

CHECK YOUR WORK REPORT

CS7346 Cloud Computing

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I.INTRODUCTION AND OVERVIEW

1.Subject Introduction

A university has greatly expanded its CS course and wants to be able to automate the grading of simple programming assignments. User needs satisfied 300+ students per year, plus staff and admin. The project requirements are Students must be able to upload their source code, which will be run and graded. Grades and runs must be persistent and auditable. Besides, there must be a plagiarism detection system involving comparing with other submissions and also submitting to a web-based service (TurnItIn). There must be some level of integration with the University's learning management system (LMS).

2.Group Solution

Through group discussion, we believe that for the LMS we use Moodle LMS, set up in AWSSES2. For the TurnItIn, our project has the TurnItIn plugin, when admin create a assignment or whatever can choose the TurnItIn option for the assignment. For grades auditable, admin has power to change and modify the grades. And for the data about the files or grades, we set up mysql database on local. We also use AWS route 53 to connect the domain name. For the project, we also use cloud front which provides access to the web server. Behind this, we use Amazon Load Balancer, providing low latency access to content while serving cached content from edge locations spread across the global. The project uses the AWS Certificate Manager (ACM), which manages secure sockets layer (SSL) certificates for secure,encrypted communication with public and private resources. For more details about the aws architectures we used is in the Section 4.

II. PROJECT DISCUSSION

1.Assumptions

We make some assumptions in the following:

- The systems has 300+ students per year, plus staff and admin.
- TurnItIn plugins works fine. Because we didn't have the account about that, we just make it as an option.
- The moodle system basic hardware requirement of AWS EC2 instance is Disk space 5GB, processor 2 GHz dual core or more recommended[6], Memory 8GB plus is likely on a large production server[9]. Assume the project can work fine as a large production, in our project just can make sure it can run successfully.

2.Use Cases And Actors

We set up our system on AWS, it can be open-source Learning Management System(LMS) that enables educators to deliver e-learning content and educational courses. Here are some key use cases and actors involved in using our system:

A) For Use Cases:

- Course Management: Teachers can create and manage various course materials such as lectures, assignments, quizzes,forums, and grade books. Our system also supports a variety of file types and media, making it easy to share different types of educational content. We offer auto grading, it can automatically grading the assignments based on teachers test case.
- Online Learning: The project can host fully online courses or be used to supplement in-person classes(blended learning). This includes delivering lectures, facilitating discussions, administering quizzes, and more. Students and teachers can easily to test the assignment and code.
- Collaborative Learning: Tools like wikis, forums, and group assignments enable collaborative learning. Learners can

work together on projects, discuss topics, and learn from each other. When auto grading the assignment code, it can points out the feed back of bugs to students, which can improve their learning efficiency.

- **Assessment and Tracking:** Our project allows teachers to assess student performance through various types of assignments and exams. Additionally, it tracks student progress and activities, providing detailed reports to teachers. And teachers and students also can see the feedback of the grade, the mistake and somewhere need to be improved.
- **Communication and Engagement:** With the project, communication between the teachers and students or among students is easy. Features like direct messaging, forums, and notifications keep everyone engaged and up-to-date.
- **Professional Development:** Companies and organizations can use our project for employee training, learning, and development activities. It can auto grading the code test, it can help companies and organizations save a lot of time and money.

B) For Actors:

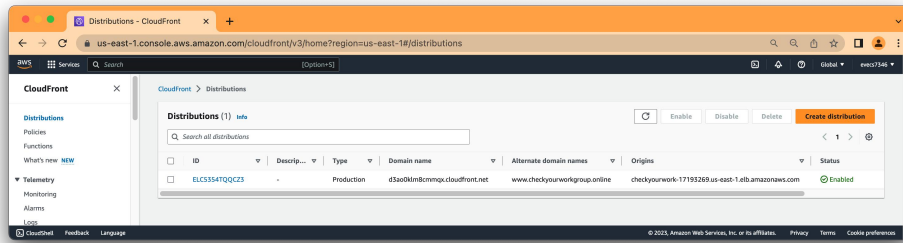
- **Students/Learners:** These are the primary users who access courses and resources, participate in activities, and communicate with peers and teachers. When student upload their code or assignment, they can get the grade immediately, and our system offer a lot of different programming environment to help students to study. They can coding, running, debugging online.
- **Teachers/Instructors:** They design and manage courses, grade student work, track progress, and communicate with learners. They are also responsible for moderating discussions and fostering an engaging learning environment. We offer lot of plugins to teachers to use. They can set the assignment auto grading or plagiarism detection. It can help teachers to know more their students. Improving the teaching efficiency. Teachers can set up some test case and different points of each test case and then let the system to grade the student assignment automatically.

