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Analysis and Comparison of Server Migration Performance on Amazon Web Services and Google Cloud Platform

Diva Nuranty Yovanka[1], Galura Muhammad Suranegara[1], Endah Setyowati[1]

[1]*Telecommunication System, Universitas Pendidikan Indonesia, Purwakarta, Indonesia*

**Corresponding Author: Diva Nuranty Yovanka*
Email: divanurantyy02@upi.edu

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Abstract

Cloud computing has emerged as a technology increasingly embraced by numerous enterprises to operate servers with high availability. The multi-cloud strategy is increasingly employed to manage servers across various platforms, guaranteeing service continuity despite disruptions on any single platform. This study analyzes and compares the migration performance of Amazon Web Services (AWS) and Google Cloud Platform (GCP) across two scenarios: migration in a homogeneous environment and migration in a heterogeneous environment, utilizing the metrics of migration time and downtime. According to the research findings, in homogenous environment migration, GCP excelled in both migration duration and downtime. In heterogeneous environment migration, AWS demonstrated superior migration speed.

Introduction

With the growing acceptance of cloud computing and the increasing number of cloud customers, viewed as a novel alternative for high availability applications, it has emerged as a technology that many enterprises are exploring and embracing (Aldossary, 2021; Utama et al., 2020). Amazon Web Services (AWS) and Google Cloud Platform (GCP) are leading cloud service providers that offer the Infrastructure as a Service (IaaS) model (Borra, 2024). The IaaS paradigm is commonly employed for storage, networking, and the creation of virtual servers to facilitate data provisioning and management, in addition to executing applications within the network (Günther & Praeg, 2023; Neto et al., 2019). The availability of servers is essential for the uninterrupted operation of services. Natural disasters, social conflicts, network disruptions, and hardware malfunctions can impede system operations and impact server availability for a service (Aziz & Awad, 2020; Fitriawati et al., 2022).

The multi-cloud paradigm in cloud computing has gained significant traction for deploying servers across various platforms, guaranteeing service continuity despite potential disruptions on any single platform (Carrasco et al., 2020). And this becomes one of the advantage of cloud computing is its capacity to offer globally spread regions, enabling servers to be situated in various locations to guarantee their worldwide accessibility (Carrasco et al., 2020). This can be accomplished through migration, which denotes the transfer of data, programs, and servers across environments (Aruna et al., 2022). Migration generally utilizes two prevalent techniques: cold migration and live migration. Cold migration necessitates a temporary cessation of the source prior to executing the migration, whereas live migration facilitates data transfer without halting the source throughout the procedure (Aruna et al., 2022; He & Buyya, 2023).

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Moreover, Migration can function as a contingency strategy in response to availability challenges, as emphasized in the research (Ranunegoro et al., 2023). The research by Aziz et al. (2020) executed live migration between the cloud providers AWS and GCP utilizing a container engine to enable the conversion. A further research by Wulandari et al. (2023) executed live migration in a private cloud environment utilizing OpenStack to assess the performance of QoS parameters. A separate research addresses a related subject concerning migration by integrating the multi-cloud concept to analyze compatibility and assess the performance of utilized cloud platforms, concentrating on essential key migration parameters (Mafakhiri, 2019; Muthiah et al., 2019). Homogeneous and heterogeneous clouds are recognized as architectural models designed for particular requirements. A homogeneous cloud environment often employs a singular cloud service for resource management, while a heterogeneous cloud environment leverages several cloud services for resource operation. A heterogeneous cloud environment is frequently synonymous with a multi-cloud configuration (John et al., 2020; Regaieg et al., 2021).

As previously mentioned, cloud possesses numerous region that can be used to encounters a disruption in a specific region, the server in that region may be relocated to another region or to an alternative platform. This research will evaluate migration between Amazon Web Services (AWS) and Google Cloud Platform (GCP) by analyzing both homogeneous and heterogeneous environments, focusing on migration time and downtime as performance metrics.

Methods

This study will employ a quantitative methodology with a research and development strategy, concentrating on the performance evaluation of multi-cloud migration through metrics such as migration duration and downtime (Aziz et al., 2020). This study utilizes servers from the AWS and GCP cloud platforms, with heterogeneous and homogeneous cloud migration the two of research scenarios.

