

CCT College Dublin Continuous Assessment

Programme Title:	BSc in Computing and Information Technology		
Cohort:	Year 4 / Semester 1 / Full time		
Module Title(s):	Cloud Services (CA3)		
Assignment Type:	Research Report (Individual assignment)	Weighting(s) (30%)	
Assignment Title:	Designing and Implementing a Proof-of-Concept Cloud Solution Based on a Client's Needs		
Lecturer(s):	Michael Weiss		
Issue Date:	Thursday 22 nd November		
Submission Deadline Date:	Sunday 8 th December – before 23:59		
Late Submission Penalty:	Late submissions will be accepted up to 5 calendar days after the deadline. All late submissions are subject to a penalty of 10% of the mark awarded . Submissions received more than 5 calendar days after the deadline above will not be accepted and a mark of 0% will be awarded.		
Method of Submission:	Moodle		
Instructions for Submission:	Report (Word count: 2500 words +/- 10%)		
Feedback Method:	Results posted in Moodle gradebook		
Feedback Date:	Typically, within two weeks of submitting assignment to Moodle		

A note about the use of Artificial Intelligence and this assignment:

You are **not** allowed the use of Artificial Intelligence to complete this assignment.

Each student is expected to do their own research and efforts.

Also, all research writing and examples **MUST** be in your own words!

Learning Outcomes:

Please note this is not the assessment task. The task to be completed is detailed on the next page. This CA will assess student attainment of the following minimum intended learning outcomes:

MLO 1 - Critically differentiate the available services of a cloud computing architecture to enhance or create agility within an organisation (Linked to PLO 1 (Stage 4 SLO 1))

MLO 4 - Review current developments in Cloud computing, through the use of case with an aim of incorporating recent changes to enhance business value when developing and deploying cloud-based solutions (Linked to PLO 4 (Stage 4 SLO 4))

MLO 5 - Interpret detailed customer requirements to implement a cloud solution, taking account of virtual networks, load balancing, auto scaling, security, and monitoring services (Linked to PLO 6 (Stage 4 SLO 6))

Attainment of the learning outcomes is the minimum requirement to achieve a Pass mark (40%). Higher marks are awarded where there is evidence of achievement beyond this, in accordance with *QQI Assessment and Standards, Revised 2013*, and summarised in the following table:

Percentage Range	CCT Performance Description	QQI Description of Attainment	
		Level 6, 7 & 8 awards	Level 9 awards
90% +	Exceptional	Achievement includes that required for a Pass and in most respects is significantly and consistently beyond this	Achievement includes that required for a Pass and in most respects is significantly and consistently beyond this
80 – 89%	Outstanding		
70 – 79%	Excellent		
60 – 69%	Very Good	Achievement includes that required for a Pass and in many respects is significantly beyond this	Achievement includes that required for a Pass and in many respects is significantly beyond this
50 – 59%	Good	Achievement includes that required for a Pass and in some respects is significantly beyond this	Attains all the minimum intended programme learning outcomes
40 – 49%	Acceptable	Attains all the minimum intended programme learning outcomes	
35 – 39%	Fail	Nearly (but not quite) attains the relevant minimum intended learning outcomes	Nearly (but not quite) attains the relevant minimum intended learning outcomes
0 – 34%	Fail	Does not attain some or all of the minimum intended learning outcomes	Does not attain some or all of the minimum intended learning outcomes

Please review the CCT Grade Descriptor available on the module Moodle page for a detailed description of the standard of work required for each grade band.

The grading system in CCT is the QQI percentage grading system and is in common use in higher education institutions in Ireland. The pass mark and thresholds for different grade bands may be different from what you have experience of in the higher education system in other countries. CCT grades must be considered in the context of the grading system in Irish higher education and not assumed to represent the same standard the percentage grade reflects when awarded in an international context.

Assignment Introduction

'Medi-Advice' is a small Medical Company start-up company based out of Dublin, Ireland.

