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SKU: 9780357114254-SOLUTIONS

Module 1
Introduction to Cloud Computing

Scenario-Based Practice Questions

Question 1-1

Raul works for a small consulting firm that assists medical organizations, such as quick care facilities, and health professionals, such as doctors' offices or alternative care providers, to establish, update, and manage their IT systems. He regularly works with patient databases and must ensure that his clients' networks and other IT resources comply with strict government regulations. Raul's boss, Cheri, recently asked him to assist in upgrading their firm's data center. The CEO has decided they need to take a major step toward a more cloud-centric business model and asked Raul how the company can ensure that their cloud provider meets industry standard requirements for data security, service availability, and confidentiality. Which standard should Raul recommend they use to compare security ratings of various CSPs?

A. PCI DSS

B. HIPAA

C. GDPR

D. SSAE 18

- **Answer:** D. SSAE 18.
- **Explanation:** The SOC 2 and SOC 3 reports both address benchmarks for information security, availability, processing integrity, confidentiality, and privacy.

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Question 1-2

Raul's company has narrowed their options to a small handful of CSPs. All of these CSPs offer a wide variety of cloud services and meet all of the company's security requirements. Cheri, Raul's boss, is now asking him to recommend what type of cloud services would best fit their needs. She explains they want to start with cloud-based email and an office productivity suite that enables easy file sharing among team members. Which cloud service model should Raul recommend they use to accomplish these goals?

A. SaaS

B. IaaS

C. RaaS

D. PaaS

- **Answer:** A. SaaS
- **Explanation:** Email, office productivity apps, and file sharing are all services offered by SaaS products.

Question 1-3

Anika has run into a problem with the VPN connection to her company's cloud-hosted database. She has a good Internet connection and can access her work email account, which uses the same sign-in credentials as the VPN. But she still can't pull reports from the database service. She calls Patrick, who works for the company's help desk. As Anika describes the problem to Patrick, he tells her to try again and make sure she's using the right password, then to restart her router, and if that still doesn't fix it, to restart her computer. Which troubleshooting step did Patrick fail to complete in the correct order?

A. Test the theory to determine cause

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B. Document findings, actions, and outcomes

C. Establish a plan of action and implement the solution

D. Establish a theory of probable cause

- **Answer:** D. Establish a theory of probable cause
- **Explanation:** Patrick tried several haphazard possible solutions that were unrelated and disorganized without considering what the probable cause of the problem might be.

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Video Questions

Video 1-1: Yellow Circle Cloud Console

What's the best way to access the Yellow Circle cloud console?

a. RDP (Remote Desktop Protocol)

b. Command Prompt

c. Browser

d. SSH (Secure Shell)

- **Answer:** C

Video 1-2: AWS Cloud Console

Which AWS service is used to manage VM instances?

a. Billing Dashboard

b. EC2

c. VPC

d. Management console

- **Answer:** B

Video 1-3: Azure Cloud Portal

Which feature in Azure is used to track expenses?

a. Subscriptions

b. Resource groups

c. Blades

d. Notifications

- **Answer:** A

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Video 1-4: GCP Cloud Console

What feature in GCP is used to organize resources?

a. Resource groups

b. Dashboards

c. Cards

d. Projects

- **Answer:** D

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Hands-On Projects

Project 1-1: Cloud Computing Certifications

Est. completion time: 15 minutes

This course prepares you to take the CompTIA Cloud+ CV0-002 exam, which is a vendor-neutral exam covering a broad array of foundational and intermediate cloud computing concepts within the context of an organization's entire IT system. Other cloud certifications are offered mostly by cloud vendors, including AWS, Google, VMware, OpenStack, Cisco, Microsoft, and IBM. Other vendor-neutral certifications are offered by Cloud Security Alliance (CSA) and Cloud Credential Council (CCC). Use the web to research and answer the following questions:

1. What are the five domains of objectives for the Cloud+ exam?
   - **Answer:** Configurations & Deployment, Security, Management, Maintenance, and Troubleshooting
   - **Source:** https://certification.comptia.org/certifications/cloud
2. What kind of experience does CompTIA recommend you have before taking the Cloud+ exam?
   - **Answer:** 2–3 years in system administration
   - **Source:** https://certification.comptia.org/certifications/cloud
3. What are the four domains of the AWS Cloud Practitioner certification?
   - **Answer:** Cloud Concepts, Security, Technology, and Billing & Pricing
   - **Source:** https://aws.amazon.com/certification/certified-cloud-practitioner/
4. What kind of experience does AWS recommend you have before taking the Cloud Practitioner exam?

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- **Answer:** 6 months experience with AWS Cloud in any role, and a basic understanding of IT services and their uses in the AWS Cloud platform

Source: https://aws.amazon.com/certification/certified-cloud-practitioner/

5. What are the five sections of the Associate Cloud Engineer certification by Google?
   - **Answer:**
     - Set up a cloud solution environment
     - Plan and configure a cloud solution
     - Deploy and implement a cloud solution
     - Ensure successful operation of a cloud solution
     - Configure access and security
   - **Source:** https://cloud.google.com/certification/cloud-engineer

Project 1-2: Get Started in Yellow Circle

Est. completion time: 15 minutes

Yellow Circle (*yellowcircle.net*) is a nonprofit cloud platform supported by many technology companies, such as Google and Microsoft, and designed solely for educational use. In addition to a free tier subscription, Yellow Circle offers several low-cost subscription options—which include increasingly larger maximums of virtual machines, memory, and storage, as well as more advanced features such as remote access, Internet access, and a public IP address.

The free tier provides sufficient resources to complete all Yellow Circle projects for this course. Working in Yellow Circle is simpler and more straightforward than working in a full-scale cloud platform. This will allow you to set up simple cloud resources quickly in each Yellow Circle project. While there aren't nearly as many resources available in

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Yellow Circle as compared to AWS, Azure, or GCP, completing the Yellow Circle project first in each module will give you an on-ramp to learning more sophisticated cloud computing skills in the AWS, Azure, and GCP projects.

Caution

Yellow Circle is not in any way intended to be used in a production environment and so does not provide any level of guaranteed uptime. It's not unusual for one or more features or even the entire website to become unavailable for various lengths of time. For example, at the time of this writing, Yellow Circle became unavailable to new accounts due to maintenance that is expected to take a few weeks to complete. While Yellow Circle is a helpful tool for educational purposes, we recommend that you not rely solely on Yellow Circle for practice in using a cloud platform. Cengage has no direct affiliation with Yellow Circle, and we cannot ensure its availability throughout your course.

To create a free Yellow Circle account, complete the following steps:

1. Go to the website at **yellowcircle.net** and look around. Which operating systems does Yellow Circle include for virtual machines?
   - **Answer:** Fedora, Ubuntu, FreeBSD, Windows, CentOS, openSUSE, and Debian
2. Sign up for the free account. Save your username and password in a safe place (a password manager such as LastPass at *lastpass.com* or KeePass at *keepass.info* is a great tool for this purpose).

Note

Yellow Circle is an educational platform only. For this reason, all running instances are shut down on Fridays.

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Also, if you don't sign in to your Yellow Circle account at least weekly, it will notify you via email and then delete the account automatically for inactivity. When you're ready to use Yellow Circle again, sign in using the same account credentials as before and create a new, free subscription.

3. To sign into the platform, go to **mylab.yellowcircle.net** and enter your username and password. What limits are listed in your account overview?
   - **Answer:** The limits for a free account are 2 instances, 2 vCPUs, 2,048 RAM, 0 floating IPs, 10 security groups, 5 volumes, and 5 storage volumes.
4. Take a few minutes to look through the Yellow Circle platform. You'll create resources in later projects. Sign out of your account when you're finished.

Project 1–3: Create an Account with AWS

Est. completion time: 20 minutes (possible delay while waiting for AWS application approval)

Note

Public cloud platforms and related account options change frequently. While the instructions given here were accurate at the time of writing, you might need to adjust the steps or options according to later changes.

AWS offers multiple options for accessing free resources for various purposes. The account itself is always free. While a typical AWS account or a standard AWS Educate account requires a credit card (even if you don't accrue charges), you do have another option. Specifically, the AWS Educate Starter Account (ESA), which is grant funded and provided by a third party, does not require a credit card. Following are the three different types of accounts:

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- ***AWS account.*** This is a standard account type open to the public. It requires a credit card and allows full access to standard AWS services.
- ***AWS Educate account.*** This account type is available to educators and students (older than age 14) from accredited educational institutions and requires a credit card. Use a school-issued email account or, if necessary, provide proof of enrollment (such as student ID card) instead.
- ***AWS Educate Starter account (ESA).*** This account type is available to educators and students (older than age 14) from accredited educational institutions, does *not* require a credit card, and has limited features. Use a school-issued email account or, if necessary, provide proof of enrollment (such as student ID card) instead.

Consider the account options shown in Table 1-2.

Table 1-2 AWS free account options

Type	Subscription	Benefits to Students	Payment Options	Notes
AWS account	Pay-as-you-go	• "12-months free" services • "Always free" services • Short-term free trials	Requires credit card	Use of services beyond the free tier offers is charged at standard, pay-as-you-go rates (free tier services will be sufficient for this course)
AWS Educate account	AWS Educate with institution membership	• $100 AWS credit* • Online labs • AWS Educate Student Portal • Access to free tier services	Requires credit card	Use of services beyond the free tier offers is charged at standard, pay-as-you-go rates (free tier services will be sufficient for this course)

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AWS Educate account	AWS Educate without institution membership	• $40 AWS credit* • Online labs • AWS Educate Student Portal • Access to free tier services	Requires credit card	Use of services beyond the free tier offers is charged at standard, pay-as-you-go rates (free tier services will be sufficient for this course)
AWS Educate Starter account (students only)	AWS Educate with institution membership	• $75 AWS credit* • Online labs • AWS Educate Student Portal	No credit card required	• Resource usage capped annually at AWS credit amount—account is terminated when credit is depleted • Can't continue to use account after graduation and can't upgrade account to pay-as-you-go • No access to free tier services • Some limitations on available services

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AWS Educate Starter account (students only)	AWS Educate without institution membership	• $30 AWS credit* • Online labs • AWS Educate Student Portal	No credit card required	• Resource usage capped annually at AWS credit amount—account is terminated when credit is depleted • Can't continue to use account after graduation and can't upgrade account to pay-as-you-go • No access to free tier services • Some limitations on available services

*AWS credit can be used only on eligible services. After creating your AWS account, watch for an email from AWS containing your credit code. To redeem the code, sign into your AWS console, click your name at the top of the screen, click **Billing & Cost Management**, and then click **Credits**. Enter the code and any additional information, and then click **Redeem**.

As shown in Table 1-2, AWS Educate offers many appealing benefits. If your institution is an AWS Educate member, you receive more AWS credits. If you don't have a credit card, you can use the AWS Educate Starter Account (ESA). However, your usage of AWS services is limited to the annual AWS credit amount. Once those credits run out each year, you can't use the account any longer until your AWS anniversary date when you can apply for a renewal.

If you can use a credit card to sign up for a regular AWS account, you'll receive more AWS credits, and you'll have access to the AWS free tier services. So long as you

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reliably shut down and delete the cloud resources you create for your projects, you should be able to complete all the AWS projects in this course without incurring any charges on your credit card.

Use Table 1-2 to determine the best account option for you. Check with your instructor if you need help making this decision. Complete the following steps to create your account.

<u>If you're creating a standard AWS account (*not* an AWS Educate Starter account):</u>

1. Go to **aws.amazon.com** and create an account. You'll need a credit card number.
2. Go to **aws.amazon.com/education/awseducate/** and apply to join AWS Educate using your existing AWS account ID (a 12-digit number). You'll need a school-issued email account, or you can submit proof of school enrollment.

<u>If you're creating an AWS Educate Starter account (you will *not* be using a credit card):</u>

1. Go to **aws.amazon.com/education/awseducate/** and apply to join AWS Educate.
2. When prompted, request an AWS Educate Starter account and *not* an AWS account. You'll need a school-issued email account, or you can submit proof of school enrollment.

After your application is approved, complete the following steps to explore the AWS console:

3. Go to **aws.amazon.com** and sign in. You'll begin at the AWS Management Console (see Figure 1-12).

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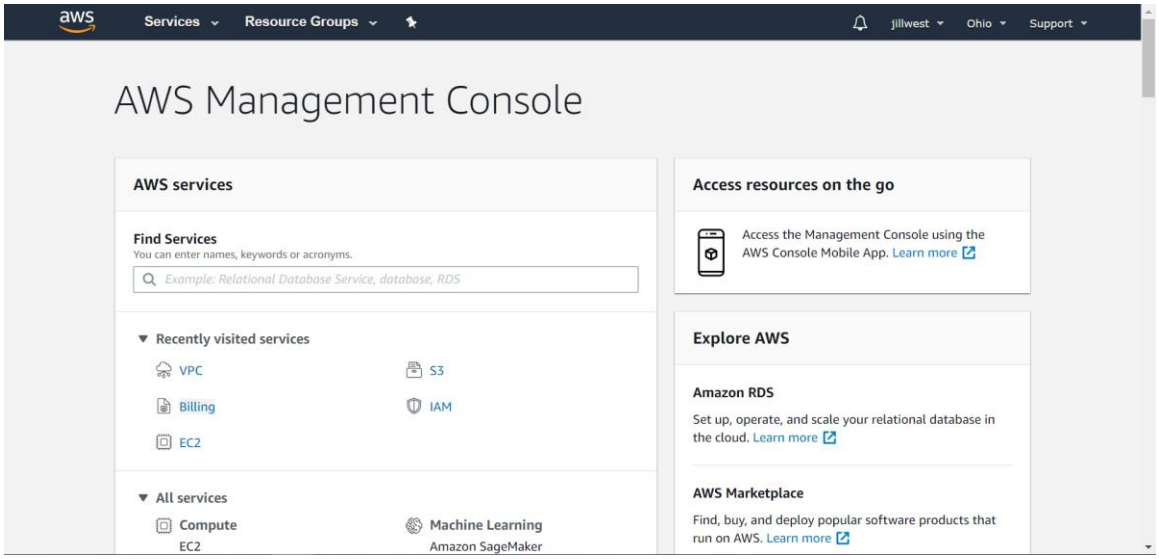

4. Spend a few minutes exploring the console. How many categories of services are listed?

   - **Answer:** At the time of this writing, there are 23 service categories.

5. Click a few services to see service-specific dashboards, such as the EC2 Dashboard.

6. Check your account information if you can (AWS ESAs do not allow much access to account information in the AWS console). What region is currently selected in your account?

   - **Answer:** Answers may vary. For AWS ESA accounts, the answer will be US East (N. Virginia).

Project 1-4: Create an Account with Azure

Est. completion time: 20 minutes

Note
Public cloud platforms and related account options change frequently. While the instructions given here were accurate at the time of writing, you might need to adjust the steps or options according to later changes.

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Microsoft Azure also offers free accounts, and some options provide special benefits for students and educators. To use Azure, you create a Microsoft account and then create one or more subscriptions within the account. If your school uses Office 365, you might already be able to authenticate to Azure using your existing Microsoft account. The three types of Azure subscriptions (there are others) most relevant to this course are as follows:

- ***Free trial subscription.*** This subscription is available to the public and requires a credit card. The credit expires after 30 days while the free trial services last for 12 months.

- ***Azure for Students subscription.*** This subscription is available to full-time faculty and students (older than age 18) in a STEM-related field at an accredited, degree-granting educational institution. Use a school-issued email account. You might also be able to generate an Azure for Students verification code through your school's Microsoft Azure Dev Tools for Teaching platform.

