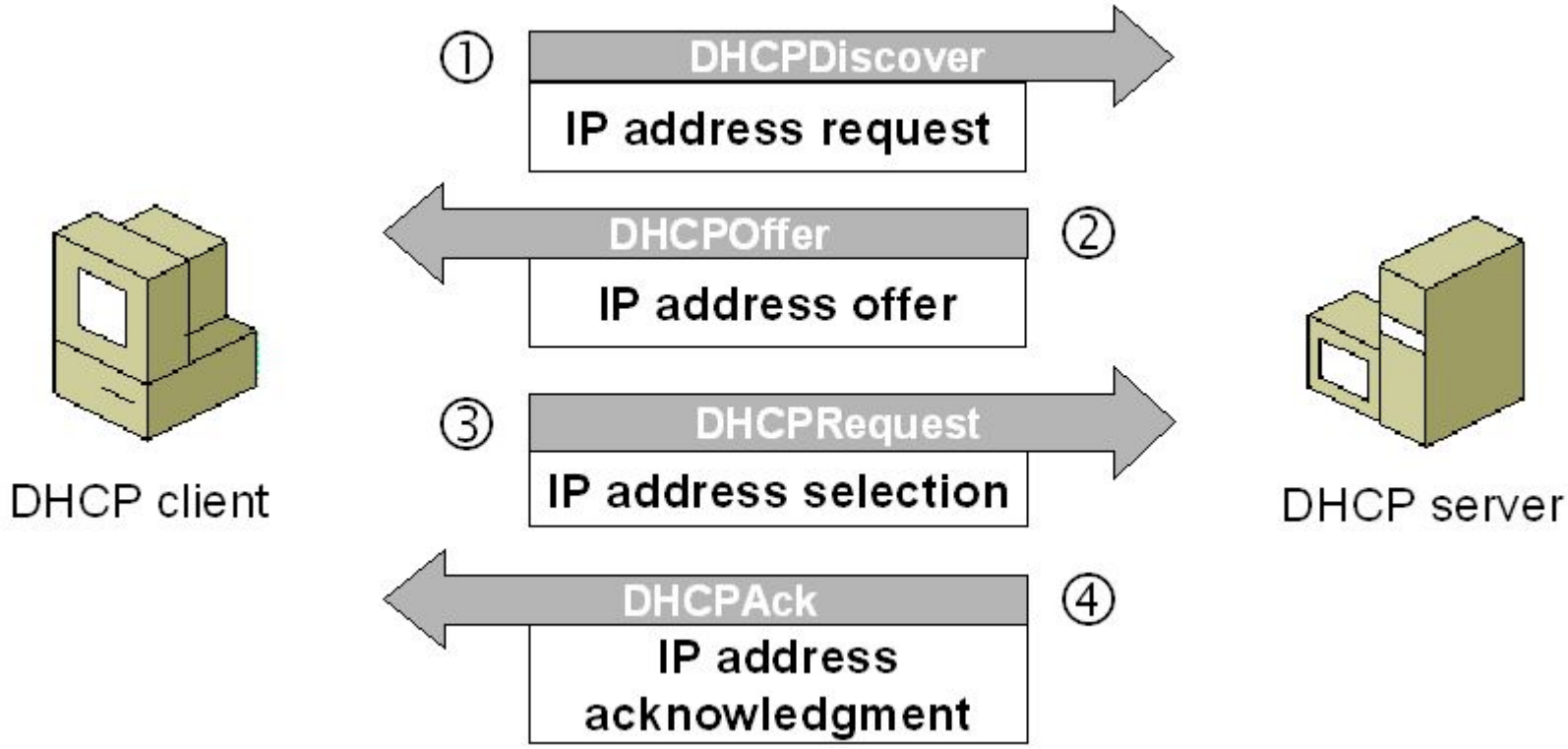
Source: Geek for Geeks [Article-Sourabhsharma56]

Asst. Prof. Ashwini Mathur

DHCP is based on a client-server model and based on discovery, offer, request, and ACK.

DHCP **port number** for **server is 67** and for the **client is 68**.

It is a Client server protocol which uses **UDP** services. IP address is assigned from a pool of addresses. In DHCP, the client and the server exchange mainly **4 DHCP messages in order to make a connection**, also called **DORA** process, but there are 8 DHCP messages in the process.

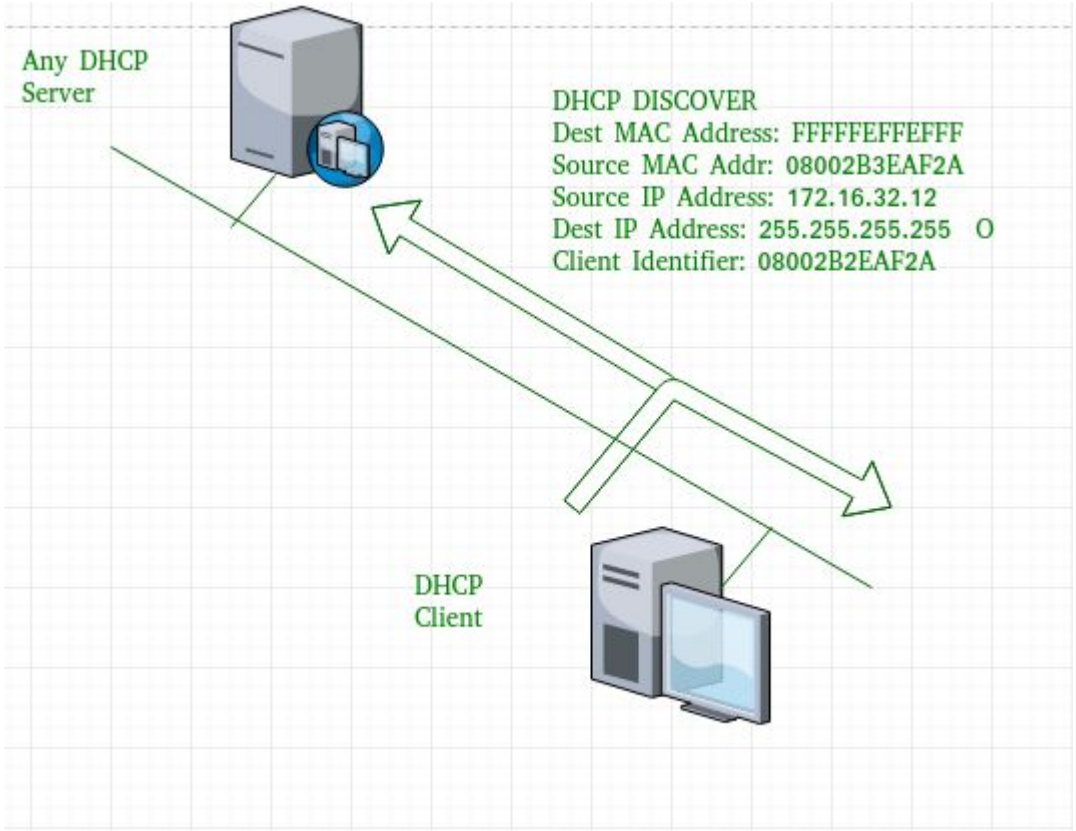

①
DHCPDiscover
IP address request
DHCPOffer
②
IP address offer
③
DHCPRequest
IP address selection
DHCPAck
④
IP address
acknowledgment
DHCP client
DHCP server

These messages are given as below:

1. **DHCP discover message –**

This is a first message **generated in the communication process** between server and client. This message is generated by Client host in order to discover if there is any DHCP server/servers are present in a network or not.

