Miercom

Lab Testing Summary Report

January 2007
Report 070222

Product Category:
Application Accelerator

Vendor Tested:
Cisco Systems

Product Tested:
Cisco 6500 ACE (Application Control Engine) Module v A.1.3

Key findings and conclusions:

- **The Cisco Catalyst 6500 Application Control Engine (ACE) module demonstrated superior speed, throughput and scalability in comprehensive performance tests**
- **The Cisco ACE provided linear scalability for throughput and connections with multiple modules in a single Catalyst 6500 switch**
- **The Cisco ACE provides improved data center efficiency through lower power consumption and heat output**
- **The Cisco ACE eases and accelerates provisioning and management with unique features including: Virtualization, Roles Based Administration, and Configuration roll-back**

Cisco Systems engaged Miercom to independently verify the performance and various unique features of the new Application Control Engine (ACE) hardware module running software release A.1.3. Designed for the Catalyst 6500 Series switch, the Cisco ACE was evaluated in the following key areas: Layer 4 and Layer 7 Load Balancing performance, SSL performance, device scalability, availability, and security. The Cisco ACE showed itself to be a superior device in all performance tests. Targeted for enterprise and service provider customers, the Cisco ACE offers data center owners the potential to lower overall capital and operating expenses based on features, performance, and measured power consumption under load.

The Cisco ACE demonstrated features and scalability not available in other solutions including the ability to create virtual devices (up to 250 per module), separate administrative logins per virtual device combined with customizable Roles Based Administration (RBA) for granular administrative and user access, hierarchical domains to further enhance security control and maintenance access; and architectural scalability.

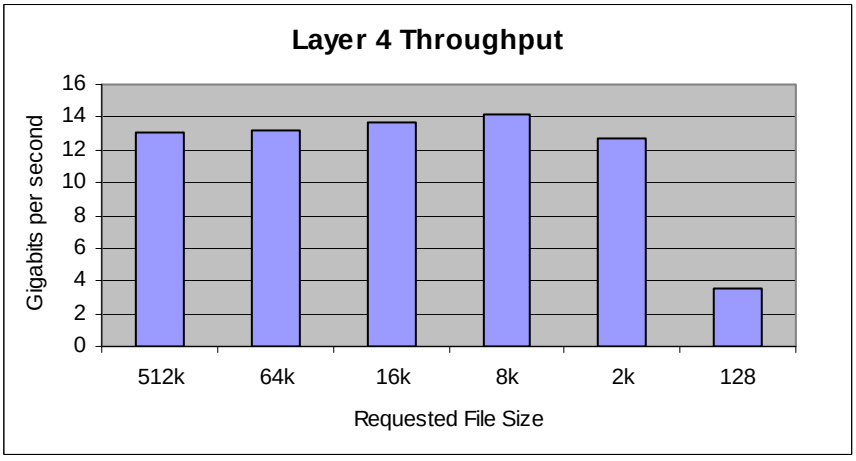
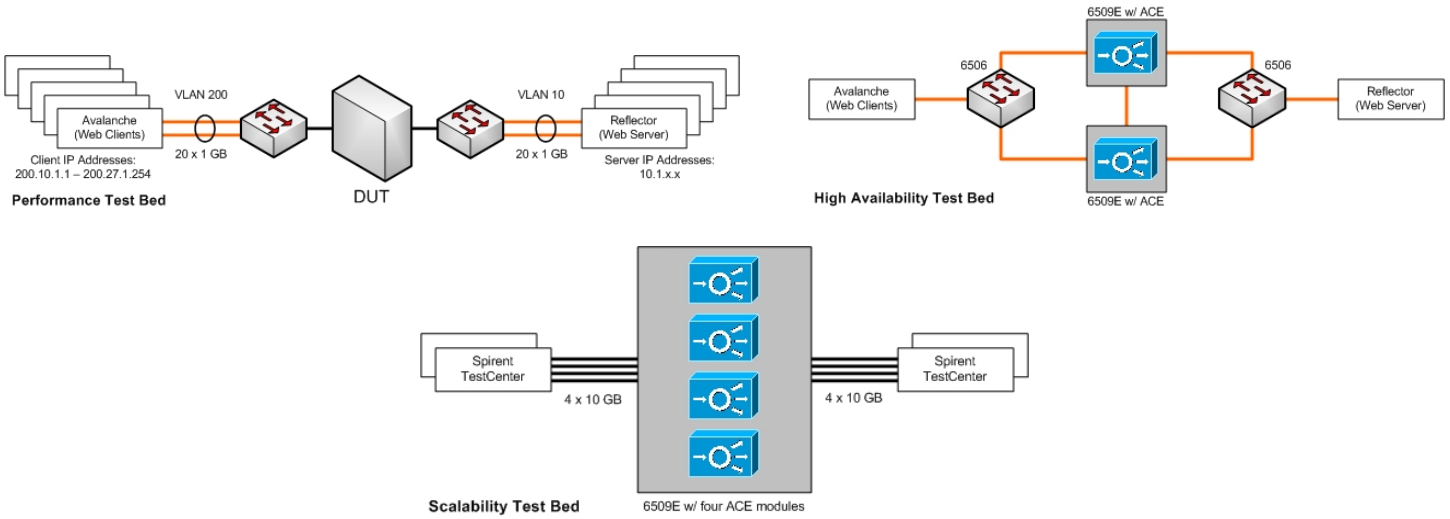


