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Comparative Analysis of Key Management Service Performance on AWS, Google Cloud, and Oracle Cloud with Performance Testing



Abstract—Although switching to cloud technology for free exclusive can give cost advantage and efficiency, it requires policies, processes, and practices best security level business calculated. Based on survey to industry experts, available problem security in cloud computing, including data breaches identified as a problem security top need _ attention more. Most entry way sense to prevent data breach involves practice security in data storage, for example data encryption. But if happen lost key encryption, then it will also that loss. It supported by abundance data breaches that have occurred in the last 5 years recently, especially in Indonesia. To overcome security and management issues key encryption, some cloud providers provide Key Management Services (KMS) services. This research will compare the perform 2:e of Key Management Services from cloud providers AWS, Google Cloud, and Oracle Cloud with load testing methods, stress testing, and benchmark testing. The parameters assessed from this research are response time, error rate, throughput, and latency. The resulting research results are recommendations for the best cloud providers in Key Management Services. The result shows AWS can say better compared Google Cloud and Oracle because constant error rate lower from Google Cloud. and Oracle, competitive response time and latency. Throughput (requests per second) obtained almost always more excels at every testing.

Keywords— Performance Analysis, Cloud Computing, Cloud Security, Data Breaches, JMater

I. INTRODUCTION

In recent years, the demand for data has increased drastically as has the number of online users. Therefore, an external storage system is required to store data. Traditional computing is unable to handle the increasing number of online users due to the growth of the global internet. A new concept in data storage systems appears, namely cloud computing [1].

Cloud computing is a model of easy resource access and can be delivered on demand [2]. In cloud computing, customers only pay for services used with the PAYG model. Benefits include flexibility in customizing software, storage, development platforms, and computing resources [3].

In Indonesia, there have been several cases of user data violations on cloud service platforms such as Bukalapak Tokopedia and BPJS [4]. These cases show that inadequate implementation of encryption can lead to leaking of user data [15]. To address security issues and management of

encryption keys, several cloud service providers provide Key Management Services (KMS) services. KMS is a system that leverages cryptography and key lifecycle management functionality to connect applications and services, and automate key management processes [5].

(AWS), Google Cloud, and Oracle Cloud are recognized as leaders in cloud platform infrastructure and services [6]. They have invested heav 34 in building data centres and offering onpremises services as well as offering a wide range of services, tools and support to their customers [6], [7].

Based on the importance of key management in cryptography and the need to reduce the impact of data caches, the author will conduct research that focuses on comparative analysis of Key Management Service (KMS) performance on AWS, Google Cloud, and Oracle Cloud using load testing, stress testing, and benchmark testing methods.

II. RELATED WORK

A. Key Management Service

Key Management Service (KMS) is system that utilizes functionality cryptography and management cycle life key to connect applications and services. Functions too expanded to manage secrets and certificates. NIST defines KMS as a system for management key cryptography and i35 netadata, include various processes such as creation, distribution, storage, backup, archiving, restoration, use, revocation, and destruction key. KMS got used in a manner automation to oversee, automate, and secure management processes key [8].

B. Load Testing

Load 24 ting is a method of performance testing that involves the continuous operation of a system within the pressure it can withstand. The purpose is to test the stability of the system by ensuring the system can run consistently under these stresses. Load testing helps understand the performance capacity of the system and can be used as a basis for performance tuning [16]. It is important 20 listinguish load testing from stress testing, in which stress testing involves evaluating a system's performance beyond its normal capacity. Load testing is part of performance testing that ensures testigg is carried out within the specified resource capacity [9], [10].

C. Stress Testing

Stress testing is a performance testing method that involves continuously increasing 22 sure on the system under test until the system fails. The goal is to test the maximum pressure that the system can withstand. *Stress testing* involves a gradual increase in system load to test for changes in system performance and determine conditions under which the system fails to deliver the maximum level of performance service. The difference with *load testing* is that in *stress testing*, the test is carried out at the maximum pressure that the system can withstand [9].

