

# DAY – 1

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## Session 1

### What are the different Installation Methods available?

RHEL 9 supports the following installation methods:

Method	Description
Graphical Installation (GUI)	Default method using Anaconda graphical installer. Best for desktops and new users.
Text-Based Installation	Uses a text-mode installer for systems with no GUI. Useful on low-resource machines.
Kickstart Installation	Automated installation using a predefined configuration file (kickstart.cfg).
PXE (Preboot Execution Environment) Installation	Network boot installation using PXE server. Useful for large-scale deployments.
Installation from USB/DVD	Boot from RHEL ISO written to USB/DVD.
VNC-based Remote Installation	Allows installation over the network via Virtual Network Computing (VNC).

### Mention the recommended Hardware requirement for RHEL 9 Installation

Component	Minimum Requirement	Recommended
CPU	2 GHz or faster	2+ cores, x86_64 architecture
RAM	2 GB (minimal), 4 GB (GUI)	8 GB or more for GUI/server applications
Storage	10 GB (minimal install), 20 GB+ (GUI/server)	50 GB or more (especially for logs/backups)
Display	1024x768 (for GUI install)	Higher resolution preferred
Network Card	Ethernet or Wireless NIC	Required for updates and network services

### Explain Kickstart Installation Method

Kickstart is an automated installation method for RHEL systems.

- It uses a Kickstart configuration file (ks.cfg) which contains all the installation answers and options.
- Ideal for mass deployments and consistent server setups.

Steps to use Kickstart Installation:

1. Create a Kickstart file manually or using the kickstart GUI tool.
2. Store it on:
  - a. HTTP/FTP/NFS server
  - b. Local media
3. Boot the system using RHEL ISO and use kernel boot option like:
  - a. linux ks=http://<server>/ks.cfg
4. The installer will automatically follow the kickstart configuration.

Advantages:

- ✓ Saves time in large deployments
- ✓ Ensures consistent server configuration
- ✓ Can be used with PXE for full automation

## What steps would you take to identify and resolve the issue in which a Linux system fails to boot?

Step	Action
Check Power and Hardware	Ensure power, cables, and BIOS are working properly.
View Boot Loader (GRUB)	Check if GRUB appears. Use e to edit entries and troubleshoot kernel.
Boot into Rescue/Single Mode	Use systemd.unit=rescue.target or single at boot to recover access.
Check /boot partition	Verify kernel/initramfs are not missing or corrupted.
Rebuild GRUB	Use grub2-install and grub2-mkconfig -o /boot/grub2/grub.cfg.

What is a kernel panic, and how would you troubleshoot it on a Linux system?

Kernel Panic is a critical system error where the Linux kernel cannot continue safely, often caused by:

- ✓ Hardware failures (RAM, disk)
- ✓ Corrupted kernel/initramfs
- ✓ Incompatible drivers/modules
- ✓ Filesystem corruption
- ✓ Incorrect boot configuration

Troubleshooting Steps:

Step	Action
Note the Panic Message	Read the message on screen (screenshot if needed).
Boot into Rescue Mode	Use Live CD or recovery mode to inspect the system.
Check for recent changes	New kernel, updates, hardware? Rollback or boot from previous kernel.
Rebuild Initramfs	dracut -f /boot/initramfs-<kernel>.img <kernel-version>
Reinstall Kernel	dnf reinstall kernel
Use Memtest	Check for RAM errors using memtest86+.
Check /etc/fstab entries	Ensure UUIDs and mount points are correct.
Verify GRUB Configuration	Especially kernel line and initrd path

## Session 2

### Explain the Booting Process in RHEL 7 Onwards (Including RHEL 8/9)

The boot process in RHEL 7, 8, and 9 follows the systemd-based architecture and includes the following stages:

- ◆ Step-by-Step Boot Process:

Stage	Description
1. BIOS/UEFI	Firmware initializes hardware and looks for a bootable disk.
2. Boot Loader (GRUB2)	GRUB loads and presents a boot menu. It loads the selected kernel and initramfs.
3. Kernel	The Linux kernel takes over from GRUB, mounts initramfs, detects hardware.
4. Initramfs	Temporary root file system used to mount the real root file system.
5. systemd (PID 1)	Replaces init (SysVinit). systemd reads its unit files and initializes the system.
6. Targets	Instead of runlevels, systemd uses targets (like graphical.target, multi-user.target).
7. Login Prompt	System displays a GUI or CLI login screen based on the target.

### Overview of Bootable Files in RHEL

Here are key bootable files used during system startup:

File	Purpose
/boot/vmlinuz-<version>	The compressed Linux kernel binary.
/boot/initramfs-<version>.img	Temporary root filesystem used during early boot.
/boot/grub2/grub.cfg	GRUB2 configuration file for boot menu entries.
/etc/default/grub	GRUB settings before grub.cfg is generated.
/boot/efi/EFI/redhat/grubx64.efi	GRUB binary in UEFI-based systems.
/etc/fstab	Tells the system which partitions/filesystems to mount.

### Recover RHEL Machine from GRUB Boot Loader Failure

If GRUB is corrupted or missing, the system may drop to a grub> prompt or show GRUB Rescue mode.

