Internet Protocol version 6 (IPv6)

Present by
Assist. Lect. Dhafer T. Shihab
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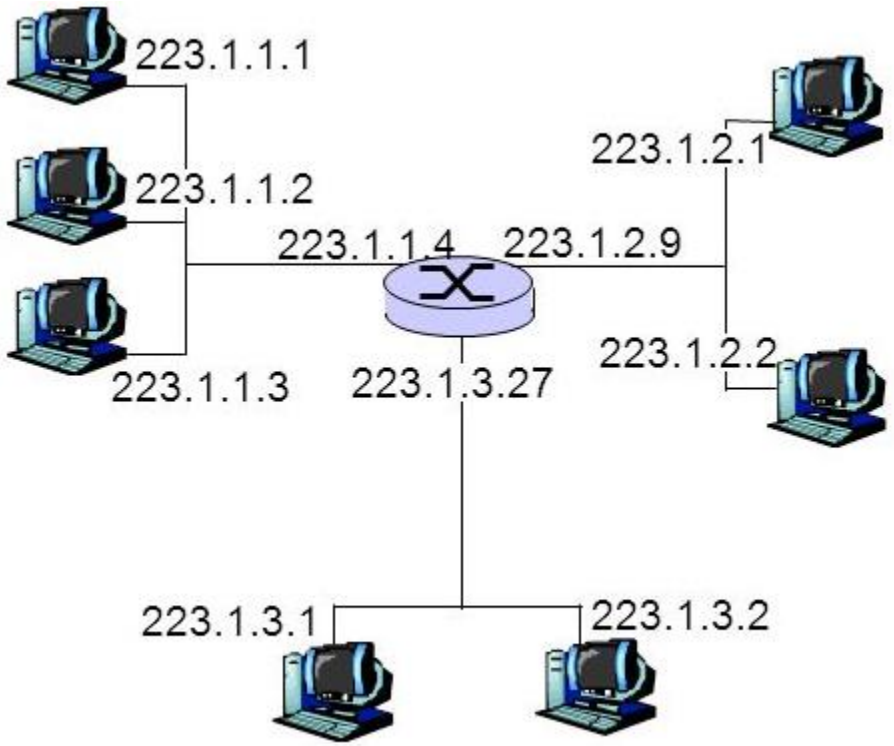
Presentation Outlines

- What is an IP Address?
- Beginning with IPv4 (Internet Protocol version 4)
- What was the internet like in 1981?
- The internet Begins to Take OFF
- IP Addresses held by the country
- IPv4: Running out of Addresses
- Introducing IPv6 (Internet Protocol version 6)
- IPv6
- IPv6 Address Structure
- IPv6 provides some rules to shorten the address
- The Need for IPv6
- Benefits of IPv6
- Transitioning to IPv6
- IPv6 Transition Methods