D. Benchmark Testing

Overall, *benchmark testing* is a performance testing method that involves measuring and comparing systet 17 performance using standardized tests [11]. The purpose of benchmark testing is to provide a standardized and objective way to evaluate and compare the performance of different computer systems, as well as identify performance bottlenecks that can be optified to improve system performance. *Benchmark testing* is used in a variety of fields, including computer architecture, hardware and software design, and system optimization [11].

E. Apache JMeter

Apache JMeter is a desktop application used to test and

III. RESEARCH METHOD

A. Method Data Analysis

At stage analysis performance, this study uses three method testing that is lod_{22} esting, stress testing, and benchmark testing. Load testing is carried out to test the stability of the system by running operations continuously within the pressure limit that can be withheld is used as a tool testing with a test plan.

TABLE I Load Test Plan Scenario 1

| Group Threads | name | Load Test Scenario 1 |
|----------------------|--------------------------------|----------------------|
| Thread Properties | Number of threads | 100 |
| | Ramp-up Period (in seconds) | 1 |
| - | Loop Count | 10 |

TABLE II Load Test Plan Scenario 2

| Group Threads | name | Load Test Scenario 2 |
|----------------------|--------------------------------|----------------------|
| Thread Properties | Number of threads 250 | |
| | Ramp-up Period (in seconds) | 1 |
| - | Loop Count 26 | 10 |

Stress testing is performed to test changes in system performance by gradually increasing system load. The pressure on the system is tested continuously until the system collapses or is unable to withstand the applied load. Apache JMeter is used for measurements in stress testing with a test plan. Sp. (77)

TABLE III Stress Test Plan Scenario 1

| Threads |
|---------|
|---------|

measure the performance and functional behavior of client/server.applications, such as web applications or FTP applications. As one of the most popular *open-source testing applications*, JMeter is designed in Java and has expandability via a provided API. By acting as the "client side" of a "client/server" application, JMeter measures response time and server resources such as CPU load, memory usage, and other resource usage. This enables automated 16 ctional testing [10].

JMeter can be used to test the performance of static and dynamic resources such as static file *Servlets*, *FTP servers*, Databases, and *queries*. To test and measure the robustness of *HTTP or FTP servers* or networks, JMeter users can simulate various types of loads on the tested system. With its graphical tools, JMeter facilitates better performance analysis in heavy load situations [10].

F. Similar Literature

After determining the topic of research and the formulation of the problem, the author collects data by reading and studying books, journals, and also thesis which is used as a reference in order to obtain a theoretical basis gⁿ,ⁿ or regarding the problem to be studied. Similar literature can be seen in Table I

| | Number of threads | 5000 |
|----------------------|--------------------------------|------|
| Thread Properties | Ramp-up Period (in seconds) | 1 |
| | Loop Count | 10 |

rong Article @TABLE IV Stress Test Plan Scenario 2

| Group Threads | name | Stress Test Scenario 2 |
|------------------|--------------------|------------------------|
| | Number of threads | 10000 |
| Thread | Ramp-up Period (in | 1 |
| Properties | seconds) | I |
| | Loop Count | 10 |

Benchmark testing is a performance testing methodology that involves measuring and comparing system performance using a series of standardized tests known as benchmarks. At this stage, the system is tested by encrypting files of various sizes and the results are compared. Apache JMeter is also used to perform benchmark testing with the test plan listed in the table.

TABLE V Benchmark Test Input Plan

| No | file sizes | Number of threads | Extension |
|----|------------|-------------------|-----------|
| 1 | 100 kb | 10 | pdf |
| 2 | 1 mb | 10 | pdf |
| 3 | 10mb | 10 | pdf |

TABLE VI Benchmark Test Plan

| Group Threads | name | Benchmark Test Plan |
|----------------------|--------------------|---------------------|
| Thread Properties | Number of threads | 10 |
| | Ramp-up Period (in | 1 |
| | seconds) | 1 |
| | Loop Count | 1 |

The output of the test is in the form of response time, error rate, throughput, and latency which will be compared.

