IBM Cloud Advocate
Study Guide

This study guide will help prepare you for the IBM Cloud Advocate Certification Examination.

What's in the Study Guide

This study guide covers:

- The Introduction to Cloud course

How to Use This Study Guide

1) **Read the content.**

2) **Take notes.**

3) **Answer practice questions.**

Preparation

Thorough study is essential to a successful outcome on the exam.

- Clear your schedule.
- Find a quiet place to study.
- Focus on the content.

- Open the associated online course for reference – **Introduction to Cloud.**
- Locate the Study Guide.
- Download the Study Guide.

- Print a copy of the Study Guide.
- Take notes.

Introduction to the Cloud Modules and Objectives

Modules

1. Overview of Cloud Computing
2. Cloud Adoption and Emerging Technologies
3. Cloud Computing Service and Deployment Models
4. Components of Cloud Computing
5. Cloud Storage
6. Cloud-Native and Emergent Cloud Trends

Objectives

- Define cloud computing and explain its essential characteristics, history, and emerging trends.
- Explain how some of the emerging technologies such as the Internet of Things, artificial intelligence, blockchain, and analytics are being supported by the cloud.
- Explain the cloud service models (IaaS, PaaS, SaaS) and deployment models (public, private, hybrid).
- Describe the concepts and components of cloud infrastructure such as virtualization, virtual machines, bare metal servers, and containers.
- Explain the different cloud storage models including direct attached, file, block, object and define content delivery networks (CDNs).
- Explain emergent trends related to cloud computing including hybrid multicloud, microservices, serverless computing, cloud-native, DevOps, and application modernization.

Module 1: Overview of Cloud Computing

Introduction and Objectives

In Module 1 of the Study Guide, the subject matter:

- Focuses on the definition and essential characteristics of cloud computing.
- Highlights the history and evolution of cloud computing.
- Emphasizes key considerations for organizations in planning their cloud strategy.
- Provides information on cloud service providers and their offerings.

Lessons

- Introduction and Objectives
- Definition and Essential Characteristics of Cloud Computing
- History and Evolution of Cloud Computing
- Key Considerations for Cloud Computing
- Key Cloud Service Providers and Their Services
- Module Summary
- Knowledge Check Questions

Objectives

- Define cloud computing.
- Describe the essential characteristics of cloud computing.
- Briefly recount the history and evolution of cloud computing.
- Describe the key considerations that organizations can use as a guide while creating their cloud strategy.
- Describe the key cloud service providers and their services.

Introduction to the Cloud

Study Guide

Module 1: Overview of Cloud Computing

Definition and Essential Characteristics of Cloud Computing

Definition of Cloud Computing

The US National Institute of Standards and Technology (NIST) defines cloud computing as a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction. Examples of computing resources include networks, servers, storage, applications, and services.

Five Essential Characteristics of the Cloud

1. On-demand self service – processing power, storage, and network via simple interface without any human interaction.
2. Broad network access – via the network through standard mechanisms and platforms such as mobile-phones, tablets, laptops, and workstations.
3. Resource pooling – uses a multitenant model – resources are dynamically assigned and reassigned according to demand without customer concern regarding the resource's physical location.
4. Rapid elasticity – access more resources when you need them or scale back when you do not.
5. Measured service – only pay for what you use or reserve.

Three Types of Cloud Deployment Models

1. Public – cloud services are leveraged over the open internet on hardware owned by the cloud provider, but its usage is shared by other companies.
2. Private – the cloud infrastructure is provisioned for exclusive use by a single organization. It could run on premise or be owned, managed, and operated by a single operator.
3. Hybrid – a computing environment that connects an organization's on-premises private cloud and a third-party public cloud into a single flexible infrastructure for running applications and workloads.

The Three Service Models

1. Infrastructure-as-a-Service (IaaS) – provides access to physical computing resources, such as servers, storage, networking, and data center space without need to manage or operate.
2. Platform-as-a-Service (PaaS) – provides access to hardware and software tools needed to develop and deploy applications to users over the internet.
3. Software-as-a-Service (SaaS) – is a software licensing and delivery model in which software and applications are centrally hosted and licensed on a subscription basis.

Multicloud – the use of two or more clouds from different cloud providers. This can be any mix of IaaS, PaaS, or SaaS. For example, you may consume email as service from one vendor, customer relationship management (CRM) from another, and IaaS from yet another.

Introduction to the Cloud

Study Guide

Module 1: Overview of Cloud Computing

A Brief History and Evolution of Cloud

Cloud computing is an evolution of technology over time.

1950s	• Concept of cloud computing evolves. • The practice of time sharing or resource pooling evolved to make more efficient use of computing power via the mainframe. • Multiple users were able to access the same data storage layer and Central Processing Unit (CPU) power from any terminal.

1970s	• The release of an operating system called Virtual Machine (VM) made it possible for mainframes to have multiple virtual systems or VMs on a single physical node. • Virtualization became a technology driver and a huge catalyst for the largest evolutions in communications and computing.

Circa 2000	• Physical hardware was still quite expensive.
	
	As the internet became more accessible and the need to make hardware costs more important, servers were virtualized into shared hosting environments, virtual private servers, and virtual dedicated servers, using the same types of functionality provided by the virtual machine operating system.
	For example, if a company needed "x" number of physical systems to run their applications, they could take one physical node and split it into multiple virtual systems. This was enabled by **hypervisors**.
	
	• Hypervisor – small software layer that enables multiple operating systems to run alongside each other, sharing the same physical computing resources.
	  ○ A hypervisor also separates the VMs logically, assigning each its own slice of underlying computing power, memory, and storage, thus preventing the virtual machines from interfering with each other.
	• Pay-as-you-go or computer utility model:
	  ○ Was a key driver for cloud computing success.
	  ○ Used as a utility billing method – customers pay for services as they are procured and/or used.

Module 1: Overview of Cloud Computing

Key Considerations for Cloud Computing

Key Drivers Related to Cloud Migration

1. Agility
2. Flexibility
3. Competitiveness

Key Considerations for Organizations Developing Their Cloud Strategy

1. Infrastructure and workloads – cost of building and operating data centers.
2. Software-as-a-Service (SaaS) and development platforms – paying for application access is more viable versus buying off-the-shelf software and required upgrades.
3. Speed and productivity – getting a new application up and running in a few hours in the cloud versus several weeks/months.
4. Use of cloud dashboards – efficiencies gained from cloud dashboards offers real-time statistics and active analytics.
5. Risk exposure – invest in hardware/software versus renting by the hour; work on a plan to build, write, test, and release the code if uncertain about adoption; or pay-as-you-go option versus little or no trial or adoption.

Benefits of Cloud Adoption

1. Flexibility
    - Users can scale back or scale up services to fit their needs, support fluctuation workloads, customize applications, and access cloud services from anywhere with an internet connection.
    - Level of control is determined with as-a-service options.
    - A menu of pre-built tools to fit specific needs.
    - Virtual Private Cloud (VPC), encryption, and Application Programming Interface (API) keys help keep data secure.
2. Efficiency
    - Enterprise users get applications to market quickly without underlying infrastructure costs or maintenance.
    - Application and data are accessible from virtually any internet-connected device.
    - Hardware failures do not result in data loss because of networked backups.
    - Uses remote resources, saving organizations the cost of servers and other equipment, and customers paying for usage.

Key Considerations for Cloud Computing

Benefits of Cloud Adoption cont.

3. Strategic Value
   - Streamline work – Cloud services gives enterprises a competitive advantage by providing the most innovative technologies available while managing the underlying infrastructure.
   - Regular updates – Service providers regularly update offerings to give users the most up-to-date technology.
   - Collaboration – worldwide access means teams can collaborate from widespread locations.
   - Competitive edge – organizations can more nimbly than competitors who must devote IT resources to managing infrastructure.

Challenges and Perceived Risks of Cloud Computing
• Data security.
• Governance and sovereignty issues.
• Legal, regulatory, and compliance issues.
• Lack of standardization.
• Choosing the right deployment and service models.
• Partnering with the right cloud service providers.
• Business continuity and disaster recovery.

Module 1: Overview of Cloud Computing

Key Cloud Service Providers and Their Services

Cloud Service Providers

Alibaba cloud, also known as Aliyun

- Largest Chinese cloud service provider.
- Provides a comprehensive list of services that include:
  - Compute, network, storage, security, monitoring and managing, communication, analytics, Internet of Things (IoT), application development, and data migration.

Amazon Web Services (AWS Cloud)

- Offers an extensive range of infrastructure and platform services to individuals, companies, and governments on a pay-as-you-go basis.
- Provides a wide range of products, services and solutions that include:
  - Compute, DevOps, data, analytics, IoT, machine learning, networking, content delivery, robotics, serverless computing, and more.

Google Cloud Platform (GCP)

- Offers a suite of cloud computing services, providing infrastructure, platform, and serverless computing environments.
- Uses GCP internally for their end-user products such as Google Search, and YouTube.
- The Google App Engine is a platform for developing and hosting web applications in Google-managed data centers, automatically allocating, and de-allocating resources to handle demand.
- Includes G Suite with products for communication, productivity, collaboration, storage, and more.

IBM Cloud

- Offers a full stack cloud platform spanning public, private, and hybrid environments.
- Products and services covering compute, network, storage, management, security, DevOps, and databases.
- More prominent offerings include bare metal servers, VMware, Cloud Paks for application modernization, and virtual private cloud.
- Suite of emerging technologies such as Artificial Intelligence (AI), IoT, blockchain, data, and analytics.
- Hybrid cloud – acquisition of Red Hat OpenShift – to position itself as leading hybrid cloud provider.

Module 1: Overview of Cloud Computing

Key Cloud Service Provider and Their Services

Cloud Service Providers cont.

Microsoft Azure

- Cloud platform for building, testing, deploying, and managing applications and services through Microsoft-managed data centers. Data centers are spread out in many regions that provide a global reach with local presence.
- Provide software, platform and infrastructure services supporting Microsoft-specific and third-party languages, tools and frameworks.

Oracle Cloud

- Primarily offers SaaS and Database-as-a-Service (Oracle Data Cloud).
- Oracle's SaaS includes wide-ranging applications such as enterprise resource planning (ERP), supply chain management (SCM), human capital management (HCM), marketing, sales, and Crunch Base (CX) running in the cloud.
- Provides one of the largest cloud-based data management platforms to assist customers in personalizing their online, offline, and mobile marketing campaigns.

Salesforce

- Specializes in SaaS focused on CRM.
- Offers multiple cloud services including Sales Cloud, Service Cloud, and Marketing Cloud.

System Analysis Program Development (SAP)

- Known for its enterprise software and applications such as ERP, CRM, human resources (HR), and finance running in the cloud.
- SAP cloud platform – builds and extends business applications.

Module 1: Overview of Cloud Computing

Module Summary

- Cloud computing is the delivery of on-demand computing resources over the internet on a pay-as-you-go basis; resources are dynamically assigned and reassigned among multiple users and scale up and down in response to users' needs.
- The origins of cloud computing can be traced back to the mainframes of the 1950s, with virtualization technologies and hypervisors serving as catalysts for the emergence of modern-day cloud computing.
- Organizations must consider their business needs, investment viability, and risk capacity in order to create a cloud adoption strategy that delivers desired benefits without causing business disruptions and security, compliance, or performance issues.
- Cloud adoption is growing faster than predicted. Driving this technological wave are cloud service providers. With a host of services ranging from infrastructure, platform, and software services. Some major Cloud providers of our times include AWS, Alibaba Cloud, Google, IBM Cloud, and Microsoft Azure.

Module 1
Check Your Knowledge

Question 1.

How does the National Institute of Standards and Technology (NIST) define cloud computing?

A. A model for enabling convenient, on-demand network access to a shared pool of compute resources.
B. A model for delivering a dedicated pool of computing resources on-premises.
C. The capability to provide dedicated network access that can be provisioned in batch mode.
D. On-demand non-configurable computer resources that can be rapidly provisioned.

Answer A. NIST defines cloud computing as a model for enabling convenient, on-demand network access to a shared pool of compute resources.

Module 1
Check Your Knowledge

Question 2.

In which decade did the practice of time sharing or resource pooling evolve to make more efficient use of computing power via the mainframe?

A. 1950s
B. 1960s
C. 1970s
D. 1980s

Answer A. During the 1950s the practice of time sharing or resource pooling evolve to make more efficient use of computing power via the mainframe.

Module 1
Check Your Knowledge

Question 3.

Which of the following best describes a computing environment that connects an organization's on-premises private cloud and a third-party public cloud into a single flexible infrastructure for running applications and workloads?

A. Public
B. Private
C. Hybrid

Answer C. A hybrid cloud is a computing environment that connects an organization's on-premises private cloud and third-party public cloud into a single flexible infrastructure for running applications and workloads.

Module 1
Check Your Knowledge

Question 4.

Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS) are generally known as which of the following?

A. Engagement models
B. Service models
C. Deployment models
D. Operation models

Answer B. IaaS, PaaS, and SaaS are generally known as the service models.

Module 1
Check Your Knowledge

Question 5.

Which of the following separates virtual machines logically, assigning each its own slice of underlying computing power, memory, and storage, thus preventing the virtual machines from interfering with each other?

A. Microservice
B. Full stack
C. Application
D. Hypervisor

Answer D. A hypervisor separates virtual machines logically, assigning each its own slice of underlying computing power, memory, and storage, thus preventing the virtual machines from interfering with each other.

Module 1
Check Your Knowledge

Question 6.

Which of the following is another term used for the utility billing method?