Chart 1: Results of Layer 4 Throughput for Cisco ACE

Test Bed



How we tested: Three test environments were created to conduct a wide range of Performance, Scalability, High Availability, and Security tests. The performance, security, virtualization and Role based administration control tests were conducted on the performance test bed. The Cisco ACE module, software release A1.3, mounted in a Cisco Catalyst 6509 chassis with a Sup720-3BXL was tested in this environment. The Spirent Web Avalanche 2700C and Reflectors 2700C, software release 7.51, were used to generate real application traffic from 2520 clients to twenty servers. Both the Spirent Avalanches and Reflectors were connected to a 48 ports GigE (WS-X6748GE-TX) line card on the Cisco Catalyst 6509 switch. The Cisco ACE module was configured in routed-mode with round-robin load balancing. The Spirent Reflectors (servers) default gateway was set to the IP address configured on the DUT.

The Scalability test environment was used to demonstrate linear scalability of the Cisco ACE module. Four Cisco ACE modules, software release A1.3, were mounted in a Cisco Catalyst 6509 chassis with a Sup720-3BXL. The Spirent TestCenter, software release 1.30, generated bi-directional traffic via 8 x 10 GigE ports connected to two 4-port 10GigE (WS-X6704-10GE) line cards on the Cisco Catalyst 6509 switch. The Cisco ACE module was configured to perform round-robin load balancing for all tests.

The High Availability test environment was used to evaluate the Cisco ACE module fail-over and fail-back capabilities. Two Cisco ACE modules, software release A1.3, were mounted in separate Cisco Catalyst 6509 chassis with a Sup720-3BXL. A dedicated VLAN was setup between the two Cisco ACE modules for all redundancy-related traffic. The Spirent Avalanche 2700C and Spirent Reflector 2700C, software release 7.51, were connected to a Cisco Catalyst 6506 Layer 2 switches and generated application traffic during the fail-over and fail-back tests.

Performance Tests: The Spirent Avalanche Commander, software release 7.51, was used for the performance tests.

- Layer 4 Connections per Second (CPS) Tests measured how rapidly new connections could be created by the Device Under Test (DUT) for various server response file sizes without errors. The tests set up new connections and completed a full transaction with graceful TCP termination.
- Layer 4 Throughput tests measured the DUT's maximum throughput for various server response file sizes.
- Layer 4 concurrent tests measured how many successful concurrent connections the DUT can sustain without any error.
- Layer 7 CPS Tests measured how many new connections could be setup by the DUT for various server response file sizes without any error. Unlike the Layer4 CPS tests, the DUT was required to perform TCP termination and analyze at least the first data packet after the TCP setup (SYN/SYN_ACK/ACK) in order to make an intelligent load balancing decision.
- Layer 7 Throughput tests measured the DUT's maximum throughput for Layer 7 traffic.
- Layer 7 Concurrent Connection tests measured how many concurrent connections the DUT can sustain without any error for Layer 7 traffic. The Spirent Reflector systems were configured to delay their response 60 seconds to keep the connections open as additional connections were created. At the end of the 60 seconds delay, the connections were closed without additional delay or error.
- SSL Bulk encryption tests stressed the symmetric encryption and decryption performance and measured the maximum SSL throughput of the DUT. The DUT was configured to terminate the SSL connections.
- SSL TPS Tests stressed asymmetric encryption performance and measured maximum number of SSL transactions per second.
- TCP Reuse tests measured the number of client HTTP transactions versus the actual TCP connections established on the Spirent Reflectors using the Spirent Avalanche Command GUI. The number of client HTTP transactions and server transactions were matched in order to ensure that all transactions were successful without any error.