- ***Azure for Students Starter subscription.*** This subscription is available only to students (older than age 13) from accredited educational institutions. Use a school-issued email account. This subscription does not provide sufficient access to services to complete the projects in this course unless you upgrade to a "pay-as-you-go" subscription, which requires a credit card.

For choosing a subscription type, consider the details shown in Table 1-3.

Table 1-3 Azure free subscription options

Subscription Option	Benefits to Students	Payment Options	Notes
Free Trial	• $200 Azure credit for up to 30 days	Requires credit card and phone number	• Must upgrade to a "pay-as-you-go" subscription* after 30 days

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	• 12 months popular, free services • "Always free" services		to continue access to free services • It's very difficult to identify which services are free in Azure or to ensure that you're not accruing charges for even basic functions
Azure for Students	• $100 Azure credit for up to 12 months • 12 months popular, free services • "Always free" services • Downloadable software developer tools • Microsoft Learn (interactive tutorials)	No credit card required	With a credit card, can be upgraded to a "pay-as-you-go" subscription* after 12 months or credit depletion to continue access to services
Azure for Students Starter	• Very limited access to services† • Downloadable software developer tools	No credit card required	With a credit card, can be upgraded to a "pay-as-you-go" subscription* to access typical Azure services

*The pay-as-you-go subscription itself is free. Any services you use beyond the free offers will be charged to your credit card. You'll also be offered a technical support plan, starting at $29/month, which you can decline.

†The Azure for Students Starter subscription does not provide sufficient access to services to complete the projects in this course unless you upgrade to a "pay-as-you-go" subscription.

Caution

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The Azure for Students Starter subscription does not provide sufficient access to services to complete the projects in this course unless you upgrade to a "pay-as-you-go" subscription, which requires a credit card.

As shown in Table 1-3, Microsoft offers a generous amount of credit for the first 30 days of the free trial. A challenging disadvantage of the free trial is that, after 30 days, you must upgrade to a pay-as-you-go subscription without any remaining credits, and at that point, it can be difficult to identify which services are free and which are not. Azure doesn't mark the free services as clearly as AWS does. Those free services are only available for a year, at which point you're left with the "always free" services, which are fairly limited. Therefore, if you use Azure, carefully pay attention to resource configurations, run times, and charge accruals.

Use Table 1-3 to determine the best subscription for you. Check with your instructor if you need help making this decision. Complete the following steps to create your account.

<u>If you're creating a standard Azure account using the free trial subscription:</u>

1. Go to **azure.microsoft.com**, activate the free trial, and create a Microsoft account or sign in with an existing account. Complete the identity verification and agreement process. Then sign into the Azure portal.

<u>If you're creating an Azure account using the Azure for Students subscription:</u>

1. Go to **azure.microsoft.com/en-us/free/free-account-students-faq/**, activate the Azure for Students offer, and create a Microsoft account or sign in with an existing account. Complete the identity verification and agreement process. Then sign into the Azure portal.

After you sign in, complete the following steps to explore the Azure portal (see Figure 1-13):

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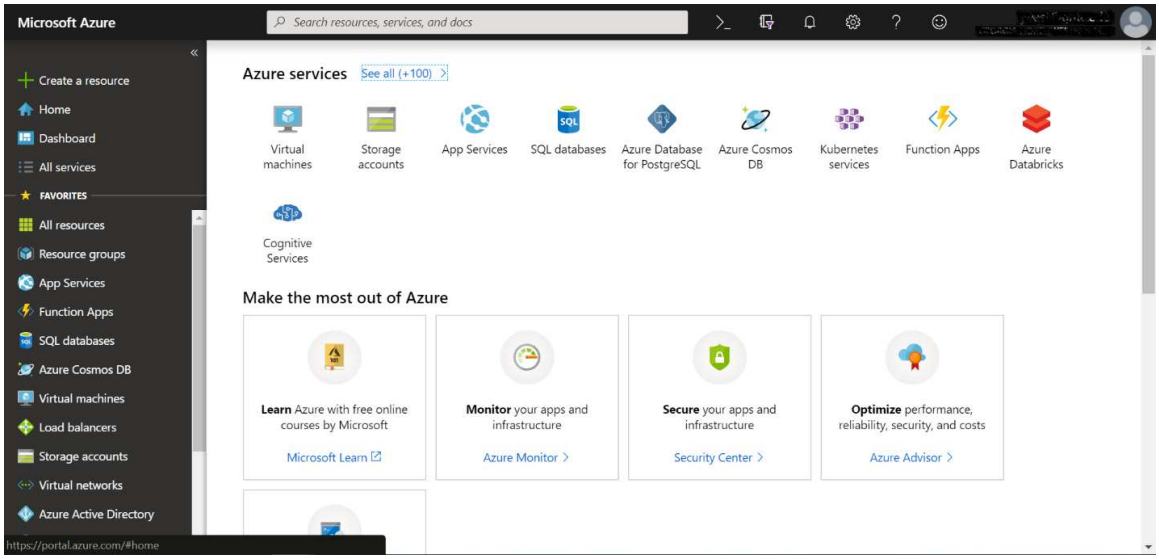

2. Spend a few minutes exploring the portal. Click **Home** on the left. What's listed at the top of the Home page?

   - **Answer:** Azure services are listed at the top, such as Virtual machines, Storage accounts, and App Services.

3. Click **Dashboard**. List three tiles showing on the dashboard.
   - **Answer:** Default tiles on the default dashboard are "All resources," "Azure getting started made easy!" "Quickstarts + tutorials," "Service Health," and "Marketplace."

4. Add a new tile to the dashboard. What tile did you add and how did you do it?

   - **Answer:** Answers may vary. To pin a new tile, you can either navigate to the resource and click the pin icon, or, on the dashboard, click Edit and add a tile from the Tile Gallery.

5. Look at the web address at the top of your browser window. What web address should you use to return to the portal later?
   - **Answer:** portal.azure.com

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Project 1-5: Create an Account with GCP

Est. completion time: 20 minutes

Note
Public cloud platforms and related account options change frequently. While the instructions given here were accurate at the time of writing, you might need to adjust the steps or options according to later changes.

Google Cloud offers an attractive free trial option available for all new accounts. However, GCP's education options must be organized through your school. Your instructor will give you this information if relevant for your specific course. Table 1-4 shows the characteristics of the GCP free trial.

Table 1-4 GCP free trial characteristics

Subscription Option	**Benefits to Students**	**Payment Options**	**Notes**
Free Trial	• $300 GCP credit for up to 12 months • "Always free" services	Requires credit card or bank account information	Some minor limitations on what the GCP credit can be used for, such as a maximum limit of eight cores or vCPUs running at a time (the free credit amount will be sufficient for this course so long as you remember to shut down running services when you're not using them)

As shown in Table 1-4, GCP's free trial offers a generous amount of credit that lasts an entire year. However, when that credit is used up, you must convert to a pay-as-you-go account. Some services continue to be available for free, but you must carefully monitor your activities to avoid accruing any charges.

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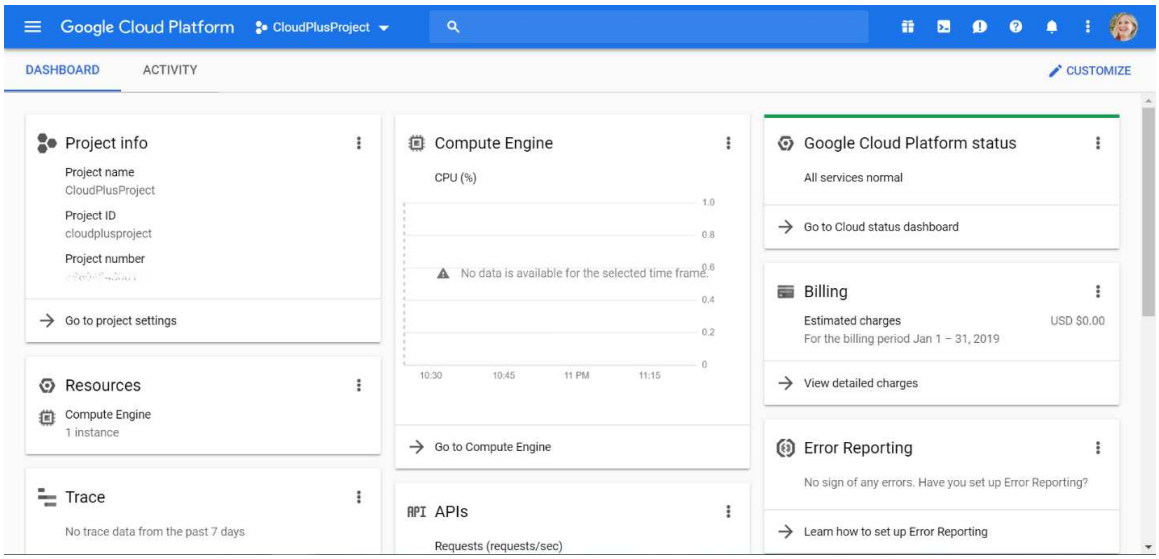
Complete the following steps to create your account:

1. Go to **cloud.google.com** and sign up for the free trial.

2. Spend a few minutes exploring the console (see Figure 1-14). An initial project has been created for you. What is the default project called?

   - **Answer:** My First Project



3. Pin a service to the top of your navigation menu. Which service did you pin and how did you do it?

   - **Answer:** Answers may vary. To pin a service, you open the navigation menu and click the pin icon next to the service.

4. Click the Activity view. How many activities have been performed in your account already?

   - **Answer:** Answers may vary. Initially, the system automatically performs four activities in order to set up the account.

5. Look at the web address at the top of your browser window. What web address should you use to return to the console later?

   - **Answer:** console.cloud.google.com

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Project 1-6: Apply Troubleshooting Methodology

Est. completion time: 30 minutes

Most likely at this point in your IT career, you've already encountered some challenging troubleshooting scenarios with computers, mobile devices, and networks. Think back to one of the more interesting scenarios you've faced, one where you were able to solve the problem. Take a few moments to write down the symptoms you encountered, the information you gathered, and the questions you asked. Try to remember the sense of confusion or concern that the problem created. Think through the theories you developed on the possible causes of the problem as well as the attempts you made to solve the problem. Write down as many details as you can remember about how you finally discovered the solution and how you arrived at that conclusion.

Now take another look at the troubleshooting flowchart, shown again in Figure 1-15.

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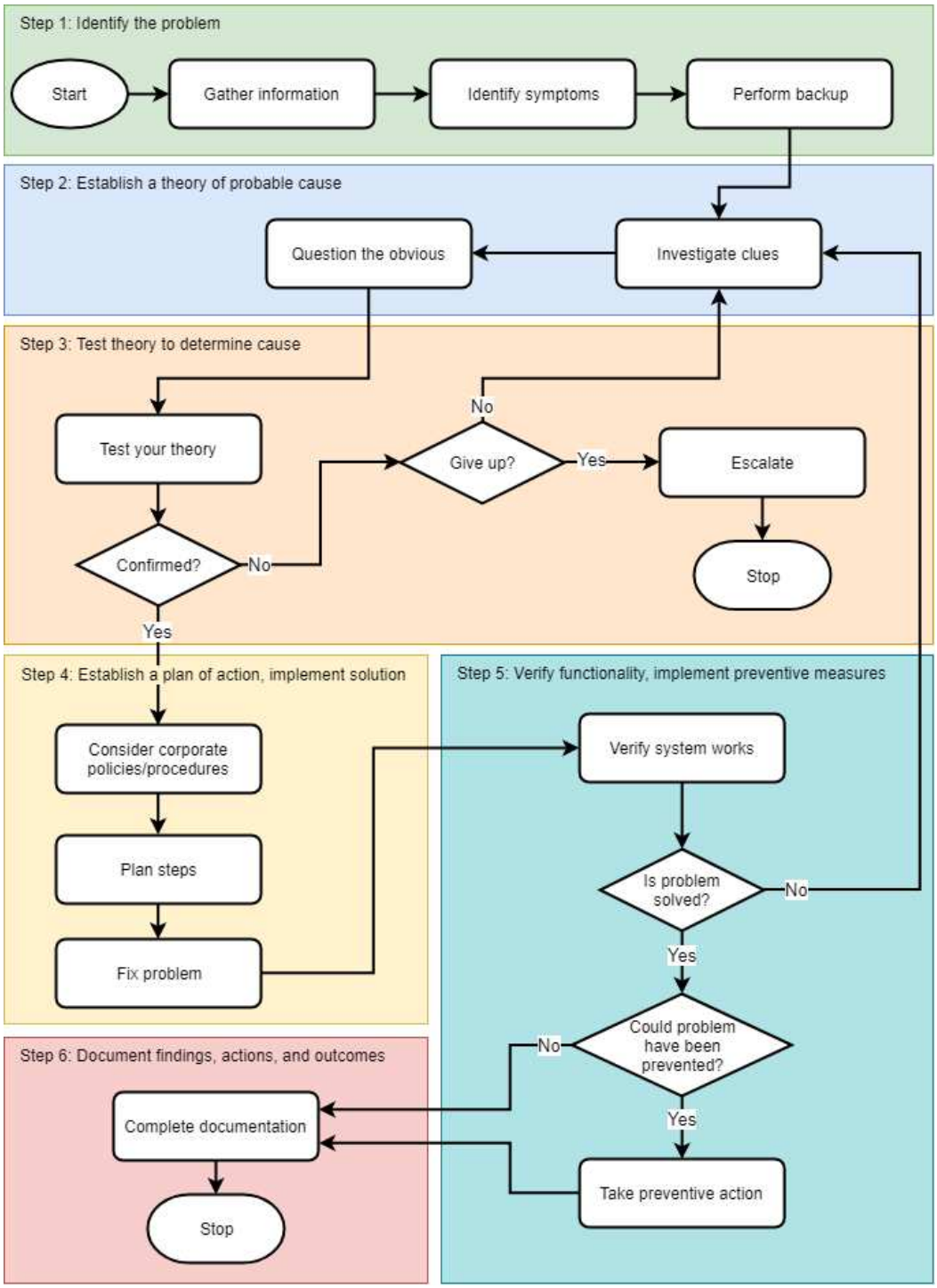

Map your problem-solving experience to the steps shown in the flowchart, and include additional details as they come to you. Then answer the following questions:

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1. What theories did you test that turned out to be wrong? What information did you learn from those dead ends?

   - **Answer:** Answers may vary.

2. Did you involve anyone else in the problem-solving process? If so, who was that person and how did they help?

   - **Answer:** Answers may vary.

3. What did you do to test your solution? What measures did you take to ensure the problem didn't happen again?

   - **Answer:** Answers may vary.

4. Considering what you've now learned about troubleshooting methodology, what could you have reasonably done differently to discover the solution more quickly?

   - **Answer:** Answers may vary.

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Reflection

Only a few years ago, the term "cloud computing" seemed more like a marketing gimmick than a legitimate evolution in technology. Today, it's become clear that cloud computing is here to stay and, within a few years will likely be as much a standard mode of operation for most data centers as virtualization is today. This means that, as an IT professional, you have a responsibility to understand how to use the cloud and how to integrate those tasks with your job role, in whatever specialty area you pursue. A decade from now, you'll be the one telling new IT professionals how you were "there" as cloud computing initially moved into data centers all over the world.

For this discussion, take a few moments to consider how cloud computing will likely affect your career, especially considering your specialty area and any specific career goals that you have in mind. Will it be a part of your daily responsibilities? Will it affect how you approach the problems you face? Will the cloud likely transform your career track, or merely give it a nudge here and there?