#### Method 1: Recover GRUB Using RHEL ISO

Step-by-Step:

- ✓ Boot from RHEL Installation DVD/ISO
- ✓ Select "Troubleshooting" > "Rescue a Red Hat Enterprise Linux system"
- ✓ Choose 1) Continue to mount your system under /mnt/sysimage
- ✓ Chroot into your system:
  - chroot /mnt/sysimage
- ✓ Reinstall GRUB:
  - ✓ For BIOS systems:
    - grub2-install /dev/sda
  - ✓ For UEFI systems:
    - grub2-install --target=x86\_64-efi --efi-directory=/boot/efi --bootloader-id=redhat
- ✓ Regenerate the GRUB configuration:
  - grub2-mkconfig -o /boot/grub2/grub.cfg
- ✓ Exit and reboot:
  - exit
  - reboot

## Method 2: Manual Recovery from grub> Prompt

If you're at the grub> prompt:

```
ls          # List all partitions  
set root=(hd0,msdos1) # Set the correct /boot partition  
linux /vmlinuz... root=/dev/sdaX ro  
initrd /initramfs...img  
boot
```

Then, once booted, reinstall GRUB as shown above.

### Tip: Prevent Future GRUB Issues

- ✓ Keep /boot on a separate partition with enough space.
- ✓ Use grub2-mkconfig after kernel upgrades.
- ✓ Always verify /etc/fstab and grub.cfg after disk cloning or partition changes.

## Session 3

Category	Command	Description
System Information	hostname	Display or set the hostname
	uname -a	Display kernel and system information
	uptime	Show how long the system has been running
	arch	Display machine architecture
	timedatectl	View or change time/date settings
	whoami	Display current logged-in username
	id	Show user ID and group ID
User Management	adduser <username>	Add a new user
	useradd <username>	Add a new user (alternative syntax)
	passwd <username>	Set/change user password
	usermod -aG <group> <user>	Add user to a group
	userdel <username>	Delete a user
	groupadd <groupname>	Create a new group
	groups	Show groups for current user
File and Directory Management	ls -l	List files with details
	cd <dir>	Change directory
	pwd	Show present working directory
	mkdir <dir>	Create new directory
	touch <file>	Create empty file
	cp <src> <dest>	Copy files or directories
	mv <src> <dest>	Move or rename files
	rm <file>	Delete files
	rm -rf <dir>	Recursively delete a directory
	find /path -name "* .log"	Search for files
	stat <file>	Show file details
Permissions & Ownership	chmod 755 <file>	Set file permissions
	chown user:group <file>	Change file owner and group
	ls -l	Show permissions
	umask	Show default permission mask
Package Management	dnf update	Update all packages
	dnf install <pkg>	Install a package
	dnf remove <pkg>	Remove a package
	dnf list installed	List all installed packages
	dnf info <pkg>	Show info about a package
	dnf clean all	Clean the cache
	dnf repolist	List enabled repositories
	ps aux	Show all running processes
	top	Live view of processes
	htop	Interactive process viewer (install via EPEL)
	kill <PID>	Terminate a process by PID
	killall <proc>	Kill process by name
	nice	Start a process with specific priority
	renice	Change priority of a running process
	systemctl status	Check system service status
Service & Systemd	systemctl start <service>	Start a service

	<code>systemctl stop &lt;service&gt;</code>	Stop a service
	<code>systemctl restart &lt;service&gt;</code>	Restart a service
	<code>systemctl enable &lt;service&gt;</code>	Enable service to start on boot
	<code>systemctl disable &lt;service&gt;</code>	Disable service from starting at boot
	<code>systemctl status &lt;service&gt;</code>	View service status
	<code>systemctl list-units --type=service</code>	List all active services
Networking	<code>ip a</code>	Show IP addresses
	<code>ip r</code>	Show routing table
	<code>nmcli</code>	Control NetworkManager CLI
	<code>ping &lt;host&gt;</code>	Check connectivity
	<code>traceroute &lt;host&gt;</code>	Trace network path
	<code>ss -tuln</code>	List listening ports
	<code>curl &lt;url&gt;</code>	Fetch content from URL
	<code>hostnamectl</code>	Set hostname
	<code>nmtui</code>	Text-based network configuration UI
Disk and Storage	<code>lsblk</code>	List block devices
	<code>df -h</code>	Show disk space usage
	<code>du -sh &lt;dir&gt;</code>	Show directory size
	<code>mount</code>	Mount file systems
	<code>umount</code>	Unmount file systems
	<code>fdisk -l</code>	List partitions (for MBR)
	<code>parted -l</code>	List partitions (for GPT)
	<code>mkfs.ext4 /dev/sdX1</code>	Create ext4 file system
	<code>blkid</code>	Show block device UUIDs
SELinux & Firewall	<code>tune2fs -l /dev/sdX1</code>	Show file system parameters
	<code>getenforce</code>	Show SELinux status
	<code>setenforce 0</code>	Temporarily disable SELinux
	<code>semanage port -l</code>	List SELinux port contexts
	<code>firewall-cmd --state</code>	Check firewall status
	<code>firewall-cmd --add-port=80/tcp --permanent</code>	Open port
Log Management	<code>firewall-cmd --reload</code>	Apply firewall changes
	<code>journalctl</code>	Show system logs
	<code>journalctl -xe</code>	Show recent critical logs
	<code>journalctl -u &lt;service&gt;</code>	Show logs for a specific service
	<code>tail -f /var/log/messages</code>	Watch system logs in real-time
Miscellaneous	<code>dmesg</code>	Show kernel ring buffer
	<code>crontab -e</code>	Edit user cron jobs
	<code>tar -cvf file.tar dir/</code>	Create a tar archive
	<code>tar -xvf file.tar</code>	Extract a tar archive
	<code>scp file user@host:/path</code>	Securely copy file to remote system
	<code>ssh user@host</code>	Connect to remote host via SSH
	<code>history</code>	Show command history
	<code>alias ll='ls -l'</code>	Create alias
	<code>compgen -c   less</code>	View all available commands

