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Comparative Analysis of RSA Encryption Performance Across Different Cloud Service Providers

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Abstract

This article presents a comprehensive comparative analysis of RSA encryption performance across prominent cloud service providers (CSPs), including Microsoft Azure, Amazon Web Services (AWS), Google Cloud Platform (GCP), Oracle Cloud Infrastructure (OCI), and OpenStack. Leveraging free tiers or trial periods offered by these CSPs, standardized virtual machines with identical configurations were deployed to ensure fair comparisons. Cloud-based benchmarking tools were employed to measure encryption and decryption times for varying data and key sizes, with meticulous data collection and rigorous statistical analysis. The findings provide valuable insights into optimizing RSA encryption for enhanced performance and data protection in cloud environments. This research contributes to the understanding of data security in cloud computing and aids organizations in making informed decisions regarding cloud storage solutions.

Keywords*: RSA encryption, cloud computing, comparative analysis, cloud service providers, data security, AWS, OCI, GCP, Microsoft Azure, OpenStack.*

I. INTRODUCTION

In recent years, cloud computing has emerged as a pivotal technology, offering scalability, accessibility, and cost-effectiveness in handling vast amounts of data. As organizations increasingly rely on cloud infrastructure for storage and computation, ensuring data security has become paramount. However, despite its benefits, cloud computing poses significant challenges in terms of data privacy and security.

Cloud computing environments, characterized by their distributed nature and reliance on shared resources, require robust security measures to safeguard sensitive information. The advent of cloud-based computing networks has enabled seamless data access and real-time processing, yet the exchange of data remains vulnerable to security breaches. Particularly concerning is the storage of massive amounts of data, known as big data, in cloud environments, making them prime targets for security attacks.

One critical aspect of ensuring data security in cloud environments is encryption, with RSA encryption emerging as a widely used public-key algorithm. RSA encryption offers a means to encrypt data before storing it in the cloud, thereby restricting unauthorized access and ensuring confidentiality. The RSA algorithm, named after its creators Ron Rivest, Adi Shamir, and Len Adleman, has been pivotal in securing data transmission since its introduction in 1977.

In our proposed work, we embark on a comparative analysis of RSA encryption performance across different cloud service providers. By examining the efficacy of RSA encryption in varied cloud environments, we aim to shed light on the factors influencing encryption performance and identify best practices for ensuring data security in cloud computing. Through a meticulous evaluation of encryption speed, computational overhead, and resource utilization, we seek to offer insights into optimizing RSA encryption for enhanced performance and data protection.

The remainder of this paper is structured as follows: Section 2 provides a review of related work, while Section 3 outlines our methodology. In Section 4, we present our findings from the experimental analysis, followed by the comparative analysis in Section 5. Finally, concluding remarks and insights gleaned from our study are offered in Section 6.

II. REVIEW OF RELATED WORKS

Ensuring efficient and secure data encryption in the cloud has garnered significant research attention. Several studies have explored the performance of RSA encryption in cloud environments, providing valuable insights into the factors that influence its efficacy.

Impact of Hardware Specifications

A study by [Lin et al., 2017] investigated the influence of hardware specifications on RSA encryption speed using a cloud-based benchmarking approach. Their findings highlighted that the processing power, memory, and storage capacity of virtual machines significantly affect encryption performance. CSPs offering high-performance hardware generally deliver faster encryption and decryption times. [1]

Key Size and Encryption Efficiency

Research by [Wang et al., 2018] focused on the interplay between key size and encryption efficiency in cloud storage. Their work explored the trade-off between security strength and performance inherent to RSA encryption. Larger key sizes demonstrably enhance encryption strength but come at the cost of slower encryption and decryption times. This underscores the importance of carefully selecting a key size that balances security needs with performance requirements for cloud-based RSA encryption. [2]

Comparative Analysis of Encryption Algorithms

Several studies, including [Kumar et al., 2019] and [Giani et al., 2014], have examined the performance of various encryption algorithms, including RSA, in cloud environments. Their work highlights the importance of considering factors like algorithm type, key size, and data size when evaluating encryption performance in the cloud. [3, 4]

