FACULTY OF COMPUTING

BCN3063 DISTRIBUTED AND PARALLEL COMPUTING

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SECTION : 01B

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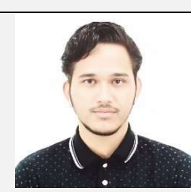
MUHAMAD ASYRAF MUHAIMIN BIN MAZLAN	CA21058	

Group : 4

1. Case Study

This case study focuses on designing a network infrastructure for two critical departments in an enterprise office which are Human Resources (HR) Department and Production Management (PM) Department

The goal is to compare Parallel Computing and Distributed Computing designs to achieve optimal network performance across two locations which are Malaysia (MY) and New Zealand (NZ): Production Management

The study measures and compare: Delay, CPU Time, and Throughput

2. Problem Statements

High CPU Utilization Limits Performance: With increasing workloads, a single machine cannot efficiently manage multiple departmental tasks [1].

Uneven Resource Distribution in the Network: Without distributed processing, resource bottlenecks slow down critical data transfer [2].

Geographical Delays in Cross-Location Communication: The separation of departments across Malaysia and New Zealand leads to network latency when central systems process all data [3].

3. Relationship of the Problem

The problems are interconnected:

- High CPU utilization results in slower processing, increasing delays.
- Inefficient resource management creates bottlenecks, worsening network performance.
- Geographically distributed departments (Malaysia and New Zealand) experience additional latency without a distributed computing solution.

By addressing resource utilization and network distribution, delays and bottlenecks can be minimized.

4. Hypotheses

-Parallel Computing will reduce CPU time compared to previous designs but may still experience performance bottlenecks under heavy workloads [4].

-Distributed Computing will reduce network delays and increase throughput compared to Parallel Computing by distributing tasks across locations [5].

-Network performance (CPU time, throughput) will improve significantly when tasks are processed locally in Malaysia and New Zealand.

5. Network Design

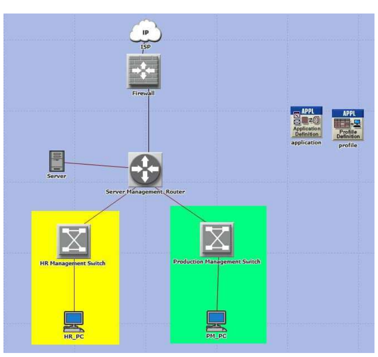


Figure 1 Parallel Topology Design

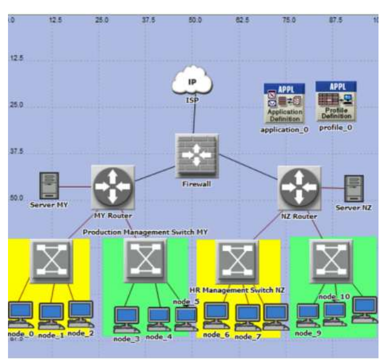


Figure 2 Distributed Topology Design

6. Sample

The enterprise network setup includes:

1. **Parallel Computing Design**
   - A single machine with **3 CPU and 1 cores** handles HR and PM tasks.
   - All processes are executed in parallel to optimize performance.
2. **Distributed Computing Design**
   - **Machine 1 (Malaysia):** HR Department tasks are processed locally.
   - **Machine 2 (New Zealand):** PM Department tasks are processed locally.
   - **Key Features:** Load balancing, reduced latency, and improved throughput.

Performance Metrics Analyzed:

- **Delay** (ms)
- **CPU Time** (s)
- **Throughput** (Mbps)

7. Information-Gathering Methods

-Simulation Results: Using OPNET software to simulate both network designs and collect data on delay, CPU time, and throughput.

-Performance Monitoring: Observing system logs and resource usage during simulation runs.

-Comparative Analysis: Comparing simulation results between Parallel and Distributed Computing designs.

-Research and Literature Review: Analyzing real-world enterprise network solutions and benchmarks.