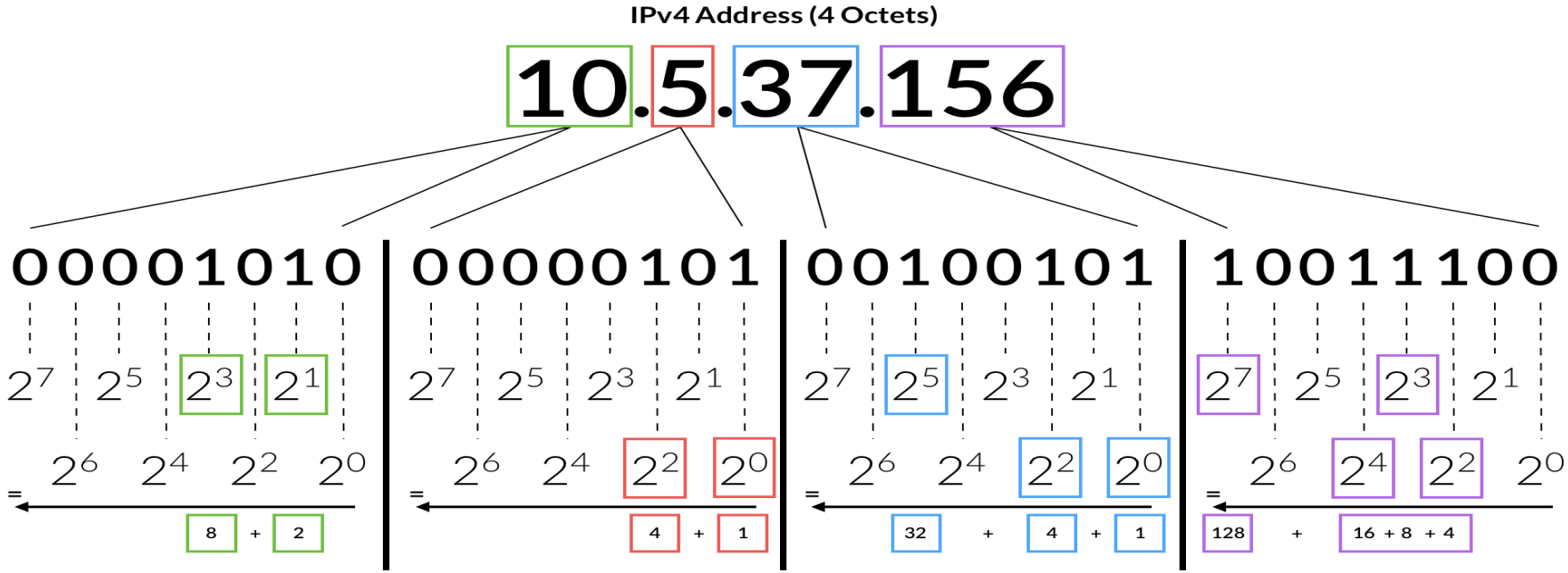
Internet Protocol IPv6

What is an IP Address?

- An IP address is a sequence of numbers.
- A way to identify machines on a network
- A unique identifier



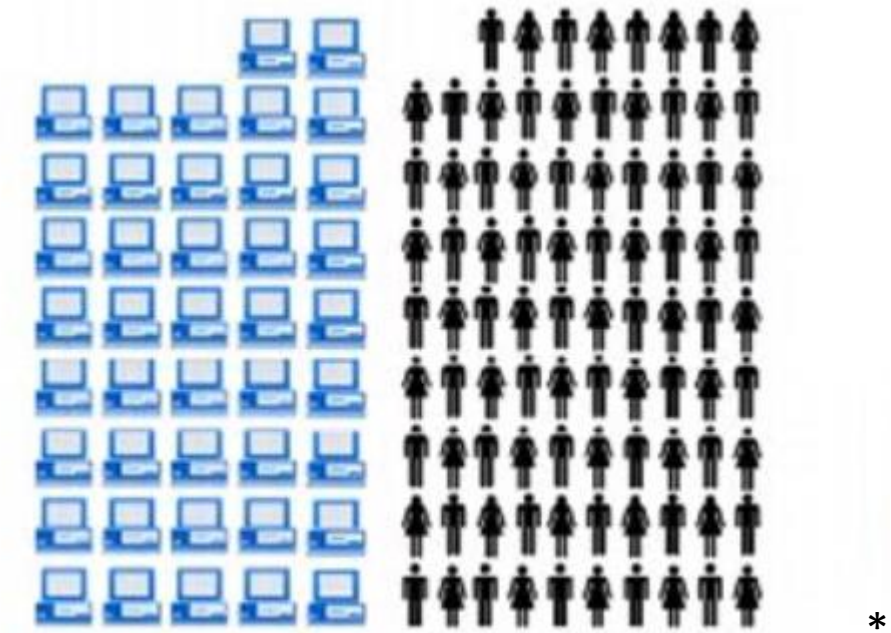
Beginning with IPv4 (Internet Protocol version 4)



- Developed in the early 1980s.
- 32-bit addresses represented in dotted-decimal notation.
- Provides 2^{32}= 4,294,967,296 addresses.
- It seemed like a lot of addresses at the time!

What was the internet like in 1981?

- 4.29 billion addresses, about 1:1 ratio with the world's population.
- No WWW, no mobile devices, and most people never heard of the internet.
- Mostly mainframe and minicomputers.