# Day – 2

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## Session 1

Linux follows the Filesystem Hierarchy Standard (FHS) — a structured layout of directories and their intended contents.

### ◆ Key Directories and Their Purpose

Directory	Purpose
/	Root directory, the base of the entire Linux file system
/bin	Essential command binaries (e.g., ls, cp, mv)
/boot	Files required for system boot (kernel, GRUB, initramfs)
/dev	Device files (e.g., /dev/sda, /dev/null)
/etc	Critical system-wide configuration files
/home	Home directories for users (/home/user1, /home/user2)
/lib, /lib64	Essential shared libraries
/media, /mnt	Temporary mount points for external filesystems
/opt	Add-on application software packages
/proc	Virtual filesystem for kernel and process info
/root	Home directory for the root user
/run	Volatile runtime data
/sbin	System binaries used by root for maintenance
/srv	Data for services provided by the system
/tmp	Temporary files (cleared on reboot)
/usr	Secondary hierarchy for user data and applications
/var	Variable data (logs, mail, spool files, etc.)

### Importance of /etc Directory

- ✓ Stores system-wide configuration files.
- ✓ Examples:
  - /etc/fstab – Filesystem mount settings
  - /etc/hostname – System hostname
  - /etc/passwd – User accounts
  - /etc/ssh/sshd\_config – SSH server configuration
  - /etc/systemd/system/ – Custom systemd unit files
- ✓ Without /etc, system settings and services cannot be managed or restored properly.

### Create Multiple Partitions and Mount Them on Mount Points

- ➔ Refer to Standard partition
- ➔ Refer to Logical Volume Manager (LVM)

## Session 2

**Convert Existing ext4 Filesystem to XFS** - Direct conversion from ext4 to XFS is not supported. You must backup, reformat, and restore data.

Steps to Convert ext4 to XFS (Manual Method)

- ✓ Backup your data:
  - rsync -av /mnt/ext4\_data/ /mnt/backup/
- ✓ Unmount the ext4 partition:
  - umount /dev/sdX1
- ✓ Format the partition to XFS:
  - mkfs.xfs /dev/sdX1
- ✓ Mount the XFS partition:
  - mount /dev/sdX1 /mnt/xfs\_data
- ✓ Restore your data:
  - rsync -av /mnt/backup/ /mnt/xfs\_data/
- ✓ Update /etc/fstab accordingly.

### Troubleshoot System Failure Due to Boot File Issues

If critical boot files are missing or corrupt (like vmlinuz, initramfs, GRUB):

Step-by-Step Recovery

- ✓ Boot using RHEL/CentOS Installation ISO
  - Select "Rescue a Red Hat Enterprise Linux system" from troubleshooting.
- ✓ Chroot into the system:
  - chroot /mnt/sysimage
- ✓ Check presence of files in /boot:
  - ls /boot
- ✓ Rebuild initramfs if missing:
  - dracut -f /boot/initramfs-<version>.img <kernel-version>
- ✓ Reinstall GRUB:
  - For BIOS:
    - grub2-install /dev/sda
    - grub2-mkconfig -o /boot/grub2/grub.cfg
  - For UEFI:
    - grub2-install --target=x86\_64-efi --efi-directory=/boot/efi --bootloader-id=centos
    - grub2-mkconfig -o /boot/efi/EFI/centos/grub.cfg
- ✓ Exit and reboot:
  - exit
  - reboot

### File Types Supported in Linux

Type	Description
Regular file	Most files (text, binary, images, etc.)
Directory	Contains other files or directories
Symbolic link	Shortcut to another file or directory (ln -s)
Hard link	Additional name for an existing file (ln)
Block device	Represents devices like hard disks (/dev/sda)
Character device	Represents character-based devices (/dev/tty)
FIFO/Named pipe	Used for inter-process communication
Socket	Endpoint for IPC over network or local sockets

## Check using ls -l:

- ✓ : regular file
- ✓ d : directory
- ✓ l : symlink
- ✓ b : block device
- ✓ c : character device
- ✓ p : named pipe
- ✓ s : socket

## File Permissions in Linux

### ◆ File Permission Types:

- Read (r) – view content
- Write (w) – modify content
- Execute (x) – run as a program/script

