IP addresses, netmasks, and routing

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 netmask)

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

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

of course, it gets more complicated than that…