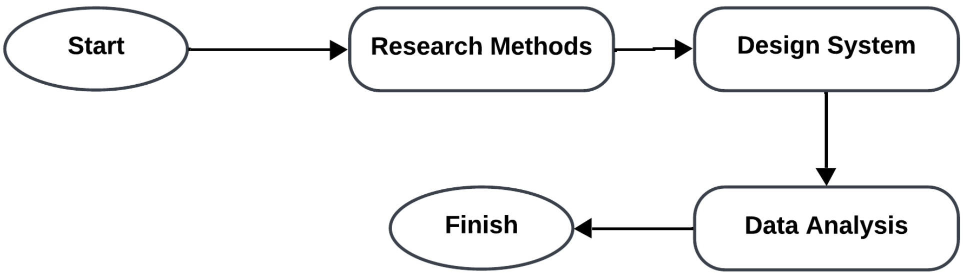

Figure 1. Research Methodology

At this point, data is taken from diverse sources like published articles, books, study papers, and additional information, which will be utilized to comprehend the theory and find issues pertinent to the research topic. The collected references will serve as the basis for acquiring testing data. Downtime denotes the interval in which a service is identified as unresponsive or encountering a problem (Gundall et al., 2022). Migration time refers to the period necessary to finalize the migration process from the source server to the destination server (Tziritas et al., 2019).

Design System

Figures 2 and 3 depict the system designs employed for migration within a homogenous environment, whereas figure 4 demonstrates the system design for heterogenous environment. In this scenario, homogenous environment entails utilizing a single cloud platform and conducting the migration within the same cloud environment, generally through a cross-

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region migration. Conversely, heterogeneous environment entails the use of many cloud platforms throughout the migration process (Bharany et al., 2022; Kommisetty & Abhireddy, 2024; Naseer, 2023; H. Singh et al., 2021).