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IV. RESULTS

A. Load Testing

1) Average Response Time

Table 8 is comparison of the average *response time load testing* function encryption and function Key Management Service decryption from scenario 1 and scenario 2 on AWS, Google Cloud, and Oracle providers. The smallest average *response time* from the encryption function is obtained by AWS in scenario 1 and scenario 2. The largest average *response time* from scenario 1 for the encryption function is obtained by Google Cloud, in scenario 2 is obtained by Oracle. In the decryption function, the least average *response time* from scenario 1 and scenario 2 is obtained by AWS, and the largest average *response time* from scenario 1 and scenario 2 is obtained by Oracle

TABLE VII COMPARISON OF AVERAGE RESPONSE TIME LOAD TESTING

| Label | Provider | Scenario 1 | Scenario 2 |
|---------------------|--------------|------------|------------|
| Encrypt Function | AWS | 197 | 402 |
| | Google Cloud | 1124 | 2694 |
| | Oracles | 978 | 2920 |
| Decrypt function | AWS | 230 | 295 |
| | Google Cloud | 1245 | 2336 |
| | Oracles | 1370 | 2.560 |

2) Minimum Response Time

Table9 is comparisonminimum responsetime loadtestingfunction encryption and function KeyManagementServicedecryption from scenario 1 and scenario 2 on AWS,GoogleCloud, and Oracle providers.The minimum responsetimeforthe encryption function is obtained by Oracle inscenario 1 and scenario 2The minimum response time forscenario 1 is obtained by AWS and scenario 2 is obtained byOracle

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TABLE VIII COMPARISON OF MINIMUM RESPONSE TIME LOAD TESTING

| Label | Provider | Scenario 1 | Scenario 2 |
|---------------------|--------------|------------|------------|
| E (| AWS | 65 | 85 |
| Encrypt Function | Google Cloud | 74 | 71 |
| Function | Oracles | 56 | 63 |
| Description | AWS | 34 | 90 |
| Decrypt function | Google Cloud | 79 | 73 |
| | Oracles | 101 | 70 |

3) Maximum Response Time

Table10 is comparisonmaximum response time loadtestingfunction encryption and function KeyManagementServicedecryption from scenario 1 and scenario 2 on AWS,14 ogleCloud, and Oracle providers.The minimum maximumresponse timeof the encryption and decryption functions isobtainedb 14 WS in scenario 1 and scenario 2The maximummaximumresponse timeof the encryption and decryptionfunctionsis obtained by Oraclein scenario 1 and scenario 2

TABLE IX COMPARISON OF MAXIMUM RESPONSE TIME LOAD TESTING

| Label | Provider | Scenario 1 | Scenario 2 |
|---------------------|--------------|------------|------------|
| Encrypt Function | AWS | 2790 | 715 |
| | Google Cloud | 7170 | 21069 |
| | Oracles | 7623 | 16355 |
| Descrit | AWS | 2417 | 537 |
| Decrypt function | Google Cloud | 7404 | 21063 |
| | Oracles | 7706 | 21411 |

4) Error

Table 11 is *error comparisons beat testing* the encryption function and decryption function Key Management Service from scenario 1 and scenario 2 on AWS, Google Cloud, and Oracle *providers*. The fewest errors in the encryption and decryption functions in scenario 1 and scenario 2 were obtained by AWS. The biggest error from the encryption function in scenario 2, is obtained by Google Cloud biggest error from the decryption function in scenario obtained by Oracle

.