Scalability Tests: The tests determined the maximum bi-directional load-balanced throughput of multiple Cisco ACE modules. The Spirent TestCenter GUI was used to measure the throughput of up to four Cisco ACE modules that were incrementally brought online within a Cisco Catalyst 6500 chassis.

High Availability Tests: For the first test a "ft" (fault-tolerant) switchover command was issued to the Cisco ACE module during the generation of 100 HTTP transactions from the Spirent Avalanche. In the second test, the external VLAN interface configured on the Catalyst 6509 was manually brought down during the HTTP transactions. The Spirent Avalanche Commander was used to monitor any unsuccessful transactions during the fail-over.

Datacenter Efficiency Tests: Using a CYBERSwitching Dualcom external power management devices the actual power consumed by the DUT during the load was measured.

Virtualization Tests: A simple script was used to create 250 virtual devices each with dedicated resources on the Cisco ACE module. Management access and load balancing configurations were manually created on several virtual devices. Manually logged in to virtual devices through dedicated management interfaces and verified the configurations.

Roles Based Administration (RBA) Tests:
- RBA tests: Several administrative user roles were created with appropriate pre-defined roles on the Cisco ACE module. In addition, a user with custom role was created to restrict access to only selected security functions on the Cisco ACE module. Commands were issued to verify the scope of access and functions available in the various roles.
- Hierarchical Management Domain: Created two separate management domains each with a VIP and real server objects inside a virtual device of the Cisco ACE module. Two administrative user roles were created with access to a specific domain. Commands were issued to verify the scope of access and functions within a management domain.

Security Tests: Security attacks and real application traffic were generated from the Spirent Avalanche servers. The Spirent Avalanche commander GUI was used to monitor the number of security attack transactions that were successfully blocked by the DUT.

Overview

The Cisco Application Control Engine (ACE) is a multi-service Cisco Catalyst 6500 series switch module designed for application delivery with features of intelligent server load balancing, server off-load, SSL acceleration, application acceleration, and network security for enterprise data centers and service providers. Miercom conducted a wide range of tests on the Cisco ACE module with software release A1.3. The testing and evaluation focused on several key areas: Scalability, Delivery Performance, Availability, Data Center Efficiency and Management Features.

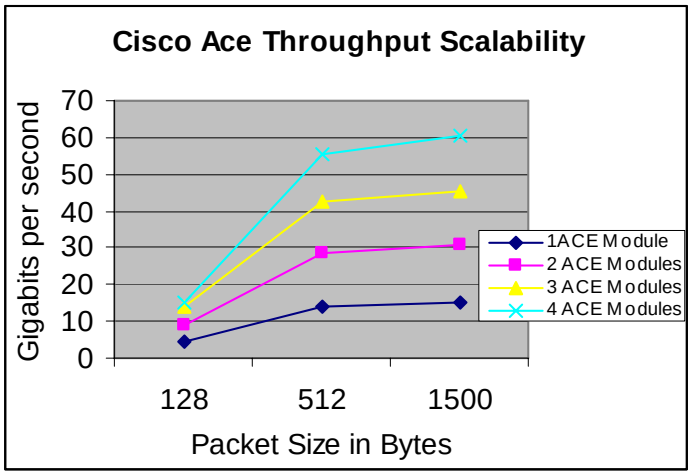


Chart 2: Cisco ACE Scalability test results

Scalability

The scalability test was performed on the Cisco ACE using Spirent TestCenter. A single Cisco ACE module achieved a maximum bi-directional load-balanced throughput of 15.3 Gbps. Cisco ACE also demonstrated linear scalability by delivering close to the theoretical limit of 64 Gbps using four ACE modules in a single

