

Application Selection Matrix

To comprehensively evaluate the system's performance, a specific set of tools has been selected to generate targeted workloads on distinct subsystems (CPU, RAM, Disk I/O, Network).

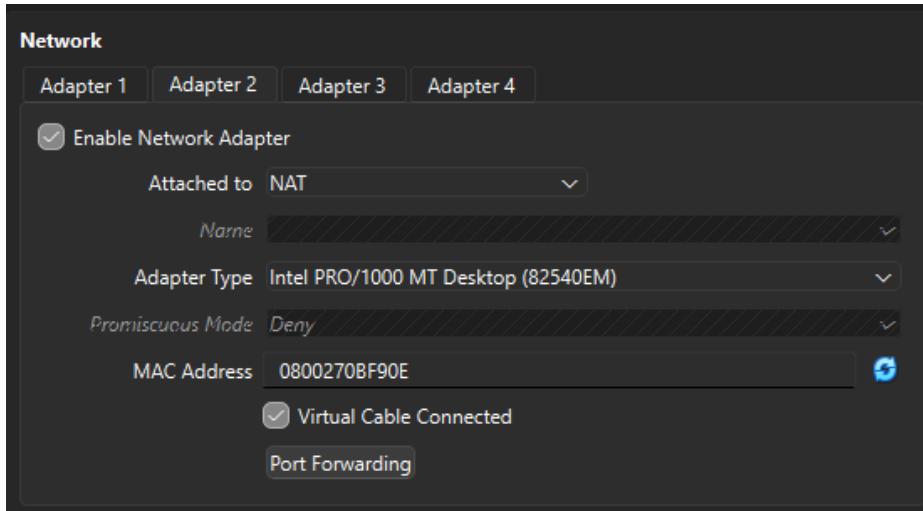
Workload Type	Selected Application	Description & Justification
CPU-Intensive	stress (cpu worker)	Justification: A synthetic workload generator. It forces 100% CPU load by calculating square roots, which is ideal for testing CPU stability, thermal throttling, and the scheduler's behavior under pressure.
Memory-Intensive	stress (vm worker)	Justification: Spawns workers that allocate (malloc) and free large chunks of memory. This is essential for testing the system's behavior under low-RAM conditions and validating Swap usage.
I/O-Intensive	stress (io worker)	Justification: Generates a high volume of disk write operations using sync() calls. This allows for the identification of storage bottlenecks and the measurement of disk write latency.
Network/Server	Apache2 (Web Server)	Justification: An industry-standard HTTP server. It is used to simulate real-world traffic (handling concurrent HTTP requests), creating load on the network stack and process management.

Installation Documentation (SSH-Based)

In accordance with the administrative constraints, all software installation was performed remotely from the Workstation via SSH.

Additional:

A second adapter for the server has been added for Internet access.



Connecting to server:

A screenshot of a terminal window titled 'Dec 14 22:38'. The window title bar also shows 'adminuser@server-vm: ~'. The terminal output is as follows:

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

adminuser@workspace-vm: $ ssh 192.168.56.10
adminuser@192.168.56.10's password:
Permission denied, please try again.
adminuser@192.168.56.10's password:
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.8.0-71-generic x86_64)

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

System information as of Sun Dec 14 10:37:52 PM UTC 2025

System load: 0.01      Processes:          110
Usage of /: 48.6% of 8.02GB   Users logged in:     1
Memory usage: 11%           IPv4 address for enp0s3: 192.168.56.10
Swap usage: 0%

Expanded Security Maintenance for Applications is not enabled.

0 updates can be applied immediately.

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

Failed to connect to https://changelogs.ubuntu.com/meta-release-lts. Check your Internet connection or proxy settings

Last login: Sun Dec 14 18:25:16 2025 from 192.168.56.11
```

Step 1: Repository Update & Package Installation Command:

```
sudo apt update && sudo apt install -y stress sysstat apache2 htop
```

```
Dec 15 00:32
adminuser@server-vm: ~
adminuser@server-vm: $ sudo apt update && sudo apt install -y stress sysstat apache2 htop
Hit:1 http://security.ubuntu.com/ubuntu noble-security InRelease
Hit:2 http://archive.ubuntu.com/ubuntu noble InRelease
Hit:3 http://archive.ubuntu.com/ubuntu noble-updates InRelease
Hit:4 http://archive.ubuntu.com/ubuntu noble-backports InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
96 packages can be upgraded. Run 'apt list --upgradable' to see them.
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
sysstat is already the newest version (12.6.1-2).
sysstat set to manually installed.
htop is already the newest version (3.3.0-4build1).
htop set to manually installed.
The following additional packages will be installed:
  apache2-bin apache2-data apache2-utils libapr1t64 libaprutil1-dbd-sqlite3 libaprutil1-ldap libaprutil1t64
    liblLua5.4-0 ssl-cert
Suggested packages:
  apache2-doc apache2-suexec-pristine | apache2-suexec-custom www-browser
The following NEW packages will be installed:
  apache2 apache2-bin apache2-data apache2-utils libapr1t64 libaprutil1-dbd-sqlite3 libaprutil1-ldap libaprutil1t64
    liblLua5.4-0 ssl-cert stress
0 upgraded, 11 newly installed, 0 to remove and 96 not upgraded.
Need to get 2,104 kB of archives.
After this operation, 8,142 kB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 libapr1t64 amd64 1.7.2-3.1ubuntu0.1 [108 kB]
Get:2 http://archive.ubuntu.com/ubuntu noble/main amd64 libaprutil1t64 amd64 1.6.3-1.1ubuntu7 [91.9 kB]
Get:3 http://archive.ubuntu.com/ubuntu noble/main amd64 libaprutil1-dbd-sqlite3 amd64 1.6.3-1.1ubuntu7 [11.2 kB]
Get:4 http://archive.ubuntu.com/ubuntu noble/main amd64 libaprutil1-ldap amd64 1.6.3-1.1ubuntu7 [9,116 B]
Get:5 http://archive.ubuntu.com/ubuntu noble/main amd64 liblLua5.4-0 amd64 5.4.6-3build2 [166 kB]
Get:6 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 apache2-bin amd64 2.4.58-1ubuntu8.8 [1,331 kB]
```

Step 2: Verification of Installation Verifying that tools are correctly installed and services are active:

- Check Stress version: `stress --version`
- Check Apache service status: `systemctl status apache2 --no-pager`
- Check iostat version (part of sysstat): `iostat -V`

