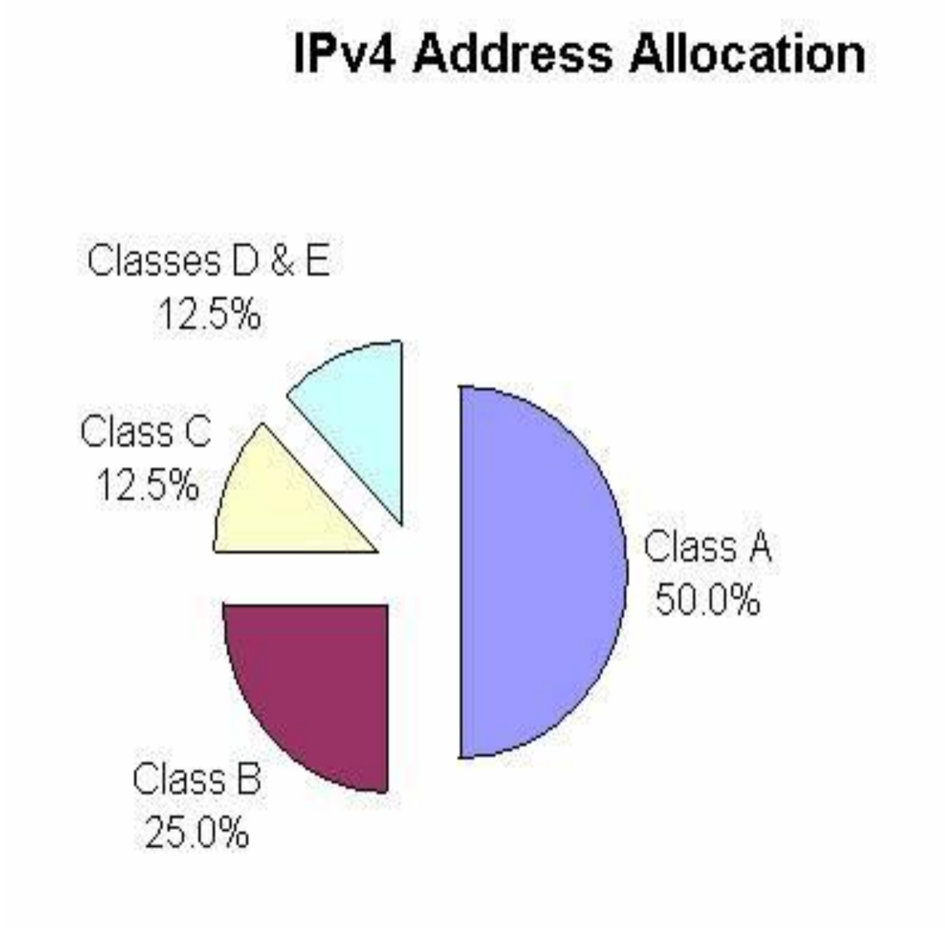
CIDR

IPv4 Classful Addressing

- 32 bit address
- How many do we get?
- ½ are class A
- ¼ are class B
- 1/8 are class C
- Rest are D & E



Wastage using classes rigidly

Class A Allocations

- $2^{32} = 4\ 294\ 967\ 296$
- ½ of these are class A = 2 147 483 648
- Class A only given to big organisations
  - Governments etc
- Each class A has $(2^{24} - 2)$ hosts = 16 777 216
- A lot of hosts!!

Class B Allocations

- 2^{16} = 65536 hosts per class B
- 1 073 741 824 addresses in total
- 16 384 different class B addresses
- 128.0.0.0 to 191.255.255.255
- Given to large companies

Class C Allocations

- 536 870 912 host addresses in all
- $2^8 - 2 = 254$ hosts per class C address
- 192.0.0.0 to 223.255.255.255
- 2 097 152 class C addresses available
- Not large enough for big company, too many for small company.

