COMP90007 Internet Technologies Workshop

Week 7

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Review

IP Address (32bits) has two components,
the network address and the host address.

A **subnet mask** separates the IP address into the network and host addresses, by setting network bits to all "1"s and setting host bits to all "0"s

Route aggregation

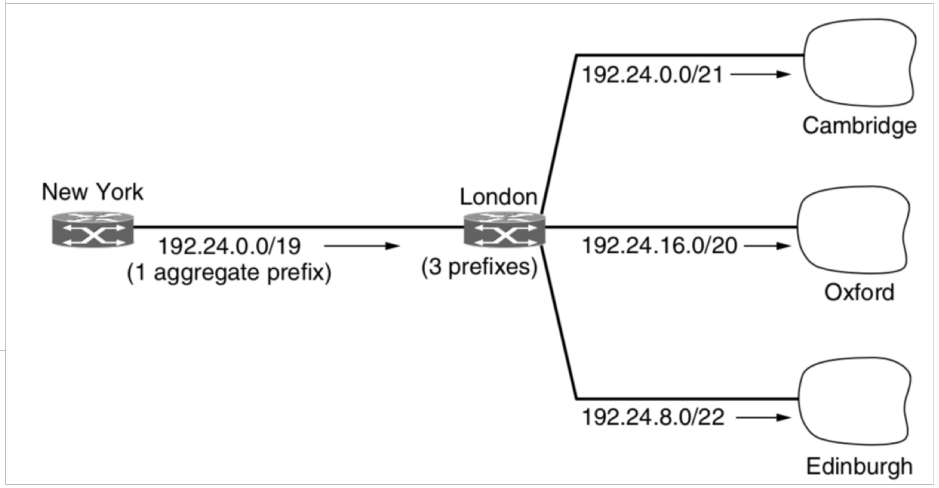
Instead of splitting an address block into subnets(Subnetting), here we **combine multiple small prefixed into a single larger prefix**. This process is called route aggregation.

The resulting larger prefix is sometimes called a **Super net**, to contrast with subnets as the division of blocks of addresses.

We can do this to reduce routing table sizes

How to do aggregation?
Longest Matching Prefix

University	First address	Last address	How many	Prefix
Cambridge	194.24.0.0	194.24.7.255	2048	194.24.0.0/21
Edinburgh	194.24.8.0	194.24.11.255	1024	194.24.8.0/22
(Available)	194.24.12.0	194.24.15.255	1024	194.24.12.0/22
Oxford	194.24.16.0	194.24.31.255	4096	194.24.16.0/20



