

Phase 3: Application Selection for Performance Testing (Week 3)

3.1 Phase Overview

The objective of Phase 3 was to select and install applications that represent **different operating system workload types** in order to evaluate system performance under varied conditions. These workloads were chosen to stress key operating system subsystems including CPU scheduling, memory management, disk I/O, network stack performance, and real-world server behaviour.

All applications were installed **remotely via SSH**, adhering strictly to the coursework requirement that the server operates headlessly without a graphical interface. The selected tools are lightweight, industry-standard, and suitable for execution within a virtualised Ubuntu Server environment.

3.2 Application Selection Matrix

Workload Type	Application	Description	Justification
CPU-intensive	stress-ng	Generates controlled CPU load	Enables evaluation of CPU utilisation, scheduler behaviour, and performance under sustained computational stress
RAM-intensive	stress-ng	Allocates and stresses system memory	Allows analysis of memory consumption, memory pressure handling, and potential swapping behaviour
Disk I/O-intensive	fio	Flexible I/O workload generator	Industry-standard benchmarking tool used to measure disk throughput, latency, and I/O efficiency
Network-intensive	iperf3	Network bandwidth measurement tool	Used to evaluate network throughput, latency, and operating system network stack efficiency
Server application	nginx	Lightweight web server	Represents a real-world server workload, enabling analysis of service responsiveness and resource overhead

The selected applications collectively provide comprehensive coverage of operating system resource management and allow meaningful performance comparison during later testing phases.

3.3 Installation Documentation (SSH-Based)

All applications were installed using the Advanced Package Tool (apt) via an SSH connection to the server.

System Update

```
sudo apt update && sudo apt upgrade -y
```

CPU & RAM Workload Tool

```
sudo apt install stress-ng -y
```

```
stress-ng --version
```

Disk I/O Workload Tool

```
sudo apt install fio -y
```

```
fio --version
```

Network Workload Tool

```
sudo apt install iperf3 -y
```

```
iperf3 --version
```

Server Application

```
sudo apt install nginx -y
```

```
systemctl status nginx --no-pager
```

Successful installation was verified using package listings:

```
dpkg -l | grep -E "stress-ng|fio|iperf3|nginx"
```

All installations were completed successfully and verified through command-line output, with screenshots captured as evidence.

3.4 Expected Resource Profiles

The anticipated resource utilisation for each application is outlined below:

stress-ng (CPU workload)

- **CPU:** Very high utilisation
- **Memory:** Low to moderate
- **Disk I/O:** Minimal
- **Network:** None

stress-ng (Memory workload)

- **CPU:** Moderate
- **Memory:** High allocation
- **Disk I/O:** Possible under memory pressure
- **Network:** None

fio

- **CPU:** Moderate
- **Memory:** Low to moderate
- **Disk I/O:** High read/write activity
- **Network:** None

iperf3

- **CPU:** Moderate
- **Memory:** Low
- **Network:** High throughput
- **Disk I/O:** None

nginx

- **CPU:** Low to moderate (request dependent)
- **Memory:** Low footprint
- **Disk I/O:** Low
- **Network:** Moderate to high depending on traffic

These expected profiles form the baseline assumptions that will be validated during Phase 6 performance testing.

3.5 Monitoring Strategy

The following monitoring tools will be used to collect performance metrics during testing:

Resource Tool		Purpose
CPU	top, htop	Monitor CPU utilisation and process scheduling
Memory	free -h, vmstat	Analyse memory usage and swapping behaviour
Disk I/O	iostat, fio output	Measure disk throughput and I/O latency
Network	iperf3, ping	Measure bandwidth, latency, and packet loss
Services	systemctl status, ss -tln	Verify service availability and listening ports

Metrics will be collected remotely via SSH to ensure accurate representation of real-world server administration practices.

3.6 Reflection

This phase highlighted the importance of selecting workloads that meaningfully represent different operating system subsystems. Using industry-standard tools such as stress-ng, fio, and iperf3 ensures that the performance analysis conducted in later phases is realistic, reproducible, and professionally relevant. The inclusion of a real server application (nginx) further bridges the gap between synthetic benchmarking and practical system evaluation.