Classless Inter-Domain Routing

- A technique that addresses two scaling concerns in the Internet
  - The growth of backbone routing table as more and more network numbers need to be stored in them
  - Potential exhaustion of the 32-bit address space
- Address assignment efficiency
  - Arises because of the IP address structure with class A, B, and C addresses
  - Forces us to hand out network address space in fixed-size chunks of three very different sizes
    - A network with two hosts needs a class C address
      - Address assignment efficiency = 2/255 = 0.78
    - A network with 256 hosts needs a class B address
      - Address assignment efficiency = 256/65535 = 0.39

Classless Inter-Domain Routing

- Exhaustion of IP address space centers on exhaustion of the class B network numbers
- Solution
  - Say "NO" to any Autonomous System (AS) that requests a class B address unless they can show a need for something close to 64K addresses
  - Instead give them an appropriate number of class C addresses
- What is the problem with this solution?

Classless Inter-Domain Routing

- Problem with this solution
  - Excessive storage requirement at the routers.
- If a single AS has, say 16 class C network numbers assigned to it, (4000 addresses)
  - Every Internet backbone router needs 16 entries in its routing tables for that AS
  - This is true, even if the path to every one of these networks is the same
- If we had assigned a class B address to the AS
  - The same routing information can be stored in one entry
  - Efficiency = 16 × 255 / 65, 536 = 6.2%

Classless Inter-Domain Routing

- CIDR tries to balance the desire to minimize the number of routes that a router needs to know against the need to hand out addresses efficiently.

- CIDR uses aggregate routes
  - Uses a single entry in the forwarding table to tell the router how to reach a lot of different networks
  - Breaks the rigid boundaries between address classes

Classless Inter-Domain Routing

- Consider an AS with 16 class C network numbers.
- Instead of handing out 16 addresses at random, hand out a block of contiguous class C addresses (4000 addresses)
- Suppose we assign the class C network numbers from 192.4.16 through 192.4.31
- Observe that top 20 bits of all the addresses in this range are the same (11000000 00000100 0001)
  - We have created a 20-bit network number (which is in between class B network number and class C number)
- Requires to hand out blocks of class C addresses that share a common prefix

Classless Inter-Domain Routing

- Requires to hand out blocks of class C addresses that share a common prefix
- The convention is to place a /X after the prefix where X is the prefix length in bits
- For example, the 20-bit prefix for all the networks 192.4.16 through 192.4.31 is represented as 192.4.16/20
- 11000000 00000100 0001|0000 00000000

  Divided as network| hosts

First Address & Last Address

- In IPv4 addressing, a block of addresses can be defined as **x.y.z.t /n** in which x.y.z.t defines one of the addresses and the /n defines the mask.

- The first address in the block can be found by setting the rightmost 32 − n bits to 0s.
- The last address in the block can be found by setting the rightmost 32 − n bits to 1s.

Example

- 192.4.16/20
- 11000000 00000100 0001|0000 00000000

  Network address
- 11000000 00000100 0001|1111 11111111

  Broadcast address

Example

- A block of addresses is granted to a small organization.
- We know that one of the addresses is 205.16.37.39/28. What is the first address in the block?

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- We know that one of the addresses is 205.16.37.39/28. What is the first address in the block?

- The binary representation of the given address is

  11001101 00010000 00100101 00100111
- What is the value of n?
- If we set 32−28 rightmost bits to 0, we get

