IP addressing

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Outline

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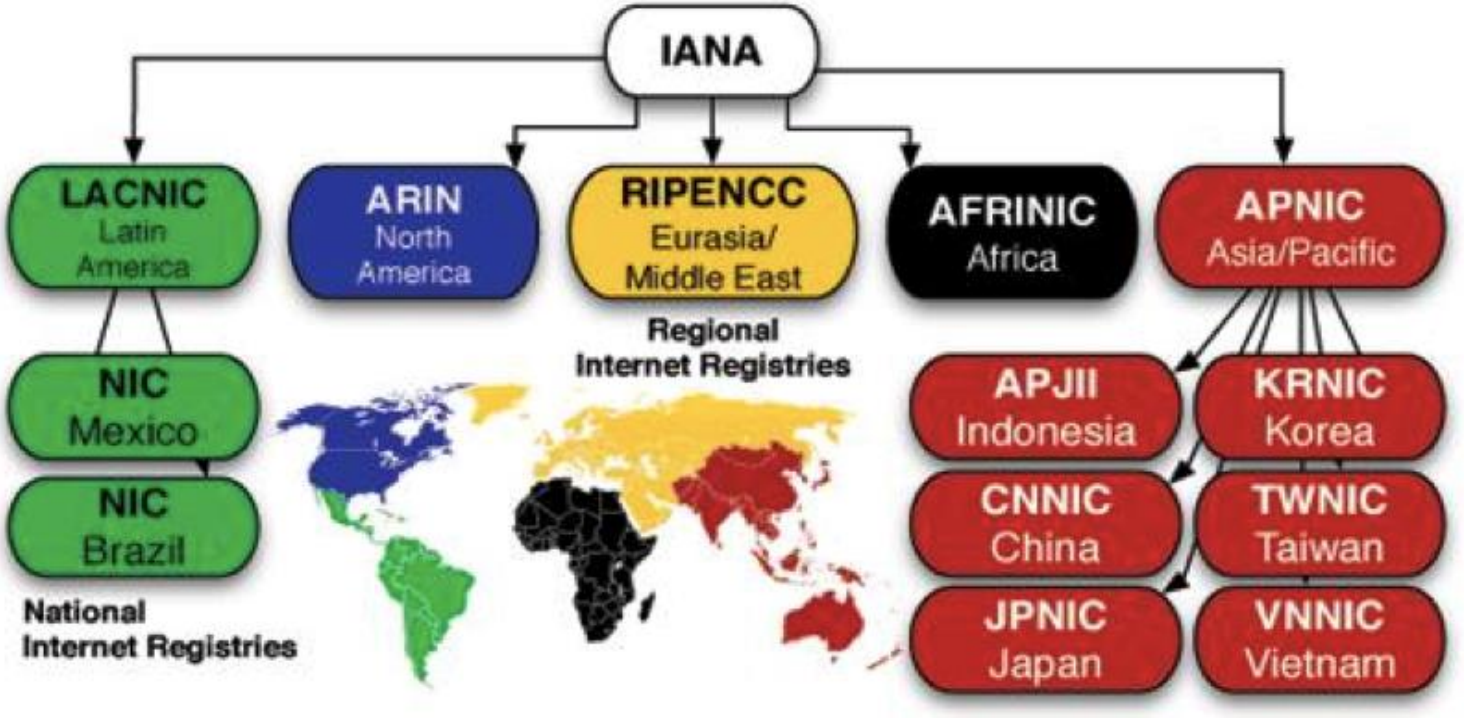
- Introduction
- IP Hierarchy
- Types of IP addresses
- NAT
- Subnetting
- IPv6 Addresses

