

## Lab Testing Summary Report

November 2011

Report 111018

Product Category:

### Supervisor Engine

Vendor Tested:



Product Tested:

### Catalyst 4500E Supervisor Engine 7L-E



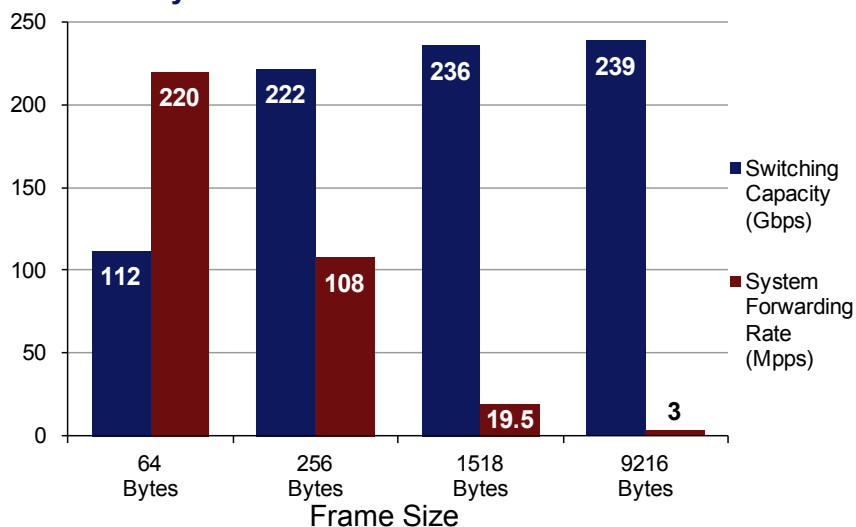
## Key findings and conclusions:

- Cisco Catalyst 4500E Supervisor 7L-E offers high performance and deterministic low latency for unicast/multicast traffic
- Innovative Universal Power Over Ethernet (UPOE) delivers 60W per port doubling the output provided by PoE+ enabling Cisco to deliver a broad range of end-to-end solutions
- High availability with less than 200ms of service outage experienced during ISSU upgrade/downgrade
- Wireshark troubleshooting capability and hardware-based Flexible NetFlow allows additional insight into network behavior and health

Cisco engaged Miercom to verify the performance and advanced features of their Catalyst 4500E Series Supervisor Engine 7L-E. The Cisco Catalyst 4500E Supervisor Engine 7L-E builds on the success of its predecessor, the Cisco Catalyst 4500E Supervisor Engine 6L-E, and provides unprecedented performance with borderless services such as Flexible NetFlow (FNF) and hosted third-party applications.

Supervisor Engine 7L-E is built to provide up to 240 Gigabit Ethernet ports or up to 60 10 Gigabit Ethernet fiber density along with hardware capabilities to support enterprise-class switching functionalities. Supervisor Engine 7L-E also features uplinks configurable in either 2 10GE interfaces or 4 1GE interfaces. Its throughput is 520 Gbps and switching capacity is 225 Mpps. The Catalyst 4500E uses a single IOS XE image where individual feature-sets can be enabled by licensing.

Figure 1: Catalyst 4500E Supervisor Engine 7L-E  
Layer 2 Unicast Performance



Source: Miercom, October 2011

Maximum and forwarding rates for Layer 2 unicast traffic with zero packet loss found during testing.

The Supervisor Engine 7L-E was evaluated for throughput and latency performance of the following performance tests in accordance to RFC 2544 for unicast benchmarking and RFC 3918 for multicast benchmarking standards:

1. Layer 2 unicast
2. Layer 3 IPv4/IPv6 unicast
3. Layer 2/3 multicast

Unicast tests were done with 240 ports arranged in pairs sending bi-directional traffic. Multicast traffic was sent with one transmit port and 239 receive ports.

High Availability, UPOE capability, Flexible NetFlow and Wireshark capability were also tested. Miercom performed these tests with two Supervisor Engine 7L-E configured in redundant mode installed in the Catalyst 4507R+E chassis along with 5 UPOE line cards (WS-X4748-UPOE+E).

## Layer 2 Unicast Performance

Load testing was conducted for a selection of frame sizes to determine the maximum throughput with zero loss. Testing was conducted using the following frame sizes: 64 bytes, 256 bytes, 1518 bytes and 9216 bytes (Jumbo Frames).