Go to the discussion forum in your school's LMS (learning management system). Write a minimum 100-word post discussing your thoughts on cloud computing's effects on your career and job responsibilities. Then respond to two of your classmates' threads with minimum 50-word posts discussing their comments and ideas. Use complete sentences and check your grammar and spelling. Try to ask open-ended questions that encourage discussion, and remember to respond to people who post on your thread.

Grading Rubric

Qu	Standard	Possible	Earned

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1	Initial post: Self-reflective discussion on career aspirations and how cloud computing is relevant to these goals	50	
2	Initial post: Length (100+ words), grammar, and spelling	10	
3	Response to classmate 1: Shows engagement and critical thinking	15	
4	Response to classmate 2: Shows engagement and critical thinking	15	
5	Responses to classmates: Length (50+ words each), grammar, and spelling	10	
	Total	**100**	

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Module 2
Virtual Hardware

Scenario-Based Practice Questions

Question 2-1

Vicki works from home developing apps for managing highly regulated data, such as patients' medical history or customers' payment information. She's always concerned with prioritizing data security and ensuring that no programming loopholes would allow hackers access to data managed by one of her apps. During the development process, Vicki performs some initial, lightweight testing of her apps in a few OS environments running in VMs on her home computer, and then she passes each app along to a team at another location for more intense and thorough testing. Which hypervisor is Vicki most likely using?

A. ESXi

B. VirtualBox

C. Windows Server 2016

D. XenServer

- **Answer:** B. VirtualBox
- **Explanation:** Vicki is running a hypervisor on her home computer for light testing. Only a type 2 hypervisor is needed, and VirtualBox is the only type 2 hypervisor in this list.

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Question 2-2

Brian is moving his network's backup DHCP server to a VM running Ubuntu Server. The VM will provide a couple of other network services as well, including DNS. Which networking mode should Brian assign to the Ubuntu VM?

A. NAT mode

B. DHCP mode

C. Host-only mode

D. Bridged mode

- **Answer:** D. Bridged mode
- **Explanation:** The VM must be accessible to the rest of the network through a static IP address. Only bridged mode will make the VM consistently available to other network devices.

Question 2-3

Douglas is setting up VM instances on a Hyper-V server to host some basic web server and legacy software workloads along with some light app testing. He needs to know how many vCPUs to allocate to each VM. The server's motherboard has two CPU sockets, both populated with eight-core processors, and hyperthreading is enabled. He's decided that the VMs' workloads can easily handle a 3:1 overcommitment ratio. He plans on creating 15 VMs at first and eventually increasing to 25 VMs as he fine-tunes the workloads and resource allocations. How many vCPUs should Douglas initially allocate to each VM?

A. 1

B. 6

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C. 32

D. 96

- **Answer:** A. 1
- **Explanation:** For this relatively small virtualization scenario, best practice is to start with one vCPU and increase that number only as needed.

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Video Questions

Video 2-1: Creating a VM Instance in Yellow Circle

What kind of address allows you to remotely connect to a VM in the cloud?

a. MAC address

b. Private IP address

c. DNS address

d. Public IP address

- **Answer:** D

Video 2-2: VM Instances in AWS

Which AWS service is used to create VM instances?

a. S3

b. Dashboard

c. EC2

d. SSH

- **Answer:** C

Which two key types are included in a key pair?

a. Micro key and macro key

b. PEM key and PPK key

c. Cryptography key and authentication key

d. Private key and public key

- **Answer:** D

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Video 2-3: VM Instances in Azure

Which Azure service is used to create VM instances?

a. Virtual machines

b. Kubernetes

c. App services

d. Resource groups

- **Answer:** A

What is the default port for RDP (Remote Desktop Protocol)?

a. 443

b. 80

c. 3389

d. 22

- **Answer:** C

What Azure resource allows an instance to be accessed from the Internet?

a. Private IP address

b. Virtual network

c. RDP

d. Public IP address

- **Answer:** D

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Video 2-4: VM Instances in GCP

Which GCP service is used to create VM instances?

a. App Engine

b. Cloud Build

c. Marketplace

d. Compute Engine

- **Answer:** D

Video 2-5: Connecting to Instances through a Browser with GCP

Which browser can be used to connect to a GCP Linux instance? Choose all that apply.

a. Edge

b. Chrome

c. Safari

d. Firefox

- **Answers:** A, B, C, D

What Linux command creates a new directory?

a. ifconfig

b. mkdir

c. documents

d. dir

- **Answer:** B

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Video 2-6: Connecting to Instances through RDP in Azure

Which protocols can create a secure remote access connection between a Windows computer and a Windows VM instance? Choose all that apply.

a. RDP

b. FTP

c. HTTP

d. SSH

- **Answer:** A, D

What Windows command shows network interface information?

a. ipconfig

b. ifconfig

c. iwconfig

d. inconfig

- **Answer:** A

Video 2-7: Connecting to Instances through SSH in AWS

What is AWS's default private key file type?

a. .pem

b. .pdf

c. .ppk

d. .png

- **Answer:** A

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What port does SSH use by default?

a. 443

b. 80

c. 3389

d. 22

- **Answer:** D

What Linux command shows network interface information?

a. dir

b. ifconfig

c. ipconfig

d. mkdir

- **Answer:** B

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Hands-On Projects

Project 2-1: Create a VM in a Hypervisor

Est. completion time: 45 minutes

Using any current edition of Windows, macOS, or Linux (Ubuntu, Debian, openSUSE, Fedora, and many others), you can download and install Oracle VirtualBox, and then use this free hypervisor to create virtual machines and a virtual network. Have available an ISO file to install Windows or a Linux OS in the VM.

Note

VirtualBox is free, easy to use, and works well on many OS platforms. However, if you have a different hypervisor you'd rather use (such as Hyper-V or VMware Workstation), you can complete the project using that hypervisor instead by adjusting the steps as necessary.

Follow these steps:

1. Make sure HAV (hardware-assisted virtualization) is enabled in UEFI/BIOS setup. If you are not sure it is enabled, power down your computer, turn it on again, press a key during startup to access UEFI/BIOS setup (check the motherboard's documentation to know which key), and make sure the virtualization feature is enabled. For the system shown in Figure 2-12, that's done on the CPU Configuration screen. Also make sure that any subcategory items under HAV are enabled. Save your changes, exit UEFI/BIOS setup, and allow the system to restart to Windows.

Screenshot of the advanced mode in the bios utility of a computer. Virtualization has to be enabled in BIOS so that hypervisor software can create virtual machines. The screenshot shows the Advanced Mode screen of the ASUS U E F I BIOS utility

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and Intel virtualization technology is being enabled.

Figure 2-12
Source: ASUS

2. Go to **virtualbox.org/wiki/Downloads** and download the appropriate **VirtualBox platform package** for your host machine. Install the software, accepting default settings during the installation. The Oracle VM VirtualBox Manager window opens as shown in Figure 2-13, although your VirtualBox won't yet have any VMs in it.

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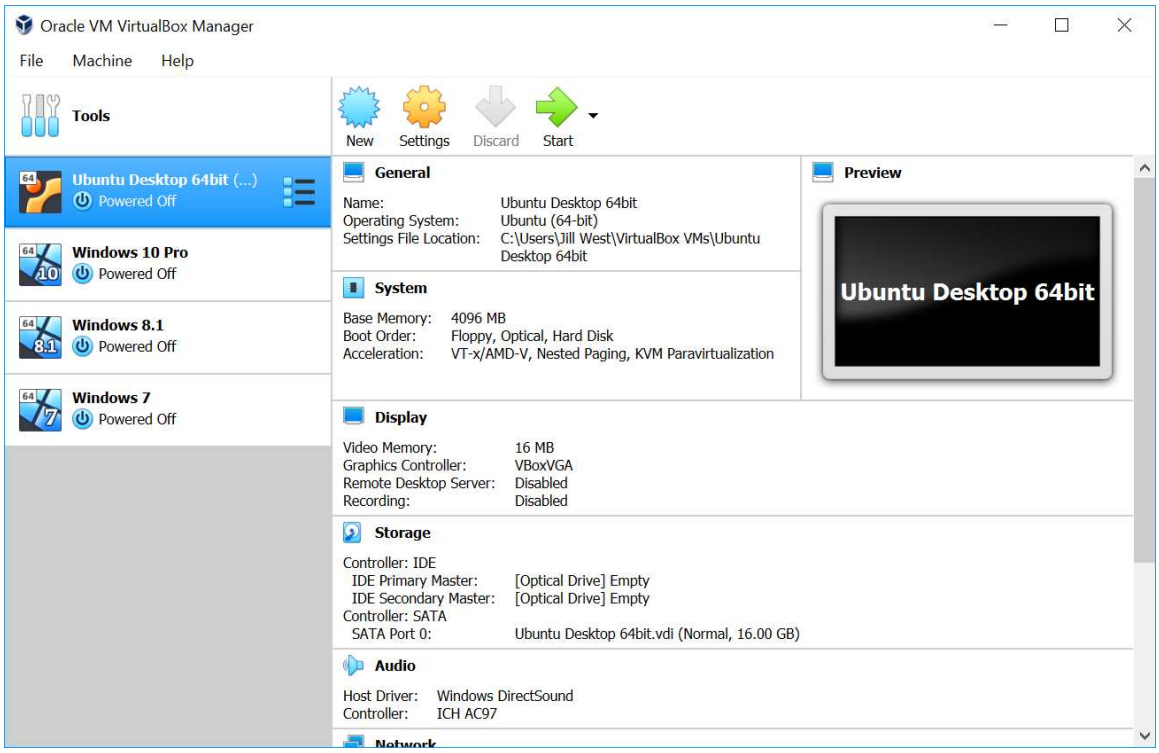

Figure 2-13
Source: Oracle Corporation

3. To create a virtual machine using VirtualBox, click **New** on the toolbar and follow the wizard to create a VM. Give your VM a name, for example VM1 or VM_Lab_A, and select the OS you will install in it.

4. For Memory size, consider increasing the amount of RAM allocated to the VM. For example, 64-bit Windows installs more easily with 4 GB of RAM (which is 4096 MB) rather than the minimum 2 GB.

5. You can accept the default settings for the VM's storage unless directed otherwise by your instructor. Notice that the default settings create a dynamically allocated VDI of 50 GB.

6. With the VM selected, click **Settings** in the VirtualBox Manager window. Before proceeding with installing the OS, answer the following questions about your VM:

   a. How much base memory is allocated to your VM?

   ➢ **Answer:** Answers may vary.

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b. What's the VM's boot order?

➢ **Answer:** By default, the boot order is Floppy, Optical, Hard Disk

c. How many processors are allocated to the VM?

➢ **Answer:** Answers may vary.

d. What network connection type is currently configured for your VM?

➢ **Answer:** Answers may vary.

7. In the VM's Settings box, click **Storage** in the left pane.

8. In the Storage Tree area, to the right of *Controller: SATA*, click the **Adds optical drive** icon, which looks like a CD with a plus (+) symbol, as shown in Figure 2-14.

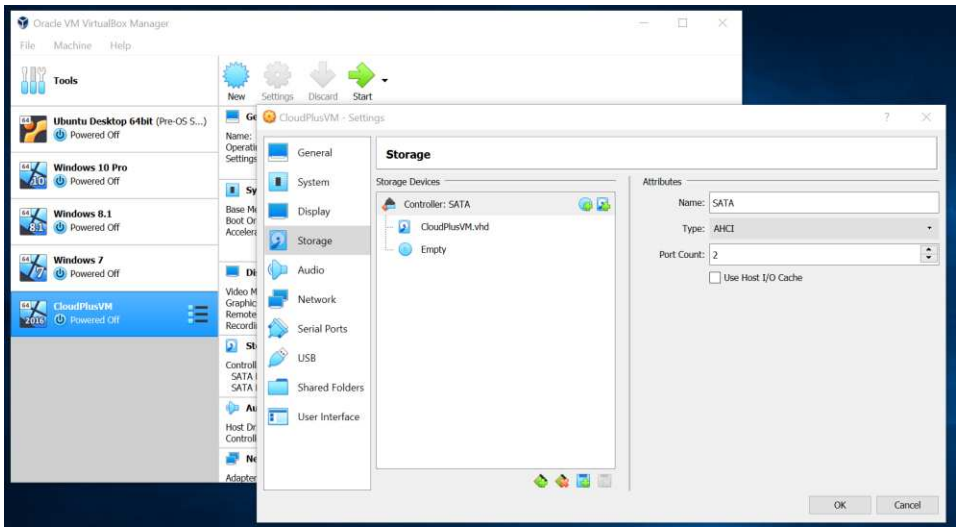

Figure 2-14
Source: Oracle Corporation

9. When a dialog box opens, click **Choose disk**. Choose an ISO file from the list or click Add to browse for a different ISO file. Click **Choose** and then click **OK**. You return to the VirtualBox Manager window.

10. Click **Start** on the toolbar. Your VM starts up and begins installing the operating system. Follow the prompts on-screen and make any adjustments to default settings as directed by your instructor.

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Note

Hyper-V and VirtualBox don't play well together on the same machine, especially if your computer uses an Intel CPU. If you get an error message that VT-x is not available when trying to start a VM, consider that Hyper-V might be enabled on your machine and you'll need to disable it. This is done in Windows Features (press **Win+R** and enter **optionalfeatures**). Make sure you disable all Hyper-V components.

11. After you have installed the OS in your VM, open its browser to confirm the VM has a good Internet connection.

Note

If you have trouble booting to the ISO file, consider increasing the VM's available memory in the Settings menu. For example, 64-bit Windows installs more easily with 4 GB of RAM rather than the minimum 2 GB.

Project 2-2: Launch a VM Instance in Yellow Circle

Est. completion time: 20 minutes

Note

Public cloud platforms and related account options change frequently. While the instructions given here were accurate at the time of writing, you might need to adjust the steps or options according to later changes.

You created a Yellow Circle account in Project 1-2, "Get Started in Yellow Circle." If you don't sign in to your Yellow Circle account at least weekly, it will automatically be deleted for inactivity and you'll get an email notification. If this happened to you, sign in

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at **yellowcircle.net** using the same account credentials as before and create a new, free subscription. Then complete the following steps to spin up a VM in Yellow Circle:

1. Sign in to the Yellow Circle platform at **mylab.yellowcircle.net**. In the left pane, click **Instances**. In the top-right corner, click **Launch Instance**.
2. Name your instance. The AZ (availability zone) is set for you. At this time, you'll create only one instance. Click **Next**.
3. For this project, you'll use a Windows server image as the boot source. Make sure **Image** is showing under *Select Boot Source*, and then click the "**+**" sign next to the Windows Server 2012 image, which is the newest version of Windows Server that you can use within the limitations of a free account. Scroll back to the top of the list and confirm that the image you selected is listed under *Allocated*. Click **Next**.
4. In Yellow Circle, different available size combinations of compute, memory, and storage are referred to as "flavors." If you're using the free account, you're limited in available flavor options. Point to each of the yellow triangles and read the warning messages about minimum requirements for the selected image and maximum limitations for your account type. Choose one of the acceptable flavor options and click **Next**.
5. Your instance is automatically assigned a network, which already contains a subnet. Click **Next**. You don't have available network ports. Click **Next** again.
6. Your instance is automatically assigned the Default security group. Click **Next**.
7. If you have a paid subscription (not a free account) and you want to connect to your instance, you'll need a key pair. Click **Create Key Pair**, give the key pair a name, and then click **Create Keypair**. You'll be prompted to save the .pem file. Save it in a safe place on your computer where you can find it later. The key pair is automatically associated with the instance. This step is not required to complete the project.
8. You're now ready to launch your instance. Click **Launch Instance**.
9. You'll see the Spawning status as the instance is being created. This will take several minutes—grab a cup of coffee while you wait. After the spawning process is complete, the power state will change to Running.