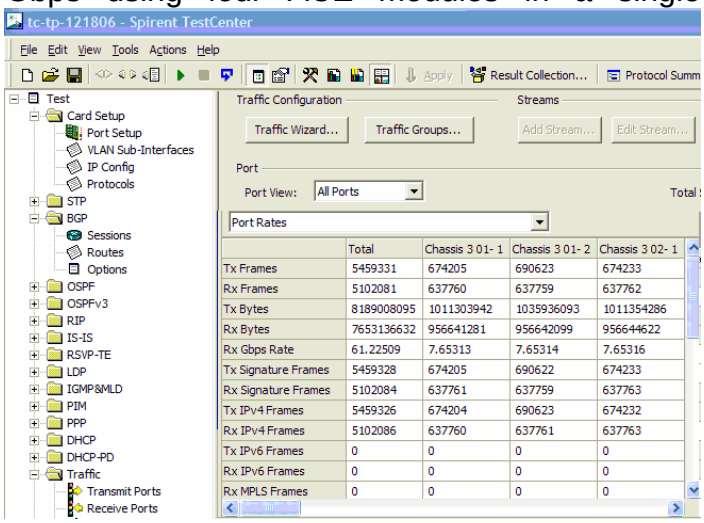


Figure 1: Screenshot of four ACE modules with 1500 byte traffic at 60+ Rx Gbps rate.

Catalyst 6500 chassis. In these tests, Spirent TestCenter was used to measure the throughput of up to four Cisco ACE modules that were incrementally brought online within the Catalyst 6500 chassis. As shown (Chart 2. and Fig. 1) the maximum throughput increased linearly as

each Cisco ACE module was brought online. In addition to the linear scalability tests across four Cisco ACE modules, the second scalability test demonstrated how the Cisco ACE enables scaling from 4 Gbps to 8 Gbps to 16 Gbps of throughput on a single Cisco ACE module using only a software license upgrade.

Performance Results

L4 CPS:

The Layer 4 connections per second (CPS), concurrent connections, and throughput tests for various server response file sizes were performed on the Cisco ACE. Across the file sizes tested, the Cisco ACE demonstrated consistently strong performance. At the largest server response file size (64K bytes), Spirent Avalanche reached its CPS (~4.5K per device) generation limit inhibiting the ability to determine the maximum CPS limit for large server response file size on the Cisco ACE module.

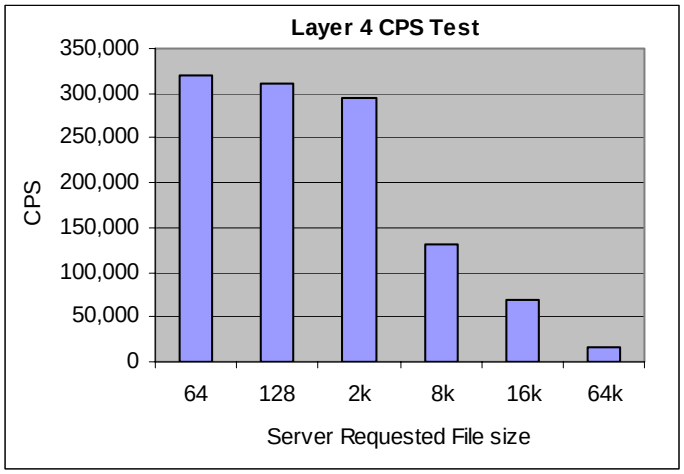


Chart 3: The Cisco ACE module for the 6500 chassis shows superior ability to create and process connections across a range of transmitted file sizes.

L4 Concurrent:

The Layer 4 Concurrent test results showed that the Cisco ACE handled almost 4 million bidirectional connections (Chart 4). Each of these connections represents both the client-to-DUT as well as the DUT-to-server side of the connection.

