# Cisco Catalyst 4500 Series Supervisor Engine 6-E IPv6 Architecture

At-A-Glance

## Why Should I Care About the Cisco Catalyst 4500 Series Supervisor Engine 6-E?

The new Cisco® Catalyst® 4500 Series Supervisor Engine 6-E features CenterFlex technology, which supports both IPv4 as well as IPv6 forwarding in hardware. The high-performance Supervisor Engine 6-E offers 320-Gbps nonblocking switching fabric and enables a rich set of security and quality-of-service (QoS) features. Like earlier supervisor engine models, the entire forwarding intelligence resides in the supervisor engine, leaving the line card design simple and easy to upgrade with new features.

The Supervisor Engine 6-E is designed for the Cisco Catalyst 4500 E-Series Switch, a modular wiring closet and aggregation Ethernet switch capable of forwarding Layer 2–4 traffic at wire speed. The Catalyst 4500-E Series is ideal for a large enterprise wiring closet, medium-sized distribution layer, or small core network. The Supervisor Engine 6-E brings IPv6 features to all existing line cards, protecting your investment in the Catalyst 4500-E Series and extending the product lifecycle.

## What Problems Need to Be Solved?

With billions of new devices becoming IP-aware, the need for increased addressing and Plug-and-Play networking solutions is best met with the deployment of IPv6. Even though technologies such as Network Address Translation (NAT) and Port Address Translation (PAT) were developed as solutions to the diminishing availability of IPv4 addresses, these schemes make peer-to-peer collaboration through shared applications more complex. IPv6 uses a 128-bit address scheme, which provides more than enough addresses for every user worldwide, with multiple global addresses that can be used for a wide variety of devices. This allows a true end-to-end model where hosts can connect to each other unobstructed and with greater flexibility.

The key IPv6 drivers include:

- The default IPv6 stack support in the Microsoft Vista OS.
- IPv6 is required for U.S. federal government network deployment starting in 2008.
- Proliferation of IP-aware consumer gadgets, broadband access, and intelligent home devices is accelerating the need for more IP addresses.

## Cisco Catalyst 4500 E-Series with Supervisor Engine 6-E IPv6 Architecture

The next-generation Supervisor Engine 6-E supports IPv4 and IPv6 natively in hardware. Its CenterFlex technology is enabled by Cisco developed application-specific integrated circuits (ASICs) specific to the Supervisor Engine 6-E that deliver industry-leading centralized performance and configuration flexibility. Primary components of the CenterFlex ASICs include the Integrated Packet Processor (IPP), which performs switching decisions for all ports; the Very-Fast Forwarding Engine (VFE), which performs packet forwarding; TCAM4, which allows 1 billion searches per second; and XgStub, which increases the slot bandwidth from 4 Gbps to 24 Gbps. These new CenterFlex ASICs supercharge the IPv6 throughput to 125 million packets per second (mpps).

The new Supervisor Engine 6-E processes the IPv6 packet similarly to how it processes the IPv4 packet. Even though IPv6 requires twice the TCAM entry width compared to IPv4, the Supervisor Engine 6-E's flexible TCAM can dynamically resize the width of a single block to 160 or 320 bits to accommodate an IPv6 entry while leaving the remaining blocks at 80 or 160 bits for IPv4, thus maintaining high performance and optimizing the valuable TCAM space.

The Supervisor Engine 6-E also supports full IPv6 QoS, very similar to IPv4, and provides full multicast support with Protocol Independent Multicast sparse mode (PIM-SM), PIM Source Specific Multicast (PIM- SSM), Multicast Listener Discovery (MLD) protocol, MLDv1, and MLDv2 Snooping. Full security support includes Unicast Reverse Path Forwarding (URPF) and routing protocol support includes Open Shortest Path First Version 3 (OSPFv3), Enhanced Interior Gateway Routing Protocol Version 6 (EIGRPv6), Routing Information Protocol next generation (RIPng), and static routes. To enable smooth migration from IPv4 to IPv6, dual-stack mode is supported in hardware, and tunneling protocols such as Intra-Site Automatic Tunnel Addressing Protocol (ISATAP), 6-over-4, 6-to-4, and 6-over-GRE are supported in software.

The best way to understand how the Supervisor Engine 6-E supports IPv6 is to examine the Day in the life of an IPv6 packet.

## The Day in the Life of an IPv6 Packet in the Supervisor Engine 6-E

When an IPv6 packet arrives at the IPP, IPP parses the basic IPv6 header and any relevant extension headers to ultimately parse the Layer 4 (TCP/UDP) data. It stores the packet in the shared Packet Memory that has 16 MB of shared bandwidth. The parsed flow label and a pointer to the start and end of the packet buffer are sent to the Very-Fast Forwarding Engine (VFE) in Packet Lookup Descriptor (PLD).