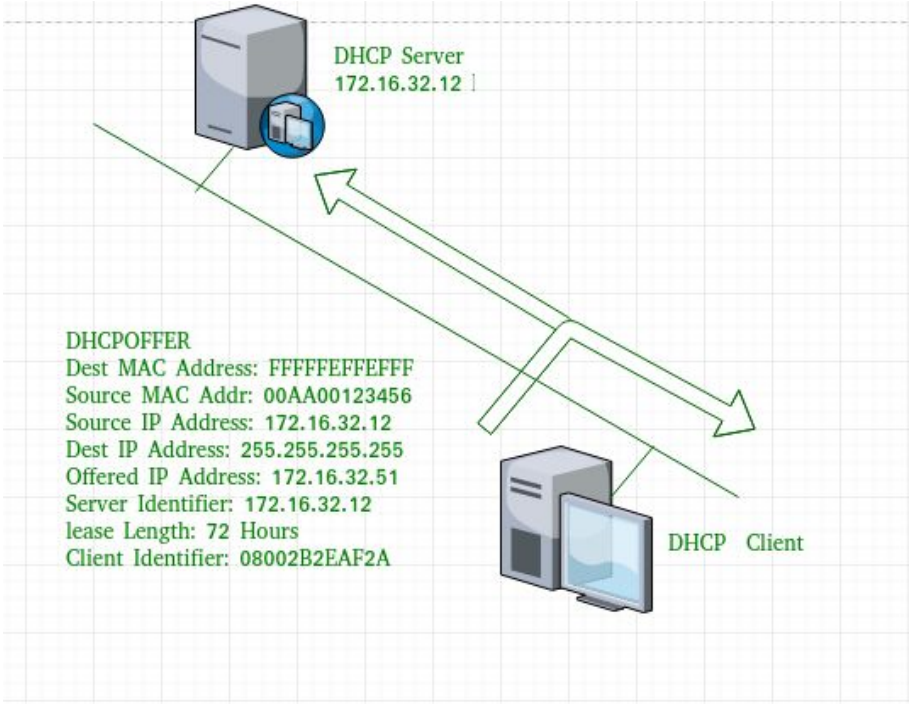
This message is broadcasted to all devices present in a network to find the DHCP server. This message is 342 or 576 bytes long



As shown in the figure, source MAC address (client PC) is 08002B2EAF2A, destination MAC address(server) is FFFFFFFFFFFF, source IP address is 0.0.0.0(because PC has no IP address till now) and destination IP address is 255.255.255.255 (IP address used for broadcasting). As the discover message is broadcast to find out the DHCP server or servers in the network therefore broadcast IP address and MAC address is used.

DHCP offer message –

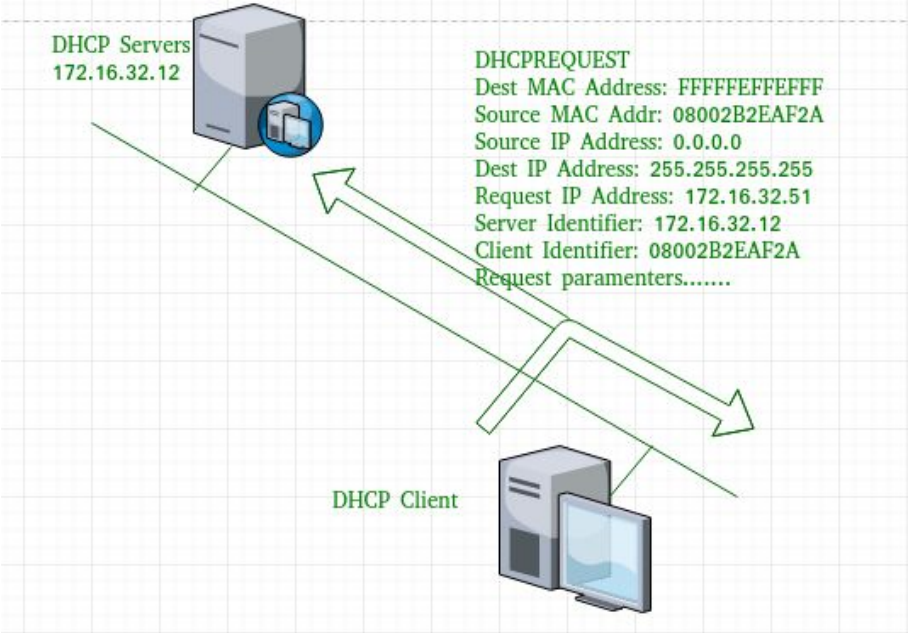
The server will **respond to host in this message specifying the unleased IP address** and other TCP configuration information. This message is broadcasted by server. Size of message is 342 bytes. If there are more than one DHCP servers present in the network then client host will accept the first DHCP OFFER message it receives. Also a server ID is specified in the packet in order to identify the server.



Now, for the offer message, source IP address is 172.16.32.12 (server's IP address in the example), destination IP address is 255.255.255.255 (broadcast IP address) ,source MAC address is 00AA00123456, destination MAC address is FFFFFFFFFFFF. Here, the offer message is broadcast by the DHCP server therefore destination IP address is broadcast IP address and destination MAC address is FFFFFFFFFFFF and the source IP address is server IP address and MAC address is server MAC address.

Also the server has provided the offered IP address 192.16.32.51 and lease time of 72 hours(after this time the entry of host will be erased from the server automatically) . Also the client identifier is PC MAC address (08002B2EAF2A) for all the messages.

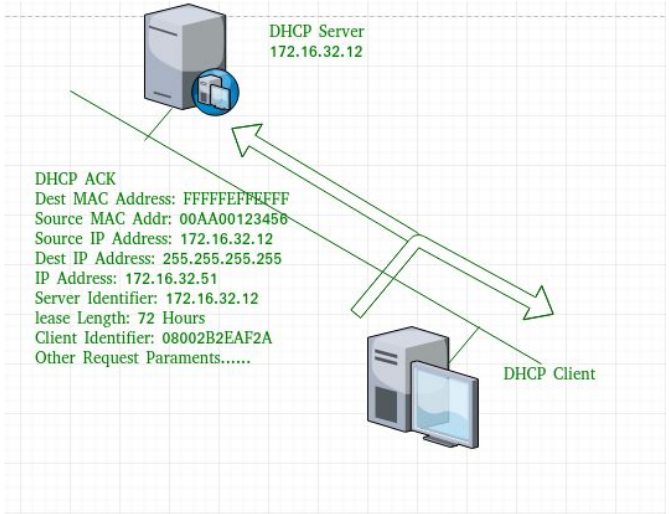
DHCP request message –
When a client receives a offer message, it responds by broadcasting a DHCP request message. The client will produce a gratuitous ARP in order to find if there is any other host present in the network with same IP address. If there is no reply by other host, then there is no host with same TCP configuration in the network and the message is broadcasted to server showing the acceptance of IP address .A Client ID is also added in this message.



Now, the request message is broadcast by the client PC therefore source IP address is 0.0.0.0(as the client has no IP right now) and destination IP address is 255.255.255.255 (broadcast IP address) and source MAC address is 08002B2EAF2A (PC MAC address) and destination MAC address is FFFFFFFFFFFF. **Note –** This message is broadcast after the ARP request broadcast by the PC to find out whether any other host is not using that offered IP. If there is no reply, then the client host broadcast the DHCP request message for the server showing the acceptance of IP address and Other TCP/IP Configuration.

DHCP acknowledgement message –

In response to the request message received, the server will make an entry with specified client ID and bind the IP address offered with lease time. Now, the client will have the IP address provided by server.



DHCP negative acknowledgement message –

Whenever a DHCP server receives a request for IP address that is invalid according to the scopes that is configured with, it send DHCP Nak message to client. Eg-when the server has no IP address unused or the pool is empty, then this message is sent by the server to client.

DHCP decline –

If DHCP client determines the offered configuration parameters are different or invalid, it sends DHCP decline message to the server .When there is a reply to the gratuitous ARP by any host to the client, the client sends DHCP decline message to the server showing the offered IP address is already in use.

DHCP release –

A DHCP client sends DHCP release packet to server to release IP address and cancel any remaining lease time.

DHCP inform –

If a client address has obtained IP address manually then the client uses a DHCP inform to obtain other local configuration parameters, such as domain name. In reply to the dhcp inform message, DHCP server generates DHCP ack message with local configuration suitable for the client without allocating a new IP address. This DHCP ack message is unicast to the client.

Advantages – The advantages of using DHCP include:

- **centralized management of IP addresses**
- ease of adding new clients to a network
- reuse of IP addresses reducing the total number of IP addresses that are required
- simple reconfiguration of the IP address space on the DHCP server without needing to reconfigure each client

The DHCP protocol gives the **network administrator** a method to configure the network from a centralised area.

