

Task 2: Operating System Security Fundamentals (Kali Linux)

Introduction

Operating System (OS) security focuses on protecting the system from unauthorized access, misuse, and cyber threats. Since the OS manages users, files, processes, and network access, securing it is critical for overall system security.

In this task, OS security concepts were practically implemented using **Kali Linux**, a Linux-based operating system widely used in cyber security.

User Accounts and Access Control

Linux uses user accounts to control access to system resources. Each user is assigned specific permissions that define what actions they can perform. Kali Linux separates users into **root (administrator)** and **normal users**, ensuring that sensitive system operations are restricted and protected from misuse.

Access control helps prevent unauthorized access and limits the damage in case a user account is compromised.

Root User vs Normal User

The **root user** has full administrative privileges and can modify system files, manage services, and install software.

Normal users have limited permissions and cannot make critical system changes.

In Kali Linux, switching between root and normal users demonstrates privilege separation, which is an essential security practice to reduce system risk.

File Permissions in Linux

Linux secures files using permission settings that define who can **read, write, or execute** a file. These permissions apply to the file owner, group, and others.

Commands such as ls -l, chmod, and chown are used to view and modify file permissions and ownership. Proper permission management prevents unauthorized file access and protects sensitive data.

Process and Service Management

Processes are running instances of programs, while services are background processes that start automatically.

Kali Linux provides tools to monitor running processes and active services, helping identify unnecessary or suspicious activity.

Regular monitoring improves system stability and security.

Disabling Unnecessary Services

Running unnecessary services increases the system's attack surface. Services that are not required should be disabled to minimize security risks.

Disabling unused services in Kali Linux reduces potential vulnerabilities and strengthens system protection.

Firewall and Network Security

A firewall controls incoming and outgoing network traffic based on security rules.

In this task, **UFW (Uncomplicated Firewall)** was used in Kali Linux to restrict unauthorized network access.

Firewalls act as a protective barrier against network-based attacks.

Operating System Hardening

OS hardening is the process of strengthening system security by reducing vulnerabilities and enforcing secure configurations.

In Kali Linux, OS hardening was achieved through:

- Managing user privileges
- Securing file permissions
- Disabling unnecessary services
- Enabling firewall protection

These practices improve the system's resistance to attacks.

Principle of Least Privilege

The principle of least privilege ensures that users and applications have only the minimum permissions required to perform their tasks.

This principle reduces the risk of privilege misuse and limits the impact of security breaches.

Conclusion

This task provided practical exposure to OS security fundamentals using Kali Linux. By implementing access control, managing permissions, monitoring processes, enabling firewalls, and applying OS hardening techniques, a secure operating system environment was achieved.