### ◆ Permission Structure:

diff

CopyEdit

-rwxr-xr-- 1 root root 23 Jun 6 12:30 example.sh

- First character: file type (-, d, l, etc.)
- Next 9: permissions for owner, group, and others

### ◆ Modify Permissions:

- chmod 755 file – changes to rwxr-xr-x
- chown user:group file – changes owner/group

## Risks of Incorrect Permissions:

Incorrect Permission	Issue
No execute on script	Script won't run
World-writable files	Security risk, any user can modify
Misconfigured /etc files	Services may fail to start or boot fails

## Create PV, VG, LV and Format as ext2

### # 1. Create Physical Volume

✓ pvcreate /dev/sdb1

### # 2. Create Volume Group

✓ vgcreate myvg /dev/sdb1

### # 3. Create Logical Volume (10 GB)

✓ lvcreate -L 10G -n mylv myvg

### # 4. Format as ext2

✓ mkfs.ext2 /dev/myvg/mylv

### # 5. Create mount point and mount

✓ mkdir /mylvm

✓ mount /dev/myvg/mylv /mylvm

### # 6. Make permanent

✓ echo '/dev/myvg/mylv /mylvm ext2 defaults 0 0' >> /etc/fstab

## Extend Swap Partition by 2 GB using LVM

✓ # 1. Create a 2 GB LV

○ lvcreate -L 2G -n swap2 myvg

✓ # 2. Format as swap

○ mkswap /dev/myvg/swap2

✓ # 3. Enable the swap

○ swapon /dev/myvg/swap2

✓ # 4. Add to /etc/fstab

○ echo '/dev/myvg/swap2 swap swap defaults 0 0' >> /etc/fstab

## Add 100 MB Swap Using Logical Volume

✓ lvcreate -L 100M -n swap100 myvg

✓ mkswap /dev/myvg/swap100

✓ swapon /dev/myvg/swap100

✓ echo '/dev/myvg/swap100 swap swap defaults 0 0' >> /etc/fstab

## RAID Levels and Benefits

RAID Level	Description	Benefit
RAID 0	Striping, no redundancy	High performance
RAID 1	Mirroring (2 disks)	High redundancy
RAID 5	Block-level striping + parity (3+ disks)	Fault tolerance + good read speed
RAID 6	Double parity (4+ disks)	Can tolerate 2 disk failures
RAID 10	Striping + Mirroring	High performance + redundancy

## Session 3

### Add 100MB of Swap Space Using a Logical Volume

To add 100MB of swap space via LVM, follow these steps:

- ✓ # 1. Create a 100MB logical volume for swap
- ✓ lvcreate -L 100M -n swap\_lv myvg
- ✓ # 2. Format the new LV as swap
- ✓ mkswap /dev/myvg/swap\_lv
- ✓ # 3. Enable the swap space
- ✓ swapon /dev/myvg/swap\_lv
- ✓ # 4. Make it permanent by editing /etc/fstab
- ✓ echo '/dev/myvg/swap\_lv swap swap defaults 0 0' >> /etc/fstab
- ✓ # 5. Verify swap is active
- ✓ swapon --show
- ✓ free -h

### Explain Different RAID Levels and Their Benefits

#### ◆ What is RAID?

RAID (Redundant Array of Independent Disks) combines multiple physical disks into a single logical unit for:

- ✓ Data redundancy
- ✓ Performance
- ✓ Fault tolerance

# DAY – 3

## Session 1

### What are Some Common Linux Package Managers?

Package Manager	Used In	Command Examples
dnf	RHEL, CentOS 8/9, Fedora	dnf install httpd
yum	Older CentOS (6/7), RHEL	yum install vim
apt	Debian, Ubuntu	apt install nginx
zypper	openSUSE, SUSE Linux Enterprise	zypper install apache2
pacman	Arch Linux	pacman -S firefox
emerge	Gentoo	emerge --ask gedit
snap	Ubuntu, multi-distro universal pkgs	snap install vlc
flatpak	Multi-distro universal packages	flatpak install app
rpm	RHEL-based systems (low-level tool)	rpm -ivh package.rpm

### How Do You Install a Package Using a Package Manager?

- ✓ CentOS 9 / RHEL 9 Example (using dnf):
  - sudo dnf install httpd
- ✓ Ubuntu/Debian Example (using apt):
  - sudo apt install apache2
- ✓ Arch Linux Example (using pacman):
  - sudo pacman -S apache
- ✓ Most package managers:
  - Download the package and dependencies
  - Verify GPG keys/signatures
  - Install and configure them

### Difference Between a Package Manager and a Package Management System

Aspect	Package Manager	Package Management System
Definition	A CLI tool to install, remove, or manage packages	A complete framework that includes tools, databases, and policies
Scope	Only the executable tool (dnf, apt, etc.)	Includes repo metadata, versioning, signatures, configs
Example	dnf, apt, yum, pacman	RPM, DEB, Portage, APT system, Flatpak system
Functionality	Executes actions like install, update, remove	Handles repo mgmt, dependency tracking, versioning, rollback
Storage & Metadata	Temporarily uses local cache	Maintains package databases and logs