A. Pay-in-advance
B. Pay-as-you-go
C. Flat rate payment
D. Billing invoice

Answer B. Pay-as-you-go is another term used for the utility billing method.

Module 1
Check Your Knowledge

Question 7.

Access to infrastructure and physical computing resources such as servers, networking, storage, and data center space best describes which of the following?

A. Software-as-a-Service (SaaS)
B. Platform-as-a-Service (PaaS)
C. Infrastructure-as-a-Service (IaaS)
D. Function as a Service (FaaS)

Answer C. Infrastructure-as-a-Service (IaaS) is described as access to infrastructure and physical computing resources such as servers, networking, storage and data centers.

Module 1
Check Your Knowledge

Question 8.

Which of the following cloud service providers specializes in Software-as-a-Service (SaaS) focused on customer relationship management?

A. SAP
B. Oracle Cloud
C. Salesforce
D. Google Cloud Services

Answer C. Salesforce is the cloud service provider that specializes in Software-as-a Service (SaaS) focused on customer relationship management.

Module 1
Check Your Knowledge

Question 9.

Which one of the following is considered a perceived risk of cloud computing?

A. Infrastructure
B. Data security
C. Workloads
D. Managing assets

Answer B. Data security is considered a perceived risk of cloud computing.

Module 1
Check Your Knowledge

Question 10.

On-demand self-service, broad network access, resource pooling, rapid elasticity, and measured services are considered which of the following?

A. Five essential characteristics of a service provider according to IBV.
B. Five essential characteristics of compute options according to Gartner.
C. Five essential characteristics of deployment models according to ITG.
D. Five essential characteristics of the cloud according to NIST.

Answer D. According to NIST, on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured services are considered the five essential characteristics of the cloud.

Module 2: Cloud Adoption and Emerging Technologies

Introduction and Objectives

In Module 2 of the Study Guide, the subject matter:

- Focuses on cloud adoption and related case studies.
- Highlights emerging technologies being supported by such things as IoT, AI blockchain and analytics on the cloud.

Lessons

- Introduction and Objectives
- Cloud Adoption – No Longer a Choice
- Cloud Adoption – Some Case Studies
- Internet of Things (IoT) on the Cloud
- Artificial Intelligence on the Cloud
- Blockchain and Analytics on the Cloud
- Module Summary
- Knowledge Check Questions

Objectives

- Describe the business case for cloud adoption and case studies that demonstrate the impact businesses have created by adopting cloud.
- Explain how emerging technologies such as the IoT, AI, blockchain, and Analytics are being accelerated by the cloud.

Module 2: Cloud Adoption and Emerging Technologies

Cloud Adoption – No Longer a Choice

Cloud adoption is a strategy used by enterprises to improve the scalability of internet-based database capabilities while reducing cost and risk. It helps them quickly provision services without any upfront costs and experiment with low risk to capital as opportunities. Permitting them to adapt quickly to changes in the marketplace.

Cloud adoption is no longer an option for the future.

- Today anyone can access the computing capacity needed via the cloud.
- An IBM Institute for Business Value study indicated more than three-quarters of enterprises today are using cloud computing to expand into new industries:
    - Seventy-four percent have adopted cloud to improve the customer experience.
    - Seventy-one percent use cloud to create enhanced products and services — while downsizing legacy systems, and reducing costs.

To remain competitive, businesses need to be able to respond quickly to marketplace changes, use analytics to understand customer experience and apply that understanding to adapt their products, and services based on what they learn.

Cloud makes it possible for businesses to greatly decrease the time from decision to value by enabling them the ability to experiment, learn, and fail fast without large amounts of capital expenditures.

Enablers for growth, agility, and innovation in today's organizations include:

- Cognitively enabled workflows.
- Applied exponential technologies such as AI, automation, IoT and blockchain applications, dOpen hybrid, and secure Multicloud infrastructures.

The power, scalability, flexibility, and pay-as-you-go economics of the cloud provided the foundation for the transformation to cloud.

The International Data Corporation (IDC) predicts by 2025, the total amount of digital data created worldwide will rise to 163 zettabytes (where one zettabyte is equivalent to a trillion gigabytes). Thirty-percent of this data will be real-time information.

A cloud strategy, more than just an IT strategy, is the core component of any business strategy today. Those organizations that have no current or future strategy for cloud adoption risk disruptions to the agility, speed, innovation, and decision-making aspects of their business.

Module 2: Cloud Adoption and Emerging Technologies

Cloud Adoption – Some Case Studies

Some of the leading organizations that have transformed the way they work to provide better customer service, remove barriers to innovation, achieve enterprise scale and accelerate growth using cloud technologies include:

American Airlines (AA) – Better Customer Service

In the highly competitive airline industry, customer experience is a major point of differentiation and digital channels are increasingly important.

Need:

To become more responsive to customer needs, AA needed a new technology platform and a new approach to development that would help it deliver digital self-service tools and customer value more rapidly across its enterprise.

Resolution:

The airline recognized the opportunity to remove the constraints of their existing customer facing applications based on monolithic code into cloud-native based microservices architecture.

Results:

- Faster development and release of new apps.
- Improved operational reliability, productivity, and end-customer response times.
- Cost savings by avoiding existing upgrade costs via migration to the IBM Cloud.

UBank – Removing Barriers to Innovation

As a lean organization with a self-imposed limit on head count, UBank excels at finding innovative ways to meet demand. Continually challenged to find more efficient ways to operate, the bank's IT team explored the PaaS cloud development model to help support their needs.

Need:

Give more control to their developers, reduce the need for additional resources, gain faster speed to market, and remove the barriers experienced going from an idea to production.

Resolution:

UBank launched new initiatives in an IBM Cloud Platform environment, including a virtual assistant that incorporates IBM Watson technology to support the bank's online home loan application service.

Results:

- Faster time to market made possible through the Cloud Platform framework that streamlines development, and empowers product teams.
- Foster greater innovation with cloud-based development resources that are quick, easy, and cost-effective to deploy.
- More efficient operations.

Module 2: Cloud Adoption and Emerging Technologies

Cloud Adoption – Some Case Studies cont.

Bitly – Demand for Enterprise Scale

Since its inception in 2008, Bitly has journeyed from a startup that offered intelligent link-shortening technology, adopted by users to compress lengthy URLs for social media posts, to an enterprise product.

Need:

Seeking an agile, cost-effective IT infrastructure to support this transition, they started planning for cloud migration. Their need was a cloud-based model with pay-as-you-go pricing, the ability to scale up and scale down, more of a global presence and the ability to geo-distribute into more Point of Presence (POP) locations. Additionally, they wanted to be low risk.

Resolution:

Bitly migrated to an IBM Cloud environment, establishing a scalable hosting platform for low-latency delivery to enterprise customers around the world.

Results:

- Twenty-five billion data-infused links migrated from one hosting site to a cloud infrastructure with worldwide data center locations.
- One billion user-interaction data set stored and managed in a flexible, cost-effective Cloud Object Storage environment.
- Transformed their IT operations to scale for growth, control costs, and focus valuable resources on new product development.

ActivTrades – Accelerating Growth

Financial traders demand extreme speed and availability from trading systems. Profitability depends on split-second decisions. As a leading online broker in forex, commodities, equities, cryptocurrencies, indices, and other financial instruments, ArctivTrades enable investors to buy and sell on numerous financial markets. Investors need reliable access to accurate market information, combined with the ability to move rapidly to execute trades.

Need:

As its client base grew, the company wanted to cut latency, accelerate execution, and streamline the delivery of new functions.

Resolution:

ActivTrades migrated three major trading systems from on-premises infrastructure to IBM Cloud for VMware solutions, backed by data storage, networking, and security offerings on the IBM Cloud.

Results:

- Up to three times a boost in performance, helping clients seize fleeting opportunities for profit.
- Security-rich cloud platform with ultra-high availability that protects client investments.
- Hours, not days, to ramp up new resources for faster response to emerging requirements.

Module 2: Cloud Adoption and Emerging Technologies

Internet of Things in the Cloud

The Internet of Things (IoT)

What Is It?

The concept of connecting any device (so long as it has an on/off switch) to the Internet and to other connected devices. The IoT is a huge network of connected things and people – all of which collect and share data about the way they are used and about the environment around them.

How It Works

Devices and objects with built-in sensors are connected to an IoT platform, which integrates data from the different devices and applies analytics to share the most valuable information with applications built to address specific needs.

What It Has Changed

IoT has changed much of how we live our daily lives – from the way we drive to how we shop, how we cook our food, ways to monitor security in our homes, our personal health, the way we travel, and how we get energy for our homes. Smart devices (such as smart or virtual assistants) and sensors are continuously tracking and collecting data from all these sources.

As an unprecedented amount of data is being generated by these devices, it has placed tremendous strain on the internet. This is where cloud computing comes in. Data collected through IoT devices is stored and processed on the cloud, and since IoT devices can be in a state of motion, the cloud serves as a collection point in closest proximity, minimizing the latency in reporting up the data points and providing a response back to the IoT application. So, from IoT platforms running entirely in the cloud, to the interfaces used by customers to interact with these devices, to the backend analytics platforms, cloud computing supports and enables IoT. Cloud service providers also offer specialized IoT services designed to help speed up the development of IoT solutions.

Use Case

IoT on the cloud is being used to combat poaching of endangered rhinos in South Africa. Rangers at Welgevonden Reserve are enlisting the help of the zebras and antelopes by fitting them with IoT sensors that alert them to poachers in the area. The rangers can track the animals' movements, which show that they tend to scatter when poachers approach.

Advantages and Disadvantages of IoT

The table below lists some of the advantages and disadvantages of IoT.

Advantages of IoT	Disadvantages of IoT
Access information.	Security.
Control a device miles away in real time.	Privacy.
Device communication is transparent.	Complex network – cloud attacks – failures.
Data packet transfer – reduces time/cost.	Use of outdated software and firmware.
Reduces human intervention.	Automation = reduction in jobs.
Increases efficiency of services.	Internet walls – created for protection.

Module 2: Cloud Adoption and Emerging Technologies

Artificial Intelligence on the Cloud

Artificial Intelligence (AI) on the Cloud

What Is It?	Artificial intelligence is a field which combines computer science and robust datasets to enable problem solving. It also has been defined as a simulation of human intelligence in machines programmed to think like humans and mimic their actions. **Applicability** Many of the applications where we apply artificial intelligence today would not have been possible without the scalable, on-demand computing offered by the cloud. Symbiotic relationship between IoT, AI, and the cloud: • IoT – delivers the data • AI – powers the insights • Cloud – scalability and processing power is leveraged by IoT and AI to provide value to its users.

Use Cases	The United States Tennis Association (USTA) – US Open • Uses AI on the cloud to deliver digital experience to millions of global fans. • IBM integrates and analyzes the data flowing from the court to the fans. • The IBM Cloud is the digital foundation of the US Open, and it scales rapidly to meet the significant increase in web traffic during the event. • With Watson on the Cloud, fans are engaged in unique ways. Slam Tracker analyzes more than 26 million data points and gives fans deep insight into featured matches and other highlights. • AI Highlights uses Watson video to process thousands of hours of US Open video. • Watson analyzes match videos, so coaches can quickly find the footage needed to guide the development of their players. • The US Open app and mobile web (Watson IoT) helps fans find parking, food, and gear.

Introduction to the Cloud

Study Guide

Module 2: Cloud Adoption and Emerging Technologies

Blockchain and Analytics on the Cloud

What Is It?

Blockchain is a secure, distributed, open technology that helps speed up processes, lower costs, and build transparency and traceability in transactional applications.

Blockchain is a growing list of records called blocks which are interconnected by utilizing cryptography. Each block contains a cryptographic hash of the previous block, a time stamp, and exchange information.

It is an immutable network allowing members to view only those transactions relevant to them. The more open, diverse, and distributed the network, the stronger the trust and transparency in the data
and transactions.

Blockchain and AI have a symbiotic relationship with the cloud. Blockchain technology provides the trusted, decentralized source of truth, AI powers the analytics and decision-making from the data collected; and the cloud provides globally distributed, scalable, and cost-efficient computing resources to support both the unprecedented amounts of data being collected, and the processing power required to draw insights from this data.

Analytic technologies on the cloud leverage the flexibility, scalability and computing resources available on the cloud. From tracking trends on social media to predicting future events, to analyzing data to build machine learning models that be deployed in cognitive applications, cloud provides the integrated environment that is required to leverage data for continuous improvement and accelerated business growth.

Use Cases

Farmers in Salinas

- Blockchain has helped them reduce waste at times of recall by building traceability and transparency in the food supply chain.
- Blockchain technology provided farmers with the ability to track their product within seconds, giving instant access to consumers if there was some type of food issue – they are able to alert consumers to its origin and if it warrants a recall.

KONE – manufactures elevators, escalators, auto walks, and doors.

- Invested in IBM Cloud and IoT technologies to power a data analytics and predictive maintenance solution for city infrastructure used by more than one million people daily.
- Uses analytics platform to collect and analyze data on equipment to predict maintenance and prevent outages.

Module 2: Cloud Adoption and Emerging Technologies

Module Summary

The adoption of cloud technologies is enabling enterprises, big and small, to be agile, innovative, and competitive, and to create differentiated customer experiences. The question organizations are asking is not whether they should move to the cloud, rather what strategy they should adopt to move to the cloud.

