



# True Router Performance Testing

Agilent Technologies RouterTester  
Application Note

## Introduction

Measuring the performance of a gigabit router is not a simple task. A test campaign that exercises both the data forwarding performance concurrent with control plane stress is the only effective method of measuring a router's performance.

To measure the performance of a router with a 40 Gb/s switching capacity, 40 Gb/s of test traffic must be generated into the router. A 40 Gb/s router is capable of handling traffic delivered over interfaces up to 16 OC-48c (2.4 Gb/s). Each physical interface must deliver many streams of instrumented test traffic — each stream representing an aggregate of traffic flows typical of the Internet. The performance of the router is measured by observing the effect on each instrumented stream of traffic.

This document describes the motivation for performance testing, and lists a series of steps that should be taken in order to measure the performance of a router.



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## The motivation to test performance

Why test a router under full load conditions? Let's take a step back, and take a look at the growth of the Internet.

It is no surprise that the Internet is exploding in size and traffic volumes. A router placed into a network today to solve today's capacity problems will be out dated in a matter of months, unless steps are taken to plan for tomorrow's traffic volumes. For example, a router that must handle an aggregate of 40 Gb/s will have to handle a load of 400 Gb/s within a year (corresponding to the widely accepted fact that traffic is multiplying by a factor of approximately ten times per year). Such dramatic growth requires the installation of a cluster of routers now, and ensuring that this installation will have the capacity to handle the expected load in one year from now.

In order to extend the life of expensive equipment to be used within the Internet, today's devices must be capable of performing as close to wire-speed as is possible. Consequently, measuring the performance of these devices must be measured before they are installed within a network. This is critical.

## Testing a router

To test a router, both the data plane and control plane must be stressed simultaneously on all ports.

To fully test the data forwarding performance of a router, we need to deliver instrumented packets, at wire speed, into every interface on the router. Every packet must be tracked to ensure accurate counts for packet loss, latency and throughput.

Delivering packets at wire speed into the ingress of the physical interface stresses many components of the router. First of all, the ability of the physical interface to handle packets at wire speed is assessed. The interface must process each packet and match the destination address against the thousands of network prefixes in the forwarding table.

Then, the router's ability to schedule the switching of packets through the switch fabric is assessed to determine whether the router can truly switch packets at wire speed. Packets may be dropped, misdirected, or corrupted as they traverse a loaded switch fabric.

Finally, at the egress interface, a router must be able to buffer packets arriving from many ingress interfaces into multiple queues and apply Quality of Service guarantees to selected queues.

Clearly, the performance of a router depends upon the load offered to it — a heavy load of test traffic will reveal the true performance of a router.

## Data forwarding and control planes are intertwined...

Each physical interface not only receives packets — it must also match the received destination address within received packets against the list of network prefixes within the forwarding table. Then, it requests the switch fabric to schedule the packet for delivery to the appropriate output port.

The forwarding table is built by exchanging routing protocol packets (OSPF, IS-IS or BGP-4) between routers. Each time an interface receives a routing protocol packet, the packet must be passed to the router's route processor. The route processor processes the routing packet, updates the forwarding table, and then distributes the forwarding table to each physical interface.

Under certain circumstances, routing packets may be received at extreme rates - rates sufficient to overload the route processor and delay the distribution of the forwarding table — some routers are even known to crash under these circumstances. Since the forwarding table is not being quickly updated, data packets may not be forwarded to the correct destination. Consequently, service levels will drop, as will customer satisfaction.

Measurements made within the Internet have shown that routing protocol messages may be exchanged with routers at rates of up to 300 route updates per second — 300 events each of which forces the route processor to potentially update the forwarding table. To effectively test the ability of a router to manage route updates that affect the forwarding tables on every interface, routing protocol updates must be delivered on every interface simultaneously and concurrently with heavy traffic loads. Only then can the effect by route updates on packet forwarding be effectively measured.

## Testing a Router - the simplistic way

A cost-effective approach to testing a router has been to purchase a limited number of interfaces for the target router, and then to generate test traffic through these interfaces. In fact, some tests utilize a single multi-port card on the target router, and then generating traffic through this card (i.e. all traffic stays local to the interface card).