The practical demonstrated how Linux OS security concepts are applied in real-world cyber security scenarios.

```
kali-linux-2026-W02-vmware-amd64 - VMware Workstation
File Edit View VM Tabs Help ||| 
Home kali-linux-2026-W02-vmwar... 
Session Actions Edit View Help
kali@kali:~$ whoami
kali
kali@kali:~$ id
uid=1000(kali) gid=1000(kali) groups=1000(kali),4(adm),20(dialout),24(cdrom),25(floppy),27(sudo),29(audio),30(dip),44(video),46(plugdev),100(users),101(netdev),103(scanner),107(bluetooth),118(lpadmin),127(wireless),128(kaboxer)
kali@kali:~$ cat /etc/passwd
root:x:0:0:root:/usr/bin/zsh
daemon:x:1:1:daemon:/usr/sbin:/usr/sbin/nologin
bin:x:2:2:bin:/usr/sbin:/usr/sbin/nologin
sys:x:3:3:sys:/dev:/usr/sbin:/usr/sbin/nologin
sync:x:4:65534:sync:/bin:/bin/sync
games:x:5:60:games:/usr/games:/usr/sbin:/usr/sbin/nologin
man:x:6:12:man:/var/cache/man:/usr/sbin:/usr/sbin/nologin
lp:x:7:7:lp:/var/spool/lpd:/usr/sbin:/usr/sbin/nologin
mail:x:8:8:mail:/var/mail:/usr/sbin:/usr/sbin/nologin
news:x:9:9:news:/var/spool/news:/usr/sbin:/usr/sbin/nologin
uucp:x:10:10:uucp:/var/spool/uucp:/usr/sbin:/usr/sbin/nologin
proxy:x:11:11:proxy:/bin:/usr/sbin:/usr/sbin/nologin
www-data:x:33:33:www-data:/var/www:/usr/sbin:/usr/sbin/nologin
backup:x:34:34:backup:/var/backups:/usr/sbin:/usr/sbin/nologin
list:x:38:38:Mailing List Manager:/var/list:/usr/sbin:/usr/sbin/nologin
irc:x:39:39:ircd:/run/ircd:/usr/sbin:/usr/sbin/nologin
apt:x:42:65534::/nonexistent:/usr/sbin:/nologin
nobody:x:65534:65534:nobody:/nonexistent:/usr/sbin:/nologin
systemd-network:x:998:998:systemd Network Management:/usr/sbin:/nologin
dhcpcd:x:996:996:DHCP Client Daemon:/usr/lib/dhcpcd:/bin/false
systemd-timesync:x:998:990:systemd Time Synchronization:/usr/sbin:/nologin
messagebus:x:989:989:System Message Bus:/nonexistent:/usr/sbin:/nologin

To direct input to this VM, move the mouse pointer inside or press Ctrl+G.
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kali-linux-2026-W02-vmware-amd64 - VMware Workstation
File Edit View VM Tabs Help ||| 
Home kali-linux-2026-W02-vmwar... 
Session Actions Edit View Help
gymx:123:126::/var/lib/openvas:/usr/sbin/nologin
kali:1000:1000::/home/kali:/usr/bin/zsh
kali@kali:~$ sudo su
[sudo] password for kali:
[root@kali]~/home/kali
# exit

kali@kali:~$ touch test.txt

kali@kali:~$ ls -l test.txt
-rw-rw-r-- 1 kali kali 0 Jan 16 11:22 test.txt
kali@kali:~$ chmod 700 test.txt
ls -l test.txt
-rwx----- 1 kali kali 0 Jan 16 11:22 test.txt
kali@kali:~$ sudo chown root test.txt
ls -l test.txt
-rwx----- 1 root kali 0 Jan 16 11:22 test.txt
kali@kali:~$ sudo apt install ufw -y
The following packages were automatically installed and are no longer required:
```

```
kali-linux-2026-W02-vmware-amd64 - VMware Workstation
File Edit View VM Tabs Help ||| 
Home kali-linux-2026-W02-vmwar...
Session Actions Edit View Help
$ sudo chown root test.txt
ls -l test.txt
-rwx----- 1 root kali 0 Jan 16 11:22 test.txt
(kali㉿kali)-[~]
$ sudo apt install ufw -y
The following packages were automatically installed and are no longer required:
libgav1-1 libmpjpegutils-2.1-0t64 libmpeg2enccpp-2.1-0t64 libmplex2-2.1-0t64
Use 'sudo apt autoremove' to remove them.
Installing:
  ufw
Suggested packages:
  rsyslog
Summary:
  Upgrading: 0, Installing: 1, Removing: 0, Not Upgrading: 0
  Download size: 169 kB
  Space needed: 880 kB / 58.8 GB available
Get:1 http://kali.download/kali kali-rolling/main amd64 ufw all 0.36.2-9 [169 kB]
Fetched 169 kB in 2s (74.4 kB/s)
Preconfiguring packages ...
Selecting previously unselected package ufw.
(Reading database ... 440446 files and directories currently installed.)
Preparing to unpack .../archives/ufw_0.36.2-9_all.deb ...
Unpacking ufw (0.36.2-9) ...
Setting up ufw (0.36.2-9) ...
Creating config file /etc/ufw(before.rules with new version
Creating config file /etc/ufw(before6.rules with new version
Creating config file /etc/ufw(after.rules with new version
Creating config file /etc/ufw(after6.rules with new version
update-rc.d: We have no instructions for the ufw init script.

To direct input to this VM, move the mouse pointer inside or press Ctrl+G.
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kali-linux-2026-W02-vmware-amd64 - VMware Workstation
File Edit View VM Tabs Help ||| 
Home kali-linux-2026-W02-vmwar...
Session Actions Edit View Help
$ sudo apt install ufw -y
The following packages were automatically installed and are no longer required:
libgav1-1 libmpjpegutils-2.1-0t64 libmpeg2enccpp-2.1-0t64 libmplex2-2.1-0t64
Use 'sudo apt autoremove' to remove them.
Installing:
  ufw
Suggested packages:
  rsyslog
Summary:
  Upgrading: 0, Installing: 1, Removing: 0, Not Upgrading: 0
  Download size: 169 kB
  Space needed: 880 kB / 58.8 GB available
Get:1 http://kali.download/kali kali-rolling/main amd64 ufw all 0.36.2-9 [169 kB]
Fetched 169 kB in 2s (74.4 kB/s)
Preconfiguring packages ...
Selecting previously unselected package ufw.
(Reading database ... 440446 files and directories currently installed.)
Preparing to unpack .../archives/ufw_0.36.2-9_all.deb ...
Unpacking ufw (0.36.2-9) ...
Setting up ufw (0.36.2-9) ...
Creating config file /etc/ufw(before.rules with new version
Creating config file /etc/ufw(before6.rules with new version
Creating config file /etc/ufw(after.rules with new version
Creating config file /etc/ufw(after6.rules with new version
update-rc.d: We have no instructions for the ufw init script.
update-rc.d: It looks like a non-network service, we enable it.
Create symlink '/etc/system/system/multi-user.target.wants/ufw.service' → '/usr/lib/systemd/system/ufw.service'.
Processing triggers for kali-menu (2025.4.3) ...
Processing triggers for man-db (2.13.1-1) ...
(kali㉿kali)-[~]
$ sudo ufw enable
Firewall is active and enabled on system startup
(kali㉿kali)-[~]
$ sudo ufw status
Status: active
(kali㉿kali)-[~]
$ ps aux
```

