Miercom

Lab Testing Summary Report

April 2005
Report 050404

Product Category:
Edge Routers

Vendors Tested:
Cisco Systems and Juniper Networks

Products Tested:
Cisco 7604 Router
and
Juniper M10i Router

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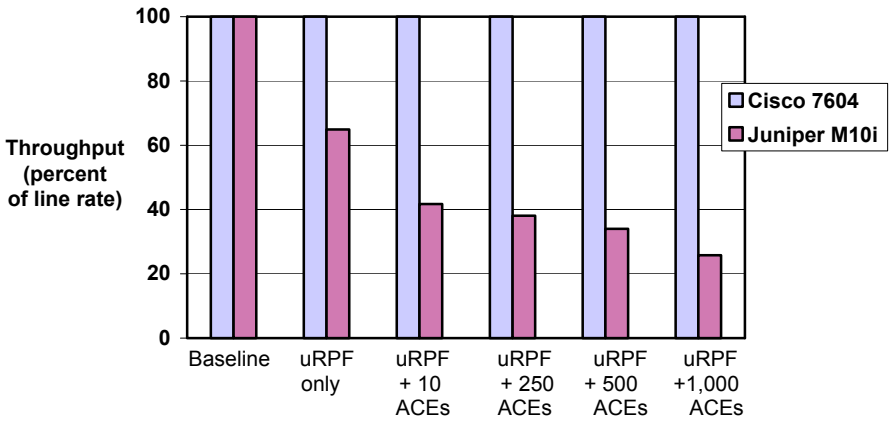
Key findings and conclusions:

- **Tested head-to-head with the Juniper M10i and using real-world set-ups and traffic, only the Cisco 7604 router delivered 100% throughput**
- **Juniper's throughput dropped by more than 25% with a 10-entry filter list, and by more than 65% with a 1,000-entry list**
- **In Class-of-Service tests, the Cisco 7604 always delivered 100% of "priority" traffic, while the Juniper M10i dropped packets in all classes**
- **In multicast tests the Juniper M10i dropped more than 17% of the offered load, while the Cisco 7604 consistently delivered 100%**
- **Running unicast Reverse Path Forwarding (uRPF) security and access lists, Juniper's throughput dropped from just 42% of offered load with small access lists, to less than 26% with large access lists.**

Cisco Systems engaged Miercom to independently assess the new Cisco 7604 router in a head-to-head performance comparison with Juniper Networks' M10i ® router. Juniper declined to actively participate in the testing.

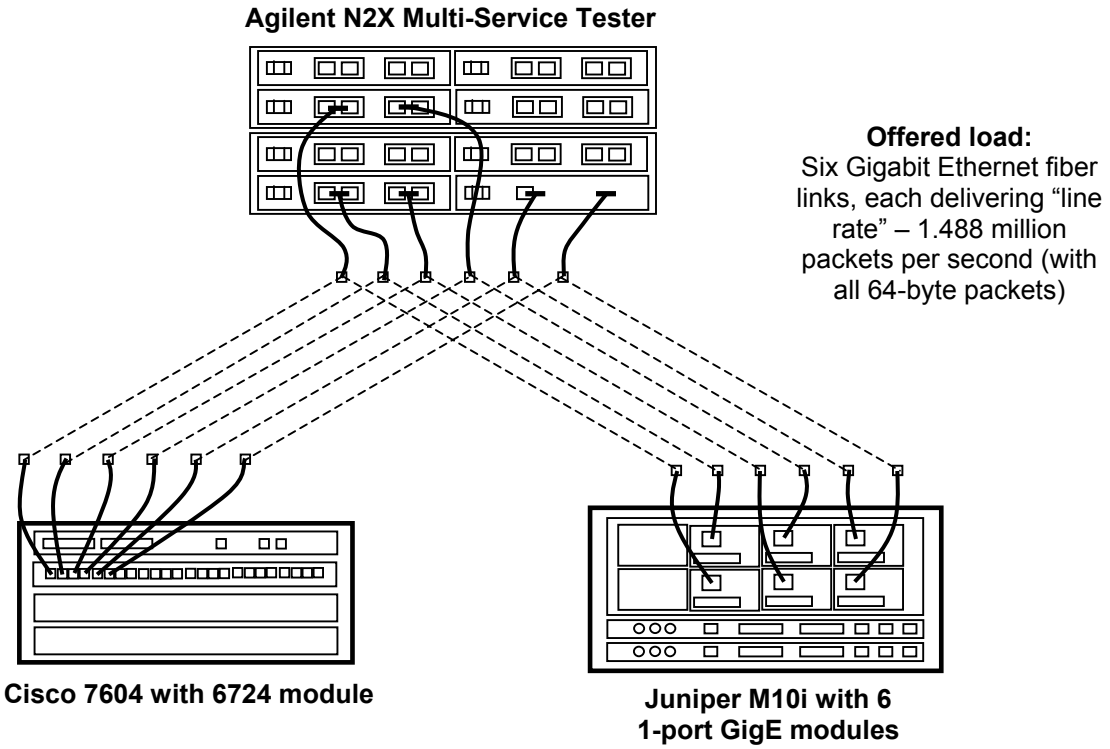
Performance measurements verified that the Cisco 7604 could enforce a strict service-level agreement (SLA), while busily running typical security services, and forwarding traffic from one to many destinations (multicast). Most noteworthy among the findings is the Cisco 7604 router's consistent throughput while under load, unlike Juniper's M10i router. These tests compared the performance and functionality of the