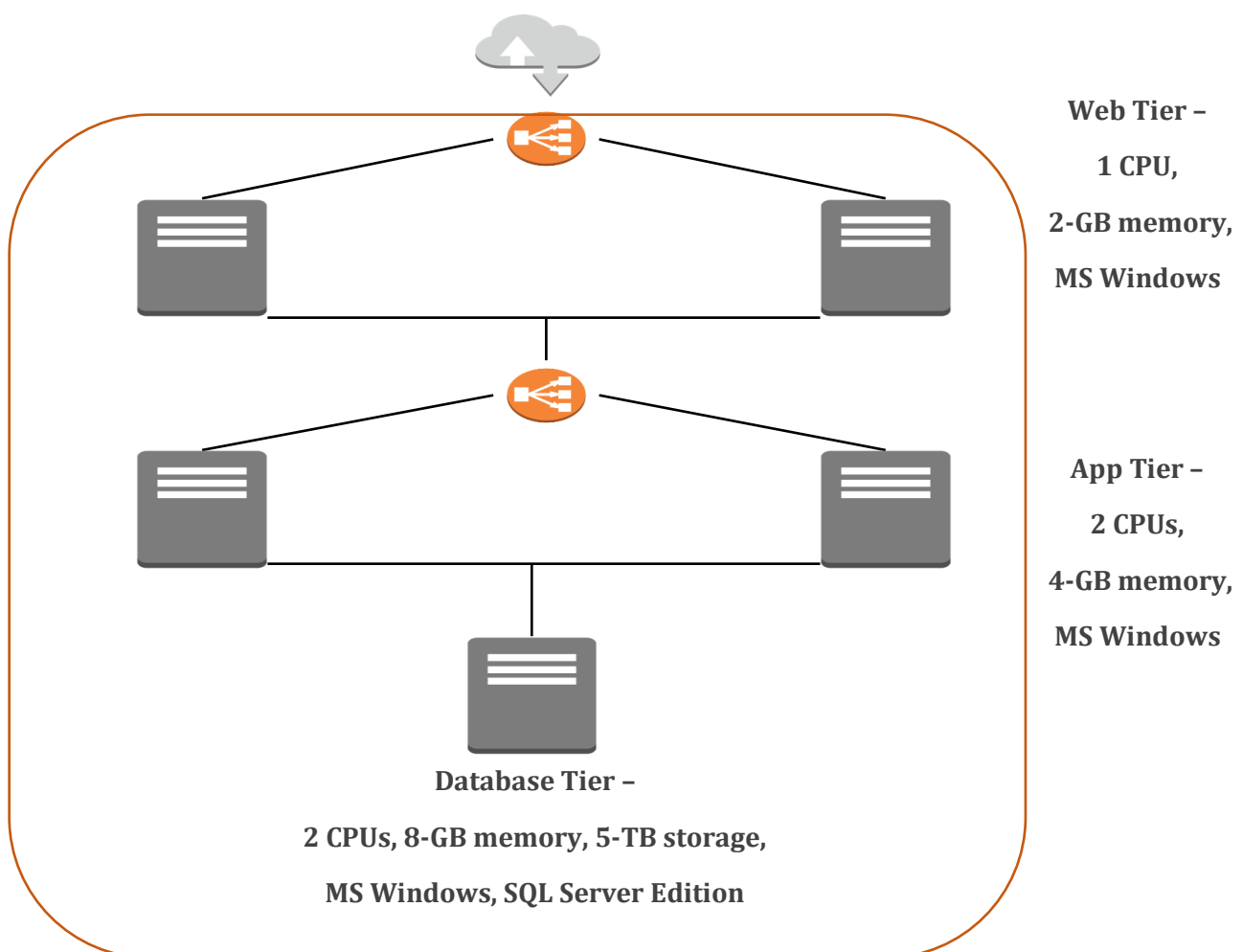
You have been hired by 'Medi-Advice' to architect an infrastructure in AWS to meet their application needs.

Medi-Advice have built an online medical diagnosis assistance application for users in Ireland and also in North America. They have been in business for 3 years.

The application connects patients and doctors together to allow online appointments, remote consultation, remote diagnosis, electronic prescription transfer and payment services.

The 'Medi-Advice' application allows patients to upload documents and images. Text is extracted from documents, and images are converted into multiple formats. This is currently a manual process; they would like recommendations to help automate some of these processes.

