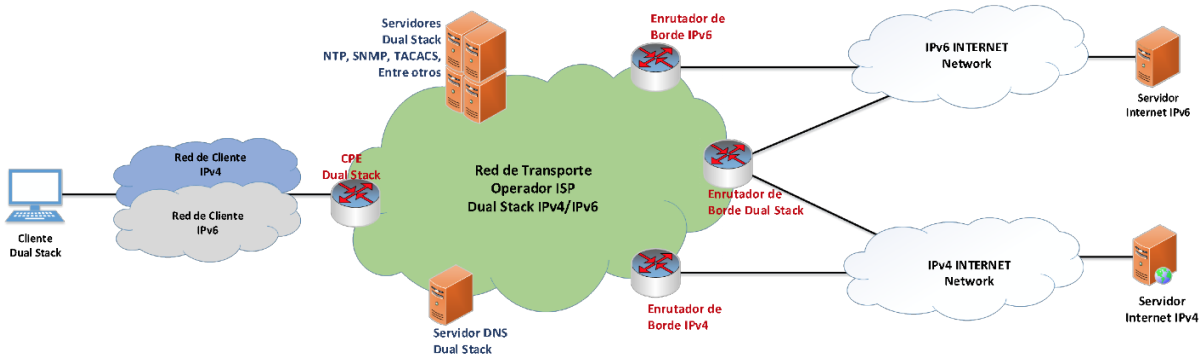
Dual Stack

Overview

Dual-stack IP implementations provide complete IPv4 and IPv6 protocol stacks in the ISP's hosts and routers. In other words, all network devices provide simultaneous support for both IPv6 and IPv4. Several RFCs address dual-stack mechanisms, including RFC4241, RFC4213, RFC6555, RFC305, and others

The idea behind the dual-stack approach is that hosts and applications can use either the IPv4 stack, the IPv6 stack, or even both stacks simultaneously to achieve a better performance when establishing connections. Dual-stack devices can handle both IPv4 and IPv6 connections through a single network interface or through separate network interfaces, depending on the network architecture to which they are connected. Applications that connect to IPv4 servers will do so from an IPv4-numbered interface, while connections to IPv6 will be made from an IPv6-numbered interface. They do not involve IPv4-to-IPv6 or IPv6-to-IPv4 connections.

IPv6 – Mecanismo de Transición Dual Stack



As for IP addressing configuration, each stack independently maintains its addressing assignment, its routing table, and its routing protocols. IPv4 allows a network interface to operate in IPoE mode, using static address assignment or autoconfiguration via DHCPv4, or PPPoE. Using PPPoE is also possible for IPv6 and IPoE can be configured with different addressing schemes, such as static assignment, SLAAC, Prefix + EUI-64, DHCPv6/DHCPv6-PD, and Privacy. As for name resolution using DNS, hosts can utilize DNS over IPv4 and/or DNS over IPv6. For IPv6, AAAA records are available, which allow resolving domain names with IPv6 addresses.

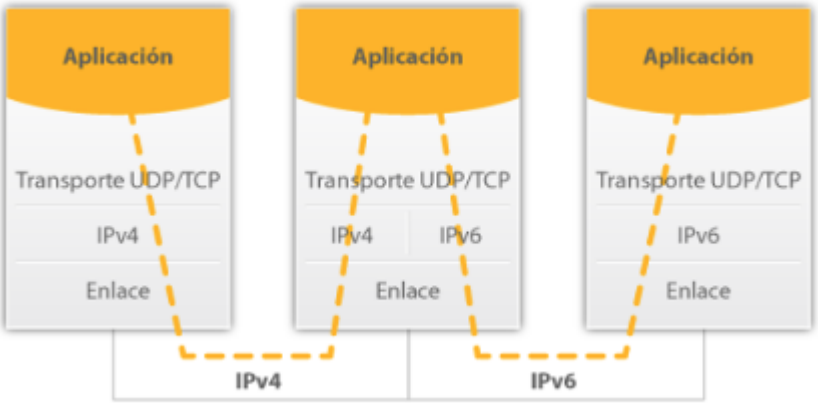
There are two ways to deploy dual stack on a host or router:

- Without tunneling: Each host or router is configured and operates natively with IPv4 and IPv6 and each protocol stack is independent of the other.