- Administrators: They are responsible for managing the site, adding and removing users, setting up course categories, maintaining the system, and implementing site-wide policies. They can create and manage courses.
- Managers: Depending on the organization's configuration of the project, managers have permissions to add/remove users, change user roles, and access and manage certain areas of the site.
- Guests: These users have limited access to the project site. They can view some content but can't participate in activities like quizzes or forums.

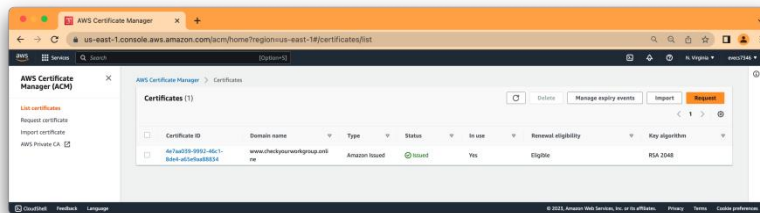
Each of these actors plays a unique role in using and interacting with our project, which aids in creating an effective, engaging, and collaborative learning environment. Especially, students are able to upload their source code, which will be run and graded. Grades and runs can be persistent and auditable. The system has the plugin of a plagiarism detection involving comparing with other submissions and also submitting to a web-based service (TurnItIn). Our system is integration with the University's learning management system (LMS).

III.DETAILED DIAGRAM OF THE SYSTEM'S ARCHITECTURE

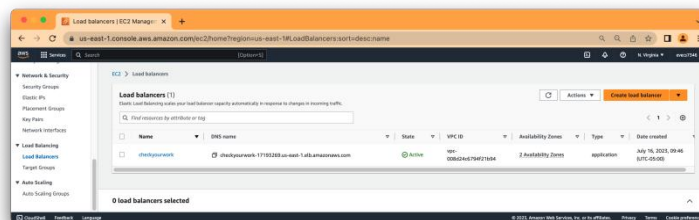
Our system is a learning platform designed to provide educators, administrators and learners with a single robust, secure, and integrated system to create personalized learning environments. We based Moodle learning management system (LMS) on AWS can be deployed using architecture and can scale up on demand[1]. Separate the application and data layers for elasticity and security. And it has a lot of plugin we like TurnItIn which is a web-based service (TurnItIn) which is plagiarism detection to help teachers to check the students assignments. Virtual programming Lab plugin can automatically grade the programming assignments.



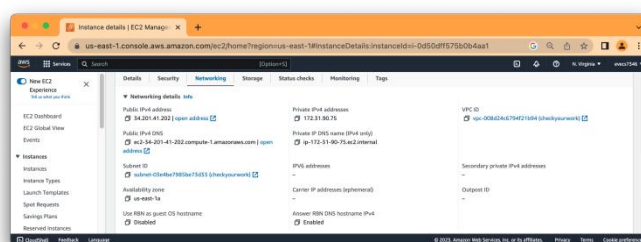
3. AWS Certificate Manager (ACM): manages secure sockets layer (SSL) certificates for secure, encrypted communication with public and private resources. It provides free SSL certificates that integrate with CloudFront or Application Load Balancer with automated certificate rotation. Our project Certificate ID is “4e7aa039-9992-46c1-8de4-a65e9aa88834”.



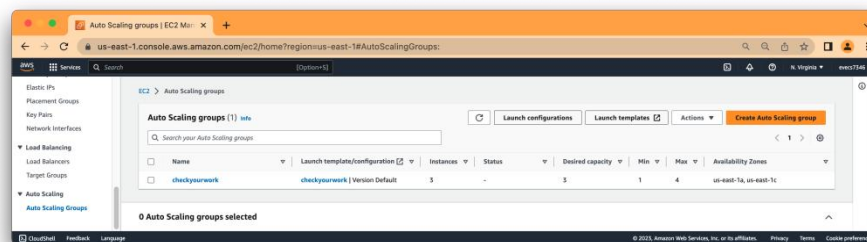
4. Application Load Balancer: automatically distributes incoming traffic to our project web servers. The internet gateway provides an entry point to virtual private cloud (VPC) resources inside the public subnet, providing access to Application Load Balancer.



