<u>IP addresses, netmasks, and routing</u>

physical space
        123 Main Street

        123 → house number on a street/block (the 100 block)
        Main Street → the street

networks
        network ID
        host ID

        123 → host ID
        Main Street → network ID

        but we use an IP address that gets us both
        we need some sort of way to identify both parts
        a netmask does this

e.g.:
        IP address
            192.   168.   1.   100
        11000000.10101000.00000001.01100100

        Netmask (used to "mask out" bits in the IP address)
            255.   255.   255.   0
        11111111.11111111.11111111.00000000

        note that, since there are 24 1s starting from the L, the netmask is also referred to as /24

        we use the netmask to break up the host ID and network ID
        from L to R, where the 1s stop in the netmask identifies the break between the network ID and host ID
                11111111.11111111.11111111.00000000
                        networkID | hostID

        network ID
        11000000.10101000.00000001.01100100 IP address
        11111111.11111111.11111111.00000000 netmask
        ----------------------------------- IP address AND netmask
        11000000.10101000.00000001.00000000
            192.   168.   1.   0

        host ID
        11000000.10101000.00000001.01100100 IP address
        11111111.11111111.11111111.00000000 netmask
        ----------------------------------- IP address AND (NOT netmask)
        00000000.00000000.00000000.01100100
            0.   0.   0.   100

```
        broadcast address
        11000000.10101000.00000001.01100100 IP address
        11111111.11111111.11111111.00000000 netmask
        ----------------------------------- IP address OR (NOT netmask)
        11000000.10101000.00000001.11111111
             192.      168.        1.      255

another e.g.:
        IP address
              10.       13.      216.       41
        00001010.00001101.11011000.00101001

        netmask
             255.      255.      192.        0
        11111111.11111111.11000000.00000000 (/18)
             networkID  |     hostID

        network ID
        00001010.00001101.11011000.00101001 IP address
        11111111.11111111.11000000.00000000 netmask
        ----------------------------------- IP address AND netmask
        00001010.00001101.11000000.00000000
              10.       13.      192.        0

        host ID
        00001010.00001101.11011000.00101001 IP address
        11111111.11111111.11000000.00000000 netmask
        ----------------------------------- IP address AND (NOT netmask)
        00000000.00000000.00011000.00101001
               0.        0.       24.       41

        broadcast address
        00001010.00001101.11011000.00101001 IP address
        11111111.11111111.11000000.00000000 netmask
        ----------------------------------- IP address OR (NOT netmask)
        00001010.00001101.11111111.11111111
              10.       13.      255.      255

an e.g. during Cyber Storm:
        IP address
              10.        4.        1.       10
        00001010.00000100.00000001.00001010

        netmask
             255.        0.        0.        0
        11111111.00000000.00000000.00000000 (/8)
     networkID|           hostID
```

network ID
```
00001010.00000100.00000001.00001010 IP address
11111111.00000000.00000000.00000000 netmask
----------------------------------- IP address AND netmask
00001010.00000000.00000000.00000000
      10.        0.        0.       0
```

host ID
```
00001010.00000100.00000001.00001010 IP address
11111111.00000000.00000000.00000000 netmask
----------------------------------- IP address AND (NOT netmask)
00000000.00000100.00000001.00001010
       0.        4.        1.      10
```

broadcast address
```
00001010.00000100.00000001.00001010 IP address
11111111.00000000.00000000.00000000 netmask
----------------------------------- IP address OR (NOT netmask)
00001010.11111111.11111111.11111111
      10.      255.      255.     255
```

routing

suppose that we have a router that is connected to two networks (via interfaces)

192.168.20.1/24 (network ID: 11000000.10101000.00010100.00000000) – let's call it e0
192.168.10.1/24 (network ID: 11000000.10101000.00001010.00000000) – let's call it e1

these would be entered in the router's routing table

suppose that it gets a packet destined for 192.168.10.2 (11000000.10101000.00001010.00000010)

let's compare to the network ID entries in the routing table
```
11000000.10101000.00001010.00000010 IP address
11000000.10101000.00010100.00000000 e0
11111111.11111111.11100001.-------- NOT (IP XOR e0)

11000000.10101000.00001010.00000010 IP address
11000000.10101000.00001010.00000000 e1
11111111.11111111.11111111.-------- NOT (IP XOR e1)
```

the router picks the network that matches all 24 network ID bits (e1)

of course, it gets more complicated than that…