ETH zürich

Networked Systems
ETH Zürich — seit 2015

Communication Networks

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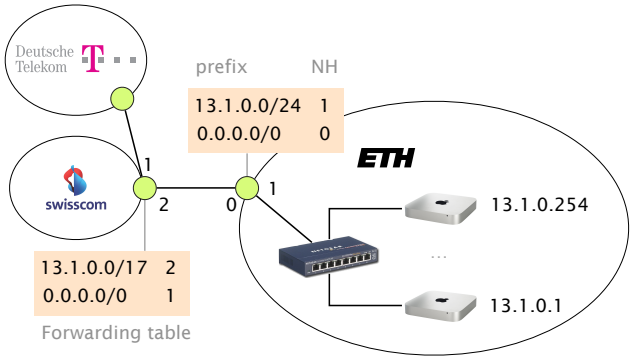
Exercise 5 – Internet Protocol (IP) forwarding & Convergence

Internet Protocol (IP) forwarding

5.1 The Art of Defaulting Properly (Exam Style Question)

Consider this simple network configuration between ETH and Swisscom. Assume that ETH owns a large IP prefix 13.1.0.0/17, but only uses 13.1.0.0/24 to address its internal hosts. For simplicity, we assume that ETH and Swisscom operators configure their forwarding table statically and rely on the use of a default route (0.0.0.0/0).



Where are my IP packets going?

a) How many IP addressable addresses does ETH "own" in total?

b) Give the first and last IP address that ETH can use for addressing a host.

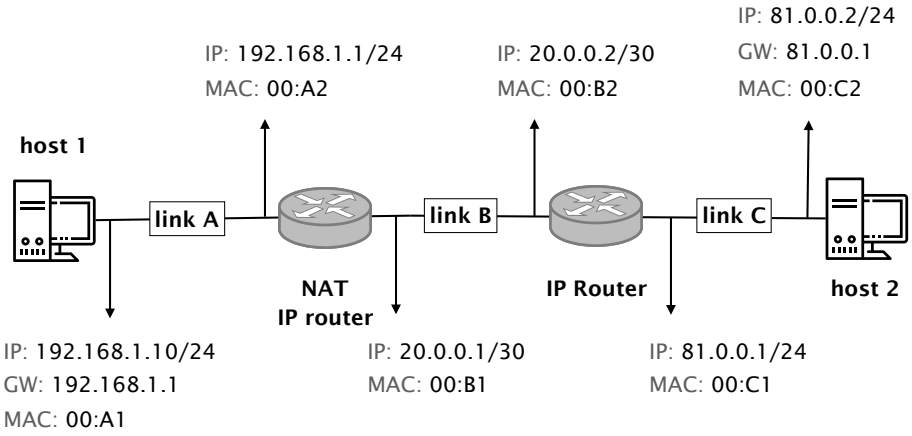
c) Suppose Swisscom receives a packet for 13.1.0.66 from Deutsche Telekom. What is the path taken by this IP packet?

d) Suppose Swisscom receives a packet for 13.1.66.1 from Deutsche Telekom. What is the path taken by this IP packet?

e) What eventually happens to the packet for 13.1.66.1? As an attacker observing this, could you use this observation to congest the ETH-Swisscom link more easily? Explain why (or why not).

5.2 Changing addresses (Exam Question 2019)

Consider the network depicted in the Figure below which is composed of two hosts along with two routers, one of which acts as Network Address Translator (NAT). Host 1 is located in a private subnet (192.168.1.0/24) and uses 192.168.1.1 as gateway, while host 2 is located in a public subnet (81.0.0.0/24) and uses 81.0.0.1 as gateway. The Figure below also depicts the MAC address of each of the 6 interfaces connected at either end of the three links. The NAT/router performs address translation between the private and the public subnets, translating traffic originating from private IPs to its public one (here, 20.0.0.1), and vice-versa.



A network topology relying on Network Address Translation.

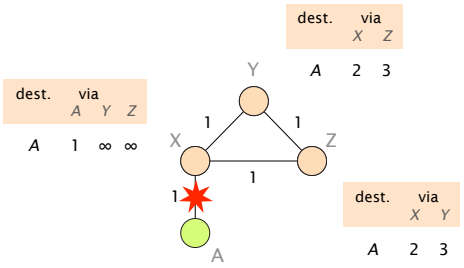
a) Consider that host 1 tries to open a TCP connection with host 2 on port 80 using 1337 as (random) source port. Write down a possible sequence of packet headers observed at each link for the first two packets (i.e., the SYN sent by host 1, and the SYN/ACK sent by host 2). Fill in the table below to answer. Assume that hosts and routers have the required MAC addresses in their ARP table.

	src MAC	dst MAC	src IP	dst IP	src TCP port	dst TCP port
link A						
link B						
link C						
link C						
link B						
link A						

b) Could host 2 initiate a TCP connection to host 1? Briefly explain why/why not.

Convergence

5.3 Convergence with Poisoned Reverse

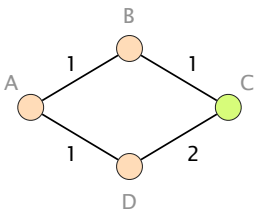


Consider the network on the left which uses distance vector routing with poisoned reverse. Each link is associated with a weight that represents the cost of using it to forward packets. Link weights are bidirectional. Assume that the link between X and A fails (as shown in the figure) and use the table below to show the first 8 steps of the convergence process. How many steps does it take until the network has converged to a new forwarding state? Explain your observations.

		X			**Y**		**Z**	
	dst=A	via A	via Y	via Z	via X	via Z	via X	via Y
$t = 0$	before the failure	1	∞	∞	2	3	2	3
$t = 1$	after X sends its vector	★						
$t = 2$	after Y sends its vector							
$t = 3$	after Z sends its vector							
$t = 4$	after X sends its vector							
$t = 5$	after Y sends its vector							
$t = 6$	after Z sends its vector							
$t = 7$	after X sends its vector							
$t = 8$	after Y sends its vector							

Add the distance vectors to this table

5.4 Convergence (Exam Style Question)



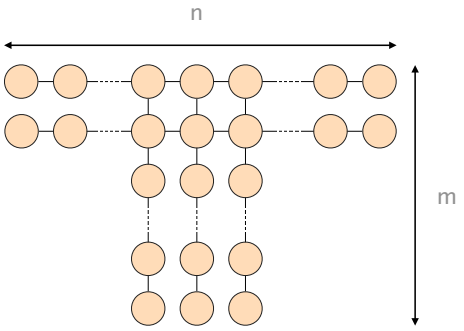
Loopy or not?

Consider this simple network running OSPF as link-state routing protocol. Each link is associated with a weight that represents the cost of using it to forward packets. Link weights are bi-directional.

Assume that routers A, B and D transit traffic for an IP destination connected to C and that link (B, C) fails. Which nodes among A, B and D could potentially see their packets being stuck in a transient forwarding loop? Which ones would not?

Assume now that the network administrator wants to take down the link (B, C), *on purpose*, for maintenance reasons. To avoid transient issues, the administrator would like to move away all traffic from the link *before* taking it down and this, without creating any transient loop (if possible). What is the minimum sequence of increased weights setting on link (B, C) that would ensure that *no packet* destined to C is dropped?

5.5 Convergence of General Topologies



Consider the T-shaped network on the left and a synchronous version of the distance vector algorithm. Suppose that at each iteration, a node exchanges its distance vectors with its neighbors and receives their distance vectors. Assume that the algorithm runs for the first time, and that each node only knows the costs to its immediate neighbors. Derive a formula for the maximum number of iterations required before the distributed algorithm converges.