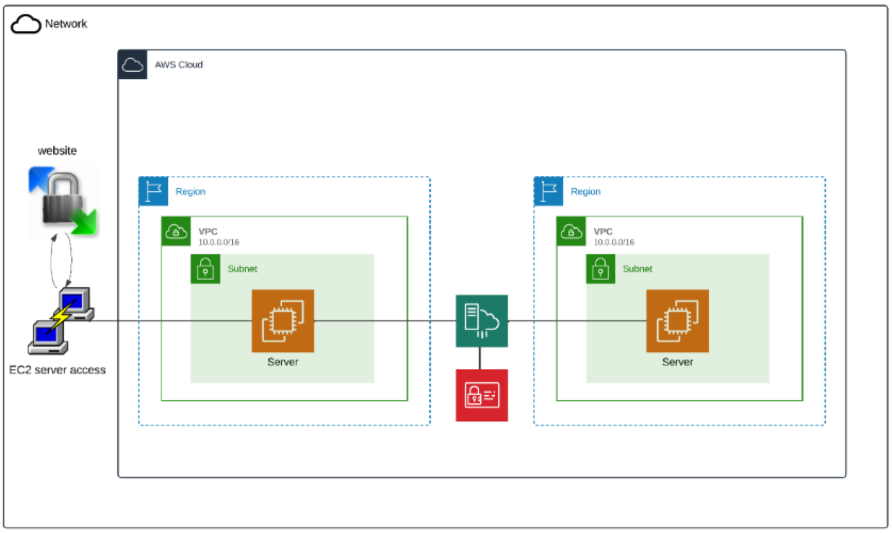

Figure 2. System Design for Homogeneous Migration on AWS

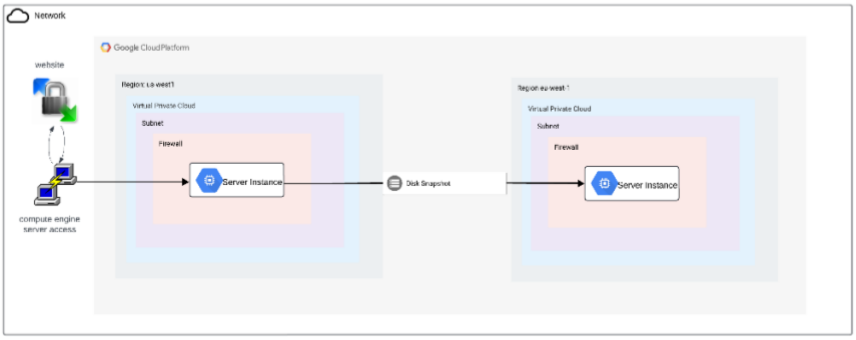

Figure 3. System Design for Homogeneous Migration on GCP

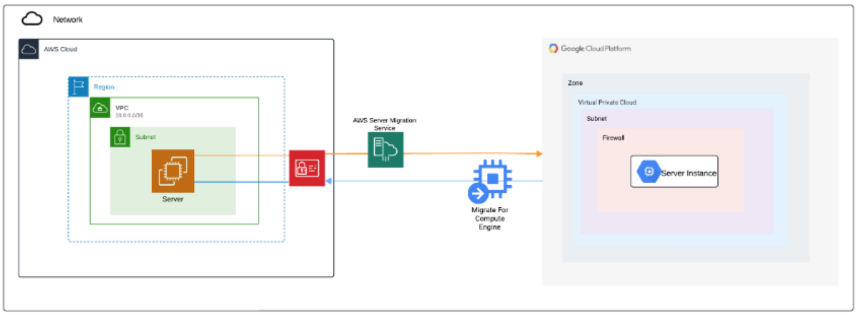

Figure 4. System Design for Heterogenous Migration

In all three design system, the instance machine will function as a web server, serving as the subject of migration. Access to the web server will be facilitated using putty using the SSH protocol, with apache2 installed. Additionally, winscp will be utilized to transfer website files to be hosted on the server. Every migration necessitates credentials to facilitate the execution of the migration process.

The specifications of the instance machines utilized are presented in table 1. All specifications are calibrated to align with one another to guarantee that the tests are similar and facilitate an accurate comparative analysis.

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Table 1. Instance Machine Spesification

configuration	Cloud Services	
	Amazon Web Services	**Google Cloud Platform**
Instance Type	t2.micro	e2-micro
vCPU	1	1
RAM	1 GiB	1 GiB
Region	US-East 1, EU-West	US-East1, EU-West1
IP Address	98.80.106.187	35.212.95.247
OS	Ubuntu/Linux	
Web Server	Apache2	

Data Analysis

Based on the specified scenario, the migration test will be conducted 135 times (15 times repetition per platform migration), with measurements being made for the parameters of downtime and migration time. From the moment the snapshot is created until the server is successfully deployed in the target region or cloud, the migration time will be computed. In the meanwhile, downtime is computed via a ping sequence at IP address with the subsequent formula:

$$downtime = ping\ lost\ \times ping\ interval$$

(1)

The gathered data will be examined by computing the average to summarize the outcomes of each migration performance test according to the criteria utilized, specifically migration time and downtime. A comparative analysis will be performed depending on the performance of each cloud. The formula for calculating the average value is as follows:

$$\boldsymbol{\bar{x} = \frac{x1+x2+x3 \dots +n}{n}}$$

(2)

Explanation:

$\bar{x}$ = average value

$x1$ = value of the n-th repetition

n = number of repetition

Results and Discussion

This research evaluates the performance of each platform by executing migration on a web server hosted within an instance machine. The tests are performed in both homogeneous and heterogeneous cloud settings, each repeated 15 times, to acquire the results for migration time and downtime parameters. The duration of migration is quantified from the initiation of the instance machine's transfer procedure from the source environment or region to the destination, encompassing the total time necessary for the migration to finalise. Downtime is quantified from the initiation of the migration procedure until its conclusion. Downtime is assessed by a ping sequence test conducted at one-second intervals.

Analysis of Test Results and Performance Comparison of Homogeneous Cloud Migration

This section delineates the outcomes of evaluating the migration performance metrics inside a homogenous cloud environment on Amazon Web Services (AWS) and Google Cloud Platform (GCP).

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Migration Time

The data reflects the outcomes of evaluating migration time performance in homogenous cloud migration. This test involved estimating the migration duration of a web server from the source location to the destination region, assessing the overall time necessary to accomplish the procedure. Table 2 presents the data acquired from the migration across 15 trials.