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10. Take a few minutes to explore the actions you can perform on your instance. What options do you have for changing its power state?
    - **Answer:** Action options that will affect power state include pause, suspend, shelve, soft reboot, hard reboot, shut off, and delete.
11. Click the instance name. What are the RAM, VCPU, and Disk specs for your instance?
    - **Answer:** Answers may vary. A common example will be 1 GB RAM, 1 VCPU, and 20 GB Disk.
12. What is the IP address of your instance?
    - **Answer:** Answers may vary. One example is 192.168.162.203. All IP addresses should be within an RFC 1918 range.
13. Click the **Console** tab. What screen do you see in your instance console? If you have a product key, you can install Windows Server if you'd like and see what you can do in it. You also have the option to skip the product key step and complete the installation as a test run. However, completing the installation is not necessary for this project.
    - **Answer:** The Windows Server install Settings page.
14. When you're finished, shut down the instance so it won't keep running when you're not using it. While you're not charged for instances in a free Yellow Circle account, shutting down unused instances is a good habit to develop.

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Project 2-3: Deploy a VM in AWS

Est. completion time: 15 minutes

Note
Public cloud platforms and related account options change frequently. While the instructions given here were accurate at the time of writing, you might need to adjust the steps or options according to later changes.

Each of the major public cloud providers works similarly when deploying VM instances in the cloud. Let's first take a look at how to deploy a VM in AWS. In the next two projects, we'll see how that process varies slightly in Azure and GCP.

Recall that in Project 1-3, you surveyed available AWS account options and had the opportunity to create an AWS account. In your AWS console, complete the following steps:

1. Go to the **EC2** dashboard. Click **Launch Instance**.
2. Choose a Linux AMI (Amazon Machine Image). If you're concerned about avoiding costs, be sure to select a free tier–eligible AMI, as shown in Figure 2-15. Which AMI did you choose?

   - **Answer:** Answers may vary.

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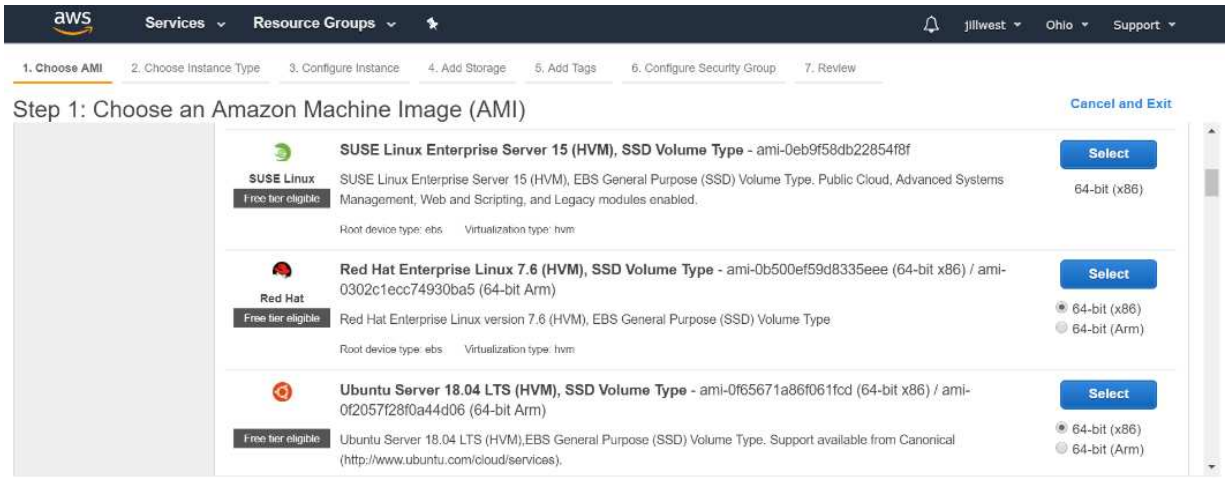

Figure 2-15
Source: Amazon Web Services, Inc.

Note

When you select an AMI, you're choosing an operating system and storage type, as well as other options that might be available from this screen. A free tier account includes up to 750 hours of certain types of EC2 instances; this is enough hours to run one EC2 instance continuously for the entire month or to split the hours among many instances. The free tier account is available to new subscribers and, at the time of this writing, lasts for 12 months.

3. Choose an instance type, again, being careful to choose a free tier–eligible option if needed. Instance types offer various combinations of capacity for CPU, memory, storage, and networking resources. The naming convention gives you significant clues as to the instance type:

    - Instance types start with a letter and a number, such as T2 or C5, where the letter represents the instance class (for example, T is general purpose, C is compute optimized, and I is storage optimized), and the number represents the generation (for example, at the time of this writing, T3a has been announced but not yet released). Different classes provide varying ratios of specifications, such as vCPU

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to RAM. Generations vary in offered features, such as local SSD (solid-state drive) storage space.

- Within a class and generation, varying sizes of resources can be selected while retaining the originally designated ratios of those resources. For example, doubling the vCPUs will also double the RAM. This sizing scheme is represented by words such as nano, micro, small, medium, large, xlarge, or 2xlarge.

In Figure 2-16, you can see that the free tier–eligible option is t2.micro, which is a general-purpose, second-generation, relatively small instance type. Which instance type did you choose?

➢ **Answer:** Answers may vary.

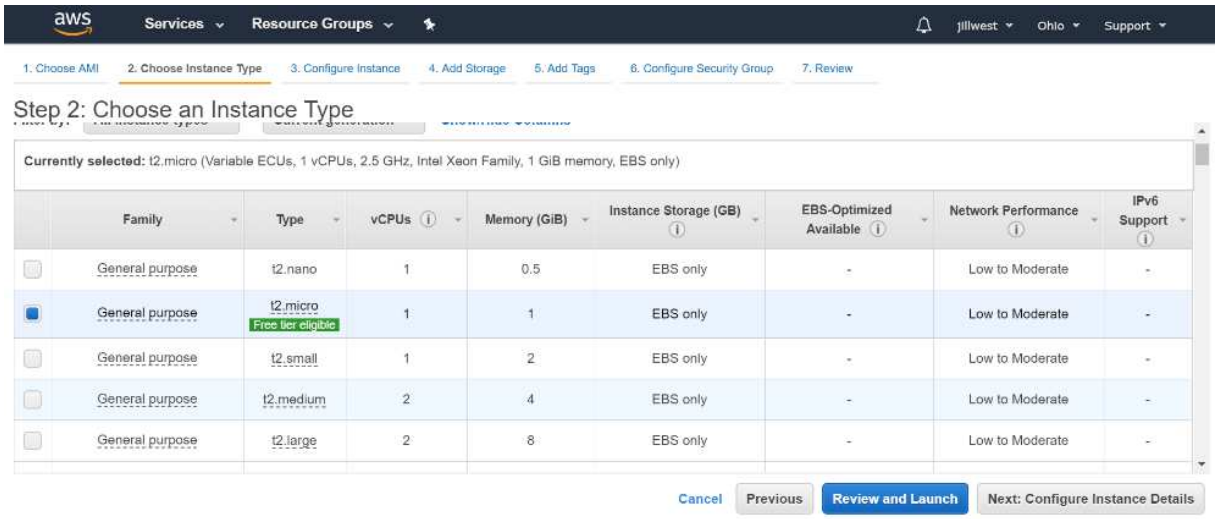

Figure 2-16
Source: Amazon Web Services, Inc.

4. Click through the additional configuration options on the tabs at the top of the window shown in Figure 2-16 to familiarize yourself with what's here. For now, we'll stick with the default settings. When you're ready, click **Review and Launch** to proceed with default settings.

5. AWS warns that your instance is accessible from any IP address. This risk is acceptable for this project. Click **Launch**.

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6. To connect to your instance in Project 2-6, you'll need a key pair. A key pair acts like a lock and a key. AWS holds the public key, similar to a lock on a door. You save the private key, similar to a key that fits the lock. When you present the private key, it's like using a custom key to unlock the front door to your house. Key pairs are more secure than passwords because the lock and the key must match—this is harder than a password for a hacker to crack. Key pairs are also encrypted when stored, so it's harder for a hacker to discover this information.

   As shown in Figure 2-17, create a new key pair, give the key pair a name, and then download the key pair as a .pem file. Be sure to save your key pair in a safe place, as anyone with that file can access your VM instance.

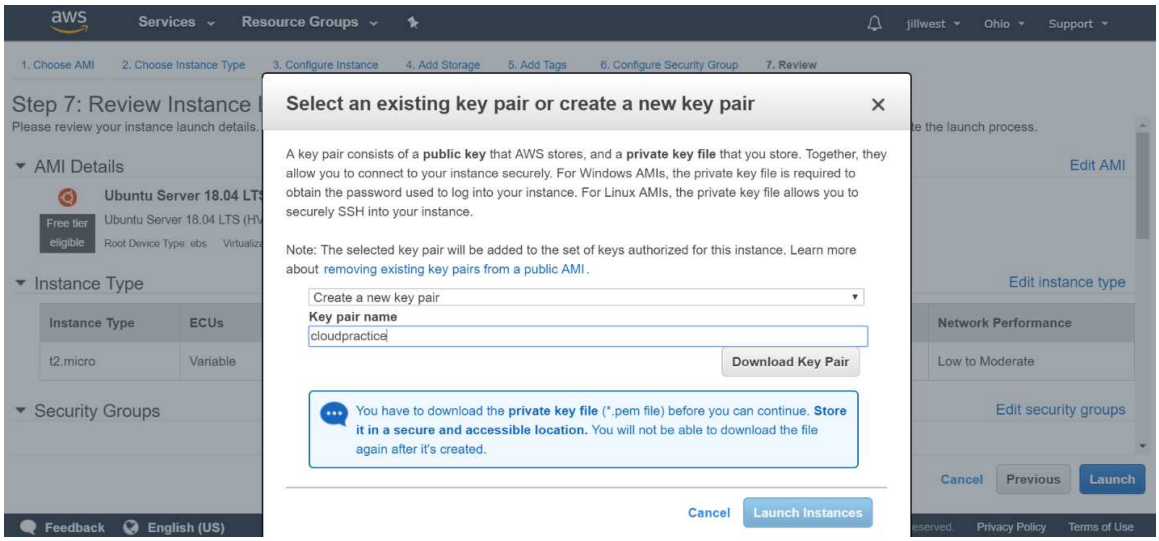

Figure 2-17
Source: Amazon Web Services, Inc.

7. Click **Launch Instances** and then click **View Instances**. It takes a few minutes for the instance to launch and enter a running state. Figure 2-18 shows the list of instances in this account, where one instance is stopped and the other—the new one—is initializing.

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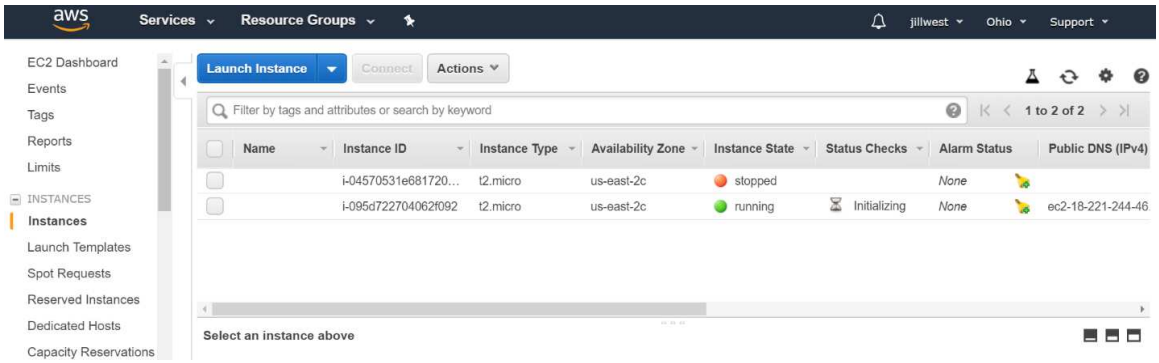

Figure 2-18
Source: Amazon Web Services, Inc.

8. When the VM is up and running, explore information about this VM on the Instances page. There's a lot of important information on this screen, such as the availability zone, security group, VPC (virtual private cloud), and subnet. You'll learn more about these items in later modules. What is your VM's private IP address? What is its public IP address?

   ➢ **Answer:** Answers will vary.

9. For now, either stop the instance or continue with your next project. Project 2-6 will guide you through connecting with this instance and the other instances from Project 2-4 and Project 2-5.

Project 2-4: Deploy a VM in Azure

Est. completion time: 15 minutes

Note
Public cloud platforms and related account options change frequently. While the instructions given here were accurate at the time of writing, you might need to adjust the steps or options according to later changes.

Creating a VM instance in Azure works similarly to AWS and other cloud platforms. There are a few significant differences, which we'll discuss in this project.

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Recall that in Project 1-4, you surveyed available Azure subscription options and had the opportunity to create an Azure subscription. Sign in to your Azure portal and complete the following steps:

1. Click **Virtual machines** to manage and create VM instances. Then click **Create virtual machine** to begin the creation process, as shown in Figure 2-19.

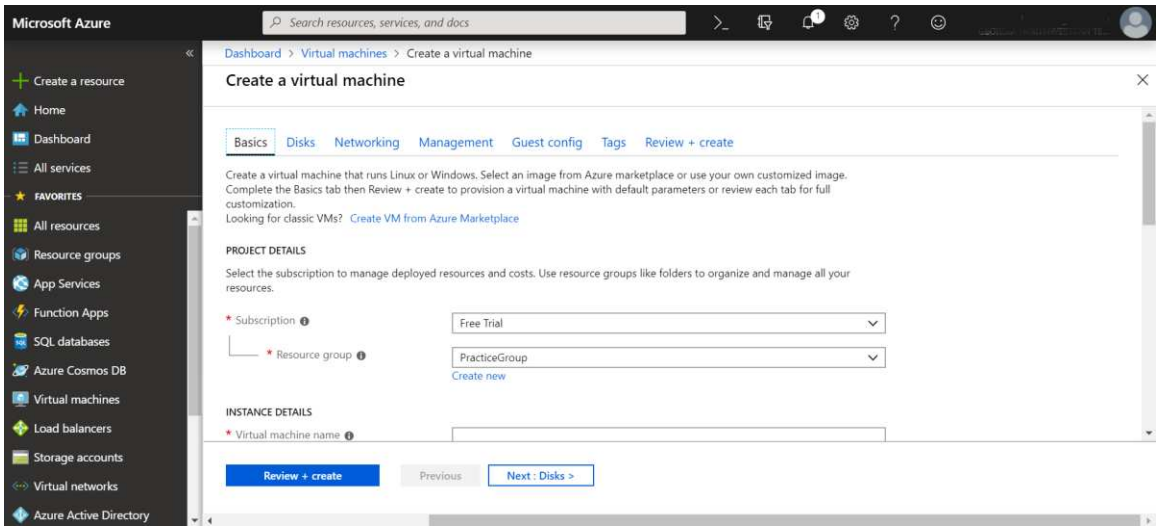

Figure 2-19
Source: Microsoft

2. Check that you're using the correct subscription. An Azure subscription identifies a payment method or some other crediting account. If you signed up for a free trial account with Azure, then you automatically have a Free Trial subscription, as shown in Figure 2-20. Other subscription types include MSDN (Microsoft Developer Network), Pay-As-You-Go, and Visual Studio. In a business environment, subscriptions allow costs to be tracked to specific departments or organizations. Subscriptions can also be transferred so that billing ownership can be reassigned to a different user.

