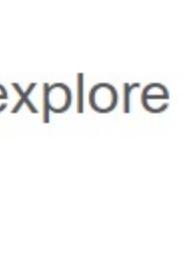# Module Practice and Quiz

13.4.1

Lab – Install Linux in a Virtual Machine and Explore the GUI

In this lab, you will install a Linux OS in a virtual machine using a desktop virtualization application, such as VirtualBox. After completing the installation, you will explore the GUI interface.

Install Linux in a Virtual Machine and Explore the GUI

13.4.2

What did I learn in this module?

Cloud Computing

Cloud computing involves large numbers of computers connected through a network that can be physically located anywhere. Cloud computing can reduce operational costs by using resources more efficiently. Cloud computing addresses a variety of data management issues:

- It enables access to organizational resources anywhere and at any time.
- It streamlines the organization's IT operations by subscribing only to needed services.
- It eliminates or reduces the need for onsite IT equipment, maintenance, and management.
- It reduces cost for equipment, energy, physical plant requirements, personnel training needs.
- It enables rapid responses to increasing data volume requirements.

The three main cloud computing services defined by the National Institute of Standards and Technology (NIST) are Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). With SaaS, the cloud provider is responsible for access to applications and services, such as email, communication, and Office 365 that are delivered over the internet. With PaaS, the cloud provider is responsible for providing users access to the development tools and services used to deliver the applications. With IaaS, the cloud provider is responsible for giving IT managers access to the network equipment, virtualized network services, and supporting network infrastructure. The four types of clouds are public, private, hybrid, and community. Cloud-based applications and services offered in a public cloud are made available to the general population. Cloud-based applications and services offered in a private cloud are intended for a specific organization or entity, such as the government. A hybrid cloud is made up of two or more clouds (example: part private, part public), where each part remains a separate object, but both are connected using a single architecture. A community cloud is created for exclusive use by a specific community.

Virtualization

The terms "cloud computing" and "virtualization" are often used interchangeably; however, they mean different things. Virtualization is the foundation of cloud computing. Virtualization separates the operating system (OS) from the hardware. Historically, enterprise servers consisted of a server OS, such as Windows Server or Linux Server, installed on specific hardware. All of a server's RAM, processing power, and hard drive space were dedicated to the service. When a component fails, the service that is provided by this server becomes unavailable. This is known as a single point of failure. Another problem with dedicated servers is that they often sat idle for long periods of time, waiting until there was a need to deliver the specific service they provide. This wastes energy and resources (server sprawl). Virtualization reduces costs because less equipment is required, less energy is consumed, and less space is required. It provides for easier prototyping, faster server provisioning, increased server uptime, improved disaster recovery, and legacy support. A computer system consists of the following abstraction layers: services, OS, firmware, and hardware. With Type 1 hypervisors, the hypervisor is installed directly on the server or networking hardware. A Type 2 hypervisor is software that creates and runs VM instances. It can be installed on top of the OS or can be installed between the firmware and the OS. A Type 2 hypervisor is software that creates and runs VM instances.

Virtual Network Infrastructure

Type 1 hypervisors are also called the "bare metal" approach because the hypervisor is installed directly on the hardware. Type 1 hypervisors have direct access to the hardware resources and are more efficient than hosted architectures. They improve scalability, performance, and robustness. Type 1 hypervisors require a "management console" to manage the hypervisor. Management software is used to manage multiple servers using the same hypervisor. The management console can automatically consolidate servers and power on or off servers as required. The management console provides recovery from hardware failure. Some management consoles also allow server over allocation. Server virtualization hides server resources, such as the number and identity of physical servers, processors, and OSs from server users. This practice can create problems if the data center is using traditional network architectures. Another problem is that traffic flows differ substantially from the traditional client-server model. Typically, a data center has a considerable amount of traffic being exchanged between virtual servers. These flows are called East-West traffic and can change in location and intensity over time. North-South traffic occurs between the distribution and core layers and is typically destined for offsite locations such as another data center, other cloud providers, or the internet.

