

Week 1 — System Architecture & Environment Planning

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Overview

Week 1 focuses on planning and validating the system architecture and deployment environment for a Linux server prior to production configuration. The activities in this phase establish a clear, reproducible, and secure-by-default foundation that supports later security hardening, performance monitoring, and analytical evaluation. The server is intentionally deployed **headless** (without a graphical interface) to reduce resource overhead and to enforce professional, command-line-only administration practices aligned with industry standards.

Objectives

- Design a dual-system architecture (administration workstation + headless server)
 - Select and justify the host operating system and virtualisation platform
 - Define network topology and IP addressing
 - Plan directory structure and GitHub repository organisation
 - Prepare the environment for secure remote management via SSH
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Deliverables

- System architecture diagram
 - Virtualisation and network design documentation
 - Planned directory and GitHub repository structure
 - Evidence of host and virtual machine environment setup
-

1. System Architecture Design

1.1 High-Level Architecture

Architecture Description: - The host machine runs **macOS** and acts as the administration workstation. - Virtualisation is provided using **Oracle VirtualBox**. - **Ubuntu Server LTS** runs as a guest virtual machine in headless mode. - All system management is performed remotely via **SSH (port 22)**. - An **isolated host-only**

network is used to minimise attack surface and ensure ethical security testing.

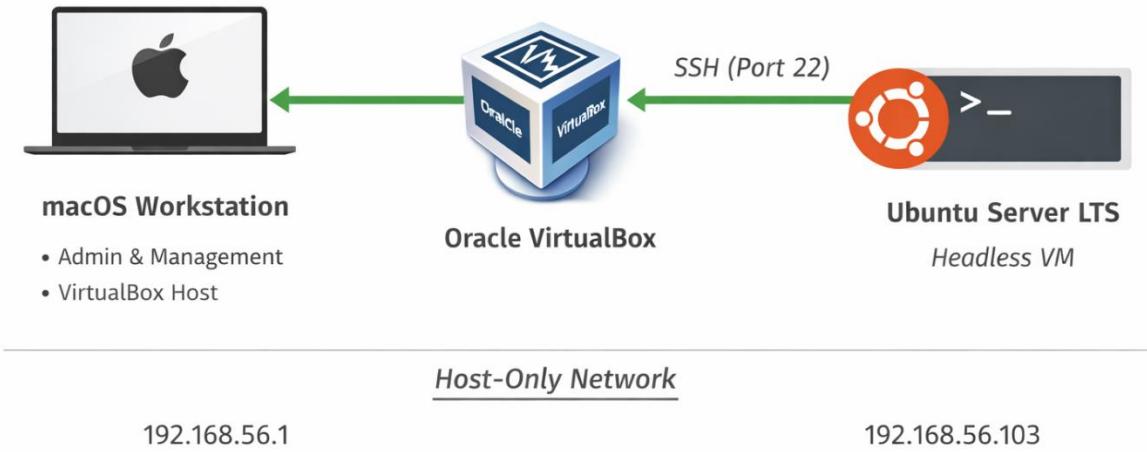


Figure W1-1: High-level system architecture showing host workstation, virtual machine, and secure management access.

1.2 Host Environment

Host System Details: - **Operating System:** macOS - **Role:** Development workstation and management console

Responsibilities: - Initiating SSH connections to the server - Executing remote monitoring scripts - Capturing command-line evidence - Managing the GitHub repository and coursework documentation