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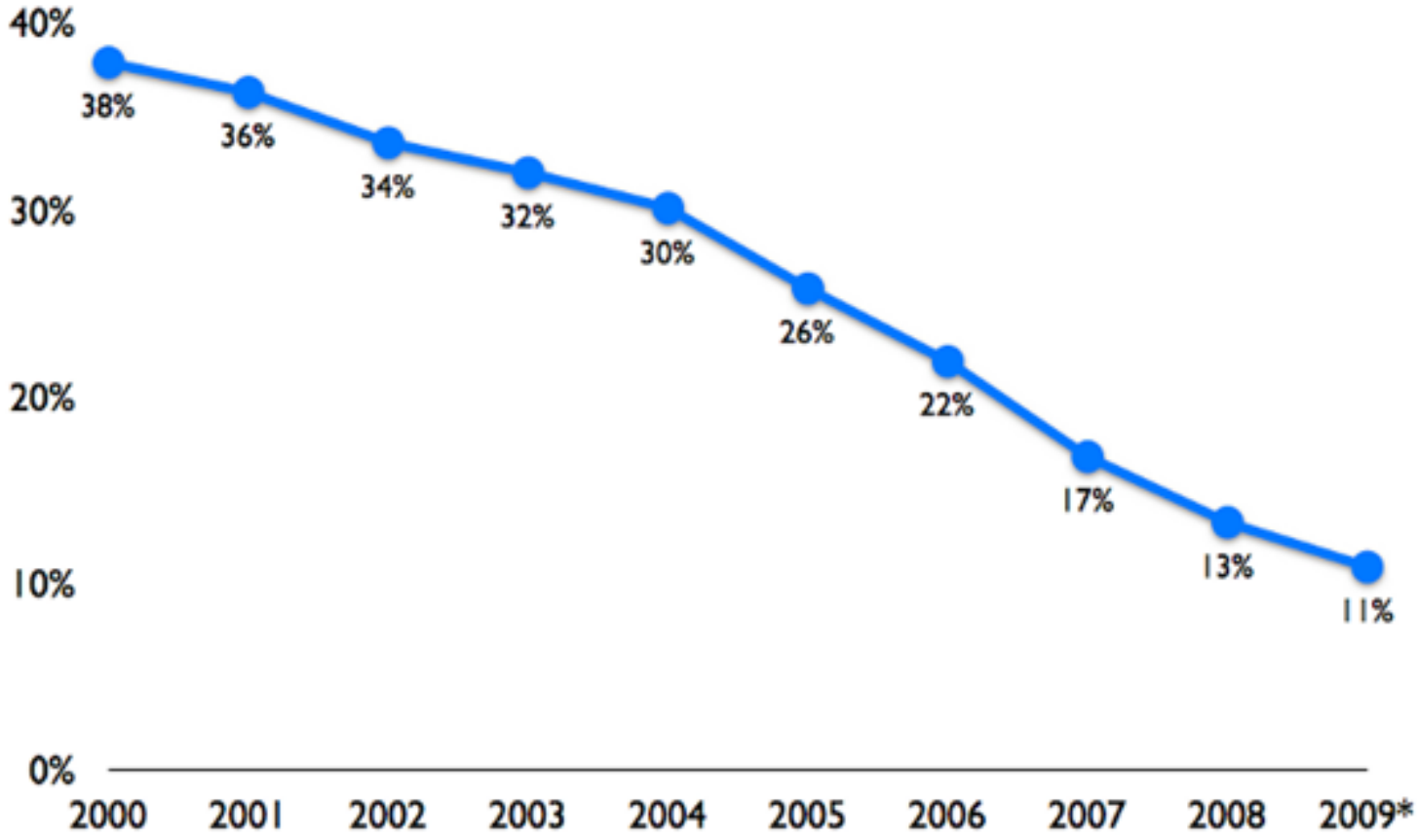
Total Population of the World by Decade, 1950–2050

(historical and projected)

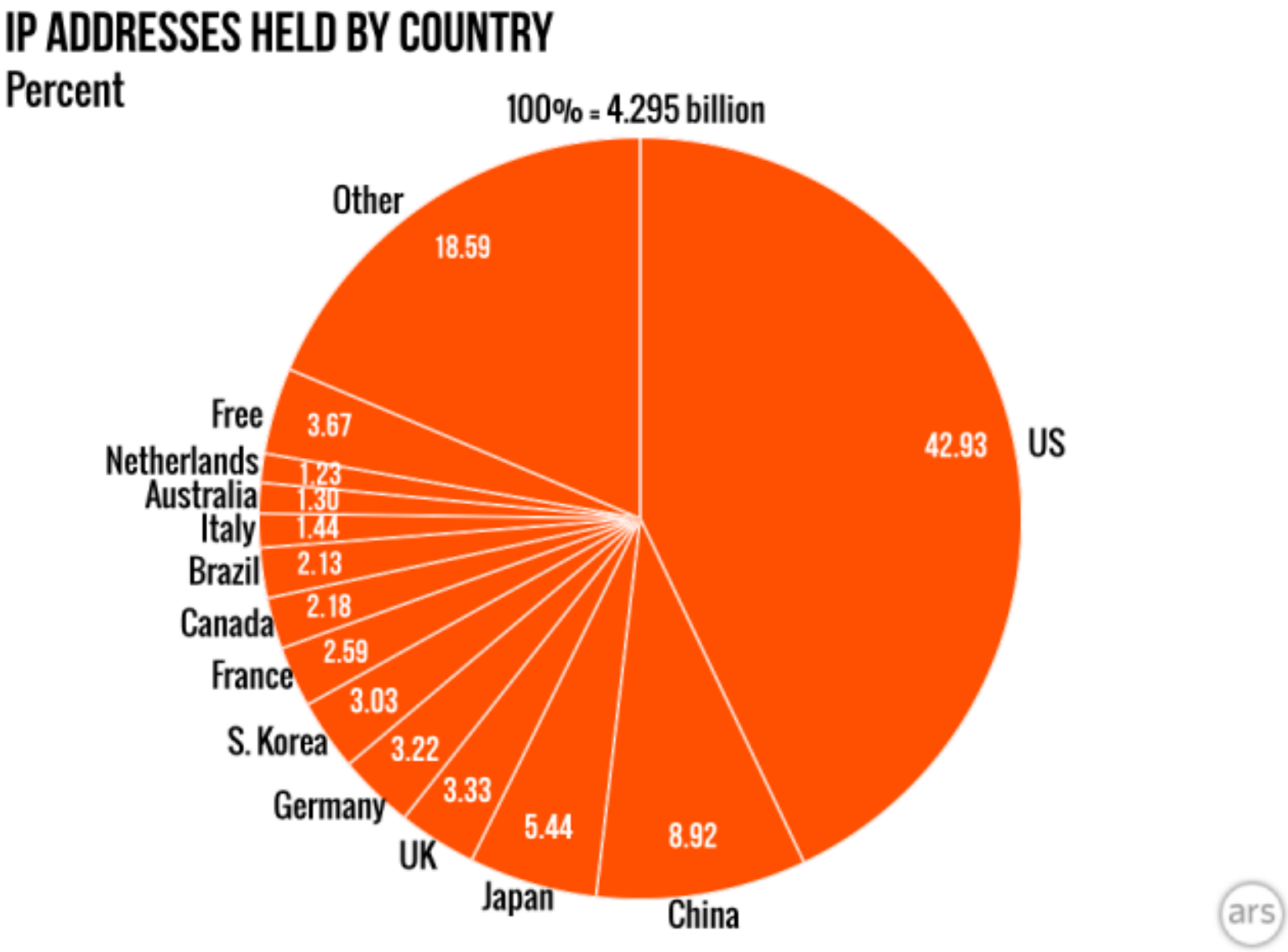
Year	Total world population (mid-year figures)	Ten-year growth rate (%)
1950	2,556,000,053	18.9%
1960	3,039,451,023	22.0
1970	3,706,618,163	20.2
1980	4,453,831,714	18.5
1990	5,278,639,789	15.2
2000	6,082,966,429	12.6
2010[1]	6,848,932,929	10.7
2020[1]	7,584,821,144	8.7
2030[1]	8,246,619,341	7.3
2040[1]	8,850,045,889	5.6
2050[1]	9,346,399,468	—