Some of the case studies that demonstrate the impact businesses have created by adopting the cloud included:

- American Airlines adopting cloud technologies to deliver customer value rapidly across its enterprise.
- UBank leveraging cloud platform services to give more control to their developers thereby removing barriers to innovation.
- Bitly leveraging the scalability offered by cloud infrastructure for low-latency delivery to its geographically disbursed enterprise customers.
- ActivTrades leveraging the infrastructure, storage, network, and security offerings on the cloud to accelerate execution and delivery of new functions in their online trading systems to their customers.

Emerging technologies, powered by the cloud, are disrupting existing business models and creating unprecedented opportunities for businesses to grow, innovate, and create value for their customers.

Some case studies that demonstrate how the use of emerging technologies on the cloud is creating value for millions around the world included:

- The use of the IoT on the cloud to combat poaching of endangered rhinos in South Africa.
- AI on the cloud being leveraged to deliver unique digital experiences to millions of fans around the world by the United States Tennis Association.
- Blockchain on the cloud helping farmers reduce waste by building traceability and transparency in the food supply chain.
- The use of data analytics for driving predictive maintenance solutions for a city’s infrastructure by KONE.

Module 2
Check Your Knowledge

Question 1.

Which of the following provided the foundation for the transformation to the cloud?

A. The power, scalability, flexibility, and pay-as-you-go economics.
B. The need to provide compute resources for complex problems.
C. Faster go-to-market strategies were needed by organizations.
D. Enablement for growth, agility and innovation.

Answer A. The power, scalability, flexibility, and pay-as-you-go economics provided the foundation for the transformation to the cloud.

Module 2
Check Your Knowledge

Question 2.

According to an IBM Institute for Business Value study what percentage of enterprises today are using cloud computing to expand into new industries?

A. 35 percent
B. 65 percent
C. 75 percent
D. 85 percent

Answer C. An IBM Institute for Business Value study indicated that 75 percent of enterprises today are using cloud computing to expand into new industries.

Module 2
Check Your Knowledge

Question 3.

As its client base grew, which of the following solutions did ActivTrades provision in order to cut latency, accelerate execution, and streamline the delivery of new functions?

A. It migrated three major systems from on-premises infrastructure to IBM Cloud for VMware solutions, backed by data storage, networking, and security offerings on the IBM Cloud.

B. It launched new initiatives in an IBM Cloud platform environment, including a virtual assistant that incorporates IBM Watson technology to support its online application service.

C. It migrated to an IBM Cloud environment, establishing a scalable hosting platform for low-latency delivery to enterprise customers around the world.

D. It recognized the opportunity to remove the constraints of their existing customer-facing applications based on monolithic code into cloud-native-based microservices architecture on the cloud.

Answer A. It migrated three major systems from on-premises infrastructure to IBM Cloud for VMware solutions, backed by data storage, networking, and security offerings on the IBM Cloud.

Module 2
Check Your Knowledge

Question 4.

A secure, distributed and open technology with lower costs that builds transparency and traceability in transactional applications describes which of the following?

A. Analytics
B. Blockchain
C. Internet of Things
D. Artificial intelligence

Answer B. Blockchain is a secure, distributed, and open technology with lower costs that builds transparency and traceability in transactional applications.

Module 2
Check Your Knowledge

Question 5.

An IBM retail client wants help with gathering data on their customers' buying habits relative to their five top products. Which one of the following cloud services can be added to help support the client with this request?

A. Internet of Things
B. Blockchain
C. Artificial intelligence
D. Analytics

Answer D. Analytic technologies on the cloud can be leveraged to help the client track trends and analyze the date.

Module 2
Check Your Knowledge

Question 6.

What type of relationship exists between IoT, AI, and the cloud?

A. Dependent
B. Independent
C. Synergistic
D. Symbiotic

Answer D. A symbiotic relationship in which IoT delivers the data, AI powers the insights and the cloud provides the scalability and processing power that leverages them both to provide value to its users.

Module 2
Check Your Knowledge

Question 7.

Which of the following best describes the software application that continues to learn about user preferences based on the frequency of use?

A. Smart tech
B. Small sensor
C. Smart assistant
D. Data stack

Answer C. A smart assistant is an IoT device that tracks data and information and continues to learn about user preferences based on frequency of use.

Module 2
Check Your Knowledge

Question 8.

The IDC predicts by the year 2025, the total amount of digital data created worldwide will rise to how many zettabytes?

A. 143
B. 153
C. 163
D. 173

Answer C. The IDC predicts by 2025, the total amount of digital data created worldwide will rise to 163 zettabytes.

Module 2
Check Your Knowledge

Question 9.

In the use case examples which one of the following companies recognized the opportunity to remove the constraints of their existing customer-facing applications based on monolithic code into cloud-native-based microservices architecture on the cloud?

A. American Airlines
B. Bitly
C. UBank
D. ActivTrades

Answer A. American Airlines recognized the opportunity to remove the constraints of their existing customer-facing applications based on monolithic code into cloud-native-based microservices architecture on the cloud.

Module 2
Check Your Knowledge

Question 10.

How can the adoption of cloud computing technologies allow a company to adapt quickly to changes in the marketplace?

Place your answer in the space below.

Answer: Cloud adoption can help a company so it can quickly provision services without any upfront cost so it can experiment with low risk to capital as opportunities arise. Cloud adoption can also help a company adapt quickly to changes in the marketplace.

Module 3: Cloud Computing Service and Deployment Models
Module Introduction and Objectives

In Module 3 of the Study Guide, the subject matter:

- Focuses on the different types of service models for cloud computing.
- Highlights the different types of deployment models.

Lessons

- Introduction and Objectives
- Overview of Service Models
- Infrastructure-as-a-Service
- Platform-as-a-Service
- Software-as-a-Service
- Public Cloud
- Private Cloud
- Hybrid Cloud
- Module Summary
- Check Your Knowledge

Objectives

- Describe the features, benefits and use cases for the three main service models – Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS).
- Describe the feature, benefits, and use cases for the three main cloud deployment models – public, private, and hybrid.

Module 3: Cloud Computing Service and Deployment Models

Overview of Service Models

Three Service Models

1. Infrastructure-as-a-Service
2. Platform-as-a-Service
3. Software-as-a-Service

Infrastructure-as-a-Service

- The cloud provider manages the physical resources, data centers, cooling power, network, and security and the computing resources that include servers and storage.
- Networking and storage resources have been virtualized by a vendor so a user can access and configure them the way they want.
- User is also known by a persona. The persona for IaaS is the system admin or IT admin.

Platform-as-a-Service

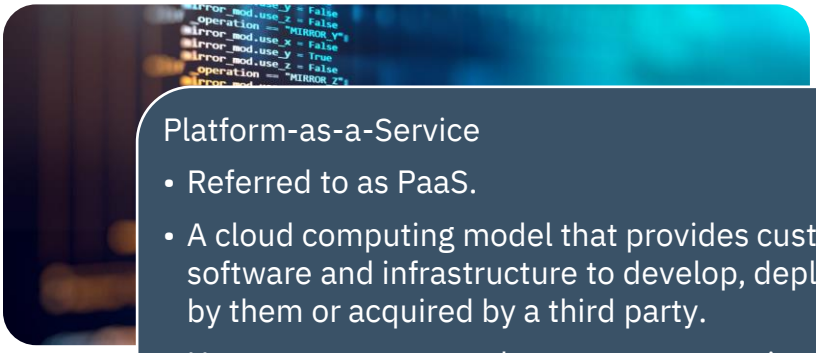
- The cloud provider manages the platform infrastructure – operating systems, development tools, databases, and business analytics.
- The user or persona for a PaaS is a developer.

Software-as-a-Service

- The cloud provider also hosts and manages the applications and data.
- Software – the user doesn't have to install or update; it is done by the provider.
- Charged via a subscription model rather than a one-time license fee.
- User or persona for SaaS can be anyone.

Module 3: Cloud Computing Service and Deployment Models
Platform-as-a-Service

Platform-as-a-Service



Platform-as-a-Service

- Referred to as PaaS.
- A cloud computing model that provides customers a complete platform-hardware, software and infrastructure to develop, deploy, manage, and run applications created by them or acquired by a third party.
- Hosts servers, networks, storage, operating systems, application runtimes, APIs, middleware, databases, and other tools at their data center.
- The cloud service provider takes responsibility for the installation, configuration and operation of the application infrastructure. The user is only responsible for application code and its maintenance.
- Customers pay for this service on a usage basis and purchase resources on demand.

Essential Characteristics of PaaS

- PaaS clouds – provide a level of abstraction to users, eliminating the complexity of deploying applications, configuring infrastructure and provisioning and configuring supporting technologies like load balancers. They provide services and APIs that help simplify the developer's job in delivering elastically scalable and highly available cloud applications. These services include APIs for distributed caching, queuing and messaging; file and data storage; workload management; user identity; and analytics. They eliminate the need to integrate disparate components.
- PaaS runtimes – executes end-user code according to policies set by the application owner and cloud provider. Many provide developers with rapid deployment mechanisms, or "push and run" mechanisms for deploying and running applications.
- PaaS offerings – support a range of application infrastructure (or middleware) capabilities (e.g., servers, database management systems, business analytics services, mobile back-end services, business process management systems, rules engines and complex event-processing systems).

Module 3: Cloud Computing Service and Deployment Models
Platform-as-a-Service cont.

Use Cases for PaaS

- One of the most important for an organization is strategic – to build, test, deploy, enhance, and scale applications rapidly and cost effectively.
- Organizations use it to develop, run, manage and secure APIs, and microservices.
- IoT is supported by a broad range of application environments, programming languages and tools used for IoT deployments.
- Business Analytics/Intelligence – allows organizations to analyze their data to find business insights that promote informed business decisions and predictions.
- Business Process Management (BPM) – organizations are using the PaaS cloud to access BPM platform delivered as a service.
- Master Data Management (MDM) – provides a single point of reference for critical business data such as information regarding customer transactions and analytical data to support decision making.

Advantages and Disadvantages of PaaS

The table below lists some of the advantages and disadvantages of PaaS.

Advantages of PaaS	Disadvantages of PaaS
Scalability.	Information security threats.
Greater agility and innovation.	Services impacted when provider's infrastructure experiences downtime.
Middleware capabilities.	Customers do not have direct control over the changes that may take place by the provider, affecting strategy, service offerings and/or tools.

Key PaaS offerings in today's market include:

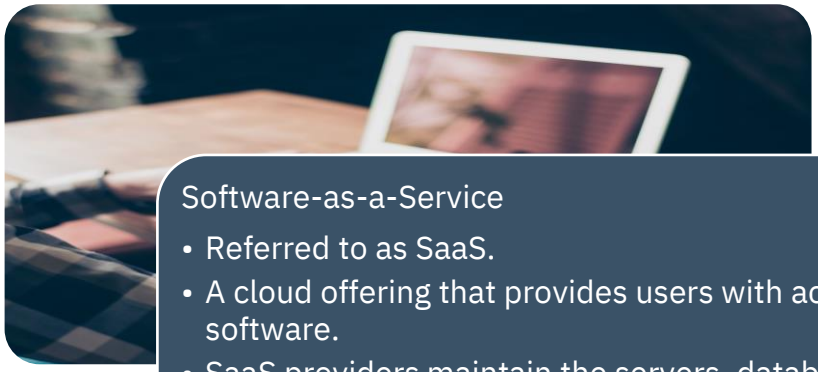
- AWS Elastic Beanstalk
- IBM Cloud Paks
- Windows Azure
- Red Hat OpenShift
- Magento Commerce Cloud
- Force.com
- Apache Stratos

Introduction to the Cloud

Study Guide

Module 3: Cloud Computing Service and Deployment Models

Software-as-a-Service



Software-as-a-Service

- Referred to as SaaS.
- A cloud offering that provides users with access to a service provider's cloud-based software.
- SaaS providers maintain the servers, databases, and code that constitute an application.
- The providers also manage access to the application including security, availability, and performance
- Applications reside on a remote cloud network and users use these applications without needing to maintain and update the infrastructure.

Core Business Processes Supported by SaaS

Email and collaboration offerings such as Microsoft Office and Google's Gmail.

CRM via services such as NetSuite CRM and Salesforce.

Human Resource Management (HRM) via services from Workday and SAP Success Factors, financial management, billing and collaboration.

Module 3: Cloud Computing Service and Deployment Models

Software-as-a-Service cont.

Key Characteristics of SaaS

SaaS clouds have a multitenant architecture.

Infrastructure and code are centrally maintained and accessed by all users.

SaaS makes it easy for users to manage privileges, monitor data use, and ensure everyone sees the same information at the same time.

Security, compliance, and maintenance are all part of the offering.

Users can customize applications to fit their business processes with point-and-click ease.

Users can customize the user interface (UI) to work with branding guidelines; they can modify data fields and enable or disable features within business processes. These customizations are preserved through upgrades.

Users pay for the use of the services via a subscription model.

Resources can be scaled easily, depending on the service needs.

Module 3: Cloud Computing Service and Deployment Models

Software-as-a-Service cont.

Benefits of Adopting SaaS and Associated Risks

The table below lists some of the benefits of SaaS adoption and the risks associated with the service.

Benefits of Adopting SaaS	Risks Related to SaaS
Businesses can directly procure solutions.	Data ownership.
Increases workforce productivity and efficiency.	Data safety.
Users can access core business apps from any location.	Data privacy.
Users can buy and deploy apps in minutes and not worry about obstacles to testing.	Security – third party maintains business critical data.
Using SaaS applications – users and small enterprises can spread out software costs over time.	Application access relies on a good internet connection. No connection, no access.