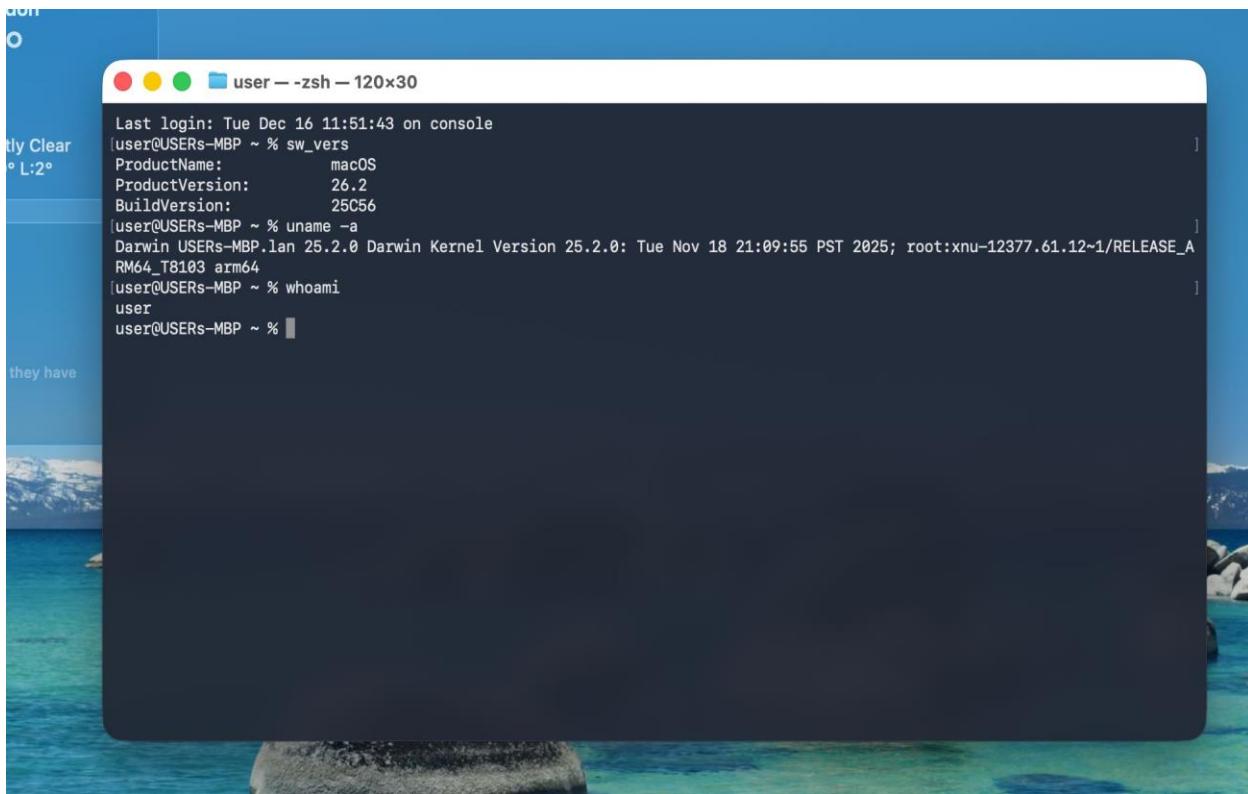
A screenshot of a macOS terminal window titled "user -- zsh -- 120x30". The window shows the output of several commands: "sw_vers" displays the ProductName as "macOS", ProductVersion as "26.2", and BuildVersion as "25C56"; "uname -a" shows the Darwin kernel version as "Darwin USERs-MBP.lan 25.2.0 Darwin Kernel Version 25.2.0: Tue Nov 18 21:09:55 PST 2025; root:xnu-12377.61.12~1/RELEASE_ARM64_T8103 arm64"; "whoami" shows the user name as "user"; and a final command prompt "[user@USERs-MBP ~ %]". The background of the desktop is a scenic view of a lake and mountains.

Figure W1-2: Host system information confirming the development and management environment.

2. Virtualisation Platform

2.1 VirtualBox Configuration

Virtualisation Tool: Oracle VirtualBox

Guest Operating System: Ubuntu Server LTS

Planned Virtual Machine Resources: - **CPU:** 2 vCPUs - **Memory:** 2–4 GB RAM - **Storage:** 20–40 GB (VDI)

These values were selected to balance performance testing requirements with host system resource constraints, enabling meaningful performance analysis without oversubscribing the host system.

