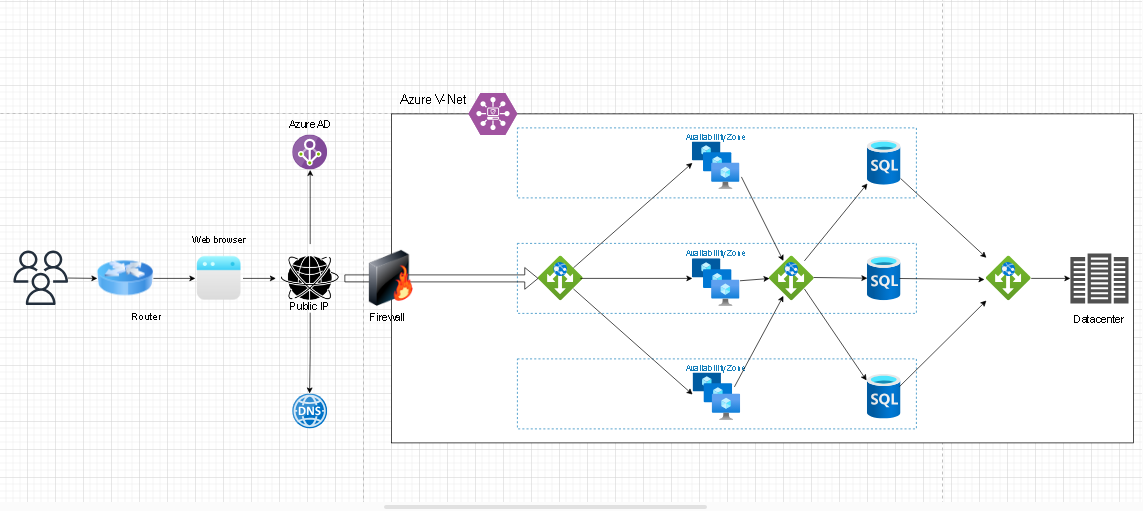
**Student Assessment Submission and Declaration**

When submitting evidence for assessment, each student must sign a declaration confirming that the work is their own.

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| Programme: Higher National Diploma in computing – Software Engineering  Higher National Diploma in cloud computing | | | |
|  | | | |
| Assignment number and title: 1. Building a well-architected cloud-based prototype | | | |

**Task2:**

**1.**

**The devices used by users to visit the site must first be connected to a router or switch before we can access the public IP address linked to DNS and Azure AD. After that, we go on to the Vnet, where security and protection require a firewall and DDoS protection. There will be three availability zones inside the Vnet. Everybody has a set of scales. They each have an application gateway that divides the workload among the three skill sets, and another that receives requests from the skill sets and distributes them to the databases that are linked to an application gateway that is also linked to the data center that houses the user accounts, user-basic data, and the site.**

**2.**

|  |  |  |
| --- | --- | --- |
| Step number | Step description | Screenshot |
| 1 | First, I created a V-Net to contain the complete design and structure and provide security and communication with the external network. |  |
| 2 | Then I added three subnets to provide high-availability  At the Kingdom level, reducing traffic and delays and the ability to absorb the load. |  |
| 3 | Here, Firewall was created to protect from any viruses or external security attacks. |  |
| 4 | Here, a DDos protection plan was created to protect the public IP resources in the v-net from distributed denial of service attacks |  |
| 5 | Here, I enabled the DDOS plan on Sanad's Vnet. |  |
| 6 | In this step, an application gateway was created to distribute the load on the scale sets, And I must create another one to collect traffic from scale sets and send and distribute it in the databases, and finally to collect traffic from the databases and send it to the data center. |  |
| 7 | In this step, I created a virtual machine scale set to host the Sanad platform |  |
| 8 | I should have chosen 3 zones according to the UML I created for Sanad, but the image I chose only provides Zone 2 and Zone 3. |  |
| 9 | In this step, I created databases to store all the data. I had to create 3, not just one, to accommodate the pressure and the huge amount of data. |  |
| 10 | I created Azure Budget to control cloud spending, facilitate financial planning, allocate resources, provide alerts, ensure compliance, optimize costs, enable chargebacks/reoffers, evaluate performance, forecast future spending, and mitigate financial risk. |  |
| 11 | I created Azure Monitor alerts for proactive problem detection and efficient resource management. They help reduce downtime by notifying us of predefined conditions like performance bottlenecks, cost overruns, security threats, or compliance violations, enabling timely responses to maintain resource health and optimize performance. |  |