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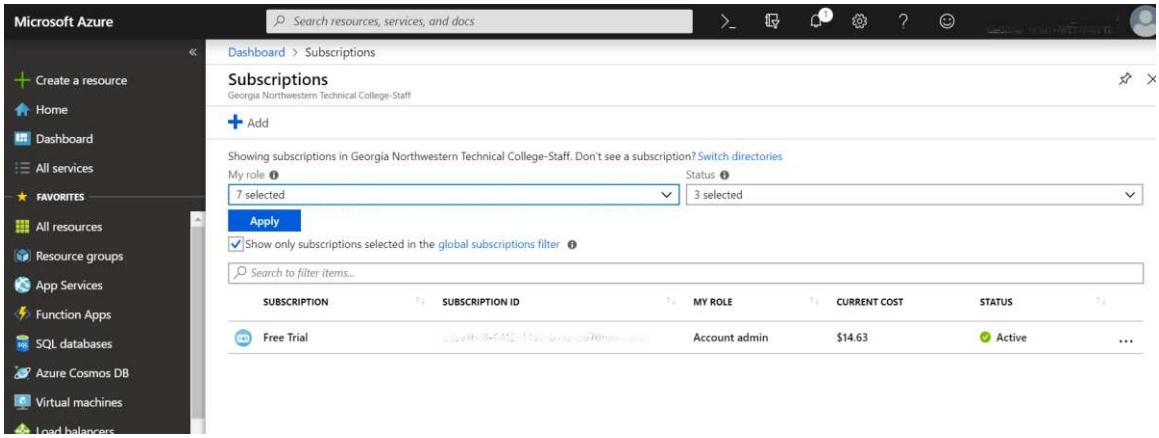

Figure 2-20
Source: Microsoft

3. Click **Create new** to create a new resource group and give it a name. Resource groups organize various resources with the same life cycle, permissions, and policies. For example, each VM instance can be related to network interfaces, storage disks, IP addresses, security groups, and a virtual network. Together, the resources that make the VM function are part of a resource group. Resource groups may contain many VMs and their associated resources. Figure 2-21 shows one resource group with a list of its resources. Figure 2-22 shows the costs for the resources in this resource group. What is the name of your resource group?

   ➢ **Answer:** Answers may vary.

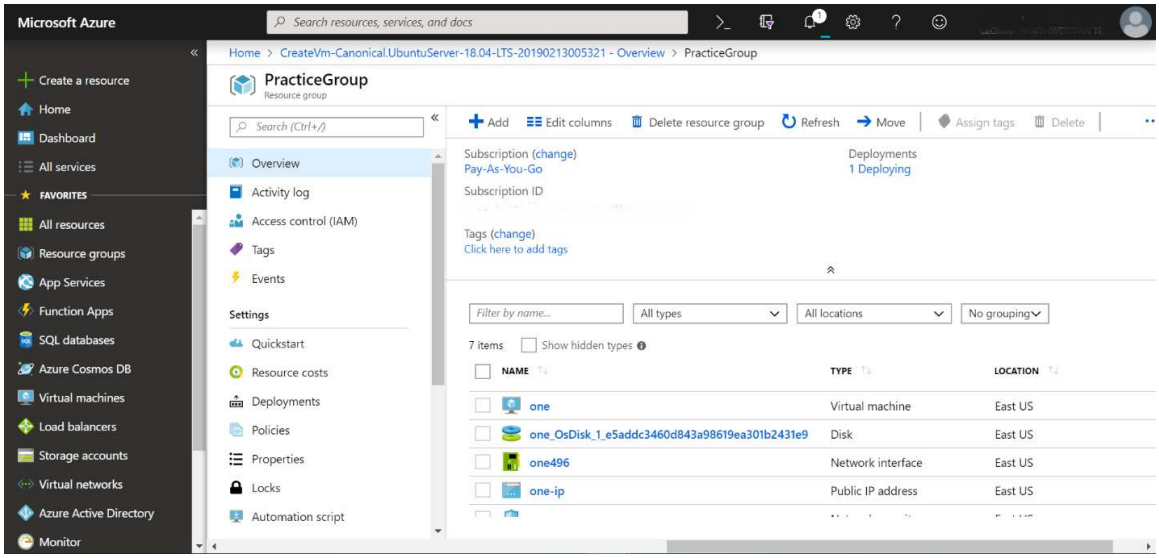

Figure 2-21
Source: Microsoft

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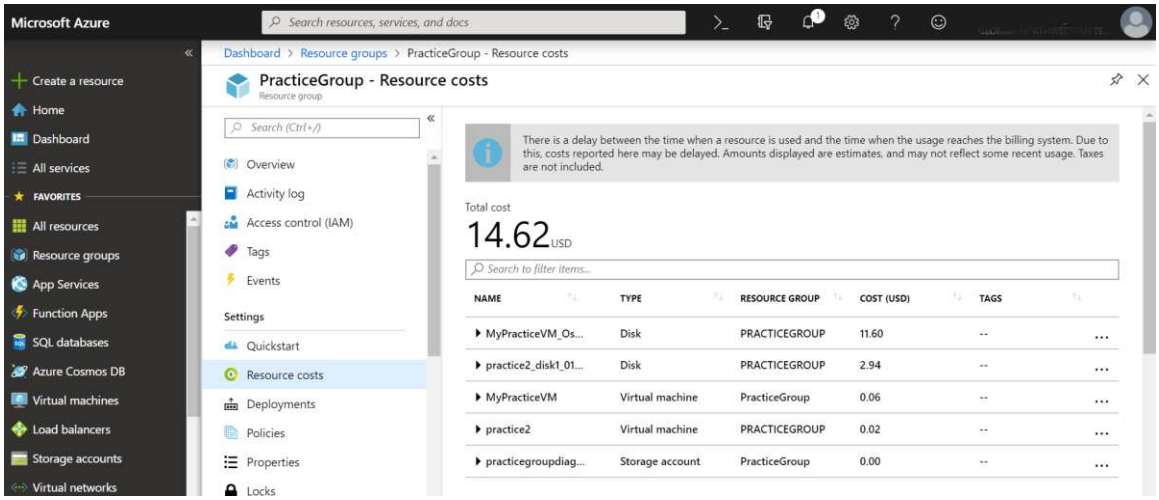

Figure 2-22
Source: Microsoft

4. Name your VM, and then choose an image. Figure 2-23 shows a few of the many other options in Azure. Notice that you can use the Marketplace to choose from images in different categories, including several BYOL (bring your own license) options, or you can use your own images. Choose a **Windows Server** image, such as Windows Server 2016 Datacenter. Which image did you choose?

   ➢ **Answer:** Answers may vary.

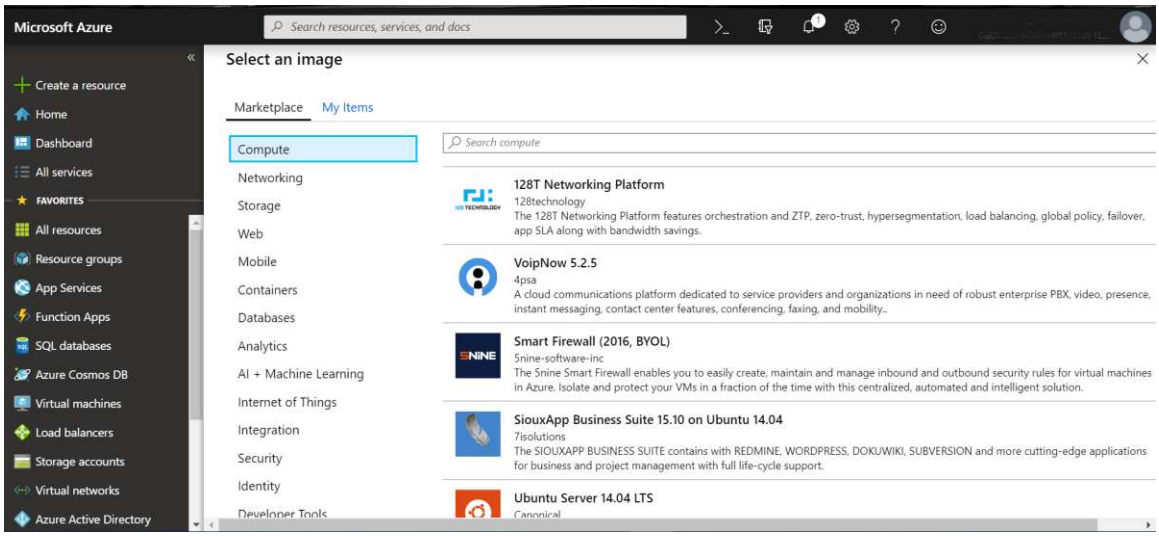

Figure 2-23
Source: Microsoft

5. Next to Size, click **Change size**. Like AWS, Azure offers options for number of vCPUs and allocation of memory, storage disks, storage space, and more. Figure 2-24

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shows a few of these options. Notice the filters and search box at the top of the figure that can be used to help you find the right size for your purposes. The Azure free trial includes 750 hours of Azure B1S General Purpose VMs for Windows Server and Linux. Choose the **B1s** size, and then click **Select**.

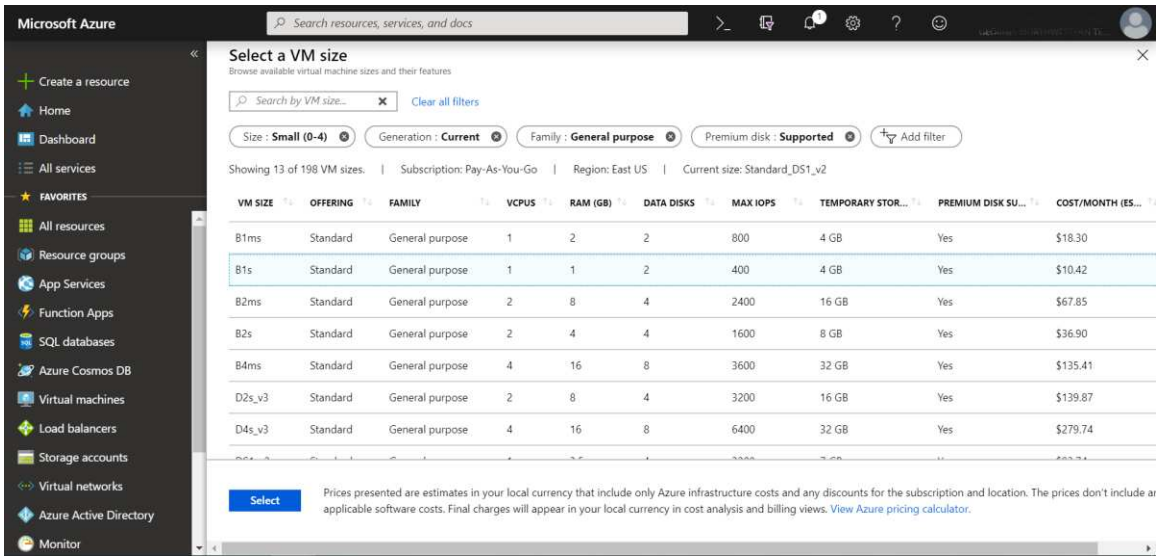

Figure 2-24
Source: Microsoft

6. Specify a username and password, and then confirm the password. Save this information where you can find it later for Project 2-6.

7. Next to Public inbound ports, allow RDP, which is Remote Desktop Protocol. You'll need this access in order to connect to your instance in Project 2-6.

8. Click **Next: Disks >** and explore the other configuration options while keeping the default settings. When you're ready, click **Review + create**. If the validation fails, troubleshoot any missing information or configurations. Once the VM passes validation, click **Create**.

9. Return to the Virtual machines page and examine available information on your VM. What is your VM's public IP address?

   ➢ **Answer:** Answers may vary.

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10. For now, either stop the instance or continue with your next project. When you get to it, Project 2-6 will guide you through connecting with this instance and the other instances from Project 2-3 and Project 2-5.

Project 2-5: Deploy a VM in GCP

Est. completion time: 15 minutes

Note
Public cloud platforms and related account options change frequently. While the instructions given here were accurate at the time of writing, you might need to adjust the steps or options according to later changes.

In GCP, you create VMs using the Compute Engine service. As with AWS and Azure, you can choose CPU, memory, storage, and networking configurations.

Recall that in Project 1-5, you surveyed available GCP account options and had the opportunity to create a GCP account. Sign in to Google Cloud and complete the following steps:

1. First check which project you're using. Google projects allow you to organize related resources for easy access. For example, projects can group a set of users with billing, authentication, and resource monitoring settings. Projects can be used to target billing activities so specific departments or programs within an organization can track their GCP expenses separately. When you create a VM in Compute Engine, you must create the VM within a project. When you first create your GCP account, a default project called "My First Project" is created for you. You can see the list of projects on the scope picker shown at the top of the screen in Figure 2-25. When you click the drop-down arrow in the scope picker, you see the list of projects and can create a new project if you choose, as shown in Figure 2-26.

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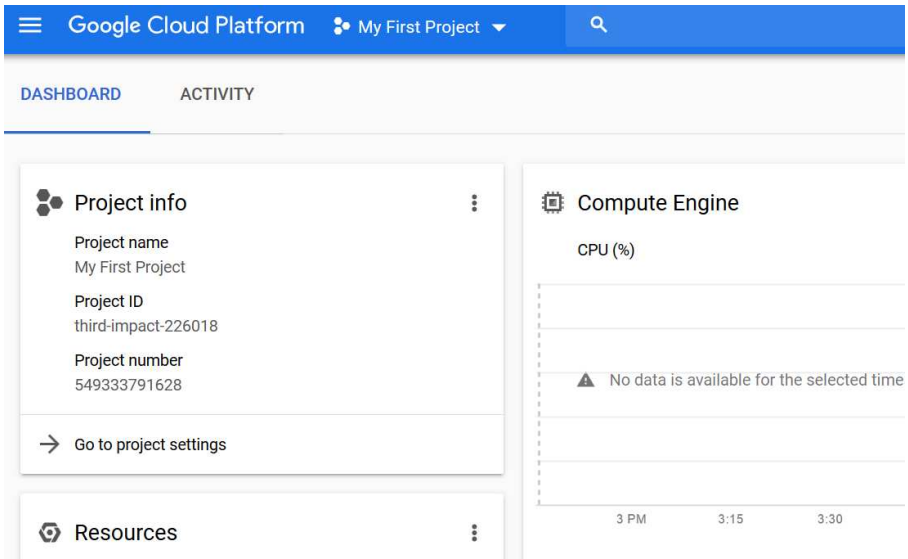

Figure 2-25
Source: Google LLC

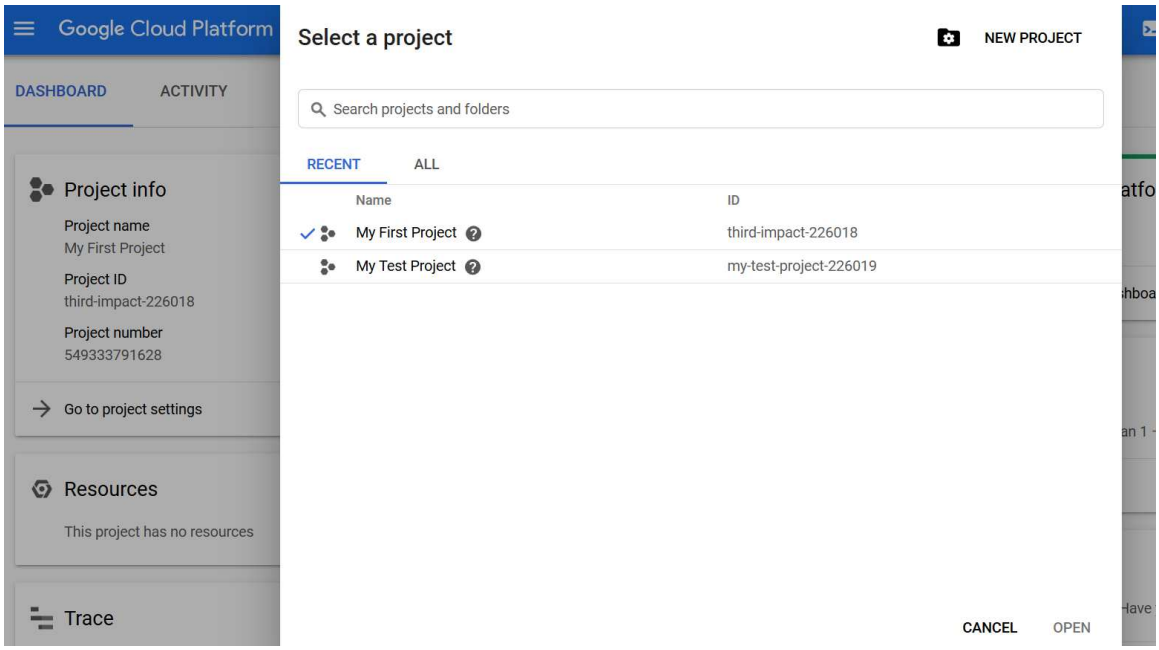

Figure 2-26
Source: Google LLC

2. Go to **Compute Engine** and click **Create**. Name the instance. What name did you give this VM?
   - **Answer:** Answers may vary.