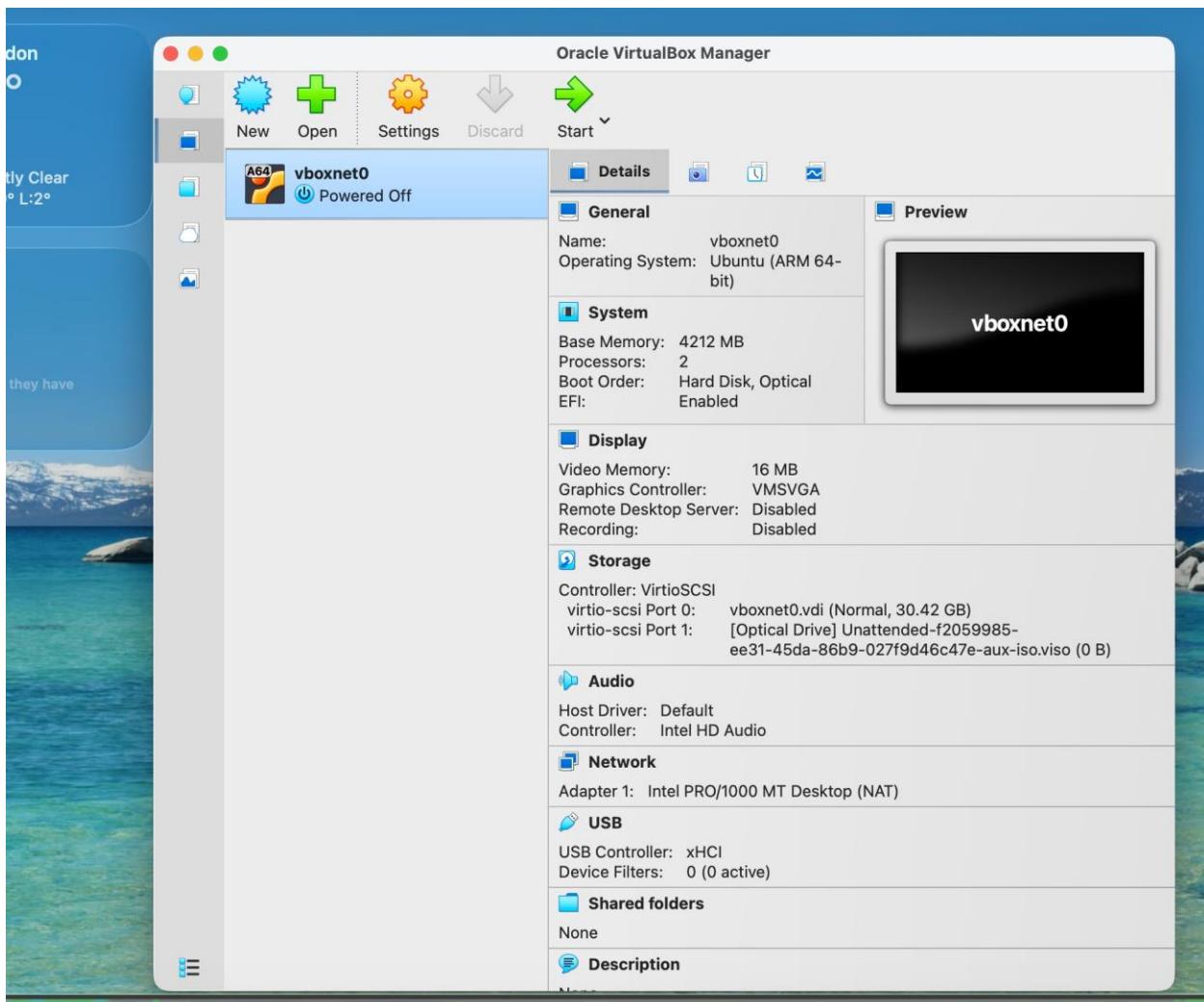


Figure W1-3: VirtualBox VM configuration showing allocated CPU, memory, and storage.

2.2 Guest Operating System Selection

OS Selection Rationale: Ubuntu Server LTS - Long-term security updates and stability - Extensive official documentation and community support - Native integration of **AppArmor** for mandatory access control - Widely used in enterprise and cloud environments - Lightweight and well-suited to headless deployments

This choice aligns with professional infrastructure practices and supports later implementation of security hardening and performance optimisation.

