Why IPv6?

In this lesson, we'll get an introduction to IP version 6.

Why IPV6?

- IPv4 was initially designed for a research network that would interconnect *some* research labs and universities. For this purpose, 32 bit addresses, i.e., $2^{32} = 4,294,967,296 \approx 4.3$ **billion addresses seemed sufficient**. Also, 32 bits was an incredibly convenient address size for software-based routers.

However, the popularity of the Internet, i.e., the number of smartphones and Internet of Things devices, was not anticipated. We've made do with 4.3 billion addresses so far by reusing them and with NAT boxes. Nonetheless, we are running out of addresses. Hence, **IPv6 was designed** to **tackle these limitations of IPv4**.

IPv6 Features

IPv6 has some distinguishing pros and cons.

Pros

- **Simplified Header:** All IPv4 options are moved to the end of the IPv6

header. IPv6 header is twice as large as IPv4 headers but only because IPv6 addresses are four times longer.

- **Larger Address Space:** IPv6 addresses face **4 times as many bits** as IPv4. So all IPv6 addresses are 128 bits wide. This implies that there are $340, 282, 366, 920, 938, 463, 463, 374, 607, 431, 768, 211, 456$ $2^{32 \times 4} = 2^{128} \approx 3.4 \times 10^{38} \approx$ **340 undecillion addresses** different IPv6 addresses. As the surface of the Earth is about $510, 072, 000 \ km^2$, this implies that there are about 6.67×10^{23} IPv6 addresses per square meter on Earth. Compared to IPv4, which offers only 8 addresses per square kilometer, this is a significant improvement on paper.

Cons

- IPv6 is a complete redesign over IPv4 and hence is **not backward compatible**. This means that devices configured over IPv4 can NOT access websites on servers configured with IPv6!

- Upgrading to IPv6 enabled hardware is an expensive shift for ISPs and is not directly translatable in terms of profit. This is part of the reason why the world has not shifted entirely to IPv6.

Textual representation of IPv6 addresses

It's sometimes necessary to write IPv6 addresses in text format, e.g., when manually configuring addresses or for documentation purposes.

The preferred format for writing IPv6 addresses is **x:x:x:x:x:x:x:x**, where the **x's** are hexadecimal digits representing the eight 16-bit parts of the address. Here are a few examples of IPv6 addresses:

- ABCD:EF01:2345:6789:ABCD:EF01:2345:6789

- 2001:DB8:0:0:8:800:200C:417A

- FE80:0:0:0:219:E3FF:FED7:1204

IPv6 addresses often contain a long sequence of bits set to 0. In this case, a compact notation has been defined. With this notation, **::** is used to indicate one or more groups of 16 bit blocks containing only bits set to 0. For example:
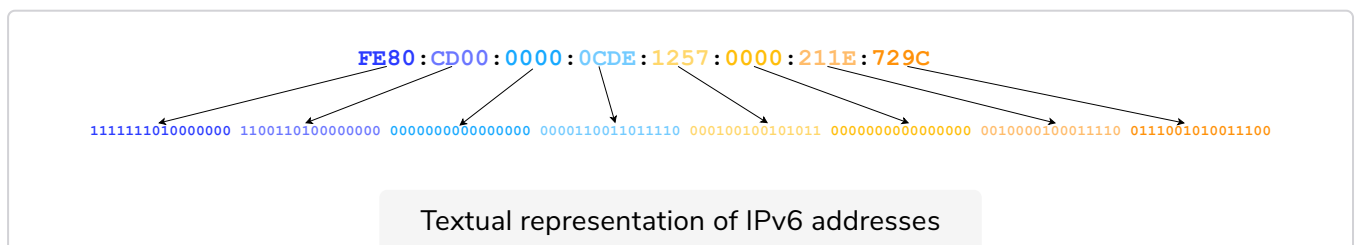
- **2001:DB8:0:0:8:800:200C:417A** is represented as **2001:DB8::8:800:200C:417A**

- **FF01:0:0:0:0:0:0:101** is represented as **FF01::101**

- **0:0:0:0:0:0:0:1** is represented as **::1**
- **0:0:0:0:0:0:0:0** is represented as **::**

An IPv6 prefix can be represented as **address/length**, where length is the length of the prefix in bits. For example,the three notations below correspond to the same IPv6 prefix:

- **2001:0DB8:0000:CD30:0000:0000:0000:0000/60**

- **2001:0DB8::CD30:0:0:0:0/60**

- **2001:0DB8:0:CD30::/60**

Here's a drawing that represents how an IPv6 address is written in text form.

FE80:CD00:0000:0CDE:1257:0000:211E:729C

1111111010000000 1100110100000000 0000000000000000 0000110011011110 0001001001011011 0000000000000000 0010000100011110 0111001010011100

Textual representation of IPv6 addresses

Quick Quiz!

> **1**
>
> What's a compact way of representing the IPv6 address: **FE00:0:0:0:219:A34F:F3D7:1204**?

In the next lesson, we'll study IPv6 address types!