Lab Book:
Data Transmission Over Digital Networks

Contents

Data Transmission over Digital Networks

Lab Objectives

1. Add a home network to the pre-configured CAS Base Internet Topology.
2. Explain the concept of IP addresses and URLs, and their importance to the operation of the Internet.
3. Use the pre-built CAS WAN Topology to explore the concept of packet switching (including packetization) within the Internet.

Lab Resources

- Packet Tracer (PT) 6.01 or higher.
- Computer with Windows OS, XP or higher.

Task 1 – Build the Home Network

1. Open the pre-built Packet Tracer file *CASBIT_BUILD.pkz* . This network simulates basic Internet services, and is fully operational, but you need to build a home network for Bob as per the diagram below:

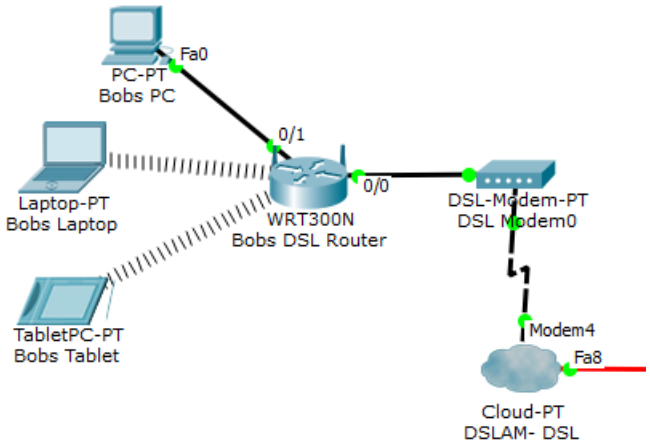


Figure 1 – Bob's Home Network

2. Laptop computers in PT have a wired Network Interface Card (NIC) fitted – you will need to change this to a wireless NIC to communicate with the wireless router. Double click on the laptop icon to open up the configuration options – ensure that the Physical tab is selected, which will allow you to change the installed hardware:

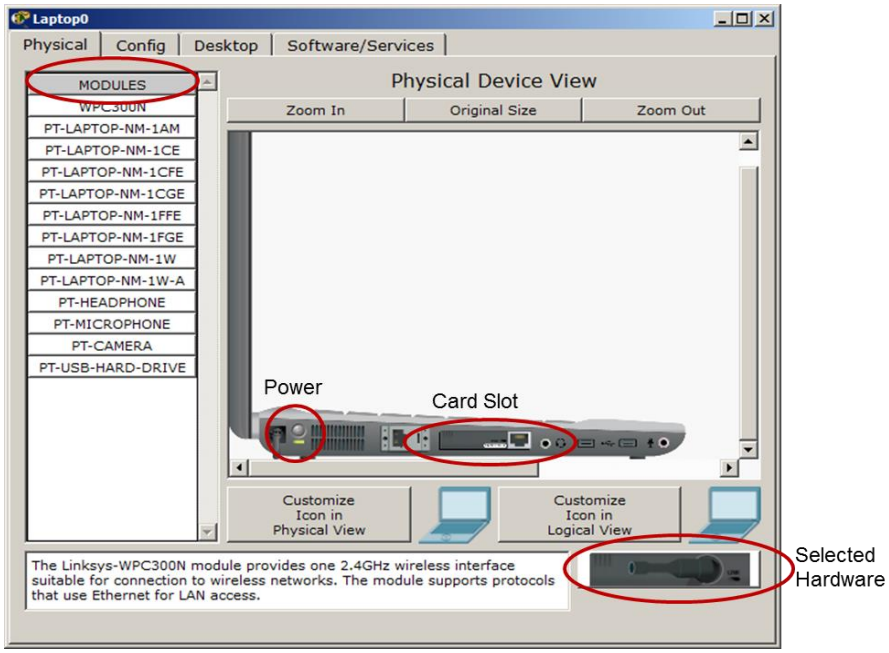


Figure 2 – Laptop Hardware Configuration

3. Turn off the power on the laptop, and select and drag the NIC in the card slot over to the *Modules* section on the left of the window, leaving the card slot empty. Select the wireless NIC in the *Selected Hardware* section, drag it into the card slot and switch the power back on. What happens if you try to remove a card with the power on? Why is it good practice to switch off the power before working on computer hardware?

