



## Peer to peer (P2P) and cloud computing on infrastructure as a service (IaaS) performance analysis

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**Abstract** — The resources of information technology and the availability of services on non-cloud network systems are limited. This condition constitutes problems for companies, especially in the efficient management of information technology. Furthermore, the high investment in infrastructure procurement is an obstacle to building centralized systems, including the adoption of cloud computing through Infrastructure as a Service (IaaS), as an elective solution. This research aims to analyze the performance of cloud servers on IaaS services using the parameters of cloud service availability, response time, resource utilization, and throughput transfer implemented in companies engaged in the toll road concession sector. Furthermore, the results are expected to be a reference in supporting company decisions/policies related to cloud system adoption. The methodology involved four steps of the Network Development Life Cycle (NDLC): analysis, design, implementation, and monitoring. The implementation system constituted by 6 (six) stages based on the initial experiment: management of user, proxy server, database, web service, monitoring service, and Remote Desktop Protocol (RDP). The results of cloud service availability indicate that the cloud system provides service availability (system interface, broad network access, and resource pooling). Furthermore, cloud systems significantly perform resource utilization (CPU) and throughput transfer parameters, while non-cloud systems only excel in response time and resource utilization (Memory) parameters. The overall analysis of this research scenario showed that the cloud system provides services according to user needs. And have all cloud services availability (Interface Sistem, Broad Network Access, Resource Pooling), and resource utilization (average 12.65% CPU) but have shortcomings in response time and throughput transfer. Meanwhile, non-cloud systems (P2P) are better in terms of response time (average 5.31s), resource utilization parameters (average 53.22% Memory), and throughput transfer/data transmission (average 357.89 kB/s).

**Keywords** – availability of cloud service, cloud computing, IaaS, P2P, resource utilization, response time, throughput transfer

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### I. INTRODUCTION

Service-Oriented Architecture (SOA) underlies the emergence of cloud computing, allowing organizations to share Information Technology (I.T.) infrastructure. This technology significantly affects the performance of initial investment and infrastructure operational costs [1]. The efficiency of processing and storing large data is another reason that underlies cloud computing. Therefore, this changes the paradigm from the conventional use of local networks to centralized services [2]. Cloud computing enhances the central storage of data on the server based on the services provided by systems where clients can access data simultaneously. These terms, in turn, enable the communication process between clients [3].

Cloud computing services are classified into three kinds, namely Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) [4]. Research by the Enterprise Strategy Group (ESG) showed that 94% of organizations that utilized public cloud computing included IaaS and SaaS services. IaaS has experienced significant development over the last five years of about 67%, and almost half (45%) of IaaS was used to support production applications [5]. IaaS is a platform in a virtual environment where companies do not need to buy servers, data centers, and network equipment [6]. Therefore, the costs are cheap.

Regarding the use of the cloud system in the company, this research has observed the business sector of the Cileunyi-Sumedang-Dawuan toll road segment located in Jatiningor, Sumedang Regency. The

interviews with stakeholders showed that the main problem faced by the company is that the use of information technology resources is not optimal. This issue is due to the continuous use of the Peer to Peer (P2P) network system. Furthermore, decentralization's disadvantages of decentralization in P2P systems are that it cannot be managed efficaciously, and the lack of safety required for it diverse applications [2]. This condition renders the company's need for service availability (system interface) unfulfilled. The perceived impact is the inefficient use of these resources altogether.

Meanwhile, a centralized system is needed to overcome these problems, but it is constrained by high investment costs for infrastructure procurement and maintenance [7]. Due to these problems, it is necessary to implement cloud technology that provides services according to company needs. Therefore, cloud adoption is a low-priced choice [8], as it gives more flexibility, accessibility, data security, and disaster recuperation advantages [9]. Furthermore, the cloud system is a solution for sharing resources [10], such as networks, servers, storage, applications, and services, to create operational efficiency [5].

Several studies examined the performance of IaaS cloud using various performance metrics such as [11], [12], [13], [14] and [15]. Ref. [11] analyzed the performance of private and public clouds by measuring CPU and memory performance, including I/O operations. Ref. [12] focused on the response time parameter in analyzing cloud performance. Ref. [13] and [14] evaluated IaaS performance on used energy consumption for cost-benefit prediction. Ref. [14] analyzed the performance and availability, while [15] analyzed IaaS on OpenStack using Queueing network models.

