Project Report

COMP-3670

Computer Networks

Cisco Academy Project

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Introduction to Packet Tracer

Cisco is one of the largest global corporations that produces, sells, and maintains multi-scale network gear, its systems, and provides training for a variety of network professionals. They provide *Cisco Networking Academy*, an online self-directed learning system where users can gain a variety of official certifications in networking and security [1] by completing the courses. One of the course catalogues includes *Introduction to Packet Tracer*, a catalogue made up of three courses where users can practice networking, IoT (Internet of Things), and cybersecurity with *Cisco Packet Tracer*, Cisco's simulation and visualization tool for networking without the risk of disrupting an existing network or needing equipment [2].

Users wishing to gain access to the course only need to enroll with an account/register with an email on *Cisco Networking Academy*. Users will be redirected to *SkillsForAll.com* as the course has been improved and is available on a new site. Through this site, users can register for a learner account using their email to access courses. Some courses have a cost attached to them, but the *Introduction to Packet Tracer* catalogue of courses is free for all users. From there, enrolling in the *Getting Started with Cisco Packet Tracer* course will include the download the link for the *Packet Tracer* software.

Technological Details

Installation

After enrolling in the *Getting Started with Cisco Packet Tracer* course, users can download the software for their respective operating systems. The installation process is identical to other software installations - launching the executable, agreeing to the license agreement, the location of folders for installation, and waiting for the installation process to finish. Once finished, users can launch *Cisco Packet Tracer*.

Interface Features

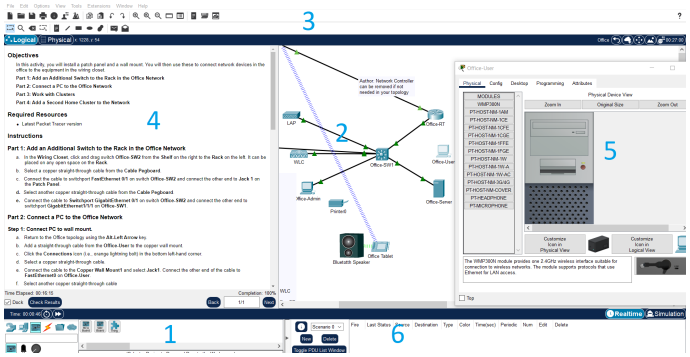

Figure 1: Interface for an activity; Source: Adapted from [4]

Packet Tracer provides three menus on its interface - adding devices and connecting them by cables or wireless (Label 1, Figure 1), managing network components/devices (Label 2, Figure 1), and network management (Label 3, Figure 1). The courses provide activities (*Packet Tracer* files) with instructions (Label 4, Figure 1) to help users understand how to explore a concept in networking in *Packet Tracer*, such as implementing a network controller to monitor compatible network devices and using a registration server for IoT devices [4]. The network management menu (Label 3) allows users to open networks, save networks, and modify preferences. Devices can be deployed by going to the appropriate device (Label 1) and dragging it to the space to manage network devices (Label 2). Depending on the device, the Physical (interacting with the device itself), Config (unique to *Packet Tracer*, configuring devices with a GUI, changes on the command line interface will match here), CLI (command line interface; "requires knowledge of device configuration with Cisco Internetwork Operating System (IOS)" [3]), Desktop (device-dependent interface to access

applications, IP and wireless configuration, and command prompt), and Services (configure common server processes such as HTTP, DHCP, DNS, and other services) [3] tabs will appear (Label 5, Figure 1). All device configuration and verification of connections are done in the Config and Desktop tabs, making them important to know how to use. Additionally, *Packet Tracer* provides an area to view sent packets (Label 6, Figure 1). To explore both the logical and physical concepts of networking, *Cisco Packet Tracer* provides both a logical mode and a physical mode.

Logical Mode

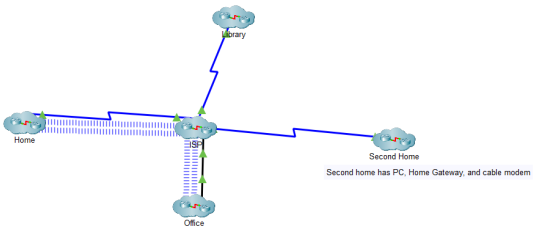

Figure 2: Logical layout networks in a city; Source: Adapted from [3]

Logical mode provides users a high-level view of the network and ignores physical aspects of the network itself [2]. Here, the devices and connections will be visible, but the physical locations will not be visible. Networks between locations are a cluster of end devices and network devices connected to the ISP. Selecting a group of devices allows the option to create a cluster, and selecting a cluster allows the option to un-cluster the devices and see them separately [3]. When connecting devices, the type of connection can be seen between the clusters. In Figure 2, coaxial wire connections have been made between the home, library, and second home as seen by the jagged blue line. Wireless connections are being made between the home and the office as seen by the dashed lines.