The budget specified for me as a university student on Azure was what governed my application of the Sanad scenario, and I was not able to fully implement it as I wanted. But I applied everything I should and the number just wasn't what I wanted

**Task 3:**

**1.**

For Sanad to develop a successful cloud-based solution, numerous business processes and their effects on the migration strategy must be taken into account. To investigate how business procedures affect the effectiveness of this cloud migration, consider the following critical points:

-Integration of Government Agencies: This is a crucial business procedure for integrating multiple government agencies. Data should be able to move securely and effectively across different departments thanks to a successful cloud-based solution's seamless integration of these divisions. A solid cloud architecture that allows API integration and data-sharing protocols is needed for this.

- Strong user access and authentication procedures are needed for electronic identification services. By adding access restrictions, identity management systems, and multi-factor authentication, the cloud solution should improve security by safeguarding sensitive data belonging to citizens.

-Service Availability: Citizens that use Sanad for different government transactions depend on the availability of services. High availability may be achieved with cloud-based systems by using failover, load balancing, and redundancy strategies. The migration plan's first objective should be to guarantee service uptime.

- Scalability: Sanad's traffic changes throughout the year, thus the cloud solution must be able to scale up and down quickly. The platform can withstand large traffic without experiencing performance deterioration because to the flexibility of cloud resources, which may be supplied or de-provisioned as needed.

-Data Security and Compliance: The highest care must be used while handling government data, especially personal information. It is crucial to adhere to data protection laws and industry standards. To protect data integrity and privacy, the migration strategy should include data encryption, frequent security audits, and compliance checks.

-Citizens' and Employees' Remote Access: A crucial part of the migration strategy is to give both citizens' and employees' remote access. Employees should have secure access to cloud services from anywhere, and business procedures should be modified to facilitate remote work. Implementing secure VPNs or other types of remote access solutions is necessary for this.

-Redundancy and Disaster Recovery: The cloud solution should include redundancy and disaster recovery solutions to handle the issue of the website constantly being offline. To maintain data resilience, data should be constantly backed up and kept in a variety of locations.

- Cost Control: To reduce cloud costs, business operations should incorporate cost control measures. Cloud resources should be distributed effectively, and methods for monitoring costs should be utilised to keep tabs on expenses and make corrections as needed.

-Training and change management: Employee and citizen training may be necessary to make the switch to a cloud-based system. Processes for managing change should be in place to aid users in smoothly adjusting to the new system.

**2.**

Designing efficient cloud solutions requires careful consideration of architectural principles and cloud services. Consider it to be similar to building a house:

-Solid Foundation: Much like a building needs a solid foundation, cloud architecture depends on ideas like scalability, dependability, and security. These guidelines guarantee that your solution can scale, won't break under stress, and protects your data.

-Flexible Design: Visualise a structure that may change its use depending on the situation. You may create systems that readily scale up or down in response to demand by using the concepts of cloud architecture. Because of this adaptability, you are not forced to use a set infrastructure and can change resources as necessary.

-Efficient Use of Resources: Using cloud services, you can optimize resource utilization, much as how a building is designed to use energy effectively. You only pay for what you use, so it's like only heating and lighting the areas of a building that you're actually using. This can save you money.

-Integration and Interoperability: Just as diverse components of a building must cooperate, cloud services enable seamless integration of multiple components. This guarantees that various components of your system interact well and exchange data as required.

-Automation and Management: Tools for automating processes are frequently included with cloud services. Imagine this as a building management system that regulates temperature and lighting. Operations are made simpler and human error is decreased through automation in the cloud.

-Scalability: Visualise a structure that may increase in height as more occupants move in. Using cloud services, you can easily grow your solution whether you're serving 10 or ten million consumers. The capacity to scale is essential for allowing for expansion.

-Security: Cloud services offer strong security measures, same as buildings have security systems. They include features like identity management, monitoring, and encryption to safeguard your data and apps against dangers.

-Cost Effectiveness: Since you only pay for the services you really use, using the cloud may be economical. It's comparable to just owning and maintaining a portion of a building and paying utility costs for the area you occupy within it.

- Cloud services frequently have data centers located all over the world. Similar to how a building may serve people from different places, your solution can now be accessed by users in multiple locations thanks to its worldwide reach.

Cloud architecture services and principles are essentially the plans and resources you employ to build a cutting-edge, effective, and flexible digital environment.