The Cisco 7604 edge router consistently maintains line-rate forwarding throughput even as additional services are added. When access filters and uRPF (unicast Reverse Path Forwarding) security processing are added, for example, the Juniper M10i performance degrades significantly.

Competitive Testing Note: The tests and test methodology that produced these results were proposed by, co-developed with and/or influenced by the vendor sponsoring this comparative review. Miercom assured their fair and accurate application. Consider all pertinent factors in your product selection or purchase.

Test-bed Setup



Six fully loaded Gigabit Ethernet links. An Agilent Technologies traffic generator, consisting of a modular chassis with dual-port, E7919B, GigE GBIC cards, and a control CPU, delivered the traffic load to the Systems Under Test (SUTs). Agilent's "N2X Packets and Protocols," version 6.4, System Release (SR1) software was used.

All the tests used the same three, dual-port Agilent modules to drive the six bi-directional, fiber Gigabit Ethernet links. The Agilent traffic generator was connected and re-connected, in turn, to each of the two test environments – the Cisco 7604 with a 6724 module, and the Juniper M10i with 6, 1-port 1000 BASE-SX modules.

The Cisco 7604 router ran Cisco IOS ® 12.2(18) SXE operating software. It had one supervisor engine, a SUP720 with integrated Switch Fabric / PFC3BXL (WS-SUP720-3BXL). In addition, the Cisco 7604 contained a 6724 module, a 24-port Gigabit Ethernet module (WS-X6724-SFP). The Juniper M10i contained six, single-port Gigabit Ethernet IQ PIC 1000BASE-SX modules, and two routing engines. The Juniper router ran JunOS 7.1R1.3 operating software.

Line rate for our fiber links was 1,488,095 packets per second (pps) for 64-byte packets. In all the tests – except QoS Oversubscription and Multicast tests – the Agilent delivered 64-byte packets at line rate (1,488,095 pps) in a fully meshed topology (where packets are routed from each input to all output interfaces). For the Multicast Test the Agilent system was configured similar to a fully meshed topology, but using PIM-SM (Sparse-mode). For the QoS Oversubscription test, two input ports were allowed to oversubscribe a single output port.

Cisco 7604 with a 6724 module (24-port Gigabit Ethernet) and the Juniper M10i with six Gigabit Ethernet IQ PIC modules.

Baseline tests were initially run on each system (see above test-bed notes). These tests measure 'optimal' throughput with a minimal configuration – where no additional services, such as uRPF and access filter lists, are running.

In the baseline configuration, the Juniper router performed comparably to the Cisco 7604. However, as additional services are added, the Juniper M10i exhibited significant throughput degradation and was unable to reliably forward high-priority Class of Service (CoS) traffic. With additional services added the Cisco 7604, by comparison, maintained full throughput and continued to assure delivery of all high-priority CoS traffic.