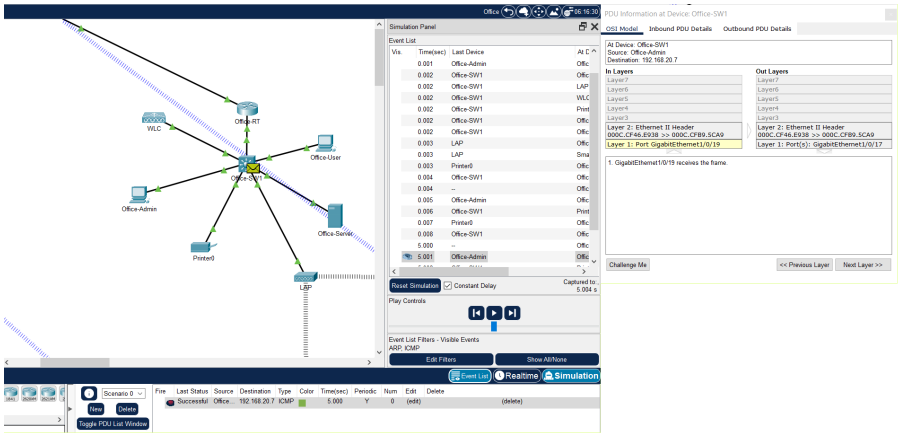

Figure 3: Inside a cluster in logical mode, viewing packet traffic; Source: Adapted from [3]

Inside the cluster (or a workspace of devices), users can send protocol data units (PDUs) from one device to another to analyze network traffic. PDUs are used to check that basic connectivity, security, and services (DNS, HTTP) are working as intended [3]. Using one of the envelope icons (open = complex, closed = simple), users can send a PDU from one device to another. Complex PDUs will have more settings to them, such as how frequently the packet is sent, the source and destination addresses, and the sequence number [3]. Additionally, the packets can be sent

in real-time mode (continuous time) or simulation mode (change speed of time) [3]. In Figure 3, a complex PDU is sent from Office-Admin to Printer-0 every 5 seconds. The user can see it is sent to Office-SW1 and then sent to Printer-0. The printer replies, sending it back to Office-SW1 and back to Office-Admin. If the event of a packet moving is clicked, the user can analyze the packet information. On the right side of Figure 3, the packet information is displayed with the OSI model, Inbound PDU Details, and Outbound PDU Details tabs. The OSI model mode provides a "summary of the addresses and contents of the headers at each layer" [3] while Inbound and Outbound PDU details provide "the exact format of the appropriate headers" [3].

Additionally, interactions with IoT devices can be done using *Packet Tracer*. After the IoT device has been configured appropriately with the Home Gateway or registration server [4], clicking the *Alt* key on a device/moving the cursor near a device with the *Alt* key held down allows users to interact with them (ex. Smart lamps can be turned on and off). Users can also create their own IoT "Things" by going into Advanced mode and working with the Thing Editor tab. Users can customize the icon of the "Thing" and its behaviour through rules and implementing a JavaScript, Python, or Visual Blocky script (modified from an existing "Thing"; ex. making a motion detecting security camera based on a motion detector). Users can also adjust environmental values to affect how IoT devices will react (ex. when the ambient temperature hits a certain threshold, turn on the air conditioner) [4] as seen in Figure 5 where users can choose to change the ambient temperature.

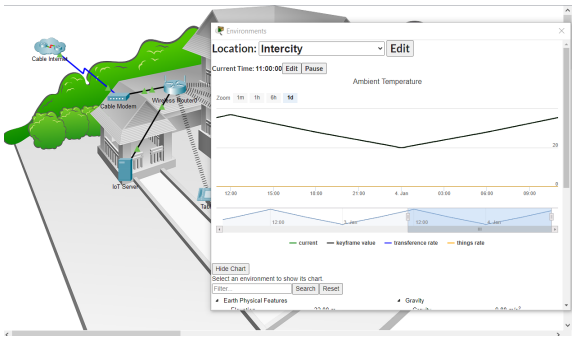

Figure 4: Ambient temperature graph; Source: Adapted from [4]

Physical Mode

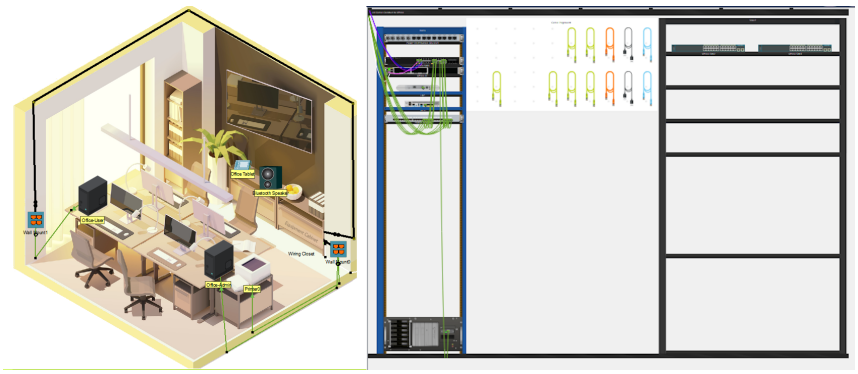

Figure 5: Physical layout of an office network and its wiring closet; Source: Adapted from [3]

