



Implementation Infrastructure as a Service for Open Source Learning Management System Moodle with 5000 plus concurrent users in K-12 and High School XYZ in Surabaya with Google Cloud Platform Compute Engine Autoscaling

By

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The Problem - Digital Transformation

Education

A study by UNESCO says that still 200+ million students in 23 countries are affected by the pandemic covid-19 now, and believe that we will not go back to normal nearly soon.

Adapt

Process for digital transformation especially for education to adapt to the new learning environment caused by Covid-19. E-learning has been emerging and increasing utilization for schools in the year 2020.

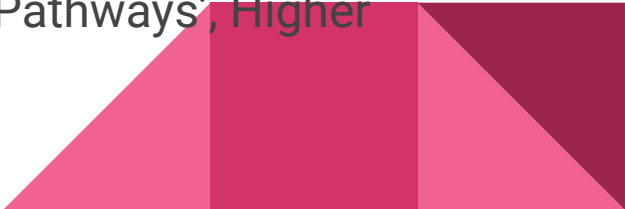
Platform

To helps teacher manage and organize educational materials online and conduct online courses. Streamline the learning process by providing a central location for accessing material online and developing content.

The Four Rationales for Introducing ICT in Education

1. Social: The perceived role that technology now plays in society and the need for familiarizing students with technology.
2. Vocational: Preparing students for jobs that require skills in technology.
3. Catalytic: Utility of technology to improve performance and effectiveness in teaching, management, and many other social activities.
4. Pedagogical: To utilize technology in enhancing learning, flexibility, and efficiency in curriculum delivery.

Source: Cross, M. & Adam, F. (2007). ICT Policies and Strategies in Higher Education in South Africa: National and Institutional Pathways', Higher Education Policy 20(1), 73–95.



Challenges deep-dive

Platform LMS

e-Learning

Application for the administration, documentation, tracking, reporting, automation, and delivery of educational courses, training programs, or learning and development programs. The learning management system concept emerged directly from e-Learning

Infrastructure

Fast to Deploy

Schools facing problems on how to build platforms that are fast to deploy and cost-effective to serve all students at the same time or concurrent connections.

Scalability

Able Scale Up

Scalability is a key requirement as LMS becomes a critical application for a school to extend education methods and teaching activities.

Solution

Moodle

Open Source

Learning Management System

On

Google Cloud Platform

Infrastructure as a Service

Methodology

PPDIOO

1. Prepare:

Involves establishing the organizational requirements, literature study, and proposing a high-level conceptual architecture identifying technologies that can best support the architecture.

2. Plan:

Involves identifying initial server and software requirements based on goals, facilities, user needs for the new sites.

3. Design:

The server design specification is a comprehensive detailed design that meets current business and technical requirements and incorporates specifications to support availability, reliability, security, scalability, and performance. The design specification is the basis for the implementation activities.



PPDIOO continued

4. Implement:


The server, software, autoscale is built or additional components are incorporated according to the design specifications.

5. Operate:

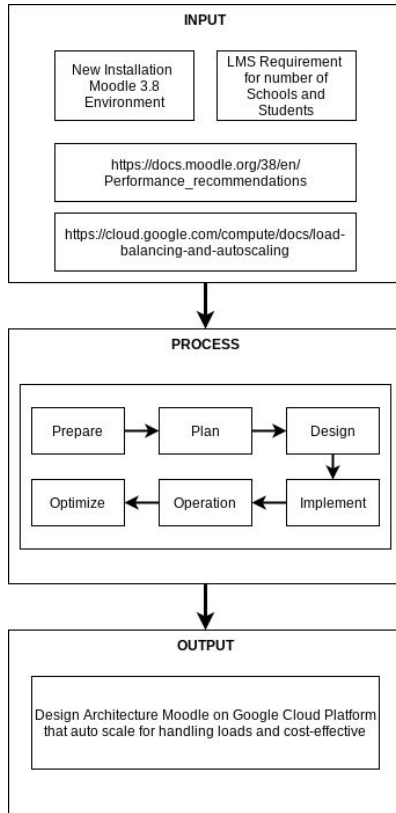
Operation is the final test of the appropriateness of the design. The operational phase involves maintaining server health through day-to-day operations, including maintaining high availability and reducing expenses. The connection problem detection, correction, and performance monitoring that occur in daily operations provide the initial data for the optimization phase.