With the help of DHCP, easy handling of new users and reuse of IP address can be achieved.

Disadvantages – Disadvantage of using DHCP is:

- IP conflict can occur

Demonstration of DHCP server in Ubuntu ..

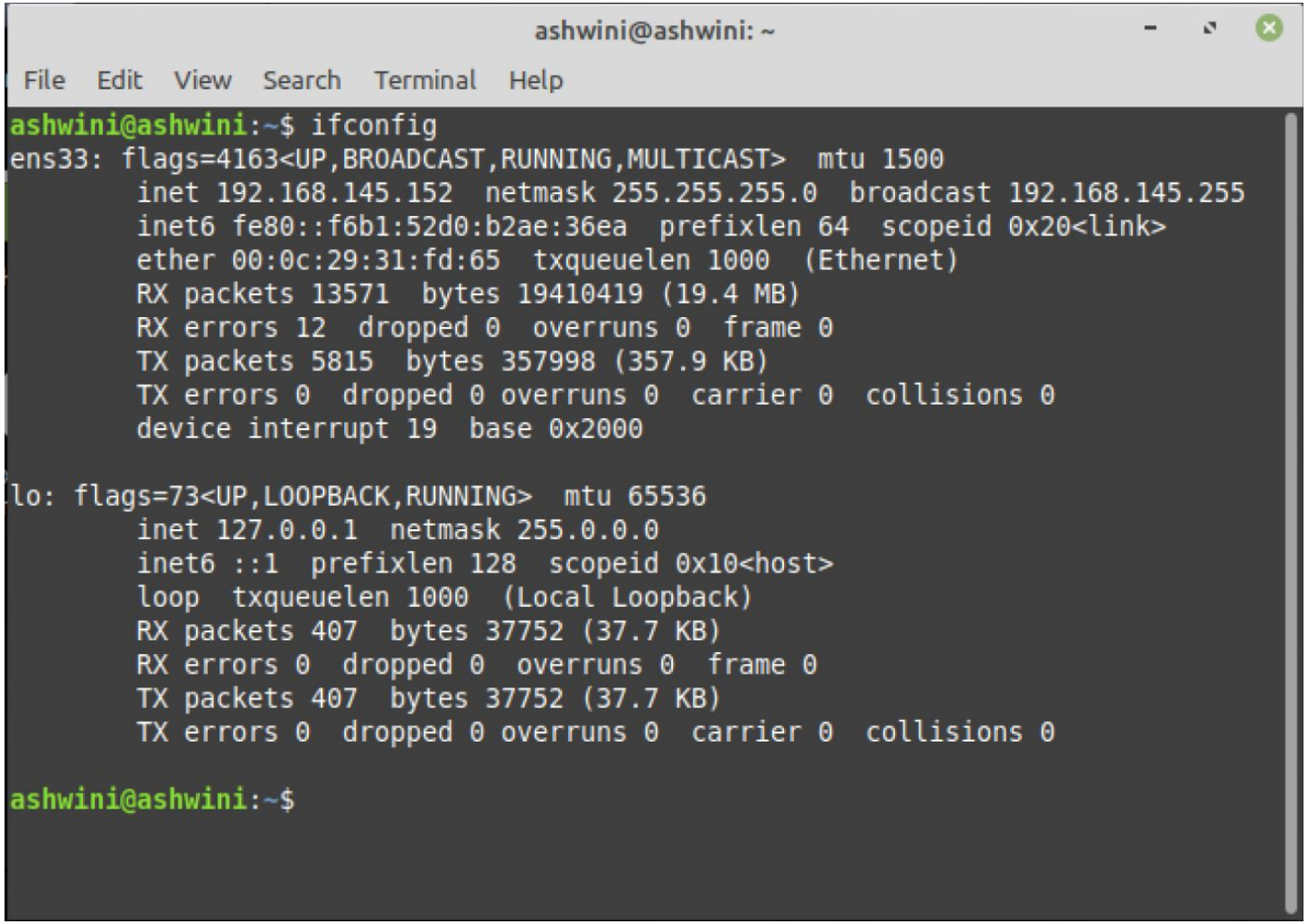
Asst. Prof. Ashwini Mathur

Steps to install and configuration of DHCP server

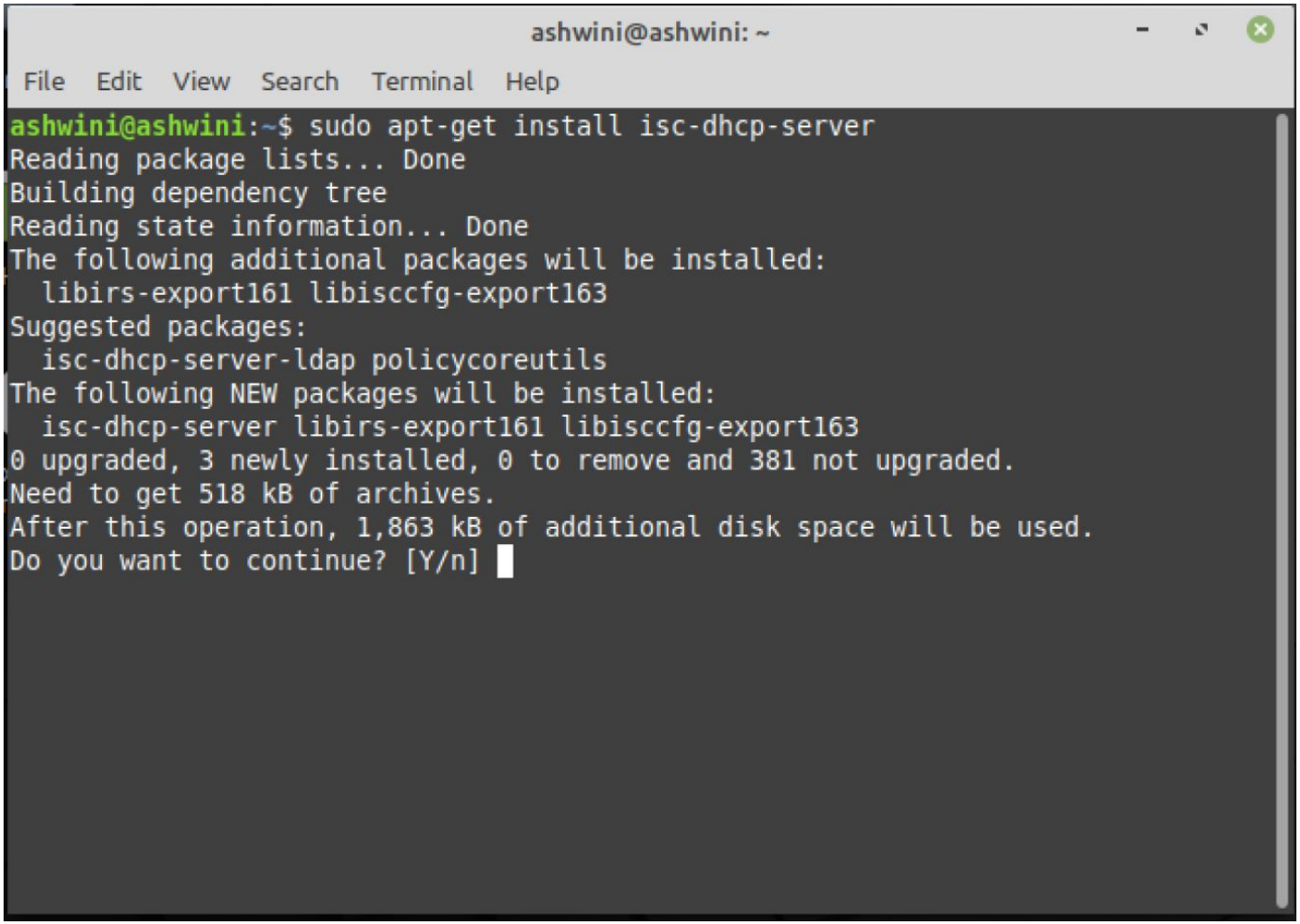
1. sudo apt-get update
2. sudo apt-get install isc-dhcp-server
3. Install net-tools of [ifconfig utility], in case if ifconfig command is not working
4. Sudo nano /etc/default/isc-dhcp-server [INTERFACES = “ens33”]
5. Sudo nano /etc/dhcp/dhcpd.conf [Configure the DHCP [prepare pool of resources]]
6. Systemctl restart isc-dhcp-server
7. Systemctl status isc-dhcp-server
8. dhcp -lease-list
9. Sudo tail -f /var/log/syslog
10. Server installation and Configuration is Done !!!!!

