**ISLAMIC UNIVERSITY IN UGANDA**

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**COURSE\_UNIT**: Cloud Computing

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**ASSIGNMENT1**

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**Qn) With appropriate justification, identify one new cloud use-case (i.e. an application that does not currently exit) for each of the following categories of cloud applications.**

**Mental Health and Well-being Platform**

**a) Soft-requirements applications**

A new cloud use-case for soft-requirements applications could be a cloud-based mental health and well-being platform that offers personalized support and therapy. The platform would leverage AI-driven chatbots and natural language processing to provide users with virtual counseling and emotional support.

The cloud infrastructure would securely store and process user data, ensuring privacy and confidentiality. Machine learning algorithms would analyze user inputs and provide personalized recommendations for coping strategies, mindfulness exercises, and therapeutic interventions.

The platform could also facilitate connection with licensed therapists and support groups for more comprehensive mental health care. By leveraging the cloud, this mental health platform would make mental health resources more accessible, scalable and tailored to individual needs.

**b) Hard-requirements applications**

A new cloud use-case for hard-requirements applications could be a cloud-based predictive maintenance and asset management system for manufacturing industries. The platform would integrate data from IoT sensors, equipment logs, and maintenance records to monitor the health and performance of industrial machinery.

The cloud infrastructure would enable real-time data processing, analytics, and machine learning algorithms to identify patterns and anomalies that indicate potential equipment failures or maintenance needs. The system could provide predictive maintenance alerts, optimize maintenance schedules, and recommend spare parts inventory management strategies. By leveraging the cloud, this predictive maintenance system would help manufacturing industries reduce downtime, enhance operational efficiency, and extend the lifespan of their assets.

**c) Best-effort applications**

A new cloud use-case for best-effort applications could be a cloud-based virtual reality (VR) training and simulation platform for disaster preparedness and emergency response. The platform would provide realistic virtual environments where emergency responders, such as firefighters, police officers, and medical personnel, can train for various emergency scenarios.

The cloud infrastructure would support the storage, processing, and delivery of high-fidelity VR content and simulations. The platform could incorporate AI-driven virtual characters and dynamic scenarios to simulate real-life emergencies and test responders' decision-making skills and coordination. By leveraging the cloud, this VR training platform would offer a cost-effective and scalable solution for training emergency responders, improving their preparedness, and enhancing their effectiveness in real-life crisis situations.

**2- Based on your expert understanding of the requirements of each of the applications identified above, discuss the features that must be present for them to run efficiently in a cloud environment.**

**Scalability**

The platform should be able to handle a large number of users and scale resources dynamically based on demand. The cloud infrastructure should provide the ability to scale up or down the computing resources, storage, and network capacity as needed.

**Data Privacy and Security**

Since mental health data is highly sensitive, the cloud platform must have robust security measures in place. This includes encryption of data at rest and in transit, access controls, and compliance with relevant data protection regulations. Strong authentication mechanisms should be implemented to ensure authorized access to user data.

**High Availability**

The platform should be highly available, ensuring minimal downtime for users. This can be achieved by leveraging redundant infrastructure, automatic failover mechanisms, and distributed data storage across multiple data centers.

**Real-time Processing**

The cloud infrastructure should support real-time data processing and analysis to provide immediate feedback and personalized recommendations to users. This requires low-latency communication between the chatbot, natural language processing systems, and machine learning algorithms.

**Integration Capabilities**

The platform should be able to integrate with external systems, such as licensed therapists' databases, appointment scheduling systems, and support group platforms. Integration APIs and protocols should be available to facilitate seamless communication and data exchange.

**b) Hard-requirements applications** (Predictive Maintenance and Asset Management System) To run efficiently in a cloud environment, the following features must be present

**Data Integration**

The cloud platform should be capable of ingesting and integrating data from various sources, such as IoT sensors, equipment logs, and maintenance records. This requires support for different data formats, protocols, and APIs to collect and consolidate data in a unified manner.

**Real-time Data Processing and Analytics**

The cloud infrastructure should enable real-time processing and analysis of streaming data from sensors and equipment logs. This includes the ability to apply machine learning algorithms for pattern recognition, anomaly detection, and predictive maintenance predictions.

**Scalable Storage and Computing**

The platform should provide scalable storage and computing resources to handle the large volume of data generated by industrial machinery. This includes distributed file systems, databases, and computing clusters that can scale horizontally to accommodate the increasing data and computational demands.

**Predictive Modeling**

The cloud platform should support the development and deployment of predictive models for equipment failure prediction. This involves training machine learning models on historical data, performing feature engineering, and deploying the models for real-time predictions.

