ADTRAN NetVanta 5660

Lab Testing Detailed Report

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Miercom
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Contents

1.0 Executive Summary

ADTRAN engaged Miercom to evaluate the NetVanta 5660 for performance and select features. This router supports a broad range of services, protocols and capabilities.

The NetVanta 5660 offers five Gigabit/s combo interfaces (RJ-45/copper or SFP/fiber), and various modules for EFM bonded WAN access technologies.

This full-featured IP router is packed with extraordinary protocol support and configuration flexibility. The NetVanta 5660 product includes multiple WAN interface options, hardware-based SLA (service-level agreement) monitoring with automated data exporting, Layer 2/3 OAM (operations, admin and management), auto-link-failover and recovery for service continuity, plug-and-play auto line detection for easy installation, and rapid routing technology for increased performance. The many security features include an integral stateful-inspection firewall and network-address translation (NAT).

The NetVanta 5660 showed well in our testing. Among the most notable findings and observations were the following:

- **Line rate**. For most packet sizes, the NetVanta 5660 handles full bidirectional traffic loads on all five Gigabit/s ports at wire speed. Bidirectional throughput of 4.94 Gigabits per second (Gbps) was achieved.
- **High Packet rates**. The NetVanta 5660 can forward packets at rates up to 3.13 million packets per second (Mpps).
- **Low latency**. Testing found that the NetVanta 5660 applies little latency to forwarded packets. The average latency ranges from 4.4 to 9.2 microseconds, depending on packet size.
- **Effective QoS handling**. Testing of DiffServ-based Quality of Service (QoS) confirmed the NetVanta 5660's ability to prioritize mission-critical user data.

Miercom has independently verified key performance and feature aspects of the ADTRAN NetVanta 5660. With proven wire-speed traffic handling on all ports, low latency and traffic-prioritization handling, the NetVanta 5660 is awarded ***Miercom Performance Verified*** as a result of this testing.

Robert Smithers

CEO

Miercom

2.0 Product Tested

The NetVanta 5660 is a Carrier Ethernet Customer Edge Router designed to interface high-speed customer premises Ethernet connections to one or more service provider "Ethernet" services. A diversity of such services are becoming available, which deliver a spectrum of Layer 2 (forwarding) and Layer 3 (routing) capabilities over extended Metropolitan and wide-area Ethernet-based transport facilities.

The proliferation of Ethernet services marks a departure from classic IP-based Virtual Private Network (VPN) offerings, which are typically carried over TDM-based static links or within Frame Relay or over Point-to-Point Protocol (PPP) connections. The ADTRAN device is designed to support many EVCs (Ethernet Virtual Connections).

The NetVanta 5660, pictured below, is a compact, rack-mountable, 1U (1.75-inch high) unit, designed to support a spectrum of configurations and services. On the front panel are ports for timing and synchronization, along with a serial management interface via DB-9 connector.