Use Cases for SaaS

Organizations are:

- Moving SaaS to as a core business need and part of their strategic transformation in order to reduce on-premises IT infrastructure and reduce capital expenditure.
- Leveraging SaaS to avoid the need for ongoing upgrades, maintenance, and patching. Applications run reliably with minimal input (e.g., email servers and office collaboration productivity tools).
- Opting for SaaS eCommerce platforms to manage their websites, marketing, sales and operations.
- Taking advantage of the resilience and business continuity of the cloud provider.
- Developing SaaS integration platforms (SIPs) for building additional SaaS applications, moving it beyond standalone software functionality to a platform for mission-critical applications.

Introduction to the Cloud

Study Guide

Module 3: Cloud Computing Service and Deployment Models

Public Cloud

Deployment Models

Deployment models indicate where the infrastructure resides, who owns and manages it, and how cloud resources and services are made available to users.

The three deployment models are Public Cloud, Private Cloud, and Hybrid Cloud. This segment focuses on the ***Public Cloud.***

Characteristics of a Public Cloud		
It has a virtualized multi-tenant architecture, enabling tenants or users to share computing resources residing outside their firewalls.	The cloud providers pool of resources, including infrastructure, platforms and software are NOT dedicated for use by a single tenant (user) or organization.	Resources are distributed on an as-needed basis offered through a variety of subscription and pay-as-you-go models.

Features of Public Cloud

- Users get access to servers, storage, network, security and applications as services delivered by cloud provider via the internet.
- With the use of web consoles and APIs, users can provision the resources, and services they need.
- The cloud provider owns, manages, provisions, and maintains the infrastructure renting it to customers either as a subscription or per a usage-based fee.
- Users do not own the servers their applications run on or the storage their data consumes. They do not manage the operations of the servers or determine how the platforms are maintained. Users pay for usage over a certain time period, much like paying for utilities (e.g., water, gas, or electricity).
- It offers significant cost savings for the consumer, as the cloud provider bears all the capital, operational, and maintenance expenses for the infrastructure and facilities in which they are hosted.
- Scalability is easier as customers only need to request additional capacity, if/when needed.

Public Cloud Providers

- Amazon Web Services
- Microsoft Azure
- IBM Cloud
- Google Cloud Platform
- Alibaba Cloud

While all these providers include a common set of core services, such as servers, storage, network, security, and databases, they also offer a variety of niche services with varied payment options.

Module 3: Cloud Computing Service and Deployment Models

Public Cloud cont.

Benefits of the Public Cloud and Associated Risks

The table below lists some of the benefits of the public cloud and risks associated with the model.

Benefits of the Public Cloud	Risks Related to the Public Cloud
Vast on-demand resource availability – respond seamlessly to fluctuations in demand.	Security issues – data breaches, data loss, account hijacking, insufficient due diligence, and system and application vulnerability.
Based on the large number of users that share the centralized cloud resources on-demand; and it offers the most significant economies of scale.	Data sovereignty compliance – with data being stored in different locations and accessed across national borders, it has become increasingly critical for companies to be compliant with the related regulations governing the storage, transfer, and security of data.
Highly reliable due to the sheer number of servers and network resources available.	Keeping up with the sovereignty compliance regulations and the interpretation of these regulations.

Use Cases for Public Cloud

Organizations are:

- Increasingly opting to access cloud-based applications and platforms so their teams can focus on building and testing applications and reducing time-to-market for their products and services.
- Using it for computing resources to build secondary infrastructures for disaster recovery, data protection, and business continuity.
- Using cloud storage and data management services for greater accessibility, easy distribution, and backing up their data.
- Letting their IT departments outsource the management of less critical and standardized business platforms and applications to public cloud providers.

Module 3: Cloud Computing Service and Deployment Models

Private Cloud

Private Cloud

NIST defines private cloud as cloud infrastructure provisioned for exclusive use by a single organization comprising multiple consumers such as the business units within the organizations.

Characteristics of a Private Cloud

- It may be owned, managed, and operated by the organization, a third party or some combination of them, and it may exist on or off premises.
- Private cloud platforms can be implemented internally or externally.
  - When the platform is provisioned over an organization's internal infrastructure, it runs on-premises and is owned, managed, and operated by the organization.
  - When it is provisioned over a cloud provider's infrastructure, it is owned, managed, and operated by the service provider. This external private cloud offering that resides on a cloud service provider's infrastructure is called a **Virtual Private Cloud or VPC.**
  - A VPC is a public cloud offering that lets an organization establish its own private and secure cloud-like computing environment in a logically isolated part of a shared public cloud.
  - Using a VPC, organizations can leverage the dynamic scalability, high availability, and lower cost of ownership of a public cloud while having the infrastructure and security tailored their unique needs.
- It is a virtualized environment designed to bring in the benefits of a public cloud platform without the perceived disadvantages of an open and shared public platform.

Benefits of a Private Cloud

- Users of a private cloud, such as developers and business units still get to leverage benefits such as economies of scale, operational efficiencies, granular scale, and user self-service while exercising full control over access, security, and compliance specific to the business.
- Provides the ability to leverage the value of cloud computing using systems that are directly managed or under perceived control of the organization's internal IT department.
- Ability to utilize internal computing resources (e.g., existing hardware and software, adding to reduced costs).
- Better scalability through virtualization and "cloud bursting" (i.e., leveraging public cloud instances for a period of time, but returning to the private cloud when the surge is met).
- Controlled access and greater security measures.
- Greater agility to expand and provision solutions in a relatively short amount of time.

Module 3: Cloud Computing Service and Deployment Models
Private Cloud cont.

Benefits of the Private Cloud and Associated Risks

The table below lists some of the benefits of the private cloud and risks associated with the model.

Benefits of Private Cloud Adoption	Risks Related to the Private Cloud
Application portability – build and move applications anywhere.	Security concerns.
Applications play a unique and competitive advantage.	Regulatory concerns.
Data is highly sensitive and subject to strict industrial or governmental regulations.	Data sensitivity.

Private Cloud Providers

- IBM
- Amazon

Use Cases for Private Cloud

Organizations are:

- Providing an opportunity to modernize and unify their in-house and legacy applications. Moving these applications from their dedicated hardware to the cloud also allows them to leverage the power of the compute resources and multiple services available on the cloud.
- Integrating data and application services from their existing application with public cloud services. This allows them to leverage their private cloud's compute capability for the larger jobs while pulling data into an application on a private cloud to leverage public cloud services – essentially opening their data centers to work with cloud services.
- Using the flexibility to build applications anywhere and move them anywhere without having to compromise security and compliance in the process.

Module 3: Cloud Computing Service and Deployment Models
Hybrid Cloud

Hybrid Cloud

Hybrid cloud is a computing environment that connects an organization's on-premises private cloud and third-party public cloud into a single, flexible infrastructure for running the organization's applications and workloads.

The mix of public and private cloud resources gives organizations the optimal cloud for each application or workload. Workloads move freely between the two clouds as needs change. Organizations can choose to run the sensitive, highly regulated, and mission-critical applications or workloads with reasonably constant performance and capacity requirements on the private cloud infrastructure while deploying the less-sensitive and more-dynamic workloads on the public cloud.

Key Tenets of Hybrid Cloud

Interoperability	Scalability	Portability
• Public and private cloud services can understand each other's APIs, configurations, data formats, and forms of authentication and authorization.	• When there is a spike in demand, a workload running on the private cloud can leverage the additional public cloud capacity, making it scalable.	• Not being locked into a specific vendor, a user can move applications and data not just between on-premises and cloud systems, but also between service providers.

Module 3: Cloud Computing Service and Deployment Models
Hybrid Cloud cont.

Two Common Types of Hybrid Clouds

Hybrid monocloud

- A hybrid cloud with one provider.

Hybrid multicloud

- An open, standard-based-stack that can be deployed on any public cloud infrastructure.
- The difference lies in the flexibility the hybrid multicloud offers organizations to move workloads and environments from one vendor to another.

Composite multicloud

- A variant of a hybrid multicloud.
- Makes the flexibility even more granular as it distributes single applications across multiple providers.
- Allows a user to move application components across cloud services and vendors as needed.

Module 3: Cloud Computing Service and Deployment Models
Hybrid Cloud cont.

Benefits of the Hybrid Cloud

The table below lists some of the benefits of the hybrid cloud.

Benefits of the Hybrid Cloud
Security and compliance – allows organizations to deploy highly regulated or sensitive workloads in a private cloud while running the less sensitive workloads on a public cloud.
Scalability and resilience – scales up quickly, inexpensively, and even automatically using the public cloud infrastructure, all without impacting the other workloads running on the private cloud.
Resource optimization – not being locked in with a specific vendor or not being forced to make the decision between the different cloud models allows an organization to decide which is the most cost-efficient option regarding their infrastructure budget.
Cost-savings – allows organizations to maintain workloads where they are most efficient, spin-up environments using the pay-as-you-go option in the public cloud and rapidly adopt new tools as they are needed.

Use Cases for Hybrid Cloud

Organizations are utilizing:

- SaaS integration
  - Through hybrid integration connecting SaaS application available in the public cloud to their existing public cloud, private cloud, and traditional IT applications to deliver new solutions.
- Data and AI integration
  - Creating richer and more personal experiences by combining new data sources on the public cloud, e.g., weather, social, IoT, CRM, and ERP, with existing data and analytics, machine learning, and AI capabilities.
- Enhanced legacy apps
  - Using public cloud services to upgrade the user experience of their on-premises applications and deploying them globally to new devices while incrementally modernizing their core business systems.
- VMware migration
  - "Lifting and Shifting" their on-premises virtualized workloads to a public cloud without conversion or modification to reduce their on-premises data center footprint and position themselves to scale without added capital expense.

Introduction to the Cloud

Study Guide

Module 3: Cloud Computing Service and Deployment Models

Module Summary

Cloud computing allows us to utilize technology as a service, leveraging remote resources on demand, on a pay-as-you-model.

There are three main service models available on the cloud — Infrastructure-as-a-Service, Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS).

- IaaS provides the fundamental compute, network, and storage resources for customers on demand.
- PaaS provides customers the hardware, software, and infrastructure to develop, deploy, manage, and run applications created by them or acquired from a third party.
- SaaS provides access to users to a service provider's cloud-based software. Users simply access the applications on the cloud while the cloud provider maintains the infrastructure, platform, data, application code, security, availability, and performance of the application.

Deployment models indicate where the infrastructure resides, who owns and manages it, and how cloud resources and services are made available to users. There are three main deployment models available on the cloud — public, private, and hybrid.

- In the public cloud model, the service provider owns, manages, provisions, and maintains the physical infrastructure such as data centers, servers, networking equipment, and storage, with users accessing virtualized compute, networking, and storage resources as services.
- In the private cloud model, the provider provisions the cloud infrastructure for exclusive use by a single organization. The private cloud infrastructure can be internal to the organization and run or on-premises. Or, it can be on a public cloud, as in the case of virtual private clouds (VPC), and be owned, managed, and operated by the cloud provider.
- In the hybrid cloud model, an organization's on-premises private cloud and third-party, public cloud is connected as a single, flexible infrastructure leveraging the features and benefits of both public and private clouds.

Module 3
Check Your Knowledge

Question 1.

You have been working with a client to secure a business deal involving one of their infrastructure platforms; subsequently, they have decided to implement IaaS for the wide range of services it provides. Who will be the typical user for IaaS?

A. Site developer
B. System administrator
C. System engineer
D. Associate architect

Answer B. The user/persona for IaaS is the system administrator.

Module 3
Check Your Knowledge

Question 2.

In which of the following service models does the cloud service provider take responsibility for the installation, configuration, and operation of the application infrastructure?

A. IaaS
B. PaaS
C. SaaS
D. FaaS

Answer B. In a PaaS service model, the cloud service provider takes responsibility for the installation, configuration, and operation of the application infrastructure.

Module 3
Check Your Knowledge

Question 3.

Which of the following represents a use case for SaaS?

A. Leveraging it to avoid the need for ongoing upgrades, maintenance, and patching.

B. Organizations use it to develop, run, manage, and secure APIs and microservices.

C. Mine massive amounts of data sets to locate valuable patterns and trends.

D. To build, test, deploy, enhance, and scale applications rapidly and cost effectively.

Answer A. Leveraging SaaS to avoid the need for ongoing software upgrades, maintenance, and patching is considered a use case for SaaS.

Module 3
Check Your Knowledge

Question 4.

It may be owned, managed, and operated by the organization, a third party, or some combination of those functions and may exist on or off premises identifies characteristics of which cloud deployment model?

A. Public Cloud
B. Private Cloud
C. Hybrid Cloud

Answer B. Two characteristics of a private cloud deployment model are; it may be owned, managed, and operated by the organization, a third party or some combination of those functions and may exist on or off premises.

Module 3
Check Your Knowledge

Question 5.

Interoperability, scalability, and portability are key tenets of which one of the following cloud deployment models?

A. Public
B. Private
C. Hybrid

Answer C. The key tenets of a hybrid cloud are interoperability, scalability, and portability.

Module 3
Check Your Knowledge

Question 6.

Which of the following is a benefit of the hybrid cloud deployment model?

A. It offers the most significant economies of scale.
B. It offers control of IT infrastructure.
C. It offers control access and security.
D. It offers resource optimization.

Answer D. One of the benefits to the hybrid cloud is it offers resource optimization – not being locked in with a specific vendor.

Module 3
Check Your Knowledge

Question 7.

Which of the following describes a use case for the public cloud?