```
Dec 15 00:33
adminuser@server-vm: ~
adminuser@server-vm: $ 
No services need to be restarted.
No containers need to be restarted.
No user sessions are running outdated binaries.

No VM guests are running outdated hypervisor (qemu) binaries on this host.
adminuser@server-vm: $ stress --version
stress 1.0.7
adminuser@server-vm: $ systemctl status apache2 --no-pager
● apache2.service - The Apache HTTP Server
   Loaded: loaded (/usr/lib/systemd/system/apache2.service; enabled; preset: enabled)
     Active: active (running) since Mon 2025-12-15 00:31:53 UTC; 1min 12s ago
       Docs: https://httpd.apache.org/docs/2.4/
   Main PID: 2397 (apache2)
      Tasks: 55 (limit: 2267)
     Memory: 5.2M (peak: 5.7M)
        CPU: 185ms
      CGroup: /system.slice/apache2.service
              └─2397 /usr/sbin/apache2 -k start
                  ├─2399 /usr/sbin/apache2 -k start
                  ├─2400 /usr/sbin/apache2 -k start

Dec 15 00:31:53 server-vm systemd[1]: Starting apache2.service - The Apache HTTP Server...
Dec 15 00:31:53 server-vm apachectl[2396]: AH00558: apache2: Could not reliably determine the server's fully qu... message
Dec 15 00:31:53 server-vm systemd[1]: Started apache2.service - The Apache HTTP Server.
Hint: Some lines were ellipsized, use -l to show in full.
adminuser@server-vm: $ iostat -V
sysstat version 12.6.1
(C) Sebastien Godard (sysstat <at> orange.fr)
adminuser@server-vm: $
```


Expected Resource Profiles

This table outlines the anticipated system behavior during testing.

Test Scenario	Primary Metric Impact	Secondary Impact	Expected Behaviour
CPU Load	100% User CPU Usage	Increased Load Average	System responsiveness may degrade. Stress processes should appear at the top of the process list.
Memory Load	Low "Available" RAM	High Swap Usage	As physical RAM fills, the kernel should move data to the Swap partition (disk), causing significant performance degradation (thrashing).
Disk I/O	High %iowait	High Load Average	The CPU will remain idle while waiting for disk operations to complete. iostat should report high await times.
Web Server	Network Traffic (RX/TX)	Moderate CPU Usage	An increase in active TCP connections and bandwidth usage. Apache will spawn worker processes to handle incoming requests.

Performance Monitoring Plan

Testing follows a "Black Box" methodology. All metrics are collected remotely to simulate a real-world headless server environment.

Scenario 1: Establishing the Baseline (Idle System)

Goal: Determine system resource usage when no applications are running.

Execute Command: `vmstat 1 5`

Action: Observe output for 5 seconds.

Analyze Result:

CPU (id): Should be near 100 (idle).

Swap (si/so): Should be 0.

Scenario 2: CPU Stress Testing

Goal: Saturation of processor cores.

Start Load (Terminal 1): `stress --cpu 2 --timeout 60s`

Execute Monitoring (Terminal 2): `top -bn1 | head -15`

Analyze Result: Look for stress processes consuming ~100% CPU.

Scenario 3: Memory Saturation Testing

Goal: Force memory allocation to test RAM limits and Swap.

Start Load (Terminal 1): `stress --vm 2 --vm-bytes 256M --timeout 60s`

Execute Monitoring (Terminal 2): `free -h`

Analyze Result: Compare used vs available memory. Check if Swap used > 0.

Scenario 4: Disk I/O Bottleneck Testing

Goal: Saturate disk write buffers.

Start Load (Terminal 1): `stress --io 4 --timeout 60s`

Execute Monitoring (Terminal 2): `iostat -x 1 5`

Analyze Result: Look for high %iowait and high await (latency in ms).

Scenario 5: Network Throughput Testing

Goal: Simulate web traffic to test bandwidth.

Execute Command: Using Apache Bench to load the Server. ab -n 10000 -c 100
<http://192.168.56.10/>

Analyze Result: Review Requests per second and Transfer rate in the final output.