Cambridge

Starting address: 11000010.00011000.00000000.00000000

2048 addresses in this range

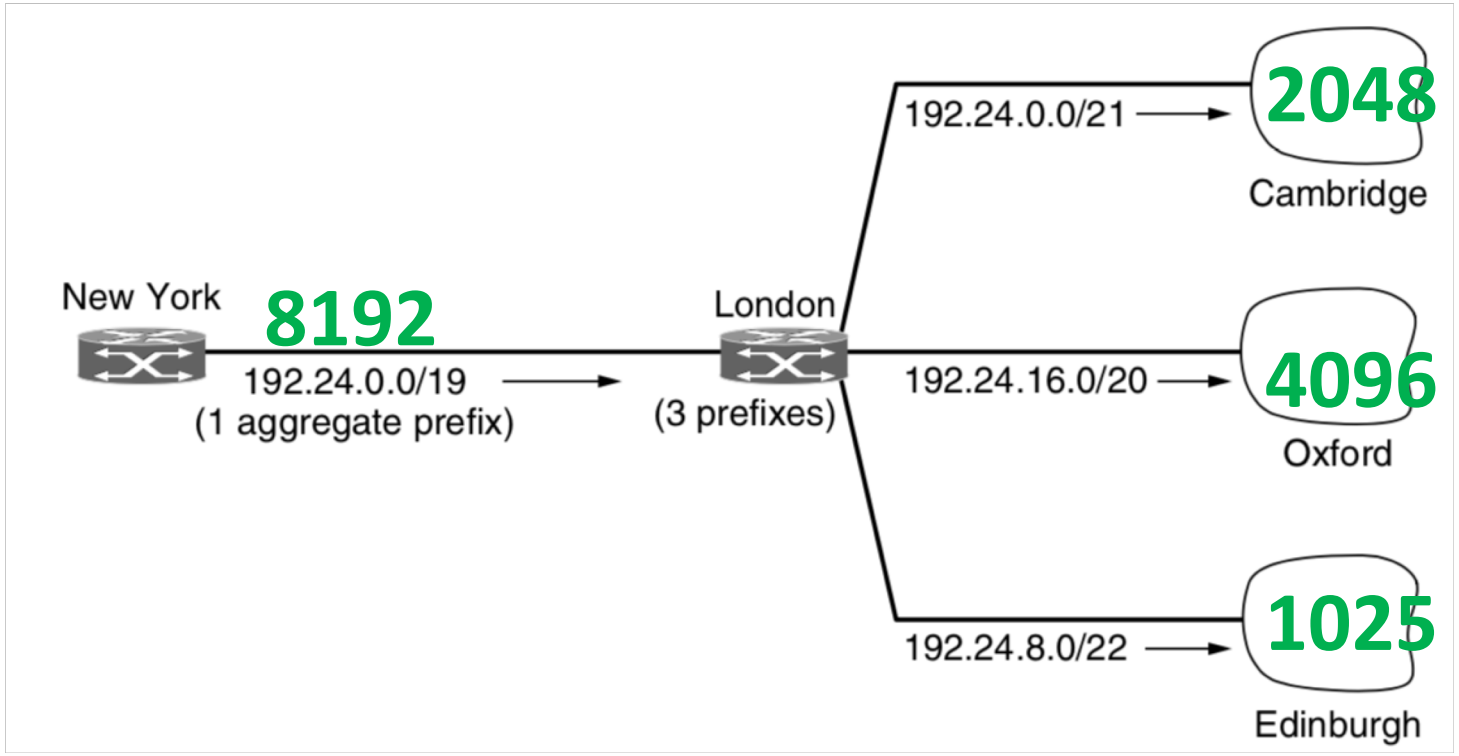
Longest Matching Prefix

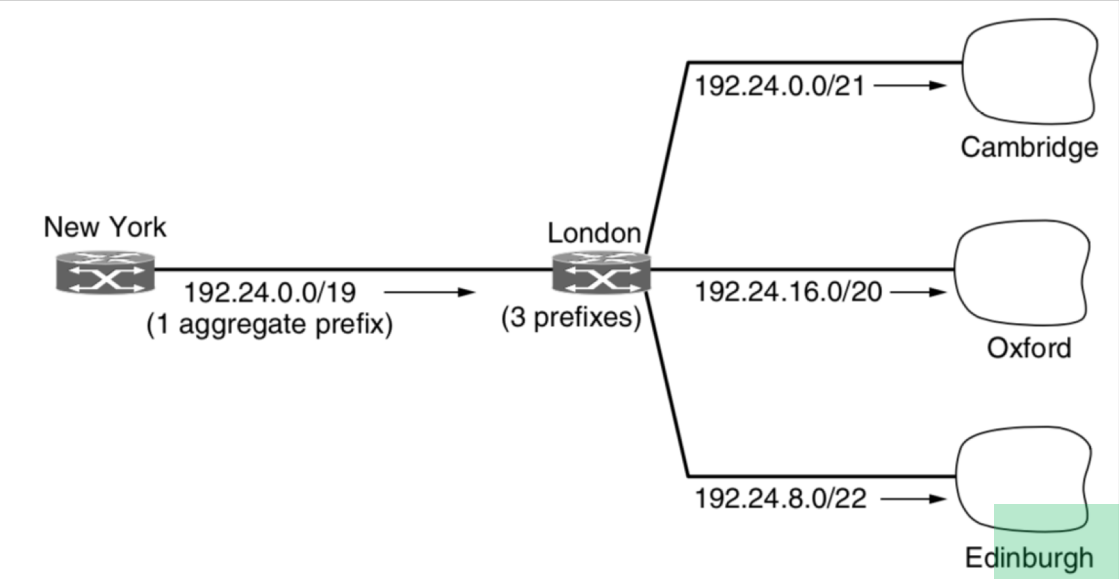
Ending address: 11000010.00011000.00000111.11111111