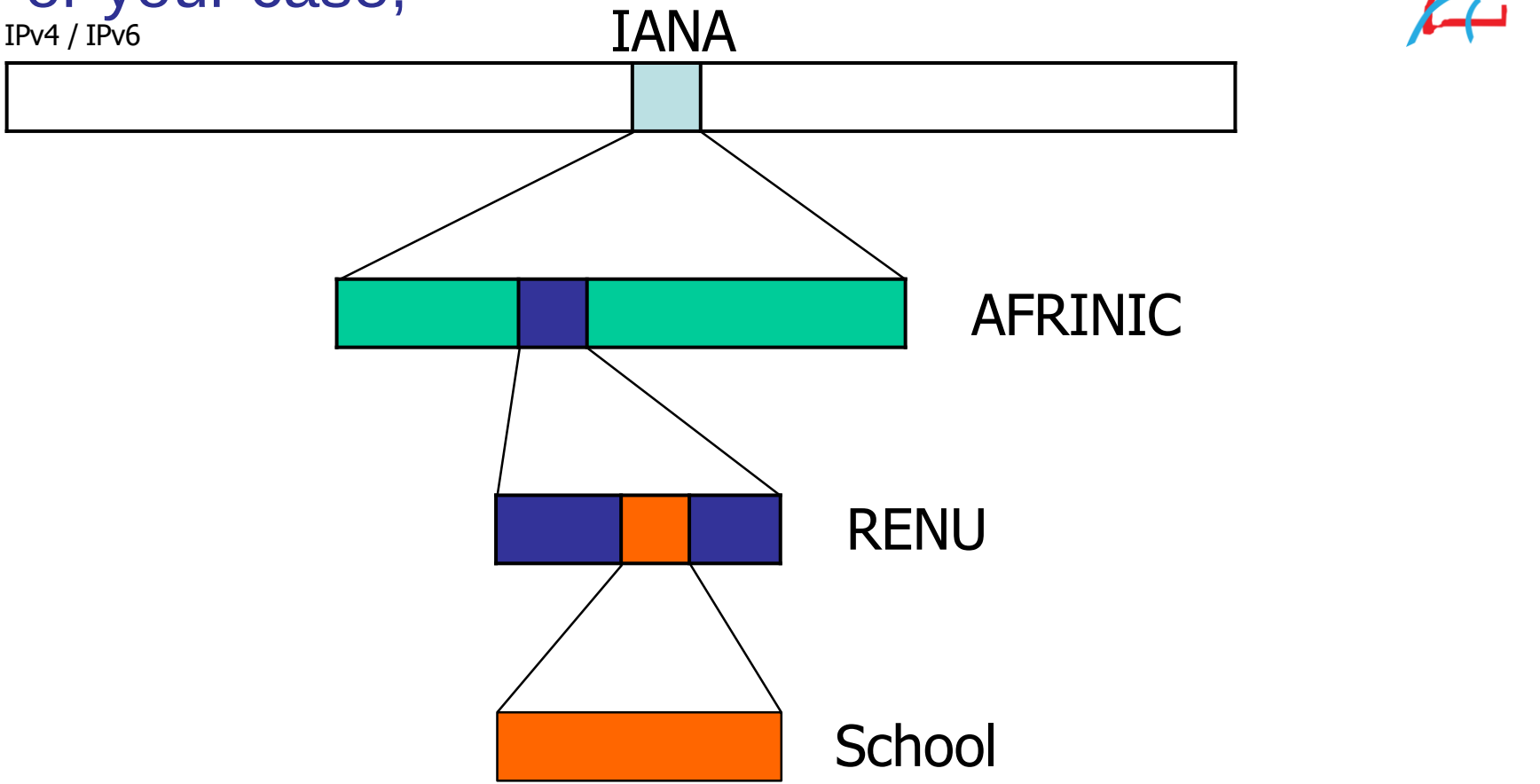
Introduction

- IP address*:*
  - Internet protocol address
  - A unique identifier for host on a network, router *interface*
- Interface: connection between host/router and physical link
  - router's typically have multiple interfaces
  - host typically has one or two interfaces (e.g., wired Ethernet, wireless 802.11)
- *IP addresses are associated with each interface*

Who assigns IP addresses ?



For your case;



Types of IP addresses

- Internet connected networks use two types of IP Addressing
  - IPv4 – legacy Internet protocol
  - IPv6 – new Internet protocol

- IPv4 addresses are 32 bits

  = 2^32 =4,294,967,296 addresses
- IPv6 addresses are 128 bits

  = 2^128 = 3.4e38 addresses

IPv4 address structure

- Conventionally represented as four dotted decimal octets
- If you turn on all bits this is:

11111111111111111111111111111111

1st Octet	2nd Octet	3rd Octet	4th Octet
255.	255 .	255 .	255

An IPv4 address has a network and host part

Public Vs Private addresses

- Private IP addresses are not routable on the internet.
- Can be used on your local area network

Explicitly defined in three classes as;

Class	Address Space	Address range
Class A	10.0.0.0 /8	10.0.0.0 to 10.255.255.255
Class B	172.16.0.0/12	172.16.31.0 to 172.31.255.255
Class C	192.168.0.0/24	192.168.0.0 to 192.168.255.255

What addresses do you use in your school ?

- Please share !