TABLE X COMPARISON OF ERROR LOAD TESTING

| Label | Provider | Scenario 1 | Scenario 2 |
|---------------------|--------------|------------|------------|
| Encrypt Function | AWS | 2790 | 715 |
| | Google Cloud | 7170 | 21069 |
| | Oracles | 7623 | 16355 |
| Description | AWS | 2417 | 537 |
| Decrypt function | Google Cloud | 7404 | 21063 |
| | Oracles | 7706 | 21411 |

5) Throughput

Table 12 is throughput comparisons had testing the encryption function and decryption function fr Key (15) Management Service from scenario 1 and scenario 2 on AWS, Google Cloud, and Oracle providers . The greatest throughput of scenario 1 and scenario 2 encryption and decryption functions was obtained by AWS. The smallest throughput of the scenario 1 encryption function is obtained by Google Cloud and the scenario 2 encryption function is obtained by Oracle. In the decryption function the smallest throughput from scenarios 1 and 2 is obtained by Google



TABLE XI COMPARISON OF THROUGHPUT LOAD TESTING

| Label | Provider | Scenario 1 | Scenario 2 |
|---------------------|--------------|------------|------------|
| Encrypt Function | AWS | 161.81 | 524,21 |
| | Google Cloud | 65,6 | 68,51 |
| | Oracles | 76,3 | 63,38 |
| Decrypt function | AWS | 169.3 | 651.04 |
| | Google Cloud | 63,2 | 73,40 |
| | Oracles | 64,3 | 78,21 |

6) Latency

Table 13 is comparison *latency load testing* function encryption and function decryption Key Management Service from scenario 1 and scenario 2 on AWS, Google Cloud, and Oracle *providers*. Least *latency* on functions encryption and function decryption Scenario 1 and Scenario 2 are obtained by AWS. The biggest *latency on* the function encryption Scenario 1 is obtained by Google Cloud and scenario 2 is obtained by Oracle. In the decryption function, the greatest *latency in scenario 1 and scenario 2 is obtained by Oracle*.

TABLE XII COMPARISON OF LATENCY LOAD TESTING

| Label | Provider | Scenario 1 | Scenario 2 |
|---------------------|--------------|------------|------------|
| Enormat | AWS | 197,059 | 402,628 |
| Encrypt Function | Google Cloud | 1124.52 | 2694.68 |
| Function | Oracles | 978,498 | 2920.76 |
| Desert | AWS | 230,262 | 295.8836 |
| Decrypt function | Google Cloud | 1245.82 | 2336.78 |
| runction | Oracles | 1370,435 | 2560.05 |

B. Stress Testing

1) Average Response Time

Table 14 is a comparison of the average *response time* stress testing the encryption function and decryption function Key Management Service from scenario 1 and scenario 2 on AWS, Google Cloud, and Oracle *providers*. In scenario 1 and scenario 2, the smallest average *response time* obtained by Oracle is 6687 ms and 6877 ms. Meanwhile, the largest average *response time* in scenario 1 encryption function was obtained by Google Cloud at 15673 ms and in scenario 2 encryption function obtained by AWS. In the scenario 1 decryption function, the smallest average *response time* is obtained by AWS of 6093 and in scenario 2 obtained by Oracle is 5576 ms. While the highest average *response time* in the scenario 1 and scenario 2 decryption function was obtained by Google Cloud at 13859 ms and 9705 ms.

TABLE XIII COMPARISON OF A VERAGE RESPONSE TIVE STRESS TEST

| Label | Provider | Scenario 1 | Scenario 2 |
|---------------------|--------------|------------|------------|
| Engrant | AWS | 7047 | 12858 |
| Encrypt Function | Google Cloud | 15673 | 9828 |
| runction | Oracles | 6687 | 6877 |
| Description | AWS | 6093 | 8574 |
| Decrypt function | Google Cloud | 13859 | 9705 |
| runction | Oracles | 6635 | 5576 |

2) Minimum Response Tim

Table 15 is minimum response time comparison stress testing function encryption and function decryption. Key Management Service from scenario 1 and scenario 2 on AWS, Google Cloud, and Oracle providers. Oracle gets the smallest minimum response time on the encryption and decryption functions in scenario 1. There are several minimum response times that produce a value of 0 so that it is not visible on the graph. This is because there are so many errors that occur at once that the request is immediately countered.