6. Optimize:

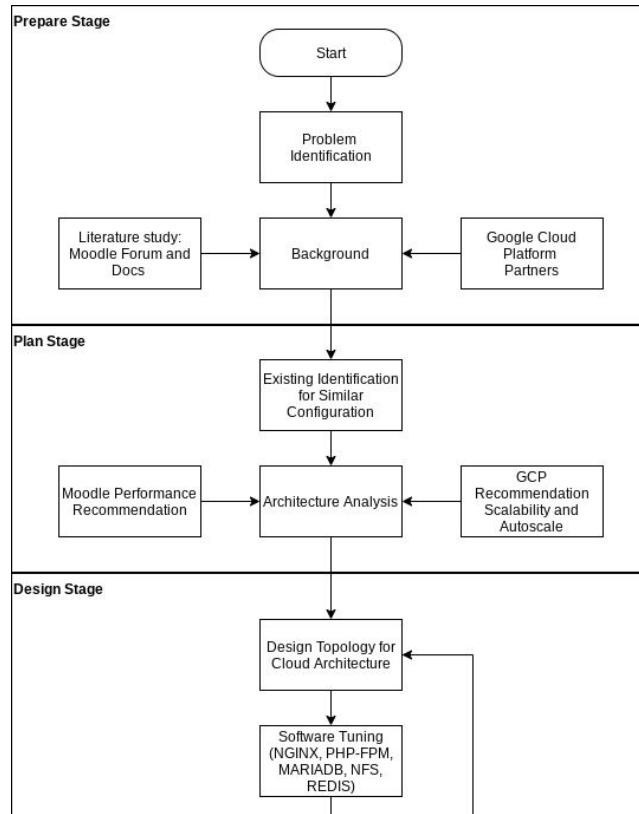
Involves proactive management of the server. The goal of proactive management is to identify and resolve issues before they affect the organization. Reactive fault detection and correction (troubleshooting) is needed when proactive management cannot predict and mitigate failures.



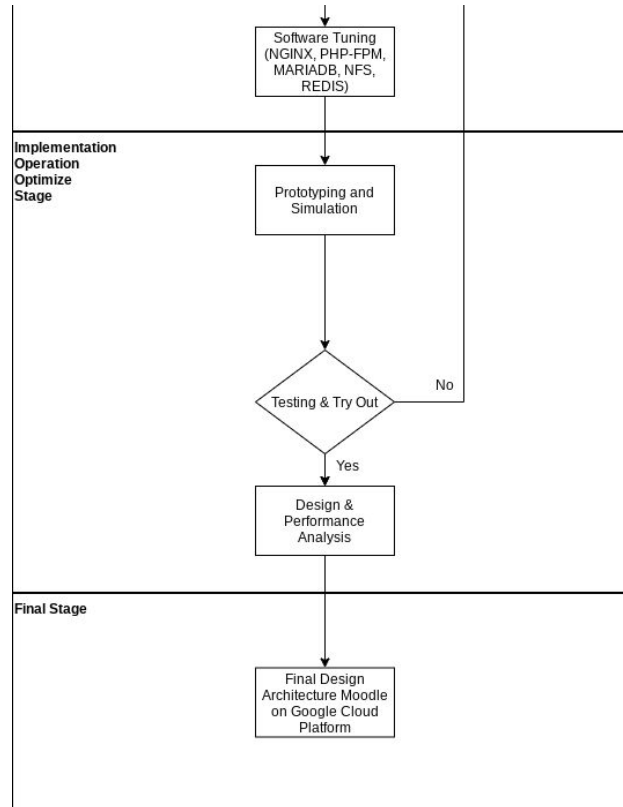
Conceptual Method



Systematic Research



Systematic Research Continued



Scope

1. Case study is Open Source Learning Management System Moodle.
2. Cloud Infrastructure is using Google Cloud Platform with auto scaling and load balancing.
3. Operating System and software components configuration.
4. Moodle for the case study is the Learning Management System that is used by School XYZ in Surabaya.