IP addresses cont'd

- Class A, Class B, Class C terminology and restrictions are now of historical interest only
  - Obsolete since 1994
  - Internet routing and address management today is classless
- **CIDR = Classless Inter-Domain Routing**
  - Routing does not assume that former class A, B, C addresses imply prefix lengths of /8, /16, /24
- **VLSM = Variable-Length Subnet Masks**
  - Routing does not assume that all subnets are the same size

Network Address Translation - NAT

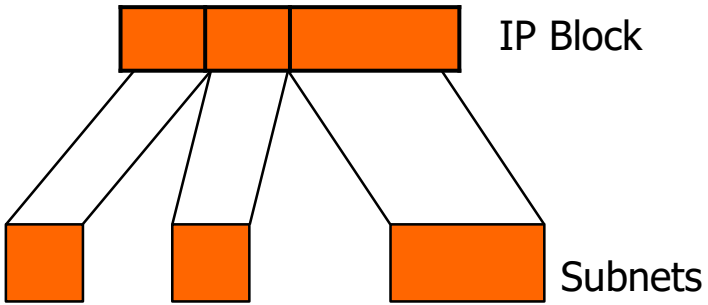
- Local network uses just one public IP address as far as outside world is concerned:
    - Range of addresses not needed from ISP: just one IP address for all devices.
- Can change addresses of devices in local network without notifying outside world
- Can change ISP without changing addresses of devices in local network
- Devices inside a local network are not explicitly addressable, visible by outside world (a security plus)

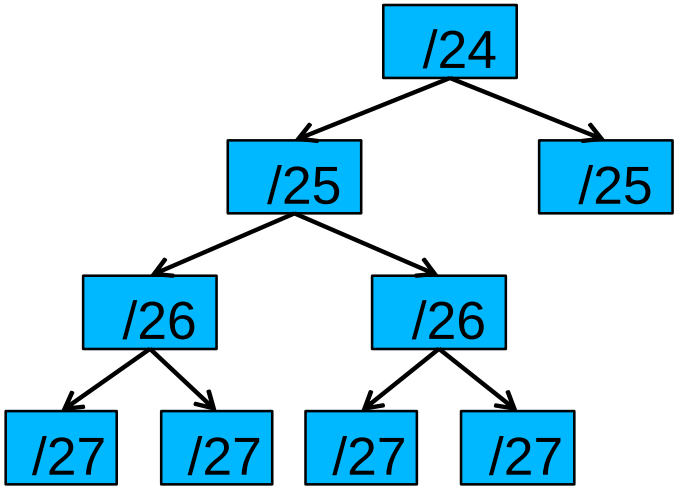
Subnetting

- You might want to take one big network and create different smaller networks from it.
- To achieve this, you have to perform **subnetting**.
- Since each L2 network needs its own prefix, then if you route more than one network you need to divide your allocation
- Ensure each prefix has enough IPs for the number of hosts on that network

Subnetting cont'd

- Blocks of IP addresses vary in size (number of unique addresses)
- Each block of IP has a unique prefix and a unique subnet mask.
- Ensure each prefix has enough IPs for the number of hosts on that network





IPv6 Addresses - Introduction

- 128-bit binary number
- Conventionally represented in hexadecimal – 8 words of 16 bits, separated by colons e.g.
  - 2607:8400:2880:0004:0000:0000:80DF:9D13
- Leading zeros can be dropped
- The right-most contiguous run of all-zero words can be replaced by "::“
  - 2607:8400:2880:4::80DF:9D13

Hexadecimal

0000	**0**	1000	**8**
0001	**1**	1001	**9**
0010	**2**	1010	**A**
0011	**3**	1011	**B**
0100	**4**	1100	**C**
0101	**5**	1101	**D**
0110	**6**	1110	**E**
0111	**7**	1111	**F**

```
0000 = 0000000000000000
FFFF = 1111111111111111
```

Why IPv6 ?

- *Larger address space*
  - IPv6 addresses are 128 bits, compared to IPv4's 32 bits.
    - There are enough IPv6 addresses to allocate more than the entire IPv4 Internet
    - address space to everyone on the planet.
- *Elimination of public-to-private NAT*
  - End-to-end communication traceability is possible.
- *Elimination of broadcast addresses*
  - IPv6 now includes unicast, multicast, and anycast addresses.
- *Support for mobility and security*
  - Helps ensure compliance with mobile IP and IPsec standards.
- *Simplified header for improved router efficiency*

Is IPv4 obsolete?

- IPv4 is in no danger of disappearing overnight.
  - It will coexist with IPv6 and then gradually be replaced.
- IPv6 provides many transition options including:
  - *Dual stack*:
    - Both IPv4 and IPv6 are configured and run simultaneously on the interface.
  - *IPv6-to-IPv4 (6to4)* tunneling and IPv4-compatible tunneling.
  - *NAT protocol translation (NAT-PT)* between IPv6 and IPv4.
  - This is also know as ***translation***

Questions ?