Assignment: 01
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Experiment: The experiment is designed to compare different computing platforms' performances in CPU-intensive programs. To do so, we ran a python script that automated the process of compiling Linux Kernel Source code on different candidate environments.

Specifications of Physical Machines used for the Experiment:

	Physical Machine 1	**Physical Machine 2**	**Physical Machine 3**
Total RAM on the machine	7.7 GiB	8 GiB	3.7 GiB
Total CPUs on the machine	8	8	4
Disc type and speed	SDD 157.7 MB/s read-rate	SDD 137.1 MB/s read rate	SDD 57.0 MB/s
OS installed on the machine	Ubuntu 20.04.5 LTS	Ubuntu 22.04.1 LTS	Linux Mint 21 Cinnamon
File system type (e.g., ext3, NTFS, etc.) used on the disk	*Partition 1*: 537 MB FAT *Partition 2*: 1000 GB Ext4	ext2	ext2

Performance Evaluation:

Physical Machine 1

Sr. No.	**1**	**2**	**3**	**4**	**5**	**Average**
Run Time	01:03:58	00:57:49	01:05:14	01:04:36	01:07:51	**01:03:42**
CPU utilization %	62.36 %	66.99 %	58.76 %	56.79 %	51.72 %	**59.32 %**
Memory Utilization %	52.64 %	40.09 %	36.67 %	40.17 %	38.56 %	**41.62 %**

Physical Machine 2

Sr. No.	**1**	**2**	**3**	**4**	**5**	**Average**
Run Time	00:54:44	00:55:47	00:55:27	00:55:57	00:55:41	**00:54:44**
CPU utilization %	57.1 %	54.61 %	60.03 %	52.40 %	52.63 %	**55.35 %**
Memory Utilization %	16.66 %	14.54 %	13.39 %	12.24 %	12.27 %	**13.82 %**

Physical Machine 3

Sr. No.	**1**	**2**	**3**	**4**	**5**	**Average**
Run Time	01:36:35	01:38:01	01:37:31	01:36:05	01:37:24	**01:36:21**
CPU utilization %	60.55 %	59.83 %	58.21 %	62.21 %	56.78 %	**59.51 %**
Memory Utilization %	19.91 %	17.49 %	16.23 %	15.45 %	16.18 %	**17.05 %**

Virtual Machine and Docker Installation Specifications:

	Virtual Machine - VMWare Workstation	**Docker**
Total RAM on the machine	3.8 GiB	6.52 GiB
Total CPUs on the machine	8	8
Disc type and speed	SDD 323.7 MB/s	SDD 171 MB/s
OS installed on the machine	Ubuntu 22.04.1 LTS	Ubuntu 22.04.1 LTS
File system type (e.g. ext3, NTFS etc.) used on the disk	ext2	ext2

Performance Evaluation

Virtual Machine - VMWare Workstation

Sr. No.	**1**	**2**	**3**	**4**	**5**	**Average**
Run Time	01:37:07	01:36:50	01:37:23	01:38:57	01:33:02	**01:36:29**
CPU utilization %	52.75 %	47.91 %	51.80 %	45.89 %	47.38 %	**49.14 %**
Memory Utilization %	30.61 %	26.24 %	24.86 %	22.72 %	23.21 %	**25.52 %**

Docker

Sr. No.	**1**	**2**	**3**	**4**	**5**	**Average**
Run Time	00:37:25	00:34:50	00:39:18	00:34:46	00:35:34	**00:35:40**
CPU utilization %	70.92 %	77.77 %	79.80 %	81.23 %	80.08 %	**77.96 %**
Memory Utilization %	28.72 %	28.54 %	29.18 %	41.52 %	41.09 %	**33.81 %**

Inference:

1. Minimal installations are required to set-up Ubuntu Command Line Interface on the Docker environment. Thus, fewer services to utilize the Processors and very few background processes directly impact the process's runtime. As a result, the Linux Kernel Compilation process takes the least average time (35 Min 40 Sec) to complete among all the environments and gives maximum average CPU utilization (77.96%).
2. On the other hand, the Virtualization environment set-up on VMWare Workstation gave the worst performance in terms of average run time (1 Hr 36 Min 29 Sec) and average CPU Utilization. Added virtualization layer between the OS and the hardware and limited resources allocated to the virtual set-up incurs some overhead.
3. Physical Machines 1 and 2 have nearly the same Hardware setup and configurations, except that the latest version of Ubuntu is installed on Physical Machine 2. It is observed that Physical Machine 2 gives about ~14% less runtime and significantly higher Memory utilization than Physical Machine 1.
4. However, installing the latest version of Linux Mint OS on a machine with fewer hardware resources does not improve the performance of the compilation process, as observed in case of the Physical Machine 3.
   In this machine, only 3.1 GiB of Main Memory is installed with the processing power of 4 CPUs. Kernel Compilation takes an average time of 1 Hr 36 Min 21 Sec.
5. All the physical machines give nearly the same CPU utilization for the compilation process.