Software Components

No	OS / Software	Version
1	Ubuntu Linux	20.04
2	Nginx Web Server	1.18.0
3	PHP-FPM Scripting Language	7.4.3
4	MariaDB Database	10.5
5	NFS Network File System	1.3.4
6	Redis Memory Store Cache Server	5.0
7	Moodle Learning Management System	3.8.x
8	Load Balancer	GCP provided



Moodle Configuration & Optimization

1. Moodle Directory Path

2. Performance Tuning Configuration

A. Moodle Application Configuration

B. PHP FPM Pool Configuration

C. Nginx Web Server Configuration

D. MariaDB Database Configuration

E. NFSv4 File Server & Client Configuration

F. Operating System File Limit Configuration



Security Configuration & Optimization

3. Security Configuration

- A. Moodle Installation

- B. PHP FPM Pool Configuration



GCP Configuration & Optimization

4. Google Cloud Platform Configuration

4.1. Create Custom Images from Ubuntu 20.04 Public Images

1. Create VM Instances
2. Choose Ubuntu 20.04 from Public Image as Boot Disk
3. Configure and copy file as necessary for each instance
4. Create custom images from disk

4.2. Create Instance Template

4.3. Create Managed Instance Group

4.4. Create a Load Balancer and Attach an HTTP(s) load balancer to an Managed Instance Group (MIGs)

4.5. Google Cloud Armour

4.6. Google Cloud Platform Price Calculator



Monitoring Tools

1. System Benchmark
2. Caching Performance Report

#	Description	Time (seconds)	Acceptable limit	Critical limit
1	Moodle loading time Load the "config.php" configuration file	0.012	0.5	0.8
2	Processor processing speed Call a PHP function with a loop to check the processor speed	0.077	0.5	0.8
3	Reading file performance Read a file multiple times to check the reading speed of the Moodle temporary folder	0.144	0.5	0.8
4	Writing file performance Write a file multiple times to check the writing speed of the Moodle temporary folder	0.338	1	1.25
5	Reading course performance Read a course multiple times to check the reading speed of the database	0.166	0.75	1
6	Writing course performance Write a course multiple times to check the writing speed of the database	0.029	1	1.25
7	Database performance (#1) Run a complex SQL query to check the speed of the database	0.110	0.5	0.7
8	Database performance (#2) Run a complex SQL query to check the speed of the database	0.150	0.3	0.5
9	Login time performance for the guest account Check the loading time of the guest account login page	0.070	0.3	0.8
10	Login time performance for a fake user account Check the loading time of a fake user account login page	0.088	0.3	0.8
Total time		1.184s		
Score		119 points		

Congratulations!
The performance of your Moodle installation seems to be perfect.

Cache store performance reporting - 10000 unique requests per operation.

Test with 1, 10, 100, 500, 1000, 5000, 10000, 50000, 100000 requests

Store requests when used as an application cache.

Plugin	Result	Set	Get - Hit	Get - Miss	Delete
APC user cache (APCu)	Unstable	-	-	-	-
File cache	Tested	5.9043	1.1982	0.4740	0.5435
Memcached	Unstable	-	-	-	-
MongoDB	Invalid plugin	-	-	-	-
Redis	Tested	2.1157	2.0998	2.0115	1.3365
Session cache	Unsupported mode	-	-	-	-
Static request cache	Unsupported mode	-	-	-	-