QoS

QoS handling without oversubscription

QoS (Quality of Service) allows specially designated traffic streams to be processed with higher priority than other traffic streams. This is becoming much more important as routed networks are expected to prioritize real-time traffic, such as video and voice (VoIP), to assure those applications' proper performance. QoS processing is also employed in situations where premium network services are governed by an SLA (Service Level Agreement).

QoS handling is of primary value when the network is oversubscribed – that is, where key links and router ports are congested. In this test however, we intentionally did not oversubscribe the network, but configured QoS on the routers as if an oversubscription condition might occur. Without oversubscription, QoS processing usually has no effect on throughput, because there is no reason to prioritize and drop packets if there is no overload.

The Agilent was configured to generate traffic for all six ports with a fully meshed topology. The traffic was delivered to the Cisco 7604 and the Juniper M10i at line rate for 64 byte packets – 1,488,095 pps. The traffic was split into four classes – denoted by different DSCP, DiffServ Code Point , values. The highest-priority class was "Gold" traffic, which was 33%, followed by "Bronze" traffic, 33%, "Silver" traffic, at 1%, and the rest, 33%, "Best Effort" traffic.

From our measurements we calculated the percentage of packets delivered to the egress ports, by QoS class, as compared to the packets delivered on the ingress ports.

In baseline tests of QoS handling with no oversubscription, both the Juniper M10i and the Cisco 7604 delivered the expected throughput – 100% of all packets were delivered for all class-of-service traffic categories.

However, when the Juniper M10i was configured with additional services, like uRPF and ACLs, with only 10 ACEs or "terms", the Juniper router dropped packets from *all* Classes of Service. The Cisco 7604, also configured with uRPF and 10 ACEs, continued to forward all of the traffic for all Classes of Service.

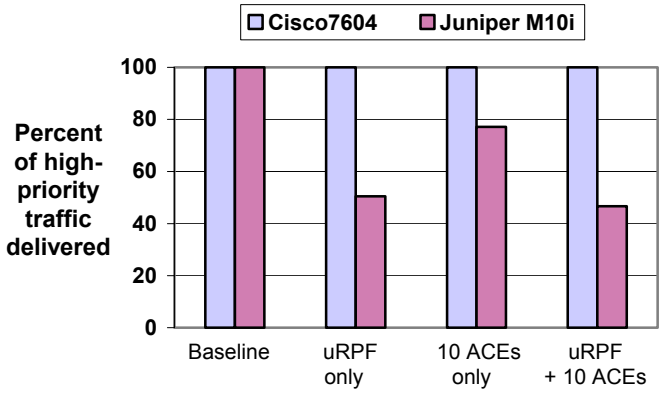
QoS throughput in an oversubscription environment

The oversubscription test indicates how well the high-priority traffic (referred to as "Gold" class) is preserved when there is network congestion, or oversubscription. In our testing we called this traffic "Gold" class. The routers were configured to afford this traffic the highest priority and protection from loss.

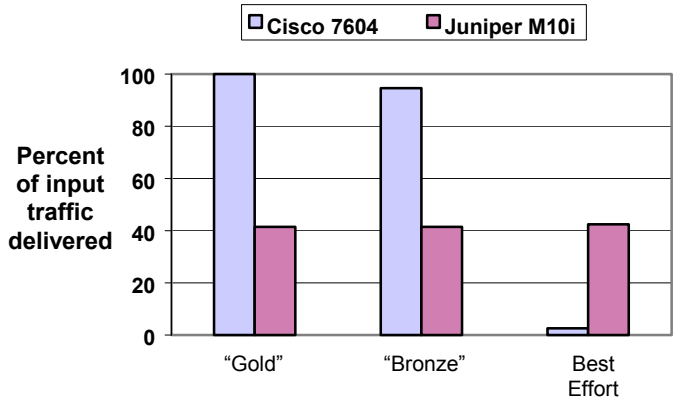
In addition to QoS configuration the two routers in this test were also configured with interface filter lists, each with only 10 ACEs (access control elements, or "terms"), on both input and output, and uRPF.

The Agilent tester was configured to use three ports – two for ingress and one for egress. This allows for a two to one (200%) oversubscription test. The traffic was delivered at line rate to the Cisco 7604 and the Juniper M10i. Each ingress traffic stream consisted of the four different traffic priority classes, as described earlier.