Physical mode allows users to see the devices on the network on the physical scale, including the placement of devices and cables [2]. Here, the devices can be seen and the physical locations they may be in, such as an office in Toronto. On the left side of Figure 6, the physical layout of an office and its network can be seen. Devices are connected with the appropriate cables to the correct ports and connections can be structured to go into the walls with bend points to be more organized and realistic (ie. no office stretches a wire all over the workspace to implement a network) [3].

Further in the physical office network, the wiring closet on the right side of Figure 6 allows users to install equipment necessary for the network. Devices from the rack (gray shelf) are inactive but can be dragged to the shelf (blue shelf) for installation with the appropriate cables (ex. copper-straight-through) in the appropriate ports (ex. the router's FastEthernet 0/1/0 and a PC's ethernet port) [3]. A table can be placed in between the two shelves to place end devices such as computers to test connections and proper installation. Cables hang from the cable pegboard between the rack and shelf at the top for the user to select. For better organization and a cleaner workspace, cables can be managed by the user so they do not loosely hang all over the workspace. The colors of the cables can also be changed to better distinguish which cable is going to which device.

Experience

My experience with the *Introduction to Packet Tracer* courses has helped give me a better understanding of how cybersecurity, networking and the IoT works. I started by downloading the software and went through each course systematically, dedicating a day to each and completing the videos and activities. The videos gave an overview on what I would be doing. The activities allowed me to become familiar with configuring IoT devices, end devices, and network devices to connect to the Internet by following what was discussed in the video and the provided instructions. Through the troubleshooting activity, knowing the details of the problem and taking a systematic approach to the solution was important for networking.

Majority of the instructions were easy to follow. Some of the activities I found interesting such as learning about the IoT in detail. I did not realize that concept was just about the network of smart devices, or "Things". Depending on the environmental values around these devices, they can change their state. The devices and their states can be monitored using a registration server, a home gateway, or a network controller. Some activities I did have issues from missing some instructions such as missing a detail to configure. An example was during the troubleshooting activity, I had issues finding the login information for the network. I had needed hints to realize I needed to find the default gateway and access the server for the wireless security login information. This experience showed that I need to pay close attention to every single detail when it comes to networking, especially cybersecurity to make sure everything is secure.

At the end of each course, I reviewed the summary of each and wrote some key notes to make sure I understood how everything worked before moving to the next topic and before taking the catalogue's final exam. The final exam was a multiple-choice exam based on the concepts learned in the three courses and how to use the *Packet Tracer* software. By taking the final exam, I was able to gain a certification in *Introduction to Packet Tracer* and gain networking skills.

Summary

Cisco Packet Tracer is a network simulation and visualization tool that allows users to build their own networks, provided by *Cisco Networking Academy's Introduction to Packet Tracer* catalogue of courses for users to practice networking, cybersecurity, and IoT. The course and software are free for all users and simple to install without the risk of potentially disrupting an existing network. *Packet Tracer* allows users to see their network from both a physical context and a logical context. The physical context allows users to see their network physically, from the devices to the cables connecting the networks together. In the logical context, users can see how the devices and networks are connected without the physical aspects of devices. Some logical aspects include examining the route a packet takes as a PDU, changing environmental variables to see how IoT devices react, and grouping devices together as a network, or a cluster of devices. The *Introduction to Packet Tracer* course catalogue is built on these views to explore the installation of devices, IoT devices, and configuring networks. My overall experience with it was valuable as I acquired new skills in networking, cybersecurity, and IoT. Completing the course activities allows users to configure devices in small networks and develop soft skills, such as taking a systematic approach to problem solving with networks. In turn, this course catalogue and software can help one acquire skills in building a career in networking and security.

References

[1] "Skills for All with Cisco Networking Academy," Cisco Networking Academy, [Online] Available: https://skillsforall.com/. [Accessed 01-Jun-2022]

[2] "Getting Started with Cisco Packet Tracer Course," Cisco Networking Academy, [Online] Available: https://skillsforall.com/course/getting-started-cisco-packet-tracer. [Accessed 01-Jun-2022].

[3] "Exploring Networking with Cisco Packet Tracer Course," Cisco Networking Academy, [Online] Available: https://skillsforall.com/course/exploring-networking-cisco-packet-tracer. [Accessed 02-Jun-2022].

[4] "Exploring IoT with Cisco Packet Tracer Course," Cisco Networking Academy, [Online] Available: https://skillsforall.com/course/exploring-iot-cisco-packet-tracer. [Accessed 03-Jun-2022].