The internet Begins to Take OFF

- 1990s introduced the World Wide Web.
- Every one was getting on the internet.
- Internet routing tables growing rapidly, 20,000 routes in 1994.
- **IETF** (Internet Engineering Task Force) realized that it would soon run out of IPv4 address space.

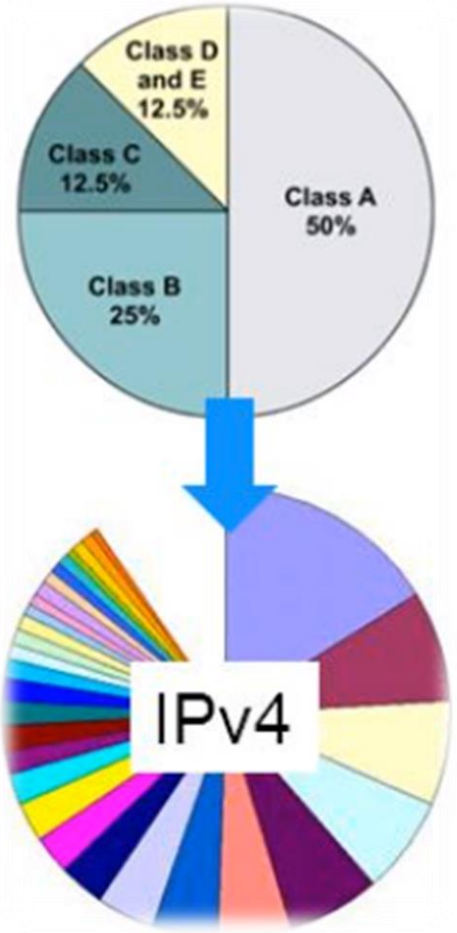


IP Addresses held by the country



IPv4: Running out of Addresses

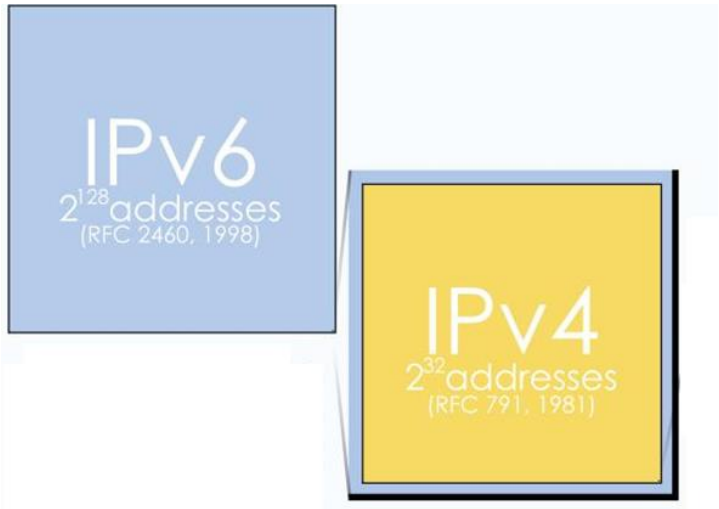
Private Address Space
10.0.0.0/8
172.16.0.0/12
192.168.0.0/16



- Short term solutions included:
  - NAT (Network Address Translation).
  - Private address space.
  - CIDR (Classless Inter-Domain Routing).
- Long-term solution: IPv6.

