

LAB TESTING SUMMARY REPORT

May 2003
Report 190503

Product Category:
Broadband Aggregation

Vendor Tested:
Cisco Systems

Products Tested:
**Cisco 10000
Performance Routing
Engine 2 (PRE-2)**



Key findings and conclusions:

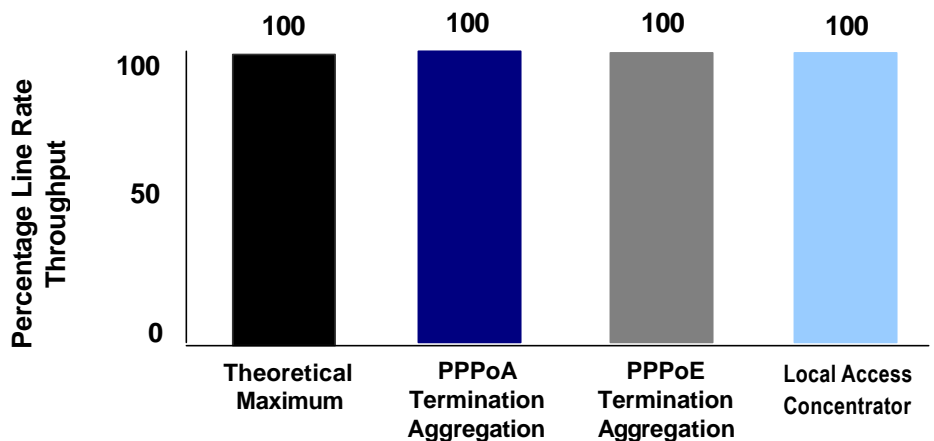
- Cisco 10000 supports more than 60K PPP over ATM/PPP over Ethernet sessions at line rate for 40-byte packets with IP services enabled
- Supports 10,000 tunnels and 60K PPP sessions at line rate for 40-byte packets
- Demonstrated a session set-up rate of 426 PPPoA sessions per second for 61,500 sessions
- Started accepting calls after failover in the primary Routing Engine in only 10.3 seconds

Cisco Systems contracted Miercom to test the Performance Routing Engine 2 (PRE-2) on Cisco 10000 Series routers. The focus of testing was on the PRE-2's scalability and performance for broadband aggregation. We evaluated the product at Cisco's laboratories in San Jose, CA. The analysis was based on a test-bed and methodology co-developed by Cisco and Miercom. Testing was conducted on a Cisco 10000 series router running IOS 12.2(15)BX.

Performance and Scalability Results

Results of testing demonstrated that the PRE-2 supported 61,500 PPPoE/PPPoA sessions and 10,000 Layer 2 Tunneling Protocol (L2TP) tunnels while forwarding traffic at line rate. Results were obtained using 40-byte packets with IP services enabled. Setup time for these 61,500 sessions was an average of 374 sessions per second using PPPoE and 426 sessions per second using PPPoA. Redundant PRE-2 fail-over time took only 10.3 seconds on average to start answering PPP calls.

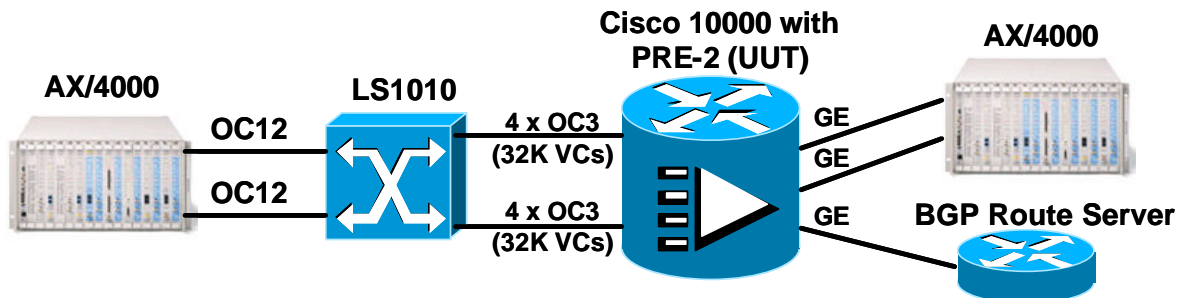
PRE-2 Line Rate Performance for 61,500 Sessions



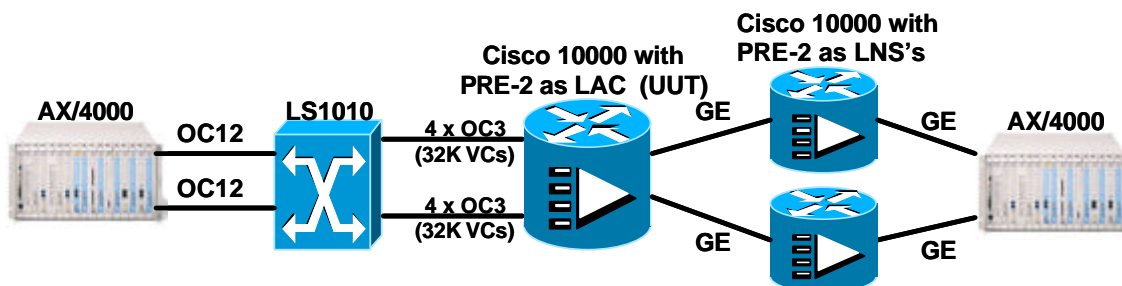
*Expressed as a percentage of the theoretical maximum rate achievable.