TABLE XIV COMPARISON OF MINIMUM RESPONSE TIME STRESS TESTING

| Label | Provider | Scenario 1 | Scenario 2 |
|---------------------|--------------|------------|------------|
| Enorm | AWS | 851 | 0 |
| Encrypt Function | Google Cloud | 0 | 0 |
| Function | Oracles | 63 | 0 |
| Description | AWS | 909 | 0 |
| Decrypt function | Google Cloud | 0 | 0 |
| Tunction | Oracles | 61 | 0 |

3) Maximum Response Time

Table 16 is comparison maximum *response time stress testing* function encryption and function decryption Key-Management Service from scenario 1 and scenario 2 on AWS, Google Cloud, and Oracle *providers*. AWS gets the smallest result the maximum *response time* of function encryption and decryption in scenario 1, but in scenario 2 it functions encryption, AWS maximum *response time increases* substantially drastic up to 320678 ms

TABLE XV COMPARISON OF MAXIMUM RESPONSE TIME STRESS TESTING

| Label | Provider | Scenario 1 | Scenario 2 |
|---------------------|--------------|------------|------------|
| Enormat | AWS | 21250 | 320678 |
| Encrypt Function | Google Cloud | 45262 | 50427 |
| Function | Oracles | 57959 | 107945 |

| Description | AWS | 10529 | 75578 |
|-------------|--------------|--------|-------|
| Decrypt | Google Cloud | 101837 | 72516 |
| function | Oracles | 81213 | 71820 |

4) Error

Table 17 is a comparison of the percentage error *stress testing* of the encryption function and the decryption function Key Management Service from scenario 1 and scenario 2 on AWS, Google Cloud, and Oracle *providers*. In the scenario 1 encryption and decryption function, AWS gets the least percentage of errors, namely 0.995% and 0.747%. But in scenario 2, the percentage of AWS errors rises to the range of 46% to 53%. Google Cloud and Oracle got somewhat consistent results in the range of 76% to 93% in scenario 1 and scenario 2.

TABLE XVI COMPARISON OF ERROR STRESS TESTING

| Label | Provider | Scenario 1 | Scenario 2 |
|---------------------|--------------|------------|------------|
| | AWS | 0.995 | 46,743 |
| Encrypt Function | Google Cloud | 78,638 | 91,292 |
| runction | Oracles | 89,943 | 90,994 |
| Desmut | AWS | 0.747 | 53,568 |
| Decrypt function | Google Cloud | 76.06 | 92,195 |
| runction | Oracles | 90,374 | 93.77 |

5) Throughput

Table 18 is *throughput comparisons stress testing* the encryption function and decryption function Key Management Service from scenario 1 and scenario 2 on AWS. Google Cloud, and Oracle *providers*. AWS got the highest *throughput result on scenario 1 encryption function, and scenario 1 and scenario 2 decryption function.* Google Cloud got results highest *throughput* on function encryption scenario 2.

TABLE XVII COMPARISON OF THROUGHPUT STRESS TESTING

| Label | Provider | Scenario 1 | Scenario 2 |
|---------------------|--------------|------------|------------|
| Enternet | AWS | 701.1285 | 554,8832 |
| Encrypt Function | Google Cloud | 278,369 | 582.5547 |
| Function | Oracles | 514,774 | 457,2054 |
| D (| AWS | 808.5473 | 916.5491 |
| Decrypt function | Google Cloud | 298.9898 | 644,1867 |
| lunction | Oracles | 498.4205 | 817.0162 |

