EP2120 Internetworking/Internetteknik
IK2218 Internets Protokoll och Principer

Homework Assignment 1
(Solutions due 17:00, Wednesday, 2014.Sept.10)
(Review due 17:00, Friday, 2014.Sept.12)

1. IPv4 Addressing (30/100)

a) What is the best fit netmask (i.e., resulting in as few host addresses as possible) for a network with 63 hosts in it? (5p)
You need 63 IP addresses for the hosts, plus a network address plus a directed broadcast address = 65 addresses required. Additionally, you might need one more IP address for the router, but the router could be one of the hosts. Whether or not the router is a host, you still need at least 65 addresses, and 7 bits are needed .Thus the netmask is 255.255.255.128.

b) What is the maximum number of hosts can you have in a /23 network? (5p)
/23 means that you have 32-23=9 bits for host addresses, which means 2^9=512 addresses in the net, out of which one is the network address, and one is the directed broadcast address, so there can be up to 510 hosts. If the router needs its own IP address then 509 hosts.

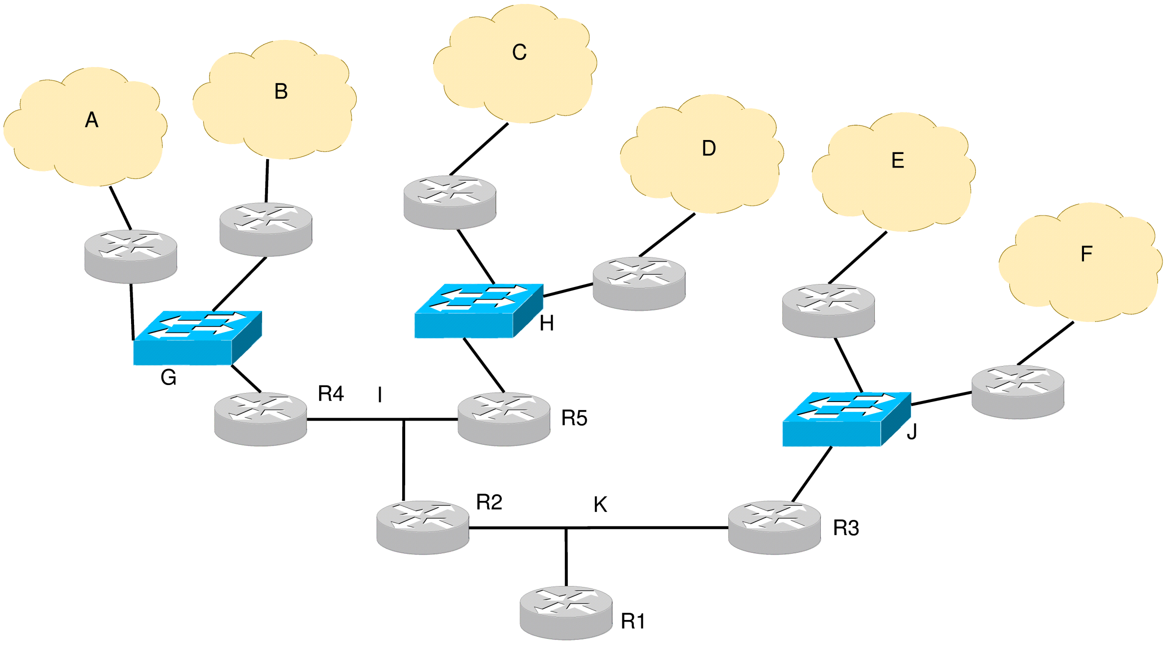
c) Split up the network 114.180.140.0/22 into four equally sized /24 networks! (5p)
/22 means that the first 22 bits of the address are the network address. Hence the first 22 bits of the four /24 networks will have to be 01110010.10110100.100011. The 4 networks will differ in the following two bits (bits 23 and 24), which will be 00,01,10 and 11. The first network in binary format will be 01110010.10110100.10001100.00000000/24, the second network 01110010.10110100.10001101.00000000/24, etc. In dotted decimal format the networks are 114.180.140.0/24, 114.180.141.0/24, 114.180.142.0/24, 114.180.143.0/24.