Aggregation 11000010.00011000.00000**000.00000000**

Aggregate these 2048 address into 1 prefix: 194.24.0.0/21

University	First address	Last address	How many	Prefix
Cambridge	194.24.0.0	194.24.7.255	2048	194.24.0.0/21
Edinburgh	194.24.8.0	194.24.11.255	1024	194.24.8.0/22
(Available)	194.24.12.0	194.24.15.255	1024	194.24.12.0/22
Oxford	194.24.16.0	194.24.31.255	4096	194.24.16.0/20





192.24.0.0/21	11000010.00011000.00000000.00000000
192.24.16.0/20	11000010.00011000.00010000.00000000
192.24.8.0/22	11000010.00011000.00001000.00000000
Aggregation	11000010.00011000.00000000.00000000

Longest Matching Prefix

Aggregate these 3 small prefix into 1 larger prefix: 194.24.0.0/19

Question 10

A router has just received the following prefix : 57.6.96.0/21, 57.6.104.0/21, 57.6.112.0/21 and 57.6.120.0/21. If all of them use the same outgoing line, can they be aggregated? If so, to what? If not, why not?

57.6.96.0/21	00111001.00000110.01100000.00000000
57.6.104.0/21	00111001.00000110.01101000.00000000
57.6.112.0/21	00111001.00000110.01110000.00000000
57.6.120.0/21	00111001.00000110.01111000.00000000
Aggregation	00111001.00000110.01100000.00000000