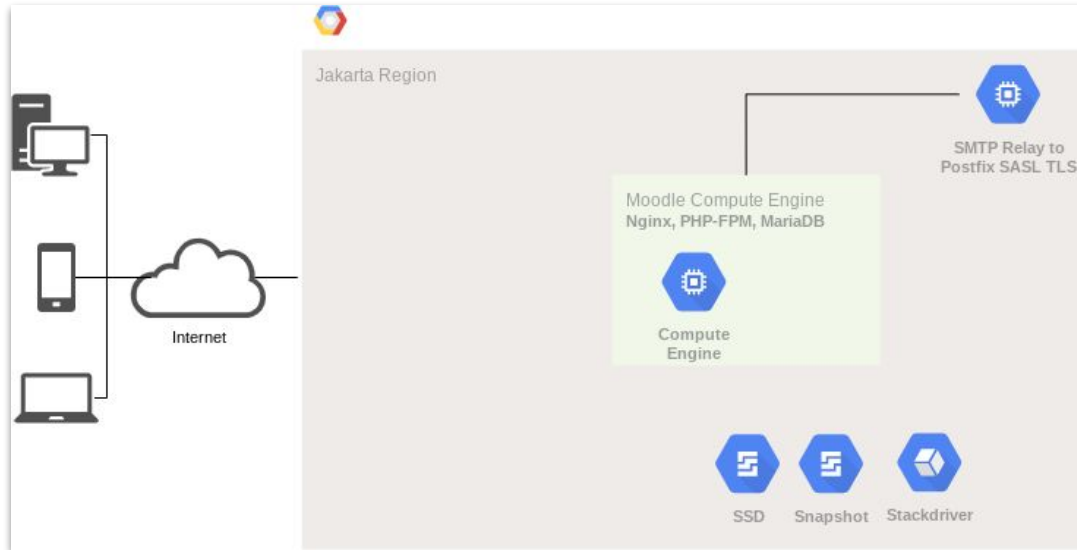
Monitoring Tools

3. Stackdriver / System Monitoring



Single Server Architecture

Single server architecture has been used for initial testing environments that combine 4 components (Web Server, PHP, Database, Cache) in a single server with 8 Core CPU, 32 GB RAM, 500GB SSD Storage.

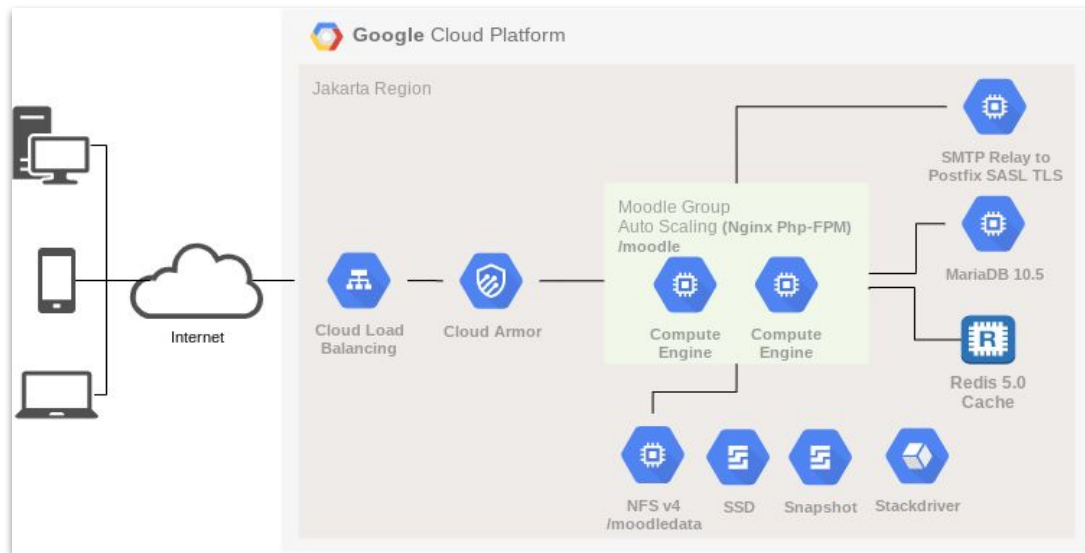


Single Architecture Concurrent Report Result

Date	Active Users	Concurrent	Spec (CPU, Memory)	Web Server
01-Aug-2020 - 07-Sep-2020	6,013	496	8 Core, 32 GB	Apache
01-Sep-2020 - 07-Oct-2020	7,547	1,079	8 Core, 32 GB	Nginx

Auto Scaling Architecture

Autoscaling is a tool that allows web servers to efficiently handle increases in traffic by dynamically adding compute capacity but also reduce capacity and costs in periods of low traffic and resource demand.



