Computer Networks: Assignment 3

6 March 2017

Solving and submitting your assignment

Requirements about the delivery of this assignment:

- Submit via Blackboard (`http://blackboard.ru.nl`);
- Upload one pdf file for written answers and all supplemental files in a single zip file;
- The file should take the name of your student number, for example student *s0123456* should submit a file named *s0123456.pdf*. This naming convention is used so that we can automatically send you the marked assignments once they are graded.
- Write both your name and student number into the document (and only your student number in the filename).

Deadline: March 15, 20:00 p.m. sharp!

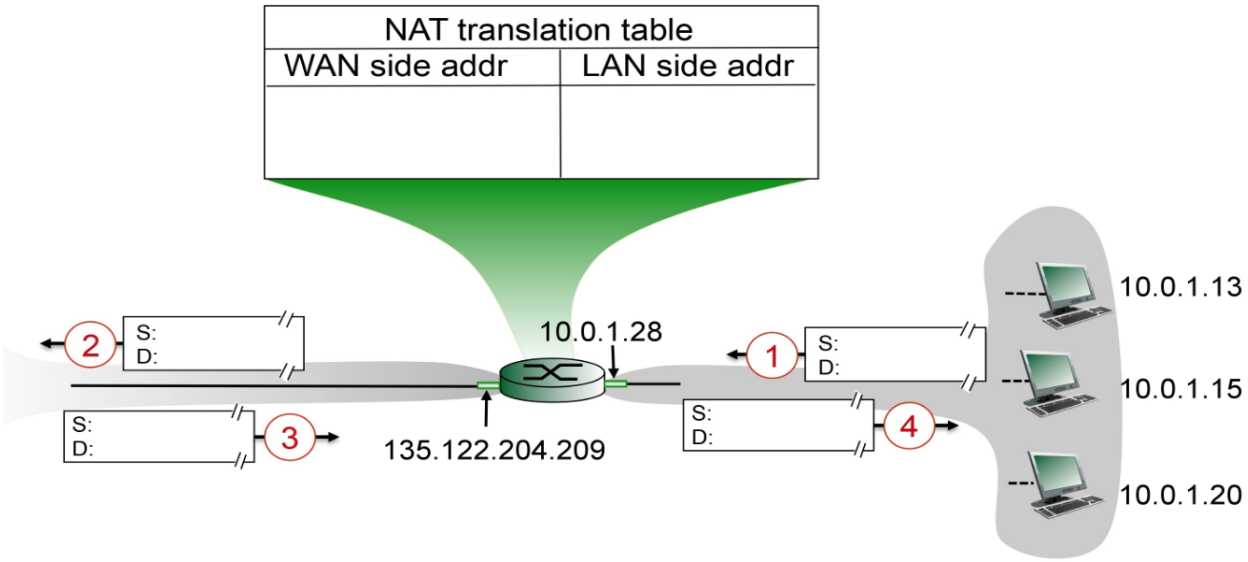
Goals: After completing these exercises successfully you should be able to:

- be able to critically study, interpret and modify P2P DHT algorithms;
- be able to build a simple SMTP client application;
- know how to elaborate a FSM for a protocol based on a specification;
- understand how reliability is provided in transport protocols.

Marks: You will be graded with marks from 0 to 3 where 0 means not serious, 1 means serious but insufficient, 2 means sufficient and 3 means good. You can have at most 1 assignment graded 0. To get 1 or more, you MUST attempt to solve ALL exercises, even if the provided solution is not correct/complete. In other words, leaving an exercise out automatically turns your grade to 0. In your solution, please explain all answers clearly and concisely.

1 NAT Translation

Consider the scenario in Figure 1, where three hosts, with private IP addresses 10.0.1.13, 10.0.1.15 and 10.0.1.20, are in a local network behind a NAT router that sits between these three hosts and the larger Internet. IP datagrams sent from, or destined to, these three hosts must pass through this NAT router. The router's interface on the LAN side has IP address 10.0.1.28, while the router's address on the Internet side has IP address 135.122.204.209.



Suppose that the host with IP address 10.0.1.13 sends an IP datagram destined to the outside host 128.119.164.189. The source port is 3366, and the destination port is 80.

a) Give the source IP, source Port, destination IP and destination Port for the datagrams at each of the steps indicated in the figure, as well as the NAT translation table after completion of the steps. Use concrete numbers for ports. You can fill in this information directly on the figure itself, or write it separately. The steps indicated are:

   Step 1: after a datagram has been sent by the host but before it has reached the NAT router

   Step 2: after the datagram has been transmitted by the NAT router to the outside host

   Step 3: just before a response datagram from the outside host is received by the NAT router

   Step 4: after the datagram has been transmitted by the NAT router but before it has been received by the host

b) Describe in detail the actions taken by the router between steps 3 and 4.

c) NAT translation for TCP and UDP packets involves modification of source or destination IP addresses and ports. Name a different field in a TCP/UDP segment, whose value also has to be adjusted. You can use RFC 3022 as reference.

2 Subnets

a) What is the maximum number of connected subnets you can make using 3 routers, with 4 interfaces each? By connected, we mean each host of each subnet can contact any host of any subnet. No connections to the outside (Internet) are allowed.
Explain how this can be achieved.

b) Consider a router that interconnects three subnets: Subnet 1, Subnet 2, and Subnet 3. Suppose all of the interfaces in each of these three subnets are required to have the prefix 223.1.17/24. Also suppose that Subnet 1 is required to support at least 60 interfaces, Subnet 2 is to support at least 90 interfaces, and Subnet 3 is to support at least 12 interfaces. Provide three network addresses (of the form $a.b.c.d/x$) that satisfy these constraints.

