

# TELECOM ITALIA TO IMPLEMENT DUAL-STACK LITE TO SUPPORT IPV6 USING MX SERIES 3D UNIVERSAL EDGE ROUTERS

## Summary

**Company:** Telecom Italia

**Industry:** Service Provider

**Challenges:**

- Overcome IPv4 address exhaustion
- Add new subscribers to the network
- Migrate to IPv6 while supporting IPv4 devices

**Selection Criteria:** Telecom Italia wanted to offer new customers IPv6 connectivity while maintaining Internet connectivity for HDTVs, older PCs, gaming consoles, and other IPv4-only endpoints.

**Solution:**

- DS-Lite
- MX Series 3D Universal Edge Routers
- Multiservices Dense Port Concentrator (MS-DPC)

**Results:**

- Handle IPv4 address exhaustion incrementally by using IPv6 as a transport layer for IPv4 in the access network
- Support both IPv4 and IPv6 devices

For Telecom Italia, the explosive growth in demand for IPv4 addresses is somewhat analogous to the explosive growth in second phone lines, direct dial-in lines, and fax machines in the 1980s, when the demand for telephone numbers exceeded the available number ranges. Now, as the IPv4 address range is nearly exhausted globally, the need for IPv6—with almost infinite address space—is a necessity to ensure the continued growth of the Internet.

## Challenges

A major challenge is that the IPv4 and IPv6 versions are not compatible. IPv4 content is not accessible using an IPv6 client, and IPv6 content is not accessible from an IPv4 client.

However, the vast majority of Internet content is accessed via IPv4. Many hosts and most applications in customer residential networks—including older PCs, game consoles, consumer electronic devices, and HDTVs—do not support IPv6. IPv4 and IPv6 clearly need to coexist for the foreseeable future.

## Selection Criteria

Telecom Italia analyzed various IPv6 transition mechanisms before deciding that Dual-Stack Lite (DS-Lite) met the requirements to introduce IPv6 in its network. The DS-Lite approach allows Telecom Italia to handle IPv4 address exhaustion incrementally while using IPv6 as a transport layer for IPv4 in the access network.

The prime criteria for Telecom Italia included the ability to offer new customers IPv6 connectivity while maintaining Internet connectivity for HDTVs, older PCs, gaming consoles, and other IPv4-only endpoints. The solution also needed to permit full user traceability and documentation.

## Solution

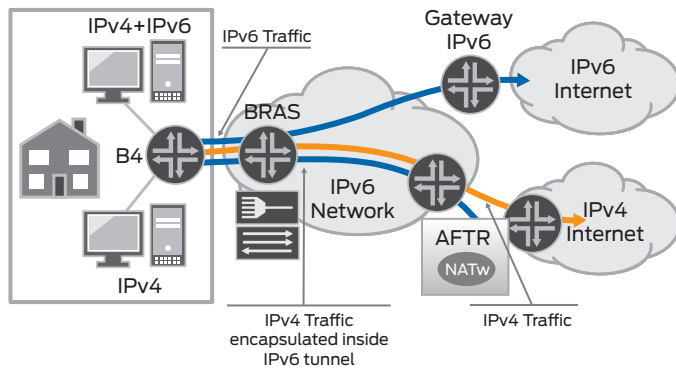
The DS-Lite architecture uses IPv6-only links between Telecom Italia and the customer premises equipment (CPE) while maintaining the IPv4 (or dual-stack) hosts in the customer network.

When a customer's device sends an IPv4 packet to an external destination, DS-Lite encapsulates the IPv4 packet in an IPv6 packet for transport into the Telecom Italia network. These IPv4-in-IPv6 tunnels are called softwires.

The softwires terminate on a softwire concentrator or Address Family Transition Router (AFTR), which decapsulates the IPv4 packets and sends them through a Carrier-Grade Network Address Translation (CGNAT) device.

IPv6 packets originated by hosts in the subscriber's home network are transported natively over the access network.