Demonstration Screenshots

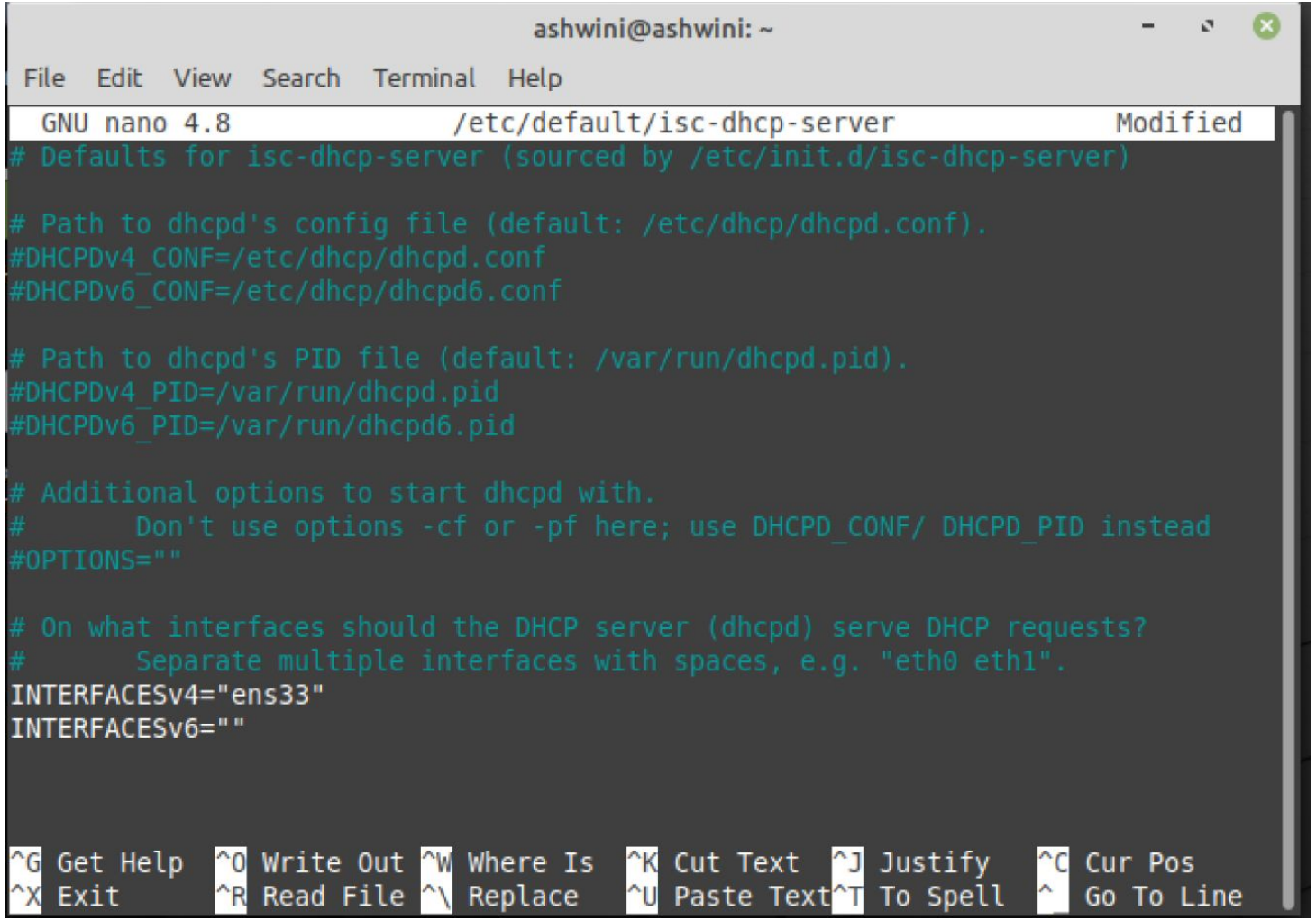
Check Network - ifconfig


ashwini@ashwini: ~
File Edit View Search Terminal Help
ashwini@ashwini:~$ ifconfig
ens33: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
inet 192.168.145.152 netmask 255.255.255.0 broadcast 192.168.145.255
inet6 fe80::f6b1:52d0:b2ae:36ea prefixlen 64 scopeid 0x20<link>
ether 00:0c:29:31:fd:65 txqueuelen 1000 (Ethernet)
RX packets 13571 bytes 19410419 (19.4 MB)
RX errors 12 dropped 0 overruns 0 frame 0
TX packets 5815 bytes 357998 (357.9 KB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
device interrupt 19 base 0x2000
lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
inet 127.0.0.1 netmask 255.0.0.0
inet6 ::1 prefixlen 128 scopeid 0x10<host>
loop txqueuelen 1000 (Local Loopback)
RX packets 407 bytes 37752 (37.7 KB)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 407 bytes 37752 (37.7 KB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
ashwini@ashwini:~$