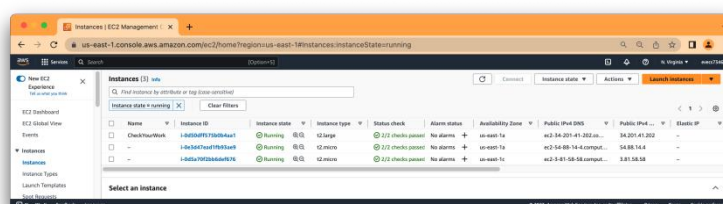
5. Network Address Translation (NAT) gateway allows outbound traffic for resources within a private subnet, such as Moodle App Server, that requires internet access.



6. Auto Scaling group: Our system is deployed horizontally using Auto Scaling groups with Multiple Amazon Elastic Compute Cloud(AmazonEC2) in stances across multiple Availability Zones (AZs), which are deployed in a separate private subnet for additional security. An AWS Systems Manager Agent (SSM Agent) can be configured on the instances to provide SSH access without exposing an SSH port.

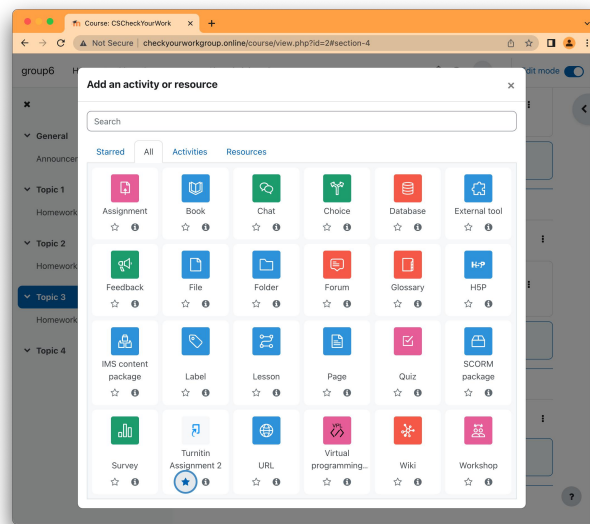


7. Amazon EC2: Amazon Elastic Compute Cloud (Amazon EC2) provides on-demand, scalable computing capacity in the Amazon Web Services (AWS) Cloud. Using Amazon EC2 reduces hardware costs so you can develop and deploy applications faster. You can use Amazon EC2 to launch as many or as few virtual servers as you need, configure security and networking, and manage storage. You can add capacity (scale up) to handle compute-heavy tasks, such as monthly or yearly processes, or spikes in website traffic. When usage decreases, you can reduce capacity (scale down) again.[3] We use EC2 to deploy our system and set up the website. We use the local database in the instance.

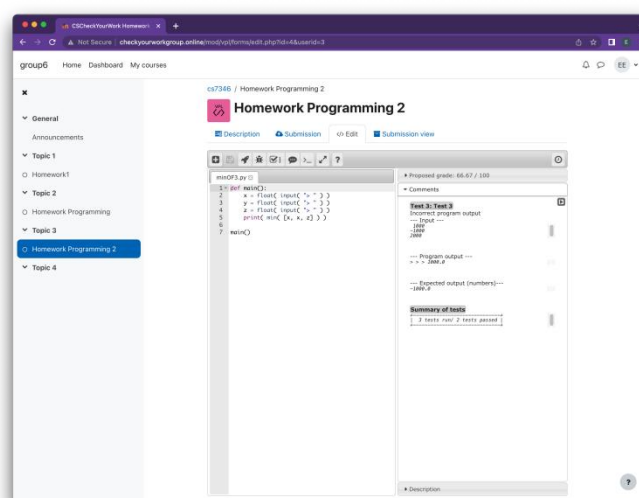


8. AWS Code Commit provides private git repositories to host system's PHP code base and CI/CD configuration files. AWS Code Build compiles source code, runs tests, and produces software packages ready to deploy onto Moodle App Server. AWS Code Deploy manages the complexity of updating applications. It can deploy into our LMS system with zero downtime using blue-green deployment methodologies. AWS Code Pipeline automates the build, test, and deploy phases for code changes.

9. Turnitin: Turnitin's Moodle Direct v2 integration activity module is a standalone Moodle module with the aim of representing the full suite of Turnitin's features within the standard Moodle workflow. The module is an upgrade on the previous Turnitin plugin and is developed and maintained by Turnitin[5].



10. Virtual Programming Lab: VPL- Virtual Programming Lab is a activity module that manage programming assignments and whose salient features are enable to edit the programs source code in the browser, students can run interactively programs in the browser, they can run tests to review the programs, allows searching for similarity between files and allows setting editing restrictions and avoiding external text pasting, [8]the programming code can be automatically graded by professors setting up some test case.