- With IPv6-over-IPv4 tunneling: The host or router natively uses the IPv4 stack and also deploys a tunneling mechanism for encapsulating IPv6 over IPv4 and the IPv6 stack over this tunnel. The use of a tunnel broker with 6to4 interfaces is an example of this.

With the dual-stack mechanism, end hosts utilize the technique specified in Happy Eyeballs to define whether they will establish IPv4 or IPv6 connections when attempting to establish outgoing connections to a dual-stack server on the Internet depending on whether it has a hostname with A and AAAA records.

Dual-Stack at the Application and End Host Level



Technical Characteristics

- With the new Happy Eyeballs algorithm (RFC8305, 2017), a host will try to initiate concurrent IPv4 and IPv6 connections to networks and servers on the Internet and connections will be established with the servers that respond in the least amount of time. This allows and promotes the deployment of new services and servers on the IPv6 Internet with better performances and response times.
- Dual stack involves dual IP addressing in end hosts, CPEs and routers.
  - Configuration of IPv4 addressing:
    - IPv4 Link-Local addresses 169.254.0.0/16 (RFC3927)
    - IPoE addressing:
      - Static/manual addressing:
        - IPv4, netmask, default gateway, DNSv4
      - DHCPv4 addressing
    - PPPoE addressing:
      - Username and password
  - Configuration of IPv6 addressing:
    - IPv6 Link-Local addresses fe80::/10

        - ULA addressing
        - GUA addressing:
            - IPoE addressing:
                - Static/Manual addressing:
                    - IPv6 and prefix length, default gateway, DNSv6
                - SLAAC addressing
                - Privacy Extensions for Stateless Autoconfiguration (RFC4941)
                - Prefix+EUI-64 addressing
                - Automatic addressing with VPN networks (e.g. OpenVPN)
            - PPPoE addressing:
                - Username and password
    - Server applications are configured and operated separately in IPv4 and IPv6. This is fully configurable. In special cases, each stack may even be disabled independently for each application.

Advantages:

- Its main advantage is its simplicity, as in most cases it does not require tunneling and encapsulation techniques, nor does it involve translation techniques that would require training and knowledge on the part of the technical staff responsible for managing and operating the network.
- Does not eliminate the use of the IPv4 stack, so IPv4 can continue to be used without any issues or adaptations.
- Currently, most operating systems and applications support IPv6. This means that IPv6 can be deployed gradually, without the need for additional adjustments or support in hosts and routers.
- Allows IPv4 and IPv6 to coexist indefinitely, so it allows applications to transition to IPv6 autonomously. Legacy IPv4-only applications can continue to operate without any issues.
- Allows hosts to resolve names using DNS servers over either IPv4 or IPv6.

Disadvantages

- Does not solve the problem of public IPv4 address exhaustion.
- Dual stack is not an optimal transition mechanism for mobile cellular telephony networks due to its dual use of processing resources, power, dual administration, and the limitations of IPv4 addressing for last-mile networks. Likewise, dual stack is not optimal for IoT networks and wherever dual processing results in an inefficient use of energy.

- The deployment of dual-protocol stacks involves planning, managing and monitoring two networks and uses double memory and processing resources.
- Requires the deployment of dual protection policies and architectures. For example, in the case of Linux hosts and servers, independent protection rules and policies must be implemented independently for IPv4 and IPv6, both of which must provide the same level of protection.
- New applications must be designed and programmed based on the principle of initiating connections based on DNS names. Applications that use literal IP addresses or API sockets will have trouble using dual stack.
- Requires dual stack not only in end customers, but also in CPEs, the ISP's edge routing and transport network, as well as in DNS, NTP, network supervision and other servers.