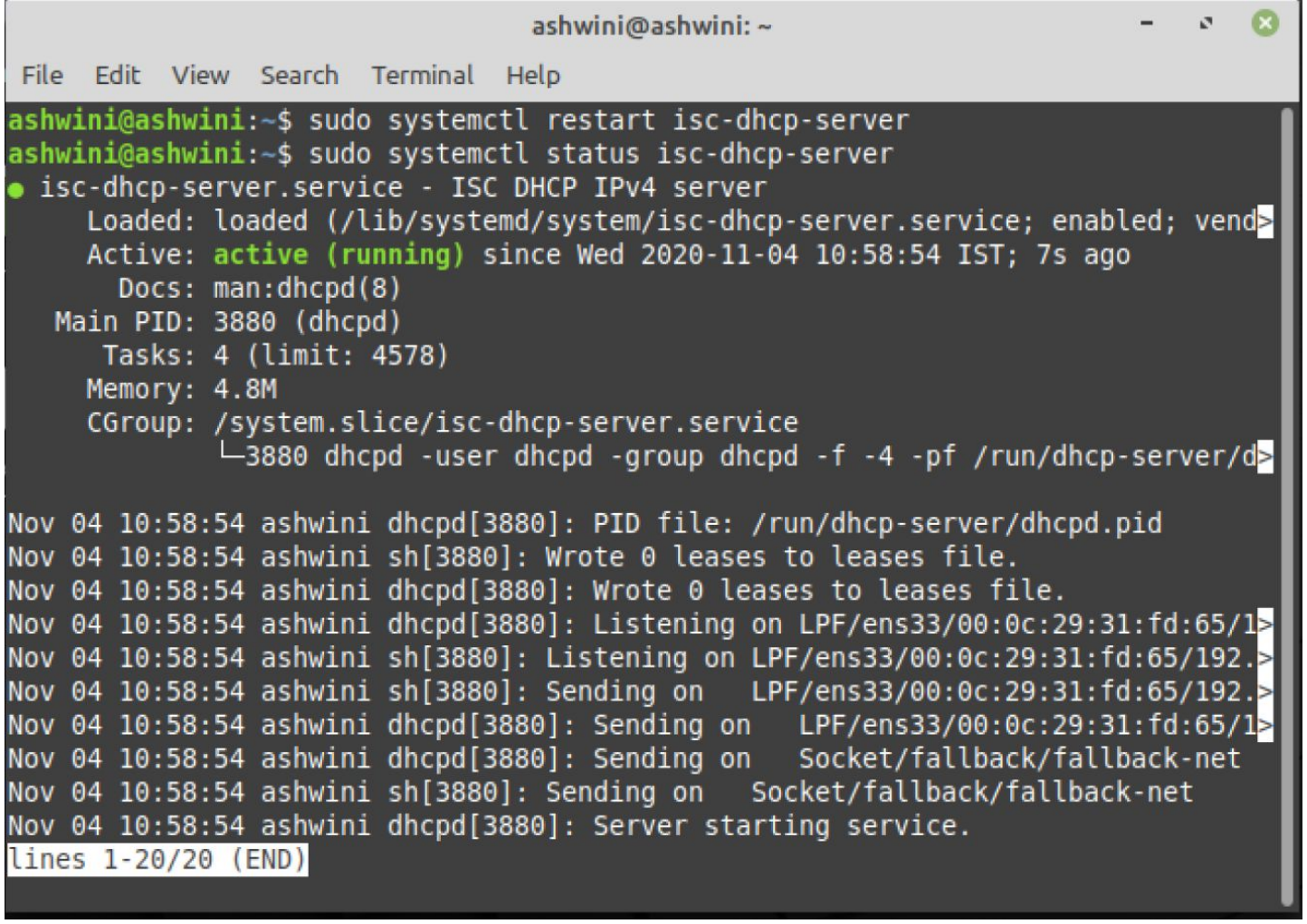
Installation of DHCP server


ashwini@ashwini: ~
File Edit View Search Terminal Help
ashwini@ashwini:~$ sudo apt-get install isc-dhcp-server
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
libirs-export161 libisccfg-export163
Suggested packages:
isc-dhcp-server-ldap policycoreutils
The following NEW packages will be installed:
isc-dhcp-server libirs-export161 libisccfg-export163
0 upgraded, 3 newly installed, 0 to remove and 381 not upgraded.
Need to get 518 kB of archives.
After this operation, 1,863 kB of additional disk space will be used.
Do you want to continue? [Y/n]

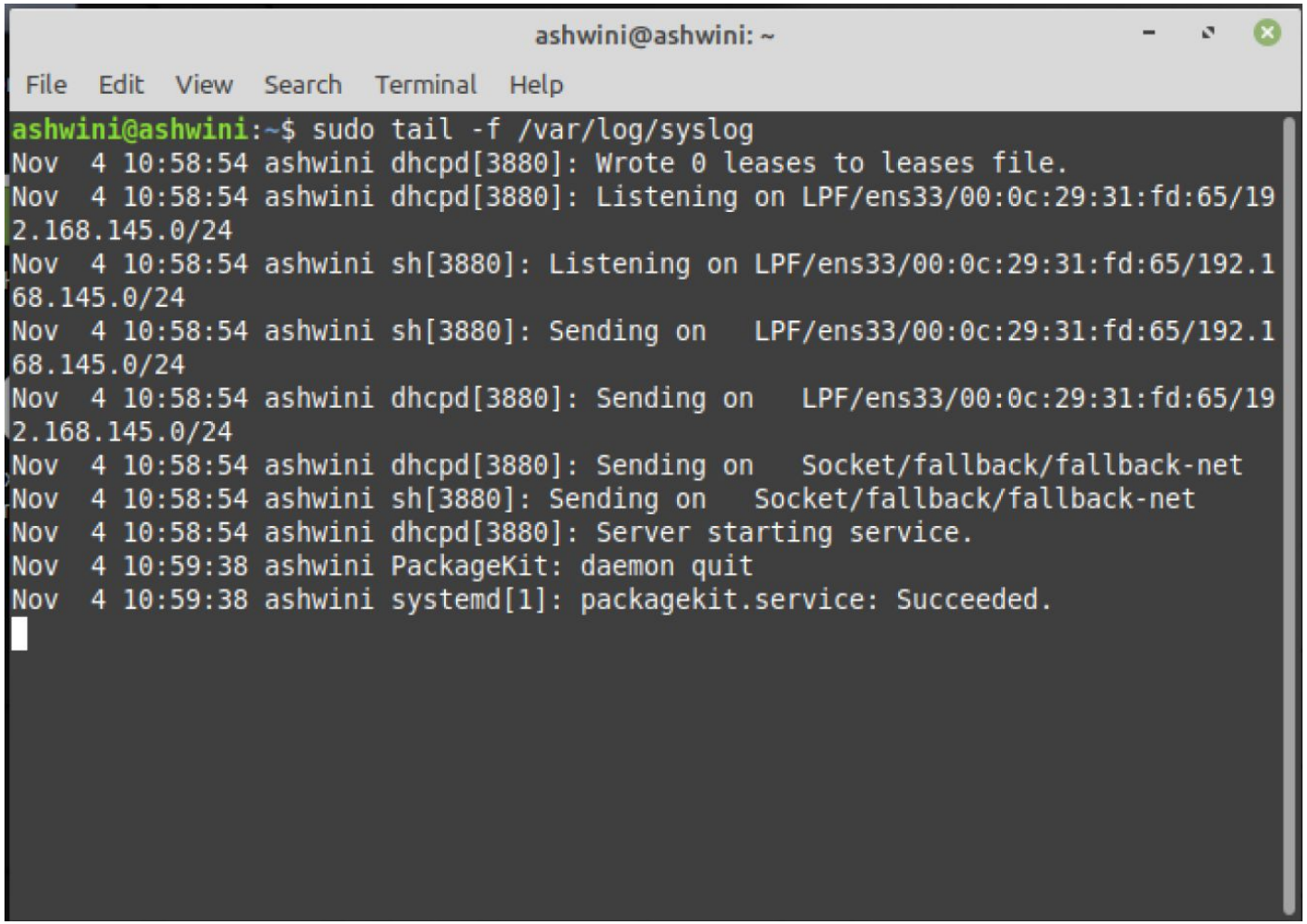
Edit the file: /etc/default/isc-dhcp-server


ashwini@ashwini: ~
File Edit View Search Terminal Help
GNU nano 4.8 /etc/default/isc-dhcp-server Modified
Defaults for isc-dhcp-server (sourced by /etc/init.d/isc-dhcp-server)
Path to dhcpd's config file (default: /etc/dhcp/dhcpd.conf).
#DHCPDv4_CONF=/etc/dhcp/dhcpd.conf
#DHCPDv6_CONF=/etc/dhcp/dhcpd6.conf
Path to dhcpd's PID file (default: /var/run/dhcpd.pid).
#DHCPDv4_PID=/var/run/dhcpd.pid
#DHCPDv6_PID=/var/run/dhcpd6.pid
Additional options to start dhcpd with.
Don't use options -cf or -pf here; use DHCPD_CONF/ DHCPD_PID instead
#OPTIONS=""
# On what interfaces should the DHCP server (dhcpd) serve DHCP requests?
# Separate multiple interfaces with spaces, e.g. "eth0 eth1".
INTERFACESv4="ens33"
INTERFACESv6=""
^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