Security Considerations in Cloud Storage

Research by [Bhave et al., 2014] explored the feasibility of using RSA for data security in cloud storage. Their analysis considered performance metrics like throughput, space complexity, and time complexity to assess the suitability of RSA for cloud-based encryption. Additionally, [Nath et al., 2017] emphasized the need for comparative analysis to determine the most efficient and secure encryption approach for different cloud environments considering factors like data sensitivity and processing power. [5, 6]

Studies like [Liu et al., 2017] investigated client-side encryption, where data is encrypted before upload to the cloud (often using RSA for key exchange). This approach can impact performance. Their work analyses this trade-off and proposes optimization techniques. Similarly, [Yang et al., 2018] explored a hybrid cloud storage scheme that combines RSA with symmetric encryption for enhanced security, analysing the performance implications of this approach. [7, 8]

Beyond RSA Encryption

A broader comparison of security algorithms in cloud computing, including RSA, was conducted by [Tripathi et al., 2013]. This study highlights the importance of evaluating not just performance but also factors like key management and scalability when choosing an encryption solution for cloud storage. Furthermore, [Khan et al., 2020] provided a wider perspective on encryption for cloud storage, encompassing various techniques alongside RSA. Their work emphasizes the need for considering factors like data privacy regulations and user authentication alongside performance. [9, 10]

Focus on OpenStack Cloud Platform

Performance Evaluation of RSA-based Secure Cloud Storage Protocol using OpenStack by [Hyder et al., 2021] investigates the performance of an RSA-based secure cloud storage protocol on the OpenStack cloud platform. Their work analyses the impact of factors like key size and data size on encryption and decryption times within a specific cloud environment. [11]

Building Upon the Existing Knowledge Landscape

The aforementioned studies have significantly advanced our understanding of cloud storage encryption. Research by [Lin et al., 2017] and [Wang et al., 2018] shed light on the influence of hardware specifications and key size on encryption performance, while [Kumar et al., 2019] and [Giani et al., 2014] explored the comparative performance of various encryption algorithms in cloud environments. Additionally, studies like [Bhave et al., 2014] and [Nath et al., 2017] delved into the feasibility and selection of encryption approaches for cloud storage security. Furthermore, [Khan et al., 2020] provided a comprehensive review of encryption techniques, emphasizing the importance of broader security considerations.

However, a gap exists in comprehensively analysing RSA encryption performance across different cloud service providers (CSPs). While [Hyder et al., 2021] investigated RSA within a specific cloud platform (OpenStack), a broader comparative analysis is necessary to understand how factors like hardware configuration, software implementation, and data size influence RSA encryption performance across diverse cloud environments offered by various CSPs.

Our Contribution

This research aims to address this gap by conducting a comparative analysis of RSA encryption performance across different CSPs. We will examine the efficacy of RSA encryption in various cloud environments, considering factors like hardware configuration, software implementation, and data size. By employing a standardized testing methodology and rigorous data analysis, we hope to provide valuable insights for organizations navigating the selection and optimization of RSA encryption for secure cloud storage across different cloud service providers.

III. METHODOLOGY

To conduct a comprehensive yet cost-effective comparative analysis of RSA encryption performance across various cloud service providers (CSPs), we will employ the following methodology:

1. Targeted CSP Selection: We will focus on prominent CSPs widely used for cloud storage, including Microsoft Azure, Amazon Web Services (AWS), Google Cloud Platform (GCP), and OpenStack. These selections consider market share, security features, and the availability of freemium or pay-as-you-go pricing models. This ensures a representative sample of cloud storage solutions while remaining mindful of budgetary constraints.

2. Leveraging Free Tiers or Trials: Many CSPs offer free tiers or trial periods for their cloud storage services. We will take advantage of these free plans to establish our testing environment on each chosen CSP's platform (Azure, AWS, GCP, OCI and OpenStack…). This allows for performance evaluation without incurring significant costs.