The results of this test showed that the Cisco 7604 was able to maintain a 100% forwarding rate for the high-priority traffic ("Gold" class). The Juniper M10i forwarded only about 42% of this high-priority traffic, dropping the rest. In addition, a similar test was run with less than 50% of the "Gold" traffic load and the Juniper M10i also dropped a significant amount of the "Gold" packets.



QoS with no oversubscription. In the baseline case, both routers faithfully delivered all high-priority traffic to the output port. However, when additional services, like uRPF or ACLs (with only 10 ACEs) are added to the configuration, the Juniper M10i begins dropping high-priority traffic even when the links are not congested.



QoS with oversubscription. Forwarding throughput for the four Classes of Service was examined in a test simulating a oversubscribed network. The Cisco 7604 delivered 100% of the high-priority traffic ("Gold"), but the Juniper M10i delivered only about 42%. For this test, uRPF and ACLs (with only10 ACEs or "terms") were also configured.

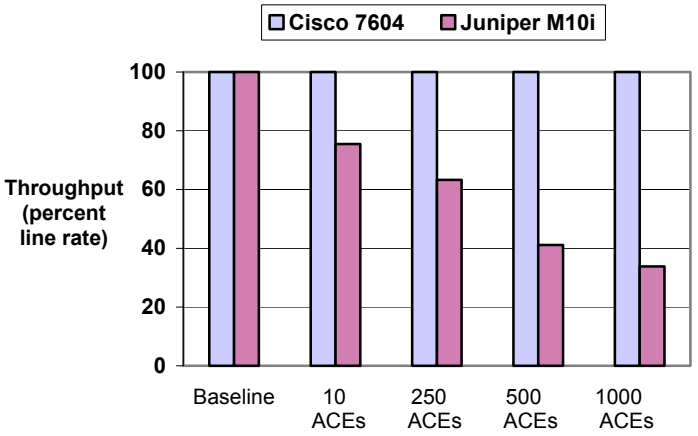
Interface filtering

Throughput with interface filters

Tests were run on the Cisco 7604 and the Juniper M10i to evaluate their throughput performance when interface filter lists (ACLs or "firewall filters") were added to the configuration.

In these tests the same filter lists were added to both the Cisco 7604 and the Juniper M10i routers (as both input and output filters). For this testing, we used "Standard ACEs" (access control elements, or "terms") which were configured to deny host or network segment access, except the default, and counters were enabled.

The Agilent system delivered traffic in a fully meshed configuration (where every port is delivered traffic to be routed to every other port). Traffic load was delivered on each port at line rate (1,488,095 pps with 64 byte packets).



Throughput with interface filter lists configured. As the size of the interface filter lists was increased, the Juniper M10i throughput performance degraded. The Cisco 7604 continued to forward all packets.

The results showed that with no interface filters (the baseline case), the routers all performed optimally: The Cisco 7604 and the Juniper M10i both delivered all packets at line rate.

However, as interface filters are added, the throughput performance of the Juniper M10i degraded. With 1,000 elements (ACEs) the M10i's throughput dropped to 34% (of offered load), while the Cisco 7604 forwarded 100% of the packets delivered.

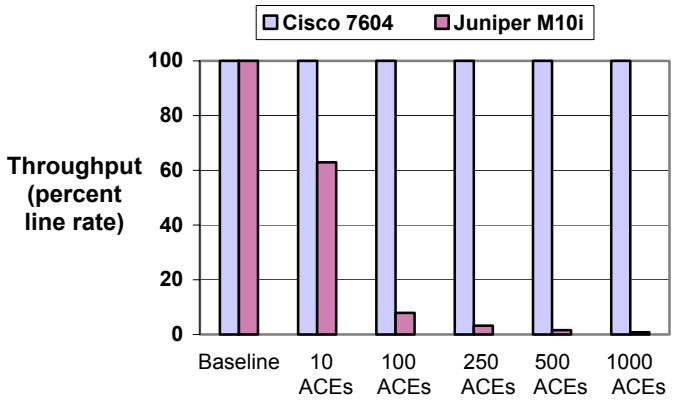
Throughput with Extended ACLs

Another test was run to evaluate the effect on throughput of a more realistic set of interface filter lists. In previous tests the network numbers in the interface filter lists were contiguous and no extended ACLs were used. However, in many real-world configurations, extended ACLs, which include specific protocol (TCP, UDP, IP, etc.) and port specifications, are used, and the network numbers are not typically contiguous.

