FIT1047 Tutorial 10 – Sample Solution

Topics and goals

Network layers and protocols

- TCP/IP: understand how subnets and routing tables work

Task 1: Subnets and masks

Each IP address identifies one particular device (or more precisely, one network interface of one device). But IP addresses have structure: a certain number of bits are used to identify the *subnet* that the device belongs to, and the remaining bits identify the concrete device in that subnet.

We use notation such as `130.196.13.5/24` to denote that the first 24 bits identify the subnet. In this case, it means any device whose IP address also starts with `130.196.13.` belongs to the same subnet. This is important: Let's say `130.196.13.5` wants to send a message to `130.196.13.32`; it can just look at the IP address to know that the destination is in the same subnet, which means that it can send the message directly. But if the destination is, e.g., `130.196.42.3`, the IP address tells us that it's in a *different* subnet, so we have to send the message to our router.

We call `/24` the *subnet mask*. An alternative notation, called "dotted-decimal", is `255.255.255.0`, which when written in binary is simply a sequence of 24 ones, followed by 8 zeroes:

`11111111.11111111.11111111.00000000`

The *subnet address* (which identifies the subnet) can be obtained by replacing the host part of an IP address with zero bits. E.g., the subnet address of `130.196.13.5/24` is `130.196.13.0/24`.

1. Write the subnet mask `/22` using "dotted-decimal" notation. `255.255.252.0`
2. Write the subnet mask `255.255.0.0` using "slash" notation. `/16`
3. Give the subnet address for `192.168.131.3/18`. Are `192.168.131.3/18` and `192.168.155.42/18` in the same subnet?

   Let's start by writing the IP address in binary:

   `11000000.10101000.10000011.00000011`

   To compute the subnet address, we need to take the leftmost 18 bits of the IP address and replace the rest with zeroes:

   `11000000.10101000.10000000.00000000`

Converting this back into decimal, we get the subnet address `192.168.128.0/18`.

In order to check if `192.168.155.42/18` is in the same subnet, let's write it in binary notation:

`11000000.10101000.10011011.00101010`

We can see that the first 18 bits are the same, so the two addresses are in the same subnet.

4. Are `192.168.211.3/18` and `192.168.155.42/18` in the same subnet?

   Let's write `192.168.211.3/18` in binary:

   `11000000.10101000.11010011.00000011`

   Comparing the first 18 bits, we can see that there's a difference: bit 18 is 1, whereas it's 0 in `192.168.155.42/18`. So the two IP addresses are **not** part of the same subnet.

Task 2: Routing

In this task you will reconstruct the structure of a network from a given set of routing tables. This will help you understand how routing works, and how routers are gateways between different networks.

Below you are given the routing tables of a (fictitious) company that has offices in Adelaide, Melbourne, Canberra and Sydney and is leasing some IT infrastructure in the USA.

In the routing tables, each line represents one *route* that specifies what to do with packets for certain subnets. E.g., the third line in the Adelaide routing table states that any packet for the `193.168.3.0` network must be sent via another router whose IP address is `201.101.1.2`. The network address `0.0.0.0/0` stands for the default gateway, i.e., any packet that doesn't match any of the concrete rules uses this route.

Based on the routing tables, answer the following questions:

1. Create a diagram of the network structure. Your diagram should contain all five routers, and connect routers using direct lines if they are directly connected to each other. *Hint: for each router, look at the networks to which they are directly connected. If two routers are directly connected to the same network, it means they are directly connected to each other!*
2. Infer the IP addresses of the routers. *Hint: most routers have their own local networks, such as `192.168.2.0/24` in Adelaide. Now look at a router that is directly connected to Adelaide, and find out where it sends packets for the network `192.168.2.0/24`.*

3. Follow the direction of the default gateways (indicate them as arrows in your diagram). From these arrows, you can see that all traffic that cannot be routed inside the company network goes to a single IP address. This can be considered the company's Internet gateway. Where is it?

Adelaide Router

```
0.0.0.0/0 via 201.101.1.2
192.168.2.0/24 is directly connected
193.168.3.0/24 via 201.101.1.2
194.168.4.0/24 via 201.101.1.2
195.168.5.0/24 via 201.101.1.2
201.101.1.0/24 is directly connected
```

Melbourne Router

```
0.0.0/0 via 202.102.2.2
172.16.0.0/16 via 202.102.2.2
192.168.2.0/24 via 201.101.1.1
193.168.3.0/24 is directly connected
194.168.4.0/24 via 202.102.2.2
195.168.5.0/24 via 202.102.2.2
201.101.1.0/24 is directly connected
202.102.2.0/24 is directly connected
204.104.4.0/24 via 202.102.2.2
210.110.10.0/24 via 202.102.2.2
```

Sydney Router

```
0.0.0.0/0 via 210.110.10.2
172.16.0.0/16 via 210.110.10.2
192.168.2.0/24 via 202.102.2.1
193.168.3.0/24 via 202.102.2.1
194.168.4.0/24 via 204.104.4.1
195.168.5.0/24 is directly connected
201.101.1.0/24 via 202.102.2.1
202.102.2.0/24 is directly connected
204.104.4.0/24 is directly connected
210.110.10.0/24 is directly connected
```