6) Latency

Table 19 is comparison of the average *latency* of the test *stress testing* function encryption and function decryption Key Management Service from scenario 1 and scenario 2 on AWS, Google Cloud, and Oracle *providers*. AWS got the lowest average *latency on scenario 1 encryption function, scenario 1 and scenario 2 decryption function. Oracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *latency on scenario 2 encryption function. Coracle got* the lowest average *lat*

| TABLE XVIII COMPARISON OF LATEN | CY STRESS TESTING |
|---------------------------------|-------------------|
|---------------------------------|-------------------|

| Label | Provider | Scenario 1 | Scenario 2 |
|---------------------|--------------|------------|------------|
| E | AWS | 7076,899 | 21624.73 |
| Encrypt | Google Cloud | 19552,47 | 23219.05 |
| Function | Oracles | 19814,49 | 20406 |
| (TS) | AWS | 6108,458 | 17165.57 |
| Decrypt function | Google Cloud | 16974,61 | 22899.32 |
| Tunction | Oracles | 20140,7 | 18436,87 |

C. Benchmark Testing

1) Average Response Time

Table 20 is comparison of the average response time of testing benchmark testing of the function encryption and function decryption Key Management Service on the insert file sizes 100KB, 1MB, and 10MB. In the 100KB file encryption function, AWS gets an average response time of less than Google Cloud. Meanwhile, the 1MB and 10MB file encryption, Google Cloud has an average response time that ong Art 4's Throughput is lower than AWS. Oracle Cloud produces a constant average response time of 0 ms due to unsuccessful benchmark testing.

TABLE XIX COMPARISON OF AVERAGE RESPONSE TIME BENCHMARK TESTING

| Label | Cloud Provider | Average Response Time (ms) |
|------------------------|----------------|---------------------------------|
| Enorumt Filos | AWS | 97 |
| Encrypt Files 100KB | Google Cloud | 133 |
| TOOKD | Oracles | 0 |
| Ensure Eller | AWS | 192 |
| Encrypt Files 1MB | Google Cloud | 147 |
| INB | Oracles | 0 |
| E (E1 | AWS | 2117 |
| Encrypt Files 10MB | Google Cloud | 1023 |
| | Oracles | 0 |

2) Minimum Response Time

Table 21 is comparison of minimum response time testing benchmarloo testing of function encryption and o function decryption Key Management Service on the insert file sizes 100KB, 1MB, and 10MB. At 100 KB file encryption, AWS gets minimum response time results more A little compared to Google Cloud. Meanwhile, at 1 MB and 10 MB file encryption, Google Cloud gets minimum response time results are more A little compared to AWS. Oracle Cloud generates a constant minimum response time of 0 ms due to unsuccessful benchmark testing.

TABLE XX COMPARISON OF MINIMUM RESPONSE TIME BENCHMARK TESTING

| Label | Cloud Provider | Min Response Time (ms) |
|------------------------|----------------|-----------------------------|
| Enormat Files | AWS | 88 |
| Encrypt Files 100KB | Google Cloud | 102 |
| TUUKB | Oracles | 0 |
| En en et Eller | AWS | 162 |
| Encrypt Files 1MB | Google Cloud | 123 |
| IIVID | Oracles | 0 |
| En ann t Eilen | AWS | 781 |
| Encrypt Files 10MB | Google Cloud | 534 |
| | Oracles | 0 |

3) Erroi

Table 22 is comparison error presentation testing benchmark testing function encryption and function decryption Key Management Service on the insert file sizes 100KB, 1MB, and 10MB. From pictures we can conclude that there are none of the errors generated at the time testing good benchmark testing from AWS or Google Cloud providers. Especially for Oracle Cloud, it produces a constant error of 0% due to unsuccessful benchmark testing.