The design of this test included interface filter lists with "pseudo-random" network numbers, as well as a "pseudo-random" assortment of protocols and ports for the extended ACLs. The ACLs were applied for both input and output. Traffic was generated in a fully meshed topology, with 64-byte packets, at line rate on all six ports. Counters were not configured on the Juniper M10i.

The Cisco 7604 forwarded 100% of the delivered traffic. With the Juniper M10i, however, the throughput degraded dramatically as the size of the interface filter list increased: With 1,000 elements in the filter list, Juniper's throughput dropped to under 1% of the delivered load.

When comparing the "Extended ACLs" test to the "Standard ACL" test, for 250 ACEs (or "terms"), the Juniper M10i throughput dropped from 64% to less than 4%.

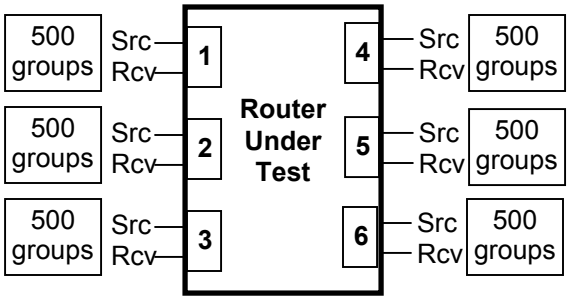


Extended ACL throughput. Throughput was measured using Extended ACLs (with protocol and port specifications) and pseudo-random network addresses. The Cisco 7604 forwarded 100% of the traffic, but as the size of the interface filter list was increased, the Juniper M10i throughput performance degraded to less than 1%.

Multicast convergence time and throughput

We also measured the convergence time (control-plane) and throughput of a Multicast Test case for the Cisco and Juniper routers. Each router was configured to be a PIM-SM (Sparse-mode) RP (Rendezvous Point). Traffic was delivered in full mesh mode – source traffic was delivered to all ports and requested multicast traffic was received on all ports for all groups sent.

This Multicast Test is a standard feature of the Agilent N2X Packets and Protocols test package. It is a component of "Agilent Quick Tests" called "Create PIM".



PIM-SM (RP)

All 500 groups were registered with the Rendezvous Point on each port. Each receiving port received traffic for all 3,000 groups, from all other ports.

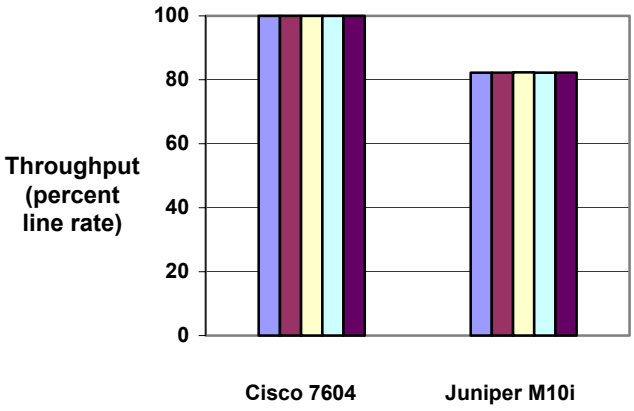
As in the other tests, traffic was delivered to the Cisco 7604 and Juniper M10i at line rate (1,488,095 pps) to all ports.

The Multicast Test was repeated five times and relatively consistent data was observed in each run. After each test, all the multicast routes were cleared in the routers, and then the Agilent Traffic Generator was re-started.

As the test started, the router starts registering the source groups and the PIM joins requests start. Over time, the router establishes all its routes and the traffic pattern stabilizes – the transmitted packet rate and the received packet rate reach a steady-state level.

The throughput in our tests was measured after the router achieved this steady state. The throughput was determined by observing the received packet rate as measured by the Agilent tester and compared to the transmitted packet rate.

The Cisco 7604 delivered 100% of the traffic while the Juniper M10i delivered about 82% of the traffic.