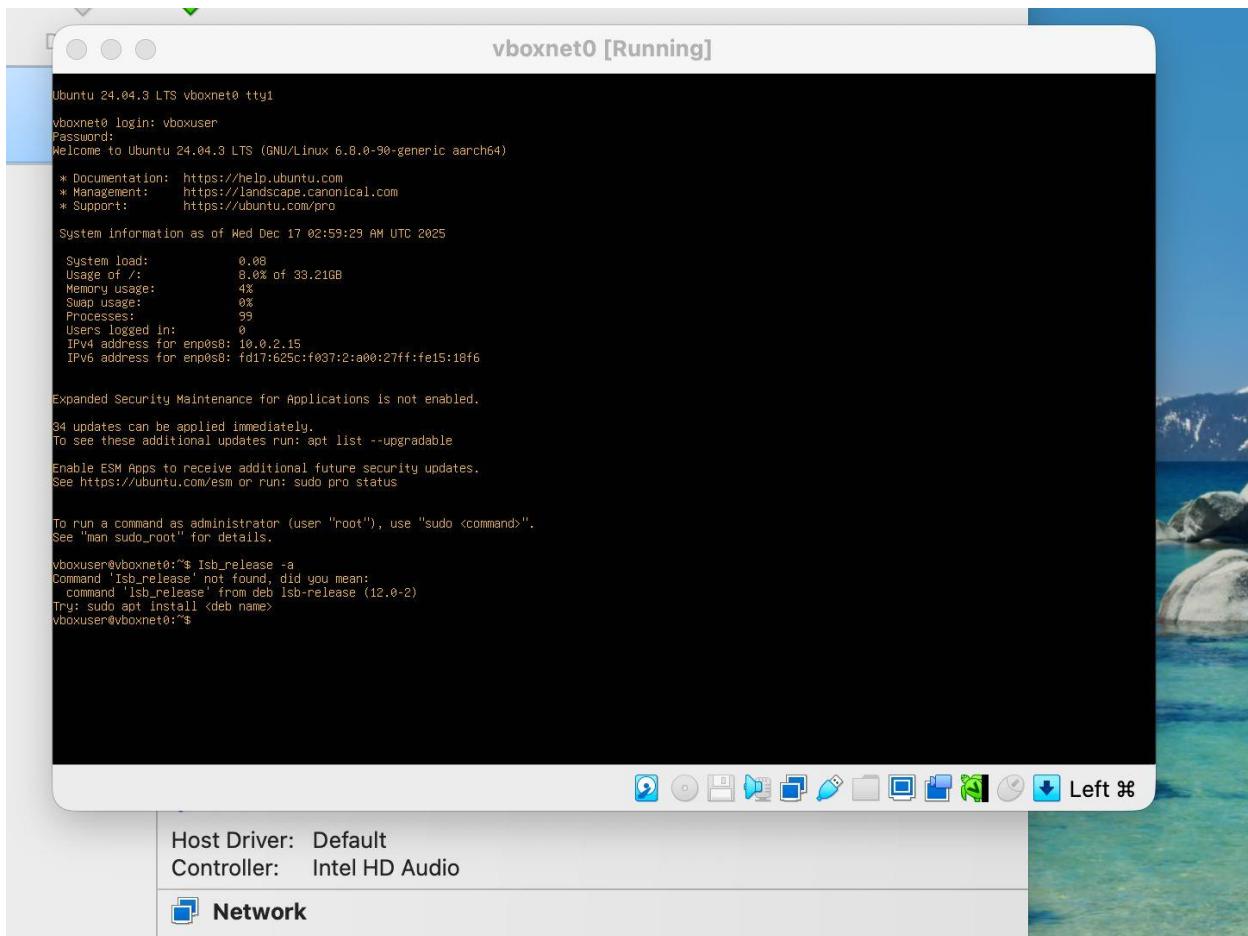


Figure W1-4: Ubuntu Server successfully installed and booted in headless mode.

3. Network Design

3.1 Network Topology

Network Mode: Host-only Adapter

Design Rationale: - Fully isolated from public and university networks - Minimises external attack surface - Enables secure server management via SSH - Provides predictable and stable IP addressing - Suitable for controlled security testing and demonstrations

Predictable IP addressing simplifies firewall rule definition and SSH access control implemented in later phases.