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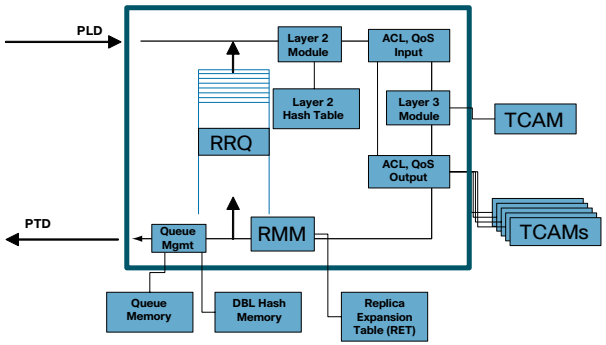
Figure 1 depicts how the packet is processed after the PLD comes into the VFE.

**Figure 1 VFE Forwarding for IPv6**




As Figure 1 shows, when the PLD arrives at the VFE:

1. The packet goes through Layer 2 lookup. Spanning tree state is checked. Packet MAC source and MAC destination together with receive VLAN ID are looked up in the Layer 2 Hash Table. Layer 2 lookup also determines whether the packet is destined for router functionality.
2. Input classification is used to classify the packet via rules loaded into the Input Classification TCAM. This stage supports features such as input access control list (ACL), QoS, redirect, Policy-Based Routing and ACL-based copy. The results indicate whether the packet is denied or permitted, whether the packet should be forwarded to a specific port or through a specific adjacency entry, which input Policer to use, source or destination user group or both, and so on.
3. The packet is looked up in Layer 3 lookup TCAM for IP bridging or routing lookup and unicast RPF check. The Layer 3 lookup TCAM supports two parallel lookups per packet, one is for unicast RPF and the other is destination address. However, it will take two lookups for IPv6 versus one for IPv4. The expected performance will be 125 mpps for IPv6 and 250 mpps for IPv4 independent of packet sizes. Unicast RPF lookup data specifies the RPF interface(s) for the packet, actions for RPF failure, and source user group. Forwarding lookup data specifies an adjacency or Replica Expansion Table (RET) index for IP routing.
4. The packet goes through output classification via rules loaded into the Output Classification TCAM. This stage supports features such as output ACL, QoS, redirect, and copy. The results indicate whether the packet is denied or permitted, whether the packet should be forwarded to a specific port, which output Policer to use, whether ToS and or CoS of the packet is rewriteable at the end of VFE processing, what DBL actions to use, etc.
5. Output mapping determines final output QoS mappings for the packet after output policing and checks whether the packet is to be sniffed. If the packet is to be replicated (for CPU copy, multicast, or broadcast), a replica request descriptor is queued to the Replica Request Queue (RRQ). The Replica Management Module (RMM) then consults with the RET to replicate the corresponding multicast packet PLDs.
6. VFE also performs the Dynamic Buffer Limiting (DBL) algorithm. DBL keeps per-flow buffer count as part of queue buffer management. DBL may drop the packet according to the congestion in the output queue.
7. A transmit descriptor is queued to the Queue Memory. The transmit queues are dynamically assigned to each line card and subsequently to each port based on chassis configuration. Each queue can have a maximum of 8184 packets independent of packet sizes.
8. When it is time to transmit the packet, the VFE sends the Packet Transmission Descriptor (PTD) to the IPP, which has the packet buffer pointer and all the information IPP needs to rewrite and forward the packet.
9. IPP reads the packet data from the Packet Memory, performs necessary header rewrites, and transmits the packet out. At the end of the packet, IPP decrements the reference count of the packet buffer and frees the buffers.

This process shows that only the IPv6 packet header is processed while the body of the packet is stored in the Packet Memory. Because every packet goes through the same pipeline and each stage is processed in hardware, the Supervisor Engine 6-E yields high yet consistent performance and low yet deterministic latency.

## What are the Benefits of the Cisco Catalyst 4500 Series Supervisor Engine 6-E with IPv6 Support?

Through CenterFlex technology, the Cisco Catalyst 4500 Series Supervisor Engine 6-E achieves high performance while enabling a rich set of QoS and security features. By supporting IPv6 forwarding in hardware, the Supervisor Engine 6-E extends the scalability and investment protection of the Catalyst 4500 E-Series Switch, and provides a smooth transition from IPv4 to IPv6.