Test-bed Setups and Methodologies

Testbed for PPPoE and PPPoA Termination:



Testbed for L2TP Access Concentrator (LAC):



About the testing...We conducted a series of three tests, based upon two different tests beds, which are shown in the above diagrams.

Test 1 – Performance for 61,500 PPPoE and PPPoA sessions and call setup rate: The unit under test (UUT) consisted of a Cisco 10000 series router running IOS 12.2(15)BX. The Cisco 10000 supported two 4-port OC3 ATM line cards terminating the ATM virtual circuits (VC's) coming from subscribers and two Gigabit Ethernet interfaces facing the core. Each of the OC-3 (155.52 Mps) ATM line cards terminated 30,750 VC's for a total of 61,500 ATM VC's. A Lightstream 1010 ATM Switch was used to convert two OC-12 (622.08 Mbps) ATM links from Adtech to eight OC-3 ATM links connected to the UUT. We used a Spirent AX/4000 test tool running release 4.41 to generate PPP over ATM (PPPoA) or PPP over Ethernet (PPPoE) sessions, as well as to send and receive traffic. We configured the Cisco 10000 with local PAP authentication, local IP address pool, no keepalives, and autoPPP to automatically detect and use the appropriate encapsulation for PPPoA or PPPoE. We used one VC for each PPPoA/PPPoE session. In addition, 150,000 BGP routes were sent to the UUT, and IP policing was turned on in each of the PPPoA/PPPoE sessions. First, we established 61,500 PPPoE sessions from the AX/4000 and measured the time it took to bring up all sessions. Next, we sent 40 million packets at wire rate on each OC-12 and Gigabit Ethernet interfaces at the OC-12 line rate in both upstream and downstream directions simultaneously using 40-byte packets and then measured the throughput. This test was repeated using PPPoA, and results for PPPoA were also collected.

Test 2 – Performance for 10,000 L2TP tunnels: The testbed for this test is the similar to the one used in Test 1, except that we added two Cisco 10000's with PRE-2's as L2TP Network Servers (LNS's). We configured 10,000 tunnels on the UUT acting as a Local Access Concentrator (LAC) with 5,000 tunnels terminated on each of the LNS's. On the AX/4000, we initiated 60,000 PPPoE sessions with 10,000 unique domains so each tunnel carried six PPPoE sessions. We sent packets on each OC-12 and Gigabit Ethernet interfaces simultaneously in both directions at the OC-12 line rate using 40-byte packets and measured throughput and whether any packets were lost.

Test 3 – Performance Routing Processor fail over time: For this test, we used the test bed for testing PRE-2 route processor failover, except that we added a redundant PRE-2 to serve as the back up. We manually failed over the primary PRE-2, then initiated PPPoE sessions from the Adtech and measured the time it took for the secondary processor to take over and start answering PPPoE calls generated from the Adtech.

Performance Results – continued

These performance metrics point to several advantages the Cisco 10000 with PRE-2 offers prospective clients. First, the 61,500 PPPoE/PPPoA sessions, or virtual circuits (VC's), were configured on only two line cards, thus saving slots on the Cisco 10000, which would allow end users to deploy them for other purposes. Furthermore, the PRE-2's scalability and performance features will help customers scale up their broadband deployment without sacrificing performance, thus lowering their overall cost of ownership of the product.

The Cisco 10000 with PRE-2 demonstrated the highest session establishment rate Miercom has observed, to date. This rate is an important factor in achieving higher scalability in high-density aggregation devices; it reduces bring-up time and minimizes disruption to subscriber services.

In this analysis, we ran three specific tests, the results of which are summarized below. See "About the testing" on Page 2 for a description of the test beds and methodologies deployed in this series of tests.