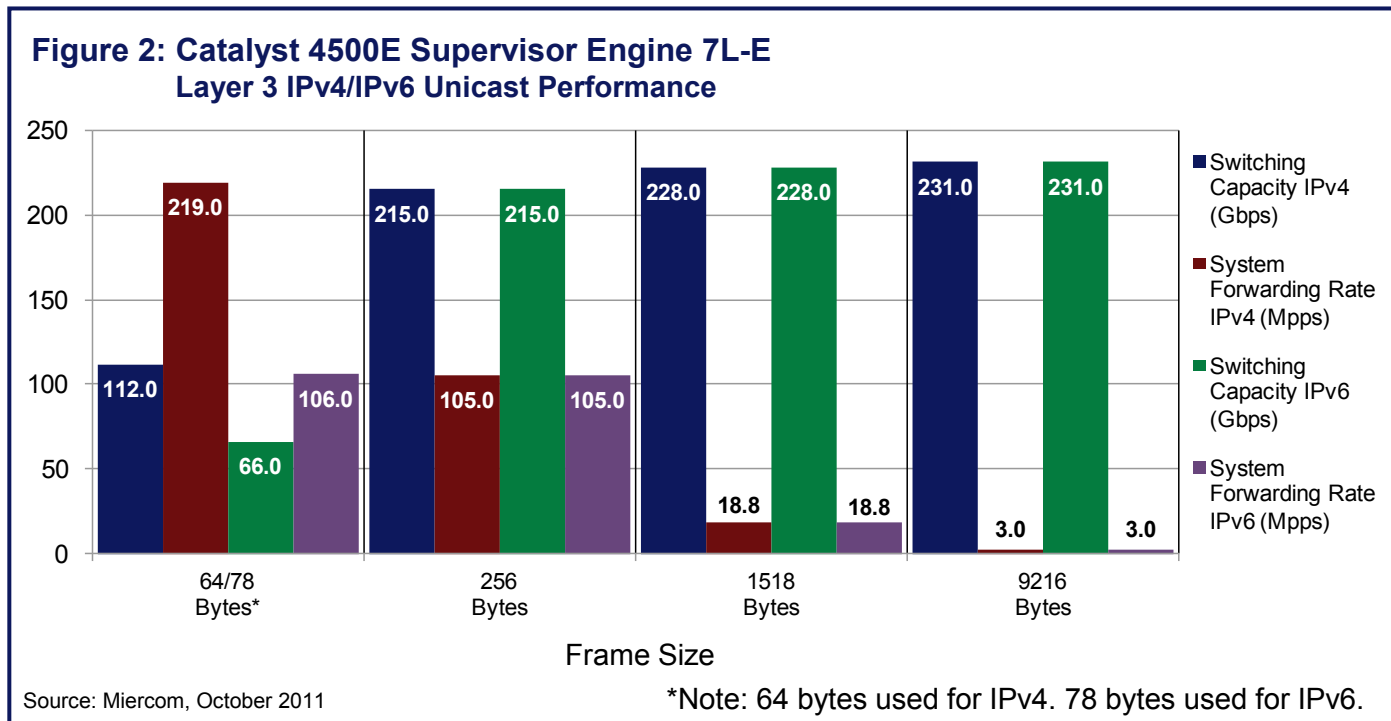
The Supervisor Engine 7L-E has a theoretical forwarding rate of 225 Mpps and therefore is blocking for 240 ports using the 64-byte frame size. The maximum recorded line rate for this frame size without any loss achieved was 61%. All other frame sizes were run at 100% line rate. *Figure 1* on page 1 shows the throughput and forwarding rates achieved in this test.

## Layer 3 IPv4/IPv6 Performance

Load testing was conducted for a selection of frame sizes to determine the maximum throughput with zero loss. Testing was conducted using the following frame sizes: 64 bytes for IPv4 / 78 bytes for IPv6, 256 bytes, 1518 bytes and 9216 bytes (Jumbo Frames). The maximum recorded line rate for the 64-byte frame size for Layer 3 IPv4 performance testing was 61%. The maximum recorded line rate for the 78-byte frame size for the Layer 3 IPv6 performance test was 35%. All other frame sizes were run at 100% line rate. The throughput and forwarding rates achieved in the tests are shown in *Figure 2*.