## Session 3

### Troubleshoot a Network Connectivity Issue on a Linux Server

Step	Command/Check	Purpose
1	ip a or ip addr show	Check IP address assigned
2	ip r or route -n	View routing table
3	nmcli or nmtui	Manage or check NetworkManager status
4	ping <gateway/IP>	Check network reachability
5	traceroute <destination>	Trace the route to the destination
6	ss -tuln or netstat -tuln	Check listening ports
7	firewall-cmd --list-all or iptables -L	Inspect firewall rules
8	cat /etc/resolv.conf	Verify DNS configuration
9	systemctl status NetworkManager	Ensure network service is running
10	journalctl -xe or dmesg	Review system logs for network errors

### Check the Status of a Service and Restart It if Not Running

- ✓ # Check service status
  - systemctl status httpd
- ✓ # If not running, start or restart the service
  - sudo systemctl restart httpd
- ✓ # Enable it to auto-start on boot
  - sudo systemctl enable httpd

### Linux Commands to Diagnose Slow Server Response Time

Command	Purpose
top / htop	Monitor CPU, memory, load averages
uptime	View system load average over time
free -h	Check RAM usage
vmstat 2	Check I/O, memory, process stats
iostat (from sysstat pkg)	View disk I/O performance
dstat, iotop	Real-time stats for disk, memory, CPU
ping <host>	Detect network latency/loss
traceroute <host>	Find where network delays occur
netstat -antp or ss -antp	Check network socket usage
sar	Historical performance data (install sysstat)
journalctl -xe	Review system logs for bottlenecks/errors

## **Set Up /home/rhce Directory for Group Collaboration**

- ✓ # 1. Create group 'rhce'
  - sudo groupadd rhce
- ✓ # 2. Create the shared directory
  - sudo mkdir /home/rhce
- ✓ # 3. Change group ownership to 'rhce'
  - sudo chown root:rhce /home/rhce
- ✓ # 4. Set directory permissions to allow group write access
  - sudo chmod 2775 /home/rhce
- ✓ # 5. Force new files to inherit group 'rhce'
- ✓ # (Already done via chmod 2775: the '2' sets the SGID bit)
- ✓ # 6. Add users to the rhce group (example: user1, user2)
  - sudo usermod -aG rhce user1
  - sudo usermod -aG rhce user2
- ✓ # 7. (Optional) Set default group to rhce for specific users
  - sudo usermod -g rhce user1

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## Session 1

### Configuring a Network Interface in Linux

There are multiple ways to configure a network interface in Linux, but the most common and modern method (in RHEL 8/9, CentOS 8/9, Fedora) is using nmcli.

Method 1: Using nmcli (Recommended for RHEL/CentOS 8/9)

To assign a static IP address:

- ✓ # 1. Identify the interface
  - nmcli device status
- ✓ # Example: eth0
- ✓ # 2. Create a new connection profile
  - nmcli con add type ethernet con-name static-eth0 ifname eth0 ip4 192.168.1.100/24 gw4 192.168.1.1
- ✓ # 3. Set DNS (optional)
  - nmcli con mod static-eth0 ipv4.dns "8.8.8.8 8.8.4.4"
- ✓ # 4. Bring up the connection
  - nmcli con up static-eth0

To assign a dynamic IP address (DHCP):

- ✓ nmcli con add type ethernet con-name dhcp-eth0 ifname eth0
- ✓ nmcli con up dhcp-eth0

Method 2: Using nmtui (Text UI)

Method 3: Manually edit configuration file (ifcfg)

For legacy systems (RHEL 7 or CentOS 7 and below):

Edit /etc/sysconfig/network-scripts/ifcfg-eth0:

```
DEVICE=eth0
BOOTPROTO=static
ONBOOT=yes
IPADDR=192.168.1.100
NETMASK=255.255.255.0
GATEWAY=192.168.1.1
DNS1=8.8.8.8
```

systemctl restart network

### Monitoring Network Traffic in Linux

Command	Purpose
ip -s link	Show interface stats (TX/RX packets, errors)
ss -tuln	Show active listening ports
netstat -i	Interface statistics
ping <host>	Check packet loss/latency
traceroute <host>	Trace route to host

## Real-Time Network Monitoring Tools

Tool	Install Command (RHEL/CentOS)	Usage
nload	dnf install nload	Live bandwidth usage per interface
iftop	dnf install iftop	Top talkers (source/destination IPs)
iptraf	dnf install iptraf-ng	Detailed traffic monitor
bmon	dnf install bmon	Visual bandwidth monitor
tcpdump	dnf install tcpdump	Capture packets for deep analysis
wireshark	GUI, dnf install wireshark-gtk	Graphical packet analysis