Introducing IPv6 (Internet Protocol version 6)

- Developed mid to late 1990s.
- Much learned from IPv4.
- 128-bit address space, written in hexadecimal.
- This gives us 340 undecillion addresses!



340 undecillion =340,282,366,920,938,463,463,374,607,431,768,211,456

$= (2^{128})$

IPv6

- How many is 340 undecillion?
- 340 undecillion addresses is 10 nonillion addresses per person!
- Internet is a much different place and will continue to evolve:
  - Mobile devices.
  - Internet of Everything.
  - A critical part in how we "live, work, play, and learn".

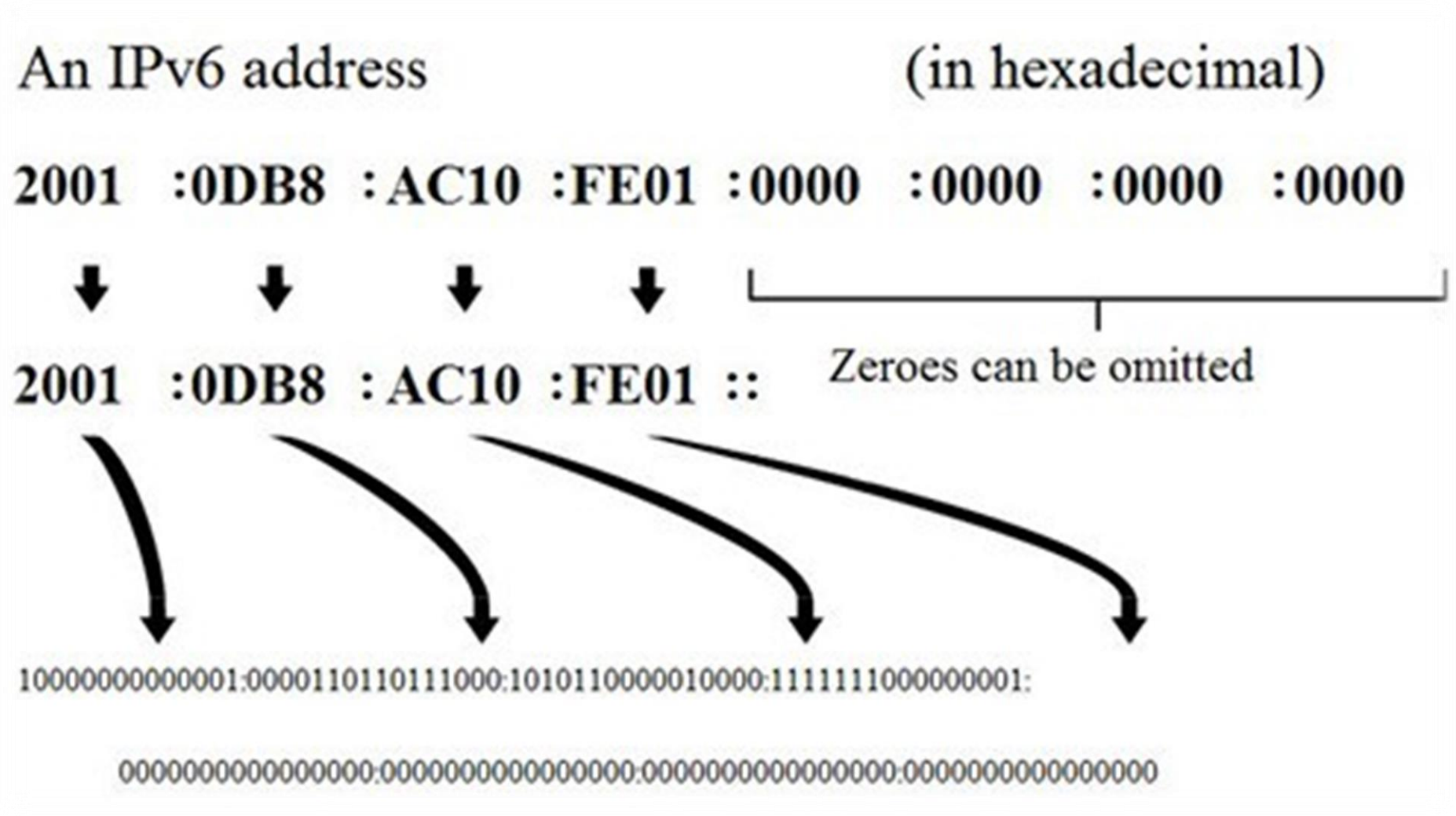
10 nonillion= 10,000,000,000,000,000,000,000,000,000,000

IPv6 (cont'd)

IPv6 is not just about more addresses.

- Stateless auto configuration.
- End-to-end reachability without private addresses and NAT.
- Peer-to-peer networking easier to create and maintain, and services such as VoIP and Quality of Service (QoS) become more robust.

IPv6 Address Structure



IPv6 Address Structure (cont'd)

```
0010000000000001 0000000000000000 0011001000111000
1101111111100001 0000000001100011 0000000000000000
0000000000000000 1111111011111011
```

Each block is then converted into Hexadecimal and separated by ':' symbol:

```
2001:0000:3238:DFE1:0063:0000:0000:FEFB
```

Even after converting into Hexadecimal format, IPv6 address remains long.

