## LESSON: Serverless Computing and Containerization

## Primer This is the beginning of the Cloud Course (2 of 2), and instructors should ensure they practice the labs, especially the ECS Fargate Container Creation (Lab 2) prior to teaching this course.

## For this lesson and upcoming lessons, instructors are required to ensure the following activities are completed for each lesson

* Check-in with the students to see if they have any questions or need further clarification from any subject from the last class and self-study module.
* Review the “Lesson Opener” and “Real World Scenario” with the learners prior to starting the module.
* Throughout the module, you will find “Consider the Real World Scenario” slides. Review the questions found on these slides, tie the concepts back to the scenario discussed at the start of the lesson as well as content you are presenting, and encourage the learners to share their thoughts.
* For each lesson, you will find a “Pulse Check” slide which is the opportunity for instructors to open a poll to gather feedback from the learners. Leave the poll open for about 1 minute and after you close the poll, share the results with the learners. Encourage the learners to share their thoughts. This information will help the instructors as well as the learners better understand where they are with regards to the lesson.
* Labs are to be demonstrated live for each module. The demonstration and student engagements of the labs are the top priority for the lead instructor. While demonstrating each lab, encourage students to participate and explore.
* At the end of each lesson, it is important to take a few minutes to review the key concepts for the lesson, provide guidance on what the learners can do to prepare for the next lesson, and wrap up with Q&A.

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### Summary

In this lesson, learners will discover the offerings of AWS, catering to both traditional and modern IT needs. They will uncover the power of serverless computing, which allows for the running of applications without the complexities of server management and provisioning. Serverless computing's auto-scaling capability will be a focal point, highlighting its potential to streamline operations and reduce costs. The lesson will emphasize the ease of hosting on S3, a pay-as-you-go model that eliminates server management, offering cost-effective and straightforward solutions.

Additionally, learners will explore the world of cloud automation, gaining insights into provisioning, data backup, configuration, and infrastructure cleanup, all achievable without manual intervention. Furthermore, they will discover the advantages of automation, such as cost reduction, simplified operations, rapid deployment, enhanced resilience, and reduced risk of errors. The lesson will introduce various tools like AWS Cloud Formation, Azure Automation, Google Cloud Composer, Terraform, and Kubernetes, which assist in automation and orchestration.

Learners will also differentiate between containers and VMs, understanding their fundamental distinctions and the resource-efficient nature of containers running on the host’s OS. They will explore container services provided by cloud service providers, with a spotlight on AWS's Elastic Container Service (ECS) as a prominent choice. The lesson will culminate in an exploration of the Fargate container setup, including the step-by-step process of cluster formation, container selection, service definition, cluster configuration, and review before initiation.

### Objectives

* Define serverless computing.
* Analyze the benefits and drawbacks of serverless computing.
* Identify the different use cases for serverless computing.
* Explain the importance of Amazon Simple Storage Service (S3) for serverless hosting.
* Illustrate how to host an SPA on S3.
* Explain the concept, use cases, and advantages of automation in the cloud.
* Define cloud orchestration.
* Identify different cloud automation and orchestration tools.
* Define containers.
* Compare and contrast containers and virtual machines.
* Explain container management with a focus on AWS.
* Set up a container using Fargate.