Table 2. Performance Testing of Migration Time for Homogeneous Migration

Testing	**Amazon Web Services**	**Google Cloud Platform**
	Migration Time (second)	**Migration Time (second)**
1	900	365
2	780	174,6
3	660	234,4
4	660	183,6
5	660	220,6
6	720	168,8
7	660	215,8
8	720	212,6
9	600	286,8
10	720	269,2
11	780	228,2
12	660	223,8
13	660	239,2
14	660	225,6
15	600	229,6
Average	652,8	231,85

Figure 5 depicts the graph of migration time performance test outcomes. The data indicate that migrating within the GCP environment surpassed AWS regarding time efficiency. Table 3 illustrates that homogenous migration within the GCP environment continuously exhibited superior migration times relative to AWS, regardless of whether the longest, shortest, or overall average migration durations are considered. The maximum migration duration for homogenous migration on GCP was 365 seconds, but AWS documented a maximum duration of 900 seconds. GCP documented a migration length of 168.6 seconds, while AWS recorded 600 seconds. The average migration time across all tests was 231.85 seconds for GCP and 652.8 seconds for AWS, yielding a time difference of about 420.95 seconds. The substantial time disparity is due to the migration technique employed by GCP, which is less intricate and shorter in duration than that of AWS (G. Singh et al., 2024).

Table 3. Analysis of Migration Time Performance Testing Outcomes for Homogeneous Cloud Migration

Cloud Services	**Migration Time**		
	Highest (second)	**Lowest (second)**	**Overall Average (second)**
AWS	900	600	652,8
GCP	365	168,8	231,85

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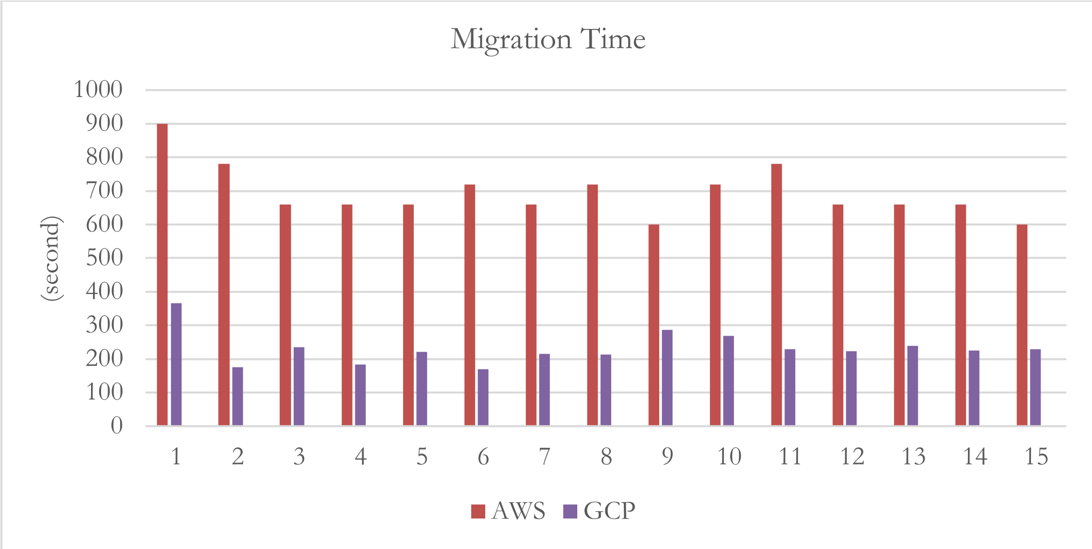

Figure 5. Migration Time of Performance Graph Migration in a Homogeneous Environment

Downtime

This section provides statistics derived from downtime performance testing during homogeneous cloud migration. The downtime performance test was executed by quantifying the number of dropped ping sequences to the IP address throughout the migration procedure, from initiation to completion and the data is presented in the table 4.