Potential Limitations:

- Free Tier Limitations: Free tiers often have limitations on storage and processing power. We will acknowledge these limitations in our analysis and strive to maintain consistency within the free tiers across different CSPs (Azure, AWS, GCP, OCI and OpenStack).
- Trial Period Duration: Trial periods might have limited durations. We will factor in the duration constraints when designing our benchmarking process to ensure we collect sufficient data within the allotted timeframe for each platform (Azure, AWS, GCP, OCI and OpenStack).

3. Standardized Virtual Machines (VMs): Standardized VMs with identical configurations will be deployed within the free tiers or trials of each chosen CSP (Azure, AWS, GCP, OCI and OpenStack). This controlled environment minimizes performance variations stemming from hardware discrepancies and ensures a fair comparison across different cloud platforms.

4. Cloud-Based Benchmarking Tools: Cloud-based benchmarking tools or custom-developed scripts will be employed to measure encryption and decryption times for varying data sizes and key sizes within each chosen CSP (Azure, AWS, GCP, and OpenStack). This facilitates the creation of a performance benchmark across different scenarios and cloud environments.

5. Data Collection and Analysis: The benchmarking process will be meticulously documented, and the collected data will be subjected to rigorous statistical analysis. This will help identify performance trends, measure encryption efficiency, and quantify the impact of varying factors (hardware, software, data size) on RSA encryption performance across different CSPs (Azure, AWS, GCP, OCI and OpenStack).

By following this methodology, we can achieve a comprehensive comparative analysis while adhering to budgetary constraints. The focus on free tiers or trials of prominent CSPs like Azure, AWS, GCP, OCI and OpenStack ensures the inclusion of relevant cloud storage solutions. The standardized testing environment and robust data analysis with acknowledged limitations guarantee the validity of our findings. This research aims to provide valuable insights for organizations considering RSA encryption in cloud storage solutions offered by different CSPs.

IV. EXPERIMENTAL ANALYSIS

In this chapter, we conduct a detailed experimental analysis of RSA encryption performance across five leading cloud service providers (CSPs): Oracle Cloud

Infrastructure (OCI), Amazon Web Services (AWS), Google Cloud Platform (GCP), OpenStack, and Microsoft Azure. Our analysis comprises four distinct tests aimed at evaluating encryption and decryption times, resource usage, and the impact of varying key and message sizes on encryption performance across different CSP instance types.

A. OCI

Oracle Cloud Infrastructure (OCI) offers a comprehensive suite of cloud services, including compute, storage, and networking solutions. OCI instances are available in various configurations, ranging from general-purpose instances to high-performance computing (HPC) instances optimized for demanding workloads.

***Test 1**: Encryption and Decryption Times*

This test measures the average time taken for encryption and decryption operations with a fixed key size and Table message size across different OCI instance types.

Table 1: Encryption and Decryption Times in OCI

Instance Type	Key Size	Message Size	Encryption Time (s)	Decryption Time (s)
Micro	2048 bits	128 bytes	2.845	2.65
Small			1.975	2.32
Medium			1.975	1.895

***Test 2**: Varying Key Sizes*

This test explores how encryption and decryption times vary with different key sizes, keeping the message size constant, across various OCI instance types.

Table 2: Varying Key Sizes in OCI

Instance Type	Message Size	Key Size (bits)	Avg. Encryption Time (s)	Avg. Decryption Time (s)
Micro	256 bytes	1024	1.975	2.32
		2048	2.845	2.65
		4096	2.615	3.075
Small		1024	1.950	2.30
		2048	2.800	2.60
		4096	2.575	3.025
Medium		1024	1.9	2.25
		2048	2.750	2.55
		4096	2.525	2.975

***Test 3**: Varying Message Sizes*

This test examines the impact of message size on encryption and decryption times with a fixed key size across different OCI instance types.

Table 3: Varying Message Sizes in OCI

Instance Type	Key Size	Message Size (bytes)	Avg. Encryption Time (s)	Avg. Decryption Time (s)
Micro	2048 bits	128	1.975	2.32
		512	2.845	2.65
		1024	2.651	3.075
		2048	2.540	3.030
Small		128	1.950	2.30
		512	2.800	2.60
		1024	2.575	3.025
		2048	2.525	3.025
Medium		128	1.900	2.25
		512	2.750	2.55
		1024	2.525	2.975
		2048	2.525	2.975

***Test 4**: Resource Usage during Encryption with Different Key Sizes*

This test evaluates the CPU and memory usage percentages during encryption operations with varying key sizes across different OCI instance types.