Software-Defined Networking

Two major network architectures have been developed to support network virtualization: Software-Defined Networking (SDN) and Cisco Application Centric Infrastructure (ACI). SDN is an approach to networking where the network is software programmable remotely. Components of SDN may include OpenFlow, OpenStack, and other components. The SDN controller is a logical entity that enables network administrators to manage and dictate how the data plane of switches and routers should handle network traffic. A network device contains a control plane and a data plane. The control plane is regarded as the brains of a device. It is used to make forwarding decisions. The control plane contains Layer 2 and Layer 3 route forwarding mechanisms, such as routing protocol neighbor tables and topology tables, IPv4 and IPv6 routing tables, STP, and the ARP table. Information sent to the control plane, is processed by the CPU. The data plane, also called the forwarding plane, is typically the switch fabric connecting the various network ports on a device. The data plane of each device is used to forward traffic flows. Routers and switches use information from the control plane to forward incoming traffic out the appropriate egress interface. Information in the data plane is typically processed by a special data plane processor without the CPU getting involved. Cisco Express Forwarding (CEF) uses the control plane and data plane to process packets. CEF is an advanced, Layer 3 IP switching technology that enables forwarding of packets to occur at the data plane without consulting the control plane. SDN is basically the separation of the control plane and data plane. The control plane function is removed from each device and is performed by a centralized controller. The centralized controller communicates control plane functions to each device. The management plane is responsible for managing a device through its connection to the network. Network administrators use applications such as Secure Shell (SSH), Trivial File Transfer Protocol (TFTP), Secure FTP, and Secure Hypertext Transfer Protocol (HTTPS) to access the control plane and configure a device. Protocols like Simple Network Management Protocol (SNMP) use the management plane.

Controllers

The SDN controller is a logical entity that enables network administrators to manage and dictate how the data plane of switches and routers should handle network traffic. The SDN controller defines the data flows between the centralized control plane and the data planes on individual routers and switches. Each flow traveling through the network must first get permission from the SDN controller, which verifies that the communication is permissible according to the network policy. If the controller allows a flow, it computes a route for the flow to take and adds an entry for that flow in each of the switches along the path. The controller populates flow tables. Switches manage the flow tables. A flow table matches incoming packets to a particular flow and specifies the functions that are to be performed on the packets. There may be multiple flow tables that operate in a pipeline fashion. A flow table may direct a flow to a group table, which may trigger a variety of actions that affect one or more flows. A meter table triggers a variety of performance-related actions on a flow including the ability to rate-limit the traffic. Cisco developed the Application Centric Infrastructure (ACI) which is a more advanced and innovative way than earlier SDN approaches. Cisco ACI is a hardware solution for integrating cloud computing and data center management. At a high level, the policy element of the network is removed from the data plane. This simplifies the way data center networks are created. The three core components of the ACI architecture are Application Network Profile (ANP), Application Policy Infrastructure Controller (APIC), and Cisco Nexus 9000 Series switches. The Cisco ACI fabric is composed of the APIC, and Cisco Nexus 9000 series switches using two-tier spine-leaf topology. When compared to SDN, the APIC controller does not manipulate the data path directly. Instead, the APIC centralizes the policy definition and programs the leaf switches to forward traffic based on the defined policies. There are three types of SDN. Device-based SDN is when the devices are programmable by applications running on the device itself or on a server in the network. Controller-based SDN uses a centralized controller that has knowledge of all devices in the network. Policy-based SDN is similar to controller-based SDN where a centralized controller has a view of all devices in the network. Policy-based SDN includes an additional Policy layer that operates at a higher level of abstraction. Policy-based SDN is the most robust, providing for a simple mechanism to control and manage policies across the entire network. Cisco APIC-EM is an example of policy-based SDN. Cisco APIC-EM provides a single interface for network management including discovering and accessing device and host inventories, viewing the topology, tracing a path between end points, and setting policies. The APIC-EM Path Trace tool allows the administrator to easily visualize traffic flows and discover any conflicting, duplicate, or shadowed ACL entries. This tool examines specific ACLs on the path between two end nodes, displaying any potential issues.