Test 1: Before initiating PPP sessions, we used a Route Generator running on a Cisco 7200 series router to send 150,000 Border Gateway Protocol (BGP) routes to the Cisco 10000 via one External BGP (EBGP) neighbor. In addition, we also applied IP policing on each of the 61,500 interfaces. After verifying BGP routes and IP policies using IOS commands, we initiated 61,500 PPPoE sessions from

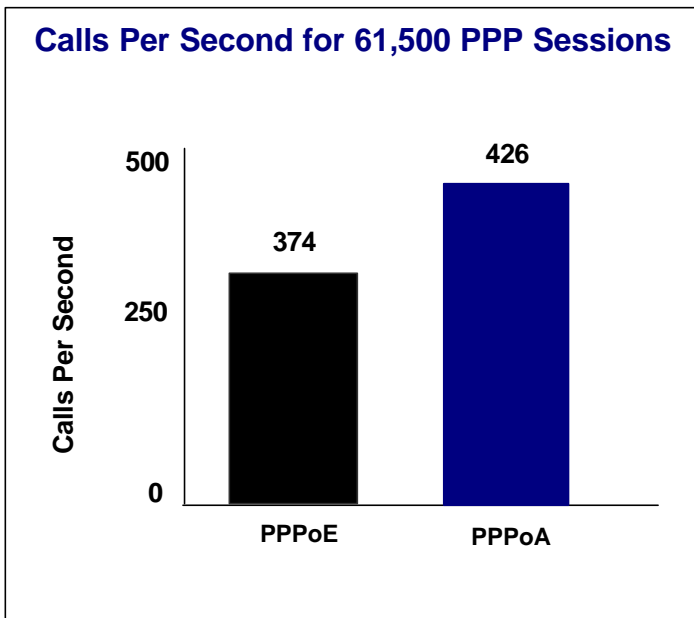
the Adtech AX/4000 test tool and observed that the Cisco 10000 correctly set up all the PPP sessions. We used IOS commands, as well as the Adtech AX/4000, to verify that all sessions were up and the IP addresses assigned to the sessions. At the end of the PPP session setup, we noted that the PRE-2 can establish PPPoE sessions at an average rate of 374 sessions per second. Bi-directional traffic was then sent over these PPP sessions using 40-byte packets. We sent 40 million packets per each OC-12 link and Gigabit Ethernet ports and verified that the PRE-2 forwarded these packets at line rate with no drops. We ran this test again with PPPoA sessions, and the call setup rate was measured at 426 sessions per second, on average. Again, the PRE-2 performed at line rate with 40-byte packets and IP services enabled.

Test 2: We initiated 60,000 PPPoE sessions to the PRE-2 functioning as a local access concentrator (LAC). We observed that the LAC correctly initiated 5,000 tunnels to each of the two L2TP Network Servers (LNS's) for a total of 10,000 L2TP tunnels from the LAC. Each tunnel carries exactly six PPPoE sessions, for a total of 10,000 tunnels and 60,000 PPPoE sessions on the LAC.

Because 61,500 sessions over 10,000 tunnels proved difficult to configure with a [username@domain.com](#) password for L2TP setup, such that equal amounts of traffic could flow through each ATM link, we settled on configuring 60,000 sessions (six per tunnel) and 10,000 tunnels. We sent 40 million, 40-byte packets from each of the two Gigabit Ethernet ports and from each of the OC-12 interfaces over these PPP sessions at line rate to the Cisco 10000, observing that the device forwarded the offered traffic at line rate.

Test 3: We inserted a secondary PRE-2 into the Cisco 10000 chassis and verified that the system had the redundant PRE-2 running as a standby. We performed a manual cut over on the primary PRE-2 and started the PPP sessions on the Adtech AX/4000 test tool.

We observed that the primary PRE-2 failed over to the secondary PRE-2, which assumed control without resetting its line cards. We calculated that the Cisco 10000 standby PRE-2 began to accept PPP calls within 10.3 seconds of the failover in the primary PRE-2.



Conclusions

Miercom recently conducted tests to assess the overall scalability and performance of Cisco 10000 with the Performance Routing Engine-2 (PRE-2). Results showed that the PRE-2 scales to support 61,500 PPPoE/PPPoA sessions and 10,000 L2TP tunnels at line rate using 40-byte packets—achieved while IP services were enabled. The PRE-2 also has a quick setup time of 374 calls per second on PPPoE sessions and 426 calls per second on PPPoA sessions for a total of 61,500 sessions. In failover tests, the secondary PRE-2 took over from the primary PRE-2 without resetting its line cards and began operation in 10.3 seconds. The Cisco 10000 series dramatically reduces the cost of broadband subscriber services with line-rate delivery of 61,500 sessions tightly coupled with QoS and other service-enabling features. This unique combination improves operational efficiency, increases revenue potential for broadband subscriber services and significantly improves return on networking infrastructure investment.



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About Miercom's Product Testing Services...

With hundreds of its product-comparison analyses published over the years in such leading network trade periodicals as *Business Communications Review* and *Network World*, Miercom's (formerly Mier Communications) reputation as the leading, independent product test center is unquestioned. Founded in 1988, the company has pioneered the comparative assessment of networking hardware and software, having developed methodologies for testing products from ATM switches to VoIP gateways and IP PBX's. Miercom's private test services include competitive product analyses, as well as individual product evaluations. Products submitted for review are typically evaluated under the "NetWORKS As Advertised™" or "Performance Verified™" programs, in which networking-related products must endure a comprehensive, independent assessment of the products' usability and performance. Products that meet the appropriate criteria and performance levels receive Miercom's endorsement.



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