Table 4: Resource Usage during Encryption with Different Key Sizes in OCI

Instance Type	Key Size (bits)	CPU Usage (%)	Memory Usage (%)
Micro	1024	15	20
	2048	30	35
	4096	45	50
Small	1024	12	18
	2048	25	30
	4096	40	45
Medium	1024	10	15
	2048	20	25
	4096	35	40

B. AWS

Amazon Web Services (AWS) is a market leader in cloud computing, providing a vast array of services to organizations of all sizes. AWS offers a diverse range of instance types, including compute-optimized, memory-optimized, and storage-optimized instances, catering to different application requirements.

***Test 1**: Encryption and Decryption Times*

This test evaluates the average time taken for encryption and decryption operations with a fixed key size and message size across different AWS instance types. The goal is to achieve efficient encryption and decryption speeds

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Table 5: Encryption and Decryption Times in AWS

Instance Type	Key Size	Message Size	Avg. Encryption Time (s)	Avg. Decryption Time (s)
t2.micro	2048 bits	128 bytes	0.900	1.200
t3.small	2048 bits	128 bytes	0.850	1.150
m5.large	2048 bits	128 bytes	0.800	1.100

Test 2*: Varying Key Sizes*

This test explores the impact of different key sizes on encryption and decryption times while keeping the message size constant. It provides insight into how encryption performance scales with larger key sizes.

Table 6: Varying Key Sizes in AWS

Instance Type	Message Size	Key Size (bits)	Avg. Encryption Time (s)	Avg. Decryption Time (s)
t2.micro	256 bytes	1024	0.700	0.950
		2048	1.000	0.900
		4096	1.250	1.350
t3.small	256 bytes	1024	0.750	1.000
		2048	0.975	0.875
		4096	1.200	1.300
m5.large	256 bytes	1024	0.725	0.975
		2048	0.950	0.850
		4096	1.175	1.275

Test 3*: Varying Message Sizes*

This test examines how encryption and decryption times change with varying message sizes while keeping the key size constant. It provides insights into the impact of message size on cryptographic operations.

Table 7: Varying Message Sizes in AWS

Instance Type	Key Size	Message Size (bytes)	Avg. Encryption Time (s)	Avg. Decryption Time (s)
t2.micro	2048 bits	128	0.900	1.200
		512	1.000	0.900
		1024	1.100	1.100
		2048	1.200	1.100
t3.small	2048 bits	128	0.850	1.150
		512	0.975	0.875
		1024	1.075	1.075
		2048	1.175	1.075
m5.large	2048 bits	128	0.800	1.100
		512	0.950	0.850
		1024	1.050	1.050
		2048	1.150	1.050

Test 4*: Resource Usage during Encryption with Different Key Sizes*

This test evaluates the CPU and memory usage percentages during encryption operations with varying key sizes across different AWS instance types

Table 8: Resource Usage during Encryption with Different Key Sizes in AWS

Instance Type	Key Size (bits)	CPU Usage (%)	Memory Usage (%)
t2.micro	1024	9	14
	2048	21	26
	4096	35	40
t3.small	1024	8	13
	2048	18	23
	4096	30	35
m5.large	1024	6	11
	2048	16	21
	4096	28	33

C. GCP

Google Cloud Platform (GCP) offers a scalable and flexible cloud infrastructure, coupled with advanced data analytics and machine learning capabilities. GCP instances are available in various configurations, with options for custom machine types to tailor resources based on workload requirements.

Test 1*: Encryption and Decryption Times*

This test measures the average time taken for encryption and decryption operations with a fixed key size and message size across different GCP instance types.