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kali-linux-2026-W02-vmware-amd64 - VMware Workstation
File Edit View VM Tabs Help ||| 
Home kali-linux-2026-W02-vmwar... 
Session Actions Edit View Help
Session Actions Edit View Help
Processing triggers for man-db (2.13.1-1) ...
(kali㉿kali)-[~]
$ sudo ufw enable
Firewall is active and enabled on system startup
(kali㉿kali)-[~]
$ sudo ufw status
Status: active
(kali㉿kali)-[~]
$ ps aux
USER PID %CPU %MEM VSZ RSS TTY STAT START TIME COMMAND
root 1 0.4 0.7 24912 15820 ? Ss 11:18 0:01 /sbin/init splash
root 2 0.0 0.0 0 0 ? S 11:18 0:00 [kthreadd]
root 3 0.0 0.0 0 0 ? S 11:18 0:00 [pool_workqueue_release]
root 4 0.0 0.0 0 0 ? I< 11:18 0:00 [kworker/R-rcu_gp]
root 5 0.0 0.0 0 0 ? I< 11:18 0:00 [kworker/R-sync_wq]
root 6 0.0 0.0 0 0 ? I< 11:18 0:00 [kworker/R-kvfree_rcu_reclaim]
root 7 0.0 0.0 0 0 ? I< 11:18 0:00 [kworker/R-slab_flushwq]
root 8 0.0 0.0 0 0 ? I< 11:18 0:00 [kworker/R-mm_percpu_wq]
root 10 0.0 0.0 0 0 ? I< 11:18 0:00 [kworker/R-0:0-events_highpri]
root 11 0.0 0.0 0 0 ? I 11:18 0:00 [kworker/0:1-mm_percpu_wq]
root 12 0.0 0.0 0 0 ? I 11:18 0:00 [kworker/u512:0-ipv6_addrconf]
root 13 0.0 0.0 0 0 ? I< 11:18 0:00 [kworker/R-mm_percpu_wq]
root 14 0.0 0.0 0 0 ? S 11:18 0:00 [ksoftirqd/0]
root 15 0.1 0.0 0 0 ? I 11:18 0:00 [rcu_prempt]
root 16 0.0 0.0 0 0 ? S 11:18 0:00 [rcu_exp_par_gp_kthread_worker/1]
root 17 0.0 0.0 0 0 ? S 11:18 0:00 [rcu_exp_gp_kthread_worker]
root 18 0.0 0.0 0 0 ? S 11:18 0:00 [migration/0]
root 19 0.0 0.0 0 0 ? S 11:18 0:00 [idle_inject/0]
root 20 0.0 0.0 0 0 ? S 11:18 0:00 [cpuhp/0]
root 21 0.0 0.0 0 0 ? S 11:18 0:00 [cpuhp/1]