This research aims to build and analyze private cloud server performance using IaaS services compared to a running system (P2P). The performance assessment of an IaaS cloud, some performance metrics are derived using a taxonomy model. The performance analysis of the IaaS cloud involved CPU, memory [11], and response time [12] by adding the availability of cloud service [16] and throughput transfer parameters. This research referred to the taxonomy metrics metamodel for cloud services [17]. Furthermore, the results of this research included an IaaS prototype that was tested using 4 test parameters. The prototype building was expected to be a reference in supporting decisions/policies (Decision support for decision-makers) regarding the adoption of cloud systems in companies to achieve efficiency in managing administrative data and pooling resources together between the head office system and branch offices.

This research was limited because it was a private cloud that used Microsoft Azure services due to the ease

of configuration by end-users. Furthermore, it involved the Three-tier model as the provision of resources for users consisting of system interfaces, web services, and monitoring services.

This research was further written as follows. Section II defined the method and described the steps in the research carried out. Section III presented the results, namely the process of designing a computer network using a cloud system. Section IV described a discussion in the test results on cloud system performance, which focused on the availability of cloud service, resource utilization, response time, and throughput parameters. This section also compared this research results with that of previous research. Finally, section V provided conclusions based on the test results.

## II. RESEARCH METHOD

This research methodology applied the Network Development Life Cycle (NDLC), which consists of six stages (Fig. 1) [18].

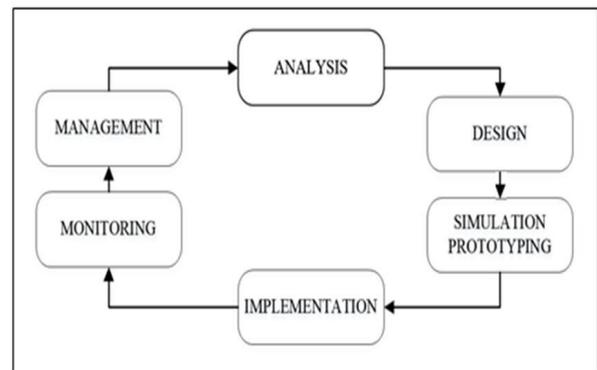


Fig. 1. NDLC stages.

In this research, the method was categorized into four stages. First, the simulation approach was not applied, as it involves direct experiments. Furthermore, the management step involves the management level policies and strategies.

The analysis was the initial stage, namely exploring the problems in this research by making observations using the interview method. From the data obtained from observations, the analysis was performed based on both the user and system requirements (Software and hardware) of both the server and client. Finally, the analysis was obtained using content analysis methods based on the examined problems.

The design step involved the design of network topology between the cloud server and the client. System configuration includes IP Address determination and system device configuration. Furthermore, the client used the public static IP from the ISP to generate requests to the server.

The implementation stage installed a cloud system (Linux Ubuntu server version 18.04) and supporting Software (Apache 2, MariaDB-Client, PhpMy Admin,

PuTTY, PHP, XRDP, NCPA, Nextcloud). The implementation process included user management, proxy servers, databases, web services, monitoring services, and Remote Desktop Protocol (RDP).

The monitoring involved a testing phase related to the performance of cloud-based servers based on the formulated test scenarios. The test parameters consisted of availability in cloud service, response time, resource utilization (CPU, Memory), and throughput transfer. The method used was comparison testing, which compared the performance of the running server (PC Server) with the proposed system (cloud server). Furthermore, the results of this stage were used as the basis for recommendations to companies regarding plans for implementing cloud servers.

### III. RESULT

The results achieved in this research are cloud servers used as data storage accommodated broad network access services, resource pooling, and measured services.

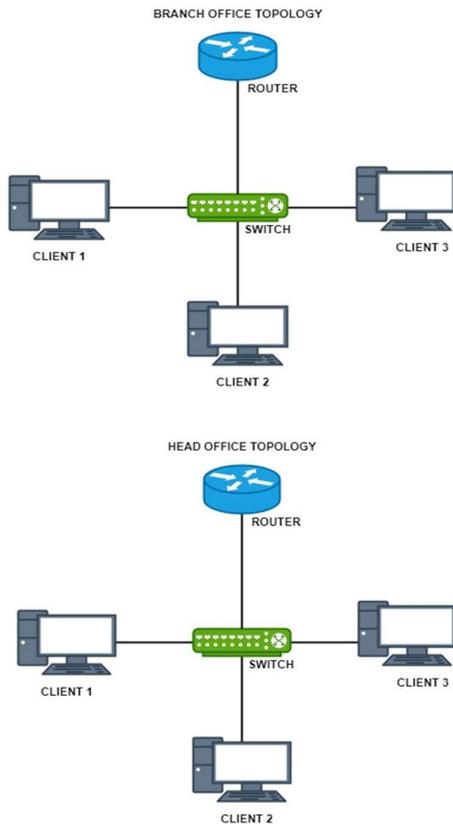


Fig. 2. Running network topology (head and branch office).