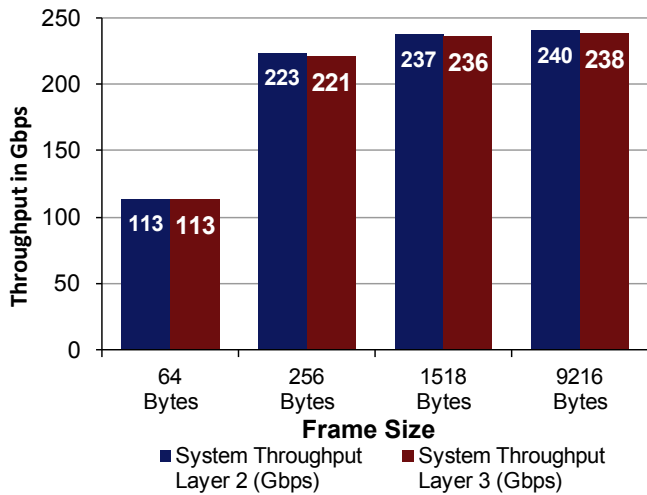
## Layer 2/3 Multicast Performance

Measurements of multicast performance were taken for Layer 2 and Layer 3 in accordance with



Maximum throughput and forwarding rates with zero packet loss for the Supervisor Engine 7L-E appliance for Layer 3 IPv4 and IPv6 unicast traffic.

**Figure 3: Catalyst 4500E Supervisor Engine 7L-E  
L2 and L3 Multicast Performance**



Source: Miercom, October 2011

*Supervisor Engine 7 L-E offers high performance, deterministic low latency, and no loss for Layer 2 and Layer 3 unicast and multicast traffic.*

the RFC 3918 IP Multicast benchmarking standards. The tests were conducted using the following frame sizes: 64-, 256-, 1518- and 9216-bytes. The maximum recorded line rate for the 64 bytes frame size for the Layer 2/3 multicast performance test was 61%. All other frame sizes were run at 100% line rate. *Figure 3* shows the throughput results.

## Latency

Average latency was also measured and recorded. The Catalyst 4500E Supervisor Engine 7L-E delivered deterministic and low latencies for all tests. Latency results for all performance tests are shown in *Figure 4* on page 4.

## UPOE

Universal Power over Ethernet is an innovative new feature developed by Cisco for the Catalyst 4500E series switches which doubles the current power output provided by PoE+ to power an increased range of devices. These new applications include virtual desktop terminals, flat-panel desktop monitors, IP turrets for trading floors, wireless access points and even compact switches which can then pass through PoE and PoE+ for devices downstream, such as phone handsets.

Cisco has created an ecosystem so that third party vendor products are supported and can leverage UPOE by using the LLDP protocol to request power. Cisco-branded devices use the proprietary CDP protocol to request power. Since UPOE also builds off the IEEE 802.3at standard, interoperability will only increase in the future.

In the case of virtualized desktops, UPOE allows workspaces such as contact centers to be quickly set up without having to provide 110/220 volt wiring and outlets. Power resiliency for IP trading turrets can be moved from uninterruptable power supplies on the trading floor, back into the wiring closet using the redundant power supplies of the switch, which reduces costs associated with maintaining the UPS.

UPOE provides 60 watts of power over the same CAT5e cable that is used to deliver data. Up to 1500W of power can be delivered per line card. In our test bed, we configured UPOE on 24 ports out of the 240 ports we were using to send data. The full output was therefore 1440W, below the 1500W maximum. We simultaneously sent a background load of Layer 3 unicast traffic to all 240 ports. Using a UPOE load tool, we verified that 60W of power was delivered to all 24 ports, and that UPOE did not negatively impact the throughput. Latency remained the same as when running without UPOE.

## High Availability

The Supervisor Engine 7L-E provides high availability features to the Cisco 4500 series switch. To demonstrate these features of the device, we performed two tests. We evaluated what, if any, impact on performance was seen when an In Service Software Upgrade (ISSU) was performed. We also simulated a failure of the active supervisor card and switchover to hot standby. Cisco claims that UPOE power should not be affected and any traffic outage should be less than 200ms during these events. A full traffic load was generated for this test using Layer 3 unicast traffic consisting of 1518-byte frames at 100% of line rate on all 240 interfaces. In addition, we also set up 24 ports of UPOE. An ISSU was performed to upgrade the IOS image. The supervisor engine allows 3 minutes after the loading of a new image to ensure stability before switching the active supervisor. There were no disruptions observed on the 24 ports of UPOE. Observed frame loss in the ISSU test was measured to be only 20msec which is the same as

observed when failing over the active supervisor to standby.