To direct input to this VM, move the mouse pointer inside or press Ctrl+G.
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kali-linux-2026-W02-vmware-amd64 - VMware Workstation
File Edit View VM Tabs Help ||| 
Home kali-linux-2026-W02-vmwar... 
Session Actions Edit View Help
Session Actions Edit View Help
(kali㉿kali)-[~]
$ ps aux
USER PID %CPU %MEM VSZ RSS TTY STAT START TIME COMMAND
root 1 0.4 0.7 24912 15820 ? Ss 11:18 0:01 /sbin/init splash
root 2 0.0 0.0 0 0 ? S 11:18 0:00 [kthreadd]
root 3 0.0 0.0 0 0 ? S 11:18 0:00 [pool_workqueue_release]
root 4 0.0 0.0 0 0 ? I< 11:18 0:00 [kworker/R-rcu_gp]
root 5 0.0 0.0 0 0 ? I< 11:18 0:00 [kworker/R-sync_wq]
root 6 0.0 0.0 0 0 ? I< 11:18 0:00 [kworker/R-kvfree_rcu_reclaim]
root 7 0.0 0.0 0 0 ? I< 11:18 0:00 [kworker/R-slab_flushwq]
root 8 0.0 0.0 0 0 ? I< 11:18 0:00 [kworker/R-mm_percpu_wq]
root 10 0.0 0.0 0 0 ? I< 11:18 0:00 [kworker/R-0:0-events_highpri]
root 11 0.0 0.0 0 0 ? I 11:18 0:00 [kworker/0:1-mm_percpu_wq]
root 12 0.0 0.0 0 0 ? I 11:18 0:00 [kworker/u512:0-ipv6_addrconf]
root 13 0.0 0.0 0 0 ? I< 11:18 0:00 [kworker/R-mm_percpu_wq]
root 14 0.0 0.0 0 0 ? S 11:18 0:00 [ksoftirqd/0]
root 15 0.1 0.0 0 0 ? I 11:18 0:00 [rcu_prempt]
root 16 0.0 0.0 0 0 ? S 11:18 0:00 [rcu_exp_par_gp_kthread_worker/1]
root 17 0.0 0.0 0 0 ? S 11:18 0:00 [rcu_exp_gp_kthread_worker]
root 18 0.0 0.0 0 0 ? S 11:18 0:00 [migration/0]
root 19 0.0 0.0 0 0 ? S 11:18 0:00 [idle_inject/0]
root 20 0.0 0.0 0 0 ? S 11:18 0:00 [cpuhp/0]
root 21 0.0 0.0 0 0 ? S 11:18 0:00 [cpuhp/1]
root 22 0.0 0.0 0 0 ? S 11:18 0:00 [idle_inject/1]
root 23 0.0 0.0 0 0 ? S 11:18 0:00 [migration/1]
root 24 0.0 0.0 0 0 ? S 11:18 0:00 [ksoftirqd/1]
root 26 0.0 0.0 0 0 ? I< 11:18 0:00 [kworker/1:0-events_highpri]
root 27 0.0 0.0 0 0 ? S 11:18 0:00 [cpuhp/2]
root 28 0.0 0.0 0 0 ? S 11:18 0:00 [idle_inject/2]
root 29 0.0 0.0 0 0 ? S 11:18 0:00 [migration/2]
root 30 0.0 0.0 0 0 ? S 11:18 0:00 [ksoftirqd/2]
root 31 0.0 0.0 0 0 ? I 11:18 0:00 [kworker/2:0-events]
root 32 0.0 0.0 0 0 ? I< 11:18 0:00 [kworker/2:0-events_highpri]
root 33 0.0 0.0 0 0 ? S 11:18 0:00 [cpuhp/3]
root 34 0.0 0.0 0 0 ? S 11:18 0:00 [idle_inject/3]

