IP address

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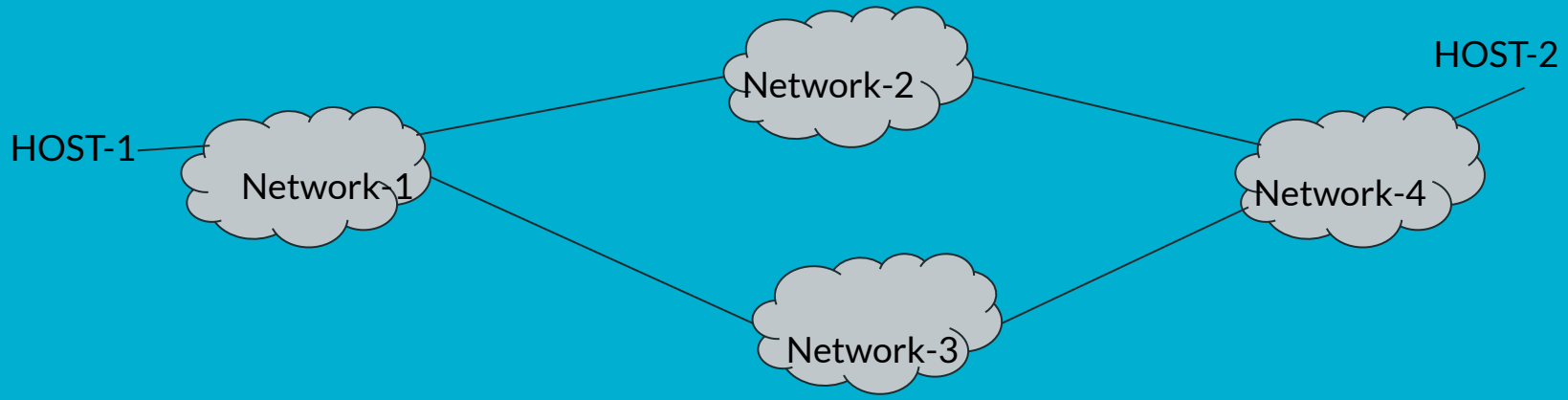
Computer science

SIUE

What should the address identify

- The address should identify
  - Network
  - A host inside the network



What should the address identify

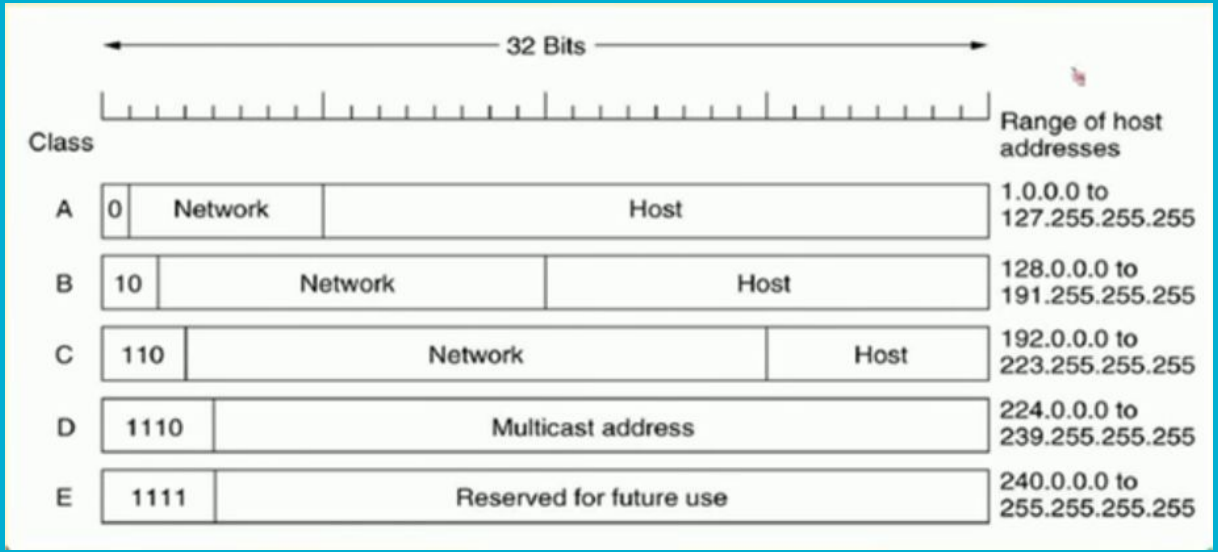
- One component of the address is to identify the network
- Another component to uniquely identify the host
- It's a hierarchical way to identify a host

IPv4

- 32 bits
- 32 bits gets divided into network and host address
- How to divide these 32 bits?