  11001101 00010000 00100101 00100000

  or 205.16.37.32 → First Address

Example Cont…

- Find the last address for the previous example

Example Cont…

- Find the last address for the previous example

- The binary representation of the given address is

  11001101 00010000 00100101 00100111

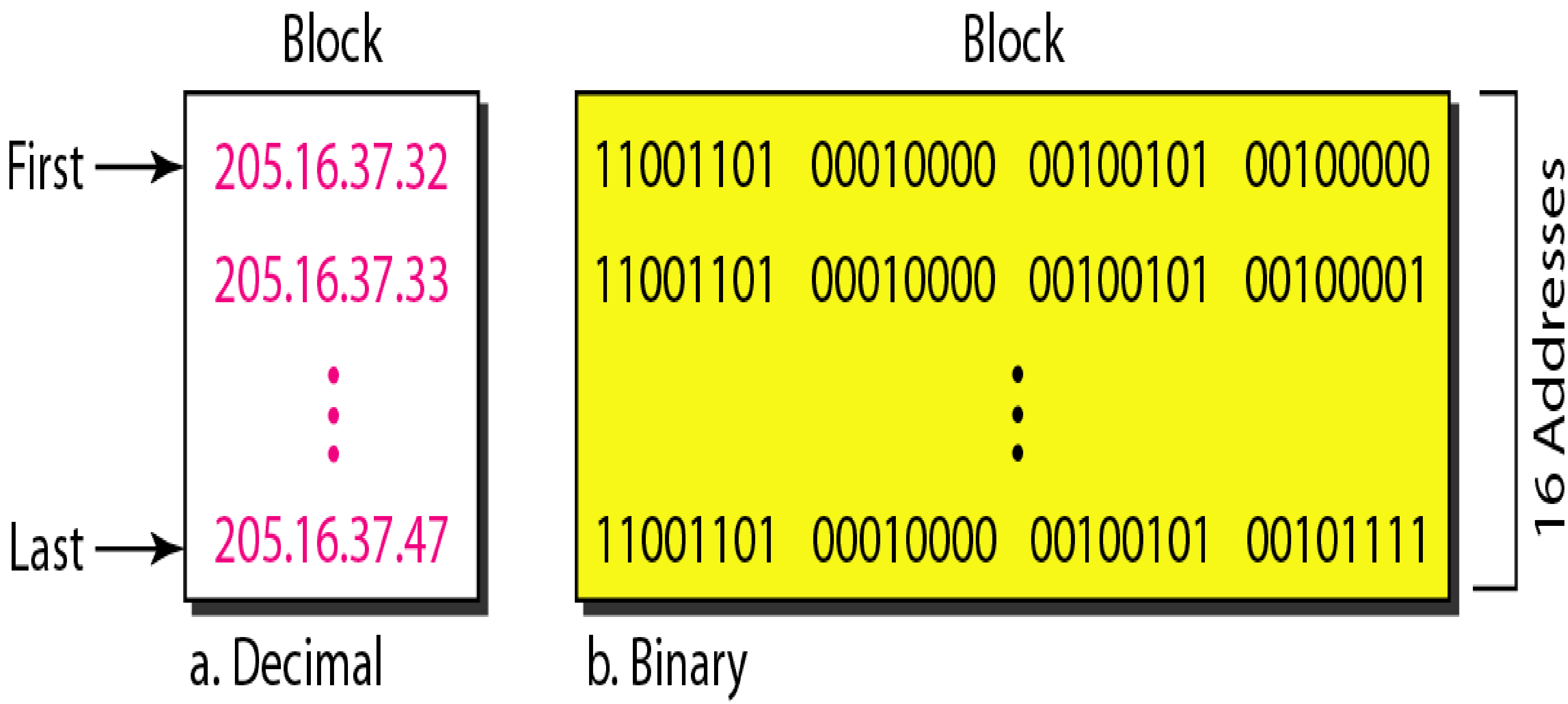
- If we set 32 − 28 rightmost bits to 1, we get