Figure 1 – Shows Medi-Advice's network infrastructure which is not currently on AWS



The Medi-Advice company currently has a small technical services team that supports their infrastructure and application. Their current infrastructure consists of two web-application servers that connect to two application servers connected to a database server (as shown in Figure 1). However, if the database server goes down, the application servers are useless because they can't connect and retrieve data. As the application has recently been launched publicly, they have had some major outages and faults with the infrastructure which has caused the doctors to occasionally not be able to access patient records on the database.

Another issue that Medi-Advice have highlighted to you is that, at present, the application is very slow to respond to changes with their resource needs. For example, when there is an increase in demand which increases the amount of incoming network traffic, a technical services member will need to manually boot up an extra machine and add it to its fleet of web servers. They would like recommendations on best practices on how to ensure their architecture can handle spontaneous changes in demand in the future.

There is also a big demand for the application both in Ireland and in the US. Doctors and patients in the US have complained of slow access speeds and 'slow loading times'.

Finally, Medi-Advice have informed you they require the system to have 'five nines' availability.

Current network environment at Medi Advice

The current infrastructure is deployed in a server hosting company who are based solely in Dublin City Centre. The architecture is continuously over-provisioned to try to handle growth and on-going performance issues.

They currently use Microsoft Windows servers to host their web and application tiers along with Microsoft SQL Server Standard Edition backend databases in the DB tier.

Figure 1 above provides an overview of their current environment (which is on-premises in a hosting company).

Additional information

The application is due to launch all functionality soon and they expect to double the number of users to start using the application. They require the elasticity of the cloud as they expect a large volume of requests in the current climate with COVID-19 but wish to scale back when the situation returns to 'normal'.

Medi-Advice believes it would be best to use cloud technologies to support its rapid growth and immediate deployment. They wish to move to Linux based machines and would like to avail of many free tier AWS services. There is a small budget allocated for this project but as

Medi-Advice are a start-up, cost optimization is key to them, and they wish to eliminate unneeded expenses (as far as possible).

Medi-Advice needs you to write a report that describes the current network infrastructure. They would like you to document any weaknesses that you can identify. Next, they want you to document any proposed improvements that will address the weaknesses of the current infrastructure and suggest improvements that meet the requirements outlined above.

Medi-Advice would like you to design a solution using services available on the AWS cloud. Because this is just a proof-concept design and not a prototype, the initial networks that you design needs to address the performance issues that affect the web tier and issues that affect the application tier and the database tier. Your report should address all aspects of the system described above.

One other important concern

Medi-Advice distributes their product brochures globally. Customers around the world are constantly complaining about slow access to these brochures. They would like to have a Content Delivery Network set up to address these latency issues by establishing Edge location 'points-of-presence' that can provide this content caching service.

Along with the above information, here are their detailed technical requirements:

- **Design** networks that conform to AWS best practices while providing all the necessary network services to the application in their different environments.
- **Design** an architecture that matches the current architecture at the server hosting company and that can handle doubling the number of servers. Also, ensure to include the ability to scale back in when demand decreases.
- In addition, Medi-Advice requires a solution whereby if there is a disruption in one region (for example North America) the application has **cross-region disaster recovery** and **utilizes Load balancers** for the web tier.
- Your final design must include the ability to **automate server VM instance** availability and setup in the event of a server VM instance failure or if the server cluster needs to scale out or scale in.
- Architecture should be highly available, secure, resilient (built for **business continuity**) at all layers of the infrastructure.
- Additionally, you need to **Demonstrate** serving a document from their S3 storage (this will be a PDF document hosted on AWS S3 storage) using an edge location caching services (content delivery network).

Your tasks

Present the proposed solution to the customer in the form of a professional report. Within the report, include the following:

TASK 1: Translate customer requirements into a proposed technical solution. Identify the key AWS Services required and **justify** the need for each based on the detailed technical requirements above. **Ensure that you articulate how each will be used to solve the needs of the Medi-Advice company.**

TASK 2: Create architecture diagrams of the proposed solution to meet the needs of Medi-Advice. Design an AWS solution meeting the requirements provided by the customer.