A. Using the flexibility it offers to build applications anywhere and move them anywhere without having to compromise security and compliance in the process.
B. Integrating data and application services from existing application.
C. Providing an opportunity to modernize and unify in-house and legacy applications.
D. Using it for computing resources to build secondary infrastructures for disaster recovery, data protection, and business continuity.

Answer D. Using it for computing resources to build secondary infrastructures for disaster recovery, data protection, and business continuity is a use case for the public cloud.

Module 3
Check Your Knowledge

Question 8.

Which of the following describes a use case for the private cloud?

A. Providing an opportunity to modernize and unify an organization's in-house and legacy applications.
B. Lifting and shifting their on-premises virtualized workloads.
C. Taking advantage of the resilience and business continuity of the provider.
D. Creating richer and more personal experiences by combining new data sources.

Answer A. One of the use cases for the private cloud includes providing an opportunity to modernize and unify an organization's in-house and legacy applications.

Module 3
Check Your Knowledge

Question 9.

A virtualized, multi-tenant architecture enabling tenants or users to share computing resources residing outside their firewalls best describes a characteristic for which cloud type?

A. Private cloud
B. Public cloud
C. Hybrid cloud

Answer B. A public cloud is a virtualized, multi-tenant architecture enabling tenants or users to share computing resources residing outside their firewalls.

Module 3
Check Your Knowledge

Question 10.

Which of the following is considered a use case for a public cloud?

A. Using the flexibility to build applications anywhere and move them anywhere without having to compromise security and compliance in the process.
B. Upgrading the user experience of the on-premises applications and deploying them globally to new devices while incrementally modernizing core business systems.
C. Increasingly opting to access cloud-based applications and platforms so an organization's teams can focus on building and testing applications and platforms, thus reducing time-to-market for their products and services.
D. "Lifting and Shifting" an organization's on-premises virtualized workloads without conversion or modification to reduce their on-premises data center footprint and position themselves to scale without added capital expense.

Answer C. Increasingly opting to access cloud-based applications and platforms so an organization's teams can focus on building and testing applications and platforms, thus reducing time-to-market for their products and services.

Module 4: Components of Cloud Computing
Module Introduction and Objectives

In Module 4 of the Study Guide, the subject matter:

- Focuses on the various components of cloud computing architecture including virtualization, virtual machines, and bare metal servers.
- Emphasizes the build of a secure cloud network presence and how container-based technologies function.

Lessons

- Introduction and Objectives
- Overview of Cloud Infrastructure
- Virtualization and Virtual Machines Explained
- Types of Virtual Machines
- Bare Metal Servers
- Secure Networking in Cloud
- Containers
- Module Summary
- Check Your Knowledge

Objectives

- Describe the key components of cloud infrastructure.
- Explain virtualization.
- List the features and benefits of virtual machines.
- List the features and benefits of bare metal servers and how they differ from virtual servers.
- Describe how to build a secure cloud networking presence.
- Explain how contain-based technology works.

Module 4: Components of Cloud Computing

Overview of Cloud Infrastructure

After selecting the cloud service model and the cloud type offered by vendors, customers need to plan the infrastructure architecture.

The infrastructure layer is the foundation of the cloud. It consists of physical resources that are housed in regions, zones and data centers.

Regions

- A geographic area or location where a cloud provider's infrastructure is clustered. It may have names such as NA (North America) South or US (United States) East.
  - The regions are isolated from one another, so if one region was impacted by a natural disaster (e.g., an earthquake, the cloud operations in other regions would continue to function).

Zones

- Each cloud region can have multiple zones (also known as availability zones or AZ) which are typically distinct data centers with their own power, cooling, and networking resources.
  - Zones can have names such as DAL-09 or us-east-1.
  - The isolation of zones improves the cloud's overall fault tolerance, decreases latency and avoids creating a single shared point of failure.
  - The availability zones and data centers within them are connected to other AZs and regions, private data centers and the internet using very high-bandwidth network connectivity.

Data Centers

- A huge warehouse or room containing cloud infrastructure equipment. These data centers contain pods and racks or standardized containers of computing resources such as servers plus storage and networking equipment.

Module 4: Components of Cloud Computing
Overview of Cloud Infrastructure cont.

Computing Resources

Cloud providers offer several compute options – virtual servers, bare metal servers and serverless computing resources.

Computing Resources	
Virtual Servers	• Many of the servers in a cloud data center run hypervisors to create servers or VMs that are software-based computers.
Bare Metal Servers	• Bare metal servers are other servers in the rack that are not virtualized.
Serverless	• Serverless computing resources are also available for users to run their workloads. They are considered an abstraction layer on top of VMs.

Storage

Information and data can consist of files, code, documents, images, videos, backups, snapshots, and databases and can be stored in many different types of storage options on the cloud.

- Bare metal servers and virtual servers are provisioned with default storage in local drives.
  - Since these cloud servers can be provisioned and decommissioned by customers on demand and freed up for use by others, any information stored on a local drive can be lost when a cloud server is deleted or decommissioned.

- Block storage, file storage and object storage options.
  - These storage options provide benefits for data that is both important and persistent (i.e., data that continues to exist over time). The benefits are related to how quickly the data needs to be accessed, how often it is accessed, and how secure it needs to be.
  - Block and file storage modes are commonly used in traditional data centers, but often struggle with scale, performance, and distributed characteristics of the cloud.
  - Object storage is the most common mode of storage in the cloud because it is both highly distributed and resilient.

Module 4: Components of Cloud Computing
Overview of Cloud Infrastructure cont.

Networking infrastructure in a cloud datacenter

- Includes traditional networking hardware such as routers and switches.
- Cloud providers use software defined networking (SDN) options where certain networking resources are virtualized or made available programmatically through APIs. This allows for easier network provisioning to setup their public and private network interfaces. The public network interfaces and connects the servers to the public internet. The private network provide connectivity to an organization's other cloud resources and helps keep them secure.
- Network interfaces in the cloud need to have IP addresses and subnets either assigned automatically or configured.
- Security groups and access control lists (ACLs) need to be configured in a cloud environment to enable network traffic and users to access resources. For further security and isolation of resources, most Cloud providers implement virtual local area networks (VLANs), virtual private clouds (VPCs), and virtual private networks (VPNs).
- Content delivery networks (CDNs)
    - Distribute content to multiple points throughout the world so users accessing the content can do so more quickly by receiving it from a point closest to them.

Introduction to the Cloud

Study Guide

Module 4: Components of Cloud Computing

Types of Virtual Machines

Virtualization

The process of creating a software based or a virtual version of a computing resource or facility, whether it be compute, storage, networks, servers, or applications.

Hypervisors and Its Types

Hypervisors	Type 1 Hypervisor	Type 2 Hypervisor
• Software that runs above the physical server or host. • They essentially pull the resources from the physical server and allocate them to a virtual environment. • They make virtualization possible.	• A hypervisor that is installed directly on top of the physical server. • Also known as a "bare metal" hypervisors. • Most frequently used and seen in the market. • Most secure. • Lower latency. • Examples include: VMware, ESXi, Microsoft Hyper-v, open source KVM.	• What makes these different is there is a layer of hosting operating system (OS) that sites between the physical server and the hypervisor. • Also known as "hosted". • Mostly used for end-user virtualization • Less frequently used. • Higher latency. • In the marketplace, they are called Oracle, VirtualBox, VMware Workstation.

Virtual Machines

Once you have a hypervisor installed you can build VMs.

- Software-based computer that runs like a physical computer. They are completely independent of one another. Multiple instances can be run on a hypervisor (e.g., one can run on Windows, one on Linux, or another on Unix).

Benefits of Virtual Machines
Cost savings – running multiple virtual environments reduces physical infrastructure footprint. Do not have to maintain as many servers and run as much electricity. A saving is realized on maintenance costs.
Agility and speed – spinning up a VM is relatively easy and quick.
Lowers downtime – if the host goes down, VMs give you the ability to move quickly to another hypervisor that is working.
Extremely portable – a VM can be moved from one hypervisor to another on a completely different machine almost instantaneously.

Module 4: Components of Cloud Computing
Types of Virtual Machines

Virtual Machines

Virtual machines (VMs) are also known as virtual servers or virtual instances. The various cloud providers make VMs available in a variety of configurations and deployment options to serve different use cases.

VM Configuration and Deployment
When a virtual server is created in the cloud, the region and zone or data center that the server is to be provisioned in and the operating system must be specified.
Select the type of VM needed – shared (multi-tenant – the underlying physical server is virtualized and shared across other tenants or users); VM or dedicated (single tenant – the underlying physical server is virtualized and serves only one customer).
Select type of billing – hourly or monthly billing.
Select storage and networking options.

Module 4: Components of Cloud Computing
Types of Virtual Machines cont.

Types of VMs

Shared or Public Cloud VMs	Transient or Spot VMs	Dedicated Hosts
• Provider-managed, multi-tenant deployments that can be provisioned on demand with predefined sizes. To satisfy different workloads, cloud providers offer predefined sizes and configurations ranging from a single virtual core and a small amount of Random Access Memory (RAM) to multiple virtual cores and a much larger amount of RAM. • Public VMs are usually priced by the hour (in some cases, even seconds) and configurations can start as low as pennies per hour. Some even have monthly options.	• Takes advantage of unused capacity in a cloud data center. Cloud providers make this unused capacity available to users at a much lower cost than regular VMs of similar sizes. • Although the transient VMs are available at a huge discount, the cloud provider can choose to de-provision them at any time and reclaim the resources for provisioning regular, higher-priced VMs. • Useful for running stateless workloads, testing scalability or running big data and high-performance computing (HPC) workloads at a low cost. • Reserved virtual server instances allow organizations to reserve capacity and guarantee resources for future deployments. Organizations reserve desired amounts of virtual server capacity, provision instances from that capacity when you need them, and choose a term (e.g., one or three years). Organizations are guaranteed this capacity within the data center of their choice for the life of the contact term. If capacity is exceeded, they can supplement usage and capacity with hourly/monthly VMs.	• Offers single tenant isolation – only your VMs run on a given host so they can make exclusive use of full capacity and resources of the underlying hardware. When provisioning, specify the data center and POD in which the organization wants the host placed, then assign VMs to the specific host. • Typically used for meeting compliance and regulatory requirements or to meet specific licensing terms.

Module 4: Components of Cloud Computing
Bare Metal Servers

A bare metal server is single tenant, dedicated physical server.

Bare Metal Features

- It is dedicated to a single customer.
- The cloud provider takes the physical server and plugs it into a rack in a data center for customers. They manage the server up to the operating system. The provider is responsible for fixing hardware or rack connections.
- The customer is responsible for administering and managing everything else on the server.
- The cloud provider can either preconfigure the server to meet workload packages or it can be custom configured per customer specifications (includes processors, RAM, hard drives, specialized components, and the OS).
- Workload examples satisfied by bare metal servers are ERP, CRM, AI, deep learning, and virtualization.
- Customer can install their own OS and install certain hypervisors that are not available from the provider.

Advantages and Disadvantages of Bare Metal Servers

The table below lists some of the advantages and disadvantages related to bare metal servers.

Advantages of Bare Metal	Disadvantages of Bare Metal
Add GPUs, designed to accelerate scientific computations, data analytics, and render professional virtualized graphics.	Physical machines – they take longer to provision (20–40 minutes).
Being fully customizable – do what a client wants in a demanding environment.	Custom builds – can take 3 to 4 hours (can vary by provider).
Intended for long-term, high-performance use in highly secure and isolated environments.	Not all cloud providers provide bare metal servers.
Clients have full access and control because no hypervisor is required.	More expensive because they are dedicated for use by a single client.
Fulfill the demanding need of high-performance computing (HPC) and data-intense applications that requires “minimal-latency-related delays”.	Physical server updates are difficult.
Excel in big data analytic applications and GPU-intensive solutions.	Information loss – if server fails and disaster strikes.
High degree of security control.	

Module 4: Components of Cloud Computing
Bare Metal Servers

Bare Metal vs. Virtual Servers

The table below identifies difference between bare metal and virtual servers.

Bare Metal Servers	Virtual Servers
Works best for CPU-and-Input/Output (I/O) intensive workloads.	Rapidly provisioned.
Excels with highest performance and security.	Provides an elastic environment.
Satisfies strict compliance requirements.	Provides a scalable environment.
Offers complete flexibility, control, and transparency.	Low cost to use.
Comes with added management and operational overhead.	Limited in throughput and performance.

Module 4: Components of Cloud Computing

Secure Networking in Cloud

As cloud environments gain greater adoption and digital data invites rapidly increasing cybersecurity threats, building secure networks on the cloud is crucial. Building a cloud network is not much different from deploying a network in an on-premises data center. The main difference is that in the cloud, use of logical instances of networking elements are employed as opposed to physical devices. In the cloud, networking functions are delivered as a service rather than in the form of rack-mounted devices.

Creating a Cloud Network

- Define the size of the network or IP address range that establishes the boundaries or the cloud network. Cloud networks are deployed in networking spaces that are logically separated segments of the networks using options, including virtual private clouds (VPCs), that in turn, can be divided into smaller segments called subnets.
- Logically segmented cloud networks are a private carveout of the cloud that offers customers the security of private clouds and the scalability of public clouds. Cloud resources, such as VMs or virtual server instances (VSIs), storage, network connectivity, and load balancers are deployed into subnets. Using subnets allows user to deploy enterprise applications using the same multitier concepts used in on-premises environments. Subnets are also the main area where security is implemented in the cloud.
- Every subnet is protected by access control lists (ACLs) that serves as a subnet-level fire wall. Within the subnet, security groups can be created that provide security at the instance level, such as VSIs. Once the subnet is built, then it's time to add some VSIs and storage so the applications can run.
- A public gateway instance is added to the network to enable users' access to the application (web-facing VSIs need internet access) in the internet tier. While public gateways are great for internet access to the cloud, enterprises are interested in extending their on-premises resources to the cloud by securely connecting them using virtual private networks, or VPNs.
- When building many subnets and deploying several workloads, it becomes necessary to ensure that applications continue to be responsive. This is achieved with load balancers. They ensure availability of bandwidth for the different applications.