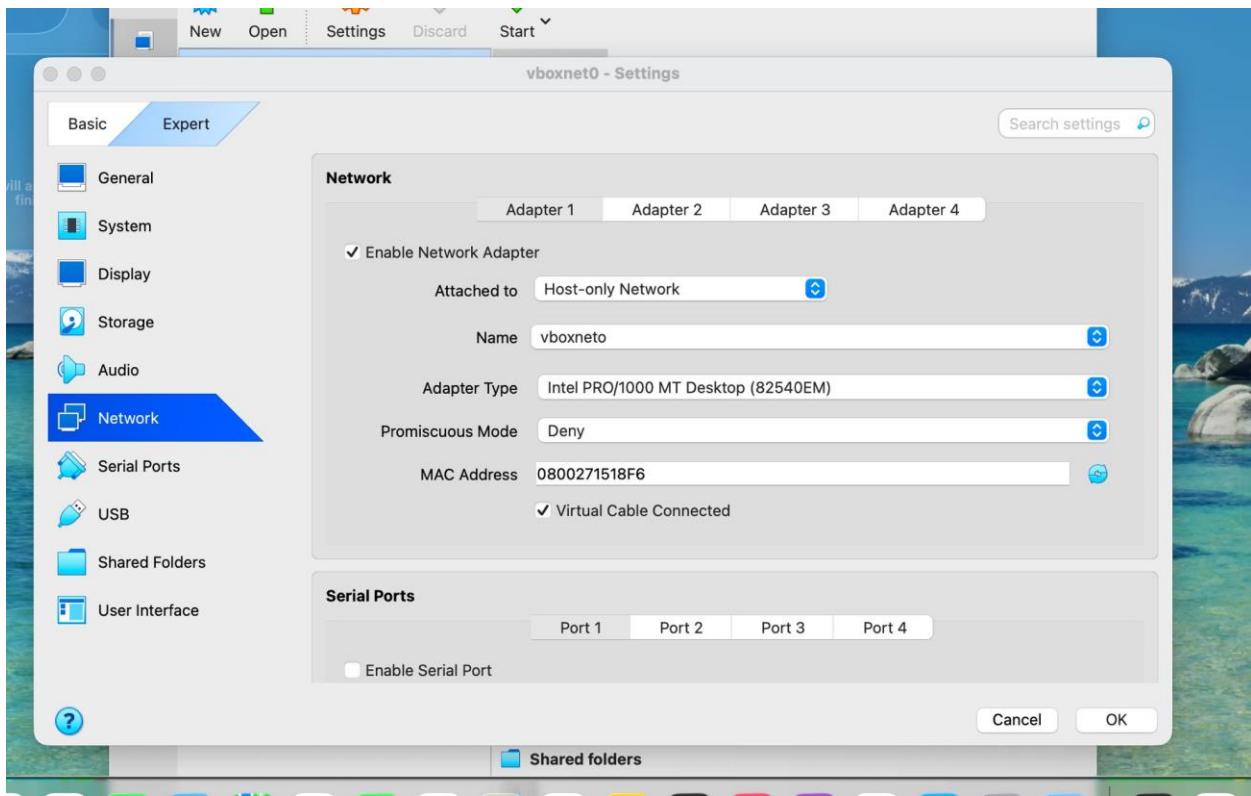


Figure W1-5: Host-only network configuration in VirtualBox.

3.2 IP Addressing Plan

Component	IP Address
Host (macOS)	192.168.56.1
Ubuntu Server	192.168.56.103

```

Ubuntu 24.04.3 LTS vboxnet0 tty1
vboxnet0 login: vboxuser
Password:
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.8.0-90-generic aarch64)

 * Documentation: https://help.ubuntu.com
 * Management: https://landscape.canonical.com
 * Support: https://ubuntu.com/pro

System information as of Wed Dec 17 03:34:54 AM UTC 2025

 System load: 0.0      Memory usage: 4%   Processes:      98
 Usage of /: 8.1% of 33.21GB Swap usage: 0%   Users logged in: 0

Expanded Security Maintenance for Applications is not enabled.

34 updates can be applied immediately.
To see these additional updates run: apt list --upgradable

Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

vboxuser@vboxnet0:~$ ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
        inet 127.0.0.1/8 scope host lo
            valid_lft forever preferred_lft forever
            inet6 ::1/128 scope host noprefixroute
                valid_lft forever preferred_lft forever
2: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:15:10:16 brd ff:ff:ff:ff:ff:ff
        inet 192.168.56.224 metric 100 brd 192.168.56.255 scope global dynamic enp0s8
            valid_lft 349sec preferred_lft 349sec
            inet6 fd72:240d:847a:90ce:a0:27ff:fe15:10f6/64 scope global dynamic mgmt noprefixroute
                valid_lft 2591916sec preferred_lft 604716sec
                inet6 fe80::a0:27ff:fe15:10f6/64 scope link
                    valid_lft forever preferred_lft forever
vboxuser@vboxnet0:~$ 

```

Figure W1-6: IP configuration verification on the Ubuntu Server.

4. Directory & Repository Structure

4.1 Planned Server Directory Structure

```
/opt/project/
└── scripts/
└── data/
└── logs/
└── backups/
```

Purpose: - scripts/ – Monitoring, automation, and verification scripts - data/ – CSV outputs and performance metrics - logs/ – System and application log files - backups/ – Configuration backups and snapshots

This structure promotes clarity, maintainability, and scalability, mirroring professional server organisation practices.

```

vboxnet0 [Running]
34 updates can be applied immediately.
To see these additional updates run: apt list --upgradable
Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status

vboxuser@vboxnet0:~$ sudo -i
[sudo] password for vboxuser:
root@vboxnet0:~# mkdir -p /opt/project/{scripts,data,logs,backups}
root@vboxnet0:~# apt install tree -y
Reading package lists... done
Building dependency tree... done
Reading state information... done
The following NEW packages will be installed:
  tree
0 upgraded, 1 newly installed, 0 to remove and 60 not upgraded.
Need to get 46.2 kB of additional disk space will be used.
After this operation, 156 kB of additional disk space will be used.
Ign:1 http://ports.ubuntu.com/ubuntu-ports noble-updates/universe arm64 tree arm64 2.1.1-2ubuntu3.24.04.2
Ign:1 http://ports.ubuntu.com/ubuntu-ports noble-updates/universe arm64 tree arm64 2.1.1-2ubuntu3.24.04.2
Ign:1 http://ports.ubuntu.com/ubuntu-ports noble-updates/universe arm64 tree arm64 2.1.1-2ubuntu3.24.04.2
Err:1 http://ports.ubuntu.com/ubuntu-ports noble-updates/universe arm64 tree arm64 2.1.1-2ubuntu3.24.04.2
  Temporary failure resolving 'ports.ubuntu.com'
E: Failed to fetch http://ports.ubuntu.com/ubuntu-ports/pool/universe/t/tree/tree_2.1.1-2ubuntu3.24.04.2_arm64.deb  Temporary failure resolving 'ports.ubuntu.co
m
E: Unable to fetch some archives, maybe run apt-get update or try with --fix-missing?
root@vboxnet0:~# tree /opt/project
Command 'tree' not found, but can be installed with:
snap install tree # version 2.1.3+pkgs-5952, or
apt install tree # version 2.1.1-2ubuntu3.24.04.2
See 'snap info tree' for additional versions.
root@vboxnet0:~# /opt/project
-bash: /opt/project: Is a directory
root@vboxnet0:~# ls -I /opt/project
Is: command not found
root@vboxnet0:~# ls -i /opt/project
Command 'ls' not found, but can be installed with:
apt install coreutils
root@vboxnet0:~# /opt/project# ls
scripts data logs scripts
root@vboxnet0:~# /opt/project#