Unfortunately, this strategy will not reveal the performance of a router.

First of all, generating traffic through a small number of interfaces will only exercise a very small portion of the switching fabric of the router. In fact, if all packets “stay local” to the interface card (i.e. packets enter the interface and leave the interface), the router's switch fabric may not even be exercised! The only purpose of this type of test is that it benchmarks the nominal performance of the router. These measurements can later be contrasted with the performance of the router under load, but on their own they are not useful measurements.

Secondly, using a small number of test ports cannot test a router's ability to manage its forwarding tables. Many routes can be advertised on each of the limited number of ports in order to build large forwarding tables in the router. But, the ability of a router to manage the forwarding table and to distribute a cache or a complete copy of the forwarding table to every



interface cannot be measured. Routing packets must be continuously generated into each interface to force continual updates to the route processor — which in turn must update each forwarding table on every interface continuously.

Thirdly, a limited number of interfaces — in particular, a single input and a single output — cannot be used for testing the QoS capabilities of a router. In order to test QoS on a single output, the output must be oversubscribed. Oversubscribing an OC-48c link can only be done when a load of more than OC-48c is delivered to the output interface.

Finally, “interesting” things happen to routers when they are loaded. For example, measurements made by Agilent Technologies on a number of routers has revealed that the overall performance of many routers drops significantly when every interface is loaded — significantly more than if just a single pair of interfaces is loaded.

## Steps to successfully measuring the performance of a router

The following questions need to be answered prior to evaluating the performance of a router:

### 1. How many interfaces do I expect my router to support?

A router should be tested with a realistic expectation of the number of interfaces that it is expected to support — both today and into the future. For example, it may only be necessary to support four OC-12c interfaces to meet today’s traffic requirements, but one year from now, when traffic increases by 10 times, the router will be required to support 40 OC-12c or ten OC-48c interfaces.

### 2. What interface types am I using in my network today, and what types of interfaces do I expect to use in my network in six months and in one year?

In a similar fashion to question 1, the types of interfaces that will be used on a router over the next six to 12 months must be considered. Generally, interface prices tend to drop by one half every 18 months while the capacity quadruples. For example, a network may be currently using OC-3c ATM, but the router might be expected to work inside an OC-12c POS network in six months.

**3. Will my router be able to support forwarding table sizes in excess of 100,000 routes?**

A typical forwarding table within a core router in the Internet contains about 80,000 entries. The size of this table is increasing by about 20,000 entries per year. A router must be able to handle tables of at least this size, on every interface.

**4. Can I allow the performance of my network to degrade as the amount of data sent into my network increases?**

As pointed out previously, the performance of some routers degrades as the amount of data sent into the router increases. One must take a hard look at router performance capabilities, and ensure that the router can handle increasing traffic loads gracefully, and that it does not become a bottleneck within the network.

**5. Is network reliability a concern in my network? If so, how can I ensure that the performance of my router (and my network) will not degrade under network instability conditions?**

Routes advertised throughout the network can change at rates of up to 300 times per second. This high rate of route changes has been shown to cripple the packet forwarding performance of routers. It has also been shown that this behavior exacerbates the problem because overloaded routers are then unable to manage their route exchange conversations with other routers. The router appears as being “down” to its neighbor routers, which in turn results in an additional volume of routing information to flood through the network. Measurements made in Agilent’s labs have shown that many routers crash when subject to extreme route flap loads.

**RouterTester**

The Agilent RouterTester is the only product capable of measuring the performance of high-performance routers. By supporting up to 64 ports of OC-48c, RouterTester is able to advertise millions of routes into the router under test, and can then generate and analyze wire-speed packets over every interface while concurrently flapping routes on every port.

An investment in RouterTester is an investment in the future of your network - the ability to ensure the scalability and resiliency of today's routers to ensure the growth of the Internet into the future.



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### Agilent Technologies RouterTester

RouterTester provides true Internet-scale testing through realistic routing protocol support, multi-stream wire-speed traffic generation and real-time analysis, and multi-port scalability. RouterTester is set to grow as the testing needs of the carrier class router industry evolve to meet the challenges of scale and Quality of Service within the Internet.

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