8. Network Design Analysis Performance

8.1 Ethernet Delay:

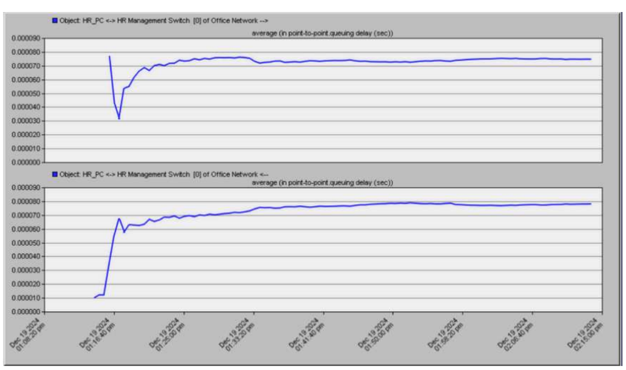


Figure 1: Parallel Ethernet Delay

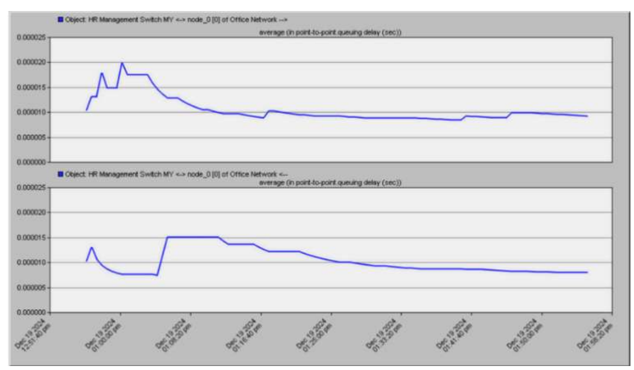


Figure 2: Distributed Ethernet Delay

The graphs show the Ethernet delay for parallel and distributed systems. In the parallel system, the delay increases sharply at first but quickly stabilizes and remains consistent. This is because the components work closely together within the same environment, leading to steady communication once tasks are distributed.

In the distributed system, the delay fluctuates at the beginning, with noticeable peaks and drops, before gradually decreasing and stabilizing. This happens because tasks are spread across multiple nodes over a network, causing initial communication overhead. Over time, as the system adjusts and synchronizes, the delays reduce and become stable.

8.2 CPU Time:

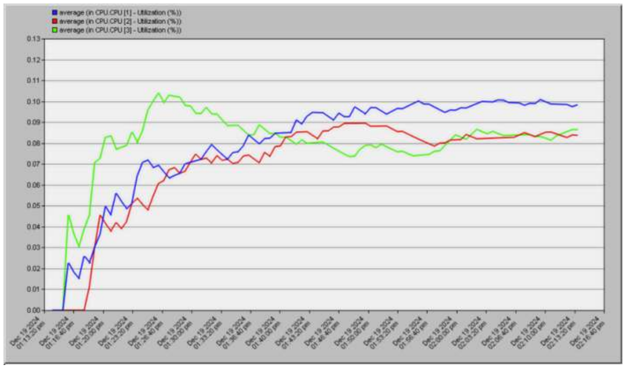


Figure 1: Parallel CPU Time

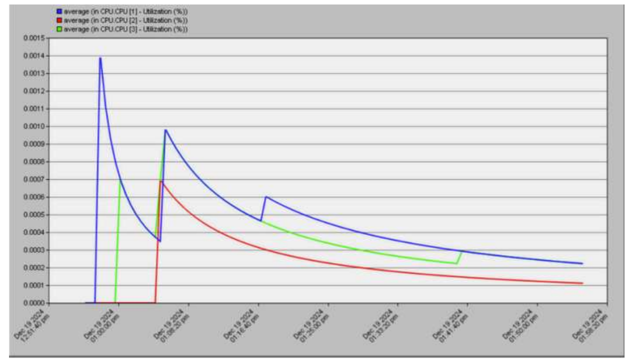


Figure 4: Distributed CPU Time

In Parallel Computing, the centralized processing of tasks on a single system allows CPU time to stabilize at a higher level. Even when several cores work at the same time, resource saturation limits improvement in performance when workloads are heavy.