#### A. Network Topology Design

The network topology is an image of a cloud server using a web interface via a proxy server. This proxy server functioned as a liaison between server and client by opening a firewall port on the server to enable the client requests forwarding to the cloud. The client used a public static IP from the ISP to request the server,

after which the data packet continued to the server IP via Remote Desktop Protocol (RDP).

The results of the network topology mapping are shown in Fig. 2 and 3. In Fig.22, the currently running topology (P2P) was converted into a cloud system that connected the head office with branch offices, where the cloud server works as a data center (Fig. 3).

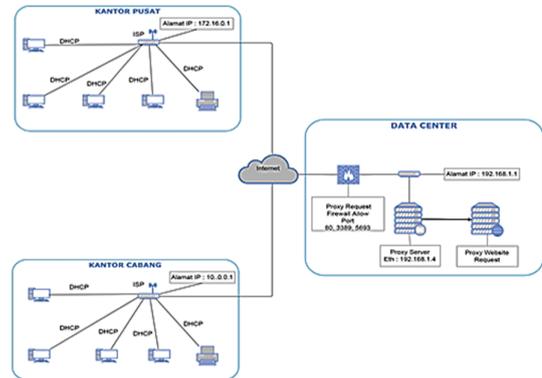


Fig. 3. Network topology design with cloud servers.

#### B. System Configuration and Implementation

The configuration and implementation consist of six stages (Fig. 4).

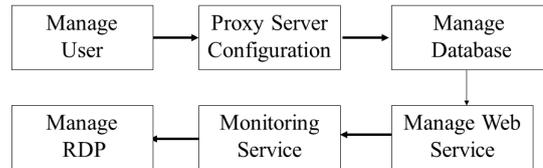


Fig. 4. Implementation stages.

The first stage was to create a user client on the server for four user employees who are responsible for managing the system (Fig. 5).

```

Creating home directory '/home/rizki' ...
Copying files from '/etc/skel' ...
Enter new UNIX password:
Retype new UNIX password:
passwd: password updated successfully
Changing the user information for rizki
Enter the new value, or press ENTER for the default
  Full Name []: rizki muhammad
  Room Number []:
  Work Phone []:
  Home Phone []:
  Other []:
Is the information correct? [Y/n] Y
admin01@CloudServer:/home$ cat /etc/group |grep -i pteitra
pteitra:x:1004:astri,rizal,sugimantoro,rizki
    
```

Fig. 5. User client creation and user checking.

The second stage of the proxy server configuration involved the creation of a rule in the cloud on the firewall server (Fig. 6). The third stage was the management of the database for web service needs using the MariaDB database server (Fig. 7).

Fig. 8 describes the addition of a user client created on the server into the database to enable the client to log in to the webserver.

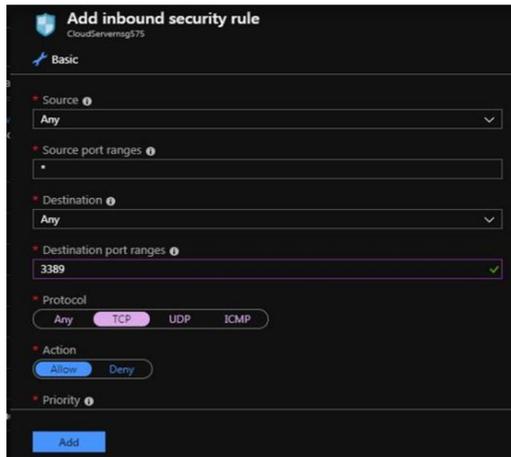


Fig. 6. Creating rules on cloud server.

```
MariaDB [(none)]> CREATE DATABASE db_nextcloud;
Query OK, 1 row affected (0.01 sec)
```

Fig. 7. Database creation on MariaDB-server.

The fifth stage was the monitoring service using the Nagios Cross-Platform Agent (NPCA) application to monitor resources (CPU, memory). The process consisted of adding tokens for authentication to the NPCA by configuring the “npca.cf” file in the directory “/usr/local/npcap/etc/” (Fig. 9 and 10). The last stage involved the management of RDP using the XRDP application on the cloud server as a service through which clients may access the server.

C. Testing Scenario

The test was carried out using the comparison testing method by taking server performance data before the cloud system begins implementation (P2P) and after the cloud system was implemented (virtual private server). Three respondents carried out this test at the head office, specifically two from the head office and one from the branch office.