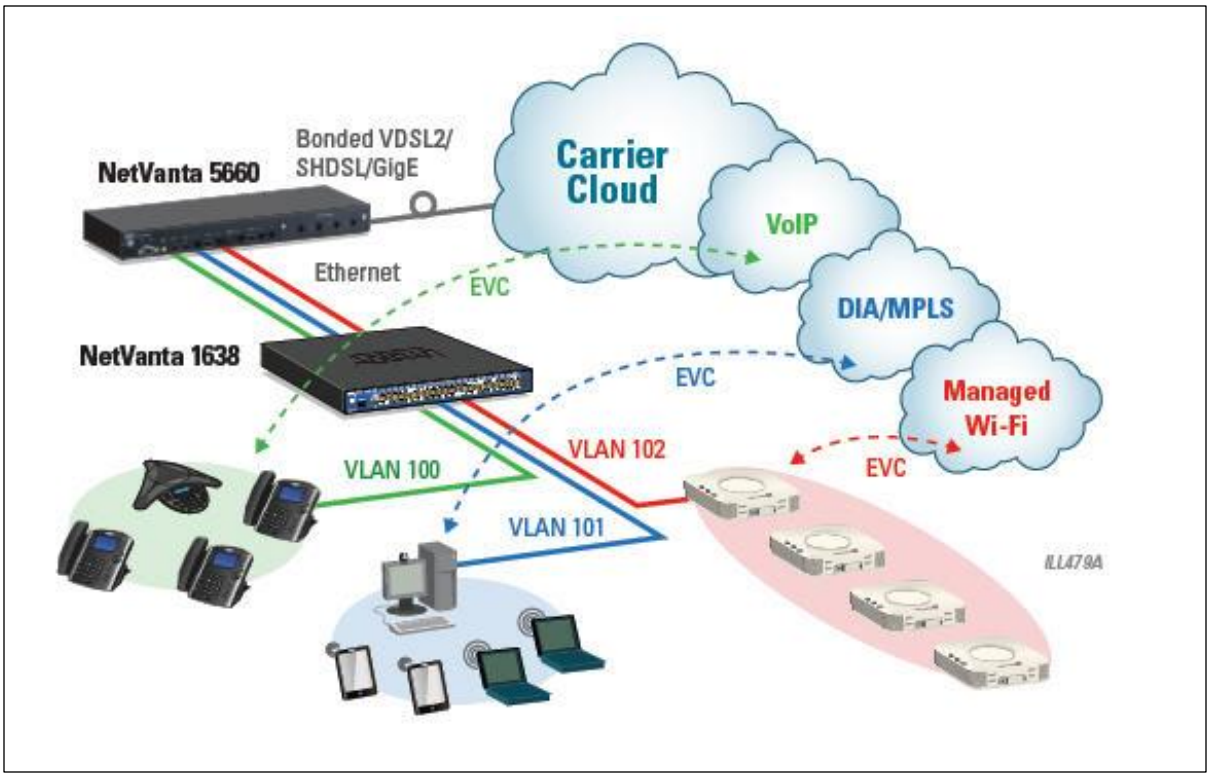
Also readily accessible on the front are five routed Ethernet interfaces, each supporting up to 1 Gbps of bi-directional data throughput, and each including full carrier Ethernet functionality. Four of these are combo interfaces – 10/100/1000Base-T combinations of copper or fiber. The copper connectors accept general purpose RJ-45 cables (good quality Cat-6 cable is recommended). Copper connections were used in our testing of the NetVanta 5560.

Instead of copper, an SFP (small form-factor pluggable) slot is offered for fiber transceivers on all five interfaces. The user can mix and match copper or fiber (one or the other on the four combo interfaces).

Multiple modules are offered, each supporting two and four VDSL2 or four and eight SHDSL connections. The NetVanta 5660 is configured with a "quad" network module, offering four SHDSL connections.

Deployment

The NetVanta 5660 is designed to provide high-speed connectivity from a customer site to a carrier's Ethernet-based service. As shown in the deployment diagram below, the NetVanta 5660 provides the logical control for running various data streams and applications over EVCs (Ethernet Virtual Connections).