While Distributed Computing utilizes load balancing to efficiently distribute workloads, resulting in red uced CPU time when jobs are handled among distributed workstations.
Comparing this decentralization to the parallel system leads to lower and more stable CPU usage by red ucing congestion on individual CPUs

8.3 Throughput Packet:

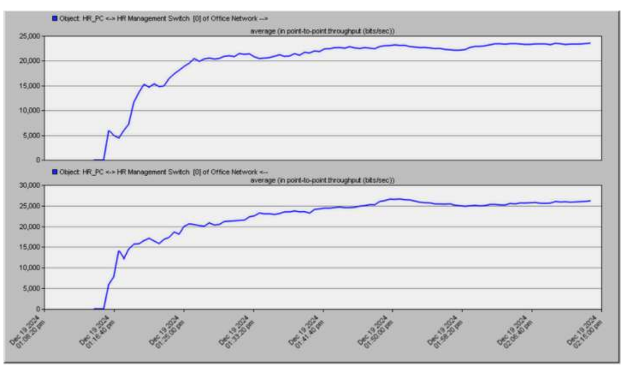


Figure 2: Parallel Throughput Packet

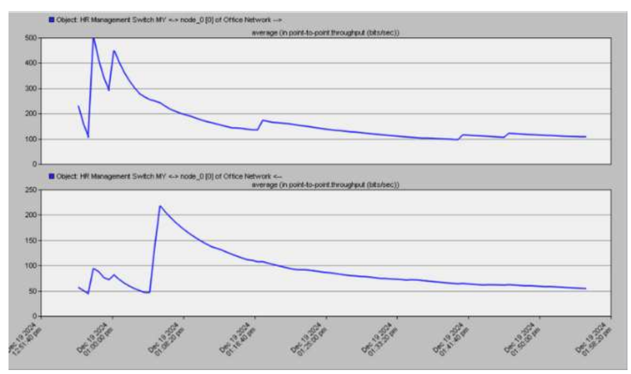


Figure 6: Distributed Throughput Packet

Because a single computer manages all tasks, throughput in the Parallel Computing design stabilizes at a lower level, which leads to resource conflict and communication delays in the centralized environment. On the other hand, distributed computing greatly increases throughput by processing the email locally on multiple nodes located in between Malaysia and New Zealand regions. This method minimizes congestion, maximizes bandwidth utilization, and allows simultaneous task execution across region. The throughput in Distributed Computing stabilizes at a significantly greater value than in the Parallel Computing structure, although initially fluctuating during synchronization.

9. Limitations

-Simulation Accuracy: Results are based on simulation models and may differ in real-world deployments.

-Hardware Constraints: The study uses only two locations (Malaysia and New Zealand) with simplified configurations.

-Limited Metrics: The analysis focuses only on **delay, CPU time, and throughput**, excluding other factors like packet loss and energy consumption.

10. Conclusion

The analysis of Parallel and Distributed Computing designs revealed the following:

1. Parallel Computing reduced CPU time by leveraging multiple CPU cores but still faced performance bottlenecks during high traffic loads.
2. Distributed Computing provided the best performance by distributing workloads:
    - **Delay:** Significantly reduced as tasks were processed locally in Malaysia and New Zealand.
    - **CPU Time:** Lower compared to Parallel Computing due to effective load balancing.
    - **Throughput:** Improved as tasks ran simultaneously on geographically distributed systems.

Recommendation:
Enterprises with multiple critical departments across geographically separated locations should adopt Distributed Computing to optimize resource utilization, reduce latency, and improve overall network performance.

Reference

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