Table 4. Performance Testing of Downtime for Homogeneous Migration

Testing	**Amazon Web Services**	**Google Cloud Platform**
	Downtime (second)	**Downtime (second)**
1	35	12
2	49	42
3	109	27
4	41	17
5	81	8
6	102	7
7	222	10
8	122	3
9	0	3
10	0	36
11	781	6
12	0	10
13	28	0
14	173	1
15	56	3
Average	119,73	12,3

Figure 6 depicts a graph representing the downtime performance outcomes. The graph indicates that homogeneous migration in the GCP environment demonstrated a markedly reduced incidence of downtime relative to homogeneous migration in the AWS environment. Table 5 illustrates that the testing results for homogenous transfer on both cloud platforms indicate AWS experienced the largest delay at 781 seconds, whilst GCP's maximum downtime was merely 42 seconds. AWS saw a minimum downtime of 174 seconds, while GCP reported no downtime (0 seconds), signifying uninterrupted service for specific tests. The mean disparity in downtime length among all uniform migration experiments was 107.43

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seconds. Consequently, GCP surpassed AWS regarding downtime, as GCP's downtime was nearly imperceptible in multiple test iterations. This phenomena can be ascribed to the divergent migration techniques of the two platforms, affecting downtime. Moreover, downtime in this context may be influenced by bandwidth, as migration operations are significantly reliant on network connections (Benjaponpitak et al., 2020).

Table 5. Analysis of Downtime Performance Testing Outcomes for Homogeneous Cloud Migration

Cloud Services	**Downtime**		
	Highest (second)	**Lowest (second)**	**Overall Average (second)**
AWS	781	174	119,73
GCP	42	0	12,3

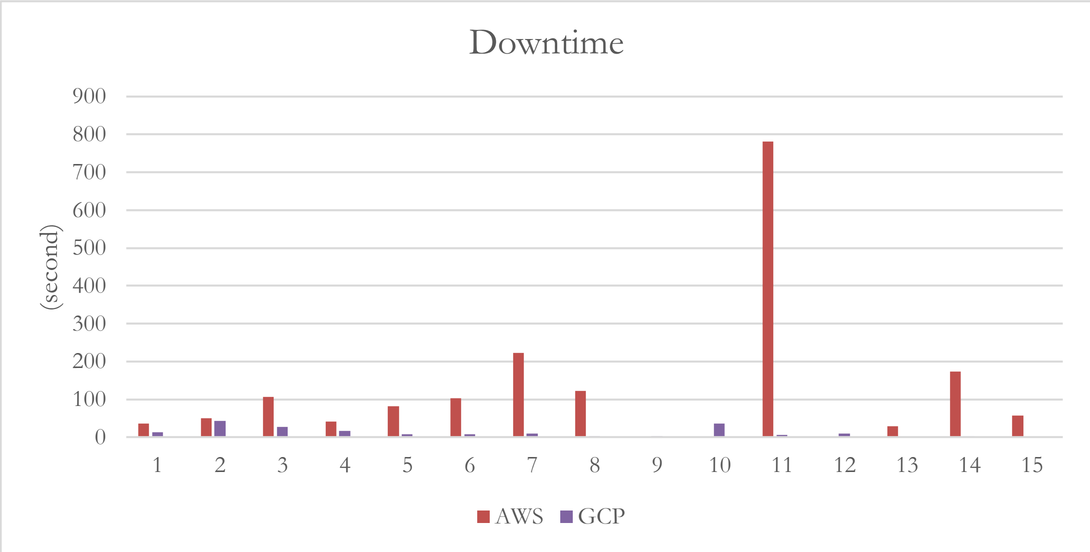

Figure 6. Downtime of Performance Graph Migration in a Homogeneous Environment

Analysis of Test Results and Performance Comparison of Heterogenous Cloud Migration

This section outlines the results of assessing the migration performance indicators during a Heterogeneous cloud migration conducted bidirectionally between AWS and GCP (from AWS to GCP and from GCP to AWS).

Migration Time

The data reflects the outcomes of evaluating migration time performance in heterogenous cloud migration. This test involved estimating the migration duration of a web server from the source location to the destination region, assessing the overall time necessary to accomplish the procedure. Table 6 presents the data acquired from the migration across 15 repetition.