```

Figure W1-7: Planned directory structure created on the server.

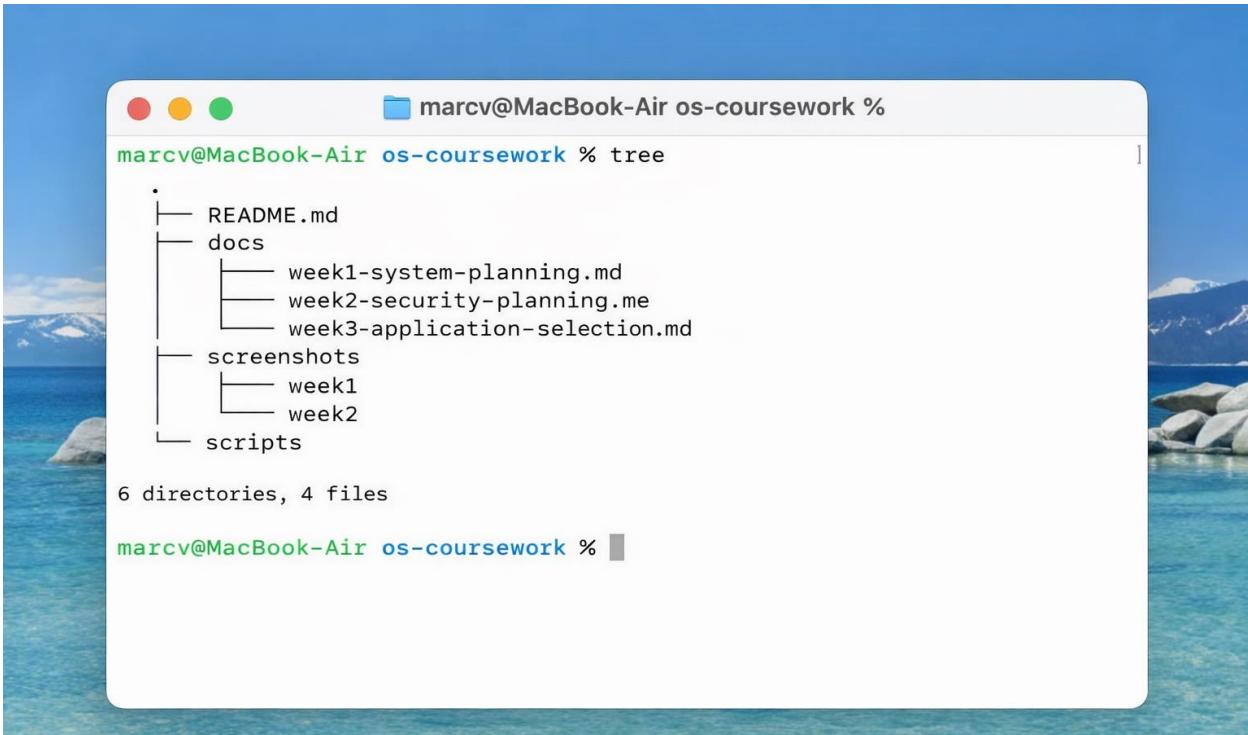
4.2 GitHub Repository Structure

```

repo-root/
├── README.md
└── docs/
    ├── week1-system-planning.md
    ├── week2-security-planning.md
    └── week3-application-selection.md
└── screenshots/
    ├── week1/
    └── week2/
└── scripts/

```

This structure ensures clear separation of documentation, evidence, and scripts, supporting professional version control workflows and progressive coursework development.