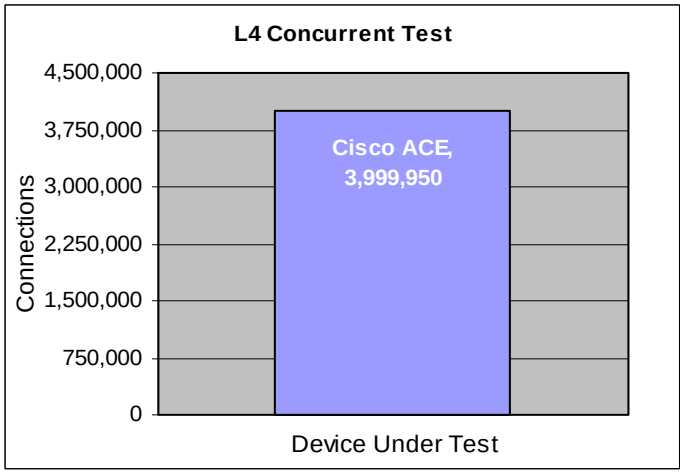


Chart 4: Number of Concurrent Layer 4 Connections sustained by DUTs

L4 Throughput:

The Layer 4 throughput test at different response file sizes shows a consistently strong performance by the Cisco ACE. From files sizes of 512K down to 2K (Chart 1, cover), the Cisco ACE maintained a performance of greater than 12 Gbps.

L7 Results:

These Layer 7 tests differ from the Layer 4 series, as the traffic generated requires the device under test (DUT) to perform TCP termination, analyzing at least the first data packet after the TCP setup sequence (SYN / SYN_ACK / ACK) in order to make an intelligent switching decision.

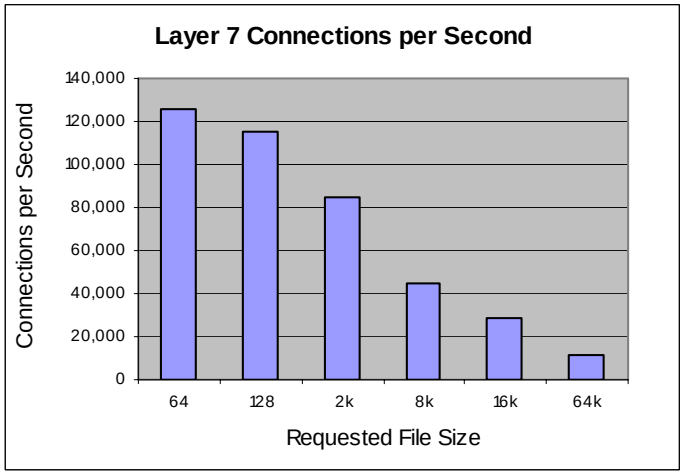


Chart 5: L7 CPS over Various File Sizes

L7 CPS:

The Layer 7 Connection per Seconds (CPS) results (Chart 5) show the continued trend of the impressively fast metrics of the Cisco ACE.

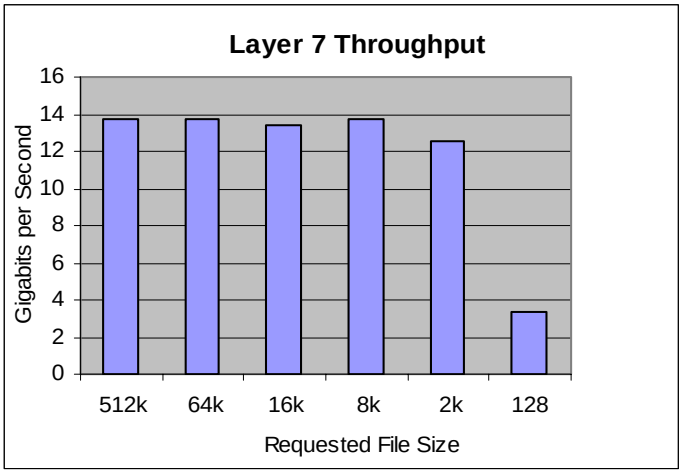


Chart 6: L7 Throughput over Various File Sizes

L7 Throughput:

In Layer 7 throughput results (Chart 6), from 512K byte file size down to 2K bytes, the Cisco ACE produced a consistent 12 to 13 Gbps rate. At 128 byte file size, the Cisco ACE throughput was 3.4 Gbps.