## How Do You Troubleshoot Network Connectivity Issues in Linux?

Step	Command	Purpose
Check interface status	ip a or ip addr show	Is IP assigned to the NIC?
Check link status	ethtool eth0 or nmcli dev status	Is the NIC connected?
Test local ping	ping 127.0.0.1	Verifies local TCP/IP stack
Test external ping	ping 8.8.8.8	Checks internet connectivity
Test DNS	ping google.com or dig google.com	Verifies DNS resolution
View routing table	ip route	Default gateway must be correct
Check firewall	firewall-cmd --state or iptables -L	Rules may block traffic
Check services	systemctl status NetworkManager	Network service may be down
Check logs	journalctl -u NetworkManager or dmesg	Look for NIC/driver errors
Restart services	systemctl restart NetworkManager	May resolve transient issues

## How to Diagnose and Fix Time Synchronization Problems in Linux

- ✓ **Check the current time** – timedatectl
- ✓ **Ensure NTP or Chrony is enabled** - systemctl status chronyd
- ✓ **Check Chrony synchronization sources** - chronyc sources -v
- ✓ **Manually force synchronization** - chronyc makestep

## What Tools Are Available for Diagnosing DNS Issues?

Tool	Command Example	Purpose
nslookup	nslookup google.com	Query DNS server for records
dig	dig google.com	Get detailed DNS query output
host	host openai.com	Simple forward/reverse lookup
ping	ping google.com	Checks DNS + ICMP (IP reachability)
traceroute	traceroute google.com	See DNS + routing path
systemd-resolve	systemd-resolve google.com	DNS status (on systems using systemd)
/etc/resolv.conf	cat /etc/resolv.conf	Check DNS server entries

## Common DNS Troubleshooting Steps

- ✓ Verify DNS servers in /etc/resolv.conf
- ✓ Try a different DNS (e.g., 8.8.8.8)
- ✓ Flush DNS cache (if using systemd-resolved):
  - sudo systemd-resolve --flush-caches
- ✓ Check if firewall blocks DNS (iptables or firewalld)

## How Do You Optimize Network Performance in a Linux Environment?

Task	Tool/Method	Command
Increase max file descriptors	/etc/security/limits.conf	ulimit -n 65535
Tune TCP stack parameters	sysctl	See below ↓
Enable Jumbo Frames (if supported)	ip link set mtu 9000 dev eth0	For large transfers
Reduce DNS lookup delays	Edit /etc/nsswitch.conf (put hosts: files dns)	Faster resolution
Check interface speed/duplex	ethtool eth0	Check for full duplex
Monitor performance	iftop, nload, bmon	Real-time stats
Use faster DNS servers	8.8.8.8, 1.1.1.1, 9.9.9.9	Low-latency resolvers

## How Can You Determine Which Process Is Consuming the Most Memory on a Linux System?

Command	Purpose
top	Live list of CPU + memory usage
htop	Enhanced top with color and filtering
free -h	Shows overall memory usage
`ps aux --sort=-%mem	head`
smem	Break down memory used per process (install separately)
vmstat 2	Show memory, swap, I/O stats
pmap <pid>	Shows memory map of a process

## Session 2

### Common Network Services and Protocols in Linux Environments

Service	Protocol	Port(s)	Purpose
SSH	TCP	22	Secure remote login
FTP/SFTP	TCP	21/22	File transfer
HTTP/HTTPS	TCP	80/443	Web services
DNS (named)	UDP/TCP	53	Domain name resolution
SMTP (Postfix)	TCP	25, 587	Mail sending
POP3/IMAP	TCP	110/143	Mail retrieval
NTP/Chrony	UDP	123	Time synchronization
NFS	TCP/UDP	2049	File sharing across network
SAMBA/SMB	TCP	445	Windows file sharing
DHCP	UDP	67/68	IP address assignment
SNMP	UDP	161/162	Network monitoring
MySQL/MariaDB	TCP	3306	Database service

### What Parameter Can Be Set at Boot Time to Enable/Disable SELinux?

SELinux can be enabled or disabled at boot using the kernel parameter.

1. Temporary Change (next boot only):
  - ✓ Edit the GRUB menu (e during boot).
  - ✓ Find the line starting with linux.
  - ✓ Add:
    - selinux=0
  - ✓ to disable, or:
    - selinux=1 enforcing=1
  - ✓ to enable in enforcing mode.
2. Permanent Change (via grub config):
  - ✓ Edit /etc/default/grub:
    - GRUB\_CMDLINE\_LINUX="... selinux=0"
  - ✓ Then regenerate GRUB:
    - grub2-mkconfig -o /boot/grub2/grub.cfg
  - ✓ This method disables SELinux at the kernel level, unlike setting it in /etc/selinux/config.

## Would You Replace iptables with firewalld on All Servers?

firewalld Pros (Modern, Recommended for RHEL 7+/CentOS 7+):

- ✓ Uses zones (more secure and flexible)
- ✓ Supports dynamic changes without restarting the service
- ✓ D-Bus/API support for automation
- ✓ Better suited for cloud/virtualized environments
- ✓ Easier for admins unfamiliar with raw iptables rules

iptables Pros (Advanced users):

- ✓ Full control with fine-grained rules
- ✓ Preferred in containerized, low-level networking
- ✓ Lighter if you're scripting rules yourself
- ✓ Works well in minimal installs