Systemctl status isc-dhcp-server

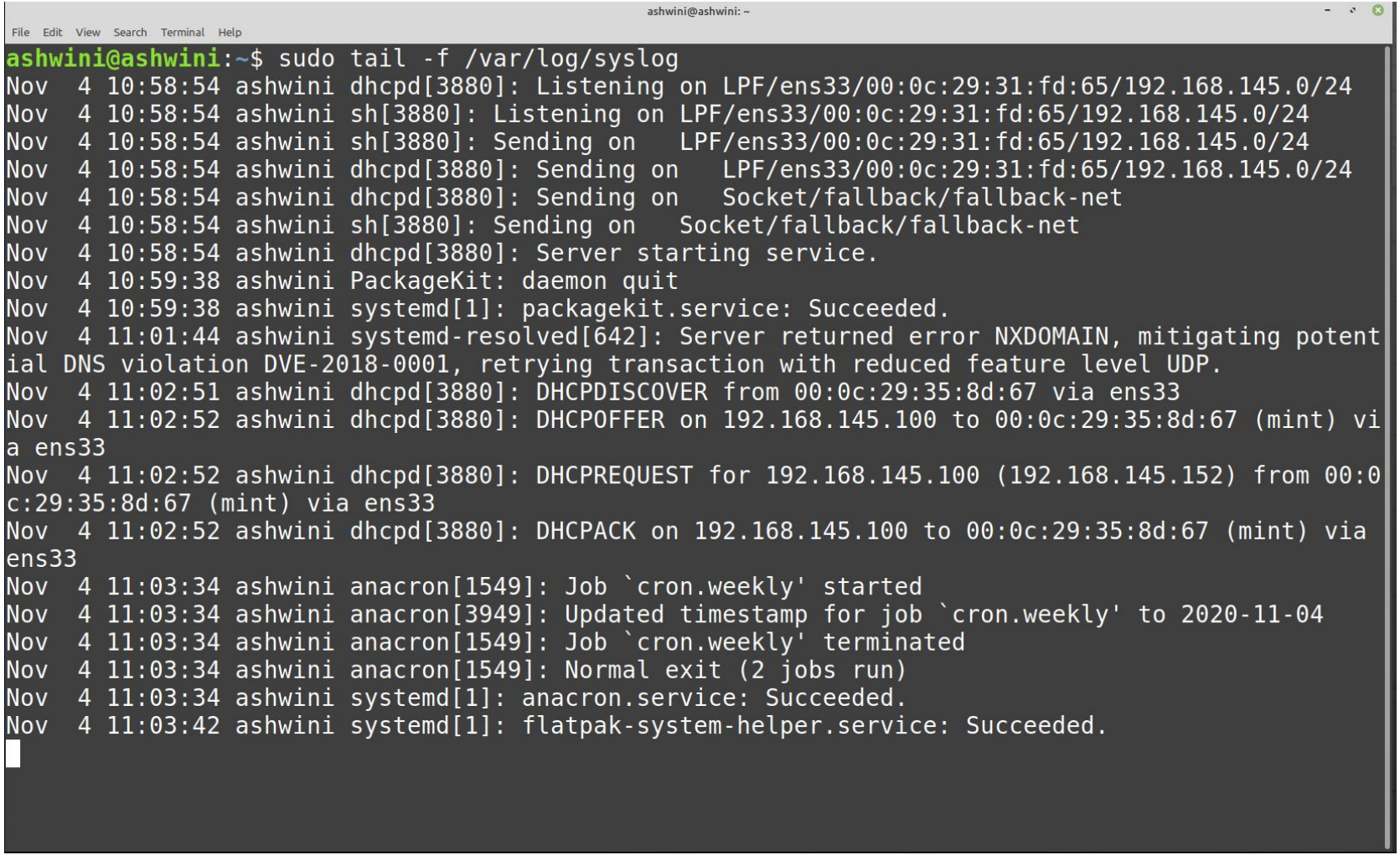

ashwini@ashwini: ~
File Edit View Search Terminal Help
ashwini@ashwini:~$ sudo systemctl restart isc-dhcp-server
ashwini@ashwini:~$ sudo systemctl status isc-dhcp-server
● isc-dhcp-server.service - ISC DHCP IPv4 server
Loaded: loaded (/lib/systemd/system/isc-dhcp-server.service; enabled; vend>
Active: active (running) since Wed 2020-11-04 10:58:54 IST; 7s ago
Docs: man:dhcpd(8)
Main PID: 3880 (dhcpd)
Tasks: 4 (limit: 4578)
Memory: 4.8M
CGroup: /system.slice/isc-dhcp-server.service
└─3880 dhcpd -user dhcpd -group dhcpd -f -4 -pf /run/dhcp-server/d>
Nov 04 10:58:54 ashwini dhcpd[3880]: PID file: /run/dhcp-server/dhcpd.pid
Nov 04 10:58:54 ashwini sh[3880]: Wrote 0 leases to leases file.
Nov 04 10:58:54 ashwini dhcpd[3880]: Wrote 0 leases to leases file.
Nov 04 10:58:54 ashwini dhcpd[3880]: Listening on LPF/ens33/00:0c:29:31:fd:65/1>
Nov 04 10:58:54 ashwini sh[3880]: Listening on LPF/ens33/00:0c:29:31:fd:65/192.>
Nov 04 10:58:54 ashwini sh[3880]: Sending on LPF/ens33/00:0c:29:31:fd:65/192.>
Nov 04 10:58:54 ashwini dhcpd[3880]: Sending on LPF/ens33/00:0c:29:31:fd:65/1>
Nov 04 10:58:54 ashwini dhcpd[3880]: Sending on Socket/fallback/fallback-net
Nov 04 10:58:54 ashwini sh[3880]: Sending on Socket/fallback/fallback-net
Nov 04 10:58:54 ashwini dhcpd[3880]: Server starting service.
lines 1-20/20 (END)

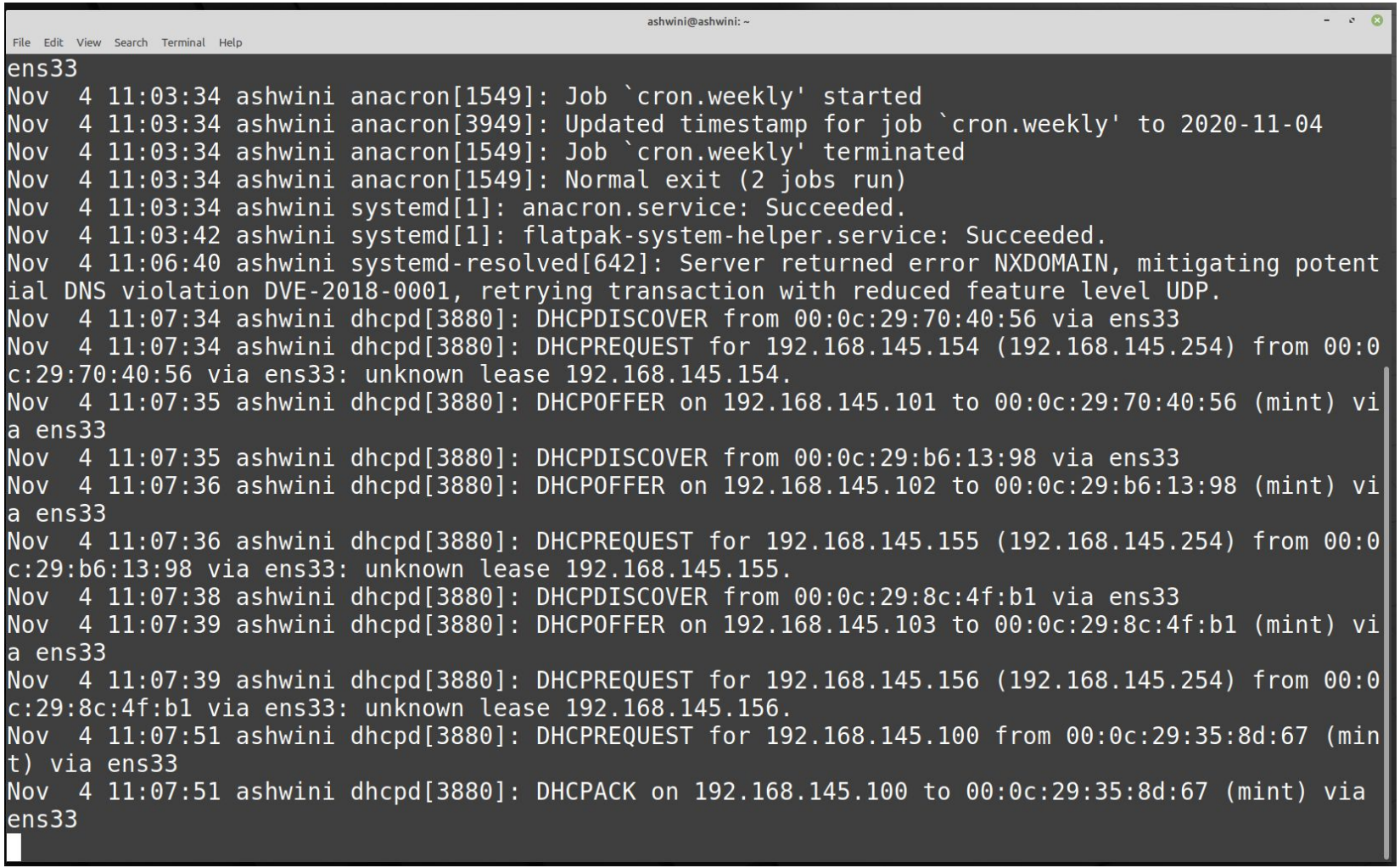
Tail -f /var/log/syslog


ashwini@ashwini: ~
File Edit View Search Terminal Help
ashwini@ashwini:~$ sudo tail -f /var/log/syslog
Nov 4 10:58:54 ashwini dhcpd[3880]: Wrote 0 leases to leases file.
Nov 4 10:58:54 ashwini dhcpd[3880]: Listening on LPF/ens33/00:0c:29:31:fd:65/192.168.145.0/24
Nov 4 10:58:54 ashwini sh[3880]: Listening on LPF/ens33/00:0c:29:31:fd:65/192.168.145.0/24
Nov 4 10:58:54 ashwini sh[3880]: Sending on LPF/ens33/00:0c:29:31:fd:65/192.168.145.0/24
Nov 4 10:58:54 ashwini dhcpd[3880]: Sending on LPF/ens33/00:0c:29:31:fd:65/192.168.145.0/24
Nov 4 10:58:54 ashwini dhcpd[3880]: Sending on Socket/fallback/fallback-net
Nov 4 10:58:54 ashwini sh[3880]: Sending on Socket/fallback/fallback-net
Nov 4 10:58:54 ashwini dhcpd[3880]: Server starting service.
Nov 4 10:59:38 ashwini PackageKit: daemon quit
Nov 4 10:59:38 ashwini systemd[1]: packagekit.service: Succeeded.