Task 2 – Configure IP Addresses

4. Data packets are sent to and from devices connected to the Internet using Internet Protocol (IP) addresses. Each device that connects to the Internet need to have an IP address assigned. Currently, the most popular type of address used is IPv4, which consists of a 32-bit binary number, which is usually displayed in a 'dotted decimal' format to make it easier to understand.

5. Bob's wireless router will automatically assign IPv4 addresses to all the devices connected to it using the Dynamic Host Configuration Protocol (DHCP).

6. Check each of Bob's device to ensure that the have received an IP address via DHCP from the wireless router LAN pool by selecting each device in turn and opening up the *desktop* tab to review the *IP configuration*:

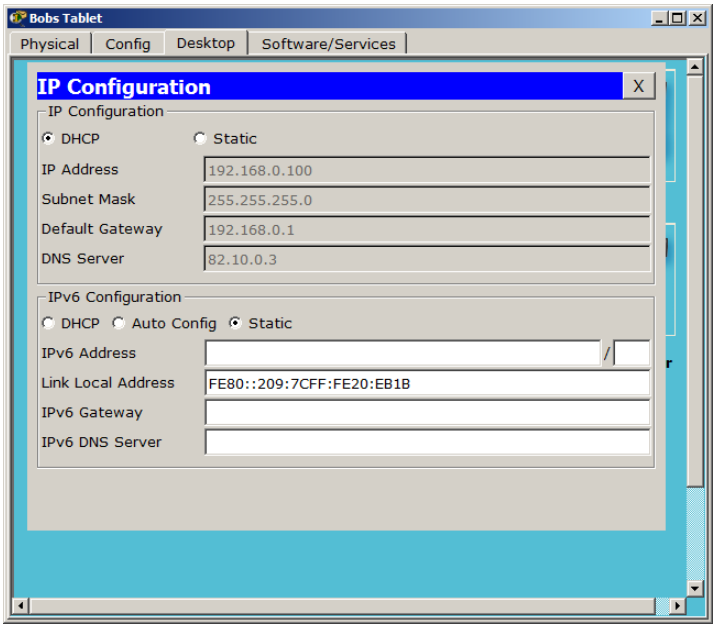


Figure 3 – Client DHCP Configuration

7. Ensure that all of Bob's devices are set to use DHCP, and that they have obtained IP address information, and then consider the following questions:

8. Which addresses has been assigned to Bob's devices?

9. Why do you think each device has a different IP address?

10. What is the address of the default router assigned to each of Bob's devices?

11. The default gateway is the device used to connect local devices to devices located on other networks. As Bob connects to the Internet via an Internet Service Providers (ISPs), then his wireless router must provide access to all other networks, and is thus acting as a default gateway. Bob's wireless router has used DHCP to advertise its own interface IP address (192.168.0.1) as the default gateway for all devices in Bob's house.

12. Select Bob's wireless router and select the *GUI* tab, and examine the settings:

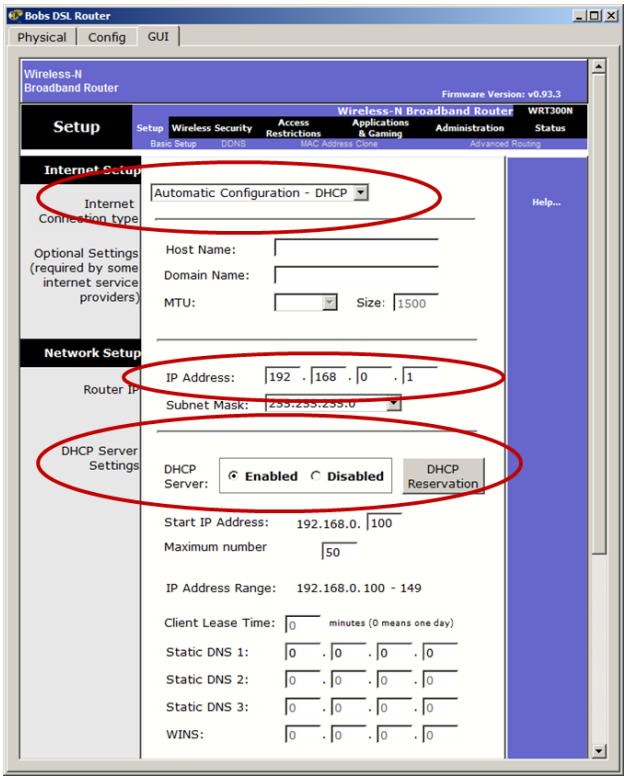


Figure 4 – Wireless Router Configuration

13. The *Network Setup* area displays the configuration of the DHCP server that is providing IP addresses to Bob's home, and it is currently enabled.