<sup>1</sup> IPv6 Adoption Monitor, <http://ipv6monitor.comcast.net:8088>



- B4 (Basic Bridging Broadband at client site)
  - Dual-stack IPv4/IPv6 (IPv4 private and IPv6 public addresses)
  - IPv6 traffic forwarding and IPv4 traffic encapsulation over an IPv4-IPv6 tunnel
- AFTR (Address Family Transition Router) as network element
  - IPv4-in-IPv6 tunnel terminator
  - NATv4 translations

Figure 1: DS-Lite architecture for IPv6 and IPv4 traffic

Telecom Italia uses Juniper Networks® MX Series 3D Universal Edge Routers with Multiservices Dense Port Concentrator (MS-DPC) blades and 10 Gigabit Ethernet (10 GbE) interfaces as the AFTRs and to act as the carrier-grade NAT (CGN) routers. The AFTR terminates the IPv4-in-IPv6 tunnels and performs the NATv4 translations.

IPv6 packets coming from a residential customer's Basic Bridging BroadBand (B4) CPE are directed to the Juniper Networks MS-DPC blade in the MX Series router where, according to the configuration, the software is created.

The IPv4 packets are extracted, the NAT rule lookup is completed, and address translation is performed. The translated IPv4 packets are then sent to the end destination. All of these functions are performed in a single pass of the MS-DPC. See Figure 2 for a graphical view of the packet flow.

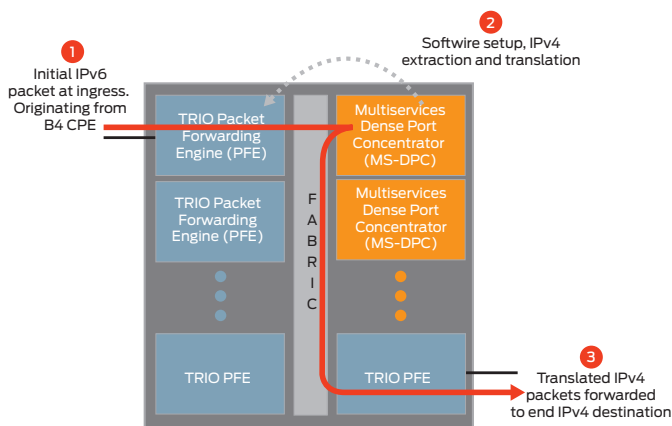


Figure 2: Packet flow on the AFTR

In the reverse path, IPv4 packets from the destination are sent to the MS-DPC blade, where de-NAT is performed, and the packet is encapsulated in an IPv6 packet corresponding to the originating software, and returned to the B4 CPE.

On Juniper Networks MX960 routers, the IPv4-over-IPv6 tunnels or softwires are automatically created as IPv6 packets are received. IPv4 flows created by the encapsulated packets are mapped to the same software. When the last IPv4 flow associated with a software is destroyed, the software is automatically removed, which reduces operational overhead.

**“Telecom Italia chose the DS-Lite approach—using IPv6-only links between the provider and the customer—to transition its production network to IPv6.”**

By design, the software construct does not use interface resources, which ensures that the number of established softwires does not affect throughput or scalability.

Telecom Italia's initial phased introduction of DS-Lite in the network is based on a centralized AFTR deployment using two points of presence (POPs). As IPv6 deployment grows substantially in future phases, the AFTR is expected to be distributed and placed in other major POPs throughout Italy. Telecom Italia chose to place the AFTR close to the international IPv4 Internet gateway, thereby minimizing flows across the network that are destined to the international connection.

Redundancy and load-balancing requirements are fulfilled by equipping each of the two main POPs in with an AFTR, as depicted in Figure 3.