IPv6 provides some rules to shorten the address

2001:0000:3238:DFE1:0063:0000:0000:FEFB

- **Rule.1:** leading zero(es) compression:

2001:0:3238:DFE1:63:0:0:FEFB

- **Rule.2:** Zero(es) compression:

2001:0:3238:DFE1:63::FEFB

The Need for IPv6

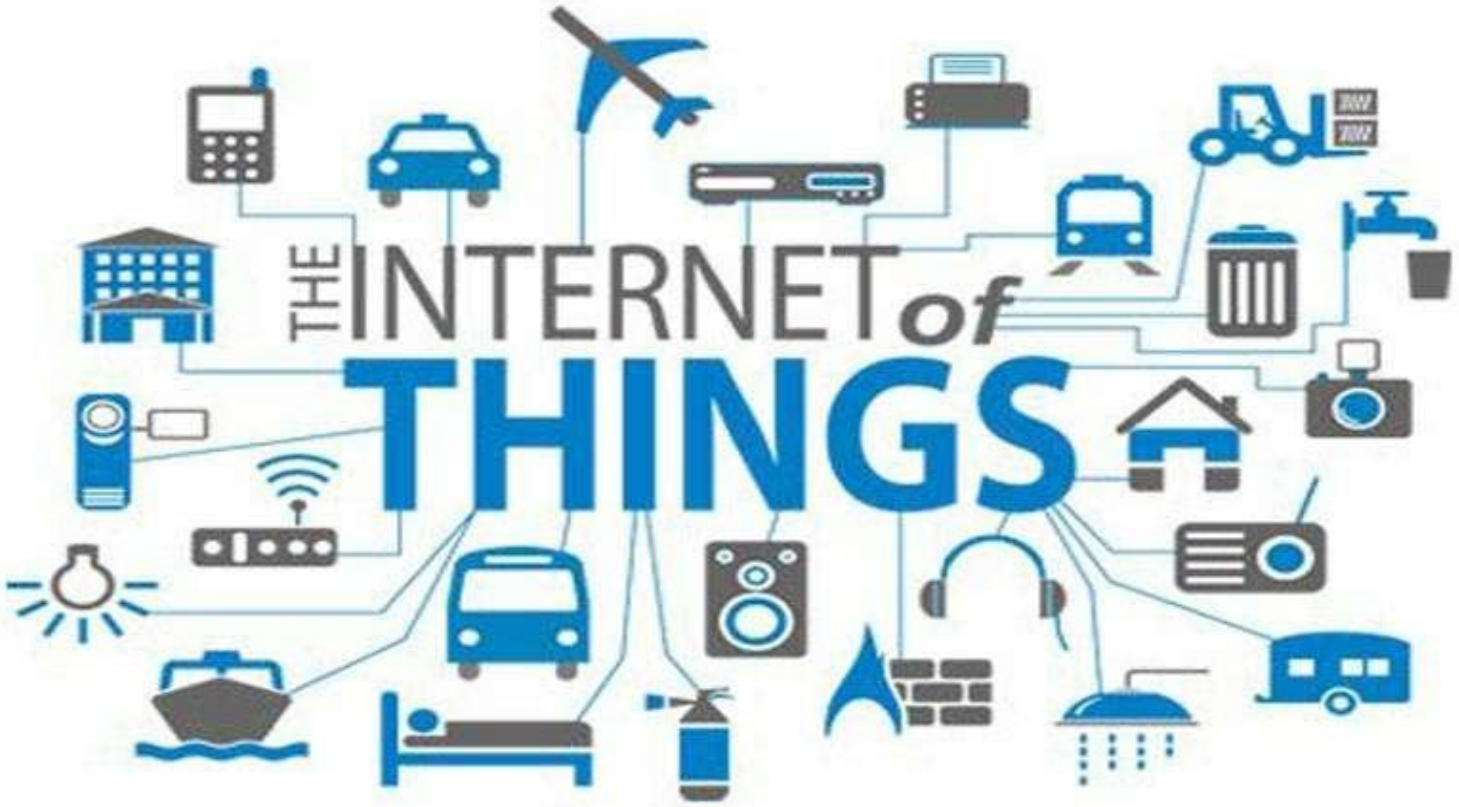
- We are running out of IPv4 address space.
- IPv4 address blocks to the RIRs (Regional Internet Registry).
- RIR's have very few, if any IPv4 address left.
- Many ISPs are severely limited and some have already run out.

