



4.9.4.7 DHCP, NAT & Port Forwarding

1) A company has a network which has a DHCP server and a web server.

a) A device wishes to join a subnet on the network, so it communicates with the DHCP server.

Explain:

- The purpose of the DHCP system
- Why the DHCP system is used
- What will happen during this communication

[4 marks]

Purpose (1 mark)

- To automate the configuration of hosts connecting to a TCP/IP network // to allocate IP addresses/subnet mask/default gateway to hosts

Why used (1 mark)

- Reduces the need for expert knowledge when configuring a host
- Reduces times required to configure hosts
- Facilitates the efficient use of a limited pool of IP addresses
- Avoids errors such as duplicate IP addresses or programming a incorrect subnet mask

Communication (2 marks)

- Host sends request to discover a DHCP server
- DHCP server offers configuration to the host
- Host requests the offered configuration
- DHCP server confirms that configuration has been allocated to the host

The web server has the IP address 192.168.16.12 and must be accessible from computers that are connected to the Internet but outside of the company's own network.

As the web server has a non-routable IP address, it cannot be accessed directly from outside the network. Therefore, access to the web server will be facilitated by the External Router, which supports Network Address Translation (NAT) and port forwarding.

b) Explain how the External Router will have been configured so that the webserver can be accessed by computers outside the network.

[2 marks]

- Traffic arriving on the HTTP(S) port (80/8080/443) from outside the network...
- Must be forwarded by the external router to the IP address (192.168.16.12) of the Web server





- 2) A packet of data is to be transmitted across the internet from a Computer A in the UK to a Computer B in Belgium.

Explain in detail how the packet will be routed across the internet from Computer A to Computer B. Include how:

- The path of the packet to the destination is determined
- How private and public IP addresses are translated

[4 marks]

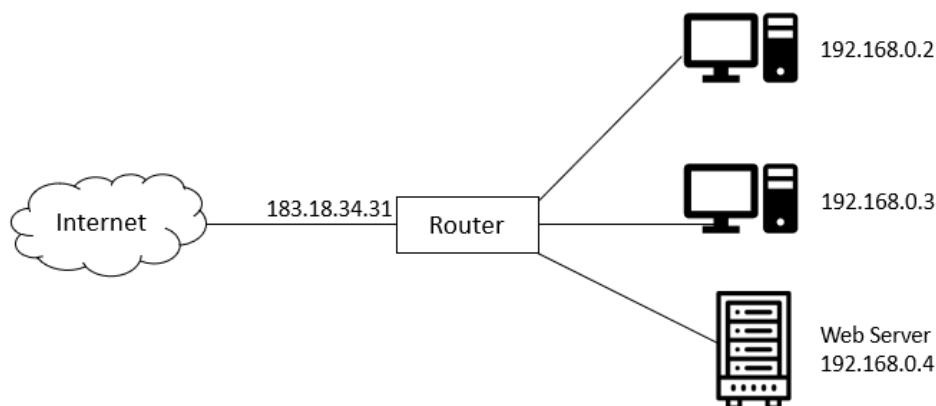
- **Packets are passed from router to router from Computer A to Computer B**
 - **Path to take is selected by each router and may change as a result of congestion/technical problems**
 - **Route is determined using the IP address / NetworkID of the destination**
 - **Router tables are used to determine the next hop**
 - **The source and destination MAC addresses are changed for each hop**
 - **NAT translates the private source IP address of Computer A to the public IP address of the external router**
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- 3) **Figure 1** shows a diagram of the LAN in the student's house. The LAN connects three computers, including the web server, to the Internet via a router.

Figure 1



The router's public IP address is 183.18.34.31. The non-routable IP addresses of each of the computers on the LAN is shown in **Figure 1**.

The router uses Network Address Translation (NAT) because the computers on the LAN, including the web server, have non-routable IP addresses.

The router also incorporates a switch and a DHCP server.

- a) Explain how a computer located outside the LAN can access the web server, despite the fact that the web server is identified by a non-routable IP address.

[3 marks]

- **Computers outside the LAN will use the public IP address of the router / 183.18.34.31 to access the web server; NE. no reference to IP address**
- **The router will perform port forwarding;**
- **Router maintains a port mapping table // router uses rules for converting port numbers and IP addresses; Accept. NAT table for "port mapping table"**
- **Router must identify traffic arriving on the HTTP port // the port used for web services // port 80/8080 from outside the network // HTTP traffic from outside the network; Accept. HTTPS / port 443**
- **Relevant traffic must be forwarded by the router to the IP address of the Web Server / 192.168.0.4;**





- b) Explain why it might be undesirable to allow the network settings of the web server to be configured by a DHCP server.

[1 mark]

- The IP address of the web server might be changed by the DHCP server
- If the IP address of the web server changes the existing port-forwarding rule will point to the wrong device

- c) The student uses the computer with IP address 192.168.0.2 to download a file from an FTP server on the Internet using the File Transfer Protocol (FTP).

Describe how NAT will be used in this process, to handle both the outgoing request and the returned data.

[4 marks]

When request sent

- When the router receives the FTP request from the computer, it will replace the IP address of the computer / the source IP address / 192.168.0.2 (A. the private IP address) with the public IP address of the router / 183.18.34.31 / (A. the public IP address); NE. references to a public IP address
- The router replaces the (source) port number with a port number it generates
- The router adds the mapping (port number to IP address and port number / socket) it has created to its NAT translation table (A. list, dictionary or similar); NE. router adds mappings without reference to some sort of structure that they might be stored in I. incorrectly stated contents of table

When reply received

- When a reply is received from the FTP server, it is recognised by its destination port number // the destination port number is looked up in the NAT translation table
- (If the port number is present in the NAT translation table) the reply is forwarded to the computer that made the original request / computer with IP address 192.168.0.2 // the student's computer (and the destination port number is replaced with the one stored in the NAT translation table / the original source port number) // (If the port number is present in the NAT translation table) the router replaces its IP address / the (public) IP address of the router / 183.18.34.31 / (A. the public IP address) with the IP address of the student's computer / 192.168.0.2 (R. the private IP address);





- d) The replacement of IPv4 with IPv6 would mean that NAT is no longer necessary.

Explain why this is the case.

[1 mark]

- IPv6 provides a sufficiently large address space for devices to have globally unique/routable IP addresses, so sharing a public IPv4 address using NAT is not necessary;
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