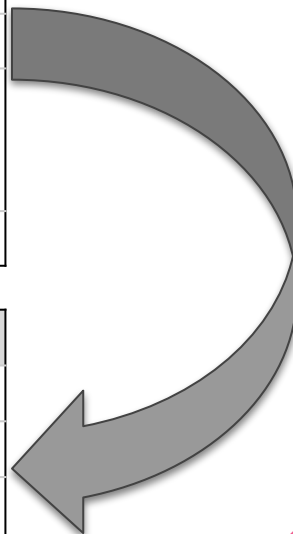
Auto Scaling Architecture Concurrent Report Result

Date	Active Users	Concurrent	Instance #	Web Server
22-Oct-2020	7,400	955	8	Nginx
28-Oct-2020	6,822	1,537	12	Nginx
02-Nov-2020	8,109	911	4	Nginx
16-Nov-2020	11,866	5,549	18	Nginx

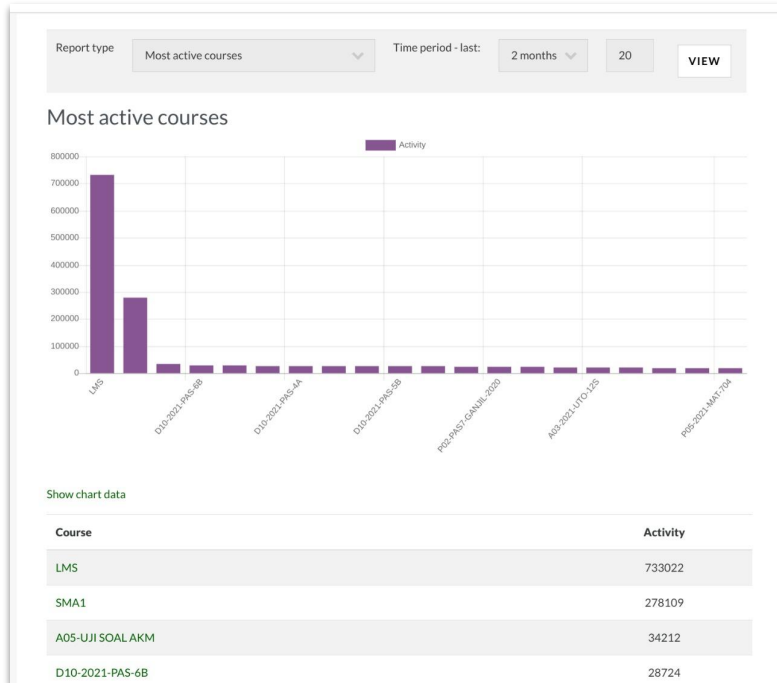
Auto Scaling Architecture Specification

VM	CPU	CPU Peak	Memory	Memory Peak	SSD	Network
Databases	12 core	80%	12 GB	96.48%	200 GB	35 MB/s
NFS	4 core	50%	6 GB	31%	750 GB	78 MB/s
Managed Instance Groups	@2 core	74%	7.5 GB	80%	20 GB	464 MB/s
Redis1	2 core	90%	4 GB	20%	10 GB	325 MB/s

VM	CPU	Memory	SSD	Instance #
DB	12 core	24 GB	250 GB	1
NFS	4 core	6 GB	750 GB	1
Managed Instance Group	@2 core	8 GB	10 GB	min: 2 max: 20
Redis Memory Store	Managed by Google	2 GB	Managed by Google	Managed by Google



LMS Live Site



LMS MY COURSES ADMIN USER

LMS

Dashboard / Site administration / Users / Accounts / Browse list of users

BLOCKS EDITING ON

14651 Users

◀ 1 ... 486 487 488 489

New filter

First name contains

Email address contains

ADD FILTER

Show more...

First name / Surname	Email address	City/town	Country	Last access	Edit
		Surabaya	Indonesia	5 hours 27 mins	🗑️ 👁️ ⚙️
		Surabaya	Indonesia	2 hours 38 mins	🗑️ 👁️ ⚙️
		Surabaya	Indonesia	2 hours 59 mins	🗑️ 👁️ ⚙️

Conclusion

Autoscale architecture on Google Cloud Platform enables for faster deployment, cost-effective and scalable for Moodle Learning Management Systems. Web server resources have been showing the most resources demand from the deployment, in this study autoscaling has been successfully to solve the problem with auto scaling and load balance technology.

The main goal for this research was to determine and testing infrastructure scalability in Google Cloud Platform while maintaining cost-effectiveness in cloud computing environments as an Infrastructure as a Services (IaaS) with autoscale and load balance architecture, this will benefit end-users to maintain cost while off-peak access and schools holiday.



Thank you

To Pendidikan Profesi Insinyur
Universitas Kristen Petra
