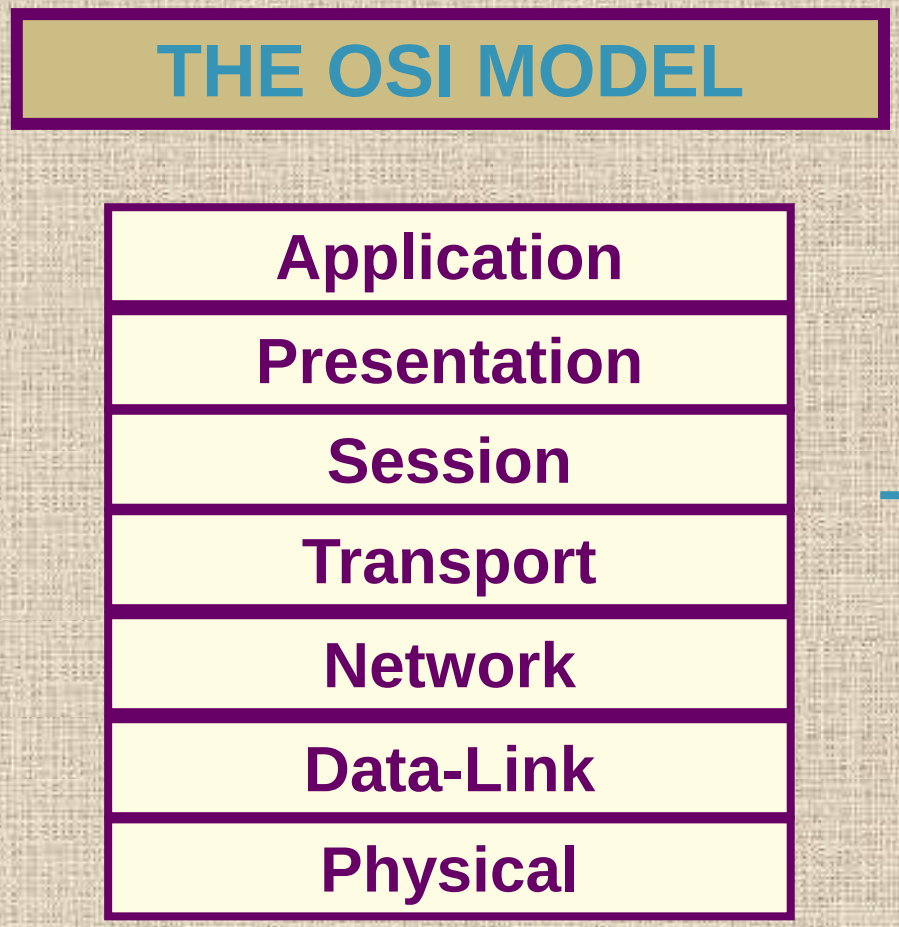

IP Addressing

Subnetting Review

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Logical Addressing

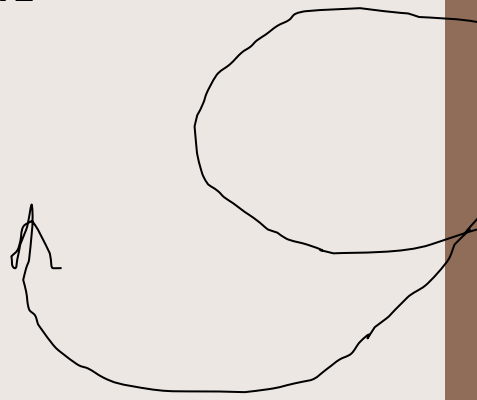
- At the network layer, we use logical, hierarchical addressing.
- With Internet Protocol (IP), this address is a 32-bit addressing scheme divided into four octets.
- Do you remember the classes 1st octet's value?
  - Class A: 1 - 126
  - Class B: 128 - 191
  - Class C: 192 - 223
  - Class D: 224 - 239 (multicasting)
  - Class E: 240 - 255 (experimental)
  - 200.1.1.1

Network vs. Host

Class A: 2^7 = 126 networks; 2^{24} > 16 million hosts

N	H	H	H

1.1.1.1



Class B : 2^{14} = 16,384 networks; 2^{16} > 65,534 hosts

N	N	H	H

Class C : 2^{21} > 2 million networks; 2^8 = 254 hosts

N	N	N	H

Why Subnet?

- Remember: we are usually dealing with a broadcast topology.
- Can you imagine what the network traffic overhead would be like on a network with 254 hosts trying to discover each others MAC addresses?
- Subnetting allows us to segment LANs into logical broadcast domains called subnets, thereby improving network performance.