## Network Configuration Files to Check for Ethernet Card Configuration (RHEL/CentOS 7/8/9)

File Path	Purpose
/etc/sysconfig/network-scripts/ifcfg-<interface>	Main config file for each NIC (e.g., ifcfg-eth0)
/etc/sysconfig/network	Global network settings (deprecated in newer RHEL versions)
/etc/hostname	Stores the system hostname
/etc/hosts	Static hostname to IP mapping
/etc/resolv.conf	DNS server configuration
/etc/nsswitch.conf	Determines name resolution order (hosts: files dns)
/etc/NetworkManager/NetworkManager.conf	NetworkManager configuration (used in CentOS/RHEL 7+)
/etc/udev/rules.d/	Custom persistent interface naming rules
/etc/netplan/*.yaml	(Ubuntu/Debian only – not used in RHEL)

## Command to Check All Open Ports on Your Machine

- ✓ ss -tuln
  - -t: TCP
  - -u: UDP
  - -l: Listening
  - -n: Don't resolve names (faster)
- ✓ netstat -tuln
- ✓ ss -tulnp
- ✓ lsof -i -P -n | grep LISTEN
- ✓ nmap -sT -O localhost

## Differences Between TCP and UDP

Feature	TCP (Transmission Control Protocol)	UDP (User Datagram Protocol)
Connection Type	Connection-oriented (3-way handshake)	Connectionless
Reliability	Reliable (guarantees delivery, retransmits lost data)	Unreliable (no guarantee of delivery/order)
Data Ordering	Maintains order of data	May arrive out of order
Error Checking	Yes (with acknowledgment)	Basic checksum only
Speed	Slower (due to overhead and retransmission)	Faster (low overhead)
Use Cases	Web, SSH, FTP, Email	Streaming, DNS, VoIP, Online Gaming
Ports Examples	HTTP(80), HTTPS(443), SSH(22)	DNS(53), TFTP(69), DHCP(67/68)

## Configuring a Network Interface in Linux

Using nmcli (Command-line method)

```
nmcli con add type ethernet con-name static-eth0 ifname eth0 ip4 192.168.1.100/24 gw4 192.168.1.1
nmcli con mod static-eth0 ipv4.dns "8.8.8.8 1.1.1.1"
nmcli con up static-eth0
```

## Tools Available for Diagnosing DNS Issues

Tool	Command Example	Purpose
ping	ping google.com	Checks if DNS resolves to an IP
dig	dig openai.com	Queries DNS servers for detailed info
nslookup	nslookup openai.com	Similar to dig, for quick lookup
host	host openai.com	Simple DNS lookup
resolvectl	resolvectl query openai.com	DNS info with systemd-resolved
systemd-resolve	systemd-resolve --status	Show DNS servers in use
cat /etc/resolv.conf		Check which DNS servers are being queried
nmap	nmap -p 53 -sU <dns-server-ip>	Scan if DNS port is open

## Commands to Start, Stop, Restart, Enable, and Disable the Firewall (firewalld)

Action	Command	Purpose
Start firewall	sudo systemctl start firewalld	Starts firewalld now
Stop firewall	sudo systemctl stop firewalld	Stops firewalld now
Restart firewall	sudo systemctl restart firewalld	Restarts firewalld
Reload firewall	sudo firewall-cmd --reload	Reloads config without restart
Enable firewall	sudo systemctl enable firewalld	Start at boot
Disable firewall	sudo systemctl disable firewalld	Prevents from starting at boot
Check status	sudo systemctl status firewalld	Check if it's running

## Difference Between TFTP and FTP Server

Feature	FTP	TFTP
Protocol	TCP	UDP
Ports	21 (control), 20 (data)	69
Authentication	Yes (user/password)	No authentication
Complexity	Complex, supports directories	Simple, single file transfers
Use Case	Full file transfer with access control	Firmware booting (PXE), simple config file transfers
Security	Requires hardening	Less secure, often restricted

## Most Important Features of VSFTPD

- ✓ High performance and security
- ✓ Supports IPv6 and virtual users
- ✓ SSL/TLS encryption support
- ✓ Chroot jail for users
- ✓ Bandwidth throttling
- ✓ Connection limits
- ✓ Passive/active mode FTP support

## Different Versions of NFS Server

Version	Key Features
NFSv2	Old, limited file size, rarely used now
NFSv3	Adds support for larger files, async writes
NFSv4	Firewall-friendly (single port), strong security with Kerberos, ACLs
NFSv4.1/4.2	Parallel NFS (pNFS), improved performance

## NFS Server Configuration Files

File	Purpose
/etc/exports	Main config: define shared directories
/etc/idmapd.conf	NFSv4 user ID mapping
/etc/sysconfig/nfs	Set ports, daemon behavior

## Common /etc(exports Options

/shared\_dir 192.168.1.0/24(rw, sync, no\_root\_squash)

Option	Description
rw/ro	Read-write or read-only
sync	Synchronous writes (safe)
no_root_squash	Allows root access from client (use with care)
anonuid/anongid	Map anonymous users
subtree_check	Ensures access within exported subtree

## On Which Ports Does a Samba Server Work?

Port	Protocol	Purpose
137	UDP	NetBIOS name service
138	UDP	NetBIOS datagram service
139	TCP	NetBIOS session service (legacy SMB)
445	TCP	Direct SMB over TCP (modern SMB)