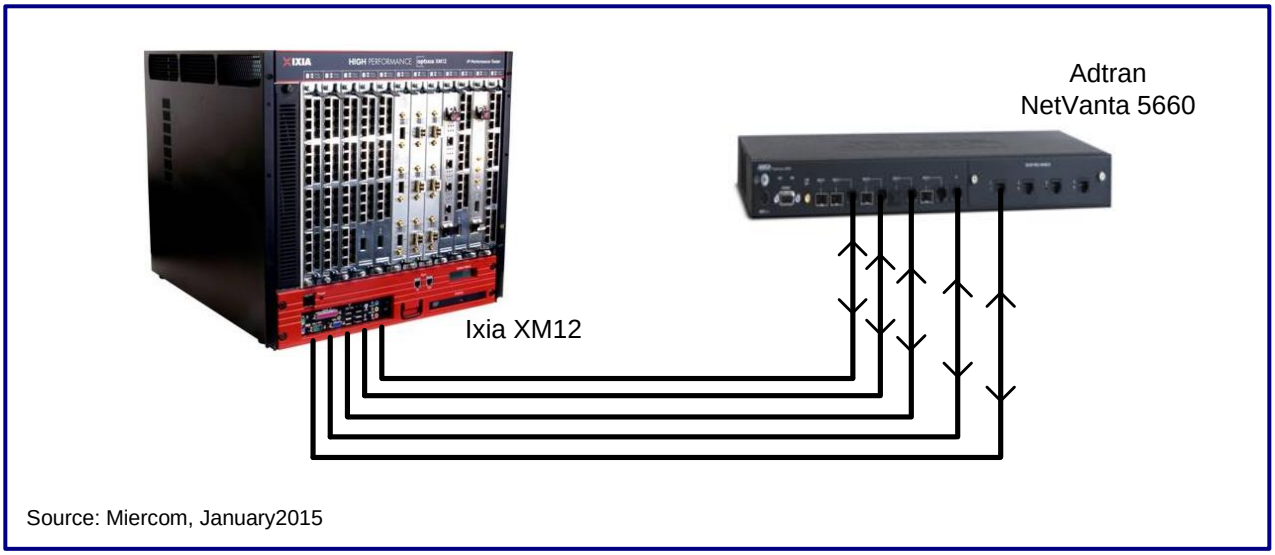
Numerous Layer 2 and Layer 3 protocols are supported for compatibility with a broad range of carrier services and to satisfy particular user configurations. Also supported are various traffic-prioritization (QoS) mechanisms including IP DiffServ and VLAN trunking. For a detailed list of supported capabilities, see the NetVanta 5660 spec sheet.

3.0 Test Bed – How We Did It

Miercom's testing of the NetVanta 5660 was designed to fully exercise the routing fabric and forwarding capacity of the device and select features, including QoS (Quality of Service) prioritization.

The testing employed the Ixia XM12, a multislot test system capable of delivering test traffic of many different characteristics at wire speed. Test traffic was delivered to the NetVanta 5660 at full wire speed on all five Gigabit/s interfaces.

The NetVanta 5660 was tested without any of the optional network modules. RJ-45 copper interfaces were used on four of the 1-Gbps combo interfaces; a fiber transceiver was used with the fifth, fiber-only port.



Source: Miercom, January2015

The throughput and latency of the NetVanta 5660 router were measured in accordance with IETF standards, namely RFC 2544 and RFC 2889. Layer 3 (IPv4) test traffic was used in all performance tests.

An RFC 2544 throughput test determines the maximum rate at which the device under test (DUT), can receive and forward packets (frames) without frame loss. The RFC 2889 test is used to verify the throughput and latency of fully meshed traffic – where received packets are forwarded to outbound ports in round-robin rotation, like a dealer dealing cards.

RFC 2544 and 2889 latency values were verified via all five 1-Gbps ports of the NetVanta 5660 router, which was configured in store-and-forward mode. The Ixia test system clocks each packet when it is sent and then when it is received back. The difference in send and receive times is recorded as the packet latency through the NetVanta 5660.

Ixia XM12 Test System

Ixia (www.ixiacom.com) is an industry leader in performance testing of networking equipment. Real-world traffic is generated by Ixia's test platform and test applications, principally the IxAutomate application for Layer 2 switching and Layer 3 routing traffic. As noted, the Ixia XM12 was also used for measuring the latency of packets traversing the NetVanta 5660.

Hardware and Software Featured in Testing

Hardware		
Name	**Function**	**Software Version**
NetVanta 5660	Router	R11.4.1.E
Ixia XM12	Traffic generator	IxOS 6.40.900.6 EA (Chassis: 7.00.395.6)
Software		
Name	**Function**	**Version**
Ixia IxNetwork	RFC 2544 and 2889 Testing Tool	7.0.801.25 EA
Ixia IxAutomate	RFC 3918 Multicast and Table Size Testing Tool	7.40.123.5 GA-Patch1

The NetVanta 5660 was not tested for compatibility with any specific carrier services, as these are too many and diverse to yield clear interoperability results. Rather, test traffic was delivered to each of the device's five gigabit/s ports and then routed in round-robin fashion to the other four ports, fully exercising the device's Layer 3 routing and Layer 2 packet-forwarding capacity.

