Networking

- IPv6 Quick Explainer

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The best information I've found that explains IPv6 in detail was on free online training from omnisecu.com. I read through all their lessons to get a good understanding of IPv6. However I'm going to briefly go over come key concepts below.

Addresses

IPv6 addresses are 128-bit and represented in 32 hexadecimal characters broken down into 8 groups seprated by a colon and look like `2001:db8:2458:a2b2:cd47:8abb:8844:1`. These groups are sometimes called hextets.

Address Types

Name	Description
unicast	Identifies an interface of an individual node.
multicast	Identifies a group of interfaces, usually on different nodes. Packets that are sent to the multicast address go to all members of the multicast group.
anycast	Identifies a group of interfaces, usually on different nodes. Packets that are sent to the anycast address go to the anycast group member node that is physically closest to the sender.

Address Components

Example: `2001:0db8:3c4d:0015:0000:0000:1a2f:1a2b`

Component	Value	Description
site prefix	`2001:0db8:3c4d`	The prefix describes the public topology that is usually allocated to your site by an ISP or Regional Internet Registry (RIR).

Component	Value	Description
subnet ID	`0015`	The subnet ID describes the private topology, also known as the site topology, because it is internal to your site.
interface ID	`0000:0000:1a2f:1a2b`	The interface ID is either automatically configured from the interface's MAC address or manually configured in EUI-64 format.

Abbreviating Addresses

IPv6 addresses can be a little scary to look at but there are two tricks when writing them to be a little more readable.

- Leading zeros in any *hextet* can be dropped. So `0db8` could be written as just `db8`
- If there are contiguous *hextets* that are all zeros like `2001:db8:0000:0000:0000:0000:abcd:1` they can be shortened with a syntax of `::`. So that address could be abbreviated as `2001:db8::1`. The only gotcha is that you can only do this once in an address, so if there are two stretches with *hextets* of `0000` you can only shorten one of them. I thought this would be annoying but I literally haven't run into a situation where that would have been needed.

Prefixes

> The leftmost fields of the IPv6 address contain the prefix, which is used for routing IPv6 packets. IPv6 prefixes have the following format:
>
> `<prefix> / <length in bits>`
>
> Prefix length is stated in classless inter-domain routing (CIDR) notation. CIDR notation is a slash at the end of the address that is followed by the prefix length in bits. For information on CIDR format IP addresses, refer to Designing Your CIDR IPv4 Addressing Scheme.
>
> The site prefix of an IPv6 address occupies up to 48 of the leftmost bits of the IPv6 address. For example, the site prefix of the IPv6 address `2001:db8:3c4d:0015:0000:0000:1a2f:1a2b/48` is contained in the leftmost 48 bits, `2001:db8:3c4d`. You use the following representation, with zeros compressed, to represent this prefix:

> `2001:db8:3c4d::/48`
>
> You can also specify a subnet prefix, which defines the internal topology of the network to a router. The example IPv6 address has the following subnet prefix.
>
> `2001:db8:3c4d:15::/64`
>
> The subnet prefix always contains 64 bits. These bits include 48 bits for the site prefix, in addition to 16 bits for the subnet ID.

Source: IPv6 Addressing Overview (oracle.com)

> The prefix 2001:db8::/32 is a special IPv6 prefix that is used specifically for documentation examples.

Features

Prefix Delegation

> Since it would not be practical to manually provision networks at scale, in IPv6 networking, DHCPv6 prefix delegation is used to assign a network address prefix and automate configuration and provisioning of the public routable addresses for the network. The way this works for example in case of a home network is that the home router uses DHCPv6 protocol to request a network prefix from the ISP's DHCPv6 server. Once assigned, the ISP routes this network to the customer's home router and the home router starts advertising the new addresses to hosts on the network, either via SLAAC or using DHCPv6.

Source: Prefix Delegation (wikipedia.com)

Neighbor Discover Protocol (NDP)

> The Neighbor Discovery Protocol (NDP, ND) is a protocol in the Internet protocol suite used with Internet Protocol Version 6 (IPv6). It operates at the link layer of

> the Internet model, and is responsible for gathering various information required for internet communication, including the configuration of local connections and the domain name servers and gateways used to communicate with more distant systems.
>
> The protocol defines five different ICMPv6 packet types to perform functions for IPv6 similar to the Address Resolution Protocol (ARP) and Internet Control Message Protocol (ICMP) Router Discovery and Router Redirect protocols for IPv4. However, it provides many improvements over its IPv4 counterparts (RFC 4861, section 3.1). For example, it includes Neighbor Unreachability Detection (NUD), thus improving robustness of packet delivery in the presence of failing routers or links, or mobile nodes.

Source: Neighbor Discovery Protocol (wikipedia.com)

Stateless address autoconfiguration (SLAAC)

> IPv6 hosts configure themselves automatically. Every interface has a self-generated link-local address and, when connected to a network, conflict resolution is performed and routers provide network prefixes via router advertisements. Stateless configuration of routers can be achieved with a special router renumbering protocol. When necessary, hosts may configure additional stateful addresses via Dynamic Host Configuration Protocol version 6 (DHCPv6) or static addresses manually.

Source: Stateless address autoconfiguration (SLAAC) (wikipedia.com)