IV. CONSIDERATION OF PRIORITIES

When we deploying our project based LMS on AWS EC2, different quality attributes (also known as "ilities") need to be considered and prioritized based on specific needs. Here's a list of these attributes with justifications:

1. High Priority:

Security: We take into account that security is Paramount in any system that processes personal data. Information leakage will lead to a series of social problems, in this subject, naturally speaking is the information of school students. AWS provides a number of built-in security measures such as IAM, security groups, vpc, and data encryption. In addition, our project has its own security features, such as role-based access control.

Performance: For LMS, system performance is crucial, because it directly affects the user experience, as a platform built for schools, performance improvement can intuitively improve learning efficiency. AWS EC2 allows you to select the type of instance that meets your performance requirements. Our project performance can be tuned with proper configuration and regular maintenance.

Availability: As the basis of the school's project, students and teachers should be available 24/7 during the use process to adapt to various learning plans. AWS offers services such as EC2 automatic scaling and elastic load balancing to ensure high availability.

Usability: Our project is user-friendly interface makes it easy for students and instructors to navigate and use the platform effectively. AWS doesn't directly influence this, but good performance and availability will enhance usability.

2. Medium Priority:

Modifiability: Our project is open-source nature allows for modifications to meet specific needs. Using AWS makes it easier to deploy these changes across instances.

Extensibility: Our project is supports a wide range of plugins for extended functionality. AWS's flexible infrastructure can accommodate these extensions easily.

Fault-tolerance: AWS offers various services like Multi-AZ deployments and auto-scaling to ensure the project remains functional in case of failures.

Affordability: Costs can be controlled by choosing appropriate EC2 instances and using AWS cost optimization tools. Project itself is free, which helps reduce overall costs.

Reliability: A reliable LMS ensures consistent access to educational resources. AWS's robust infrastructure and Our project is stable platform make for a highly reliable system.

Responsiveness: Responsiveness impacts user experience. Quick server responses and efficient course delivery are crucial, which can be achieved through proper EC2 instance selection and project configuration.

V. CLOUD SERVICES WE EMPLOYED

When deploying our project LMS on AWS, a number of different services are employed to ensure optimal performance, availability, security, and other key features.

Amazon has lot of part services, like EC2 (Elastic Compute Cloud), it is used to create virtual servers where our project will run.[9] Its flexibility in selecting appropriate instance types allows you to balance performance and cost effectively. And for CloudFront which is a content delivery network (CDN) service that securely delivers data, videos, applications, and APIs to users globally with low latency and high transfer speeds.

This can improve the performance of project by reducing the load time of static content. We also use Route 53, a scalable and highly available DNS web service, essential for mapping your domain name to your EC2 instances. And finally is AWS ELB (Elastic Load Balancer), it automatically distributes incoming application traffic across multiple targets, such as EC2 instances, containers, IP addresses. This increases the availability of your application.

In general, these services combine to provide a robust, scalable, and high-performance environment for project LMS, while also addressing key aspects like security and cost-efficiency.

1. Why Choose One Service Over Another

There are indeed many options in the process of choosing a service, and the final choice to choose one service over another often depends on our specific needs, budget, and the unique features of each service. Here I present the choice problem that we face in this subject.

Amazon EC2 vs AWS Lambda

EC2 instances provide a server-based environment which is suitable for hosting a complex, stateful application like Moodle. Lambda is serverless and ideal for event-driven use cases, but it's not typically used for hosting full-featured web applications due to its stateless nature and execution time limits. So, we think Amazon EC2 over AWS Lambda.

Amazon RDS vs Amazon DynamoDB

Project requires a relational database management system (MySQL, MariaDB, PostgreSQL, etc.). RDS provides these, while DynamoDB is a NoSQL database service, which is not compatible with our project's requirements.

Amazon CloudFront vs direct S3 access

Serving content directly from S3 might be simpler, but using CloudFront can provide better performance (through caching and edge locations) and potentially lower data transfer costs. So that Amazon CloudFront over direct S3 access.

AWS Auto Scaling vs manual scaling

Auto Scaling automatically adjusts capacity to maintain steady, predictable performance at the lowest possible cost. Manual scaling would require constant monitoring and manual intervention to add/remove resources based on demand. So we think AWS Auto Scaling over manual scaling.