Actual or projected dates as of November 2014

IANA: Internet Assigned Numbers Authority

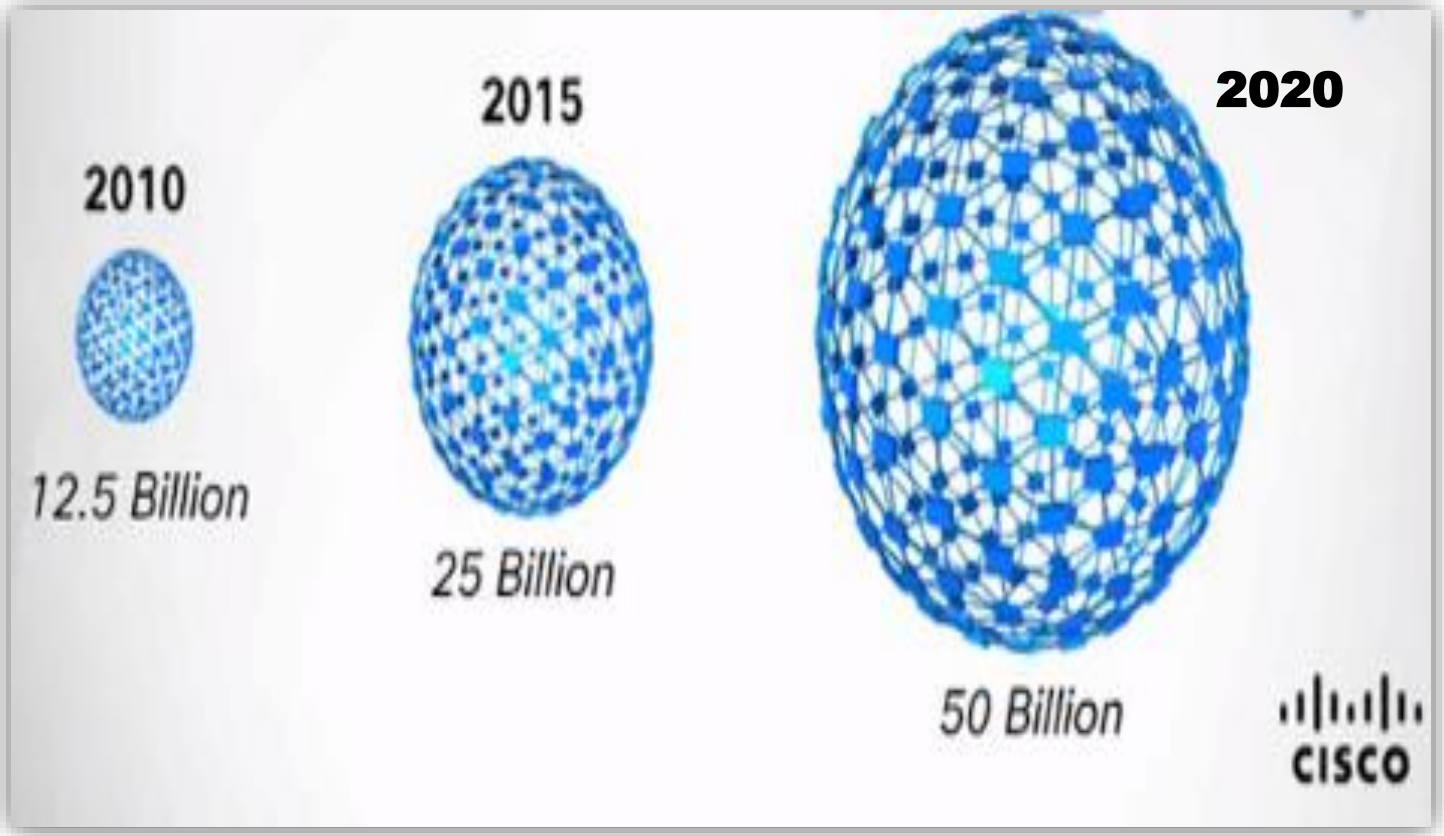
The Need for IPv6 (cont'd)

- The future protocol for scaling up the internet.
- Enabling the internet of things (IoT)



The Need for IPv6 (cont'd)

- Cisco defines the Internet of Everything (IoE) as bringing together people, process, data, and things to make networked connections more relevant and valuable than ever before.
- Cisco estimates that there will be **50 billion** "connected" devices in 2020.