## Flexible NetFlow

Cisco Catalyst 4500E Supervisor Engine 7L-E ships with hardware-based Flexible NetFlow. More scalable and customizable than traditional NetFlow, Flexible NetFlow tracks a larger amount of information for Layer 2 and IP flows, such as source and destination MAC, IPv4, and IPv6 addresses. It also records source and destination TCP/UDP ports in the type of service, packet and byte counts, flow timestamps, routing information, input and output interface numbers and sections of the packet for application visibility. This information is useful in tracking network anomalies and behavior, as well as monitoring network security for DoS attacks and network worms. In our testing on the Catalyst 4507E, we observed 240 NetFlows while transmitting 1518-byte Layer 3 IPv4 traffic at 100% line rate with no loss on 240 ports, and providing UPOE on 24 ports. Latency was observed to be only 9.5us. Cisco claims that they can support 128K NetFlows on the Supervisor Engine 7L-E.

## Onboard Packet Analyzer

The Supervisor Engine 7L-E includes an onboard packet analyzer that allows an administrator to perform a packet capture and perform detailed

analysis on the switch itself. To examine this feature, we selected a capture start point and began a capture of 1,000 packets while background traffic was running through the switch. After the packet capture was complete, we were able to save it to a file on the switch. Directly from the switch console, we could display a summary of the standard pcap file, and also dive into a frame-by-frame detailed analysis of the capture.

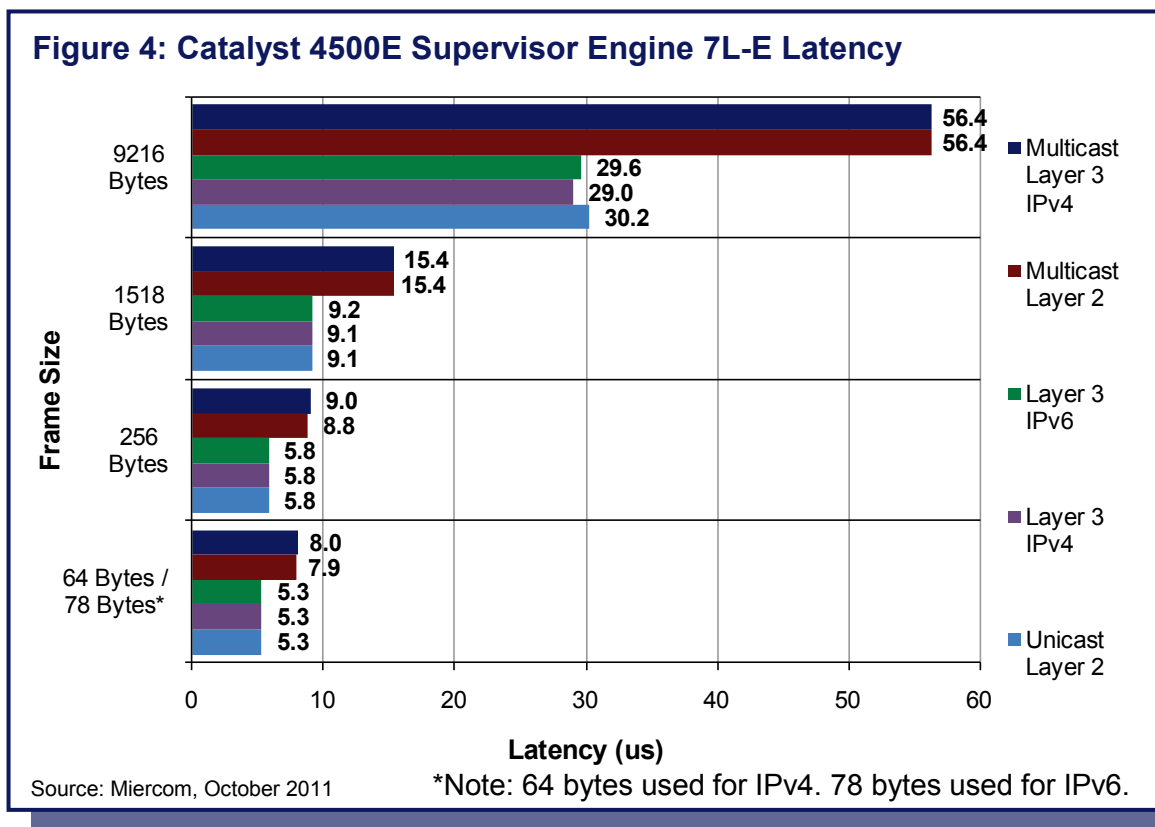
## Bottom Line

The latest version of the Supervisor Engine for the Catalyst 4500E series, the 7 L-E, delivers impressive performance, consistently low latency, and no loss for Layer 2 and Layer 3 unicast and multicast traffic.

Innovative UPOE line card (WS-X4748-UPOE+E) delivers 60W of UPOE per port for up to 1500W per line card to power a wider range of devices, allowing greater flexibility, simplicity and resiliency.

