

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).

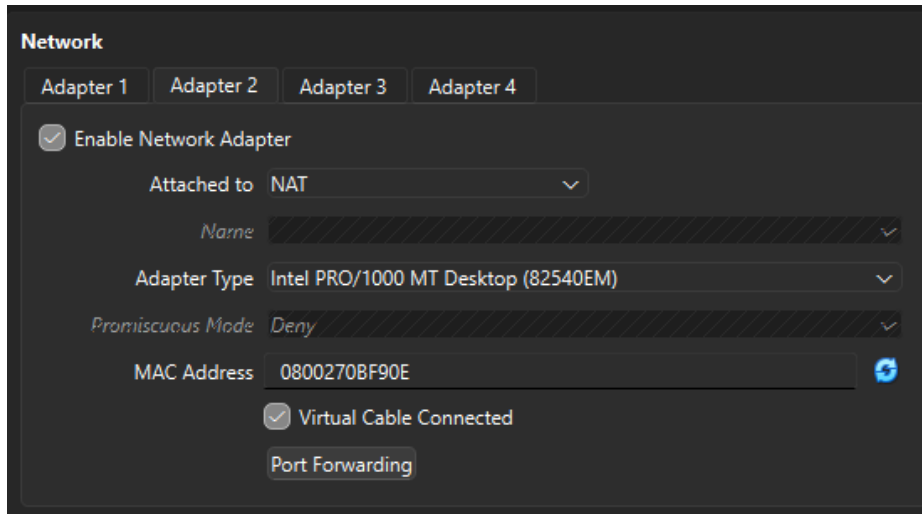
| Workload Type | Selected Application | Description & Justification |
|------------------|----------------------|--|
| CPU-Intensive | stress (cpu worker) | Justification: A synthetic workload generator. It forces 100% CPU load by calculating square roots, which is ideal for testing CPU stability, thermal 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)

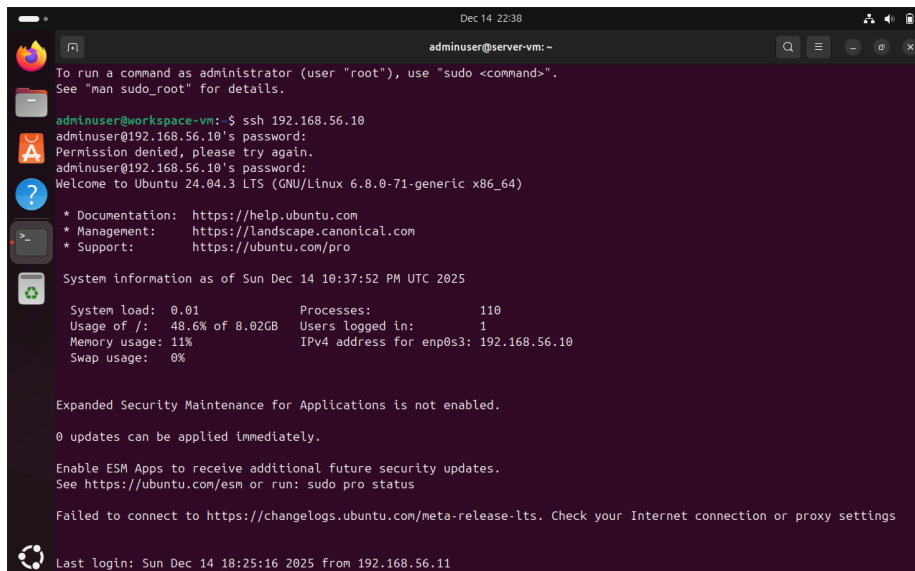
In accordance with the administrative constraints, all software installation was performed remotely from the Workstation via SSH.

Additional:

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



Connecting to server:



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
  liblua5.4-0 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
  liblua5.4-0 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 liblua5.4-0 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: ~
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 apache2[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:~$ S
```


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.