3. As shown in Figure 2-27, you choose a machine type by the number of vCPUs, which then determines the amount of memory the VM will have and gives an initial indication of how much it will cost to run the machine. Under Machine type, click the

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drop-down arrow next to 1 vCPU, and choose **micro**, which is the f1-micro machine type. At the time of this writing, the f1-micro instance type running in one of only a few regions is included in Google's list of Always Free products at *cloud.google.com/free*. If you don't have free credit available in your account, be sure to check GCP's website for a current list of regions for the free f1-micro instance, and then choose one of those regions in the options above the instance type field. At the time of this writing, the regions to use are us-central1, us-east1, or us-west1. To explore other machine types, you can click Customize.

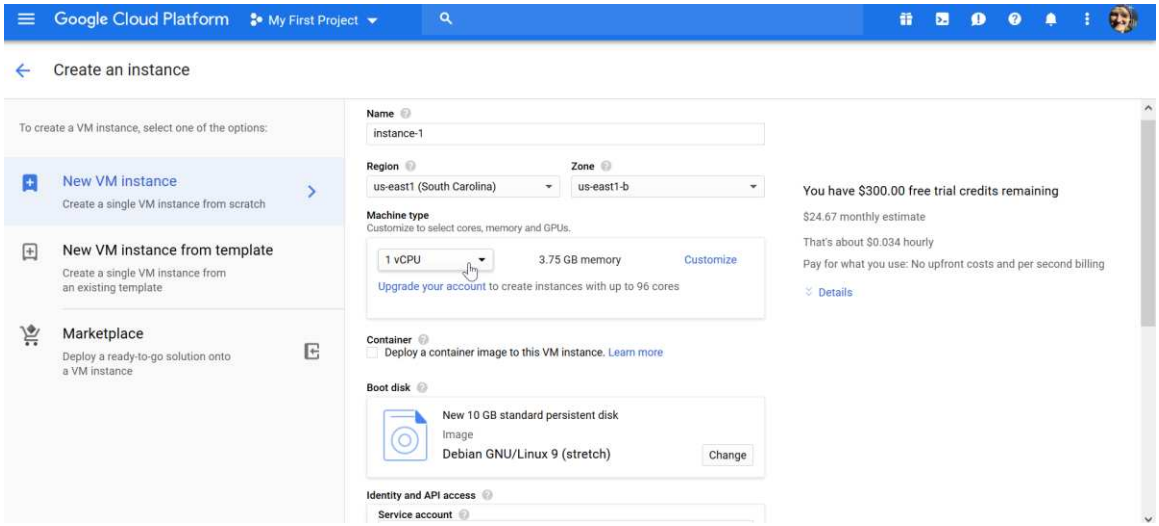

Figure 2-27
Source: Google LLC

4. The boot disk holds the OS image for the VM. GCP supports several varieties of Linux and Windows operating systems, as shown in Figure 2-28. The boot disk can be either a standard persistent disk or an SSD persistent disk, which will load the OS more quickly. You can also change the size of the disk; however, know that you're charged according to that size. Under Boot disk, click **Change**. Choose a Linux boot disk, and click **Select**. Which boot disk did you choose?

   ➢ **Answer:** Answers may vary.

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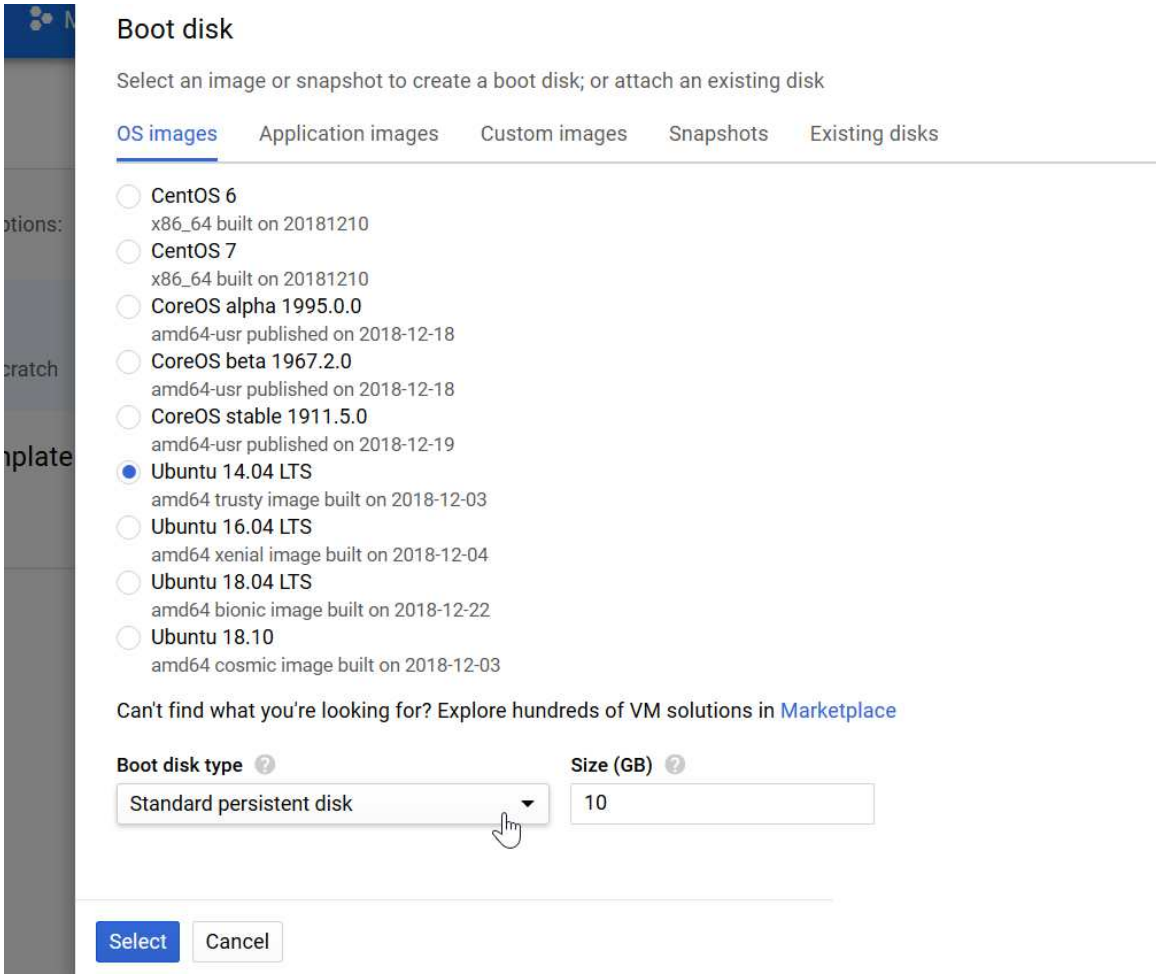

Figure 2-28
Source: Google LLC

5. Click **Management, security, disks, networking, sole tenancy**, and explore the other configuration options. When you're ready, click **Create**.
6. After the instance spins up, click the instance and explore its configuration information. What is this VM's private IP address? What is its public IP address?
   - **Answer:** Answers may vary.

7. For now, either stop the instance or continue with your next project. Project 2-6 will guide you through connecting with this instance and the other instances from Project 2-3 and Project 2-4.

Project 2-6: Connect to VMs in AWS, Azure, and GCP

Est. completion time: 30 minutes

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Note

Public cloud platforms and related account options change frequently. While the instructions given here were accurate at the time of writing, you might need to adjust the steps or options according to later changes.

In Project 2-3, you created a VM instance in AWS. In Project 2-4, you worked with Azure, and in Project 2-5, you launched a VM in GCP. In this project, you'll connect to those VMs. Normally we cover AWS first, then Azure, and finally GCP. In this case, we're going to reverse this order because connecting to VM instances in GCP is very simple compared to the others. GCP allows you to connect to VMs directly through the browser.

Connect to GCP Instance

Although it's possible to use a separate SSH (Secure Shell) client to connect to your GCP instance, it's easy to connect directly through your browser (see Figure 2-29). If you have trouble connecting with your VM instance, view the network interface details and make sure the firewall rules allow SSH traffic (see Figure 2-30).

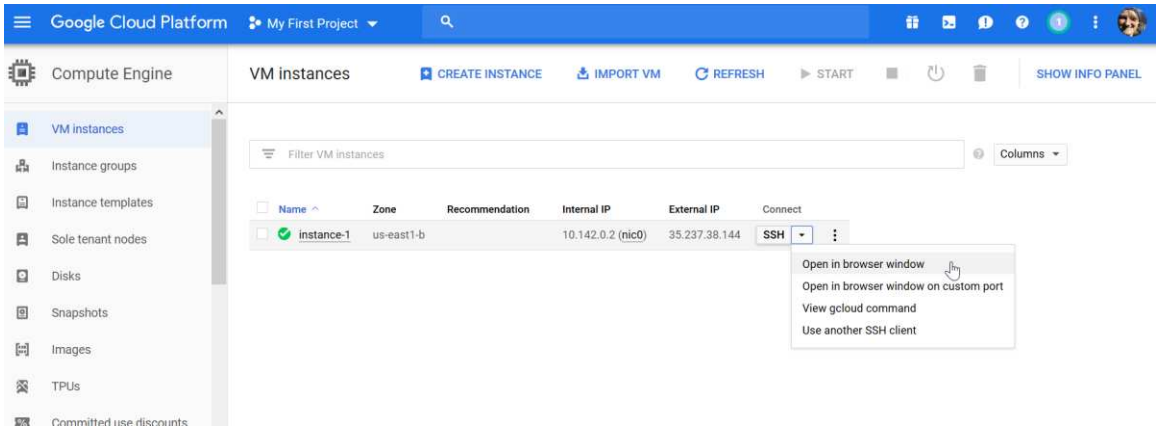

Figure 2-29
Source: Google LLC

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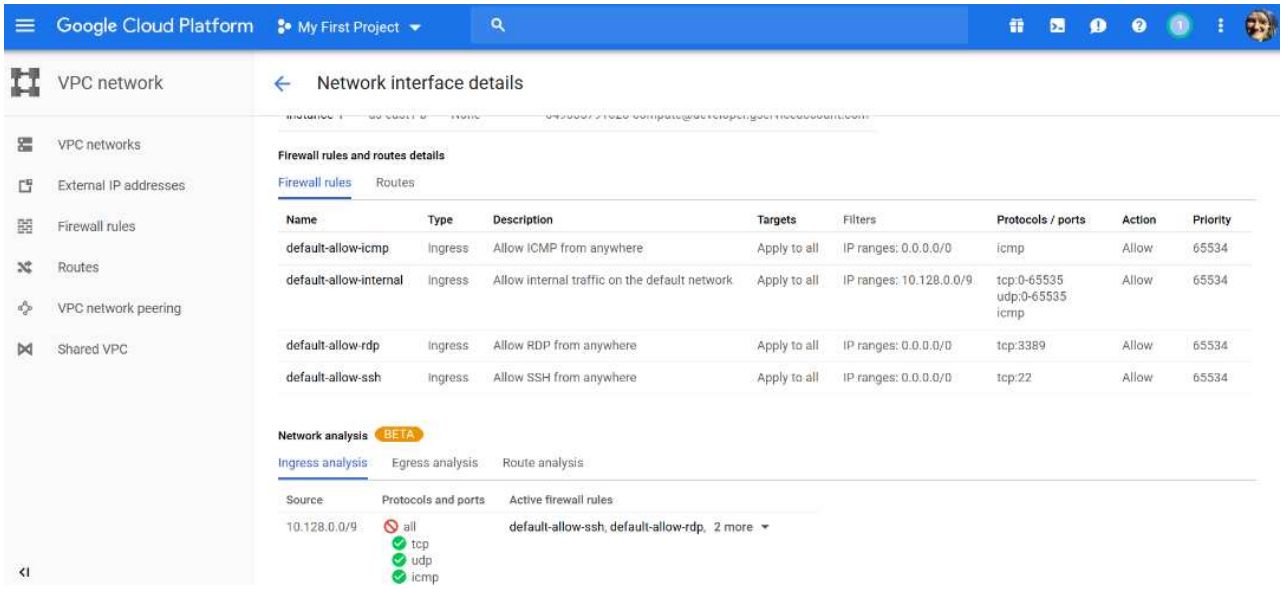

Figure 2-30
Source: Google LLC

Complete the following steps:

1. Make sure your instance is running. Under Connect, click the **SSH** drop-down arrow to see the options you have, and then click **Open in browser window**. Note that in the future, you can click SSH to go straight to the new tab in your browser.
2. When the VM's connection opens, interact with it by running some Linux commands. Which commands did you run?
   - **Answer:** Answers may vary.
3. End the connection by entering the **exit** command.
4. Delete the instance.

Connect to Azure Instance

In Azure, you can also use SSH to connect to your Linux VM. You created a Windows VM in Project 2-4, so for this project, you'll use RDP (Remote Desktop Protocol) to connect to the instance. This process is particularly simple and straightforward when using Azure from a Windows computer.

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Complete the following steps:

1. Make sure your instance is running. Click the ellipsis icon, and then click **Connect**.
2. Download and then open the RDP file. If required, click **Connect** and then click **Yes** to continue. Sign in using the credentials you created in Project 2-4.
3. When the RDP connection is established, interact with your VM's apps, utilities, or other resources. What tasks did you perform?
   - **Answer:** Answers may vary.
4. Disconnect from the VM, and then delete the instance.
5. Click **Resource groups** and delete the resource group you created in Project 2-4.

Connect to AWS Instance

Connecting to a Linux instance using an SSH client is more complicated than what you've seen so far. If you're working from a Linux computer, you'll need to use SSH (Secure Shell) to connect to your VMs. If you're using a Windows computer, you can use PuTTY, which is a free and open-source terminal emulator, or WSL (Windows Subsystem for Linux), which is the embedded Linux shell in Windows 10, to connect to Linux VMs. If you don't have PuTTY on your computer, you can download it from *putty.org*, as shown in Figure 2-31. Had we created a Windows VM, we could instead use RDP (Remote Desktop Protocol) from a Windows computer.