Longest Matching Prefix

Aggregate these 4 small prefix into 1 larger prefix: 57.6.96.0/19

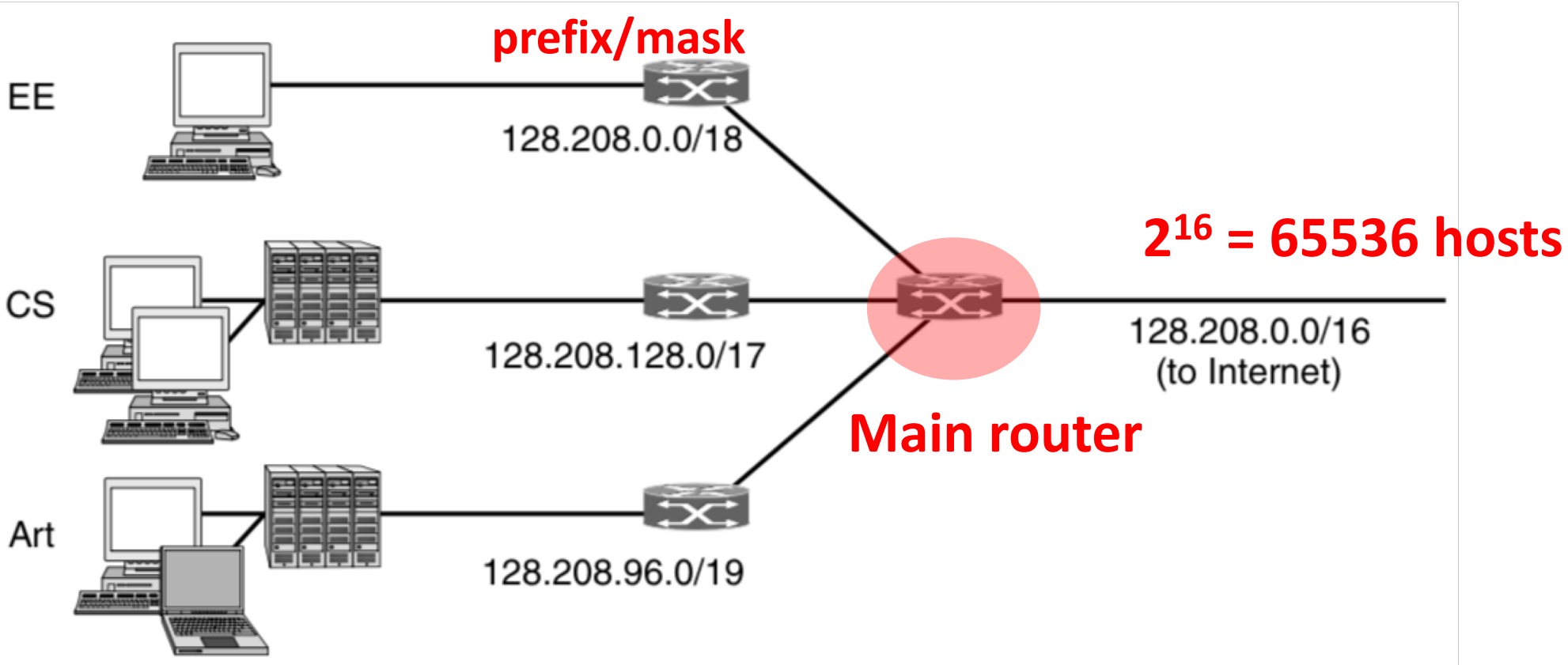


Figure 5-49. Splitting an IP prefix into separate networks with subnetting.

Question: When a packet comes into the main router, how does the router know which subnet to give it to?

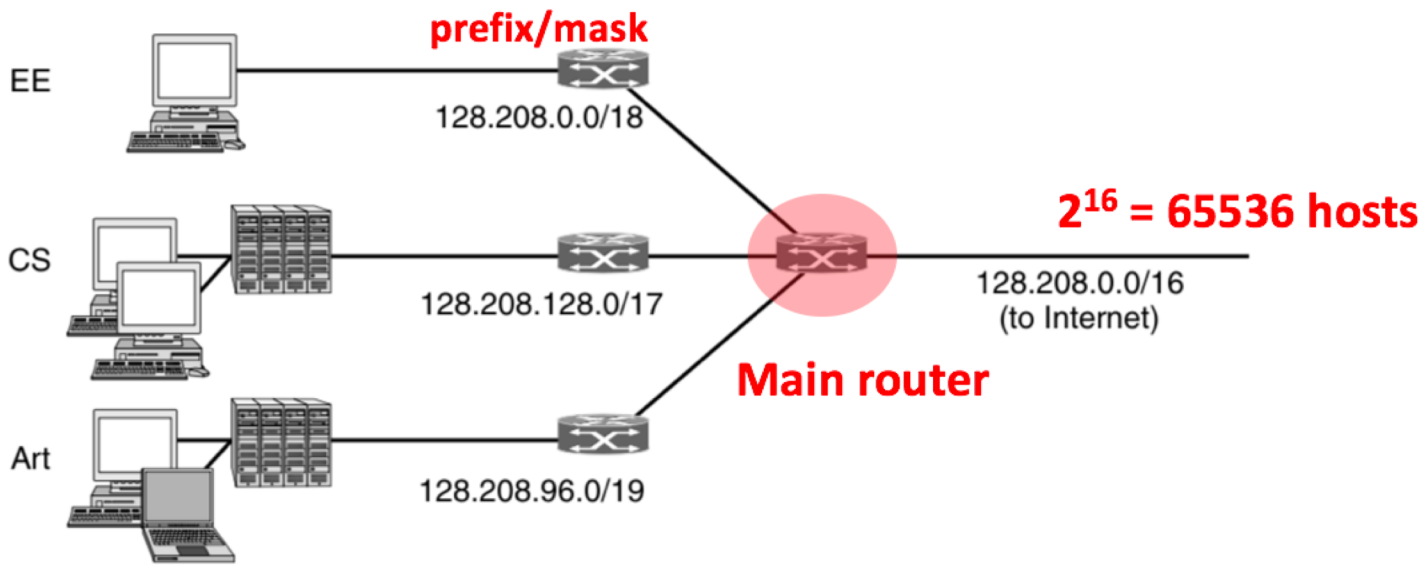


Figure 5-49. Splitting an IP prefix into separate networks with subnetting.