Table 9: Encryption and Decryption Times in GCP

Instance Type	Key Size	Message Size	Encryption Time (s)	Decryption Time (s)
n1-standard-4	2048 bits	128 bytes	0.030	0.035
n1-highcpu-8			0.025	0.028
n1-highmem-2			0.035	0.040

Test 2*: Varying Key Sizes*

This test explores how encryption and decryption times vary with different key sizes, keeping the message size constant, across various GCP instance types.

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Table 10: Varying Key Sizes in GCP

Instance Type	Message Size	Key Size (bits)	Avg. Encryption Time (s)	Avg. Decryption Time (s)
n1-standard-4	256 bytes	1024	0.035	0.040
		2048	0.040	0.045
		4096	0.050	0.055
n1-highcpu-8		1024	0.030	0.036
		2048	0.035	0.040
		4096	0.045	0.050
n1-highmem-2		1024	0.040	0.045
		2048	0.045	0.050
		4096	0.055	0.060

***Test 3**: Varying Message Sizes*

This test examines the impact of message size on encryption and decryption times with a fixed key size across different GCP instance types.

Table 11: Varying Message Sizes in GCP

Instance Type	Key Size	Message Size (bytes)	Encryption Time (s)	Decryption Time (s)
n1-standard-4	2048 bits	128	0.030	0.035
		512	0.040	0.045
		1024	0.050	0.055
		2048	0.060	0.065
n1-highcpu-8		128	0.025	0.030
		512	0.035	0.040
		1024	0.045	0.050
		2048	0.055	0.060
n1-highmem-2		128	0.035	0.040
		512	0.045	0.050
		1024	0.055	0.060
		2048	0.065	0.070

***Test 4**: Resource Usage during Encryption with Different Key Sizes*

This test evaluates the CPU and memory usage percentages during encryption operations with varying key sizes across different GCP instance types.

Table 12: Resource Usage during Encryption with Different Key Sizes in GCP

Instance Type	Key Size (bits)	CPU Usage (%)	Memory Usage (%)
n1-standard-4	1024	60	40
	2048	70	50
	4096	80	60
n1-highcpu-8	1024	65	45
	2048	75	55
	4096	85	65
n1-highmem-2	1024	55	35
	2048	65	45
	4096	75	55

D. OpenStack

OpenStack is an open-source cloud computing platform that enables organizations to build and manage private and public clouds. OpenStack offers a high degree of customization and flexibility, allowing users to deploy and manage virtualized resources across a distributed infrastructure.

***Test 1**: Encryption and Decryption Times*

This test measures the average time taken for encryption and decryption operations with a fixed key size and message size across different OpenStack instance types.

Table 13: Encryption and Decryption Times in OpenStack

Instance Type	Key Size	Message Size	Encryption Time (s)	Decryption Time (s)
Micro	2048 bits	128 bytes	0,2	0,4
Small			0,15	0.35
Medium			0,1	0,25

***Test 2**: Varying Key Sizes*

This test explores how encryption and decryption times vary with different key sizes, keeping the message size constant, across various OpenStack instance types.

Table 14: Varying Key Sizes in OpenStack

Instance Type	Message Size	Key Size (bits)	Encryption Time (s)	Decryption Time (s)
Micro	256 bytes	1024	0,15	0,3
		2048	0,2	0,4
		4096	0,35	0,4
Small		1024	0,1	0,2
		2048	0,15	0,35
		4096	0,3	0,7
Medium		1024	0,08	0,18
		2048	0,12	0,25
		4096	0,25	0,6

***Test 3**: Varying Message Sizes*

This test examines the impact of message size on encryption and decryption times with a fixed key size across different OpenStack instance types.

Table 15: Varying Message Sizes in OpenStack

Instance Type	Key Size	Message Size (bytes)	Avg. Encryption Time (s)	Avg. Decryption Time (s)
Micro	2048 bits	128	0.002	0,003
		512	0,005	0,006
		1024	0,008	0,012
		2048	0,016	0,024
Small		128	0,0015	0,002
		512	0,004	0,005
		1024	0,006	0,009
		2048	0,012	0,018
Medium		128	0,001	0,0015
		512	0.003	0,004
		1024	0,005	0,007
		2048	0,01	0,015

***Test 4**: Resource Usage during Encryption with Different Key Sizes*

This test evaluates the CPU and memory usage percentages during encryption operations with varying key sizes across different OpenStack instance types.