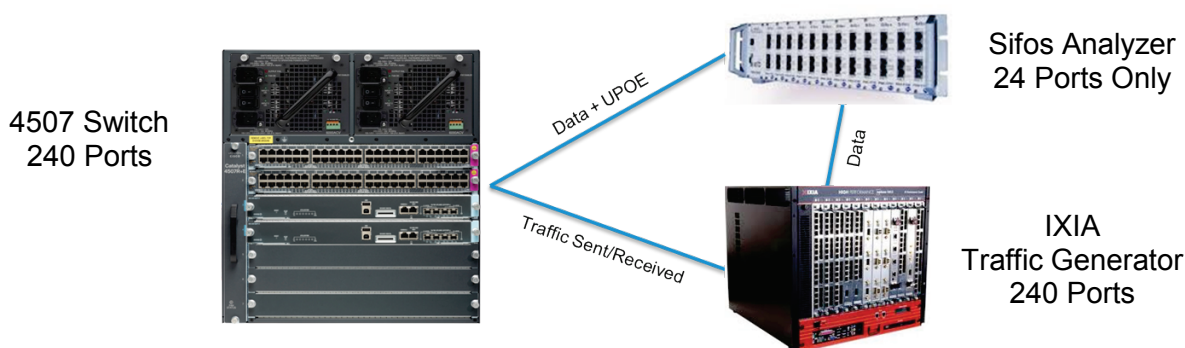
High availability with less than 200ms of service outage experienced during ISSU upgrade/downgrade.

Integrated onboard packet analyzer troubleshooting capability, and Flexible NetFlow allows additional insight into network behavior and health directly from the switch console.



*Catalyst 4500E Supervisor Engine 7L-E delivered deterministic low latency at all frame sizes for both Layer 2 and Layer 3 unicast and multicast traffic.*

## Test Bed Diagram



### Platform:

- 4507R+E Chassis
- 5 WS-X4748-UPoE+E Line Cards
- 2 6000W Power Supplies
- 2 WS-X45-SUP7L-E

### Test Tools:

- IXIA Traffic Generator (240 ports)
- Sifos PowerSync Analyzer (24 ports – 60W)



## How We Did It

The test bed was configured as shown with 240 ports of traffic being delivered by the Ixia XM12 to the 4507R+E switch chassis.

The 4507R+E was configured with five WS-X4748-UPoE+E Line cards, two 6000W power supplies, and two WS-X45-SUP7L-E Supervisor Engines for redundancy. It was running version IOS-XE 3.20.9.60.

A Sifos Powersync Analyzer was used to provide UPoE load on 24 ports at 60W per port. It was placed inline between the Ixia and the switch chassis.

Two Ixia XM12 chassis ([www.ixiacom.com](http://www.ixiacom.com)), each with ten LSM1000XMSP12-01 12-port Load Modules were used to drive traffic to the switch in accordance with RFC2544 for Unicast flows, and RFC3198 for Multicast. The Ixia hardware was configured with IxOS version 6.10.750.5 EA, IxNetwork 6.0.400.22 EA-Patch1, and IxAutomate 7.0.110.5 GA.

IxNetwork tests network infrastructure, capacity, scalability, and convergence using scaled protocol emulation and ViperCore technology. Some attributes of IxNetwork include supplying rapid isolation of network issues, service modeling at Internet scale, carrier class scaling, and accurate convergence measurement with TrueView™. The Aptixia IxAutomate application provides a customizable test tool to automate the performance, scalability and functional testing of network devices. Using Ixia test hardware features, such as wire-speed traffic generation, filtering, capturing, and statistics collection, IxAutomate offers a suite of pre-built tests based on industry standard RFCs and customer requirements.

The tests in this report are intended to be reproducible for customers who wish to recreate them with the appropriate test and measurement equipment. Current or prospective customers interested in repeating these results may contact [reviews@miercom.com](mailto:reviews@miercom.com) for details on the configurations applied to the Device Under Test and test tools used in this evaluation. Miercom recommends customers conduct their own needs analysis study and test specifically for the expected environment for product deployment before making a product selection.

## Miercom Performance Verified

In tests conducted of the Cisco Catalyst 4500E Supervisor 7L-E, Miercom was impressed with its superior performance, high availability, Flexible NetFlow and Wireshark capabilities along with UPOE, making it an ideal platform for campus access networks.

Showing high performance and consistently low latency with no loss, the appliance met the required criteria to achieve the Miercom Performance Verified Award.



**Catalyst 4500E  
Supervisor Engine 7L-E**



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