Method:
The router can do this by **ANDing** the **destination address** with the **mask for each subnet** and checking to see if the result is the corresponding prefix.

Destination IP Address = 128.208.2.151

10000000.11010000.00000010.10010111

To see if it is for the **Computer Science Dept**

Prefix/mask = 128.208.128.0/17

Subnet mask: 11111111 11111111 10000000 00000000

Result = 10000000.11010000.00000000.00000000

128.208.0.0

Doesn't match prefix 128.208.128.0

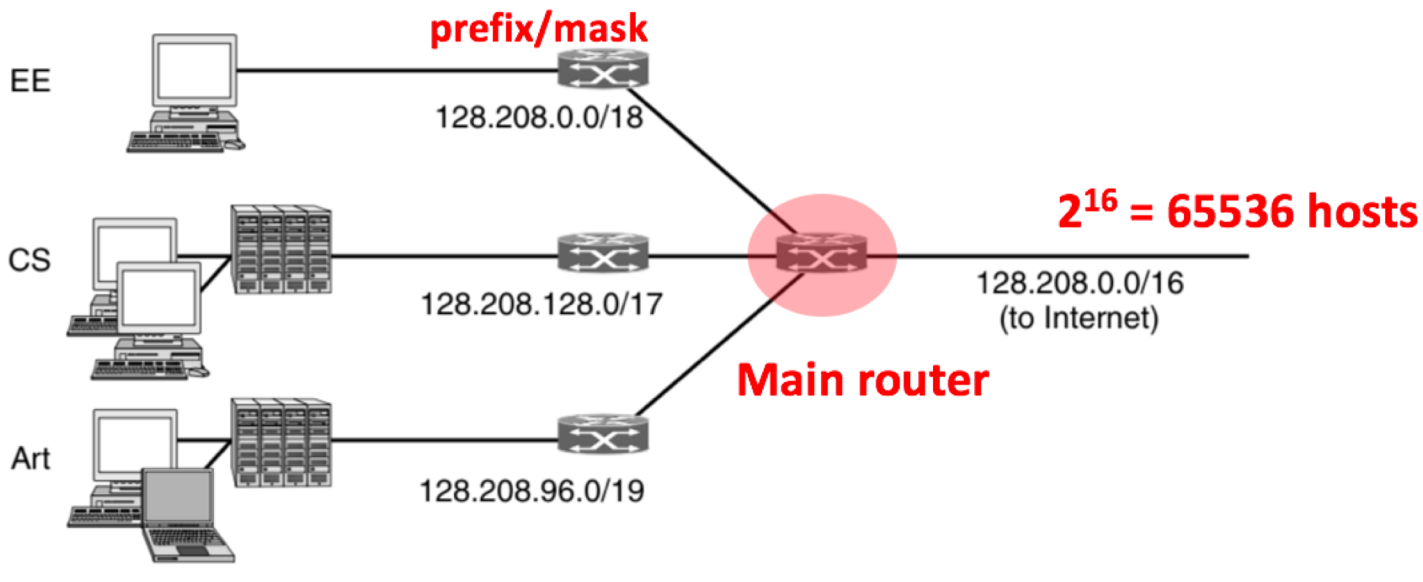


Figure 5-49. Splitting an IP prefix into separate networks with subnetting.

Method:
The router can do this by **ANDing** the **destination address** with the **mask for each subnet** and checking to see if the result is the corresponding prefix.