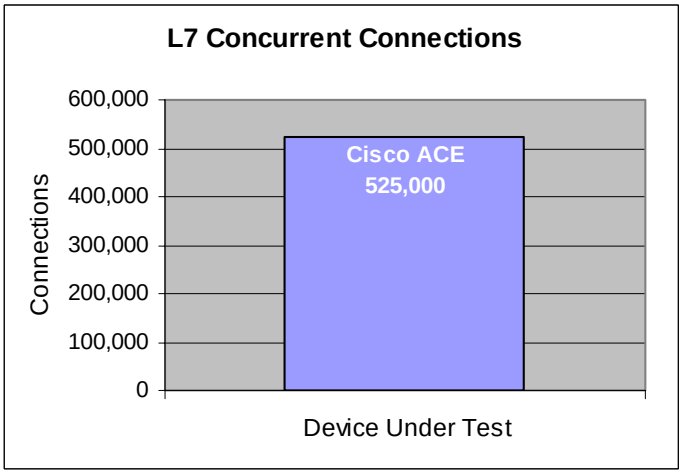


Chart 7: L7 Concurrent Connections

L7 Concurrent Connections:

The Layer 7 concurrent connections test showed the Cisco ACE sustaining 525,000 concurrent connections.

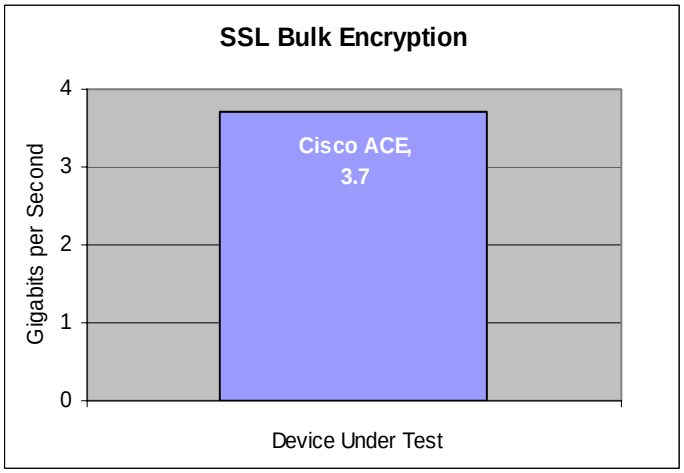


Chart 8: SSL Bulk Encryption

SSL Test Results:

SSL Bulk encryption testing was performed on the Cisco ACE to stress its symmetric encryption performance and verify the maximum SSL throughput of the device. The Cisco ACE results showed that it was able to deliver a consistently high throughput of 3.7 GB/s for SSL traffic. SSL Transactions per second (TPS) testing was performed on the Cisco ACE to stress its asymmetric encryption performance and verify the maximum number of SSL transaction per second. The test results showed that the Cisco Ace achieved 14, 700 SSL TPS.

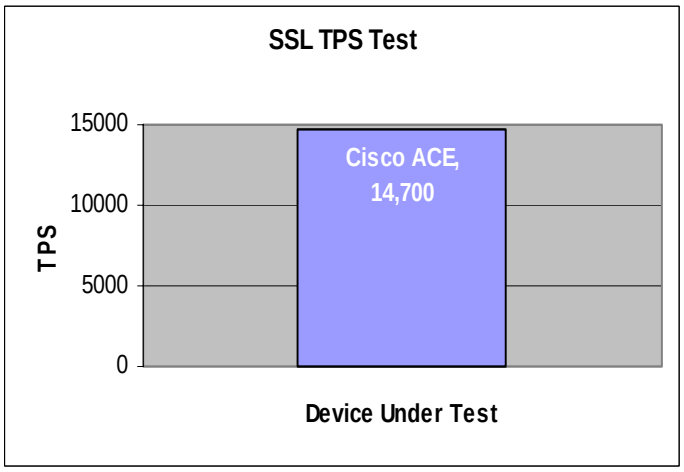


Chart 9: SSL TPS Test

Data Center Efficiency

Given that the Cisco ACE module draws power from the backplane of Catalyst 6500 series switch, the Catalyst 6500 "show power" command was used to measure maximum