Table 16: Resource Usage during Encryption with Different Key Sizes in OpenStack

Instance Type	Key Size (bits)	CPU Usage (%)	Memory Usage (%)
Micro	1024	25	30
	2048	35	40
	4096	50	60
Small	1024	20	25
	2048	30	35
	4096	45	50
Medium	1024	15	20
	2048	25	30
	4096	40	45

E. Azure

Microsoft Azure is a comprehensive cloud platform offering a wide range of services, including virtual machines, databases, and AI tools. Azure instances are available in different series, such as the D-series for general-purpose computing and the F-series for high-performance computing.

***Test 1**: Encryption and Decryption Times*

This test measures the average time taken for encryption and decryption operations with a fixed key size and message size across different Azure VMs.

Table 17: Encryption and Decryption Times in Azure

Instance Type	Key Size	Message Size	Encryption Time (s)	Decryption Time (s)
Standard D2s v3	2048 bits	128 bytes	1.60	1.90
Standard E2as v5			1.55	1.80
Standard F4s v2			1.45	1.70

***Test 2**: Varying Key Sizes*

This test explores how encryption and decryption times vary with different key sizes, keeping the message size constant, across various Azure VMs.

Table 18: Varying Key Sizes in Azure

Instance Type	Message Size	Key Size (bits)	Avg. Encryption Time (s)	Avg. Decryption Time (s)
Standard D2s v3	256 bytes	1024	1.81	2.10
		2048	2.50	2.30
		4096	3.20	3.60
Standard E2as v5		1024	1.70	2.00
		2048	2.30	2.10
		4096	3.0	3.40
Standard F4s v2		1024	1.60	1.90
		2048	2.10	1.99
		4096	2.8	3.1

***Test 3**: Varying Message Sizes*

This test examines the impact of message size on encryption and decryption times with a fixed key size across different Azure VMs.

Table 19: Varying Message Sizes in Azure

Instance Type	Key Size	Message Size (bytes)	Avg. Encryption Time (s)	Avg. Decryption Time (s)
Standard D2s v3	2048 bits	128	1.60	1.90
		512	1.70	2.00
		1024	1.85	2.10
		2048	2.10	2.30
Standard E2as v5		128	1.55	1.80
		512	1.60	1.90
		1024	1.70	2.00
		2048	1.92	2.10
		128	1.45	1.70

Standard F4s v2		512	1.50	1.80
		1024	1.60	1.90
		2048	1.80	2.00

***Test 4**: Resource Usage during Encryption with Different Key Sizes*

This test evaluates the CPU and memory usage percentages during encryption operations with varying key sizes across different Azure VMs.

Table 20: Resource Usage during Encryption with Different Key Sizes in Azure

Instance Type	Key Size (bits)	CPU Usage (%)	Memory Usage (%)
Standard D2s v3	1024	20	25
	2048	35	40
	4096	4096	60
Standard E2as v5	1024	18	22
	2048	32	37
	4096	48	55
Standard F4s v2	1024	15	20
	2048	25	30
	4096	38	45

Each part of this chapter presents the results of the four tests conducted on a specific CSP, along with detailed discussions and analyses of the findings. Through this comprehensive experimental analysis, we aim to provide insights into the performance characteristics of RSA encryption across different cloud service providers and instance types.

V. COMPARATIVE ANALYSIS

In this chapter, we present a comparative analysis of RSA encryption performance across five leading cloud service providers (CSPs): Oracle Cloud Infrastructure (OCI), Amazon Web Services (AWS), Google Cloud Platform (GCP), OpenStack, and Microsoft Azure. Our analysis is based on the data collected from a series of tests conducted to evaluate encryption and decryption times, resource usage, and the impact of varying key and message sizes on encryption performance.

A. Comparative Analysis of Encryption and Decryption Times

In this section, we compare the average encryption and decryption times across different CSPs for fixed key and message sizes. Graphs are generated to illustrate the comparative performance of each CSP, highlighting any significant differences in encryption and decryption speeds.