d) What is the directed broadcast address of the network 82.211.96.0/21? (5p)
The directed broadcast address of this network is the address with all bits set to 1 between positions 22 and 32. That is, 82.211.103.255.

e) What is the limited broadcast address of the network 82.211.96.0/21? (5p)
The limited broadcast address is the address with all bits set to 1. Consequently, it is 255.255.255.255.

f) Use the services of IANA and a regional registry to figure out to whom the IP network 130.243.128.0/17 belongs. Provide the name of the organization and the AS number. (5p)
Based on the RIPE whois database (http://apps.db.ripe.net/search/query.html) the network is UpUnet-S, that is, it is the Uppsala University Student Network. The AS number is AS43844.

2. Address allocation (30/100)



Consider the network above, a routed network in an organization's enterprise network. The organization built a core network connected to a central router R1 (network K), and connected their edge/access routers with (long-haul) switched Ethernet (networks G, H, I, J). The access routers are connected to a set of local offices (networks A to F). All networks use Ethernet on the link layer. The enterprise allocated prefix 190.124.200.0/21 for its internal addresses.
Make an *address allocation* using 190.124.200.0/21 in the network by assigning a sub-block to each network A-J in the following way:

1) The networks A – D require 200 hosts each, while networks E and F require 500 hosts each. Create a minimal block for each local office A through F. Start with the lowest address for network A.
2) There are no unnumbered point-to-point links: all Ethernet networks have IP sub-networks and all nodes (routers and hosts) have an IP address on all their network interfaces. All nodes need to be reachable from any other host.
3) The address allocation should be such that the sub-networks can be *aggregated*.

Based on your address allocation, provide the required entries of the forwarding tables of routers R1 and R2! Give a sketch of your reasoning to support your solution. (30p)

Any solution should be accepted that is correct in the sense that packets destined to ANY of the subnets and to any of the IP addresses assigned to actual nodes (host or router) can be forwarded.
The solution does not necessarily have to give a detailed explanation, but a good explanation is a merit, of course.

One possible solution is given below.
Assign the networks as follows:
A: 190.124.200.0/24 – up to 254 hosts
B: 190.124.201.0/24 – up to 254 hosts
C: 190.124.202.0/24 – up to 254 hosts
D: 190.124.203.0/24 – up to 254 hosts
E: 190.124.204.0/23 – up to 510 hosts
F: 190.124.206.0/23 – up to 510 hosts
G: 190.124.201.248/29 – up to 6 hosts
H: 190.124.203.248/29 – up to 6 hosts
I: 190.124.203.240/29 – up to 6 hosts
J: 190.124.206.248/29 – up to 6 hosts
K: 190.124.206.240/29 – up to 6 hosts

We assume that within the subnet allocated to network K router R1 has IP address 190.124.206.241 (interface m0),router R2 has IP address 190.124.206.242 (interface m0), and router R3 has IP address 190.124.206.243 (interface m0). Similarly within the subnet allocated to network I router R2 has IP address 190.124.203.241 (interface m1), router R4 has IP address 190.124.203.242 (interface m0), and router R5 has IP address 190.124.203.243 (interface m0). Note that a symbolic assignment of addresses to router interfaces, such as router R1 has interface m0 on network K with IP address R1M0, and router R2 has interface m0 on network K with IP address R2M0 is a good solution.