allocated power to the Cisco ACE module during load. The externally measured power consumption by the Cisco ACE module was lower than the maximum allocated power. The results show that the Cisco ACE maximum allocated power was only 220 Watts. This translates to an estimated 751 BTUs. Customers traditionally require multiple devices when they need to isolate applications and service or boost performance. The Cisco ACE supports virtualization (see virtualization discussion below) to accommodate isolated services in a single Cisco ACE module eliminating the need for multiple devices. The high through put performance also remove the need for multiple devices. This means that compared to traditional means, the total power consumption remained constant for Cisco ACE regardless of number of virtual devices created on a single Cisco ACE module.

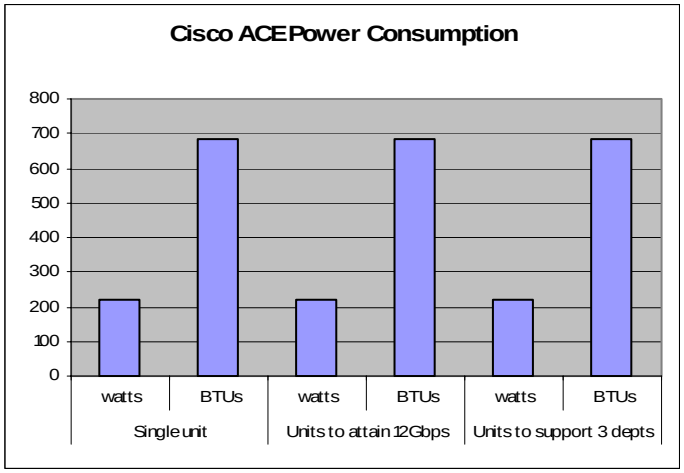


Chart 10: Power Consumption

Operational Benefits

Virtualization:

The Cisco ACE virtual device with Roles Based Administration (RBA) was demonstrated. Tests showed that a single Cisco ACE can provide up to 250 virtual devices, each with dedicated resources, configurations and direct management login. It was also demonstrated that the virtual devices are completely independent in terms of management, resources, configuration, RBA, routing tables, and functionality. As an example, each device has a separate management interface that is logged into directly, and separate from the high level device admin logins.

Roles Based Administration (RBA), a Cisco feature that meshes with the administration of the virtual devices, was demonstrated several times by creating a custom user role and leveraging pre-defined roles to restrict access to specific functions. Commands were issued to verify the scope of access and functions available in the various roles. RBA has many control features that allow individual user roles and template roles to be created to segregate the update and maintenance role of network personnel. By defining and limiting the overlap of user creation and update functions, network admin and security functions can be assigned and accomplished with planned workflow roles.

In addition, Cisco ACE's hierarchical domain feature was demonstrated. It enabled assignment of more granular responsibilities so that IT functional groups are exposed to only specific functions or commands when multiple applications are hosted on the same physical device or virtual device.

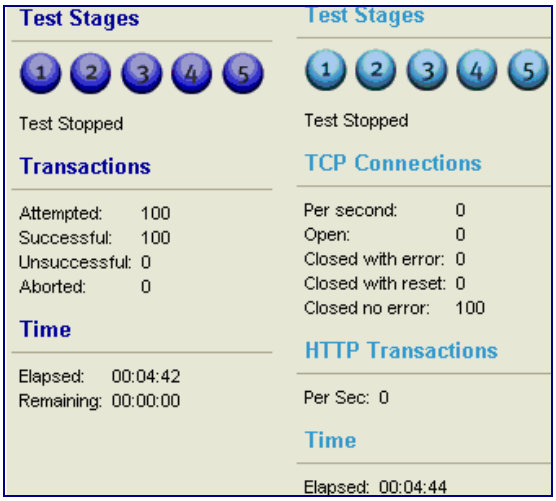


Figure 3: Failover test screenshot of Avalanche Commander Monitor test results screen

High Availability:

The Cisco ACE demonstrated no impact to application availability in the simulation of device failure. A fail-over and fail-back between two Cisco ACE modules was performed at the virtual device level to demonstrate this unique capability. The Cisco ACE active virtual device

was forced to fail-over to the standby virtual device using a "ft" (fault-tolerant) switchover command during the generation of 100 HTTP transactions from the Spirent Avalanche. The test results (Figure 2) showed that all 100 transactions were successful without any error. A second successful Cisco ACE fail-over scenario was demonstrated by tracking the failure of a VLAN. This test showed that the Cisco ACE could track and detect failures of other devices (example: MSFC on the Catalyst 6500) and perform fail-over from the active virtual device to the standby virtual device if the tracked device became unresponsive. In the High Availability setup, the Cisco ACE active virtual device automatically synchronized any new configuration or changes made in the existing configuration to the standby virtual device.