WS ELB (Elastic Load Balancer) vs single EC2 instance

While a single EC2 instance could serve Moodle, using an ELB allows for distribution of traffic to multiple instances for better performance and fault tolerance. It also integrates with Auto Scaling for dynamic adjustment of capacity. So WS ELB over single EC2 instance.

2. The Advantages And Limitations Of The Cloud Services

Using cloud services like AWS for deploying Moodle LMS can have several advantages and some limitations.

A) Advantages

In the course of the project, we found that AWS services like EC2, RDS, and S3 allow you to scale your resources based on your needs. Auto Scaling can adjust the number of EC2 instances based on demand, ensuring you have sufficient resources during peak times. What's more, With AWS, you only pay for the services you use. This can be more cost-effective than maintaining your own physical servers. In addition, services like AWS Cost Explorer and AWS Budgets can help you track and manage your costs. AWS also

provides several features to ensure the security of your application, such as IAM for access control, Security Groups for firewall settings, and data encryption for stored data. Services like ELB and Multi-AZ deployments for RDS enhance the availability of your application by distributing traffic and providing failover support. And with AWS's global infrastructure, you can deliver your project LMS to students around the world with low latency.

B) Limitations

AWS offers a wide range of services, and navigating these options can be complex. It requires understanding the interactions between services and the best ways to configure them to meet your needs. And while AWS can be cost-effective, it's also easy to incur additional costs if services are not properly monitored and managed. For example, leaving unused EC2 instances running or storing unnecessary data in S3 can increase costs.[6] Also, while AWS provides a lot of powerful features, moving to another cloud provider in the future may require significant effort due to the use of AWS-specific technologies and configurations. Besides, Using AWS effectively requires understanding the various services and how they can best be utilized for your specific application. This may require significant time investment or hiring AWS experts.

VI. RISKS AND MITIGATION TECHNIQUES

When deploying project LMS on AWS EC2, various potential risks can be encountered. Identifying these risks and employing suitable mitigation strategies can help ensure a smooth, reliable, and secure deployment. Here's what I think the risks are and how they can be mitigated:

- 1.Data Security and Privacy Risks: Storing sensitive student and instructor data in the cloud introduces potential security and privacy risks.

Mitigation: Use AWS IAM to enforce strict access controls and policies. Or Implement data encryption at rest (in storage) and in transit (during data transfer). Or regularly audit AWS logs and activity using AWS CloudTrail.

2.Downtime Risk: There's a risk of application downtime due to various reasons like server failures, network issues, or unanticipated traffic spikes.

Mitigation:Use AWS Auto Scaling and Elastic Load Balancer to ensure high availability and handle traffic spikes.[4] Or Implement AWS RDS Multi-AZ deployments for failover support for the database layer. Or like Regularly back up data using AWS Backup or snapshot features of RDS and EBS.

3. Performance Risk: Inadequate resource provisioning can lead to slow response times and poor user experience.

Mitigation: Monitor performance metrics using Amazon CloudWatch to understand resource utilization. Or use AWS Auto Scaling to adjust resources based on demand. Or Use Amazon CloudFront to accelerate content delivery to users globally.

4.Compliance Risk: Failing to meet regulations like FERPA, GDPR, or HIPAA (if applicable) could lead to legal and reputational risks.

Mitigation: Understand the compliance requirements relevant to your organization and ensure AWS services are configured accordingly. Or Use AWS Artifact for on-demand access to AWS' compliance reports.

5. Vendor Lock-In Risk: Being dependent on AWS services and solutions can make it difficult to migrate to a different cloud provider in the future.[8]

Mitigation:Design the system with portability in mind, using open standards where possible. Or Regularly backup data in a format that can be easily migrated. Or likeBy considering these risks and mitigation strategies, you can ensure a more successful deployment of Moodle LMS on AWS EC2.

VII. CONCLUSION

By thoughtfully choosing specific AWS services, we can create a highly performant and cost-effective learning management solution that caters to a wide range of users. While there are several potential risks associated with the deployment, such as data security, downtime, and cost management, these can be mitigated through the various tools and services provided by AWS and careful planning. Potential limitations like complexity and vendor lock-in can be managed through adequate training, good architectural practices, and careful selection of services and configurations. Despite these challenges, the advantages of deploying Moodle LMS on AWS EC2 far outweigh the limitations.

Moving forward, the key to a successful deployment will be continuous monitoring, periodic auditing, and responsive adjustments to maintain optimal performance, security, and cost-efficiency. With these measures in place, we can leverage the power of AWS to deliver a reliable, efficient, and effective learning experience through Moodle LMS.

VIII. REFERENCES

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