**Task 4:**

**1+2.**

I applied QuickTest, and here’s the final result:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Num | Plan | Parameter | Result | Screenshot |
| 1 | **Load testing** |  | **Done/ passed** |  |
| 2 | **Virtual**  **users** |  | **32/m** |  |
| 3 | **Response time (successful response)** |  | **2.17**  **mins** |  |
| 4 | **Request/sec**  **(avg)** |  | **12/**  **mins** |  |
| 5 | **Errors**  **(total)** | **51** |  |  |

**3.**

The results from the quick test I conducted on the Sanad application after migrating it to Azure reveal several important insights in relation to Sanad's business requirements, objectives, and goals. Let's break down these results and analyze their implications:

-Virtual Users (32/m vs. 50):

The number of virtual users that the application can handle per minute (32/m) is less than what you initially planned for (50). This suggests that the application's current configuration may not be optimized for handling the expected load. To meet the business requirements, we may need to consider scaling the application further or optimizing its performance.

-Response Time (2.17 mins):

The response time of 2.17 minutes is relatively high. It means that users are experiencing delays when interacting with the application. This is not aligned with the business goal of providing improved services. To address this, we should identify and optimize the bottlenecks in the application architecture or consider additional resources for better performance.

-Requests per Second (12/min):

The application is handling 12 requests per minute. This is a relatively low throughput rate, which may not meet the demands of the users during peak traffic periods. To align with Sanad's goal of enhanced availability and scalability, we should consider optimizing the application for higher request throughput.

-Errors (51):

The presence of 51 errors during the test indicates that there are issues within the application, which can negatively impact user experience and security. Reducing errors is crucial for maintaining the security and reliability of the application. we should conduct thorough error analysis and implement appropriate error-handling mechanisms to address this issue.

Overall, the testing results suggest that there are performance and reliability issues that need to be addressed to meet Sanad's business requirements and objectives. The application should be optimized for better response times, higher request throughput, and reduced errors to provide improved services, enhanced security, and reduced dependency on physical government offices, which are key goals of the Jordanian Government's vision for a sustainable and efficient future.

Blulogics team should work on fine-tuning the Azure infrastructure, optimizing application code, and implementing robust monitoring and error-handling mechanisms to achieve these goals. Regular performance testing and monitoring will be essential to ensure that the application consistently meets the desired performance and security standards.

**4.**

To guarantee the dependability, scalability, and security of apps and services, testing cloud-based prototypes is essential. An evaluation of several testing strategies that may be used for cloud-based prototypes is provided below:

-Unit testing:

Evaluation: A core testing strategy is unit testing. It entails testing discrete parts or operations to make sure they perform as planned.

Suitability: Excellent for testing microservices, functionalities, or code modules in cloud prototypes.

Advantages: Helps catch and fix bugs early in the development process, aids in code maintainability.

Limitations: Does not test interactions between components.

-Smoke testing:

Evaluation: Smoke testing confirms that the cloud prototype's fundamental features operate without significant flaws.

Suitability: Helpful for swiftly locating significant problems following deployments or revisions.

Benefits: Quick feedback is given, which saves time by avoiding time-consuming testing of complex functions.

Limitations: Limited in scope and does not account for all potential outcomes.

-Integration testing:

Evaluation: Integration testing verifies the communications and information flow among various cloud-based system elements or services.

Appropriateness: Required for cloud prototypes with several connected services or APIs.

Advantages: Ensures that various system components interact as intended.

Limitations: Difficult to set up; might not cover all edge circumstances.

- Acceptance testing:

Evaluation: Acceptance testing determines whether the cloud prototype satisfies user and business needs.

Suitability: Important to guarantee that the prototype meets stakeholder expectations.

Benefits: Verifies the entire system operation from the viewpoint of the end user.

Limitations: Frequently takes more time and money, and it might not always catch technical problems.

- Stress testing:

Evaluation: Stress testing analyses how a cloud prototype functions in difficult circumstances (such as heavy traffic or load).

Suitability: Essential for determining performance constraints and evaluating scalability.

Benefits: Highlights system flaws and aids in peak load optimization.

Limitations: Difficult to plan and carry out, may not exactly mirror real-world events.

- Fault Injection:

Evaluation: Fault injection purposely introduces mistakes or faults into the system to assess its fault tolerance and resilience.

Appropriate for evaluating how the cloud prototype responds to unforeseen errors.