3 Inter- and Intra-AS Routing

Before you start working on this problem, watch the video 'Gluing the Internet Together: BGP' by Keith Ross (one of the authors of the book). This short lecture can be found on the Student Resources website[1] under the Video Notes section.

Consider the network in Figure 1. Suppose that AS3 and AS2 are running OSPF for their intra-AS routing protocol, and AS1 and AS4 are running RIP for their intra-AS routing protocol. Assume further that external BGP (eBGP) and internal BGP (iBGP) are used for the inter-AS routing protocol. Initially, there is no physical link between AS2 and AS4.

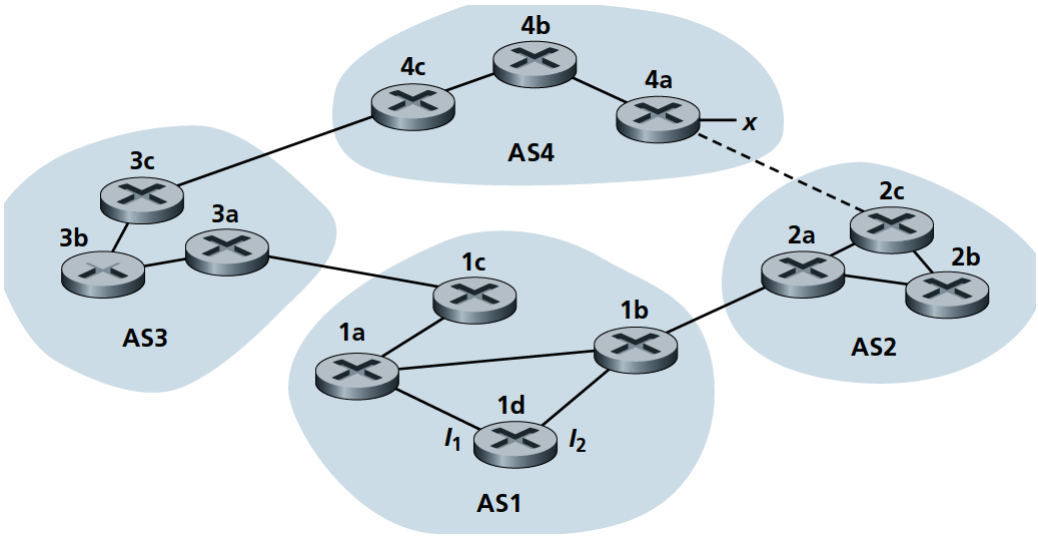


Figure 1: Inter-AS topology

Note that *multiple* answers may be correct!

1. Router 3c learns about prefix x from which routing protocol?

   A: OSPF

   B: RIP

   C: eBGP

   D: iBGP

2. Router 3a learns about x from which routing protocol?

   A: OSPF

   B: RIP

   C: eBGP

   D: iBGP

3. Router 1c learns about x from which routing protocol?

   A: OSPF

   B: RIP

   C: eBGP

[1] https://wps.pearsoned.com/ecs_kurose_compnetw_6/216/55463/14198700.cw/index.html

D: iBGP

4. Router 1d learns about x from which routing protocol?

   A: OSPF

   B: RIP

   C: eBGP

   D: iBGP

   Assume for the rest of the problem that router 1d learns about x.

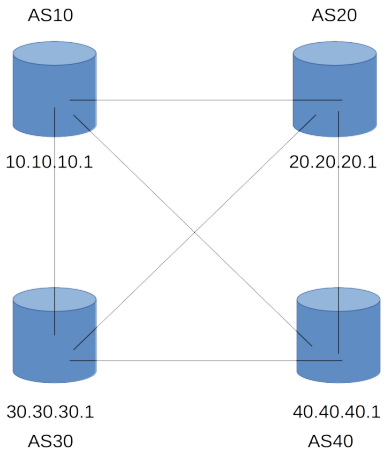
5. It will then put an entry (x, I) in its forwarding table. Will the interface I be I_1 or I_2 for this entry? Explain why in one sentence.

6. Now suppose that there is a physical link between AS2 and AS4, shown by the dashed line. Suppose further that router 1d learns that x is accessible via AS2 as well as via AS3. Will I be set to I_1 or I_2? Explain why in one sentence.

7. What does one mean by *hot-potato routing*?

4 Netkit startup and intro to Zebra

Netkit has built in facilities for configuring a VM on boot to save time. Additionally netkit allows for lab files which can automate the startup of many virtual machines at the same time. Included with this assignment you should find a zip file called 'zebraLab.zip'. Zebra is an open source program used to implement a number of routing protocols. Quagga is a fork of the zebra project and is the modern version.This zip file contains a two node BGP routing network using the Zebra/Quagga routing program and can be started with the 'lstart' command. Your task is to extend this example to a four node fully connected system where only two VMs are on any given netkit ethernet domain and where any VM can ping any other VM. Each node should be a /24 network. Use the local addresses of 10.10.10.1, 20.20.20.1, 30.30.30.1, and 40.40.40.1 for your VMs. This is shown visually as



Turn in your lab.conf, X.startup files and the associated VM configuration files in a zip file.

5 IPv6

a) Compare and contrast the IPv4 and the IPv6 header fields. Do they have any fields in common?

b) It has been said that when IPv6 tunnels through IPv4 routers, IPv6 treats the IPv4 tunnels as link-layer protocols. Do you agree with this statement? Why or why not?