Classful addressing

- Fixed bits for network and hosts
- Pay close attention to the starting bits



IPv4 representation

- Divide 8 bits into 4 chunks

11000101	01011001	11001100	11111100

- 197.89.204.252
- Max 2^8 - 1
- Class-A number of host can be 2^24. Not all are used some are reserved

Network address and broadcast address

- Network address- Identify network (not host)
  - Zeros in host address
  - Class-B: 10110110.01110010.00000000.00000000 [182.114.0.0]
  - Class-C: 11000000.10101000.00001011.00000000 [192.168.11.0]
- Broadcast address:
  - Send data to all the host nodes
  - One's in host address
  - Class-B: 10110110.01110010.11111111.11111111 [182.114.255.255]
  - Class-C: 11000000.10101000.00001011.11111111 [192.168.11.255]
- Not used as host address 0 and 255
- For class-A at most will be 2^24 -2

Case study

- Which class to choose if you have 255 unique hosts?

Case study

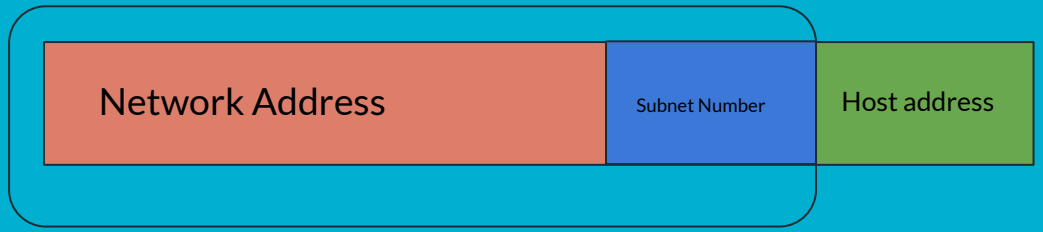
- Which class to choose if you have 255 unique hosts?
- Is it class-C or class-B?
- Class-C not possible
- Class-B possible but huge wastage of network address space. Only 255 out of 2^16 -2 addresses
- Disadvantage of classfull addressing

Classless Inter-Domain Routing (CIDR)

- Split or combine network part of the address space more efficiently
- Subnetting: splitting a large network into many smaller ones
- Supernetting: combine many smaller networks into a single large network
- Subnet mask: to denote the number of bits in the address field

Subnet

Subnet ip



Subnet

- To use 255 host in a network
- 11000000.10101000.00001011.xxxxxxxx [192.168.11.x]
- 11000000.10101000.0000101x.xxxxxxxx
- 11111111.11111111.11111110.00000000 [subnet address]
- A total of 510 hosts can be used
- Example IP will be 11000000.10101000.00001011.01110011 [192.168.11.115/23]
- The subnet mask is: 255.255.254.0
- 9 bits to represent the hosts

How to divide a network?

- 146.163.0.0/16 [10010010.10100011.00000000.00000000]
- Subnet mask is [11111111.11111111.00000000.00000000]
- Divide into three networks
- Take bits from the host part, but how many bits?
- 2 bits or 3 bits
- 146.163.xxx|xxxxx.xxxxxxxx or 146.163.xx|xxxxxx.xxxxxxxx

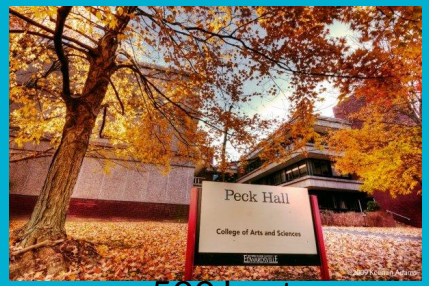
- 2bits configuration: 10,01,11 (all one subnet 146.163.255.255),00 (subnet zero 146.163.0.0)
- Never use all one's or all zero's

How to divide a network?