To direct input to this VM, move the mouse pointer inside or press Ctrl+G.
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kali-linux-2026-W02-vmware-amd64 - VMware Workstation
File Edit View VM Tabs Help ||| 
Home kali-linux-2026-W02-vmwar... 
Session Actions Edit View Help
kali 4977 100 0.2 9808 4436 pts/0 R+ 11:24 0:00 ps aux
(kali㉿kali)-[~]
$ top
top - 11:25:06 up 6 min, 1 user, load average: 0.17, 0.17, 0.09
Tasks: 223 total, 1 running, 222 sleeping, 0 stopped, 0 zombie
%Cpu(s): 10.5 us, 0.0 sy, 0.0 ni, 89.5 id, 0.0 wa, 0.0 hi, 0.0 si, 0.0 st
MiB Mem: 1936.5 total, 249.9 free, 882.9 used, 967.7 buff/cache
MiB Swap: 953.7 total, 953.7 free, 0.0 used. 1053.7 avail Mem

USER PR NI VIRT RES SHR S %CPU %MEM TIME+ COMMAND
root -51 0 0 0 0 S 0.0 0.0 0:00.00 irq/48-pciehp
root -51 0 0 0 0 S 0.0 0.0 0:00.00 irq/49-pciehp
root -51 0 0 0 0 S 0.0 0.0 0:00.00 irq/50-pciehp
root -51 0 0 0 0 S 0.0 0.0 0:00.00 irq/51-pciehp
root -51 0 0 0 0 S 0.0 0.0 0:00.00 irq/52-pciehp
root -51 0 0 0 0 S 0.0 0.0 0:00.00 irq/53-pciehp
root -51 0 0 0 0 S 0.0 0.0 0:00.00 irq/54-pciehp
root -51 0 0 0 0 S 0.0 0.0 0:00.00 irq/55-pciehp
root 0 -20 0 0 0 I 0.0 0.0 0:00.00 kworker/R-acpi_thermal_pm
root 0 -20 0 0 0 I 0.0 0.0 0:00.00 kworker/R-mld
root 0 -20 0 0 0 I 0.0 0.0 0:00.00 kworker/R-ip6_addrconf
root 20 0 0 0 0 I 0.0 0.0 0:00.00 kworker/R-ip128_ip6_addrconf
root 0 -20 0 0 0 I 0.0 0.0 0:00.00 kworker/R-kstrip
root 20 0 0 0 0 I 0.0 0.0 0:00.00 kworker/us143-events_unbound
root 0 -20 0 0 0 I 0.0 0.0 0:00.00 kworker/us150
root 0 -20 0 0 0 I 0.0 0.0 0:00.01 kworker/us160-ttm
root 0 -20 0 0 0 I 0.0 0.0 0:00.00 kworker/us170-ttm
root 0 -20 0 0 0 I 0.0 0.0 0:00.03 kworker/0:1h-kblockd
root 0 -20 0 0 0 I 0.0 0.0 0:00.07 kworker/1:1h-kblockd
root 0 -20 0 0 0 I 0.0 0.0 0:00.03 kworker/2:1h-kblockd
root 20 0 0 0 0 I 0.0 0.0 0:00.27 kworker/12-cgroup_release
root 0 -20 0 0 0 I 0.0 0.0 0:00.00 kworker/R-ata_sff
root 0 -20 0 0 0 I 0.0 0.0 0:00.00 kworker/R-mpt_poll_0
root 0 -20 0 0 0 I 0.0 0.0 0:00.00 kworker/R-mpt_0

