Internet Protocol Version 6 (IPv6)

by Sophia

WHAT'S COVERED

In this lesson, you will learn about internet Protocol Version 6, popularly referred to as IPv6.

Specifically, this lesson will cover:

1. Internet Protocol Version 6 (IPv6)

People refer to **IPv6** as “the next-generation internet protocol,” and it was originally created as the answer to running out of IPv4 addresses. Though you’ve probably heard a thing or two about IPv6 already, it has been improved to enable the flexibility, efficiency, capability, and optimized functionality that can truly meet our ever-increasing needs.

TERM TO KNOW

IPv6

A successor to IPv4 allowing for a much larger number of possible IP addresses.

1a. Why Do We Need IPv6?

The number of people and devices that connect to networks increases each day and we are going to run out of IPv4 addresses to use.

KEY CONCEPT

IPv4 has only about 250 million addresses that can be assigned to devices, and the world needs more than that. IPv6 is the solution.

1b. The Benefits of and Uses for IPv6

IPv6 solves the problem of using up the available IPv4 address. Not only does IPv6 give us lots of addresses (3.4×10^{38}), which is about 50,000 IPv6 addresses for every square meter of Earth! There are many other features built into this version that may make it well worth the cost, time, and effort required to migrate to it.

IPv6 has improved upon and included many of those features as standard and mandatory. One of these new standards is **IPSec**, which is a feature that provides end-to-end security. You will learn more about IPSec later in the course. Another benefit is **mobility**, and as its name suggests, it allows a device to roam from one network to another without dropping connections.

Efficiency is another key benefit of IPv6. The header in an IPv6 packet has half the fields compared to IPv4, and they are aligned to 64 bits, which supports high performance processing speed. Most of the information that used to be bound into the IPv4 header was taken out, and now you can choose to put it, or parts of it, back into the header in the form of optional extension headers that follow the basic header fields.

TERMS TO KNOW

IPSec

A secure network protocol suite that authenticates and encrypts packets of data to provide secure encrypted communication between two computers over an IP network.

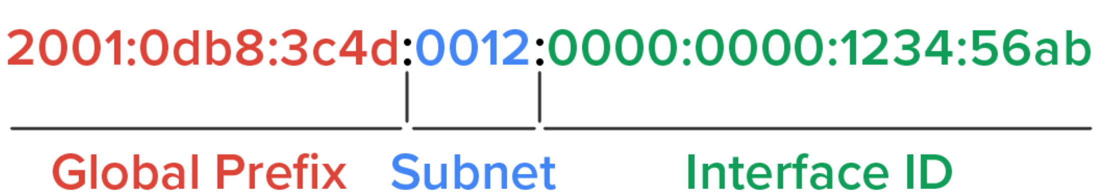
Mobility

Human–computer interaction by which a computer is expected to be transported during normal usage.

1c. IPv6 Addressing and Expressions

Just as understanding how IP addresses are structured and used is critical with IPv4 addressing, it's also vital when it comes to IPv6. You've already read about the fact that at 128 bits, an IPv6 address is much larger than an IPv4 address. Because of this, IPv6 may be more complicated to manage.

EXAMPLE So, let's take a look at the illustration below, which has a sample IPv6 address broken down into sections.



As you can now see, the address is much larger. Notice that it has eight groups of numbers instead of four, and also that those groups are separated by colons instead of periods. An IPv6 address is expressed in hexadecimal just like a MAC address is, so you could say this address has eight 16-bit hexadecimal colon-delimited blocks.

1d. Shortened Expression

When typing out an IPv6 address, you can leave out parts of the address to abbreviate it, but to get away with doing that, you have to follow a couple of rules.

First, you can drop any leading zeros in each of the individual blocks. You can’t drop trailing zeros (that is, zeroes at the end of a number, like ab00) because they have meaning.

> EXAMPLE After you do that, the sample address from the last illustration would look like this:
> 2001:db8:3c4d:12:0:0:1234:56ab

You can also eliminate whole blocks that don’t have anything in them except zeros.

> EXAMPLE Again, referring to our sample address, you can remove the two blocks of zeros by replacing them with a set of double colons, like this:
> 2001:db8:3c4d:12::1234:56ab

A single set of double colons can stand for different numbers of zero values. You can deduce how many zero values a set of double colons represents by counting the remaining numbers and then subtracting that count from 8.