- Three subnets:
  - Subnet-1: 100
  - Subnet-2: 101
  - Subnet-3: 110
- The subnets are:
  - 146.163.128.0/19 [10010010.10100011.10000000.00000000]
  - 146.163.160.0/19
  - 146.163.192.0/19

Supernet

2000 hosts
11bits



500 hosts
9bits

500 hosts
9bits

213.128.0.0/19

Supernet

- 13 bits remaining (32-19=13)
- Max host bits needed 11bits
- Available for network addressing = 2 bits (13-11=2)
- 3 networks but only 2 bits available
- Combine MUC and Peck hall network together
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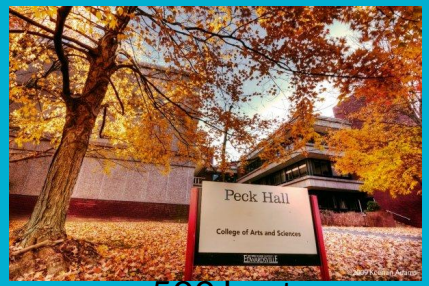
Supernet

2000 hosts
11bits



500 hosts
9bits

500 hosts
9bits

1000 hosts
10 bits **Router**

213.128.0.0/19

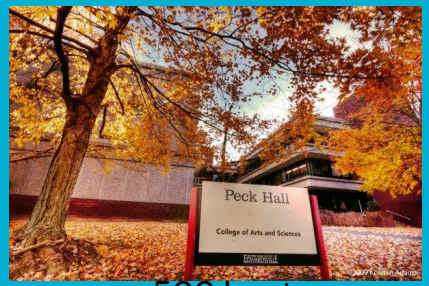
Only need to address two networks

Supernet

- Cougar village: 11bits, MUC+Peck Hall: 10bits
- 213.128.0.0/19, 213.128.000xxxx.xxxxxxxx
- Cougar village: 213.128.00010xxx.xxxxxxxx ->213.128.16.0/21
- MUC+Peck Hall: 213.128.00001xxx.xxxxxxxx -> 213.128.8.0/21
- The two subnets are:
  - 213.128.16.0/21
  - 213.128.8.0/21
- Now let's divide the network further

Supernet

2000 hosts
11bits



500 hosts
9bits

500 hosts
9bits

1000 hosts
10 bits **Router**

Divide here

213.128.0.0/19

Only need to address two networks

Supernet

- Divide between cougar village and MUC
- Cougar village -9bits, MUC- 9bits
- Bits remaining:213.128.8.0/21 -> 32-21=11bits
- 11 bits remaining need 9bits to calculate host, 2bits for network address
- 213.128.0.0/19, 213.128.000xxxxx.xxxxxxxx
- Cougar village: 213.128.00010100.xxxxxxxx ->213.128.20.0/23
- MUC+Peck Hall: 213.128.00001010.xxxxxxxx -> 213.128.10.0/23
- The two subnets are:
  - 213.128.20.0/23 ->MUC
  - 213.128.10.0/23 ->Peck Hall

Variable length subnet mask

- We can divide it unequally (e.g instead of IP/14 and IP/14 CIDR to two networks we can divide it IP/14 and IP/16)
- 213.128.00001xxx.xxxxxxxx /21 (e.g 2000 hosts)
- 213.128.000101xx.xxxxxxxx /22 (e.g. 1000 hosts)
- 213.128.000100xx.xxxxxxxx /22 (e.g. 1000 hosts)
- Directly divide into three networks, no hierarchy

Why IPv6 needed

- IPv4 is 32bit
- We cannot use all the 2^32 bits because there is many class and we need dedicated bits for network as well as hosts
- IPv4 not inherently built for mobile communication. There is patch on top of IPv4 to address this, by default IPv4 doesn’t support mobility
- QoS: Modern application need real time service support (buffered: youtube, etc., live streaming)
- QoS was not defined well in IPv4
- Security features
- Many more…