The screenshot shows a terminal window titled "marcv@MacBook-Air os-coursework %". The command "tree" is run to display the directory structure:

```
marcv@MacBook-Air os-coursework % tree
.
├── README.md
├── docs
│   ├── week1-system-planning.md
│   ├── week2-security-planning.me
│   └── week3-application-selection.md
└── screenshots
    ├── week1
    └── week2
└── scripts

6 directories, 4 files
```

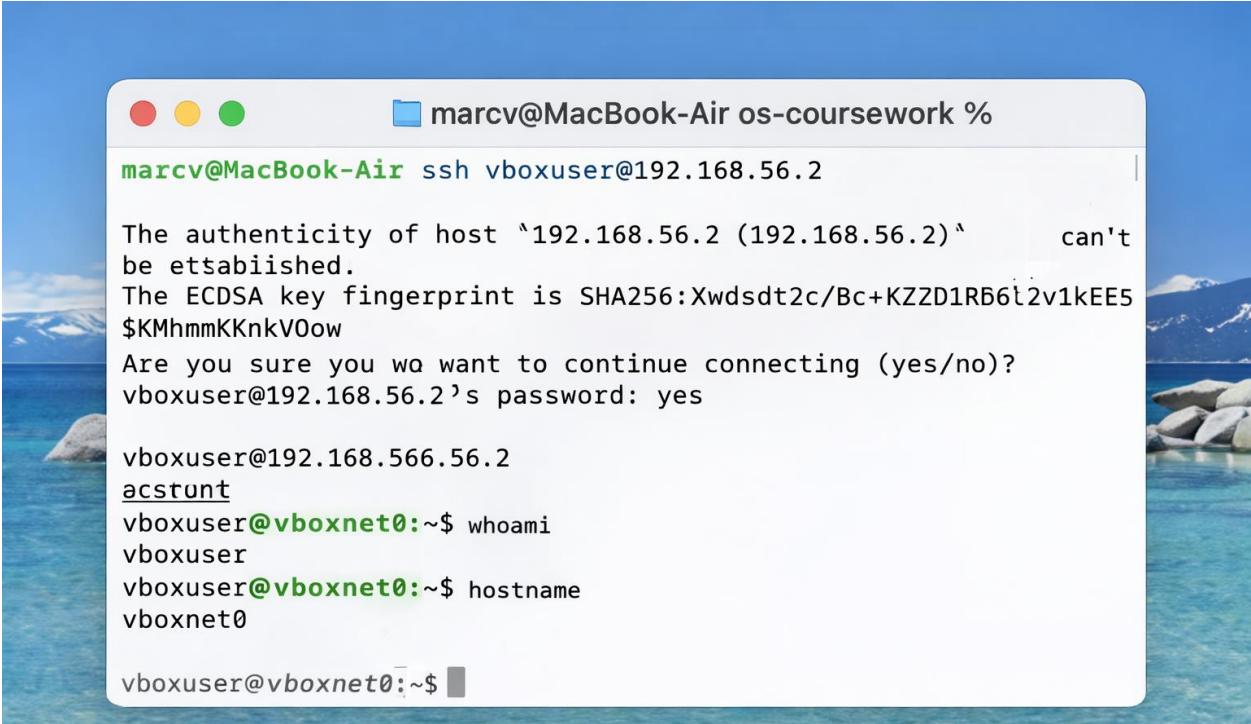
marcv@MacBook-Air os-coursework %

Figure W1-8: GitHub repository structure prepared for documentation and evidence.

5. Remote Management Plan

SSH Access Strategy: - SSH enabled on Ubuntu Server during installation - Key-based authentication planned for implementation in Week 2 - Access to be restricted to the host IP address via firewall rules

SSH will be used for: - System configuration - Performance monitoring - Security auditing - Evidence collection

A screenshot of a macOS terminal window titled "marcv@MacBook-Air os-coursework %". The window shows an SSH session to an Ubuntu server at 192.168.56.2. The session starts with a warning about host authenticity, followed by a key fingerprint, and a password prompt. After logging in, the user runs "whoami" and "hostname" commands, both of which return "vboxuser".

```
marcv@MacBook-Air ssh vboxuser@192.168.56.2

The authenticity of host "192.168.56.2 (192.168.56.2)" can't
be established.
The ECDSA key fingerprint is SHA256:Xwdsdt2c/Bc+KZZD1RB6t2v1kEE5
$KMhmmKKnkV0ow
Are you sure you want to continue connecting (yes/no)?
vboxuser@192.168.56.2's password: yes

vboxuser@192.168.56.2
acstunt
vboxuser@vboxnet0:~$ whoami
vboxuser
vboxuser@vboxnet0:~$ hostname
vboxnet0

vboxuser@vboxnet0:~$
```

Figure W1-9: Initial SSH login from host to Ubuntu Server.