  11001101 00010000 00100101 00101111

  or

  205.16.37.47 → Last Address

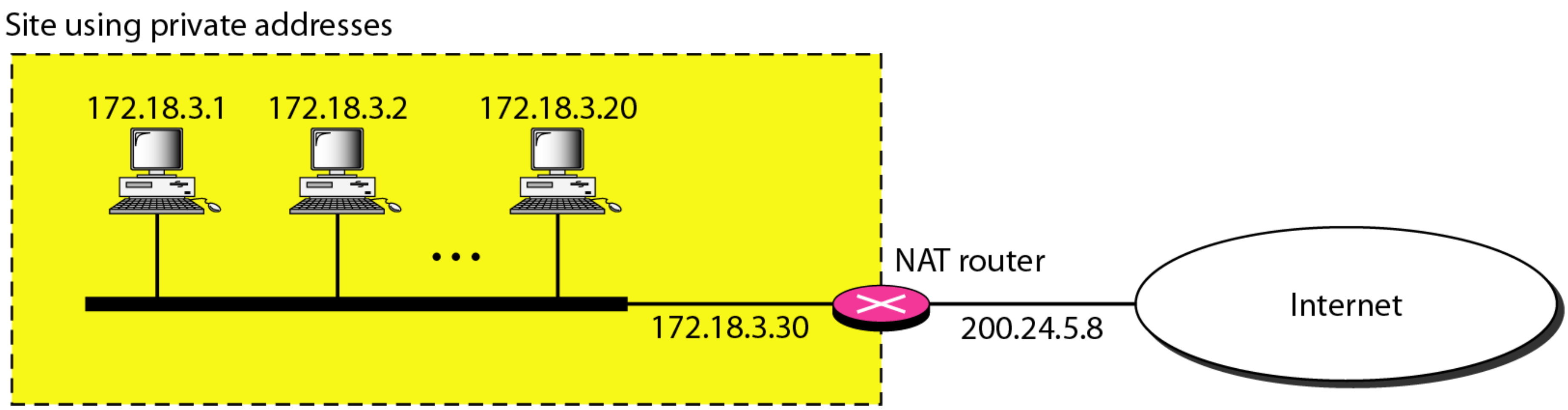
Example Cont…



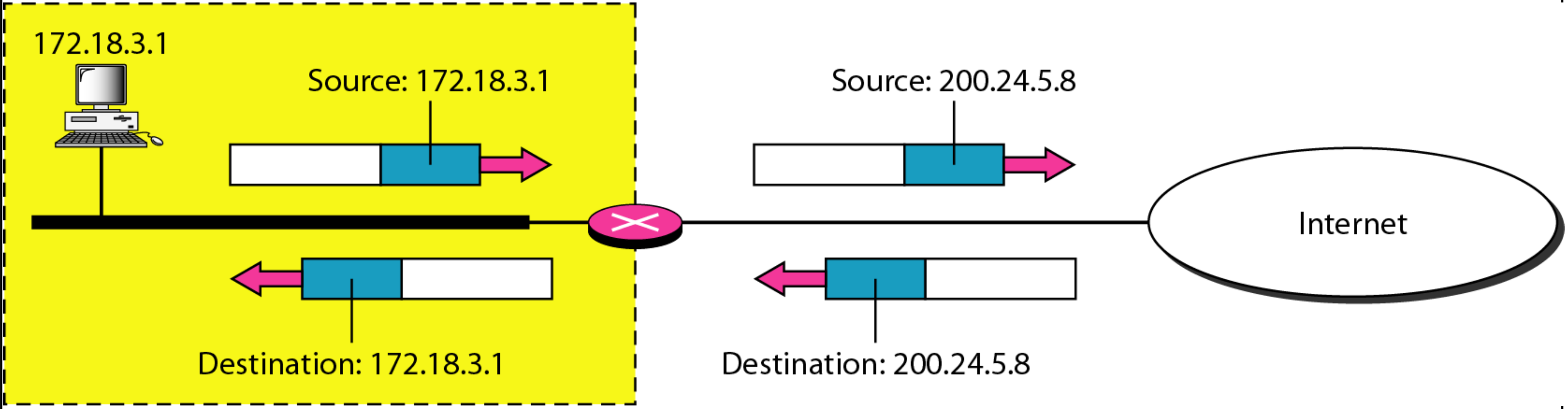
Network Address Translation

Range			*Total*
10.0.0.0	to	10.255.255.255	2^{24}
172.16.0.0	to	172.31.255.255	2^{20}
192.168.0.0	to	192.168.255.255	2^{16}

NAT Implementation



Address in a NAT



Address in a NAT