IPv6

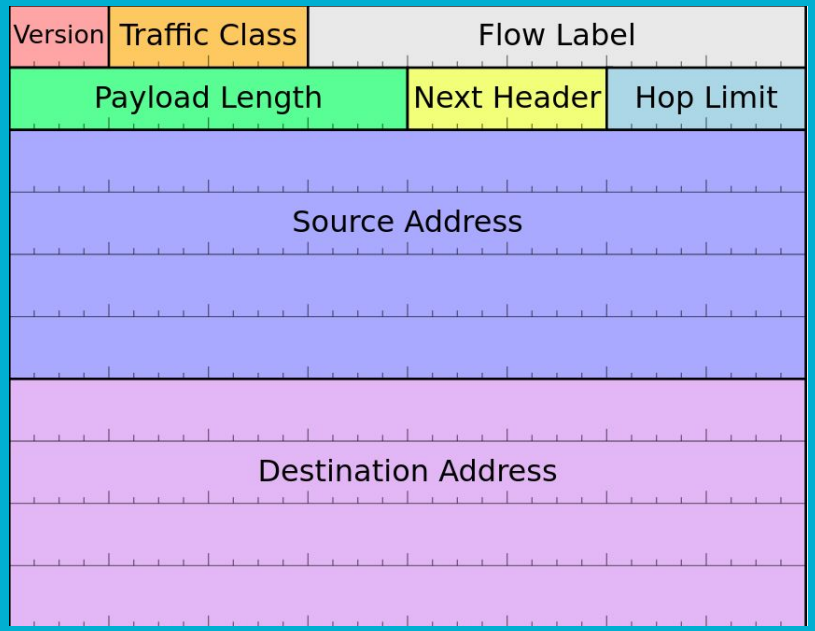
- Very large address space, 2^128

  “**So we could assign an IPV6 address to EVERY ATOM ON THE SURFACE OF THE EARTH, and still have enough addresses left to do another 100+ earths. “**

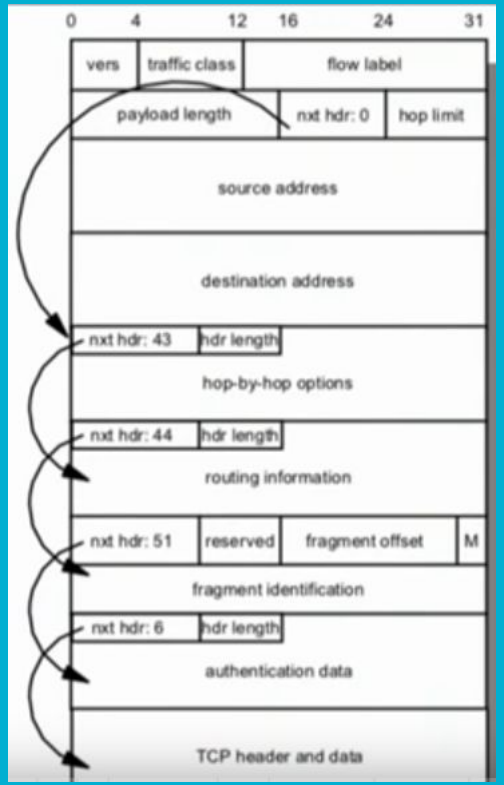
- Optimized routing by using prefix rather than address classes
- Service class support to manage QoS
- Built-in authentication and encryption
- Compatible with IPv4 (for gradual migration)
- Auto-configuration of network interface (DHCP in IPv4)
- It took almost 10 years to standardize this protocol

IPv6 header

- Traffic class for QoS
- Flow label: depends on QoS
- Hop limit: number of hops before the packet get destroyed
- This is the mandatory basic header



IPv6 header extension



Order	Header Type	Next Header Code
1	Basic IPv6 Header	-
2	Hop-by-Hop Options	0
3	Destination Options (with Routing Options)	60
4	Routing Header	43
5	Fragment Header	44
6	Authentication Header	51
7	Encapsulation Security Payload Header	50
8	Destination Options	60
9	Mobility Header	135
	No next header	59
Upper Layer	TCP	6
Upper Layer	UDP	17
Upper Layer	ICMPv6	58

IPv6 addressing

- 128 bits represented by hexadecimal numbers
- Hexadecimal: 0-9, a-f
- FB10:0000:0000:0000:FFA0:0002:0990:001B (example)
- FB10::324:FFA0:2:990:1B
  - replace zeros by double colon, but use only once (FB::1:0:0:0:23:FAA)
  - Remove leading zeros

IPv4 to IPv6 and vice versa

- IPv4: 192.168.21.9 -> IPv6: C0A8:159::FFFF
- IPv6: AFBC:A123:0000:0000:0000:1000:26C:FA:C7A8 -> 175.188.161.35

Thank you

See you all in the next class