Table 6. Performance Testing of Migration Time for Heterogeneous Migration

Testing	**AWS to GCP**	**GCP to AWS**
	Migration Time (second)	**Migration Time (second)**
1	1018	600
2	1052	660
3	956	600
4	1067	780
5	988	660
6	1004	600

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7	900	720
8	1018	600
9	959	900
10	1020	1020
11	1018	900
12	956	660
13	1018	660
14	1052	660
15	960	840
Average	999,06	740

Figure 7 illustrates the results of the migration time performance test. Every cloud platform transfer demonstrates that heterogeneous migration to the AWS environment is more expedient than heterogeneous migration to the GCP environment. Table 7 indicates that the greatest migration period for heterogeneous migration in the GCP environment was 1052 seconds, but it was 1020 seconds for heterogeneous migration to the AWS environment. The minimal migration period for heterogeneous migration to AWS was 600 seconds, but GCP's shortest migration lasted 1052 seconds. The average migration duration across all performance tests indicated that heterogeneous migration to AWS necessitated 999.06 seconds, whereas GCP averaged 740 seconds. The time disparity between the two platforms is 259.06 seconds, rendering AWS's heterogeneous migration more expedient overall. The performance advantage is ascribed to the migration mechanism, which encompasses designated intervals for configuration and preparation, including the process of capturing snapshots. Moreover, network speed is crucial in ascertaining the rapidity with which servers can be relocated to the designated location (G. Singh et al., 2024).

Table 7. Analysis of Migration Time Performance Testing Outcomes for Heterogeneous Cloud Migration

Cloud Services	**Migration Time**		
	Highest (second)	**Lowest (second)**	**Overall Average (minute)**
AWS to GCP	1048,2	933,6	16,86
GCP to AWS	1020	600	12,33

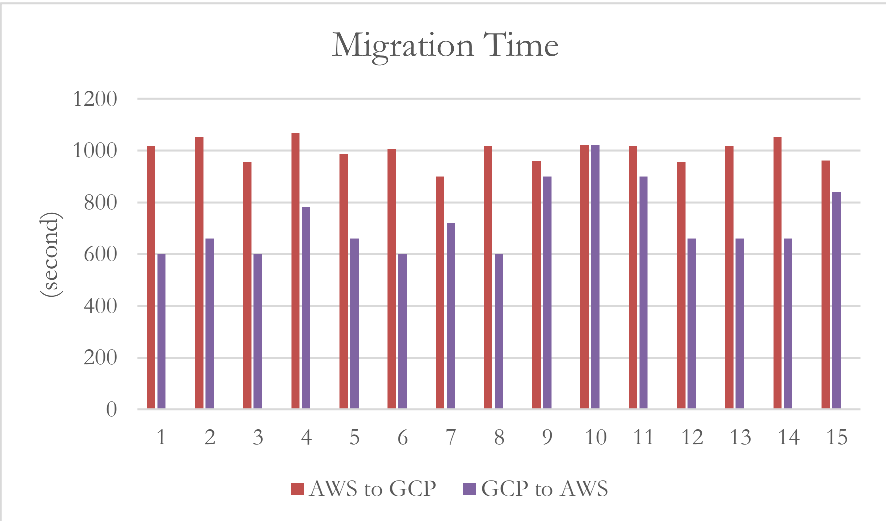

Figure 7. Migration Time of Performance Graph Migration in a Heterogeneous Environment

Downtime

This is the outcome of assessing the performance of heterogeneous cloud migration during downtime. The test involved quantifying the number of lost ping sequences during the

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migration from the source environment to the target environment until its conclusion. Ping tests were conducted on the IP address and The data is presented in the table 8.

Table 8. Performance Testing of Downtime for Heterogeneous Migration

Testing	**AWS to GCP**	**GCP to AWS**
	Downtime (second)	**Downtime (second)**
1	134	0
2	112	0
3	109	0
4	123	0
5	85	0
6	137	0
7	91	103
8	97	0
9	116	0
10	118	0
11	95	0
12	181	0
13	125	0
14	128	0
15	71	0
Average	114,8	6,83

Figure 8 was the downtime performance testing graph indicates that heterogeneous migration to the AWS environment saw negligible downtime during the migration process. Conversely, heterogeneous migration to the GCP environment encountered downtime, leading to AWS exhibiting a markedly reduced total downtime frequency in comparison to GCP. Table 4.8 indicates that the GCP environment saw the largest frequency of downtime during heterogeneous transfer, totaling 181 seconds. Simultaneously, AWS saw a peak downtime of 103 seconds. GCP observed a minimum delay of 71 seconds, while AWS saw no downtime (0 seconds) during its shortest migration tests. The mean downtime variation across all heterogeneous migration experiments was 107.94 seconds.