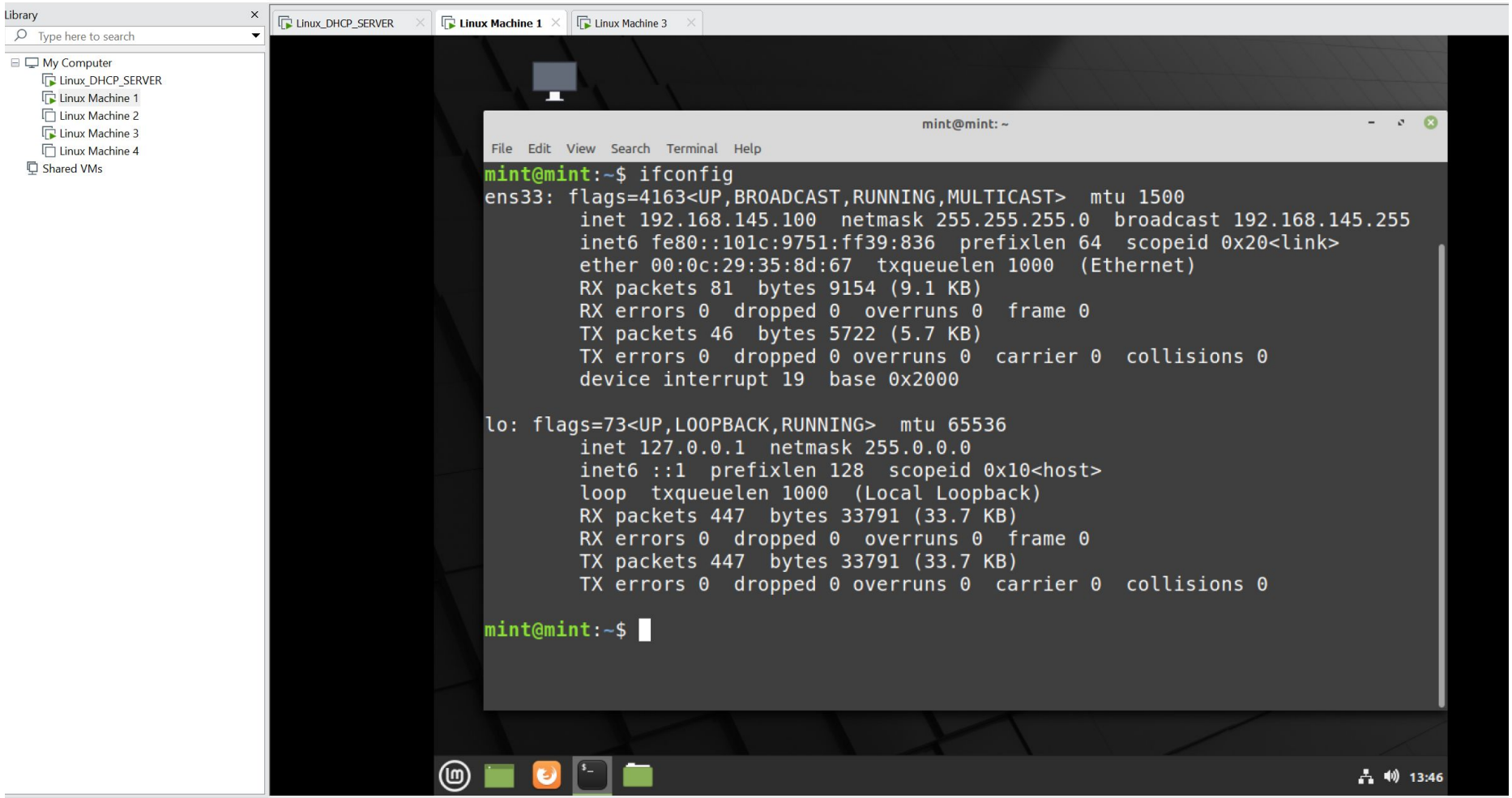
Start a New VM with Network setting : Obtaining IP automatically