You can easily make these AWS diagrams using a tool such as **Draw.io** or *Visual Paradigm Community Edition* (<https://www.visual-paradigm.com/download/community.jsp>). Make sure to articulate the highly available architecture design needs of Medi-Advice and their cross-region design.

TASK 3: Exploring AWS best practices:

TASK 3a) The term ‘best practices’ are defined as ‘commercial or professional procedures that are accepted or prescribed as being correct or most effective’. Anti-patterns are the opposite of best practices. You should discuss TWO anti-patterns that Medi-Advice currently have. Clearly explain the problems that you identify and justify how your solution would solve these two anti-patterns.

TASK 3b) Conclude your report by discussing ways how Medi-Advice can optimize the cost and resilience of their AWS infrastructure. Use ‘The 6 Pillars of the AWS Well-Architected Framework’ as a framework for your discussion.

TASK 4: Work with the AWS Virtual Private Cloud (VPC) and demonstrate network connectivity for the public and private networks of Medi-Advice as specified below:

TASK 4a) Describe what a VPC is and explain its various components. Be sure to include discussion about public and private subnets, CIDR Blocks for private IP addressing, Internet Gateway public Internet access, NAT Gateway and NAT instances for private networks, Security Groups, Network Access Control lists (NACLs) VPC peering.

Also discuss some **hybrid solutions** (such as Direct Connect and VPNs) that can benefit Medi-Advice when they connect their network to the cloud.

TASK 4b) The Management at Medi-Advice needs you to create a separate VPC network for Medi-Advice. Create a custom VPC network for Medi-Advice and name it **MediAdviceVPC**. This new VPC will need to have both public and private subnets so you need to make sure that there is an Internet

Gateway that supplies Internet access to the public subnets. They need to see the Medi-Advice website hosted on this custom VPC. Create an Amazon Linux EC2 instance on a public subnet and then use the FileZilla FTP program to upload the Medi-Advice website up to this Linux instance. There is a sample 'DigiTech' website on Moodle that you can modify to create this Medi-Advice website.

Demonstrate that the Medi-Advice website works when you place the IP address of the Linux server into a web browser.

TASK 5: Your supervisor at Medi-Device would like more information about how to speed up the availability of their new sales brochure for their global customer base using Edge caching using a Content Delivery Network (CDN). Describe, using examples, how Edge computing using technologies such as AWS CloudFront CDN speeds up the process of making resources available to the end users. Discuss how use of a CDN can benefit Medi-Advice.

Challenge TASK 1: Demonstrate Edge Location content caching of the Medi-Advice brochures (the AWS content delivery network should use a sample Medi-Advice Sales Brochure which resides inside S3 storage). **Create** a simple Medi-Advice sales brochure PDF document to demonstrate the content delivery network. Include your name and student number in the sample brochure. Use print screens to showcase this work.

Note: If you get any error messages that prevent you from completing this task be sure to mention this in your report.

Challenge TASK 2: Implement a proof-of-concept solution for hosting a fault tolerant and highly available website for the Medi-Advice company (create a Highly available solution):

On the AWS Cloud, create a new VPC network for the Medi-Advice company. Name the VPC **medi-advice-private-network**. The VPC must span across two Availability Zones in the Region that you have chosen to use. Each of the Availability Zones should have two subnets, and each AZ should have with one public subnet and one private subnet. You will set up the appropriate allocation of private IP addresses for each subnet. Since you will be hosting the Medi-Advice you will need to configure an Internet Gateway.