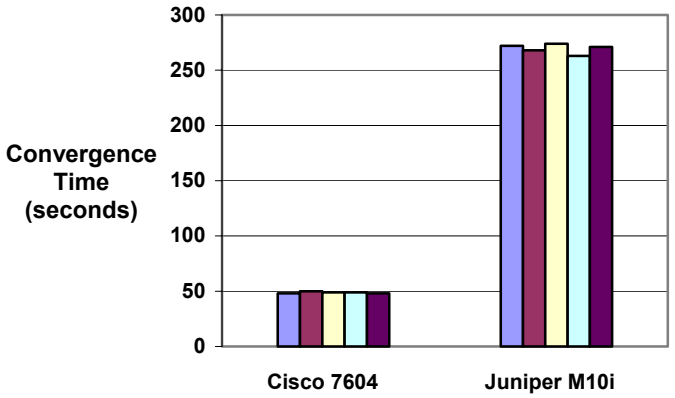


Multicast throughput. The Multicast Test was run five times and overall throughput was closely monitored. The Cisco 7604 forwarded 100% of the traffic after the test reached steady state, while the Juniper forwarded about 82%.

The measured Multicast convergence time is control-plane convergence only. It starts from the time the generator sends out PIM joins and traffic, and ends when all multicast routes with correct Outgoing Interface List (OIL) for each multicast route in the routing table.

We measured the convergence time by observing when the router achieved its steady state. The received packet rate was monitored. As each test starts the received packet rate was zero. The rate climbs as PIM join requests are routed to the receivers. The receive packet rate continued to climb until a steady rate is achieved – this was the observed convergence time.

The tests showed the Cisco 7604 converged in about 50 seconds. The Juniper M10i took more than five times as long, converging in about 260 seconds with only 82% throughput.

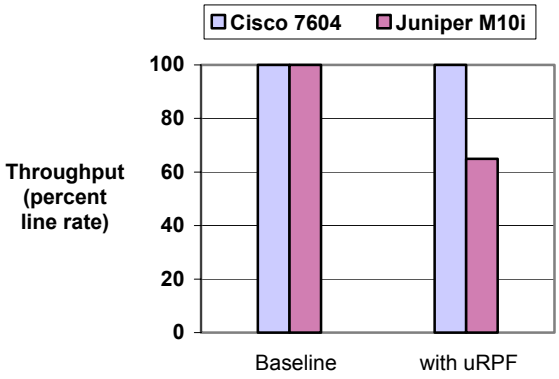


Multicast convergence time. The Multicast Test was run five times and the convergence time was monitored. The Cisco 7604 converged in about 50 seconds, while the Juniper M10i took over 260 seconds.

The Multicast Test focused on multicast traffic handling. There was no QoS configured, no ACLs, no uRPF, and only the multicast traffic streams were run. The traffic all consisted of 64-byte packets.

Configuring uRPF security

Separate tests were run to evaluate the effect of configuring uRPF (unicast Reverse Path Forwarding) on the throughput of the routers. uRPF is a security function that is increasingly being used – by enterprises and service providers – to prevent spoofing. For each router, its baseline configuration was modified to include uRPF on all six interfaces (uRPF was configured in loose mode).



Throughput with uRPF. When uRPF (unicast Reverse Path Forwarding) is configured on the routers, Juniper's throughput drops to below 65% of line rate. The Cisco 7604 continues to forward at line rate.

The results show that with uRPF configured, the Juniper M10i's throughput drops to below 65% of line rate, while the Cisco 7604 continues to process packets at full line rate.

Miercom Performance Verified

Based on Miercom's thorough examination of these systems' configuration, operation and features, as described herein, Miercom hereby attests to these findings:

- Tested head-to-head with the Juniper M10i and using real-world set-ups and traffic, only the Cisco 7604 router delivered 100% throughput
- Juniper's throughput dropped by more than 25% with a 10-entry filter list, and by more than 65% with a 1,000-entry list
- In Class-of-Service tests, the Cisco 7604 always delivered 100% of "priority" traffic, while the Juniper M10i dropped packets in all classes
- In multicast tests the Juniper M10i dropped more than 17% of the offered load, while the Cisco 7604 consistently delivered 100%
- Running unicast Reverse Path Forwarding (uRPF) security and access lists, Juniper's throughput dropped from just 42% of offered load with small access lists, to less than 26% with large access lists.

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