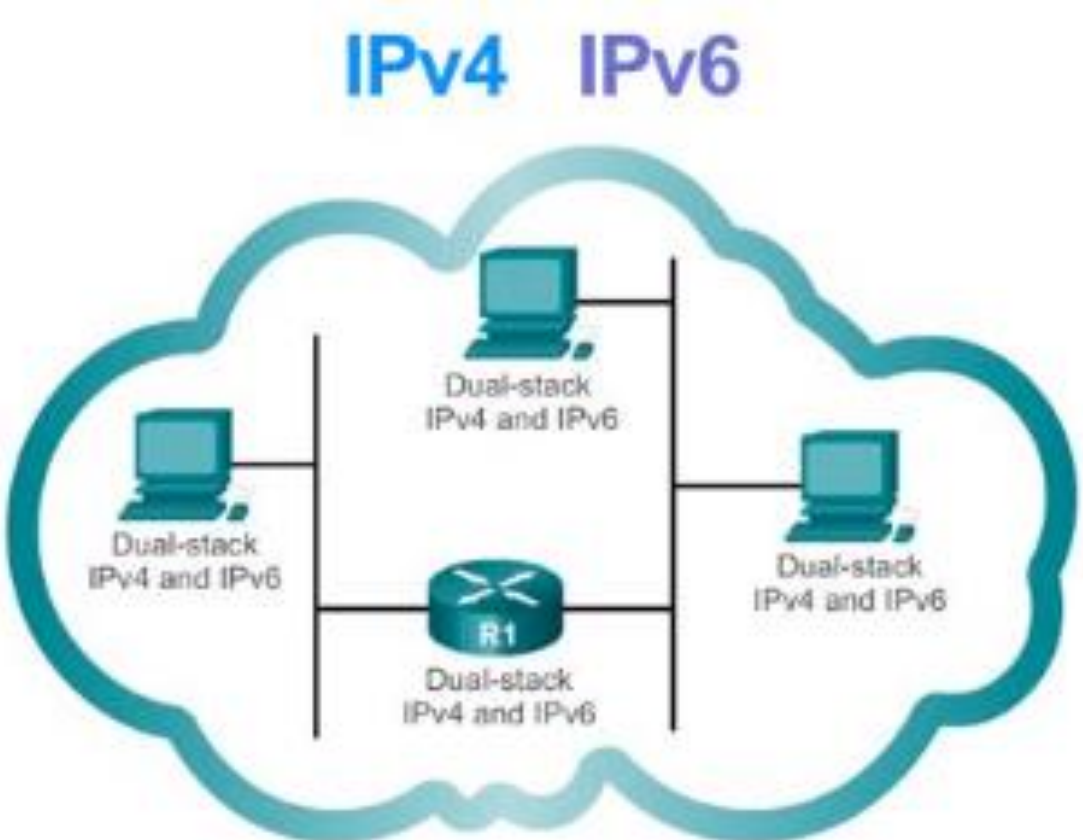
Benefits of IPv6

As mentioned previously the benefits of IPv6 include:

- Larger address space.
- Stateless auto configuration.
- End-to-end reachability without private addresses and NAT.
- Better mobility support.
- Peer-to-peer networking easier to create and maintain, and services such as VoIP and Quality of Service (QoS) become more robust.

Transitioning to IPv6

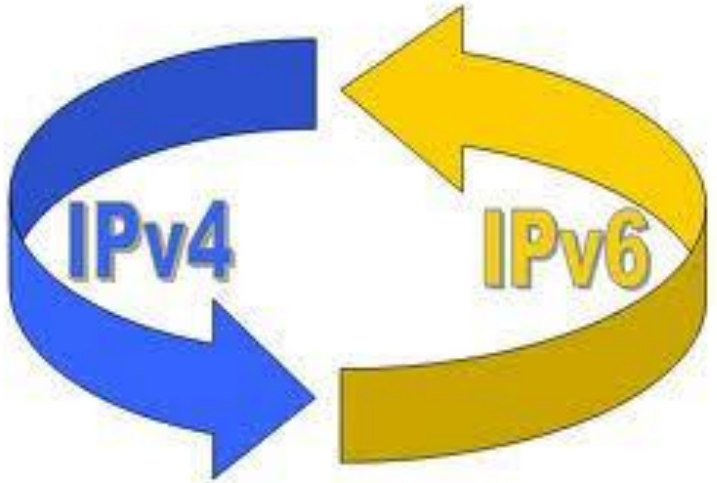
- IPv4 and IPv6 will coexist for the foreseeable future.
- Enterprises and ISPs have to support both protocols, which is a reason to eventually go to only IPv6.




```
C:\Users\dhafer>nslookup
Default Server:  google-public-dns-a.google.com
Address:  8.8.8.8

>
> www.google.com
Server:  google-public-dns-a.google.com
Address:  8.8.8.8

Non-authoritative answer:
Name:    www.google.com
Addresses:  2a00:1450:4001:818::2004
          216.58.207.68

> www.facebook.com
Server:  google-public-dns-a.google.com
Address:  8.8.8.8

Non-authoritative answer:
Name:    star-mini.c10r.facebook.com
Addresses:  2a03:2880:f12d:83:face:b00c:0:25de
          31.13.90.36
Aliases:  www.facebook.com

>
```

IPv6 Transition Methods

- **Dual Stack** – Running both IPv4 and IPv6 on the same devices.
- **Tunneling** – Transporting IPv6 traffic through an IPv4 network transparently.
  - Manual IPv6 Tunnels
  - Generic Routing Encapsulation (GRE) IPv6 tunnels
  - 6to4 Tunnels
  - IPv6 rapid deployment (6rd)
  - IPv4 Compatible Tunnels
  - Intra-Site Automatic Tunnel Addressing Protocol (ISATAP) Tunnels
- **Translation** – Converting IPv6 traffic to IPv4 traffic for transport and vice versa.
  - Network Address Translation
  - NAT64




THANK YOU