Benefits: Aids in locating holes and flaws in the system's error-handling procedures.

Limitations: May not cover all failure scenarios, and might be harmful if not well-regulated.

- Security testing:

Evaluation: Security testing focuses on locating holes and flaws in the cloud prototype's security protocols.

For cloud-based prototypes managing sensitive data or transactions, suitability is essential.

Benefits: Aids in preventing unauthorized access and data breaches.

Limitations: Demands specialized expertise and equipment; takes time.

In reality, a thorough testing strategy for cloud-based prototypes frequently combines several testing techniques. The precise needs, hazards, and restrictions of the project determine which tests should be used. An efficient testing strategy should balance guaranteeing functionality, performance, and security with making the most use of the resources at hand.

**Task 5:**

**1.**

Sanad's organisational goals may be significantly impacted by moving to the Azure cloud platform and implementing an Agile strategy. Here is a thorough analysis of how the migration initiative affected Sanad's goals:

-Enhanced Service Availability: Moving to the cloud can greatly increase the accessibility of Sanad's website. Azure provides high availability and redundancy characteristics, lowering the possibility of website outages during periods of heavy demand. This is in line with Sanad's goal of giving residents accessible services.

-Improved Scalability: Sanad can now withstand large traffic volumes during various seasons thanks to the scalability characteristics of Azure. In order to provide a seamless user experience, auto-scaling can dynamically distribute resources based on demand. This aids in resolving the problem of excessive latency and network outages during peak hours.

-Enhanced Security: Azure offers strong security features including threat detection, identity and access control, and encryption. This resolves the security issues that Sanad's website had, assuring the security of private citizen information.

-Cost Effectiveness: Sanad can reduce expenses thanks to Azure's pay-as-you-go concept. Decreasing the energy usage of on-premise servers and the requirement for physical government offices, it is in line with the government's objective for a greener future. Cost savings might be used to enhance services.

-Agility and Flexibility: Using an Agile method makes it possible to create and implement new features and enhancements more quickly. Sanad can react to shifting public demands and governmental regulations more rapidly, ensuring that the application stays useful and efficient.

-Improved User Experience: In line with the goal of making government services accessible to everyone, residents may now readily access services from home thanks to increased availability and decreased latency.

-Streamlined Government Integration: By integrating multiple government agencies, Azure's cloud services may make it simpler for individuals to access their information and documents. This helps Sanad achieve its objective of providing electronic identity services.

-Employee Productivity: The migration strategy assists workers in their jobs, enabling them to better serve residents and work with other government departments. It does this by giving safe access to cloud services from anywhere.

-Disaster Recovery and Business Continuity: Azure provides strong disaster recovery solutions to guarantee the protection of crucial data and services. This is in line with the goal of maintaining service continuity even in difficult circumstances.

-Environmental Impact: By reducing the requirement for physical infrastructure and energy-guzzling data centers, the switch to Azure can help Sanad's activities have a smaller environmental impact.

Sanad's organizational goals may be significantly changed by moving to Azure and using an Agile strategy. As a result, the government is better equipped to meet the requirements of its constituents while also enhancing security, reducing reliance on physical offices, and aligning with environmental goals. Sanad is positioned for a more productive and citizen-focused future thanks to its all-encompassing strategy.

**2.**

Enhancing Sanad's cloud-based solution is essential to ensuring that the company and its consumers continue to receive value from it. Here are some ways that the cloud-based system might be improved going forward:

-Cost Optimisation: Constantly track and improve how cloud resources are used to cut expenses. To make sure Sanad is getting the most out of its cloud investment, implement cost governance tools and procedures.

-Scalability: Take use of cloud scalability capabilities to have resources adjusted automatically in response to demand. By doing this, Sanad's services are guaranteed to be able to cope with changes in user traffic.

-High Availability: To guarantee high availability of Sanad's services, use multi-region redundancy and disaster recovery solutions. By doing this, downtime is reduced and residents always have access.

-Data Analytics and AI: To acquire a better understanding of user behavior and preferences, utilize cloud-based analytics and AI services. Personalization and service enhancements can be informed by this data.

-Serverless Databases: To effectively manage and expand databases based on workload needs, take into account serverless database solutions like Azure Cosmos DB.

-Implement DevOps practices to automate the deployment process for quicker and more dependable upgrades and feature releases.

-Security Improvements: To protect citizen data, continuously review and improve security methods such as threat detection, identity and access management, and encryption.