14. What is the first address that the wireless router will provide to Bob's home?

15. How many devices can be assigned IP address from the configured DHCP pool? Can this be changed?

16. The Wireless router is also configured to use DHCP to get an IP address for the interface that connects to the ISP, as shown in the Internet Setup area.

17. Try and discover the IP address that has been assigned to the wireless router by the ISP. How does it compare with the addresses being used by Bob's devices?

Task 3 – Access a Web Site from Bob's House

18. The ISP provides access to three web servers, identified by addresses called Uniform Resource Locaters (URLs). These are usually written as a sequence of letters and numbers, making it easy for you access web sites. However, data will be exchanged between the device in Bob's house and the web servers using IP addresses, as they do not understand URLs. Thus it is necessary to use a Domain Name System server to convert between URLs and the IP addresses that devices need to reach services on the Internet.

19. Open Bob's PC, select the *Desktop* tab and open the web browser. Type the URL of the Cisco Networking Academy (www.netacad.com) website into the address bar and select Go (or just use the 'enter' key):

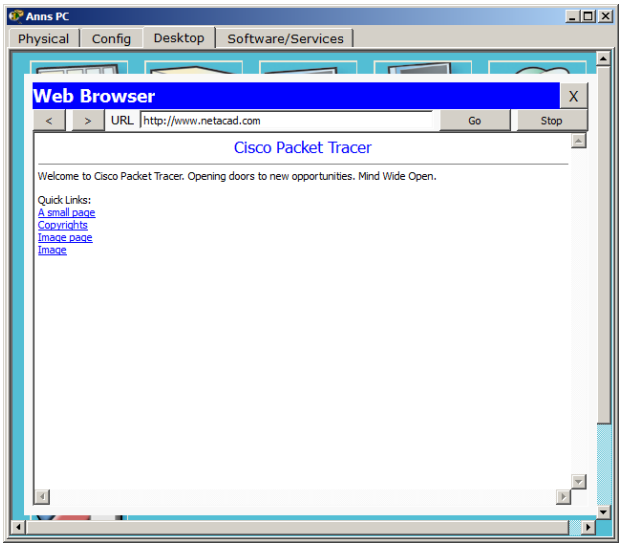


Figure 5 – PT Web Browser Application

20. Access the remaining two web servers using their URLs, and ensure that you can display their web pages:

    a. www.computingatschool.org.uk
    b. www.bcu.ac.uk

21. Examine the IP configuration of all Bob's devices – what is the address of the DNS server that they are using? How did they learn this address?

22. Try and access all three web servers by typing their IP addresses directly into the web browser of Bob's PC:

    a. www.computingatschool.org.uk – IP: 129.12.3.236
    b. www.bcu.ac.uk – IP: 193.60.133.109
    c. www.netacad.com – IP: 107.21.52.76

23. When you access a web server using its IP address, are you using DNS to resolve the IP addresses of the servers?

24. Locate the DNS server in the ISP network, and switch it off:

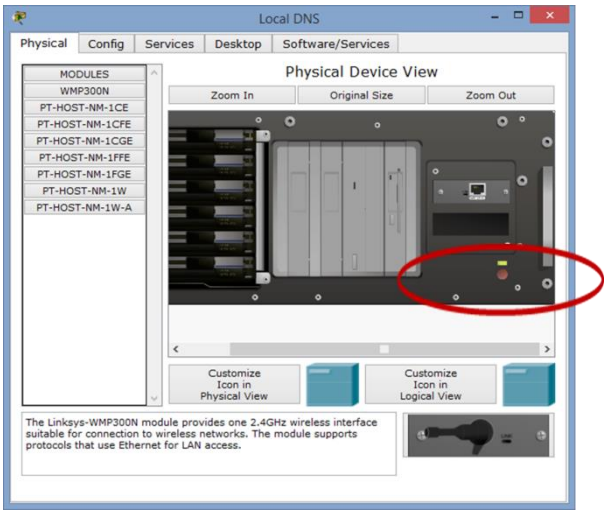


Figure 6 – Server Power Switch

25. With the DNS server switched off, try and access the three web servers from Bob's PC using both their IP addresses and their URLs. What are the results?