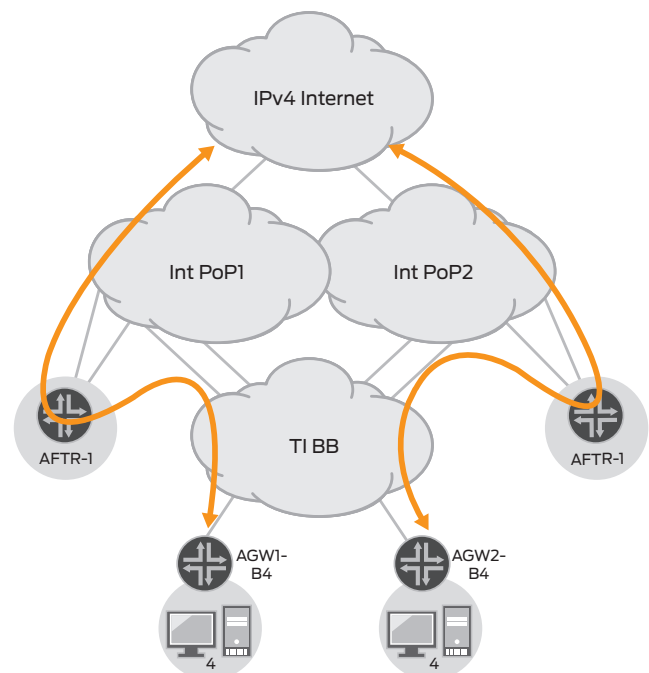


Figure 3: The AFTRs are located in two POPs in the Telecom Italia network.

Telecom Italia plans to provide new customers with a B4 CPE. These CPEs support:

1. PPPoE.
2. DS-Lite (according to RFC6333 on Dual-Stack Lite Broadband Deployments Following IPv4 Exhaustion), which means the CPE must be able to perform the IPv4 traffic encapsulation into IPv6 packets.
3. Acceptance of IPv6 tunnel termination via DHCPv6 (according to RFC6334 on Dynamic Host Configuration Protocol for IPv6 (DHCPv6) Option for Dual-Stack Lite).
4. WAN numbered and WAN unnumbered models.
5. DHCPv6-PD (RFC3633) for devices connected in the home network.
6. Management of the interworking with DNSv6 and DNS proxy for IPv4-only terminals.
7. Remote management for IPv4 and IPv6.

The Telecom Italia team used a CPE for internal testing that has been re-flashed with OpenWRT—embedded Linux developed by Internet Systems Consortium with assistance from Comcast—as the experimental residential gateway device. In the future, Telecom Italia will migrate to devices that support DHCPv6-PD, DNSv6, and DNS proxy.

## Results

Functionally, the DS-Lite solution with Juniper Networks MX Series 3D Universal Edge Routers, CGN services and 10 GbE card operates well, allowing Telecom Italia to define a solution ready for IPv6 while at the same time maintaining IPv4 services for their customers. Some fine-tuning and additional features will be needed to help Telecom Italia to realize the target architecture and to deploy DSLite.

- Dynamic configuration of the software tunnel termination on the B4, in order to let TI to define different terminations based on specific policies per user groups;
- Possibility to implement dynamic services, such as turbo button for IPv4 and IPv6 traffic;
- End user CGNAT configuration on the AFTR: according to the availability of features like the Port Control Protocol, the user will be able to negotiate the needed ports for specific applications (such as gaming or web servers) directly with the centralized NAT.

Along with these efforts, Telecom Italia continues to evaluate other CGNAT technologies and pure Dual Stack models with the purpose of conserving public IPv4 addresses for specific customer requirements and applications. At the same time, Telecom Italia is also offering the IPv6 transport layer as a premium service to clients.

## For More Information

Please visit the following link for more detailed configuration examples of MX Series 3D Universal Edge Routers:  
**[www.juniper.net/techpubs/en\\_US/junos10.4/topics/example/ipv6-access-ds-lite-configuring.html](http://www.juniper.net/techpubs/en_US/junos10.4/topics/example/ipv6-access-ds-lite-configuring.html)**.

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