Destination IP Address = 128.208.2.151

10000000.11010000.00000010.10010111

To see if it is for the **EE Dept**

Prefix/mask = 128.208.0.0/18

Subnet mask: 11111111 11111111 11000000 00000000

Result = 10000000.11010000.00000000.00000000

128.208.0.0

Match prefix 128.208.0.0

Question 11

A router has the following (CIDR) entries in its routing table:

Address/mask	Next hop
135.46.56.0/22	Interface 0
135.46.60.0/22	Interface 1
135.46.0.0/16	Router 0
192.53.40.0/23	Router 1
default	Router 2

For each of the following IP addresses, what does the router do if a packet with that address arrives?

a) 135.46.63.10 b) 135.46.57.14 c) 135.46.52.2
d) 192.53.40.7 e) 192.53.56.7 f) 135.46.22.35

Answer:

The packets are routed as follows:

a) Interface 1 b) Interface 0
c) Router 0 d) Router 1
e) Router 2 f) Router 0

Address/mask	Next hop
135.46.56.0/22	Interface 0
135.46.60.0/22	Interface 1
135.46.0.0/16	Router 0
192.53.40.0/23	Router 1
default	Router 2

Method:

The router can do this by **ANDing** the **destination address** with the **mask for each subnet** and checking to see if the result is the corresponding prefix.

a) 135.46.63.10

10000111.00101110.00111111.00001010

AND

22 bits for network addresses.

So the **subnet mask** is **11111111.11111111.11111100.00000000**

Result=10000111.00101110.00111100.00000000

135.46.60.0

Not match prefix 135.46.56.0. So this packet is not for Interface 0

Address/mask	Next hop
135.46.56.0/22	Interface 0
135.46.60.0/22	Interface 1
135.46.0.0/16	Router 0
192.53.40.0/23	Router 1
default	Router 2

Method:
The router can do this by **ANDing** the **destination address** with the **mask for each subnet** and checking to see if the result is the corresponding prefix.

a) 135.46.63.10

10000111.00101110.00111111.00001010

AND

16 bits for network addresses.
So the **subnet mask** is **11111111.11111111.00000000.00000000**

Result=10000111.00101110.00000000.00000000 **135.46.0.0**

Match prefix 135.46.0.0.

Address/mask	Next hop
135.46.56.0/22	Interface 0
135.46.60.0/22	Interface 1
135.46.0.0/16	Router 0
192.53.40.0/23	Router 1
default	Router 2

Method:
The router can do this by **ANDing** the **destination address** with the **mask for each subnet** and checking to see if the result is the corresponding prefix.

a) 135.46.63.10

Question : Both interface 1 and Router 0 can match our destination address 135.45.63.10, which one we direct our packet to? Interface 1 or Router 0?

We always prefer the **more specific** one, which means the one that can have longer match with destination address

SO, we choose **Interface 1.**

Question 11

A router has the following (CIDR) entries in its routing table:

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default	Router 2

For each of the following IP addresses, what does the router do if a packet with that address arrives?

a) 135.46.63.10 b) 135.46.57.14 c) 135.46.52.2
d) 192.53.40.7 e) 192.53.56.7 f) 135.46.22.35

Answer:

The packets are routed as follows:

a) Interface 1 b) Interface 0
c) Router 0 d) Router 1
e) Router 2 f) Router 0

Additional Questions

Question 1

A router an entry in its table that can be represented with mask as 135.46.56.0/21. What is the maximum number of hosts that this network can represent?

21 bits means network has 21 bits reserved

In total, 32bits for IP address
So, remaining 11 bits are for hosts

2^{11} hosts

Question 12

IPv4 uses 4 bytes = 32bits addresses
IPv4 uses 16 bytes = 128 bits address

IPv6 uses 16 bytes addresses. If a block of 1 million addresses is allocated every picosecond, how long will the addresses last?

picosecond = 10^{-12} second

Answer:
With 16 bytes there are 2^{128} or addresses. If we allocate them at a rate of $10^6/10^{-12} = 10^{18}$ addresses per second. Therefore it will take 3.4×10^{20} seconds to run out of IP addresses, which is about 10^{13} years.

This number is 1000 times the age of the universe. Of course, the address space is not flat, so they are not allocated linearly, but this calculation shows that even with an allocation scheme that has an efficiency of 1/1000 (0.1 percent), one will never run out.