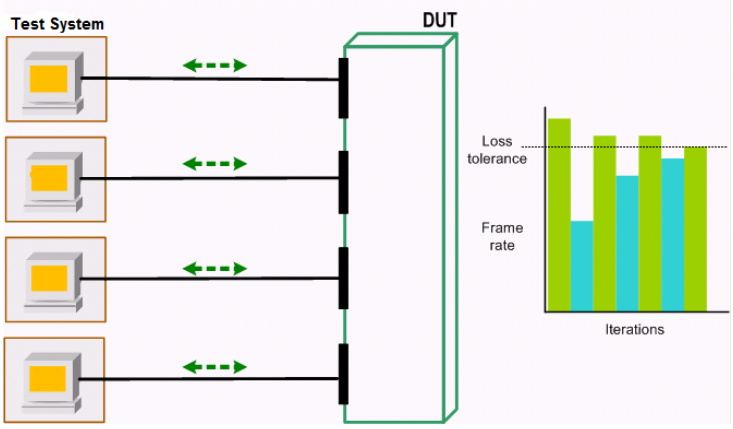
The tests in this report are intended to be reproducible for customers who wish to recreate them with the appropriate test and measurement equipment. Contact Miercom Professional Services via reviews@miercom.com for assistance. Miercom recommends customers test specifically for the expected environment for product deployment before making a product selection. Miercom engineers are available to assist customers for their own custom analysis and specific product deployments on a consulting basis.

4.0 Performance Testing

To test the forwarding performance of NetVanta 5660, Miercom engineers connected each of the router's Gigabit/s ports to a port on the Ixia traffic load generator.

4.1 Throughput

Throughput tests determine the maximum rate at which the NetVanta 5660 receives and forwards packets without loss. The Ixia XM12 test-traffic generator forwarded traffic at the maximum theoretical rate based on the supported port speed. This test is configured with traffic mapping as shown in the figure below.



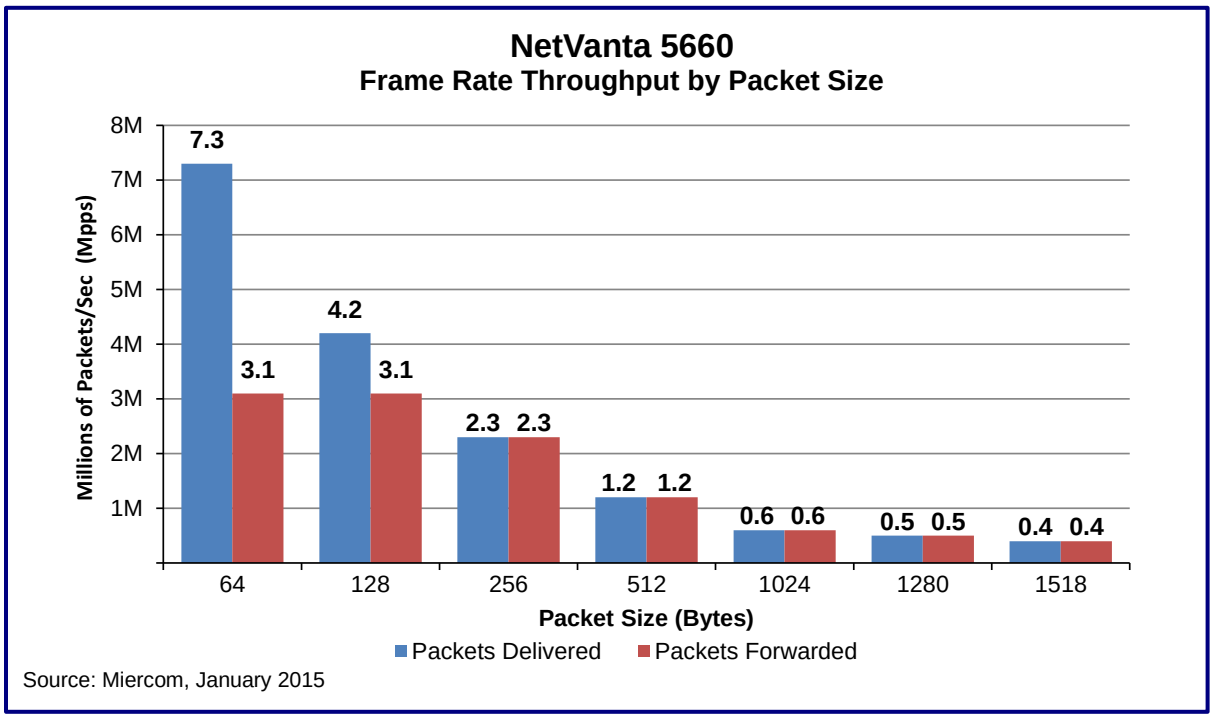
Throughput and latency performance tests were conducted in accordance with the RFC 2544 and 2889 benchmark methodologies. Configuring the NetVanta 5660 was done using the vendor's command-line interface. To conduct Layer-3 testing, each GE (1 Gigabit Ethernet) port was assigned a unique VLAN.