Enterprises with hybrid cloud environments find using dedicated high-speed connections between clouds and on-premises resources is a more secured and more efficient way rather than public connectivity solutions.

Some cloud service providers offer such connectivity, such as IBM Cloud and its Direct Link solution. It enables extending on-premises resources to the cloud as needed.

Building a cloud network entails creating a set of logical constructs that deliver networking functionality that is akin to the data center networks. IT professionals have come to rely on the functionality for securing their environments and ensuring high-performing business applications.

Module 4: Components of Cloud Computing
Containers

What are Containers?

Containers are an executable unit of software in which application code is packaged, along with its libraries and dependencies, in common ways so that it can be run anywhere, whether it be on desktop, traditional IT, or the cloud.

Container Characteristics

Containers are small, fast, and portable, and unlike VMs, they do not need to include a guest OS in every instance. They can instead simply leverage the features and resources of the host OS.

Advantages of Containers

- Portability.
- Scalability.
- Takes advantage of cloud-native based architectures.
- Streamline development and deployment of cloud-native applications.

Benefits of Containers

- Allow for agile DevOps and continuous integration, and delivery.
- Contain code, system tools, the system libraries, and runtime and settings of the application.
- Streamline ways to build, test, deploy, and redeploy on multiple environments.

Three-Step Container Deployment Process

1. Create the container manifest – the document that describes the configuration.
2. Create the image – unchangeable static file that includes executable code.
3. Upload the image to container registry – contains runtimes, binaries, and libraries

Module 4: Components of Cloud Computing

Module Summary

- Cloud infrastructure consists of data centers, storage, networking components, and compute resources.

- Virtualization is the process of creating a software-based version of physical resources made possible through hypervisors.

- A few different types of VMs can be provisioned on the cloud. These include:
  - **Shared or public cloud VMs** – provider-managed, multitenant deployments that can be provisioned on-demand with predefined sizes.
  - **Transient or spot VMs** – take advantage of unused capacity in a cloud data center.
  - **Reserved VMs** – allow you to reserve capacity and guarantee resources for future Deployments.
  - **Dedicated hosts** – offer single tenant isolation.

- Bare metal servers are single-tenant physical servers that are dedicated to a single customer. Bare metal servers fulfill the demanding needs of high-performance computing (HPC) and data intense applications. They are ideal for applications that have a high degree of security or compliance requirements.

- Networking capabilities in the cloud are delivered as a service rather than in the form of rack-mounted devices. Cloud resources, such as VMs (or VSIs), storage, network connectivity, and load balancers, are deployed into subnets within virtual private clouds (VPCs). Using private and public subnets allows users to deploy multitier enterprise applications securely. Load balancers distribute the traffic and allow applications to be responsive.

- Containers are an executable unit of software in which application code is packaged, along with its libraries and dependencies, in common ways so that it can be run anywhere — desktops, traditional IT, or the cloud. Containers are lighter weight and consume fewer resources than VMs – helping streamline the development and deployment of cloud-native applications.

Module 4
Check Your Knowledge

Question 1.

Which one of the following layers is considered the foundation of the cloud?

A. Control layer
B. Orchestration layer
C. Infrastructure layer
D. Application layer

Answer C. The infrastructure layer is considered the foundation of the cloud. It consists of physical resources that are housed in regions, zones, and data centers.

Module 4
Check Your Knowledge

Question 2.

Which of the following is known as distinct data centers with their own power, cooling, and networking resources?

A. Zones
B. Regions
C. Domains
D. Locals

Answer A. Zones are typically known as distinct data centers with their own power, cooling, and network resources.

Module 4
Check Your Knowledge

Question 3.

Which of the following are characteristics of a region? Identify all that apply.

A. Has a name such as NA South or US East.
B. Is isolated from other regions, so if one was impacted by a natural disaster, the cloud operations in others would continue to function.
C. The cloud's overall fault tolerance decreases latency and avoids creating a single shared point of failure.
D. A geographic area or location where a cloud provider's infrastructure is clustered.

Answer A, B and D. A region has a name such as NA South or US East; is isolated from other regions, so if one was impacted by a natural disaster, the cloud operations in others would continue to function; and is a geographic area or location where a cloud provider's infrastructure is clustered.

Module 4
Check Your Knowledge

Question 4.

Which one of the following is a characteristic of both a bare metal server and a virtual server?

A. Commonly used in traditional data centers, but often struggle with scale.
B. Provisioned with default storage in local drives.
C. Used to enhance the functionality and management of web pages.
D. Enable users to request information from applications.

Answer B. Bare metal and virtual servers are provisioned with default storage in local drives.

Module 4
Check Your Knowledge

Question 5.

What is the function of a hypervisor?

A. Used to connect availability zones and regions.
B. Distributes content to multiple points throughout the world so users can access.
C. Pulls resources from the physical server and allocate them to a virtual environment.
D. An executable unit of software in which application code is packaged.

Answer C. The function of a hypervisor is to pull resources from the physical server and allocate them to a virtual environment.

Module 4
Check Your Knowledge

Question 6.

What is another name given to a Type 2 hypervisor?

A. Bare metal
B. Single tenant
C. Dynamic LPAR
D. Hosted

Answer D. Type 2 hypervisors are also known as hosted.

Module 4
Check Your Knowledge

Question 7.

Virtual servers and virtual instances are two terms used synonymously in the IBM Cloud with which of the following?

A. Virtual machines
B. Virtual service
C. Virtual platform
D. Virtual resources

Answer A. Virtual machines is the term used synonymously with virtual servers and virtual instances in the IBM Cloud.

Module 4
Check Your Knowledge

Question 8.

What type of server satisfies workload examples such as ERP, CRM, AI, deep learning and virtualization?

A. dBase
B. Bare metal
C. Virtual machine
D. LPAR

Answer B. Bare metal servers satisfy workload examples such as ERP, CRM, AI, deep learning and virtualization.

Module 4
Check Your Knowledge

Question 9.

VMware, ESXi, Microsoft Hyper-v, and open-source KVM are some examples of which Type of hypervisor?

A. 1
B. 2
C. 3
D. 4

Answer A. VMware, ESXi, Microsoft Hyper-v, open-source KVM are examples of a Type 1 hypervisor.

Module 4
Check Your Knowledge

Question 10.

Which of the following is added to the network to enable users' access to the application in the internet tier?

A. IP address
B. Cloud network
C. Private gateway
D. Public gateway

Answer D. A public gateway is added to the network to enable users' access to the application in the internet tier.

Module 4
Check Your Knowledge

Question 11.

What is the main difference between deploying a network in an on-premises data center and deploying a cloud network?

A. Peripheral devices
B. Standard devices
C. Physical devices
D. Material devices

Answer C. The main difference is that in the cloud, the logical instances of networking elements are used as opposed to the use of physical devices used in an on-premises facility.

Module 4
Check Your Knowledge

Question 12.

Portability, scalability, streamlined development and deployment of cloud-native applications and architectures are some of the advantages of which one of the following components?

A. Networks
B. Containers
C. Servers
D. Storage

Answer B. The advantages of containers include portability, scalability, streamlined development, and deployment of cloud-native applications and architectures.

Module 5: Cloud Computing Storage and Content Delivery Networks

Introduction and Objectives

In Module 5 of the Study Guide, the subject matter:

- Focuses on the features regarding the four main types of cloud storage, direct attached, file, block, and object storage and what differentiates them.
- Highlights the benefits of a content delivery network.

Lessons

- Introduction and Objectives
- Basics of Cloud Storage
- File Storage
- Block Storage
- Object Storage Overview
- Object Storage – Tiers and APIs
- Content Delivery Networks
- Module Summary
- Check Your Knowledge

Objectives

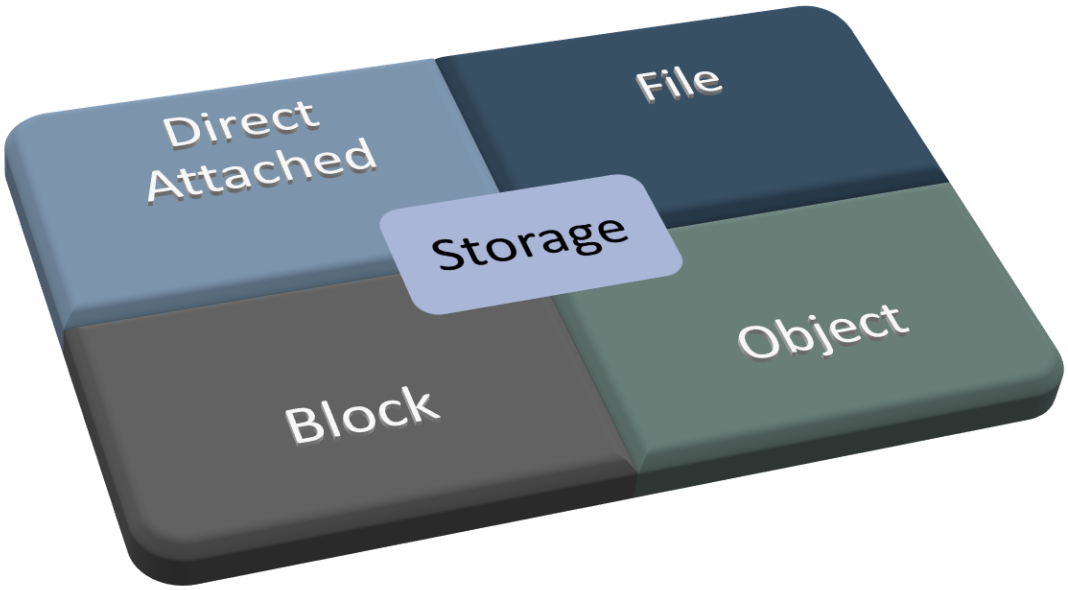
- Describe and differentiate between the four main types of cloud storage – direct attached, file storage, block storage and object storage.
- Explain the benefits of content delivery networks.

Module 5: Cloud Computing Storage and Content Delivery Networks

Basics of Cloud Storage – Direct Attached

Cloud storage is a computer model where data and files are stored in digital format in the cloud. Certain storage must be attached to a compute node before the storage can be accessed, whereas other storage types can be directly accessed either through the public internet or a dedicated private network connection.

The four types of cloud storage are direct attached, file, block, and object.



Direct Attached Details

Direct Attached Storage
• Referred to as local storage.
• Presented to a cloud-based server – sits either within the host server chassis or within the same rack.
• Storage is fast and normally used to store a server's operating system.
• Operating system is "Ephemeral" – it only lasts as long as the compute resource is attached to it. It is deleted after the virtual instance is terminated.
• Cannot be shared with other nodes.
• Redundant array of independent disk (RAID) techniques can be used. It is not as resilient to failure as other types of storage.
Disadvantage of Direct Attached Storage
• Poor performance when data needs to be shared.

Module 5: Cloud Computing Storage and Content Delivery Networks

File Storage

File Storage Details

File Storage
• File storage must be attached to a compute node before it can be accessed and have data stored on it.
• Presented as network file system (NFS) – means the storage is connected to compute nodes over a standard ethernet network. Also referred to as network attached storage, network file storage or simply NFS.
• Can be mounted or used on multiple servers at once.
• Extremely resilient to failure and the data is far more secure because the storage appliances offer services such as encryption in transit and encryption at rest.
• Involves less disk management and maintenance.
• File Storage is mounted to compute nodes via an ethernet network.
• Tends to be slower than Direct Attached or block storage because it travels over an ethernet network.
• Allows for larger amounts of storage to be provisioned. It can be presented as a disk to a server.
• It tends to be used for workloads where consistently high network speeds are not a requirement.
• File storage is a good choice where file shares are required, where workloads do not require lightning-fast connectivity to storage, or where cost is a factor.
• Works well for organizing data in a hierarchical folder structure.
• It is less expensive than direct attached or block storage.
• Input/Output operations per second (IOPS) – refers to the speed at which the disks can write and read data (not the speed of the network between storage and the compute node). The higher the IOPS value, the faster the speed of the underlying disk. A higher IOPS will also normally cost more. Understanding IOPS is important because if the IOPS value is too low for your application, the storage can become a bottleneck and cause your application to run slowly.
Disadvantage of File Storage
• Consistent speed cannot be guaranteed. One of the issues with ethernet networks is their speed can vary – the more loaded an ethernet network is, the more likely the speed and bandwidth will be affected.