13.4.3

Module Quiz – Network Virtualization

1. A company uses a cloud-based payroll system. Which cloud computing technology is this company using?
   - ○ wireless as a service (WaaS)
   - ○ browser as a service (BaaS)
   - ○ infrastructure as a service (IaaS)
   - ● software as a service (SaaS)

2. For a data center, what is the difference in the server virtualization data traffic compared with the traditional client-server model?
   - ○ Data traffic from clients will be routed to multiple virtual servers.
   - ○ More network control traffic is generated between virtual servers and clients.
   - ○ There is more data traffic flowing from virtual servers to clients.
   - ● There are significant data exchanges between virtual servers.

3. Which component in a traditional infrastructure device provides Layer 2 and Layer 3 functions to create data paths within a network?
   - ○ adjacency table
   - ● control plane
   - ○ forwarding information base
   - ○ data plane

4. Which network traffic management technology is a basic element in SDN implementations?
   - ○ OpenStack
   - ○ Interface to the Routing System
   - ● OpenFlow
   - ○ IEEE 802.1aq

5. Which two technologies are core components of Cisco ACI architecture? (Choose two.)
   - ☐ OpenFlow enabled switches
   - ☐ Transparent Interconnection of Lots of Links
   - ☑ Application Policy Infrastructure Controller
   - ☐ Interface to the Routing System
   - ☑ Application Network Profile

6. Which Cloud computing service would be best for a new organization that cannot afford physical servers and networking equipment and must purchase network services on-demand?
   - ● IaaS
   - ○ ITaaS
   - ○ PaaS
   - ○ SaaS

7. Which services are provided by a private cloud?
   - ● multiple internal IT services in an enterprise
   - ○ secure communications between sensors and actuators
   - ○ encrypted data storage in cloud computing
   - ○ online services to trusted vendors

8. What are two reasons an organization might use cloud computing? (Choose two.)
   - ☐ enables connectivity between disparate networks
   - ☑ enables global access to corporate data
   - ☐ reduces the time needed for maintenance windows
   - ☑ provides power and physical plants capable of meeting increased requirements
   - ☐ increases corporate use of technology resources

9. What is a characteristic of data flow processing in SDN?
   - ○ OpenStack is used to construct the entry in switches to facilitate data forwarding.
   - ○ The SDN controller attaches an entry to each packet to identify the flow.
   - ● Each data flow through the network must be approved by the SDN controller first.
   - ○ The SDN controller routes a data flow first and the data plane will use policies to permit or deny the flow.

10. What are three abstraction layers of a computer system? (Choose three.)
    - ☐ security
    - ☑ hardware
    - ☑ services
    - ☐ data
    - ☐ network
    - ☑ firmware

11. In software defined network architecture, what function is removed from network devices and performed by an SDN controller?
    - ○ application policies
    - ○ data plane
    - ○ security
    - ● control plane

12. Which term describes the data exchanges between virtual servers in a data center?
    - ○ vertical traffic
    - ● east-west traffic
    - ○ backbone traffic
    - ○ north-south traffic

13. How is the control plane modified to operate with network virtualization?
    - ○ Control plane redundancy is added to each network device.
    - ● The control plane function is consolidated into a centralized controller.
    - ○ A hypervisor is installed in each device to allow multiple instances of the control plane.
    - ○ The control plane on each device is interconnected to a dedicated high-speed network.

14. Which Cloud computing service would be best for an organization that needs to collaboratively create applications and deliver them over the web?
    - ● PaaS
    - ○ SaaS
    - ○ ITaaS
    - ○ IaaS

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