Traffic was sent to the router in many separate tests, each time with a different packet size. In the first test, 64-byte frames were sent to the router at 100-percent load (line rate).

Subsequently, larger 128-byte packets were delivered at wire rate, and each subsequent test delivered large and larger packets, up to 1,518 bytes. This testing used all five 1-Gbps ports and required the NetVanta 5660 to route packets in a mesh pattern.

The following chart shows the results when packets of a particular size are delivered to the NetVanta 5660 at wire speed on all five 1-Gigabit/s ports.

ADTRAN NetVanta 5660 – Forwarding Frame Rate by Packet Size



Test Notes:

- Based on L3 IPv4 packets
- All test traffic was bi-directional
- Full line-rate load was applied on all five 1GE (Gigabit Ethernet) ports

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Several conclusions can be inferred from the packet-forwarding results:

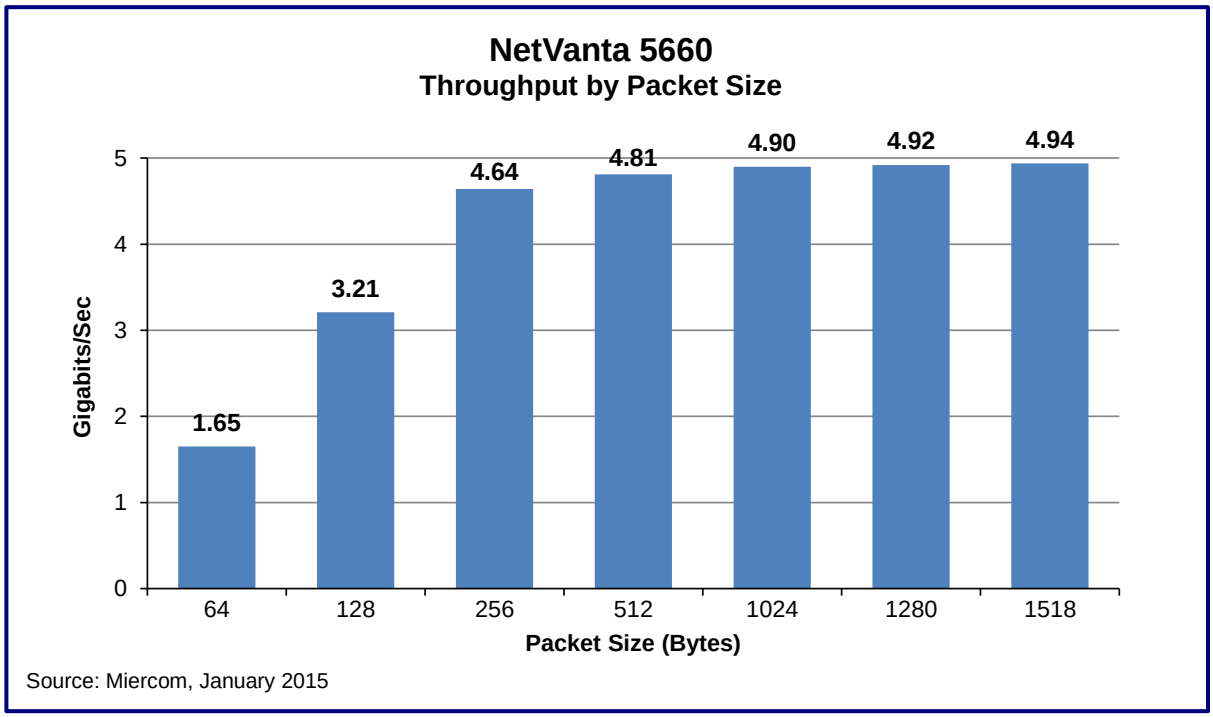
- With packet sizes over about 250 bytes, the NetVanta 5660 can forward packets on all ports at wire speed.
- Based on the configuration tested on the NetVanta 5660, testing results indicate a platform limit on the number of packets that can be forwarded per second. In the tested environment, that limit seems to be about 3.1 million packets per second.
- As with most routers that the NetVanta 5660 competes with, the packet-forwarding engine is not designed to handle all minimum-sized packets arriving at wire speed on all ports. In this extreme test environment – with all line-rate traffic consisting of 64-byte packets - more than 50 percent of the delivered load is dropped.