Task 4 – Challenge Activities

26. Compare the IP addresses that have been assigned to the devices in Bob and Ann's houses. What do you notice about them?

27. What test can you carry out in order to see if you can send data between Bob and Ann's house? Does it work?

28. Based on your findings above, can you explain which additional service the wireless routers have to perform in order to provide Internet connectivity?

Task 5 – Packet Switching in Networks

29. Data must be sent across a network in manageable pieces, as networks have a limitation on the amount of data that can be included in a single packet. Thus network protocols such as User Datagram Protocol (UDP) and Transmission Control Protocol (TCP) are used to segment the data received from applications such as web and email, into blocks of data that are an appropriate size for transmission over the network.

30. At the packets destination, UDP or TCP is again used to reconstruct the many packets received into a complete data stream that is useful to the application. TCP adds additional information to each packet (called an 'overhead') that a receiving device can use to reassemble the data pieces in the correct order or sequence. UDP is far simpler (thus less overhead), and does not include information that allows packets to be re-sequenced.

31. Packets containing TCP or UDP are **routed** through the Internet by devices called **routers** that are capable of making switching decisions based on the destination IP address contained within each packet. Figure 7 shows the CASWANT topology, which provides multiple routed network paths between Bob and Ann and the web servers accessed via the ISP:

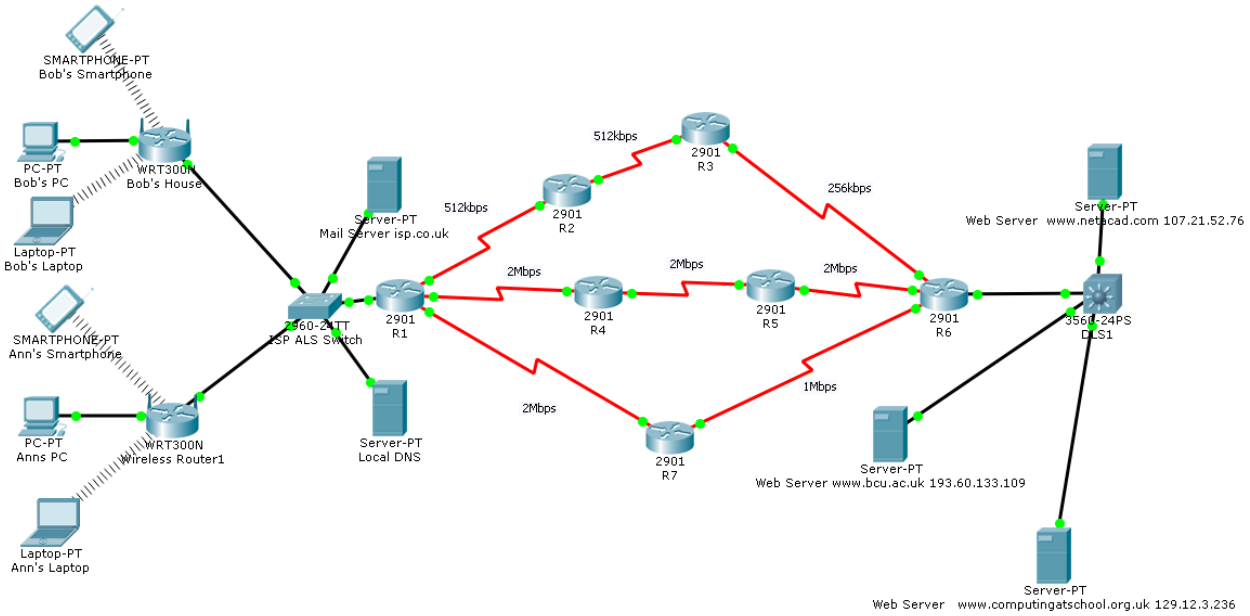


Figure 7 – Packet Switching Topology

32. Open up the *CASWANT.pkz* file, and check that you can access the three web servers from both Bob and Ann's PCs.

33. Examine the red links between the routers (identified as R1 to R7). Each link is operating at a different speed, indicated in either kbps or Mbps.