TABLE XXI COMPARISON OF ERROR BENCHMARK TESTING

| Label | Cloud Provider | Error % |
|-------|----------------|---------|
| | AWS | 0 |

| | Encrypt Files | Google Cloud | 0 |
|----|-----------------------|--------------|---|
| | 100KB | Oracles | 0 |
| 21 | Engrand Files | AWS | 0 |
| | Encrypt Files 1MB | Google Cloud | 0 |
| | IMB | Oracles | 0 |
| | Enount Eller | AWS | 0 |
| | Encrypt Files 10MB | Google Cloud | 0 |
| | TUMB | Oracles | 0 |

Table 23 is a comparison of throughput for benchmark testing of the encryption function and decryption function Key Management Service in the file enter size 100KB, 1MB, and 10MB. At 100 KB file encryption, AWS gets slightly more throughput than Google Cloud. Meanwhile, for 1 MB and 10 MB file encryption, Google Cloud gets greater throughput than AWS. Oracle Cloud generates a constant throughput of 0 requests per second due to unsuccessful benchmark testing.

TABLE XXIIII COMPARISON OF THROUGHPUT BENCHMARK TESTING

| Label | Cloud Provider | Throughput(s) |
|------------------------|----------------|---------------|
| E | AWS | 10.04016 |
| Encrypt Files 100KB | Google Cloud | 9.8912 |
| TOOKB | Oracles | 0 |
| Enount Elles | AWS | 9.43396 |
| Encrypt Files 1MB | Google Cloud | 9.68054 |
| INB | Oracles | 0 |
| E | AWS | 2.6462 |
| Encrypt Files 10MB | Google Cloud | 4.58926 |
| TONIB | Oracles | 0 |

5) Latency

Table 24 is comparison of the average latency of benchmark testing function testing encryption and function decrypt Key Management Service in the insert file sizes 100KB, 1MB, and 10MB. At 100 KB file encryption, AWS gets more latency results A little compared to Google Cloud. However, at 1 MB file encryption and 10 MB Google Cloud gain more latency results A little compared to AWS. Oracle Cloud produces an average constant latency of 0 ms due to unsuccessful benchmark testing.

TABLE XXIII COMPARISON OF LATENCY BENCHMARK TESTING

| Label | Cloud Provider | Latency (ms) |
|------------------------|----------------|----------------|
| English Eller | AWS | 97.1 |
| Encrypt Files 100KB | Google Cloud | 133,4 |
| TOOKD | Oracles | 0 |
| Ensue Eller | AWS | 171 |
| Encrypt Files | Google Cloud | 142.9 |
| IMB | Oracles | 0 |
| Enound Eller | AWS | 1774,4 |
| Encrypt Files 10MB | Google Cloud | 975.3 |
| TUMB | Oracles | 0 |

V. CONCLUSION

Based on results analysis Key Management Service performance on AWS, Google Cloud, and Oracle using load testing methods, stress testing, and benchmark testing, can concluded things following:

1. In the load testing test, AWS shows the best results compared to Google Cloud and Oracle. AWS has more response time, throughput, and latency well, as well No generates an error in the load testing test. Google Cloud and Oracle experienced an error rate of 0.44% to 2.44%.

- 2. In stress testing, the percentage of errors is a determining factor for the success of requests. AWS has more error percentage low than Google Cloud and Oracle, while the best latency, throughput, and response time alternate between AWS, Google Cloud, and Oracle.
- 3. In benchmark testing, AWS has more results good at encrypting file sizes of 100 KB, while Google Cloud is more both in encryption file size of 1 MB and 10 MB in terms of response time, throughput, and latency. No, there is an error that occurs in benchmark testing.
- 4. Based on testing whole, author recommend AWS provider in implementing Key Management Service because more error rate low, competitive response time and latency, as well as more throughput superior.

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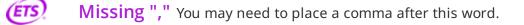
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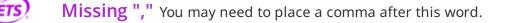
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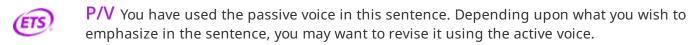
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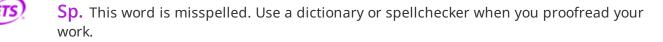


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Article Error You may need to use an article before this word.

P/V You have used the passive voice in this sentence. Depending upon what you wish to emphasize in the sentence, you may want to revise it using the active voice.

Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.



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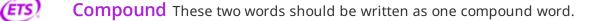
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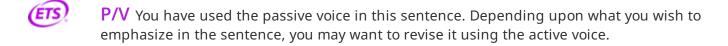
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- **P/V** You have used the passive voice in this sentence. Depending upon what you wish to emphasize in the sentence, you may want to revise it using the active voice.
- (ETS) Missing "," You may need to place a comma after this word.
- **ETS Compound** These two words should be written as one compound word.
- **ETS** Article Error You may need to use an article before this word.

P/V You have used the passive voice in this sentence. Depending upon what you wish to emphasize in the sentence, you may want to revise it using the active voice.

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- **P/V** You have used the passive voice in this sentence. Depending upon what you wish to emphasize in the sentence, you may want to revise it using the active voice.
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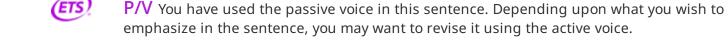


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Article Error You may need to use an article before this word. Consider using the article **the**.



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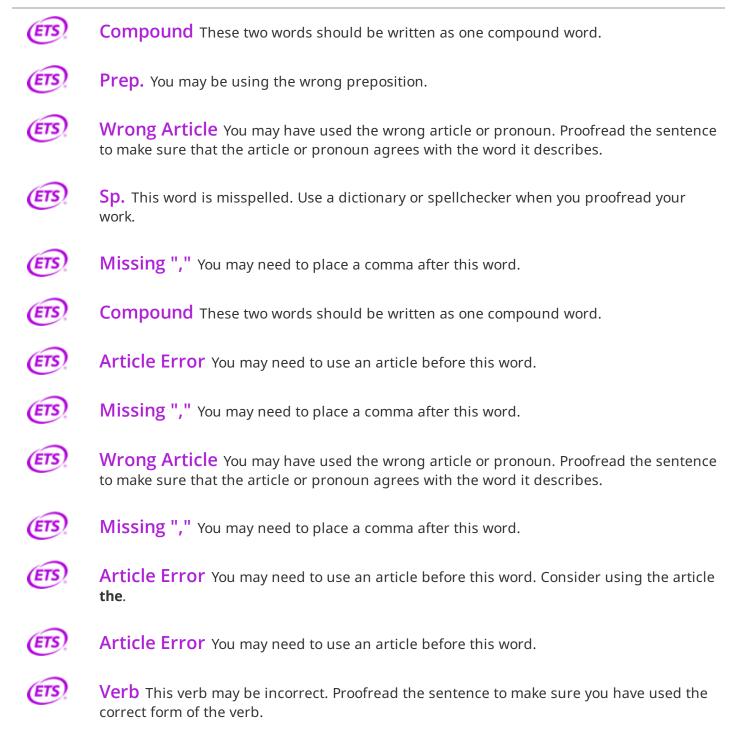
(ETS) Compound These two words should be written as one compound word.

Proper Noun If this word is a proper noun, you need to capitalize it.



- **P/V** You have used the passive voice in this sentence. Depending upon what you wish to emphasize in the sentence, you may want to revise it using the active voice.
- Article Error You may need to use an article before this word. Consider using the article the.
- **Proper Noun** If this word is a proper noun, you need to capitalize it.
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- *P/V* You have used the passive voice in this sentence. Depending upon what you wish to emphasize in the sentence, you may want to revise it using the active voice.
- **(ETS)** Compound These two words should be written as one compound word.
- (ETS) Article Error You may need to use an article before this word.
- (ETS) Missing "," You may need to place a comma after this word.
- (ETS) Missing "," You may need to place a comma after this word.
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- **ETS** Missing "," You may need to place a comma after this word.
 - **Proper Noun** If this word is a proper noun, you need to capitalize it.

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Article Error You may need to use an article before this word.

S/V This subject and verb may not agree. Proofread the sentence to make sure the subject agrees with the verb.