The parameters tested include the availability of cloud services [16], response time, and 2 QoS parameters, namely resource utilization and throughput transfer. Resource utilization measures the level of use/percentage of resources (CPU and memory), response time represents the speed of time required from sending requests to receiving responses. In contrast, throughput transfer measures the number of requests successful within a definite time interval [17].

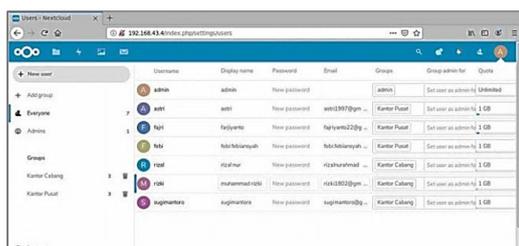


Fig. 8. Adding a client user to the database server.

```
GNU nano 2.9.3 ncpa.cfg Modified
#-----
[api]
# The token that will be used to log into the basic web GUI (API browser, graphs)
# and to authenticate requests to the API and requests through check_ncpa.py
community_string = Febifebiansyah18[]
#-----
[passive]
#-----
[passive]
```

Fig. 9. NPCA application configuration.

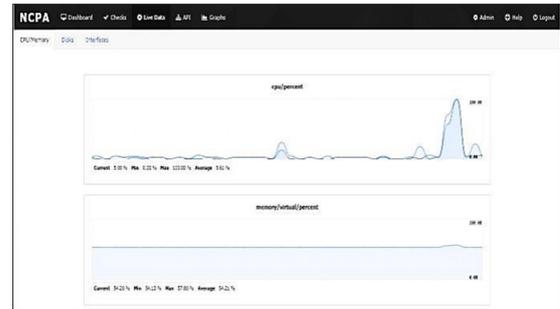


Fig. 10. Resources monitoring cloud server process (CPU dan RAM).

Server access utilized both single and multiple accesses. Single access was performed by one test user and multiple access by three test users. Testing system performance in data access service availability involves the availability of cloud service and resource utilization parameters, while server access time uses response time and throughput transfer parameters.

D. Test Results

1) Availability of Cloud Service

Table 2 shows the availability of cloud service tests on system interface services, broad network access, and resource pooling. The system interface is a service provided by the operating system as a means of interaction between the user and the operating system. Broad network access is a service capability where customers’ access involves using any device and web browser connected to the internet. Furthermore, pooling resources is related to the use of computing resources dynamically by the customer at a different location, but the resources are at a data center [19].

Table 1. Testing Scenario

Parameters	Testing Scenario
Availability of cloud service response time	Testing the availability of data center services for clients measurement of the 54 MB file transfer process carried out by testers in a Local Area Network (LAN) network with a Virtual Private Server (VPS) network
Resource utilization	In this research, the CPU and memory usage data on servers used by one user and three users simultaneously was compared in the network administration process
Throughput transfer	Measurement of the average data transfer speed (kB/s) received by the server, transfer time after testing, Response time

The test data showed that a cloud server could provide all three services (100%) while P2P is only able to provide 1 (one) service (33.33%), specifically the system interface. Therefore, comparing cloud servers with P2P is 3:1.

Table 2. Availability of Cloud Service Test Results.

E	IS	CSBNA	RP	IS	P2P-BNA	RP
E1	✓	✓	✓	✓	—	—
E2	✓	✓	✓	✓	—	—
E3	✓	✓	✓	✓	—	—

where E = examine, IS = Interface system, CSBNA = Cloud server broad network access, RP = Resource pooling, P2P-BNA = P2P broad network access, ✓ means available, and — means not available.

2) Response Time

Response time testing took the average response time to the file transfer process of 54MB by the testers in a Local Area Network (LAN) network with a Virtual Private Server (VPS) network at the head office. The transfer process uses the services of each server and is carried out in stages starting from the use by one examiner to simultaneously using three examiners. The results are shown in Table 3.

Table 3. Response Time Test Results

Number of Testers	Cloud Server (second)	PC Server (second)
1	3.18	4.14
2	5.51	5.25
3	8.05	6.54
Average	5.58	5.31

Based on observations and test data result in Table 3, there was an increase in the upload process time because three examiners used the servers (cloud server and PC server) simultaneously. This condition is due to a decrease in the performance of the server used simultaneously by two and three testers. On the other hand, the average PC server (faster at 5.31 seconds) response time was better than the cloud server because the file transfer process on a LAN network depends on network traffic conditions.

3) Resource Utilization

Table 4 shows the results of the resource utilization test on the CPU and RAM (where M in Table 4 means memory). The observations involved the use of the NCPA application installed on each server. Testing was carried out when the server was used by one examiner first and three examiners simultaneously during the administration process.