34. Which path would provide the fastest route between R1 and R6?

35. Routers communicate the availability of IP networks using routing protocols, which use a parameter called a **metric** to decide on the best path to a particular network. Each network will thus have an associated metric value, which the router uses to decide which path presents the optimal route to that network. The CASWANT topology has been configured with a routing protocol that assesses the speed (also referred to as bandwidth) of the links available to reach a given network.

36. Use the Internet to identify three different routing protocol. What value do they use as metrics?

37. In order for the routers to be able to forward packets to a destination network, they must build a routing table, which identifies the direction in which to switch the packets. The three web servers are located on the following networks: Use the *Inspect* tool to examine the IP routing tables of the routers you selected in step 34, and confirm that these networks are present.

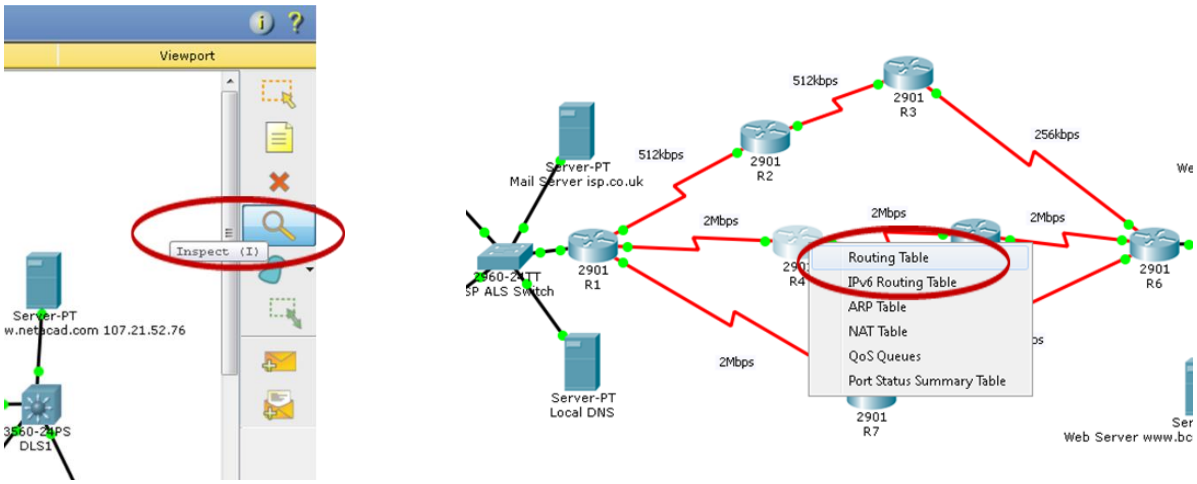


Figure 8 – Inspecting IP Routing Tables

38. You can now test to see if the network routes packets along the path you expect. Enter *simulation* mode, and select the *add simple PDU* tool (creates a test packet). With the tool selected, click on Bob's PC followed by the www.bcu.ac.uk web server. You should now see a coloured packet symbol sat on Bob's PC.