SCREENSHOTS:

```
pujeet@pujeet-VirtualBox:~$ stress-ng --version?
stress-ng: unrecognized option '--version?'
Try 'stress-ng --help' for more information.
pujeet@pujeet-VirtualBox:~$ stress-ng --version
stress-ng, version 0.17.06 (gcc 13.2.0, x86_64 Linux 6.14.0-37-generic) 🖥️🔥
pujeet@pujeet-VirtualBox:~$ sudo apt install fio -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following package was automatically installed and is no longer required:
  libllvm19
Use 'sudo apt autoremove' to remove it.
The following additional packages will be installed:
  libaio1t64 libboost-iostreams1.83.0 libboost-thread1.83.0 libdaxctl1
  libgfapi0 libgfrpc0 libgfxdr0 libglusterfs0 libnbd0 libndctl6 libpmem1
  libpmemobj1 librados2 librbd1 librdmacm1t64
Suggested packages:
  fio-examples gnuplot
The following NEW packages will be installed:
  fio libaio1t64 libboost-iostreams1.83.0 libboost-thread1.83.0 libdaxctl1
  libgfapi0 libgfrpc0 libgfxdr0 libglusterfs0 libnbd0 libndctl6 libpmem1
  libpmemobj1 librados2 librbd1 librdmacm1t64
```

```
pujeet@pujeet-VirtualBox:~$ dpkg -l | grep -E "stress-ng| fio|iperf3|nginx"
ii  fio                      3.36-1ubuntu0.1
      amd64                flexible I/O tester
ii  iperf3                   3.16-1build2
      amd64                Internet Protocol bandwidth measuring tool
ii  nginx                    1.24.0-2ubuntu7.5
      amd64                small, powerful, scalable web/proxy server
ii  nginx-common             1.24.0-2ubuntu7.5
      all                  small, powerful, scalable web/proxy server - common file
s
ii  stress-ng                0.17.06-1build1
      amd64                tool to load and stress a computer
```

```
pujeet@pujeet-VirtualBox:~$ systemctl status nginx --no-pager
● nginx.service - A high performance web server and a reverse proxy server
   Loaded: loaded (/usr/lib/systemd/system/nginx.service; enabled; preset: enabled)
   Active: active (running) since Wed 2025-12-24 18:55:50 GMT; 32s ago
     Docs: man:nginx(8)
   Process: 19592 ExecStartPre=/usr/sbin/nginx -t -q -g daemon on; master_process on; (code=exited, status=0/SUCCESS)
   Process: 19593 ExecStart=/usr/sbin/nginx -g daemon on; master_process on; (code=exited, status=0/SUCCESS)
   Main PID: 19625 (nginx)
    Tasks: 4 (limit: 4603)
   Memory: 3.0M (peak: 6.9M)
      CPU: 30ms
   CGroup: /system.slice/nginx.service
           └─19625 "nginx: master process /usr/sbin/nginx -g daemon on; maste..."
             └─19627 "nginx: worker process"
               └─19628 "nginx: worker process"
                 └─19629 "nginx: worker process"

Dec 24 18:55:50 pujeet-VirtualBox systemd[1]: Starting nginx.service - A high performance web server and a reverse proxy server.
Dec 24 18:55:50 pujeet-VirtualBox systemd[1]: Started nginx.service - A high performance web server and a reverse proxy server.
Hint: Some lines were ellipsized, use -l to show in full.
pujeet@pujeet-VirtualBox:~$
```

```
pujeet@pujeet-VirtualBox:~$ stress-ng
stress-ng 0.17.06-1build1
      amd64                tool to load and stress a computer
pujeet@pujeet-VirtualBox:~$ iperf3 --version
iperf 3.16 (cJSON 1.7.15)
Linux pujeet-VirtualBox 6.14.0-37-generic #37~24.04.1-Ubuntu SMP PREEMPT_DYNAMIC
Thu Nov 20 10:25:38 UTC 2 x86_64
Optional features available: CPU affinity setting, IPv6 flow label, SCTP, TCP congestion algorithm setting, sendfile / zerocopy, socket pacing, authentication, bind to device, support IPv4 don't fragment, POSIX threads
pujeet@pujeet-VirtualBox:~$
```