-Compliance and Governance: Ensure that the cloud environment at Sanad conforms with all applicable industry and governmental rules. To preserve compliance, put cloud governance policies into practice.

-Microservices design: If you haven't already, think about switching to a microservices design. By dividing monolithic programs into smaller, more manageable services, a microservices architecture may increase agility and scalability.

-API Gateway: Set up an API gateway to simplify service access and allow secure third-party integrations.

-Advanced Identity Management: To increase security, and improve the electronic identification system with cutting-edge components such as multi-factor authentication and identity verification.

-Utilise serverless computing services to reduce operating expenses and overhead for certain workloads.

-Data Privacy and Consent Management: Introduce tools that give users more control over their data, such as data deletion requests and consent management.

-Edge Computing: Investigate the potential of edge computing to lower latency for users using Sanad's services from outlying or underserved locations.

-Continuous Monitoring and Performance Optimisation: Use continuous monitoring tools to spot performance problems and bottlenecks early on and fix them.

-Feedback Loops: Create channels for citizens to report problems, make ideas, and monitor the progress of their questions or complaints.

-Training and Documentation: Provide Sanad's IT staff with training and documentation to help them become adept at maintaining and optimizing the cloud environment.

Sanad can make sure the cloud-based solution stays flexible, secure, affordable, and in accordance with its purpose to provide beneficial e-government services to Jordanian residents by routinely evaluating and improving it along these lines.

**3.**

Sanad's objectives can benefit greatly from a cloud-based solution while overcoming the difficulties it has previously encountered. The value that a cloud-based solution may provide is evaluated below, along with a breakdown of the difficulties in the past:

Contributions of Value:

-Enhanced Availability: Sanad may achieve improved availability with cloud-based solutions, cutting downtime and guaranteeing residents never lose access to crucial government services. Sanad's objective of providing easily available electronic identity and services is perfectly aligned with this.

-Scalability: Sanad can adjust resource scaling as necessary thanks to cloud services. The system can easily manage increased user traffic at peak times, such as when people register for vaccinations, addressing the problem of high latency and network outages.

-Better Security: Cloud service providers like Azure offer strong security features including threat detection, identity and access control, and encryption. This improves data security and takes care of the security flaws Sanad previously experienced.

-Cost Effectiveness: Cloud solutions can save money since they do not require a substantial on-premises infrastructure. This lowers energy use and operating expenses, advancing the government's objective for a more sustainable future.

-Agility and Flexibility: By using an Agile strategy in the cloud, Sanad is able to swiftly create and implement new features and enhancements while adapting to shifting user demands and governmental mandates.

-Seamless Government Integration: Cloud services make it easier to integrate with different government agencies, allowing individuals to simply access their information from a single interface. This is consistent with Sanad's goal of providing services for electronic identification.

-Disaster Recovery: Cloud service providers provide reliable disaster recovery options that guarantee data integrity and service continuity even in the face of unanticipated disasters.

Obstacles Overcame:

-High Latency and Network disruptions: During times of high traffic, the cloud's scalability and performance optimization capabilities reduce high latency and network disruptions.

-Website Downtime: Cloud solutions with high availability and redundancy capabilities lower the chance of website downtime, assuring continuous service access.

-Security Breaches: To prevent security and data breaches and ensure the protection of citizen data, robust cloud security measures are necessary.

-Operational Costs: By removing the need for expensive on-premises infrastructure and lowering operational costs, cloud services can result in cost savings.

-Dependency on Physical Offices: The cloud makes it possible for citizens to access government services from a distance, decreasing the need for physical offices and supporting the government's aim for a future with more efficiency.

-Scalability: By addressing the issue of managing variable user traffic, cloud scalability makes sure that services continue to be responsive.

-Environmental effect: By maximizing resource consumption and investigating renewable energy sources for data centers, cloud migration can lessen the environmental effect of Sanad's operations.

In addition to addressing the difficulties Sanad previously encountered, a cloud-based solution is in line with the organization's objectives of providing Jordanians with safe, effective, and accessible governmental services. It supports sustainability and agility in service delivery while improving availability, scalability, security, and cost-effectiveness.

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**Student Declaration**

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| **Student declaration**  I certify that the assignment submission is entirely my own work and I fully understand the consequences of plagiarism. I understand that making a false declaration is a form of malpractice.  Student signature: Shahed Montaser. Date:4/9/2023 |