Module 5: Cloud Computing Storage and Content Delivery Networks

Block Storage

Block Storage Details

Block Storage
• Block storage breaks files into chunks (or blocks) of data and stores each block separately under a unique address.
• Suitable for databases and other applications where disk speed is important.
• Normally mounted onto only one compute node at a time. Since these disks run at a consistent high speed, they are perfect for workloads that need consistently fast storage (e.g., databases and mail servers). Perfect for workloads that need low-latency storage to work effectively.
• Presented to compute nodes using high-speed fiber connections, meaning read/write speeds are faster and reliable.
• It is mounted as a volume to compute nodes using a dedicated network of fibers, through which signals move at the speed of light. The fiber optic networks are more expensive to build – one reason why block storage tends to have a higher price-point.
• Infinite in size to the end user. Great repository for all sorts of unstructured data types – videos, logs, backups, data from IoT, application binaries, and virtual machine images.
• Highly available and resilient and will often include data encryption at rest and in transit.
• Provisioned in 'volumes' which can then be mounted onto a compute node.
• Input/output operations per second (IOPS) – how quickly data can be read or written to the storage. A consideration when provisioning block storage.
• Persistent – will not be deleted and data are preserved and available.
Disadvantages of Block Storage
• Block storage is not suitable for workloads where there needs to be some level of disk sharing between compute nodes.
• Block storage is more expensive than the other types of storage.

Module 5: Cloud Computing Storage and Content Delivery Networks

Object Storage

Object Storage in Detail

Object Storage
• Accessed via an application program interface (API) – it is not attached to a compute node.
• Infinite in size to the end user. Great repository for all sorts of unstructured data types – videos, logs, backups, data from IoT, application binaries and virtual machine images (unstructured means not stored in in any kind of hierarchical folder or directory structure).
• Object storage uses buckets and objects are stored within these buckets in a structurally flat way. You can provision multiple buckets, however, you cannot place buckets within buckets.
• Customer consumes the storage needed and pays (per gigabyte) for what is consumed.
• Slowest in terms of read and write speeds.
• Used to store files that are static.
• The least expensive of the storage models.
Disadvantage of Object Storage
• Not suitable for running operating systems, nor applications such as databases or anything where the content of the files change.

Module 5: Cloud Computing Storage and Content Delivery Networks

Object Storage – Tiers and APIs

Object storage buckets also have storage “tiers” or “classes” associated with them, and these tiers are based on how frequently the data is accessed. A standard tier bucket is where you would store objects that are frequently accessed.

- Priced per gigabyte of storage used per month, plus includes some charges for data retrieval.
- Much cheaper than file or block storage.
- Slow in comparison to file and block storage.
- Can often create rules which allow the automatic “archiving” of objects to cheaper tiers when they are infrequently accessed.
- Many object storage providers have an S3 compatible API, which means developers can create code that will work with multiple vendors object storage solutions.
- Offers an effective backup and disaster recovery solution.

Content Delivery Networks

Content Delivery Networks (CDNs)

- A distributed server network that delivers temporarily stored, or cached, copies of website content to users based on the users' geographical location.
- A CDNs stores content in distributed locations and reduces the distance between website visitors and the website server.
- A service that accelerates internet content delivery. Its main benefit is that it makes websites faster.

Benefits of CDNs

- Better performance and user experience.
- Ease of use – increases websites speeds and file distribution.
- Cost efficiencies.
- Scalable and secure.
- Usage based pricing.

Module 5: Cloud Computing Storage and Content Delivery Networks

Module Summary

Cloud storage is available in four main types – direct attached, file, block, and object storage. These storage types differ in how they can be accessed, the capacity they offer, how much they cost, the types of data they are best suited to store, and their read-write speed.

- Direct attached (or local) storage is storage that is presented directly to a cloud-based server and is effectively either within the host server chassis or within the same rack.
- File storage is typically presented to compute nodes as a network file system (NFS), which means that the storage is connected to compute nodes over a standard ethernet network.
- Block storage is presented to compute nodes using high-speed fiber connections, typically provisioned in volumes, which are mounted onto a compute node.
- Object storage is accessed via an API and doesn't need an underlying compute node. Object storage offers infinite capacity as you can keep adding files to it and just pay for what you use. Compared to the other storage types, object storage is slowest in terms of read and write speeds.
- A content delivery network (CDN) is a distributed server network that accelerates internet content delivery by delivering temporarily stored or cached copies of website or media content to users based on their geographic location.

Module 5
Check Your Knowledge

Question 1.

Direct attached, file, block, and object are considered which one of the following?

A. Types of containers
B. Types of networks
C. Types of tiers
D. Types of cloud storage

Answer D. Direct attached, file, block and object are considered types of cloud storage.

Module 5
Check Your Knowledge

Question 2.

Which type of storage is also referred to network attached storage, network file storage, or simply NFS?

A. Direct attached
B. File
C. Block
D. Object

Answer B. File storage is also referred to Network Attached Storage, Network File Storage or simply NFS.

Module 5
Check Your Knowledge

Question 3.

Poor performance when data needs to be shared is considered a disadvantage of which of the following types of storage?

A. Direct attached
B. File
C. Block
D. Object

Answer A. Poor performance when data needs to be shared is considered a disadvantage of direct attached storage.

Module 5
Check Your Knowledge

Question 4.

Highly available and resilient and will often include data encryption at rest and in transit are characteristics attached to what type of storage?

A. Direct attached
B. Tape
C. Block
D. Object

Answer C. Characteristics of block storage include, highly available and resilient and will often include data encryption at rest and in transit.

Module 5
Check Your Knowledge

Question 5.

Which type of storage is accessed via an application program interface (API) and is not attached to a compute node?

A. Direct attached
B. File
C. Block
D. Object

Answer D. Object storage is accessed via an application program interface (API), and it is not attached to a compute node.

Module 5
Check Your Knowledge

Question 6.

Which one of the following describes a characteristic of object storage?

A. Provisioned in volumes which can then be mounted onto a compute node.
B. A great repository for all sorts of unstructured data types.
C. Storage is fast and normally used to store a server's operating system.
D. Involves less disk management and maintenance.

Answer B. A characteristic of object storage is that it is a great repository for all sorts of unstructured data types – videos, logs, backups, data from IoT, application binaries, and virtual machine images.

Module 5
Check Your Knowledge

Question 7.

Which one of the following describes a characteristic of direct attached storage?

A. Offers infinite capacity as you can keep adding files to it.
B. Is typically provisioned in volumes.
C. Is mounted to compute nodes via an ethernet network.
D. The operating system only last as long as the compute resource is attached to it.

Answer D. One of the characteristics of direct attached storage is that the operating system only lasts as long as the compute resource is attached to it. It is deleted after the virtual instance is terminated.

Module 5
Check Your Knowledge

Question 8.

What is the purpose of a content delivery network (CDN)?

A. To accelerate read and write speeds.
B. To protect content delivered over a network.
C. To make websites faster and more responsive.
D. To safeguard backup and disaster recovery.

.

Answer C. A content delivery network (CDN) makes websites faster and more responsive.

Module 5
Check Your Knowledge

Question 9.

What is the definition of a content delivery network?

Place your answer in the space below.

Answer: A content delivery network is a distributed server network that delivers temporarily stored, or cached, copies of website content to users based on the users' geographical location.

Module 5
Check Your Knowledge

Question 10.

How does a content delivery network reduce the distance between website visitors and the website server?

Place your answer in the space below.

Answer : A content delivery network stores content in geographically distributed locations (proxy servers and data centers) globally.

Module 6: Emergent Trends, Cloud-Native, DevOps, and Application Modernization Introduction and Objectives

In Module 6 of the Study Guide, the subject matter:

- Focuses on the emergent trends such as hybrid multicloud, microservices and serverless computing.
- Provides an overview of cloud-native applications.
- Highlights how DevOps addresses some of the complexities posed by the cloud.
- Provides insights into how organizations can modernize their applications for the cloud.

Lessons

- Introduction and Objectives
- Hybrid Multicloud
- Microservices
- Serverless Computing
- Cloud-Native Applications
- DevOps in the Cloud
- Application Modernization
- Module Summary
- Check Your Knowledge

Objectives

- Describe the emergent cloud trends such as hybrid multicloud, microservices and serverless computing.
- Explain how cloud-native application work.
- Explain how DevOps helps tackle some of the complexities posed by the cloud.
- Describe the benefits of application modernization and how organizations can modernize their applications.

Module 6: Emergent Trends, Cloud-Native, DevOps, and Application Modernization

Hybrid Multicloud

As a brief review, hybrid cloud is a computing environment that connects organizations, on-premises private cloud and third-party public cloud into a single infrastructure for running the organization's applications (gives access to a combination of public and private clouds).

Multicloud is a cloud adoption strategy that embraces a mix of cloud models from different service providers, public, private, and managed across infrastructure, platform, or software (gives the opportunity to choose from multiple providers).

Hybrid multicloud – leveraging the best of the cloud models and services across different providers where applications and workloads work seamlessly across multiple different cloud types. For example, hybrid multicloud would allow a customer to have an ERP service from one provider, a cloud database application from another, and a platform service from some other.

Main Benefit of Hybrid Multicloud

- Cloud scaling

Use Cases for Hybrid Cloud

- Cloud scaling, for example in the flower delivery industry, business need to be able to scale at a global level. Cloud scaling scales up in response to peak seasons/holiday in different global locations (EU and US) and then deprovision resources when no longer need.

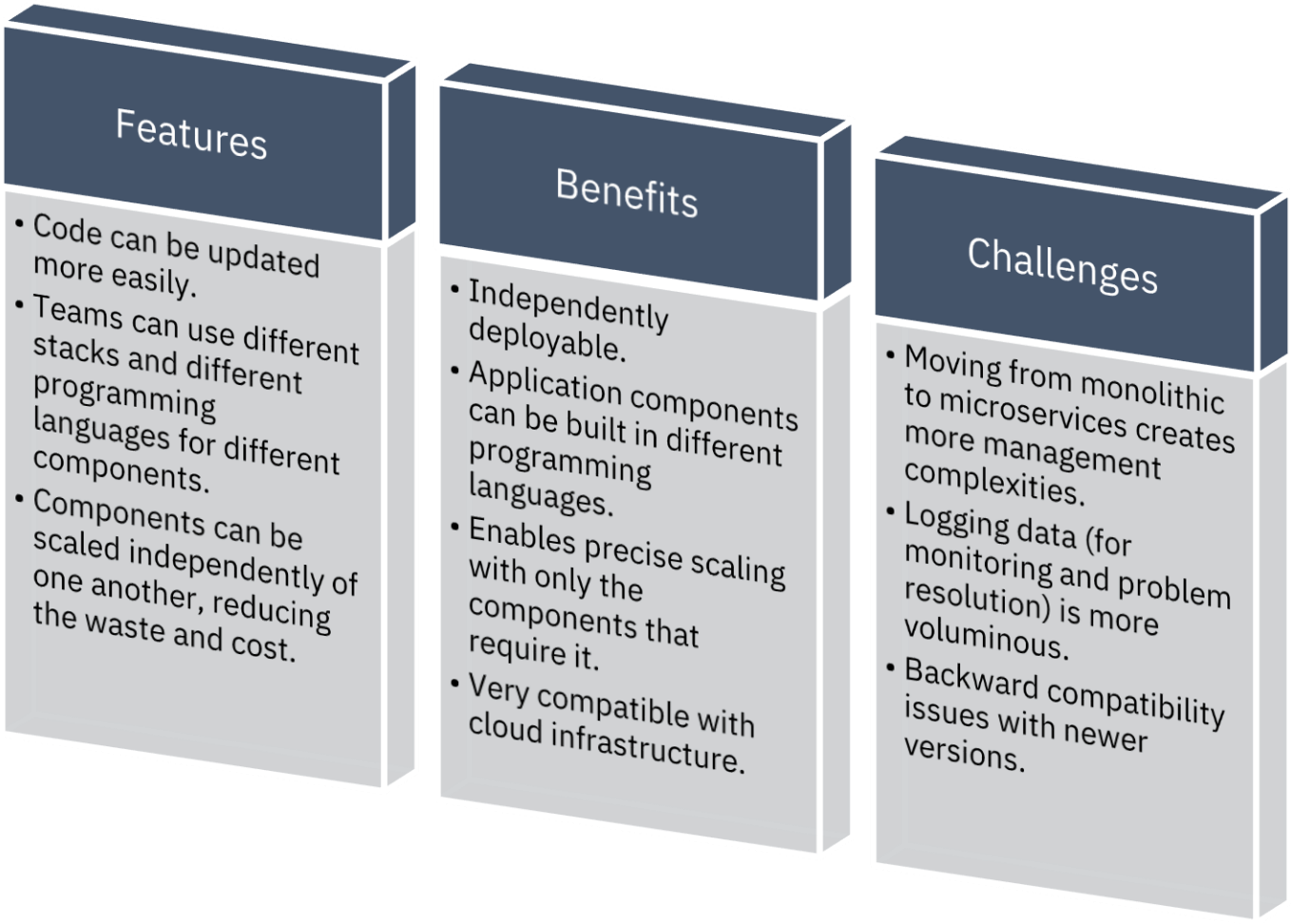
- Modernization in data and AI for the airline industry – cumbersome legacy reservation systems has led to the need to modernize. Development and use of a mobile app to book/rebook flights coupled with the use of predictive analytics to gain insights into historical data of when unplanned maintenance has happened and address potential unplanned maintenance incidents.

- Prevents being locked in with a specific vendor – being able to move workloads from one cloud platform to another as needs arise.

Module 6: Emergent Trends, Cloud-Native, DevOps, and Application Modernization

Microservices

Microservices architecture is an approach in which a single application is composed of many loosely coupled and independently deployable smaller components or services. These services typically have their own stack running on their own containers. They communicate with one another over a combination of APIs events streaming and message brokers for a business. Microservices break down large applications into their core functions (e.g., search recommendations, customer ratings, or product catalogs).