Forwarding Throughput

In addition to the packet-forwarding rate, the Ixia test system also calculates and reports the aggregate throughput – the total user data volume – achieved in each test.

The following chart shows the Layer-3 (IPv4 packets) throughput achieved by packet size.

ADTRAN NetVanta 5660 - Throughput by Packet Size



Source: Miercom, January 2015

Test Notes:

- Based on L3 IPv4 packets
- All test traffic was bi-directional
- Full line-rate load was applied on all five 1GE ports

Several conclusions can be drawn from the throughput results:

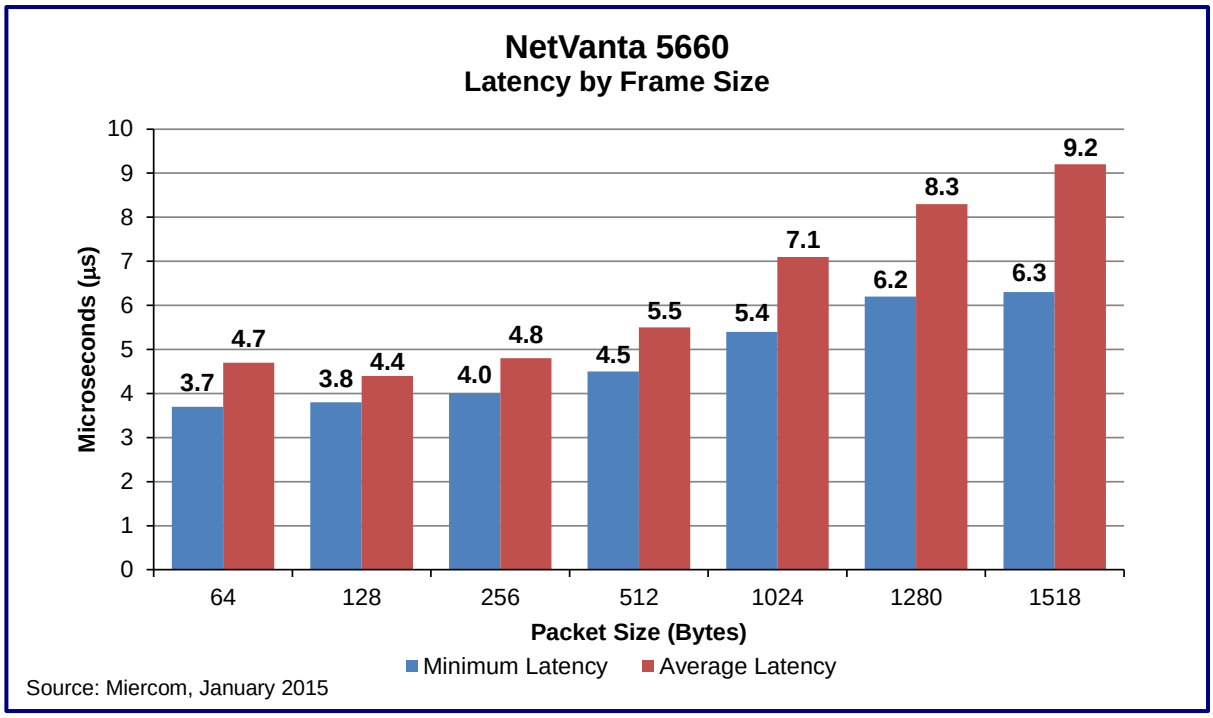
- The NetVanta 5660 delivers line-rate (wire speed) forwarding performance, on all five 1-Gbps port for packet sizes over about 200 bytes, and up to 4.94 Gbps of throughput (with 1,518-byte packets).
- Throughput for 64-byte packets represents 47.11 percent of line-rate throughput. Throughput for 128-byte packets represents 74.28 percent of line-rate throughput.
- Based on packet overhead and required interframe spacing, throughput is lowered with the small packet sizes. The NetVanta 5660's packet-forwarding engine responded as expected with a full load of 64- and 128-byte packets on all ports.