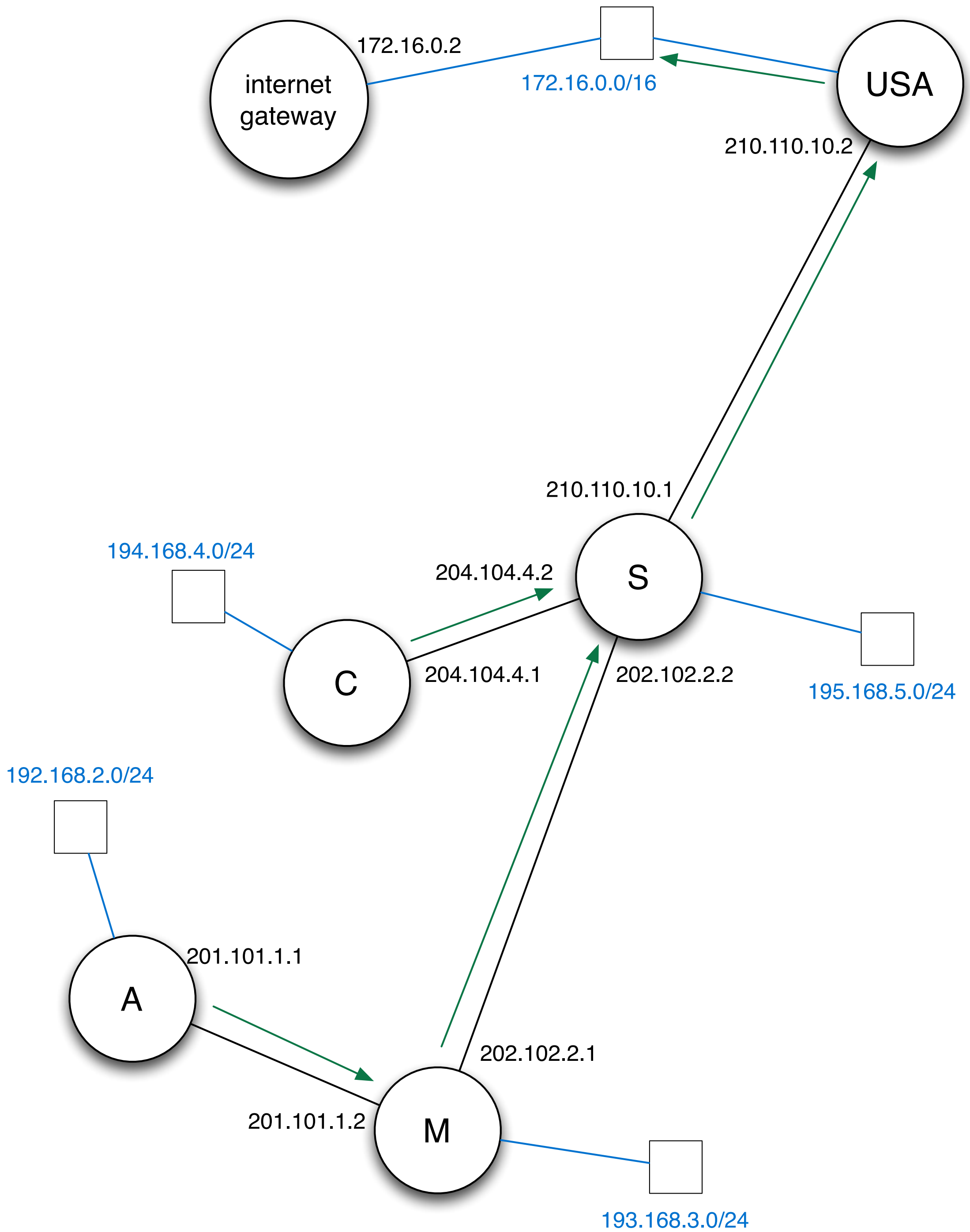
Canberra Router

```
0.0.0.0/0 via 204.104.4.2
172.16.0.0/16 via 204.104.4.2
192.168.2.0/24 via 204.104.4.2
193.168.3.0/24 via 204.104.4.2
194.168.4.0/24 is directly connected
195.168.5.0/24 via 204.104.4.2
201.101.1.0/24 via 204.104.4.2
202.102.2.0/24 via 204.104.4.2
204.104.4.0/24 is directly connected
210.110.10.0/24 via 204.104.4.2
```

USA Router

```
0.0.0.0/0 via 172.16.0.2
172.16.0.0/16 is directly connected
192.168.2.0/24 via 210.110.10.1
193.168.3.0/24 via 210.110.10.1
194.168.4.0/24 via 210.110.10.1
195.168.5.0/24 via 210.110.10.1
201.101.1.0/24 via 210.110.10.1
202.102.2.0/24 via 210.110.10.1
204.104.4.0/24 via 210.110.10.1
210.110.10.0/24 is directly connected
```

Solution:


172.16.0.2
internet gateway
172.16.0.0/16
USA
210.110.10.2
210.110.10.1
194.168.4.0/24
204.104.4.2
S
C
204.104.4.1
202.102.2.2
195.168.5.0/24
192.168.2.0/24
A
201.101.1.1
202.102.2.1
201.101.1.2
M
193.168.3.0/24