> EXAMPLE If you had 2001:db8:3c4d:12::56ab, there are 5 numbers here plus the double colon, so the fully written-out number would be 2001:db8:3c4d:12:0000:0000:0000:56ab.

You can replace only one contiguous block of zeros in an address. So, if my address has four blocks of zeros and each of them is separated, I don’t get to replace them all.

> EXAMPLE 2001:0000:0000:0012:0000:0000:1234:56ab
>
> And just know that you can’t do this:
> 2001::12::1234:56ab
>
> Instead, this is the best that you can do:
> 2001::12:0:0:1234:56ab

The reason this example is your best shot is that if you remove two sets of zeros, the device looking at the address will have no way of knowing where the zeros go back in.

1e. Address Types

We’re all familiar with IPv4’s unicast, broadcast, and multicast addresses, which basically define who or at least how many other devices we’re talking to. IPv6 introduces the **anycast** address type. Broadcasts, as we know them, have been eliminated in IPv6 because of their inefficiency.

Since a single interface can have multiple types of IPv6 addresses assigned for various purposes, let’s find out what each of these types of IPv6 addresses are and the communication methods of each.

Unicast are packets addressed to a unicast address are delivered to a single interface, same as in IPv4. For load balancing, multiple interfaces can use the same address.

Global Unicast Addresses are typical publicly routable addresses, and they're used the same way globally unique addresses are in IPv4.

Link-Local Addresses are like the private addresses in IPv4 in that they're not meant to be routed and are unique for each local area network. Think of them as a handy tool that gives you the ability to throw a temporary LAN together for meetings or for creating a small LAN that's not going to be routed but still needs to share and access files and services locally.

Unique Local Addresses are also intended for non-routing purposes, but they are nearly globally unique, so it's unlikely you'll ever have one of them overlap with any other address. Unique local addresses were designed to replace site-local addresses, so they basically do almost exactly what IPv4 private addresses do—allow communication throughout a site while being routable to multiple local networks. The difference between link-local and unique local is that unique local can be routed within your organization or company.

Multicast, as in IPv4, packets addressed to an IPv6 multicast address are delivered to all interfaces identified by the multicast address. Sometimes people call them *one-to-many addresses*. It is really easy to spot multicast addresses in IPv6 because they always start with *FF*.

Like multicast addresses, an **Anycast** address identifies multiple interfaces, but there's a big difference: The anycast packet is delivered to only one of many possible addresses: to the first IPv6 address it finds, defined in terms of routing distance. You could call anycasts one-to-one-of-many addresses, but just saying "anycast" is a lot easier. This is also referred to as one-to-nearest addressing.

You're probably wondering if there are any special, reserved addresses in IPv6 because you know they're there in IPv4. Well, there are—plenty of them! Let's go over them now.

Special Addresses and address ranges that are reserved for a specific use.

Address	Meaning
0:0:0:0:0:0:0:0	Equals ::. This is the equivalent of IPv4's 0.0.0.0 and is typically the source address of a host before the host receives an IP address when you're using DHCP-driven stateful configuration.
0:0:0:0:0:0:0:1	Equals ::1. The equivalent of 127.0.0.1 in IPv4.
0::FFFF:192.168.100.1	This is how an IPv4 address would be written in a mixed IPv6/IPv4 network environment.
2000::/3	The global unicast address range allocated for Internet access.
FC00::/7	The unique local unicast range.
FE80::/10	The link-local unicast range.
FE00::/8	The multicast range.
3FFF:FFFF::/32	Reserved for examples and documentation.
2001:0DB8::/32	Also reserved for examples and documentation.
2022::/16	Used with 6to4 tunneling, which is an IPv4-to-IPv6 transition system. The structure allows IPv6 packets to be transmitted over an IPv4 network without the need to configure explicit tunnels.

TERMS TO KNOW

Anycast

A network addressing and routing scheme whereby data is routed to the nearest or best destination as viewed by the routing topology.

SUMMARY

In this lesson, you learned about **Internet Protocol Version 6 (IPv6)**, including why we need it, its benefits, how its addressing is expressed, how to shorten the expressions, and various address types.

Source: This content and supplemental material has been adapted from CompTIA Network+ Study Guide: Exam N10-007, 4th Edition. Source **Lammle: CompTIA Network+ Study Guide: Exam N10-007, 4th Edition - Instructor Companion Site (wiley.com)**

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