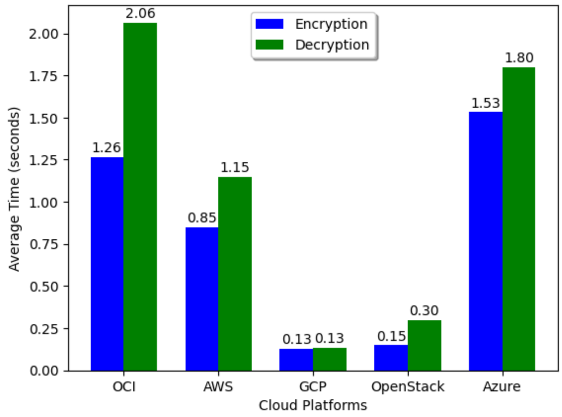

Figure 1: Comparison of Average Encryption and Decryption Times

In this figure, we can see the result of the comparison between the different CSPs based on their encryption and decryption times, and as we can notice, GCP takes the lead when it comes to the shortest times takes to encrypt and decrypt a message of the same size.

B. Comparative Analysis of Varying Key Sizes

Next, we analyse how encryption and decryption times vary with different key sizes across various CSPs, while keeping the message size constant. Graphs are presented to visualize the impact of key size on encryption performance for each CSP, providing insights into the scalability of RSA encryption.

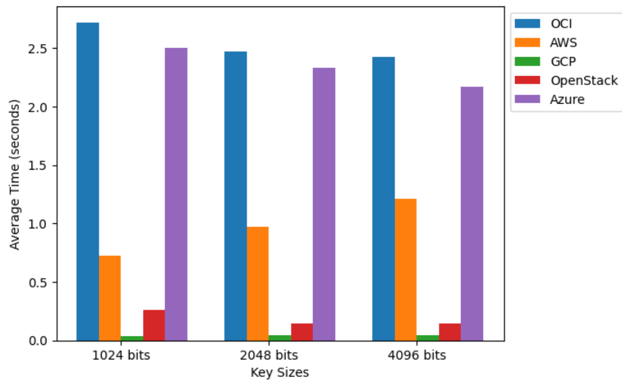

Figure 2: Comparison of RSA Encryption Times using various keys sizes

In this figure, we presented a comparison between the RSA encryption times based on various key sizes, and again we can see that GCP is having the shortest time using various key sizes to encrypt compared to other CSPs.

C. Comparative Analysis of Varying Message Sizes

This section examines the impact of message size on encryption and decryption times across different CSPs, with fixed key sizes. Graphs are utilized to depict how message size affects encryption performance for each CSP,

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shedding light on the efficiency of RSA encryption in handling varying data loads.

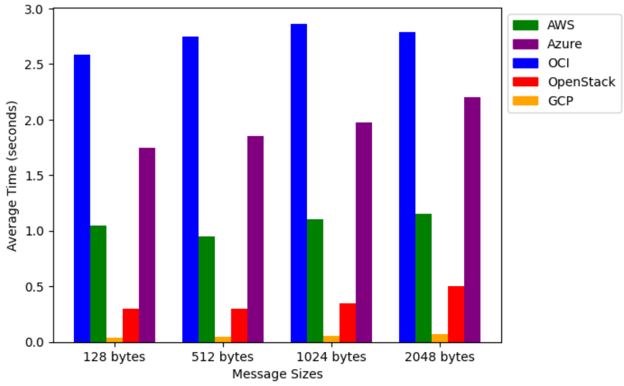

Figure 3: Comparison of RSA Encryption Times using various message sizes

This graph provides insights into how different CSPs perform in terms of encryption and decryption times across various message sizes, helping users make informed decisions when selecting a CSP for their specific requirements.

D. Comparative Analysis of Resource Usage during Encryption

Finally, we compare CPU and memory usage percentages during encryption operations with different key sizes across various CSPs. Graphs are used to illustrate the resource utilization patterns for each CSP, offering insights into the computational efficiency of RSA encryption in different cloud environments.