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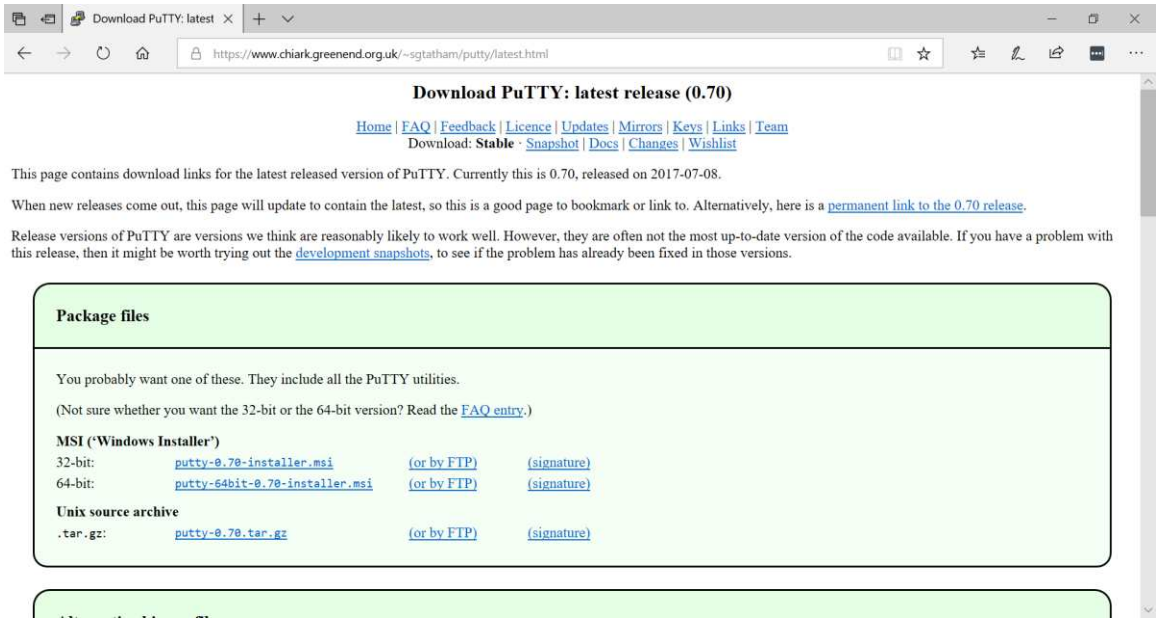

Figure 2-31
Source: Simon Tatham

These instructions apply to PuTTY on a Windows computer. If you're using a different SSH client, the steps will be similar. Complete the following steps:

1. Use PuTTYgen (see Figure 2-32) to convert the private key file from .pem to .ppk. Choose the RSA key type, and be sure to save the private key.

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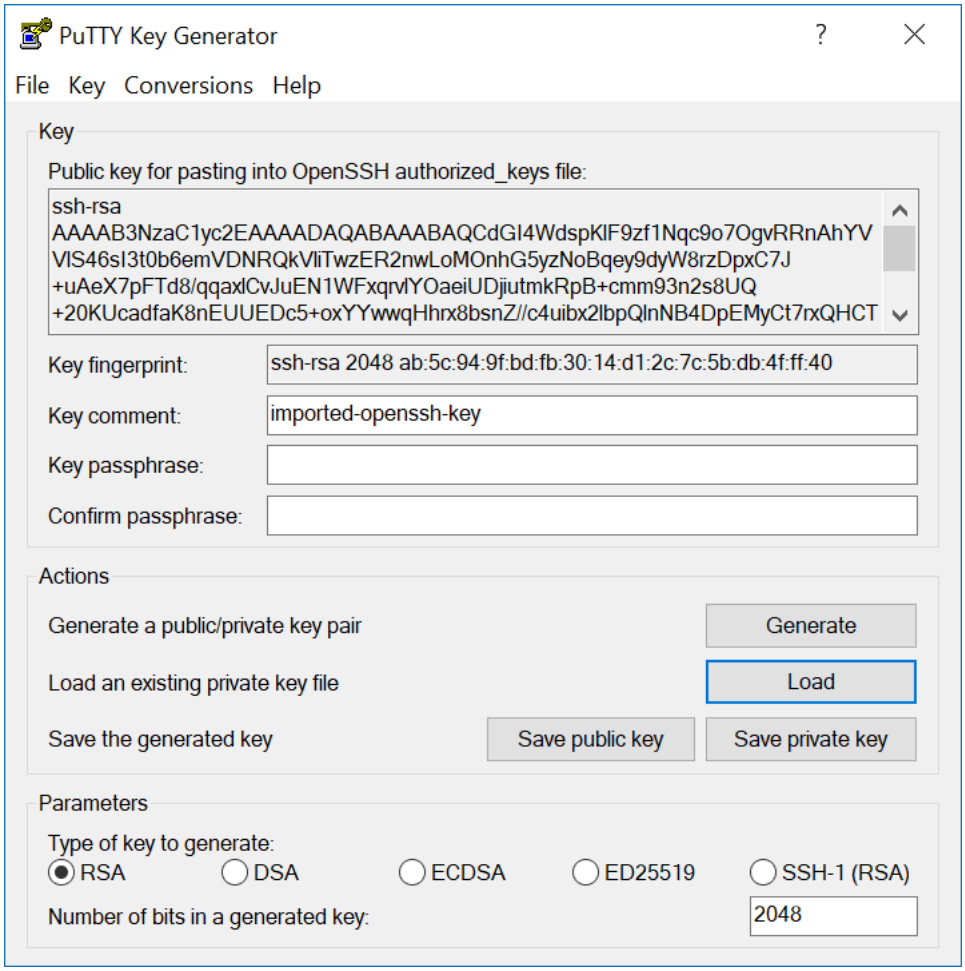

Figure 2-32
Source: Simon Tatham

2. Make sure your instance is running, and check its security group to ensure that SSH traffic is enabled for the instance. Collect needed information, including the public IPv4 address and the default username. For example, the default username for an Ubuntu VM is *ubuntu*. Common default usernames are listed in Table 2-2. Note that some OSs have multiple default username possibilities. What is the default username for your VM?
   - **Answer:** Answers will vary.

Table 2-2 Common default usernames

Default username	Operating systems
ec2-user	Amazon Linux, Red Hat Linux, SUSE Linux

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root	Red Hat Linux, SUSE Linux, Debian Linux
ubuntu	Ubuntu Linux
admin	Debian Linux
fedora	Fedora Linux
centos	CentOS Linux

3. In the PuTTY application, add the default username and the public IPv4 address in the following format: **[*username*]@[*ipaddress*]**

   Make sure the port is 22 and SSH is selected as the connection type. In the left pane, expand **SSH** and click **Auth**. Select the private key file for authentication; then click **Open**. In the security alert dialog box, click **Yes** to add your private key to PuTTY's cache.

Note

If the connection with your VM is not successful, you'll need to do some troubleshooting. For example, make sure your local firewalls (both on your network and on your physical computer) allow SSH traffic, and make sure your VM instance allows SSH traffic from the local IP address of your physical network. Make sure you used the correct private key file and that it was formatted using the correct file type. Make sure you typed the default username and the public IPv4 address of your VM correctly.

4. When the SSH connection is established, interact with your VM's apps, utilities, or other resources. What tasks did you perform?
   - **Answer:** Answers may vary.
5. Disconnect from the VM, and then terminate the instance.

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Reflection

In this module, you've seen three public cloud platforms in action: AWS, Azure, and GCP. Each has various strengths and weaknesses, such as available resources and options, ease of use, and affordability. Thinking about what you've seen so far for each, which do you like better and why?

In reality, organizations deploy multiclouds because their business needs are diverse and sometimes one platform is a better fit than another. In what situations do you think each of these platforms would be a best fit?

Go to the discussion forum in your school's LMS. Write a post of at least 100 words discussing your thoughts on these three public cloud platforms. Then respond to two of your classmates' threads with posts of at least 50 words discussing their comments and ideas. Use complete sentences, and check your grammar and spelling. Try to ask open-ended questions that encourage discussion, and remember to respond to people who post on your thread.

Grading Rubric

Qu	Standard	Possible	Earned
1	Initial post: Self-reflective discussion on each of the three cloud platforms, including a description of the favorite and descriptions of ideal use cases for each	50	
2	Initial post: Length (100 words), grammar, and spelling	10	
3	Response to classmate 1: Shows engagement and critical thinking	15	

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4	Response to classmate 2: Shows engagement and critical thinking	15	
5	Responses to classmates: Length (50 words each), grammar, and spelling	10	
	Total	**100**	

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Module 1

Introduction to Cloud Computing

At a Glance

Instructor's Manual Table of Contents

- Overview
- Objectives
- Teaching Tips
- Quick Quizzes
- Class Discussion Topics
- Additional Projects
- Additional Resources
- Key Terms

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Lecture Notes

Overview

Only a few years ago, the term "cloud computing" seemed more like a marketing gimmick than a legitimate evolution in technology. Today, it's become clear that cloud computing is here to stay and, within a few years, will likely be as much a standard mode of operation for most data centers as virtualization is today. This means that, as an IT professional, you have a responsibility to understand how to use the cloud and how to integrate those tasks within your job role in whatever specialty area you pursue. Furthermore, cloud technicians must understand a great deal about the context of services provided through the cloud, including business goals and processes, software development processes, infrastructure concepts, and necessary adaptations to security strategies specific to cloud-hosted resources. This course prepares you to take the CompTIA Cloud+ CV0-002 exam, which is a vendor-neutral exam covering a broad array of foundational and intermediate cloud computing concepts within the context of an organization's entire IT system.

Module Objectives

After reading this module and completing the exercises, the student will be able to:

- Evaluate reasons for pursuing a Cloud+ certification.
- Explore defining characteristics of cloud computing.
- Determine new skill sets required for working in the cloud.
- Identify various cloud deployment models, including public cloud, private cloud, hybrid cloud, multi-cloud, and community cloud.
- Analyze security concerns specific to each cloud deployment model.
- Identify various cloud service models, including SaaS (Software as a Service), PaaS (Platform as a Service), and IaaS (Infrastructure as a Service).
- Analyze security concerns specific to each cloud service model.
- Recognize popular cloud service providers.
- Evaluate common cloud service types, including compute, storage, network, and security services.
- Analyze security concerns specific to each cloud service model.
- Anticipate common cloud issues.
- Explain the troubleshooting steps.
- Identify helpful preventive measures.

Teaching Tips

Module 1 Scenario

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1. Summarize the introductory case study scenario presented in this module.

2. Review the ways the school in the scenario can save money by migrating to the cloud.

3. Review the action list questions identified by the team to commence their cloud conversion project. Use them to introduce the purpose of the course.

Section 1-1 Characteristics of Cloud Computing

1. Review the section learning objectives students should understand after completing this section:
   - Evaluate reasons for pursuing a Cloud+ certification.
   - Explore defining characteristics of cloud computing.
   - Determine new skill sets required for working in the cloud.

Reading 1-1-1 Cloud Computing Certifications

1. Explain the history of the CompTIA Cloud+ certification. Be sure to emphasize that the newest version of the Cloud+ certification, CV0-002, became available to the public in early 2018.

2. Use Figure 1-1 to illustrate how the Cloud+ certification builds upon the knowledge gained from the CompTIA A+, Network+, and Security+ exams. Emphasize that Cloud+ takes the foundational concepts covered in these earlier exams and applies that information to a cloud environment.

Teaching Tip	Mention that while the CompTIA A+, Network+, and Security+ certifications are not required for the Cloud+ exam, the knowledge covered by their objectives is directly relevant to the skills required of a Cloud+ certified technician.

CompTIA Cloud+ Certification

1. Explain what "vendor neutral" means and how this characteristic sets the Cloud+ exam apart from other certifications.

2. Review four reasons for pursuing the Cloud+ certification.
   - Prepare for a new job or a promotion that likely will include assuming responsibility for interacting with an organization's existing cloud services.
   - Build a foundational understanding of cloud computing in preparation for vendor-specific cloud certifications.
   - Complement certifications in other specialty areas (such as infrastructure, security, database management, or programming).

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- Develop a big-picture perspective of cloud computing technologies, major players, and industry expectations in preparation for choosing vendors and migrating on-premises ("on-prem" for short) services to the cloud.

Other Cloud Certifications

1. Describe other vendor-neutral certifications.
   - CCSP (Certified Cloud Security Professional) certification from CSA (Cloud Security Alliance)
   - $(ISC)^2$, which is the International Information System Security Certification Consortium

2. Describe vendor-specific cloud certifications.
   - Amazon Web Services (AWS) - A subsidiary of Amazon that is headquartered in Seattle, WA, and provides extensive cloud computing services to businesses and individuals.
   - Azure - Microsoft's cloud computing platform, designed for optimal compatibility with existing Microsoft products.
   - Google Cloud Platform (GCP) - Google's collection of public cloud computing services, designed to take advantage of Google's own extensive physical infrastructure around the globe.
   - Cisco's CCNA Cloud
   - VMware Certified Professional 7 – Cloud Management and Automation (VCP7-CMA) cert

Teaching Tip	5 Best Cloud Certifications 2019: https://www.businessnewsdaily.com/10748-top-5-cloud-certifications.html

Reading 1-1-2 What Is Cloud Computing?

1. Introduce the NIST (National Institute of Standards and Technology) agency's five essential characteristics of cloud computing. Refer to Figure 1-2 during the discussion.

2. Introduce the cloud computing characteristic of on-demand self-service, explaining that it refers to the ability of the service subscriber or other users to add, adjust, or remove cloud services at any time.

3. Introduce the cloud computing characteristic of broad network access, explaining that it refers to the ability to connect to cloud-hosted resources from anywhere on the Internet using a variety of device types. Compare broad network access to VPN access used by traditional network resources.

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4. Introduce the cloud computing characteristic of resource pooling, explaining that it refers to the availability of physical and virtual cloud resources to multiple subscribers according to consumer demand without regard to geographic location.

5. Introduce the cloud computing characteristic of rapid elasticity, explaining that it refers to the ability to scale cloud resources up or down according to demand.

6. Introduce the cloud computing characteristic of being a measured service, explaining that it refers to the ability to charge for cloud resource usage according to an incremented schedule based on the type of service being used.

7. Identify and describe additional cloud computing characteristics and benefits for cloud providers:
   - Self-patching/self-healing infrastructure
   - Adaptive, intelligent security
   - Cross-platform

8. Discuss the many reasons an organization might cite for transitioning to a cloud environment.

9. Explain that with mergers, acquisitions, and divestitures, cloud services that support the business will in turn need to be adapted, migrated, or replaced.

Reading 1-1-3 What Do I Need to Know?

1. Emphasize that IT professionals must continuously acquire new skills to stay relevant as cloud computing technologies emerge and mature.

2. Explain how security skills must be updated as cloud technologies emerge and mature.

3. Review other specialty areas that must be updated as cloud technologies emerge and mature.
   - Business goals and the business processes and workflows that affect every department within an organization
   - Software development processes
   - Infrastructure concepts, skills, and tools
   - Security vulnerabilities, technologies, and best practices that are specific to cloud-hosted resources

4. Emphasize how process automation is often a big cloud migration advantage. Describe how orchestration refers to the design, development, and optimization of automation processes.

5. Explain how lifelong learning ultimately requires the ability to teach oneself.

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Section 1-2 Cloud Deployment Models

1. Review the section learning objectives students should understand after completing this section:
   - Identify various cloud deployment models, including public cloud, private cloud, hybrid cloud, multi-cloud, and community cloud.
   - Analyze security concerns specific to each cloud deployment model.

Reading 1-2-1 Cloud Deployment Models

1. Compare the advantages and disadvantages of using someone else's hardware to host applications, data, and network infrastructures.