### Lesson Activities and Teaching Strategies

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| Estimated Time | Lesson Portion | Directions |
| 2 min | **Lesson Opener:**  Serverless Computing and Containerization | * Introduce learners to the importance of serverless computing and containerization​ in cybersecurity. |
| 5 min | **Real World Scenario:**  Serverless Computing and Containerization | * Review the real world scenario challenge and inform learners that you will be constantly coming back to this scenario throughout the lesson to discover how to solve and apply concepts to this real situation. |
| 2 min | **Lesson Companion Review:**  Serverless Computing and Containerization | * Review the lesson companion, and inform learners that you will be constantly coming back to this scenario throughout the lesson to discover how to solve and apply concepts to this real situation. |
| 20 min | **Cyber Uncovered:**  Serverless Computing​ | * Begin by introducing the concept of serverless computing, emphasizing that it's a computational model in which hardware resources are allocated on-demand by the cloud service provider (CSP). * Mention that this model aims to improve efficiency by only using resources when the application is running. * Discuss the benefits of serverless computing, including cost savings due to charges only being applied for consumed resources, scalability handled by the cloud provider, efficiency in deploying and updating applications, and simplicity for developers who don't need to worry about OS maintenance. * Explore the drawbacks of serverless computing, focusing on complex monitoring issues with traditional tools, built-in limitations like maximum execution times, and challenges related to state management. * Move on to serverless computing use cases, explaining how it's suitable for APIs and microservices triggered by HTTP requests, IoT devices for processing triggered events, data processing on demand, like file uploads or database inserts, and hosting static websites or single-page applications (SPAs). * Dive into serverless computing with AWS, mentioning specific implementation options provided by AWS: S3 buckets for deploying single-page websites, ecsFargate for scalable container deployment without dedicated servers, and Lambda as AWS' function as a service (FaaS) for event-driven execution. * Transition to the practical exercise on estimating serverless computing costs. Instruct students to navigate to https://chat.openai.com/ and log in. Guide them through the process of asking ChatGPT to estimate the cost of using S3 to host a static website. Provide relevant details, such as website size, region, daily visitors, and the S3 tier used. Encourage students to compare the estimated cost to average hosting costs. * Highlight that the AI might make different assumptions during the calculation and students can instruct it to adjust those or start a new conversation to see how the price changes. * Be prepared to discuss the implication of the real world scenario presented at the beginning of class on serverless computing. There are specific prompts that you should ask learners to reflect on to apply this concept to the real world scenario. |
| 5 | **Real World Scenario:**  Serverless Cloud Computing | * Review the lesson companion, and inform learners that you will be constantly coming back to this scenario throughout the lesson to discover how to solve and apply concepts to this real situation. |
| **5 min Break** | | |
| 20 min | **Cyber Uncovered:**  Use Case: Serverless Site Hosting | * Start the lesson by introducing the concept of serverless hosting, emphasizing its suitability for static websites and single-page applications (SPAs). * Clarify that SPAs can have dynamic functionality using JavaScript. * Transition to the importance of Amazon Simple Storage Service (S3) in serverless hosting. Explain that S3 is a popular storage service offered by AWS designed for scalability, high availability, and low latency. * Describe how S3 stores data as objects within buckets, each with data, metadata, and a unique identifier. * Highlight the reasons for choosing S3 for hosting, including its cost-effectiveness by not requiring server management, its ability to handle varying levels of traffic, and its design for availability and durability. * Dive into the practical process of hosting an SPA using S3. * Begin with Part 1: S3 Bucket Creation. Instruct students to locate the AWS console search bar, search for "S3," and guide them to select the appropriate service and find the "Create Bucket" option. * Emphasize the need for unique lowercase names and region selection while discouraging the Block Public Access option. * Continue to Part 2: SPA Page Upload. * Explain how students can access the created bucket, click the Upload button, and import files using the "Add Files" button. * Emphasize the importance of saving changes to the bucket and introduce the concept of objects in S3 buckets. * Progress to Part 3: Accessing the SPA. * Instruct students to access the SPA by selecting the bucket via the main S3 page and to open the uploaded file in a new tab. * Move to Part 4: Providing Public Access. * Explain the process of allowing public access to the SPA by generating a presigned URL. * Guide students to click the file name in the S3 bucket, select "Object actions," choose "Share with a presigned URL," set a time interval, and create and copy the presigned URL for access. * Conclude the lesson with an interactive SPA hosting demonstration. * Encourage students to follow along as you demonstrate the steps for hosting a site using S3. * Be prepared to discuss the implication of the real world scenario presented at the beginning of class on Serverless Computing Hosting. There are specific prompts that you should ask learners to reflect on to apply this concept to the real world scenario. |
| 5 | **Real World Scenario:**  Serverless Hosting Site | * Review the lesson companion, and inform learners that you will be constantly coming back to this scenario throughout the lesson to discover how to solve and apply concepts to this real situation. |
| 20 min | **Lab:**  Serverless SPA | * Remind learners to use this lab to practice and apply the concepts they have learned throughout the day. * Learners will receive direct feedback on their lab to properly assess their knowledge and determine where they might need additional assistance. * Use incognito mode or In-Private browsing to illustrate that the pre-signed URL you use generated in the lab can be accessible anywhere else. |
| **5 min Break** | | |