**Integration with Existing Systems**

The platform should seamlessly integrate with existing asset management systems, enterprise resource planning (ERP) systems, and maintenance workflows. This requires APIs and connectors to enable data exchange and synchronization between the cloud platform and other enterprise systems.

**c) Best-effort applications (VR Training and Simulation Platform)**

To run efficiently in a cloud environment, the following features must be present;

**High-bandwidth and Low-latency Network**

The cloud infrastructure should provide a high-speed and low-latency network to ensure smooth and immersive VR experiences. This includes fast data transfer between the cloud servers and the VR headsets or devices used by the emergency responders.

**Scalable and Distributed Rendering**

VR simulations require rendering high-quality graphics in real-time. The cloud platform should support distributed rendering techniques to offload rendering tasks across multiple servers, reducing latency and improving performance. The infrastructure should be scalable to accommodate rendering-intensive workloads.

**Storage and Delivery of VR Content**

The cloud platform should provide efficient storage and delivery of VR content, which can be large in size. This includes high-capacity storage systems optimized for handling multimedia content and efficient content delivery networks (CDNs) to minimize latency during content streaming.

**3- For each of the applications identified in 1 above, in a scenario-based way, discuss the most suitable of the various scheduling algorithms, that could be utilized in such a cloud environment.**

**a) Soft-requirements applications** (Mental Health and Well-being Platform)

In the scenario of a cloud-based mental health and well-being platform, where personalized support and therapy are provided, the most suitable scheduling algorithm would be the Priority-based Scheduling algorithm.

The Priority-based Scheduling algorithm assigns priorities to different tasks or processes based on their importance or urgency. In this application, different users may have varying levels of need for virtual counseling and emotional support. By assigning priorities to user requests or sessions, the platform can ensure that users with more critical needs are given higher priority in terms of resource allocation and response time.

For example, if a user is in immediate distress and requires urgent attention, their session can be assigned the highest priority, and resources such as chatbot capacity or therapist availability can be allocated accordingly. On the other hand, users with lower-priority needs can be scheduled in a way that balances resource utilization and response times.

The Priority-based Scheduling algorithm allows the platform to prioritize critical tasks, ensuring efficient resource allocation and timely responses to users in need. It aligns well with the goal of providing personalized support and therapy in a mental health platform, where urgent cases require prompt attention and care.

b) **Hard-requirements applications** (Predictive Maintenance and Asset Management System)

In the scenario of a cloud-based predictive maintenance and asset management system for manufacturing industries, the most suitable scheduling algorithm would be the Predictive Scheduling algorithm.

The Predictive Scheduling algorithm takes into account the predicted maintenance needs and equipment failure probabilities to schedule maintenance activities optimally. It utilizes the data collected from IoT sensors, equipment logs, and maintenance records to make informed decisions about maintenance schedules and resource allocation.

With predictive maintenance, the system can anticipate when equipment is likely to fail or require maintenance, enabling proactive scheduling of maintenance tasks. The Predictive Scheduling algorithm can leverage machine learning models to predict future maintenance needs based on historical data and real-time sensor readings.

By scheduling maintenance activities in advance, the system can optimize resource utilization, minimize downtime, and reduce the risk of unexpected failures. It can prioritize maintenance tasks based on urgency, equipment criticality, and available resources. This algorithm allows the cloud-based system to schedule maintenance activities intelligently, leading to efficient asset management and enhanced operational efficiency.

c) **Best-effort applications** (VR Training and Simulation Platform)

In the scenario of a cloud-based VR training and simulation platform for disaster preparedness and emergency response, the most suitable scheduling algorithm would be the Load Balancing algorithm.

Load Balancing algorithms distribute the workload evenly across multiple servers or computing resources to ensure optimal resource utilization and performance. In the context of a VR training platform, load balancing becomes crucial to deliver immersive and real-time VR experiences to emergency responders.

As multiple users engage in VR simulations simultaneously, the platform must distribute the computational load and network traffic efficiently to provide smooth and lag-free experiences. Load Balancing algorithms can analyze the workload on each server or computing resource and dynamically allocate users to different servers based on their resource availability and utilization.

By balancing the workload across multiple servers, the VR training platform can prevent bottlenecks, reduce latency, and provide consistent performance to all users. This is especially important in scenarios where emergency responders require real-time responsiveness and seamless interactions within the virtual environment.

The Load Balancing algorithm enables the cloud-based VR training platform to optimize resource usage, maintain high performance, and ensure a quality user experience for emergency responders undergoing training and simulations.