Consequently, diverse transfer to the AWS environment surpassed GCP regarding downtime, as evidenced by the test results. This is due to the use of live migration utilizing a pre-copy technique, aimed at reducing downtime, as examined in the research (Rezazadeh et al., 2022). Nonetheless, downtime may still arise from variables like as bandwidth, as indicated by (Najm & Tamarapalli, 2022). Consequently, migration to the AWS environment is preferable regarding downtime, as it experiences less downtime than migration to the GCP environment.

Table 9. Analysis of Downtime Performance Testing Outcomes for Heterogeneous Cloud Migration

Cloud Services	**Downtime**		
	Highest (second)	**Lowest (second)**	**Overall Average (second)**
AWS to GCP	181	71	114,8
GCP to AWS	103	0	6,86

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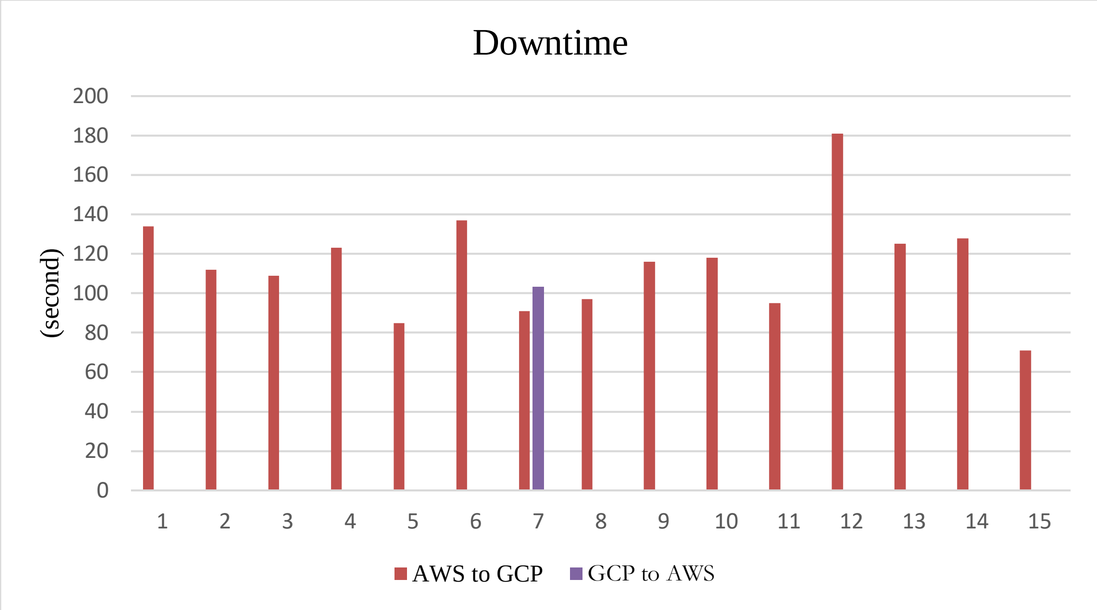

Figure 8. Downtime of Performance Graph Migration in a Heterogeneous Environment

Conclusion

The performance testing findings indicated that GCP outperformed AWS regarding migration time and downtime during homogeneous migration. In diverse migration performance evaluations, AWS surpassed GCP in terms of both migration duration and downtime. This gap can be ascribed to many factors noted during testing. In homogenous migration testing, GCP's migration procedure was more straightforward and less intricate. The migration necessitated merely capturing a server snapshot for deployment on the destination server, in contrast to AWS's uniform migration procedure. AWS necessitated multiple processes, including linking the server to the target region, capturing a server snapshot, executing a cutover, and establishing a new server in the destination. These supplementary measures affected both the duration of downtime and the time required for migration. Both platforms utilized virtually comparable strategies for heterogeneous migration. Nonetheless, AWS demonstrated superior migration speed, providing them with an advantage in diverse migration efficacy. Both homogeneous and heterogeneous migrations necessitated an internet connection, which was directly correlated with bandwidth use. This aspect considerably impacted the process, especially regarding downtime. The migration method employed in this study also influenced the downtime throughout the migrating procedure.

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