Introduction to the Cloud

Study Guide

Module 6: Emergent Trends, Cloud-Native, DevOps, and Application Modernization

Serverless Computing

Serverless is an approach to computing that offloads responsibility for common infrastructure management tasks such as scaling, scheduling, patching, and provisioning application stacks to cloud providers, allowing developers to focus their time and effort on the code and business logic specific to their applications or process. Serverless doesn't mean there are no servers; only that the management of the underlying physical or virtual servers is removed from their users.

Use Cases for Serverless Computing

- Data and event processing, microservices, and mobile backends.
- Inherent and automatic scaling, rapid provisioning, and a pricing model that does not charge for idle time.
- Working with structured text, audio, image and video data, and tasks such as data enrichment, transformation, validation and cleansing, PDF processing, audio normalization, thumbnail generation, and video transcoding.
- Well suited for working with all sorts of data stream ingestions, including business data steams, IoT sensor data, log data, and financial market data.

Serverless architecture computing services include IBM Cloud Functions (based on Apache OpenWhisk), AWS Lamb-da and Microsoft Azure Functions. IBM Cloud Functions is a polyglot (written in multiple programming languages), function-as-a-service (FaaS) programming platform for developing lightweight code that scalably executes on demand.

Benefits

- Requires no provisioning of servers, installation of application stacks and software, or operation of the infrastructure by the developer.
- Components facing too much load can be scaled independently, reducing waste and cost.
- Enables end user to only pay for services consumed and no idle time.
- Abstracts the infrastructure away from developers.

Characteristics

- Short-running stateless functions.
- Seasonal workloads with varying peaks and off-peaks.
- Production volumetrics data.
- Implementation differs around service providers, and capabilities vary including supported runtimes, authentication, scaling, and monitoring.

Challenges

- Designed to scale up and down in response to workloads – those requiring long-running processes – a traditional server may be better.
- Due to scaling of workloads – may have to start from zero to serve new request.
- Can be vendor dependent – potential for vendor lock-in.

Module 6: Emergent Trends, Cloud-Native, DevOps, and Application Modernization

Cloud-Native Applications

A cloud-native application is an application developed from the outset to work only in the cloud environment, or an existing app that has been refactored (restructured) and reconfigured with cloud-native principles.

A cloud-native application consists of microservices working together as a whole to comprise an application, yet each can be independently scaled and iterated through automation and orchestration processes. These microservices are often packaged in containers, which are executable units of software, in which the application code is packaged along with its libraries and dependencies so that it can be run from anywhere. This independence enables frequent, iterative improvement of cloud-native applications, without disrupting the experience of end users.

Cloud-native applications are unlike traditional or monolithic applications that are built out of one huge piece of software. These applications tightly couple the user interface, business-logic layer, and data layer. A monolithic application is described as a single-tiered software application in which the user interface and data access code are combined into a single program from a single platform.

Benefits of Cloud-Native Apps

- Agile and scalable.
- Accelerate innovation.
- Commoditization.

Whether creating a new cloud-native application or modernizing an existing application, developers adhere to a consistent set of development principles. They are as follows:

1. Follow the microservices architecture approach by breaking applications down to single-function microservices.
2. Rely on containers for maximum flexibility, scalability, and portability.
3. Adopt agile methods that speed the creation and improvement process through quick iterative updates based on user feedback.

Module 6: Emergent Trends, Cloud-Native, DevOps, and Application Modernization

DevOps on the Cloud

DevOps — a collaborative approach where business owners and the development, operations, and quality assurance teams collaborate to continuously deliver software.

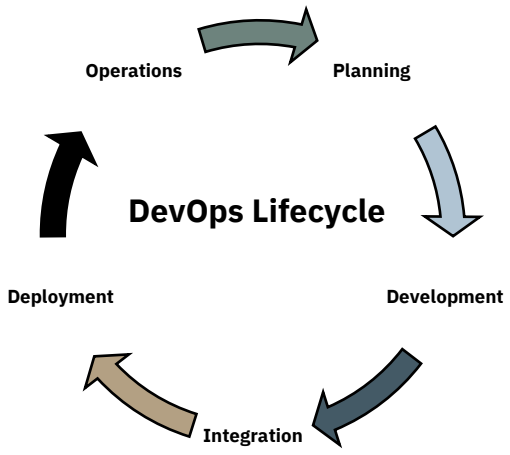
Development teams need to design, develop, deliver, and run software as reliably and efficiently as possible. Operations teams need to identify and resolve problems as soon as possible by monitoring, predicting failure, managing the environment, and fixing issues. Combining development and operations with the ability to monitor and analyze and optimize bottlenecks gives us DevOps.

Using the DevOps approach, developers can produce software in short iterations on a continuous delivery schedule of new features and bug fixes in rapid cycles allowing businesses to seize market opportunities and reduce time to include customer feedback in their products.

DevOps Lifecycle (Delivery Pipeline)

An automated sequence of steps that involves the stages of ideation, coding, building, deploying, managing, and continuous improvement, which loops back to the ideation phase in the delivery pipeline.

- **Planning (or Ideation)** – teams scope out new features and functionality for the release.
- **Development** – programming step where developers test, code, and build new features.
- **Integration** (continuous integration) – or build.
- **Deployment** (continuous deployment) – build output is deployed.
    - Continuous monitoring – using tools that help developers understand the performance and availability of their applications, even before being deployed to production.
- **Operations** – features are delivered to a production environment.
- **Continuous Feedback (or Learning)** – feedback is gathered through end users regarding features and functionalities.



Module 6: Emergent Trends, Cloud-Native, DevOps and Application Modernization

Application Modernization

Application modernization is often described as updating or improving legacy applications, their architecture, and the methods for developing them by using new technologies and modern methods for implementing them.

Legacy applications are also often monolithic applications. Monolithic applications have two characteristics that make it desirable to modernize them: they are difficult to update, and they are difficult and expensive to scale.

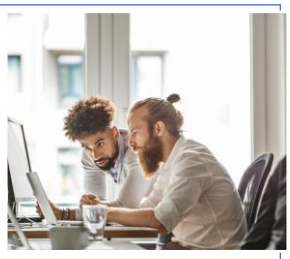
Benefits of Application Modernization

- Accelerate digital transformation.
- Take advantage of new technologies and services (containers, microservices, Function-as-a-Service, DevOps).
- More responsive to customer needs and changing market dynamics.

Challenges With Application Modernization

- Cost
- Complexity

Microservice Architectures



DevOps

Cloud Migration

Common Goals of Application Modernization Initiatives

- Microservices architecture – splits applications into multiple services that perform more granular functions and are part of the application as a whole. Each of the microservices will have a different logical function for an application.
- DevOps – helps in application modernization by supporting developers in building, deploying, running, and monitoring the applications associated with infrastructure and architecture and/or its features.
- Cloud migration – migrating to the cloud helps organizations that are running traditional applications transition to a cloud environment.

Module 6: Emergent Trends, Cloud-Native, DevOps and Application Modernization Module Summary

- Hybrid multicloud is a cloud adoption strategy that makes it possible for public clouds, private clouds, and on-premises IT to interoperate seamlessly while leveraging the best cloud-based services from different public cloud providers.
- Microservices architecture is an approach in which an application is built as a collection of loosely coupled, and independently deployable components or services, leading to efficient development, maintenance, and upgradation cycles.
- Serverless computing is an approach to computing that offloads responsibility for common infrastructure management tasks for application runtimes to cloud providers, allowing developers to focus their time and effort on development and testing, and not have to worry about provisioning, maintaining, and scaling compute resources.
- Cloud-native applications are applications that are built or refactored to work in the cloud environment. These applications, developed using DevOps methodologies, consist of microservices packaged in containers that can run in any environment — making it possible to create and update features in quick iterative cycles.
- DevOps is a collaborative approach that enables development and operations teams to continuously deliver software in quick, iterative cycles while reducing overhead, duplication, and rework. DevOps' tools, practices, and processes help tackle the complexities and challenges posed by the cloud, allowing solutions to be delivered and updated quickly and reliably.
- Application modernization helps organizations accelerate their digital transformation, take advantage of new technologies and services, and become more responsive to changing market dynamics. Cloud computing is one of the key enablers of application modernization.

Module 6
Check Your Knowledge

Question 1.

Which of the following describes the type of cloud that leverages the best of the cloud models and services across different providers and where applications and workloads work seamlessly across multiple different cloud types?

A. Private cloud
B. Hybrid cloud
C. Public cloud
D. Hybrid multicloud

Answer D. A hybrid multicloud describes the type of cloud that leverages the best of the cloud models and services across different providers where applications and workloads work seamlessly across multiple different cloud types.

Module 6
Check Your Knowledge

Question 2.

Which of the following is described as an approach in which a single application is composed of many loosely coupled and independently deployable smaller components or services?

A. Application modernization
B. Hybrid multicloud
C. Microservices architecture
D. Virtualization

Answer C. Microservices architecture is an approach in which a single application is composed of many loosely coupled and independently deployable smaller components or services.

Module 6
Check Your Knowledge

Question 3.

What are three key features of microservices?

List your answers in the space provided below.

Answers: Key features of microservices include: Code can be updated more easily. Teams can use different stacks and different programming languages for different components. Components can be scaled independently of one another, reducing the waste and cost.

Module 6
Check Your Knowledge

Question 4.

IBM Cloud Functions is a Function-as-a-Service (FaaS) programming platform used for developing lightweight code that scalably executes on demand. What open source serverless platform is it based on?

A. Microsoft Azure
B. AWS Lamb-da
C. Terraform
D. Apache OpenWhisk

Answer D. IBM Cloud Functions is based on the Apache OpenWhisk open-source serverless platform.

Module 6
Check Your Knowledge

Question 5.

Which of the following best describes serverless computing?

A. Serverless computing means there are no physical servers utilized.
B. Serverless computing is a cloud computing execution model that provisions computing resources on demand and offloads all responsibility for common infrastructure management tasks to a cloud provider.
C. Serverless is an approach to computing that offloads responsibility for common infrastructure management tasks such as scaling, scheduling, patching, and provisioning to a company's IT team.
D. Serverless computing is a model where the existence of servers becomes abstracted and without function.

Answer B. Serverless computing is a cloud computing execution model that provisions computing resources on demand and offloads all responsibility for common infrastructure management tasks.

Module 6
Check Your Knowledge

Question 6.

Fill in the Blank:
A cloud-native application consists of _____ working together as a whole to comprise an application, yet each can be independently scaled and iterated through automation and orchestration processes.

A. Microservices
B. Developers
C. Providers
D. Services

Answer A. A cloud-native application consists of microservices working together as a whole to comprise an application, yet each can be independently scaled and iterated through automation and orchestration processes.

Module 6
Check Your Knowledge

Question 7.

Which of the following best describes a single-tiered software application in which the user interface and data access code are combined into a single program from a single platform?

A. Microservice
B. Container
C. Monolithic
D. Program

Answer C. A monolithic application describes a single-tiered software application in which the user interface and data access code are combined into a single program from a single platform.

Module 6
Check Your Knowledge

Question 8.

Which of the following is considered a collaborative approach where business owners and the development, operations, and quality assurance teams collaborate to continuously deliver software.

A. Collaboration
B. DevOps
C. Modernization
D. Teamwork

Answer B. DevOps is considered a collaborative approach where business owners and the development, operations, and quality assurance teams collaborate to continuously deliver software.

Module 6
Check Your Knowledge

Question 9.

Which of the following terms is often described as updating or improving legacy applications, their architecture, and the methods for developing them by using new technologies and modern methods for implementing them?

A. Application modernization
B. Microservices architecture
C. Software-as-a-Service
D. Application infrastructure

Answer A. Application modernization is often described as updating or improving legacy applications, their architecture, and the methods for developing them by using new technologies and modern methods for implementing them.

Module 6
Check Your Knowledge

Question 10.

Which of the following include the common goals of application modernization? Select all that apply.

A. Microservices architecture
B. DevOps
C. Cloud migration
D. Portability

Answers A, B, and C. Microservices architecture, DevOps, and Cloud migration are three common goals of application modernization.

Acronyms

Acronym	Acronym Expansion
AA	American Airlines
ACL	Access Control List
AI	Artificial Intelligence
API	Application Programming Interface
AWS	Amazon Web Services
AZ	Availability Zone
BPM	Business Process Management
CDN	Content Delivery Network
CPU	Central Processing Unit
CRM	Customer Relationship Management
CX	Crunch Base – personal cloud computing and productivity platform
CX	Customer Experience
DevOps	DevOps is a set of practices that combines software development (Dev) and IT operations (Ops)
ERP	Enterprise Resource Planning
FaaS	Function-as-a-Service
G Suite	Google Suite of products
GCP	Google Cloud Platform
HPC	High-Performance Computing
HCM	Human Capital Management
HR	Human Resources
I/O	Input/Output
IaaS	Infrastructure-as-a-Service
IDC	International Data Corporation

Acronyms

Acronym	Acronym Expansion
MDM	Master Data Management
NFS	Network File Storage / Network File System
NICs	Network Interface Controllers
NIST	National Institute of Standards and Technology (US)
OS	Operating System
PaaS	Platform-as-a-Service
POP	Point of Presence
RAID	Redundant Array of Independent Disks
RAM	Random Access Memory
S3	Simple Storage Service
SAP	System Analysis Program Development
SaaS	Software-as-a-Service
SCM	Supply Chain Management
SDN	Software Defined Network
SIP	SaaS Integration Platform
UI	User Interface
VLAN	Virtual Area Local Network
VM	Virtual Machine
VPC	Virtual Private Cloud
VSI	Virtual Server Instances