## How to Check and Configure Network Settings in Linux?

Command	Purpose
ip a or ip addr	View IP addresses and interfaces
ip r	Show routing table
nmcli device status	Check device status (active, disconnected)
nmcli con show	List all network profiles
cat /etc/resolv.conf	View DNS server configuration
hostnamectl	View or set hostname

## Common Reasons for a Linux System Not Booting Up & Troubleshooting Steps

Issue	Cause	Troubleshooting/Action
RUB Bootloader error	Corrupted or missing GRUB	Boot with Live CD → grub2-install + grub2-mkconfig
Kernel panic	Incompatible kernel/module, missing root device	Boot older kernel → Check /boot → Reinstall kernel
Filesystem corruption	Improper shutdown, bad disk	Boot into rescue mode → fsck
Missing initramfs/initrd	Wrong/missing initramfs	Rebuild with dracut or reinstall kernel
Disk not detected	SATA/RAID misconfiguration in BIOS/UEFI	Check BIOS → Verify disk presence via Live CD
Incorrect fstab entries	Invalid UUID, mount options	Boot into rescue mode → Edit /etc/fstab
SELinux misconfiguration	Invalid contexts blocking init	Boot with selinux=0 → Fix labels using restorecon
Wrong boot target	System stuck in emergency or multi-user.target	systemctl get-default → change with systemctl set-default
Hardware failure	Disk, RAM, GPU failure	Use SMART tools, memtest, check hardware logs

## Significance of Log Files in Troubleshooting

Log File	Purpose
/var/log/messages	General system logs
/var/log/secure	Authentication, sudo, ssh, su logs
/var/log/boot.log	Boot process info
/var/log/dmesg	Kernel ring buffer (hardware init logs)
/var/log/yum.log	Package install/removal history
/var/log/cron	Cron job activity
/var/log/audit/audit.log	SELinux and security events (audited)
journalctl	Systemd-managed logs (use filters)

## What Are Forward and Reverse Lookup?

Type	Description	Example
Forward Lookup	Resolves a hostname to an IP address	ping google.com → 142.250.183.206
Reverse Lookup	Resolves an IP address to a hostname	dig -x 142.250.183.206 → google.com

## What Is an Authoritative DNS Server?

- ✓ An **authoritative DNS server** holds the **original zone file** for a domain and responds with **official answers** (no recursion) for DNS queries related to that domain.
- ✓ Example: If you're querying example.com, the authoritative server provides the final answer from its zone data.

## What Is DNS Spoofing?

DNS Spoofing (or DNS Cache Poisoning) is a type of attack where false DNS responses are inserted into a resolver's cache, redirecting users to malicious or unintended websites.

Prevention:

- ✓ Use DNSSEC
- ✓ Regularly update your OS
- ✓ Restrict access to DNS servers

## What Are Resource Records in DNS?

Record Type	Purpose	Example
A	Maps hostname to IPv4 address	example.com → 192.168.1.1
AAAA	Maps hostname to IPv6 address	example.com → ::1
MX	Mail exchange server	mail.example.com
CNAME	Canonical name (alias)	www → example.com
PTR	Reverse lookup (IP → hostname)	1.1.168.192.in-addr.arpa
NS	Nameservers for the domain	ns1.example.com
SOA	Start of authority (zone control info)	Contains serial, TTL, etc.

## Where to Find Configuration Directories for Apache?

File/Directory	Purpose
/etc/httpd/conf/httpd.conf	Main Apache configuration file
/etc/httpd/conf.d/	Directory for additional configs
/etc/httpd/conf.modules.d/	Module configuration files
/var/www/html	Default DocumentRoot (web root)
/etc/httpd/logs → /var/log/httpd/	Default log file location

## What Are the Different Log Files of Apache? Where Are They Located?

Log File	Purpose
/var/log/httpd/access_log	Records every request to Apache
/var/log/httpd/error_log	Logs warnings, errors, and diagnostics
/var/log/httpd/ssl_error_log	SSL-related errors (if using HTTPS)
/var/log/httpd/ssl_access_log	SSL access log

## What Are the Different Filters That Can Be Applied Using Squid?

Filter Type	Example
IP-based	Allow or block specific client IPs
Time-based	Restrict access by time of day/week
Domain-based	Block or allow websites using domain names
URL regex	Match specific URLs or patterns
MIME type	Block file types (e.g., .mp3, .exe)
Port-based	Allow/deny traffic to specific destination ports
User-based (with auth)	Allow per-user access using authentication

## What Is ACL in Squid? What Are Important ACL Elements?

Element	Description	Example
src	Source IP or subnet	acl office_users src 192.168.1.0/24
dst	Destination IP	acl blocked_dst dst 10.0.0.1
dstdomain	Destination domain name	acl badsites dstdomain .facebook.com
url_regex	Match regex in URL	acl downloads url_regex \.exe\$
time	Match by time/day	acl working_hours time MTWHF 9:00-17:00
port	Destination port	acl ssl_ports port 443
myip	Squid server IP	acl local_ip myip 10.0.0.2