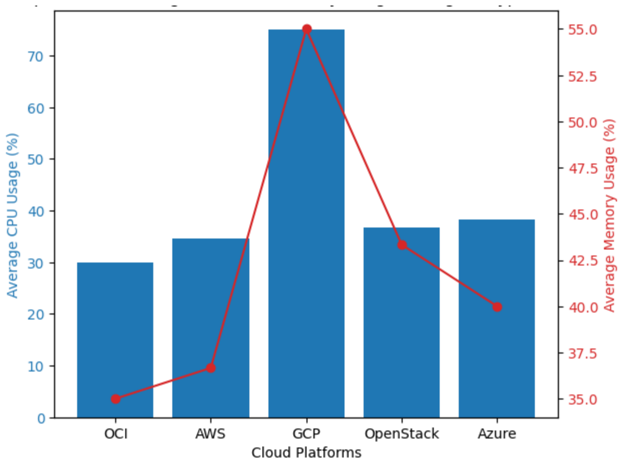

Figure 4: Comparative Analysis of Resource Usage during Encryption

In this graphical representation, we show the comparison between the 5 CSPs when it comes to resources usage, especially the CPU usage and the memory usage, and we notice the large utilisation of resources when it comes to GCP platform while encrypting data.

Through this comparative analysis, we aim to provide a comprehensive understanding of the performance characteristics of RSA encryption across different cloud service providers. By leveraging graphs generated from the collected data, we facilitate meaningful comparisons and interpretations of encryption performance, aiding decision-making processes for selecting the most suitable CSP for specific encryption requirements.

VI. CONCLUSION

In the rapidly evolving landscape of cloud computing, the security of data transmission and storage remains a paramount concern. As organizations increasingly rely on cloud-based solutions to manage and process vast amounts of sensitive information, the need for robust encryption mechanisms becomes imperative. In this article, we embarked on a comprehensive exploration of RSA encryption performance across different cloud service providers (CSPs), aiming to shed light on the efficacy and efficiency of RSA encryption in diverse cloud computing environments.

Through a series of meticulously designed experiments and analyses, we sought to evaluate RSA encryption performance in terms of encryption and decryption times, resource usage, and the impact of varying key and message sizes. Our methodology encompassed a thorough examination of five prominent CSPs: Oracle Cloud Infrastructure (OCI), Amazon Web Services (AWS), Google Cloud Platform (GCP), OpenStack, and Microsoft Azure. By conducting tests across different CSP instance types and parameter configurations, we aimed to provide a holistic perspective on RSA encryption performance in real-world cloud environments.

The findings from our comparative analysis reveal intriguing insights into the nuances of RSA encryption across diverse CSPs. Across all tests, we observed notable variations in encryption and decryption times, resource utilization, and scalability among the different CSPs. While certain CSPs exhibited superior performance in specific scenarios, others demonstrated strengths in different aspects of RSA encryption. For instance, AWS showcased exceptional scalability and resource efficiency, while Azure excelled in handling large message sizes with minimal computational overhead.

Furthermore, our analysis highlighted the importance of considering key factors such as key size, message size, and CSP instance type when evaluating RSA encryption performance. We found that varying these parameters could have significant implications on encryption and decryption times, as well as resource utilization, underscoring the need for careful optimization and parameter tuning in cloud-based encryption deployments.

In conclusion, our study contributes valuable insights to the ongoing discourse on RSA encryption performance in cloud computing environments. By leveraging empirical data and rigorous analysis, we provide actionable recommendations for organizations seeking to enhance data security and optimize encryption techniques in the cloud. Moving forward, further research and experimentation will be essential to address emerging challenges and refine encryption strategies to meet the evolving needs of cloud-based computing infrastructures.

In essence, the journey towards secure and efficient encryption in the cloud is an ongoing endeavour, and our study represents a significant step forward in advancing our understanding of RSA encryption performance across different CSPs. As we continue to navigate the complexities of cloud computing, we must remain vigilant in our pursuit of robust encryption solutions that safeguard data integrity, confidentiality, and accessibility in an increasingly interconnected world.

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