2. Emphasize how cloud computing simultaneously increases convenience while reducing an organization's control of the hardware supporting their IT resources. Point out that security concerns arise in this situation.

Reading 1-2-2 Public Cloud

1. Use Figure 1-4 to illustrate a public cloud deployment model in which shared and flexible data storage, applications, or services are managed centrally by service providers. Emphasize that hardware resources managed by the cloud service provider (CSP) are not accessible by the customer.

2. Explain the security implications from both the CSP and customer points of view, focusing on the responsibility for data security.

3. Review the CSP's industry certifications and available audit compliance reports to assist in ensuring the security of a public cloud:
   - ISO/IEC 27001
   - SSAE 18
   - PCI DSS
   - HIPPA
   - GDPR

4. Introduce the SLA (service level agreement) as a contract defining service standards a telecommunications company promises to meet for its customer and options for recourse should those service levels not be met. Explain the importance of reviewing the CSP's SLA for security standards.

5. Describe how a consumer should go about investigating the CSP's security measures by asking questions regarding the handling of data leakage between tenants, use of third-party vendors, and measures in place to ensure those organizations' compliance with standards and compliance measures.

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6. Explain the importance of understanding CSP recommendations and requirements for each organization's security measures.

Reading 1-2-3 Private Cloud

1. Explain how a private cloud represents a deployment model in which flexible data storage, applications, or services are managed centrally by an organization or service provider on hardware dedicated to that one organization.

2. Review the security implications within a private cloud.

3. Compare a private cloud hosted on-prem to the traditional data center that most organizations already have.

4. Explain how a cloud API (application programming interface) layer of communication managed by comprehensive virtualization software allows a cloud to be abstracted from the physical hardware in the data center.

5. Use Figure 1-5 to illustrate the use of an on-prem data center that is running a private cloud.

6. Discuss reasons why private cloud security requires more of a traditional approach to securing a network perimeter.

7. Remind students to implement security measures that do not rely solely on having a secure boundary around network resources. Provide examples, which might include thorough and secure data encryption, host firewalls, internal network monitoring, and both internal and external access controls.

8. Remind students to secure the virtual environment, hypervisor, VMs, and physical hosts.

Reading 1-2-4 Hybrid Cloud

1. Explain how a hybrid cloud represents a deployment model in which both private and public clouds or both cloud-based and on-prem services are used simultaneously.

2. Use Figure 1-6 to illustrate the hybrid cloud's mix of both public and private cloud components where those components and services interact with each other in a direct and seamless manner.

3. Describe the different ways an organization might move applications and services to the hybrid cloud.

4. Explain why a hybrid cloud model is the most common cloud deployment.

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Teaching Tip	For more information on public, private, and hybrid clouds, see: https://azure.microsoft.com/en-us/overview/what-are-private-public-hybrid-clouds/

Reading 1-2-5 Multi-Cloud

1. Use Figure 1-7 to illustrate how a multi-cloud model involves using cloud services from multiple vendors at one time.

2. Provide examples of how a multi-cloud model involves multiple CSPs to custom build a cloud best suited to the organization's needs.

Teaching Tip	Emphasize that the rise in popularity of hybrid and multi-clouds necessitates an expansion of skills for IT professionals. No longer is it sufficient to develop expertise in only one cloud platform. Student skill sets should cross several cloud platforms at many levels of available services.

Reading 1-2-6 Community Cloud

1. Introduce and describe a community cloud deployment model as one in which flexible data storage, applications, or services are managed centrally by an organization or service provider on hardware dedicated to a specific group of organizations. It is accessible to multiple organizations with similar concerns, but not to the general public.

Quick Quiz 1

1. What term refers to the ability to connect to cloud-hosted resources from anywhere on the Internet using a variety of device types?
   a. Resource pooling
   b. Broad network access
   c. On-demand self-service
   d. Rapid elasticity

   Answer: B

2. What term refers to the ability to scale cloud resources up or down according to demand?
   a. Resource pooling
   b. Broad network access
   c. On-demand self-service

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   d. Rapid elasticity

   Answer: D

3. True or False: A cloud is more abstracted from the physical hardware in the data center, relying on a virtualization layer of communication that is managed by comprehensive virtualization software.

   Answer: False

4. Which term refers to a legal agreement designed to restrict sharing of proprietary information by employees, partners, vendors, or customers?
   a. HIPPA
   b. On-demand self-service
   c. SLA
   d. NDA

   Answer: D

5. Which certification document refers to a European Union law establishing broad-reaching data protection standards for any information that could be tied to a single individual?
   a. The Health Insurance Portability and Accountability Act (HIPAA)
   b. General Data Protection Regulation (GDPR)
   c. NDA (nondisclosure agreement)
   d. ISO/IEC 27001

   Answer: B

Section 1-3 Cloud Service Models

1. Review the section learning objectives students should understand after completing this section:
   - Identify various cloud service models, including SaaS (Software as a Service), PaaS (Platform as a Service), and IaaS (Infrastructure as a Service).
   - Analyze security concerns specific to each cloud service model.

Reading 1-3-1 Cloud Service Models

1. Remind students that cloud computing takes functions and resources that would normally happen/reside on a local network, abstracts those functions to a software-defined level, and then provides those services back to the local network from across the Internet or another network.

2. Introduce the concept of FWaaS (firewall as a service) and explain the advantages it provides.

3. Use Figure 1-8 to introduce cloud computing modules.

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4. Introduce and explain the features of SaaS (Software as a Service). Note that most cloud consumers are familiar with SaaS. Define SaaS as the provision of application services through the cloud where those applications can be accessed from many different types of devices without having to manage any of the underlying infrastructure.

5. Introduce and explain the features of PaaS (Platform as a Service). Define PaaS as an intermediate level of cloud capability that allows consumers to deploy applications on various platforms without having to manage lower-layer infrastructure.

6. Introduce and explain the features of IaaS (Infrastructure as a Service). Note that IaaS is more technically challenging. Define IaaS as a cloud service that allows consumers to deploy a cloud-based network with services such as operating systems, applications, storage, and virtual devices.

7. Refer to Figure 1-9 and explain that these service models are often characterized according to how much a customer must know about configuring and managing cloud networks in order to use the service, and how much control that customer has over the exact configurations, features, and security measures.

8. Refer to Figure 1-10 to illustrate how each type of cloud service is accessible to users.

Reading 1-3-2 Service Model Security Concerns

1. Point out that as organizations transition to the cloud, security strategies must also evolve to protect new vulnerabilities and defend against new types of attacks.

2. Explain why each service model has different security concerns.

3. Describe the two primary areas of security concerns that organizations using SaaS must address: data security and application access.

4. Describe the two primary areas of security concerns that organizations using PaaS must address: data security and application access. Explain that PaaS users must also be concerned with application configurations and administrative or root access.

5. Explain that IaaS customers must consider similar security concerns as when running their own, on-prem infrastructure. Point out that the issues include compliance regulations, audit requirements, and identity management in addition to all the other concerns previously listed. Also note that that because IaaS customers have no control over the hardware underlying their cloud infrastructure, they must ensure that the CSP complies with standards common to the customer's industry.

Teaching Tip	SaaS, PaaS, and IaaS: three cloud models; three very different risks:

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	https://www.zdnet.com/article/saas-paas-and-iaas-three-cloud-models-three-very-different-risks/

Section 1-4 Cloud Service Providers

1. Review the section learning objectives students should understand after completing this section:
   - Recognize popular cloud service providers.
   - Evaluate common cloud service types, including compute, storage, network, and security services.
   - Analyze security concerns specific to each cloud service model.

Reading 1-4-1 Cloud Providers and Platforms

1. Remind students that cloud service providers (CSPs) offer a variety of cloud services, noting that some services are specific to a particular market niche whereas others are more generalized to meet a wider base of consumer needs.

2. Mention that salesforce.com focuses on its SaaS CRM products.

3. Mention that AWS (Amazon Web Services), Microsoft Azure, and GCP (Google Cloud Platform) are three of the top contenders for market share in the PaaS and IaaS consumer area.

4. Introduce AWS (aws.amazon.com) CSP and describe its consumer offerings in the cloud arena.

5. Introduce Microsoft Azure (azure.microsoft.com) and describe its consumer offerings in the cloud arena.

6. Introduce GCP (cloud.google.com) and describe its consumer offerings in the cloud arena.

7. Introduce IBM Cloud (ibm.com/cloud) and describe its consumer offerings in the cloud arena.

8. Introduce Oracle Cloud (cloud.oracle.com) and describe its consumer offerings in the cloud arena.

9. Introduce Alibaba Cloud (alibabacloud.com) and describe its consumer offerings in the cloud arena.

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10. Mention that there are companies that can assist you in hosting your own private cloud—essentially DIY cloud computing—using cloud management software of some kind.

11. Introduce OpenStack (openstack.org) and describe its consumer offerings in the private DIY cloud arena.

12. Introduce VMware (vmwarecom) and describe its consumer offerings in the private DIY cloud arena.

13. Introduce Eucalyptus (eucalyptus.cloud) and describe its consumer offerings in the private DIY cloud arena.

Reading 1-4-2 Common Cloud Services

1. Remind students that each CSP offers different cloud services and configures their user interfaces and product offerings in different ways.

2. Introduce the concept of a product type and explain that the major CSPs offer the same basic product types.

3. Introduce the compute product type, explaining how it refers to cloud functions that process data in some way.

4. Introduce the storage function, explaining that it refers to cloud services that store or preserve data.

5. Introduce options for configuring network functions such as connection configurations, subnets, IP addressing, VPNs, trunk lines, DHCP services, and load balancing. Note that other tools include migration resources and content delivery products, which might be grouped into their own categories.

6. Mention the traditional security functions that also apply to the cloud: security functions in the cloud include perimeter security (firewalls, IPS/IDS, and proxies for the virtual network), identity management, certificate or key management, authentication services, access controls, and token or federation services.

7. Explain why cloud services, by definition, present a larger attack surface than do traditional networks, where access can be more tightly monitored and controlled. Point out that because of this, the security tools selected—especially when configuring a public cloud—will take the needs of this abstracted, remote environment into account.

8. Describe some of the CSP application components tools that can be used for building and hosting cloud-based applications. Cloud services optimized for app development, such as testing or hosting environments, micro services, templates, security auditing, e-commerce, machine learning, and mobile services, might also be available.

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9. Describe some of the CSP management and monitoring tools, which include dashboards, monitoring services, and data analytics services.

Section 1-5 Troubleshooting Methodology

1. Review the section learning objectives students should understand after completing this section:
   - Anticipate common cloud issues.
   - Explain the troubleshooting steps.
   - Identify helpful preventive measures.

Reading 1-5-1 Common Cloud Computing Problems

1. Discuss how the troubleshooting method defined by CompTIA can help a student organize their thoughts and their approach to solving problems.

2. Provide an overview of common cloud issues that can be addressed by a methodical troubleshooting process.
   - Connectivity issues
   - Latency
   - Capacity
   - Security

Reading 1-5-2 Troubleshooting Steps

1. Refer to Figure 1-11 to identify and describe each of the six steps in the CompTIA troubleshooting methodology:
   - Step 1: Identify the problem.
   - Step 2: Establish a theory of probable cause.
   - Step 3: Test the theory to determine cause.
   - Step 4: Establish a plan of action to resolve the problem and implement the solution.
   - Step 5: Verify full system functionality, and, if applicable, implement preventive measures.
   - Step 6: Document findings, actions, and outcomes.

Teaching Tip	Emphasize that the Cloud+ exam might give a student a troubleshooting scenario that requires them to identify the next step according to the troubleshooting method described in this section. Explain how to do this by using the information given to identify which steps of the troubleshooting process have been completed so far in the scenario, and then identifying which step should come next and which of the task options would accomplish that step.

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Reading 1-5-3 Preventive Measures

1. Introduce and explain the measures that can be taken to help minimize the likelihood of problems cropping up in a cloud environment:
   - Maintain good monitoring and analysis techniques.
   - Thoughtfully configure your dashboards to show the most helpful information.
   - Follow good change management processes.
   - Understand your cloud services and how to identify where problems are likely to occur, how to locate those problems, and how best to address them.

Quick Quiz 2

1. Under which cloud computing service does Google's office productivity suite fall?
   a. PaaS
   b. IaaS
   c. SaaS
   d. DBaaS
   Answer: C

2. True or False: IaaS customers must understand more about configuring their cloud infrastructure than do SaaS customers.
   Answer: True

3. Which cloud computing platform is open-source software designed by Rackspace and NASA to create do-it-yourself compute, storage, and networking cloud services?
   a. GCP
   b. Eucalyptus
   c. Alibaba Cloud
   d. OpenStack
   Answer: D

4. What are the two primary areas of security concern for organizations using SaaS?
   a. Data security and network security
   b. Root access to servers and application access
   c. Network security and server monitoring
   d. Data security and application access
   Answer: D

5. "_____" is the first step in the troubleshooting process.
   Answer: Identify the problem

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Class Discussion Topics

1. As a class, discuss the differences between IT security implementations for a traditional local data center and a cloud environment.

2. As a class, discuss the difference between a private cloud service and public cloud services. Why are both necessary?

Additional Projects

1. The students have learned that there are several cloud services providers. AWS (Amazon Web Services), Microsoft Azure, and GCP (Google Cloud Platform) are the three top contenders for cloud platform market share. Have each student research these CSPs, comparing them in relation to the cloud services features they support and their prices. The students should then prepare a report summarizing their research.

Additional Resources

1. What is cloud computing? Everything you need to know about the cloud, explained: https://www.zdnet.com/article/what-is-cloud-computing-everything-you-need-to-know-from-public-and-private-cloud-to-software-as-a/

2. What is Firewall as a Service (FWaaS) and Why You Need It: https://www.techwalls.com/firewall-as-service-fwaas-why-you-need-it/

3. Seven Key Challenges to Cloud Computing: https://e2logy.com/blog/seven-key-challenges-to-cloud-computing/

4. How to diagnose cloud performance issues: https://www.infoworld.com/article/3237824/how-to-diagnose-cloud-performance-issues.html

Key Terms

For definitions of key terms, see the Glossary near the end of the book.

- **acquisition**
- **Alibaba Cloud**
- **API (application programming interface)**

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- **automation**
- **AWS (Amazon Web Services)**
- **Azure**
- **broad network access**
- **cloud bursting**
- **community cloud**
- **compute**
- **CRM (customer relationship management) system**
- **CSP (cloud service provider)**
- **DevOps (development and operations)**
- **divestiture**
- **DR (disaster recovery)**
- **Eucalyptus (Elastic Utility Computing Architecture for Linking Your Programs To Useful Systems)**
- **G Suite**
- **GCP (Google Cloud Platform)**
- **GDPR (General Data Protection Regulation)**
- **HA (high availability)**
- **HIPAA (Health Insurance Portability and Accountability Act)**
- **hybrid cloud**
- **IaaS (Infrastructure as a Service)**
- **IBM Cloud**
- **ISO/IEC 27001**
- **knowledge base**
- **latency**
- **measured service**
- **merger**
- **NDA (nondisclosure agreement)**
- **NIST (National Institute of Standards and Technology)**
- **on-demand self-service**
- **OpenStack**
- **Oracle Cloud**
- **orchestration**
- **PaaS (Platform as a Service)**
- **PCI DSS (Payment Card Industry Data Security Standard)**
- **private cloud**
- **public cloud**
- **rapid elasticity**
- **resource pooling**
- **SaaS (Software as a Service)**
- **SLA (service level agreement)**
- **SOC (Service Organization Control) report**
- **SSAE (Statement on Standards for Attestation Engagements No. 18)**
- **storage**
- **tenant**
- **virtualization**

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- **VMware**
- **VPN (virtual private network)**

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