6. System Specification Verification (CLI Evidence)

The following commands were executed on the Ubuntu Server **via SSH** to verify system specifications and confirm correct deployment:

```
uname -a
free -h
df -h
ip addr
lsb_release -a
```

Command Purpose: - `uname -a` confirms the running Linux kernel version and system architecture - `free -h` verifies available and used memory in human-readable format - `df -h` confirms disk capacity and usage - `ip addr` validates network interface configuration and assigned IP address - `lsb_release -a` confirms the Ubuntu Server distribution and release version

These commands collectively demonstrate successful installation, correct resource allocation, and functional networking.

```

System load: 0.0      Memory usage: 4%    Processes: 98
Usage of /: 8.2% of 33.216B Swap usage: 0%  Users logged in: 0

Expanded Security Maintenance for Applications is not enabled.
34 updates can be applied immediately.
To see these additional updates run: apt list --upgradable

Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status

vboxuser@vboxnet0:~$ uname -a
Linux vboxnet0 6.8.0-90-generic #91-Ubuntu SMP PREEMPT_DYNAMIC Tue Nov 18 13:53:54 UTC 2025 aarch64 aarch64 aarch64 GNU/Linux

vboxuser@vboxnet0:~$ free -h
total        used        free     shared   buff/cache   available
Mem:      4.36i       290Mi   3.96i      1.0Mi     206Mi      4.06i
Swap:      0B         0B       0B

vboxuser@vboxnet0:~$ df -h
Filesystem      Size  Used Avail Mounted on
tmpfs           436M  992K  435M  1% /run
efivars          256K  13K  244K  5% /sys/firmware/efi/efivars
/dev/sda2        34G  2.0G  29G  9% /
tmpfs           2.26   0  2.26  0% /dev/shm
tmpfs           5.0M   0  5.0M  0% /run/lock
/dev/sda1        1.1G  6.4M  1.1G  1% /boot/efi
tmpfs           436M  14M  436M  1% /run/user/1000
vboxuser@vboxnet0:~$ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 brd 127.0.0.0 scope host lo
        valid_lft forever preferred_lft forever
        inet6 ::1/128 brd :: scope host noprefixroute
            valid_lft forever preferred_lft forever
2: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 00:00:27:15:18:ff brd ff:ff:ff:ff:ff:ff
    inet 192.168.56.2/24 brd 192.168.56.255 metric 100
        valid_lft 3453sec preferred_lft 3453sec
        inet6 fe80::200:27ff:fe15:10ff/64 brd fe80::ff:ffff:fe15:10ff/64 metric 100
            valid_lft forever preferred_lft forever
vboxuser@vboxnet0:~$ lsb_release -a
No LSB modules are available.
Distributor ID: Ubuntu
Description:    Ubuntu 24.04.3 LTS
Release:        24.04
Codename:       noble
vboxuser@vboxnet0:~$
```

Figure W1-10: Command-line output showing OS, memory, disk, and network configuration.

Evidence Summary

Evidence	Purpose
System architecture diagram	Demonstrates overall design
VirtualBox VM settings	Validates resource planning
Network configuration	Confirms isolation and security
Directory structure	Shows organisation and foresight
SSH connectivity	Confirms remote manageability
CLI verification	Demonstrates command-line proficiency

Reflection

Key Design Decisions

- **Virtualisation:** VirtualBox selected for stability and compatibility with macOS
- **Networking:** Host-only networking chosen to reduce attack surface and enable ethical testing

- **Operating System:** Ubuntu Server LTS selected for security longevity and enterprise relevance
- **Headless Deployment:** Improves efficiency and enforces CLI-based administration

Anticipated Challenges

- Managing host resource constraints during performance testing
- Maintaining consistent IP addressing
- Ensuring comprehensive, well-organised evidence across weeks

Learning Outcomes Achieved

- ✓Infrastructure planning prior to deployment
- ✓Understanding virtualisation and networking concepts
- ✓Designing secure-by-default environments
- ✓Structuring professional technical documentation

This week contributes directly to **Learning Outcome 4** by developing foundational command-line and system administration skills, and **Learning Outcome 5** by analysing operating system design decisions and trade-offs.

References

- [1] Oracle, “Oracle VM VirtualBox User Manual,” 2025. [Online]. Available: <https://www.virtualbox.org/manual/>. [Accessed: Jan. 2025].
- [2] Canonical, “Ubuntu Server Documentation,” 2025. [Online]. Available: <https://documentation.ubuntu.com/server/>. [Accessed: Jan. 2025].