| 20 min | **Cyber Uncovered:**  Automation and Orchestration​ | * Start the lesson by introducing the concept of automation in the cloud. * Explain that it involves the automatic creation and management of cloud resources, processes, and tasks without manual intervention. * Mention some examples, such as launching servers, data backup, and configuration. * Move on to discuss the various automated tasks in cloud computing. * Present the tasks along with explanations to ensure students understand their significance in cloud operations. Tasks include auto-provisioning VMs, backup, auto-configuration, and cleanup of retired infrastructure. * Highlight the benefits of automation in the cloud. * Emphasize the advantages, including lower operating costs, simplified operations, faster deployment, resilience, and a reduced risk of errors. Provide real world scenarios in which these benefits can be realized. * Introduce the concept of cloud orchestration. * Explain that it involves managing multiple automated tasks and coordinating complex cloud services and resources. * Describe how orchestration allows for quick adaptation of the cloud environment based on workload demands. * Use an orchestration example to illustrate the concept. Walk students through a scenario in which a spike in traffic overloads servers, leading to the allocation, configuration, and deployment of new VMs to resolve the issue. * Emphasize the role of orchestration in efficiently managing such situations. * Transition to automation and orchestration tools available to cloud professionals. * Mention that most cloud service providers offer built-in tools, but there are also third-party systems for cloud orchestration. List some of these tools, including AWS CloudFormation, Azure Automation, Google Cloud Composer, Terraform, and Kubernetes. * Dive deeper into each tool, reviewing them one by one. * Provide a brief overview of their capabilities, use cases, and compatibility with different cloud environments. Include AWS CloudFormation, Azure Automation, Google Cloud Composer, Terraform, and Kubernetes. * Be prepared to discuss the implication of the real world scenario presented at the beginning of class on network types and devices. There are specific prompts that you should ask learners to reflect on to apply this concept to the real world scenario. |
| 5 | **Real World Scenario:**  Automation and Orchestration | * Review the lesson companion, and inform learners that you will be constantly coming back to this scenario throughout the lesson to discover how to solve and apply concepts to this real situation. |
| 5 | **Pulse Check** | * Before you launch the pulse check, explain each section clearly, and encourage the learners to participate in the survey. * After administering the survey, share the poll results with learners and ask learners to provide feedback * Encourage learners to attend office hours with the associate instructor. |
| **5 min Break** | | |
| 20 min | **Cyber Uncovered:**  Containerization​ | * Begin the lesson by introducing the concept of containers. * Explain that containers are packages containing operating system kernels, software, and application code required to run applications. * Emphasize that containers allow for deploying applications with all their dependencies, reducing the need to set up applications in new environments. * Compare containers to virtual machines (VMs). * Highlight key differences between containers and VMs, such as their resource efficiency, isolation, and initialization speed. * Use the provided table to clearly illustrate these differences. * Explore the history of containerization. * Discuss the significant milestones in container technology development, including the introduction of cgroups by Google, the Linux Containers (LXC) project, and the emergence of Docker as a popular open-source project for managing application containers. * Describe how containers are managed. * Explain that containers are typically managed by a container engine running on the host’s OS. * Emphasize that containers use the host OS kernel, making them more efficient than VMs. * Discuss the limitations of containers. * Highlight that containers are limited by the host OS kernel, which can affect compatibility, and that containers do not save changes by default, potentially leading to data loss if not configured correctly. * Transition to containers in the cloud. * Explain that containers are available in popular cloud service providers (CSPs) and are scalable, allowing companies to easily deploy additional containers. * Mention that each CSP provides its container service, which is mostly similar from a configuration perspective. * Introduce AWS Elastic Container Service (ECS). * Explain that ECS is AWS' container management service used for deploying and managing Docker containers. * Mention the concept of clusters in ECS. * Describe AWS Fargate. * Explain how Fargate simplifies container management by removing the need for users to manually set up virtual environments. * Contrast it with the traditional approach of running containers on EC2 instances. * Break down the process into manageable steps, including creating and configuring a task definition, creating and configuring a new Fargate cluster, creating and configuring a new service, creating and configuring a security group, and reviewing the deployed container. * Mention that this will be a hands-on demonstration in the lesson. * Provide guidance on using the AWS console to perform each step. * Be prepared to discuss the implication of the real world scenario presented at the beginning of class on network types and devices. There are specific prompts that you should ask learners to reflect on to apply this concept to the real world scenario. |
| 5 | **Real World Scenario:**  Containerization | * Review the lesson companion, and inform learners that you will be constantly coming back to this scenario throughout the lesson to discover how to solve and apply concepts to this real situation. |
| 20 min | **Lab:**  Containerization | * Remind learners to use this lab to practice and apply the concepts they have learned throughout the day. * Learners will receive direct feedback on their lab to properly assess their knowledge and determine where they might need additional assistance.   + Provide the key takeaway for the serverless computing, cost benefits, use cases such as APIs, micro services, S3 buckets, etc.   + Provide a summary of Serverless Site Hosting using S3 bucket, Pre-Signed URLs for public static/dynamic contents   + Highlight the advantages of using S3 for hosting, and deployment of S3 buckets   + Provide the summary and takeaway for automation and orchestration, its benefits, and tools such as AWS CloudFormation, Azure automation, and Terraform   + Highlight the benefits of Containerization, and the difference between a container and virtual machines   + Provide the takeaway of AWS ECS Cluster, and Fargate |
| 5 | **Lesson Closure** | * Encourage learners to read ahead of time * Provide learners additional resources to read / practice and assign homework (e.g., future labs) before you demonstrate the labs during the next class * Spend some time to highlight what are the key takeaways from today’s lesson * Important topics covered during the class includes   + Definition of Serverless Computing and provide examples to remind the students of the benefits and various services APIs, microservices, SPAs, etc.   + Provide the summary of SPA use cases such as using S3 bucket deployment of single page application |
|  | **Add Additional Time Filler** | * Review using Kahoot or other similar platforms * Conduct interview preparation conversations * Continue discussions on real-world scenarios * Demonstrate how to create users in Linux and grant them permissions * Discuss different career paths in cybersecurity and highlight the roles that require Linux skills |

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