ELEC-H417: Lab 0 - Exercises

Exercises - IP Routing and Addressing

Definition in IPv4

- **Address** - The unique number ID assigned to one host or interface in a network.
- **Subnet** - A portion of a network that shares a particular subnet address.
- **Subnet mask** - A 32-bit combination used to describe which portion of an address refers to the subnet and which part refers to the host.
- **Interface** - A network connection.

Understand IP Addresses

An IP address is an address used in order to uniquely identify a device on an IP network.

The address is made up of 32 binary bits, which can be divisible into a network portion and
host portion with the help of a subnet mask. The 32 binary bits are broken into four octets (1
octet = 8 bits). Each octet is converted to decimal and separated by a period (dot). For this
reason, an IP address is said to be expressed in dotted decimal format (for example, 172.16.81.100). The value in each octet ranges from 0 to 255 decimal, or 00000000 - 11111111 binary.

And this sample shows an IP address represented in both binary and decimal:

```
      10.       1.      23.      19 (decimal)
00001010.00000001.00010111.00010011  (binary)
```

Network Masks

A network mask helps you know which portion of the address identifies the network and

which portion of the address identifies the node. Class A, B, and C networks have default
masks, also known as natural masks, as shown here:

```
Class A: 255.0.0.0
Class B: 255.255.0.0
Class C: 255.255.255.0
```

An IP address on a Class A network that has not been subnetted would have an address/mask pair similar to: 8.20.15.1 255.0.0.0 . In order to see how the mask helps you identify the network and node parts of the address, convert the address and mask
to binary numbers.

```
8.20.15.1 = 00001000.00010100.00001111.00000001
255.0.0.0 = 11111111.00000000.00000000.00000000
```

Once you have the address and the mask represented in binary, then identification of the
network and host ID is easier. Any address bits which have corresponding mask bits set to 1
represent the network ID. Any address bits that have corresponding mask bits set to 0
represent the node ID.

8.20.15.1 = 00001000.00010100.00001111.00000001
255.0.0.0 = 11111111.00000000.00000000.00000000

```
8.20.15.1 = 00001000.00010100.00001111.00000001
255.0.0.0 = 11111111.00000000.00000000.00000000
            ----------------------------------
             net id |          host id
netid  = 00001000                    = 8
hostid = 00010100.00001111.00000001 = 20.15.1
```

There are **special adresses**:

- `hostid = 0` refers to the **network as a whole** (e.g. `192.168.1.0` in a /24 network is equivalent to the network starting with 192.168.1)

- `hostid = 255` refers to **all hosts in the network** (e.g. all from 192.168.1.1 to 192.168.1.254)
- `0.0.0.0/0` refers (in CISCO notation) to the default route (note that it matches always since it has the /0 netmask, hence the name default entry or default gateway)

There are some reserved subnets, for instance:

- 10.0.0.0/8
- 172.16.0.0/12
- 192.168.0.0/16
- etc.

Examples of subnetting

Example 1

Let us consider your home network. It is more likley in the form `192.168.1.0/24` (24-bits for the subnet part). Equivalently, that can be written as `192.168.1.0 netmask 255.255.255.0` meaning that all nodes are within 192.168.1.1 - 192.168.1.254 . Remember that192.168.1.0 refers to the network as a whole and 192.168.1.255 is the broadcast address.

Example 2

In this example, you are given two address / mask combinations, written with the prefix/length notation, which have been assigned to two devices. Your task is to determine if these devices are on the same subnet or different subnets. You can use the address and mask of each device in order to determine to which subnet each address belongs.

```
DeviceA: 172.16.17.30/20
DeviceB: 172.16.28.15/20
```

Determine the Subnet for DeviceA:

```
172.16.17.30  = 10101100.00010000.00010001.00011110
255.255.240.0 = 11111111.11111111.11110000.00000000
```

```
              =        subnet        |   host id
subnet = 10101100.00010000.00010000.00000000 = 172.16.16.0
```

Looking at the address bits that have a corresponding mask bit set to one, and setting all the other address bits to zero (this is equivalent to performing a logical "AND" between the mask and address), shows you to which subnet this address belongs. In this case, DeviceA belongs to subnet 172.16.16.0.

Determine the Subnet for DeviceB:

```
172.16.28.15  = 10101100.00010000.00011100.00001111
255.255.240.0 = 11111111.11111111.11110000.00000000
              =        subnet        |   host id
subnet = 10101100.00010000.00010000.00000000 = 172.16.16.0
```

DeviceA and DeviceB have addresses that are part of the same subnet: 172.16.16.0

Exercices

IP subnet computation

1. Write the IP address 10.0.1.0 mask 255.255.255.0 in CIDR notation
2. What is the netmask of 192.168.1.0/24 ?
3. For the network 192.168.0.0/16, what is the brodcast address ? What are the first and last addresses ?
4. You have been allocated a class B (/16) network with address of 172.16.0.0. Compute the first host, the last host, the host range, the netmask, and the boradcast address.
   Break it into multiple C class (/24) subnets. What is the form of each subnet ? How
   much subnets do you have ? WHat is the netmask and the range of the first subnet ?
5. For the network 172.16.1.0/20, what is the first address, the last address, the brodcast address and the corresponding netmak ?

IP Routing

1. A part of the IP routing table at an IP router, R, is here:

Destination	Subnet Mask	Next Hop	Interface
192.168.1.0	255.255.255.0		FastEthernet0/0
192.168.4.0	255.255.255.0		FastEthernet0/1
0.0.0.0	0.0.0.0	192.168.1.1	FastEthernet0/0

IP datagrams arrive at Router R carried destination IP addresses in their headers. Determine the next hop and interface (output port) to which each datagram will be forwarded:

- Destination IP: 192.168.1.1
- Destination IP: 192.168.1.4
- Destination IP: 192.168.4.12
- Destination IP: 192.168.1.2555
- Destination IP: 164.15.59.200

2. Could you change the default gateway to 192.168.3.254 ? What do you need to do that ? Modify the routing table accordingly IP Routing.