To direct input to this VM, move the mouse pointer inside or press Ctrl+G.
20°C Clear Search ENG IN 22:01 16-01-2026
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kali-linux-2026-W02-vmware-amd64 - VMware Workstation
File Edit View VM Tabs Help ||| 
Home kali-linux-2026-W02-vmwar... 
Session Actions Edit View Help
kali㉿kali)-[~]
$ systemctl list-units --type=service
UNIT          LOAD ACTIVE SUB   DESCRIPTION
accounts-daemon.service loaded active running Accounts Service
colord.service    loaded active running Manage, Install and Generate Color Profiles
console-setup.service loaded active exited Set console font and keymap
cron.service     loaded active running Regular background program processing daemon
dbus.service      loaded active running D-Bus System Message Bus
getty@tty1.service loaded active running Getty on tty1
hwclock.service   loaded active running Ensure time is synchronized based on the HAVEGE algorithm
ifupdown.service  loaded active running Help to synchronize boot up for ifupdown
keyboard-setup.service loaded active exited Set the console keyboard layout
kmod-static-nodes.service loaded active exited Create list of Static Device Nodes
lightdm.service   loaded active running Light Display Manager
ModemManager.service loaded active running Modem Manager
networking.service loaded active exited Raise network interfaces
NetworkManager-wait-online.service loaded active exited Network Manager Wait Online
NetworkManager.service loaded active running Network Manager
open-vm-tools.service loaded active running Service for virtual machines hosted on VMware
plymouth-quit-wait.service loaded active exited Hold until boot process finishes up
plymouth-read-write.service loaded active exited Tell Plymouth To Write Out Runtime Data
plymouth-start.service loaded active exited Show Plymouth Boot Screen
polkit.service    loaded active running Authorization Manager
rpc-statdNotify.service loaded active exited Notify NFS peers of a restart
rtkit-daemon.service loaded active running RealtimeKit Scheduling Policy Service
systemd-bifrost.service loaded active exited Set up Additional Binary Formats
systemd-boot-flush.service loaded active exited High Priority Persistent Storage
systemd-journal.service loaded active running Journal Service
systemd-login.service loaded active running User Login Management
systemd-modules-load.service loaded active exited Load Kernel Modules
systemd-randomseed.service loaded active exited Load/Save OS Random Seed
systemd-remount-fs.service loaded active exited Remount Root and Kernel File Systems
systemd-sysctl.service loaded active exited Apply Kernel Variables
systemd-timesyncd.service loaded active running Network Time Synchronization
systemd-tmpfiles-setup-dev-early.service loaded active exited Create Static Device Nodes in /dev gracefully

To direct input to this VM, move the mouse pointer inside or press Ctrl+G.
20°C Clear Search ENG IN 22:01 16-01-2026
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```
kali@kali:~$ systemctl status
Session Actions Edit View Help
plmout-quit-wait.service loaded active exited Hold until boot process finishes up
plmout-read-write.service loaded active exited Tell Plymouth To Write Out Runtime Data
plmout-start.service loaded active running Show Plymouth Boot Screen
polkit.service loaded active running Authorization Manager
rpc-statd-notify.service loaded active running Notify NFS peers of a restart
rtkit-daemon.service loaded active running RealtimeKit Scheduling Policy Service
systemd-binfmt.service loaded active running Set up Additional Binary Formats
systemd-local-fs.service loaded active running Mount Local Persistent Storage
systemd-journald.service loaded active running Journal Service
systemd-logind.service loaded active running User Login Management
systemd-modules-load.service loaded active exited Load Kernel Modules
systemd-random-seed.service loaded active exited Load/Save OS Random Seed
systemd-remount-fs.service loaded active exited Remount Root and Kernel File Systems
systemd-sysctl.service loaded active exited Apply Kernel Variables
systemd-timesyncd.service loaded active running Network Time Synchronization
systemd-tmpfiles-setup-dev-early.service loaded active exited Create Static Device Nodes in /dev gracefully
systemd-tmpfiles-setup-dev.service loaded active exited Create Static Device Nodes in /dev
systemd-tmpfiles-setup.service loaded active exited Create System Files and Directories

(kali㉿kali)-[~]
$ sudo systemctl stop apache2
sudo systemctl disable apache2
Synchronizing state of apache2.service with SysV service script with /usr/lib/systemd/systemd-sysv-install.
Executing: /usr/lib/systemd/systemd-sysv-install disable apache2
(kali㉿kali)-[~]
$ sudo systemctl stop apache2
sudo systemctl disable apache2
Synchronizing state of apache2.service with SysV service script with /usr/lib/systemd/systemd-sysv-install.
Executing: /usr/lib/systemd/systemd-sysv-install disable apache2
(kali㉿kali)-[~]
$
```

To direct input to this VM, move the mouse pointer inside or press Ctrl+G.

20°C
Clear



22:02
ENG IN 16-01-2026