Create a simple one-page Medi-Advice web site and host it on a fleet of 5 Amazon Linux Servers that integrate an Application Load Balancer (ALB) into an Autoscaling Group (ASG). The ALB target group will have 5 Amazon-Linux servers (T2-micro) and the ASG will have a minimum of two server, a desired load of three servers and a maximum spread of 5 servers in the Auto Scaling configuration. You must host this configuration on the new custom Virtual Private Cloud (VPC) **medi-advice-private-network** that you just created on the AWS Cloud platform. Demonstrate that this configuration load-balances the Medi-Advice website. Note that you must demonstrate the full load balancing of the Medi-Advice website in order to gain

marks for this challenge. **Explain how integrating the Load-Balancer together with the Autoscaler will benefit a company such as Medi-Advice.**

Challenge TASK 3: AWS Cloud Formation (Infrastructure as code)

1. Clouds-Are-Us wishes to automate infrastructure deployment for many of their future clients.

They would like to see a proof of concept:

A1 - Your supervisor would like a demonstration of CloudFormation in action. Deploy a VPC networking layer infrastructure using the AWS CloudFormation template provided. Read through the json or yaml code provided in template and notice that the code is divided into sections. Briefly explain what task each section of the code is implementing.

A2 - Once the VPC is created, go to the EC2 panel of the AWS Cloud console and demonstrate that you can launch a Windows or Linux EC2 instance into that new VPC.

B1 - Discuss one advantage of using a CloudFormation to create a custom VPC as you did in Part A above.

B2 - Provide one example to help support why you feel that CloudFormation (and 'infrastructure-as-code') can be beneficial when deploying cloud resources.

Provide screen shots for each of the above and provide a label that provides a short explanation of the purpose of each screenshot

[Delete any CloudFormation Stacks that you have created for this assignment.

Note: If you are using the AWS Learning Labs, be sure that you do not delete the Learning Lab Template!]

IMPORTANT NOTES:

Be sure to include references (both text and images) to help backup the points you make. Note the Harvard referencing system should be used.

Provide screen shots for each of the above TASKS and provide a label that provides a short explanation of the purpose of each screenshot.

WORD COUNT: Approx. 2500 words. This is a guide only. You will not be penalized for being over or under this suggestion, however if your report is very short then you have probably not dealt with the requirements. Equally, if it is very long then you have probably included unnecessary information.

In the tasks highlighted above, you would use AWS Academy Learner Labs to recreate proposed infrastructure.

Use an AWS resources that are available through the Learning Lab that you have been provided with (you are NOT required to spend any money on implementing this proof-of-concept solution).

A note about the use of Artificial Intelligence and this assignment:

You are not allowed the use of Artificial Intelligence to complete this assignment.

Each student is expected to do their own research and efforts.

Also, all research writing and examples MUST be in your own words!

Your submission must be your own work. When the work is completed, it must be uploaded to Moodle within the time frame above. Any student found breaking College regulations will receive zero marks.

Copying and pasting large sections of text directly from web sites / resources is NOT permitted

Marking Scheme Summary		
Weight	Description	Marking
[0 to 20]	TASK 1: Translate customer requirements into a proposed technical solution	
[0 to 10]	TASK 2: Create architecture diagrams to meet Medi-Advice's needs	
[0 to 10]	TASK 3a) Discuss TWO anti-patterns and provide solution justifications (recommended best practices)	
[0 to 15]	TASK 3b) Discuss ways how Medi-Advice can optimize the cost and the resilience of their AWS infrastructure using AWS 6 Pillars of the Well Architected Framework	
[0 – 7.5] [0 - 7.5]	TASK 4a: Describe what a VPC is and explain its various components. TASK 4b: Demonstrate that you have uploaded the Medi-Advice website to a Linux EC2 instance	
[0 - 5] [0 - 5]	TASK 5a: Describe, using examples, how Edge computing speeds up the process of making resources available to the end users. Challenge TASK 1: Demonstrate Edge Location caching (Content Delivery Network) for the sample Medi-Device document which is in S3 storage.	
[0 to 5] [0 to 5]	Challenge Task 2: Create a Highly available solution: Explain the advantage for Medi-Advice of integrating the Load Balancer with the Autoscaling group of server instances. Implement a proof-of-concept solution that integrates an Application Load Balancer (ALB) into an Autoscaling Group (ASG) on a custom VPC to host a basic Medi-Advice web site.	
[0 to 5] [0 to 5]	Challenge Task 3: Infrastructure as Code. Explain the benefits for Medi-Advice when using CloudFormation Infrastructure-as-code Additionally, Demonstrate CloudFormation as specified.	
[0 - 100]	TOTAL	