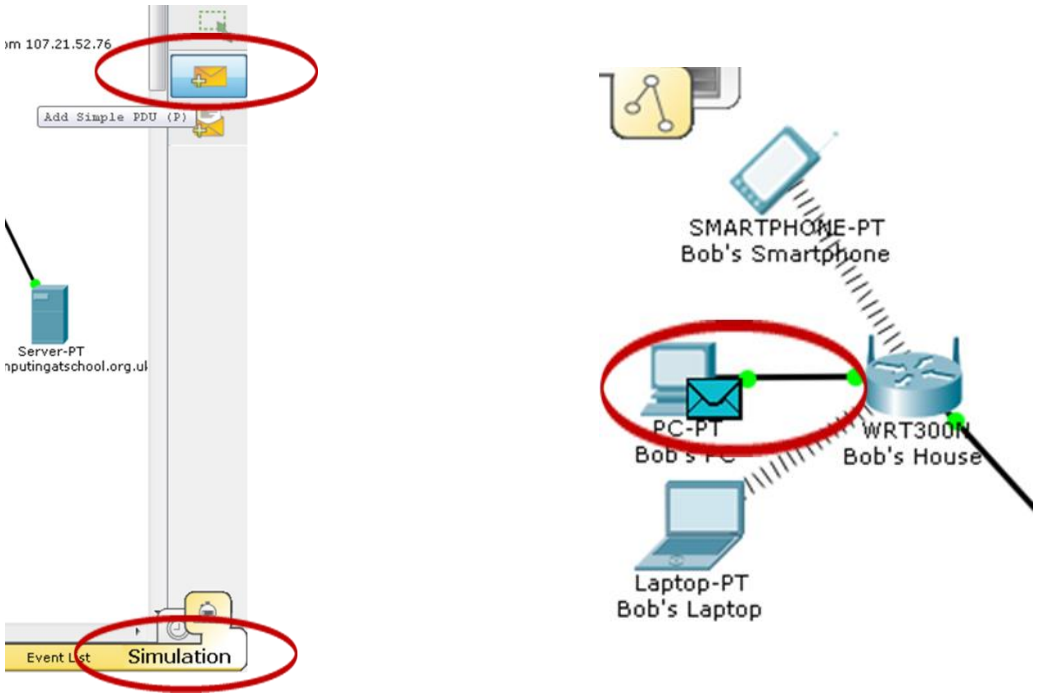


Figure 9 – Creating a Test Packet

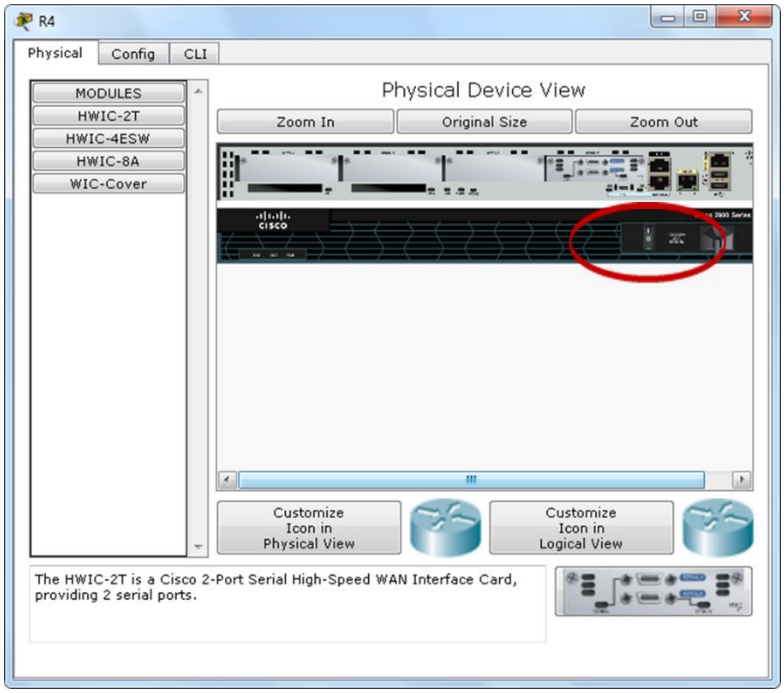
39. Select *Auto Capture/Play*, and you should see the packet travel from Bob's PC to www.bcu.ac.uk. Does it follow the patch through the routers that you expected?

Figure 10 – Simulation Auto Capture/Play

40. Create another test packet between Ann's PC and the www.bcu.ac.uk server – does it follow the same path? Why do you think it does this?

41. Examine the bandwidth figures against the red links between routers again. Which way would you expect traffic to go if R4 was no longer available?

42. Select R4, and from the physical tab, switch off the power:



43. Enter simulation mode again, and send a test packet from first Bob's and then Ann's PC to the www.bcu.ac.uk server. Does it follow the path you expected?

Task 6 – Challenge Activities

44. Ensure that R4 is switched back on. Send a test packet between R3 and www.bcu.ac.uk. Explain why the routers have made the decision to forward packets in the direction they do.

45. What could you do to change this behavior?