Table 4. Resource Utilization Test Results

Category Access	Cloud Server		PC Server	
	CPU	M	CPU	M
Single user (1 user)	5.56	52.24	27.34	47.02
Multiple access (3 users)	19.75	68.45	36.34	59.42
Average	12.65	60.34	31.84	53.22

The test data signified an increase in utility both on the CPU and memory in multiple access due to

the simultaneous use of resources. Based on these two categories of access, the average value of the overall CPU usage for cloud servers (12.65%) is better than a PC Server. Otherwise, the memory usage on a PC Server is superior (53.22%).

4) Throughput Transfer

This test was performed by measuring the average data transfer rate received by the server in kB/s. The observational data is shown in Table 5.

Table 5. Throughput Transfer Test Results

Category Access	Cloud Server (kB/s)	P2P (kB/s)
Single user (1 user)	166.54	140.57
Multiple access (3 users)	474.81	575.21
Average	320.67	357.89

The throughput for 1 (one) examiner is smaller than that of three due to the increasing number of activities at the server, causing it to receive more data packets. However, the average data transfer rate (kB/s) the cloud server is better than the P2P. This form is because the Internet connectivity to the cloud server is more stable.

Based on the results of the four test variables on server performance between cloud and non-cloud systems (P2P), the cloud system is superior in the availability of cloud service and resource utilization (CPU). Meanwhile, non-cloud systems are better in terms of response time, resource utilization parameters (Memory), and throughput transfer parameters

IV. DISCUSSION

The overall analysis showed that the cloud system has a significant performance in service provision. The services provided by IaaS meet the needs of today's companies in terms of System Interface, Broad Network Access, and Resource Pooling. Resource utilization on a cloud server occurs when CPU usage is efficient (average difference of 19.19%) but is not efficient in memory usage (average difference of 7.12%) compared to a PC Server. The disadvantage of cloud computing systems is that they have a slower response time than P2P systems (0.27 seconds). Based on the observations, it is affected by the network traffic when file transfer is completed. The average data transfer speed in cloud computing is longer than in the P2P system, with a difference of 37.22 kB/s. Therefore, cloud systems are more efficient in CPU resources but lack response time.

Similar results were observed in previous research on the performance of cloud computing [20]. IaaS cloud using four test parameters (setup time, response time, access area, package install, and ability). This research complements previous studies analyzing cloud server compared to P2P systems by adding test parameters that have not been analyzed by [20], namely availability of cloud service based on the taxonomy model [16] and throughput transfer.

The results of [20] indicated that the cloud system provides the better ability for cloud servers but has a longer response time. Ref. [20] involved a different test scenario specifically calculating the response time between when the commands is launched until execution in stable network traffic. The commands tested in [20] consist of vim (Linux editor app), ifconfig (configure network interface), apt-get install (install apt package on a linux system), iptables (filtering of data traffic), ssh x.x.x.x (remote server). The test result showed cloud systems have an average response time of 4 seconds meanwhile non-cloud 1.67 seconds, a difference of 2.33 seconds longer than non-cloud systems. If the test was performed at a different time, the results vary due to the influence of network traffic conditions as access goes through the network. Otherwise, non-cloud systems are accessed directly through the operating system interface.

The results of previous research, including [21] based on test scenario (upstream/downstream link capacity 1 Gb/s, file bit rate 10Mb/s) that system reply to local traffic requests showed that the use of resources (CPU) in cloud was more efficient than P2P. The proposed cloud system can reduce CPU utility by half of the CPU on a P2P system.

## V. CONCLUSION

This research implemented a cloud system using IaaS services from Microsoft Azure. Testing of resource utilization and throughput transfer was carried out via single and multi-user (three users) categories, specifically to compare the performance of the P2P system with the cloud system. The results showed that the cloud system can provide the types of services required by the company.

Overall, considering the four parameters of cloud service availability, resource utilization, response time, and throughput transfer. Cloud computing possesses better performance in two test parameters than non-cloud systems/P2P, specific the availability of cloud services (able to provide three services) and resource utilization (CPU average 5.19%). However, the cloud system has shortcomings in response time, which is 0.27 seconds slower than P2P systems, resource utilization (Memory 60.34%), and the transfer throughput is smaller at 37.22 kB/s than P2P. Conversely, the P2P system excels at 3 test parameters (RAM resource utilization response time and throughput transfer). The final result concluded P2P system has a better performance than Cloud systems.

Further research is required to apply the load balancing technique [22] to maximize transfer throughput and avoid overload. Furthermore, the addition of performance tests on cloud security parameters is also necessary, such as firewall management [23], security, which is an important area

in the cloud [24], and turnaround time to maximize cloud performance.

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