4.2 Latency

A latency value – the time it takes the packet to traverse the device under test – was captured by the Ixia test system for each frame delivered in our testing. To specifically measure and report latency it cannot be subject to overload conditions, where packets may be dropped, queued or buffered. Congestion can add thousands of microseconds of delay to packets.

The below chart shows the statistical mean for the minimum and average latency times, by packet size. These times, in microseconds (µs), are for test-traffic streams sent at 10 percent of full load, bidirectionally through each of the NetVanta 5660's 1-Gbps ports.

ADTRAN NetVanta 5660 – Latency by Frame Size



Test Notes:

- Traffic was bi-directional
- Based on L3 IPv4 packets
- Traffic delivered at 10 percent line-rate

Several observations based on the latency results:

- The NetVanta 5660's latency results are in line with of router products in its class. Packets incur at least 1 microsecond of latency in traversing even the fastest switches and routers available today. An average latency for comparable products is about 3 to 5 microseconds for 64-byte packets. The min and average latencies of the NetVanta 5660 range from 3.7 to 9.2 microseconds.
- Latency applied by the NetVanta 5660 is linear and proportional to packet size. Some products are architected to minimize the latency of packets of a particular size, such as 400 bytes. The NetVanta 5660's latency, however, is almost perfectly linear indicating it is optimized for any size packet.

4.3 QoS (Quality of Service)

QoS allows the prioritization of traffic to ensure transmission preference for the most important or time-sensitive traffic. In the event of network congestion, the highest priority traffic is delivered first. This policy is used to assure delivery of the most business-critical traffic.

The NetVanta 5660 router supports QoS functionality in several ways at different protocol layers, including 802.1q trunking, Weighted Fair Queuing, and Differentiated Services (or DiffServ, as defined in RFC 3246).

To test the NetVanta 5660's DiffServ support, five queues were set up. One was defined as EF (Expedited Forwarding) – where packets bear a value of 46 in the six-binary-bit DSCP (Differentiated Services Code Point) field of IP packets. The rest were defined as AF (Assured Forwarding) – a DSCP value of 40 was used. The EF designation guarantees priority handling and delivery (low delay, loss and jitter), while AF requires guaranteed delivery, but at a lower priority. The default handling of packets is Best-Effort, the lowest priority.

Bandwidth was set to 500 Megabit/s for each queue in the system. We then sent traffic at 700 Megabit/s and observed that the traffic in the EF queue was delivered first and subsequent traffic was delivered after.

The QoS settings and capabilities of the NetVanta 5660 router worked as expected.

5.0 About Miercom Testing

This testing and report was sponsored by ADTRAN, Inc. The data was obtained completely and independently as part of Miercom's own lab testing.

Miercom has published hundreds of network-product-comparison analyses in leading trade periodicals and other publications. Miercom's reputation as the leading, independent product test center is undisputed.

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6.0 Use of This Report

Every effort was made to ensure the accuracy of the data contained in this report but errors and/or oversights can occur. The information documented in this report may also rely on various test tools, the accuracy of which is beyond our control. Furthermore, the document relies on representations by vendors that were reasonably verified by Miercom but beyond our control to verify to 100 percent certainty.

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