Check the system log file in DHCP server

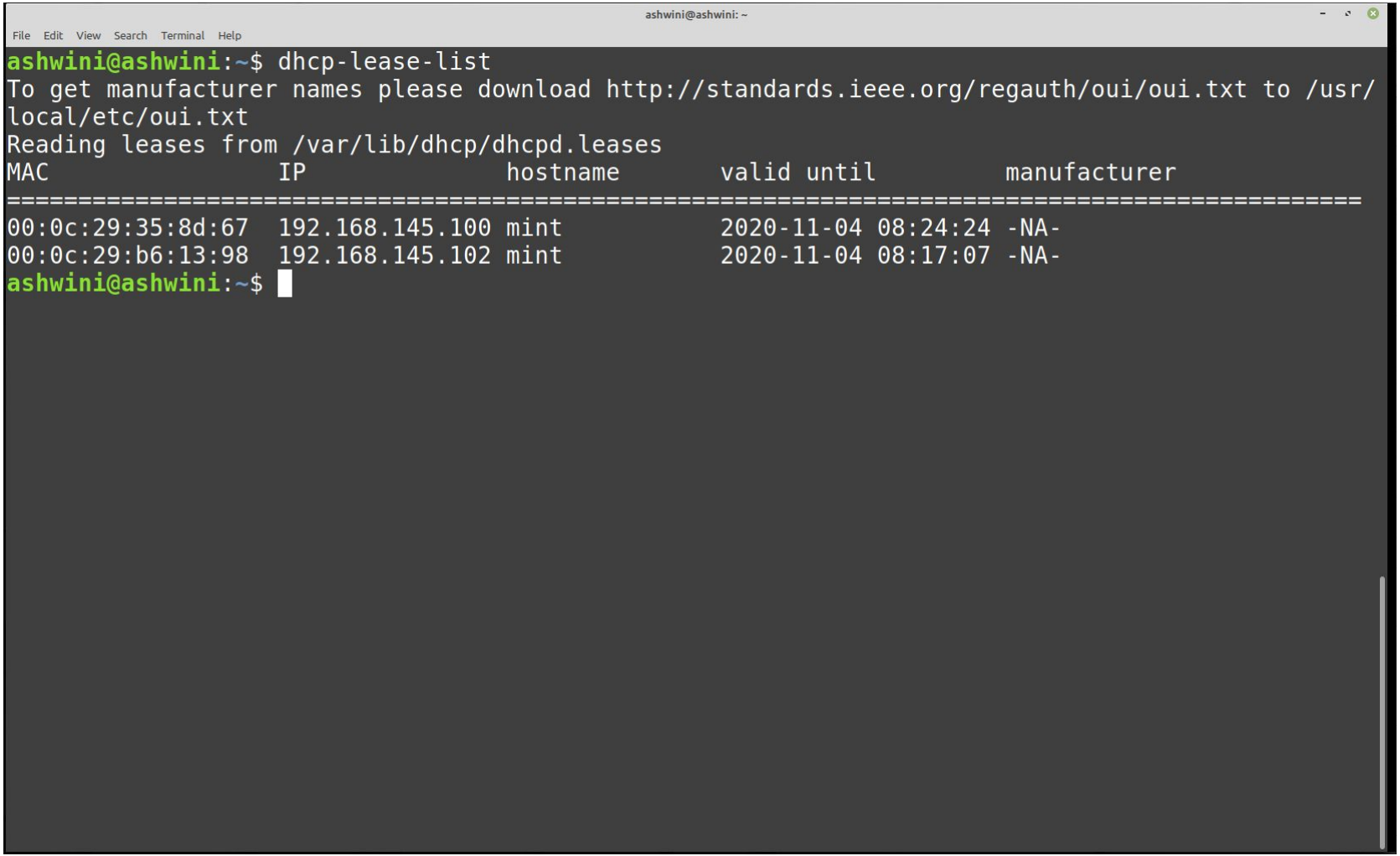

ashwini@ashwini: ~
File Edit View Search Terminal Help
ashwini@ashwini:~$ sudo tail -f /var/log/syslog
Nov 4 10:58:54 ashwini dhcpd[3880]: Listening on LPF/ens33/00:0c:29:31:fd:65/192.168.145.0/24
Nov 4 10:58:54 ashwini sh[3880]: Listening on LPF/ens33/00:0c:29:31:fd:65/192.168.145.0/24
Nov 4 10:58:54 ashwini sh[3880]: Sending on   LPF/ens33/00:0c:29:31:fd:65/192.168.145.0/24
Nov 4 10:58:54 ashwini dhcpd[3880]: Sending on   LPF/ens33/00:0c:29:31:fd:65/192.168.145.0/24
Nov 4 10:58:54 ashwini dhcpd[3880]: Sending on   Socket/fallback/fallback-net
Nov 4 10:58:54 ashwini sh[3880]: Sending on   Socket/fallback/fallback-net
Nov 4 10:58:54 ashwini dhcpd[3880]: Server starting service.
Nov 4 10:59:38 ashwini PackageKit: daemon quit
Nov 4 10:59:38 ashwini systemd[1]: packagekit.service: Succeeded.
Nov 4 11:01:44 ashwini systemd-resolved[642]: Server returned error NXDOMAIN, mitigating potential DNS violation DVE-2018-0001, retrying transaction with reduced feature level UDP.
Nov 4 11:02:51 ashwini dhcpd[3880]: DHCPDISCOVER from 00:0c:29:35:8d:67 via ens33
Nov 4 11:02:52 ashwini dhcpd[3880]: DHCPOFFER on 192.168.145.100 to 00:0c:29:35:8d:67 (mint) via ens33
Nov 4 11:02:52 ashwini dhcpd[3880]: DHCPREQUEST for 192.168.145.100 (192.168.145.152) from 00:0c:29:35:8d:67 (mint) via ens33
Nov 4 11:02:52 ashwini dhcpd[3880]: DHCPACK on 192.168.145.100 to 00:0c:29:35:8d:67 (mint) via ens33
Nov 4 11:03:34 ashwini anacron[1549]: Job `cron.weekly' started
Nov 4 11:03:34 ashwini anacron[3949]: Updated timestamp for job `cron.weekly' to 2020-11-04
Nov 4 11:03:34 ashwini anacron[1549]: Job `cron.weekly' terminated
Nov 4 11:03:34 ashwini anacron[1549]: Normal exit (2 jobs run)
Nov 4 11:03:34 ashwini systemd[1]: anacron.service: Succeeded.
Nov 4 11:03:42 ashwini systemd[1]: flatpak-system-helper.service: Succeeded.


ashwini@ashwini: ~
File Edit View Search Terminal Help
ens33
Nov 4 11:03:34 ashwini anacron[1549]: Job `cron.weekly' started
Nov 4 11:03:34 ashwini anacron[3949]: Updated timestamp for job `cron.weekly' to 2020-11-04
Nov 4 11:03:34 ashwini anacron[1549]: Job `cron.weekly' terminated
Nov 4 11:03:34 ashwini anacron[1549]: Normal exit (2 jobs run)
Nov 4 11:03:34 ashwini systemd[1]: anacron.service: Succeeded.
Nov 4 11:03:42 ashwini systemd[1]: flatpak-system-helper.service: Succeeded.
Nov 4 11:06:40 ashwini systemd-resolved[642]: Server returned error NXDOMAIN, mitigating potential DNS violation DVE-2018-0001, retrying transaction with reduced feature level UDP.
Nov 4 11:07:34 ashwini dhcpd[3880]: DHCPDISCOVER from 00:0c:29:70:40:56 via ens33
Nov 4 11:07:34 ashwini dhcpd[3880]: DHCPREQUEST for 192.168.145.154 (192.168.145.254) from 00:0c:29:70:40:56 via ens33: unknown lease 192.168.145.154.
Nov 4 11:07:35 ashwini dhcpd[3880]: DHCPOFFER on 192.168.145.101 to 00:0c:29:70:40:56 (mint) via ens33
Nov 4 11:07:35 ashwini dhcpd[3880]: DHCPDISCOVER from 00:0c:29:b6:13:98 via ens33
Nov 4 11:07:36 ashwini dhcpd[3880]: DHCPOFFER on 192.168.145.102 to 00:0c:29:b6:13:98 (mint) via ens33
Nov 4 11:07:36 ashwini dhcpd[3880]: DHCPREQUEST for 192.168.145.155 (192.168.145.254) from 00:0c:29:b6:13:98 via ens33: unknown lease 192.168.145.155.
Nov 4 11:07:38 ashwini dhcpd[3880]: DHCPDISCOVER from 00:0c:29:8c:4f:b1 via ens33
Nov 4 11:07:39 ashwini dhcpd[3880]: DHCPOFFER on 192.168.145.103 to 00:0c:29:8c:4f:b1 (mint) via ens33
Nov 4 11:07:39 ashwini dhcpd[3880]: DHCPREQUEST for 192.168.145.156 (192.168.145.254) from 00:0c:29:8c:4f:b1 via ens33: unknown lease 192.168.145.156.
Nov 4 11:07:51 ashwini dhcpd[3880]: DHCPREQUEST for 192.168.145.100 from 00:0c:29:35:8d:67 (mint) via ens33
Nov 4 11:07:51 ashwini dhcpd[3880]: DHCPACK on 192.168.145.100 to 00:0c:29:35:8d:67 (mint) via ens33

Client Machine


Library
Type here to search
My Computer
Linux_DHCP_SERVER
Linux Machine 1
Linux Machine 2
Linux Machine 3
Linux Machine 4
Shared VMs
Linux_DHCP_SERVER
Linux Machine 1
Linux Machine 3
mint@mint: ~
File Edit View Search Terminal Help
mint@mint:~$ ifconfig
ens33: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
inet 192.168.145.100 netmask 255.255.255.0 broadcast 192.168.145.255
inet6 fe80::101c:9751:ff39:836 prefixlen 64 scopeid 0x20<link>
ether 00:0c:29:35:8d:67 txqueuelen 1000 (Ethernet)
RX packets 81 bytes 9154 (9.1 KB)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 46 bytes 5722 (5.7 KB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
device interrupt 19 base 0x2000
lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
inet 127.0.0.1 netmask 255.0.0.0
inet6 ::1 prefixlen 128 scopeid 0x10<host>
loop txqueuelen 1000 (Local Loopback)
RX packets 447 bytes 33791 (33.7 KB)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 447 bytes 33791 (33.7 KB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
mint@mint:~$
13:46

Check DHCP lease table : dhcp-lease-list


ashwini@ashwini: ~
File Edit View Search Terminal Help
ashwini@ashwini:~$ dhcp-lease-list
To get manufacturer names please download http://standards.ieee.org/regauth/oui/oui.txt to /usr/local/etc/oui.txt
Reading leases from /var/lib/dhcp/dhcpd.leases
MAC IP hostname valid until manufacturer
00:0c:29:35:8d:67 192.168.145.100 mint 2020-11-04 08:24:24 -NA-
00:0c:29:b6:13:98 192.168.145.102 mint 2020-11-04 08:17:07 -NA-
ashwini@ashwini:~$

DHCP fundamentals completed successfully !!!