Stealing Bits

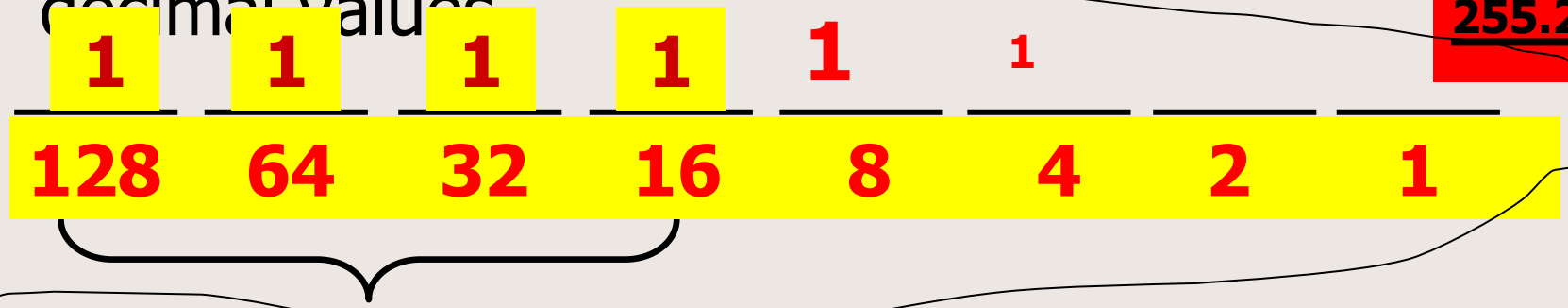
- In order to subnet, we must steal or "borrow" bits from the host portion on the IP address.
- First, we must to determine how many subnets we need and how many hosts per subnet.
- We do this through the power of 2
  - For example, I need 8 subnets from a Class C:
    - ✓ $2^4 = 16 - 2 = 14$ subnets
    - ✓ Remember: we subtract 2 because these subnets are not used
  - How many host do we have?
    - ✓ It's a Class C, so 4 bits are left: $2^4 = 16 - 2 = 14$ hosts
    - ✓ Remember: we subtract 2 because one address is the subnet address and one is the broadcast address

Subnet Mask

200.200.200. 1 → 14

- We determine the subnet mask by adding up the decimal value of the bits we borrowed.
- In the previous Class C example, we **borrowed** 4 bits. Below is the host octet showing the bits we borrowed and their decimal values.

255.0.0.0
255.255.0.0
255.255.255. **0**



We add up the decimal value of these bits and get 240. That's the last non-zero octet of our subnet mask.

So our **subnet mask** is 255.255.255.240

Last Non-Zero Octet

- Memorize this table. You should be able to:
  - Quickly calculate the last non-zero octet when given the number of bits borrowed.
  - Determine the number of bits borrowed given the last non-zero octet.
  - Determine the amount of bits left over for hosts and the number of host addresses available.

Bits Borrowed	Non-Zero Octet	Hosts
2	192	62
3	224	30
4	240	14
5	248	6
6	252	2

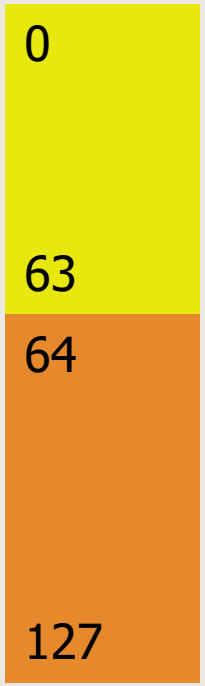
CIDR Notation

- Classless Interdomain Routing is a method of representing an IP address and its subnet mask with a prefix.
- For example: **192.168.50.0/27**
- What do you think the 27 tells you?
  - 27 is the number of 1 bits in the subnet mask. Therefore, **255.255.255.224**
  - Also, you know 192 is a Class C, so we borrowed 3 bits!!
  - Finally, you know the magic number is 256 - 224 = 32, so the first useable subnet address is 197.168.50.32!!
- Let's see the power of CIDR notation.

- 11111111111111111111111111111111111111111111111110101

202.151.37.0/26

- Subnet mask?
  - 255.255.255.192
- Bits borrowed?
  - Class C so 2 bits borrowed
- Magic Number?
  - 256 - 192 = 64
- First useable subnet address?
  - 202.151.37.64
- Third useable subnet address?
  - 64 + 64 + 64 = 192, so



198.53.67.0/30

- Subnet mask?
  - 255.255.255.252
- Bits borrowed?
  - Class C so 6 bits borrowed
- Magic Number?
  - 256 - 252 = 4
- Third useable subnet address?
  - 4 + 4 + 4 = 12, so 198.53.67.12
- Second subnet's broadcast address?
  - 4 + 4 + 4 - 1 = 11, so 198.53.67.11

200.39.89.0/28

- What kind of address is 200.39.89.32?
  - Class C, so 4 bits borrowed
  - Last non-zero octet is 240
  - Magic number is 256 - 240 = 16
  - 32 is a multiple of 16 so 200.39.89.32 is a subnet address--the second subnet address!!
- What's the broadcast address of 200.39.89.32?
  - 32 + 16 -1 = 47, so 200.39.89.47

194.53.45.0/29

- What kind of address is 194.53.45.26?
  - Class C, so 5 bits borrowed
  - Last non-zero octet is 248
  - Magic number is 256 - 248 = 8
  - Subnets are .8, .16, .24, .32, ect.
  - So 194.53.45.26 belongs to the third subnet address (194.53.45.24) and is a host address.
- What broadcast address would this host use to communicate with other devices on the same subnet?
  - It belongs to .24 and the next is .32, so 1 less is .31 (194.53.45.31)

No Worksheet Needed!

- After some practice, you should never need a subnetting worksheet again.
- The only information you need is the IP address and the CIDR notation.
- For example, the address 221.39.50/26
- You can quickly determine that the first subnet address is 221.39.50.64. How?
  - Class C, 2 bits borrowed
  - 256 - 192 = 64, so 221.39.50.64
- For the rest of the addresses, just do multiples of 64 (.64, .128, .192).

The Key!!

- MEMORIZE THIS TABLE!!!

Bits Borrowed	Non-Zero Octet	Hosts
2	192	62
3	224	30
4	240	14
5	248	6
6	252	2

Practice On Your Own

- Below are some practice problems. Take out a sheet of paper and calculate...
  - Bits borrowed
  - Last non-zero octet
  - Second subnet address and broadcast address

1. 192.168.15.0/26
2. 220.75.32.0/30
3. 200.39.79.0/29
4. 195.50.120.0/27
5. 202.139.67.0/28
6. Challenge: 132.59.0.0/19
7. Challenge: 64.0.0.0/16

Answers