TCP Reuse:
Cisco ACE with the TCP Reuse feature significantly reduced the number of connections established to the server. As shown in Chart 9, Cisco ACE established only 400 connections to real servers for 80,000 client transactions. The Cisco ACE TCP Reuse feature freed up CPU resources on servers to establish and tear-down TCP connections.

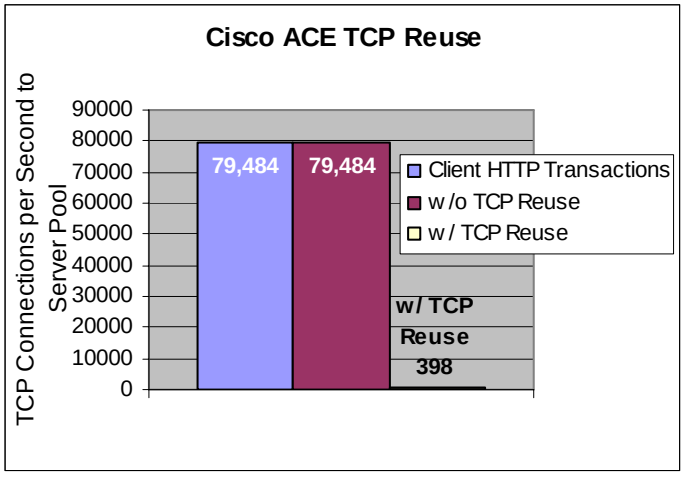


Chart 11: Cisco ACE TCP Reuse test results

Configuration Rollback:
The Cisco ACE configuration checkpoint and rollback service was demonstrated at the virtual device level. The test results showed that up to ten maximum snapshots of running configuration could be taken per virtual device and any of them could be restored. This service helps customers to immediately revert to the last known stable configuration in case any unforeseen problems occur due to new configuration changes.

Integrated Security

Application security tests were performed on the Cisco ACE using Spirent Avalanche devices. With a simple configuration, Cisco ACE successfully blocked and nullified various security attacks such as HTTP tunnel, Nimda, Obfuscated Nimda, and Xmas Tree attack. Cisco ACE also performed many TCP/IP/ICMP checks such as TCP/IP header validation, automatic anti-spoofing, illicit IP addresses validation, overlapping fragments validation, ICMP request and response matching by default during all performance tests. No performance degradation of Cisco ACE was seen when these capabilities were enabled.

Conclusion

In the testing conducted the Cisco ACE module for the Catalyst 6500 switch chassis showed its power and strengths. It demonstrated good performance in all L4, L7 and SSL bulk encryption testing and also showed linear scalability for throughput and connection processing across multiple modules in a single switch chassis. This together with lower power consumption along with innovative management features such as virtualization, RBA, hierarchical domains and configuration rollback earned the Cisco ACE module the Miercom Performance Verified certification.

Miercom Performance Verified

Based on Miercom's examination and testing of scalability and performance throughput of this system's configuration, operation and features, as described herein, Miercom hereby issues the Performance Verified certification for the product in this report. Miercom certifies the following key observations made during this review:

- **The Cisco Catalyst 6500 Application Control Engine (ACE) module demonstrated superior speed, throughput and scalability in comprehensive performance tests**
- **The Cisco ACE provided linear scalability for throughput and connections with multiple modules in a single Catalyst 6500 switch**
- **The Cisco ACE provides improved data center efficiency through lower power consumption and heat output**
- **The Cisco ACE eases and accelerates provisioning and management with unique features including: Virtualization, Roles Based Administration, and Configuration roll-back**

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