Forwarding tables:
R1

Destination	*Next hop*	*Flags*	*Interface*
190.124.200.0/22	*190.124.206.242*	*UG*	*m0*
190.124.204.0/22	*190.124.206.243*	*UG*	*m0*
190.124.206.240/29	*-*	*U*	*m0*

R2

Destination	*Next hop*	*Flags*	*Interface*
190.124.200.0/23	*190.124.203.242*	*UG*	*m1*
190.124.202.0/23	*190.124.203.243*	*UG*	*m1*
190.124.203.240/29	*-*	*U*	*m1*
190.124.206.240/29	*-*	*U*	*m0*
190.124.204.0/22	*190.124.206.243*	*UG*	*m0*
0.0.0.0/0	*190.124.206.241*	*UG*	*m0*

Note: The above allocation is somewhat unusual, as the address block for network G overlaps with that of network B, H and I overlap with D, J and K overlap with F. While such an allocation would topically not be chosen if IP addresses are abundant, it is a valid allocation for our example. It is easy to see that with the proper forwarding tables all hosts can communicate with each other.

3. IPv4 forwarding (20/100)

A router has the forwarding table shown below. Determine the next-hop address and the outgoing interface for the packets arriving to the router with destination addresses as given in points (a)-(e).

Destination	Next hop	Flags	Interface
70.7.0.0/18	77.58.204.40	UG	m2
198.54.128.0/17	-	U	m0
77.58.200.0/18	-	U	m2
136.12.2.0/25	198.54.148.212	UG	m0
182.247.19.18/32	198.54.148.213	UGH	m0
193.114.236.0/22	-	U	m1
162.168.31.232/30	77.58.204.41	UG	m2
0.0.0.0/0	193.114.237.1	UG	m1

a) 193.114.240.84 (4p)
193.114.237.1 on m1, default route

b) 182.247.19.18 (4p)

198.54.148.213 on m0 (host specific)

c) 162.168.31.234 (4p)
77.58.204.41 on m2

d) 70.7.23.140 (4p)
77.58.204.40 on m2

e) 87.176.148.61 (4p)
193.114.237.1 on m1, default route

4. IPv4 and IPv6 transition strategies (20/100)

Since IPv6 is not backwards compatible with IPv4, certain strategies have been proposed in order to ensure that nodes in an internet where are still able to communicate with one another.

a) In your own words, describe the three proposed strategies of "dual stack", "tunneling", and "header translation". (5p)

A dual stack host supports both IPv4 and IPv6, and as such can send and receive packets of either version. Similarly, dual stack routers are able to handle both IPv4 and IPv6 datagrams.

Tunneling is useful when two hosts using the same protocol want to communicate over a network region that does not support the protocol of the hosts. While in transit across the unsupported region, the entire packet (including the original header) is encapsulated in a new packet. The new packet is of a protocol that is supported by the network region, e.g., an IPv6 datagram could be encapsulated in IPv4, in which case the protocol field would have value 41.

When performing header translation, the header of the packet is altered (translated) to a different protocol (version) which the receiver is able to process.

b) Consider two hosts, H1 and H2, connected by an internetwork. H1 can only use IPv6 and H2 can only use IPv4. The network is compatible with both IPv4 and IPv6. What will happen if H1 tries to send a datagram to H2? What if it is H2 that wants to send a datagram to H1? (5p)

The IPv4 address can be represented by and IPv6 address and later translated to IPv4 so H1 can send a datagram to H2. The other direction is not possible as the IPv6 address can not be represented in IPv4.

c) Consider two hosts, H1 and H2, connected by an internetwork. Both hosts can use IPv6 only. There is a region in the network that is using IPv4 only. How are IPv6 datagrams delivered between H1 and H2 so that they can reach their destinations? (5p)

By using tunneling, the IPv6 packet is encapsulated in an IPv4 packet while it travels through the IPv4 only region.

d) Consider two hosts, H1 and H2, connected by an internetwork. Both hosts can use IPv4 only. There is a region in the network that is using IPv6 only. How are IPv4 datagrams delivered between H1 and H2 so that they can reach their destinations? (5p)

Either header translation or tunneling would work. Which one is used depends on how the routers are set up.