THE TOLLY GROUP

No. 7286 July 1997

Ascend Communications

GRF 1600 and GRF 400

Comparative Forwarding Performance vs. Cisco 7513 RSP2 and RSP4

Test Summary

Ascend Communications commissioned The Tolly Group to compare the Fast Ethernet performance of its GRF™ 1600 and GRF 400 (version 1.3) to two models of the Cisco 7513 router (version 11.2(4)), using two versions of its routing engine, the Route Switch Processor (RSP) 2 and Cisco's latest, the RSP4. Testing was performed from April through July of 1997.

The Tolly Group determined aggregate throughput by sending streams of traffic through each device. Additional streams were added until the maximum throughput of each chassis was reached. Additionally, to approximate a more real-world routing scenario, The Tolly Group determined how both routers performed while forwarding IP packets to varying Class C IP destination addresses.

Results

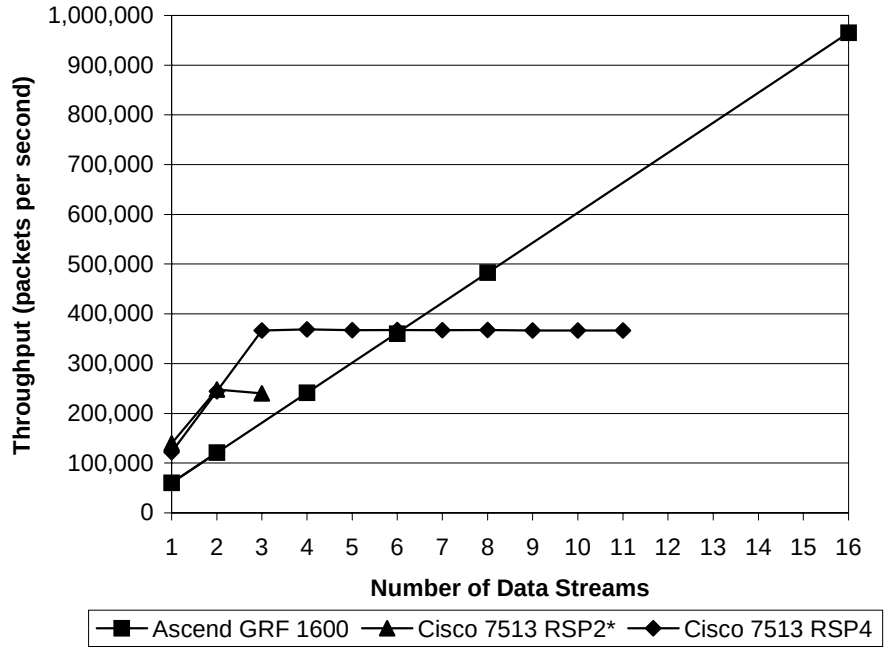
The results show that the aggregate throughput of the GRF 1600 was nearly triple (262%) the Cisco 7513/RSP4 processor, and 389% greater than the Cisco 7513/RSP2. Further, The Tolly Group found no significant degradation in performance of the GRF 1600 when routing packets to the same destination address or packets to varying IP addresses.

Performance of the 7513 was adversely affected when routing packets to varying destination IP addresses. The 7513's aggregate throughput (RSP4) dropped to nearly one fifth of its single-destination packet performance when forwarding frames to varying IP destinations.

As figure 1 illustrates, the aggregate throughput of the GRF 1600 reaches nearly

Test Highlights

- The Ascend GRF 1600 aggregate Fast Ethernet throughput is more than 262% that of the Cisco 7513 with RSP4.
- The GRF performance does not significantly degrade when forwarding packets to varying IP destination addresses.
- The GRF provides forwarding performance that scales linearly up to the full capacity of the chassis.
- The GRF 400 and GRF 1600 perform identically on a per module basis, up to the limit of the GRF 400 chassis capacity of 4 modules.(GRF 1600's capacity is 16 modules.)



* 7513/RSP2 was tested with FDDI interfaces. Since the rate of the modules was less than line rate for both FDDI and Fast Ethernet, it is The Tolly Group's opinion that the performance of Fast Ethernet would be similar.

Source: The Tolly Group, July 1997

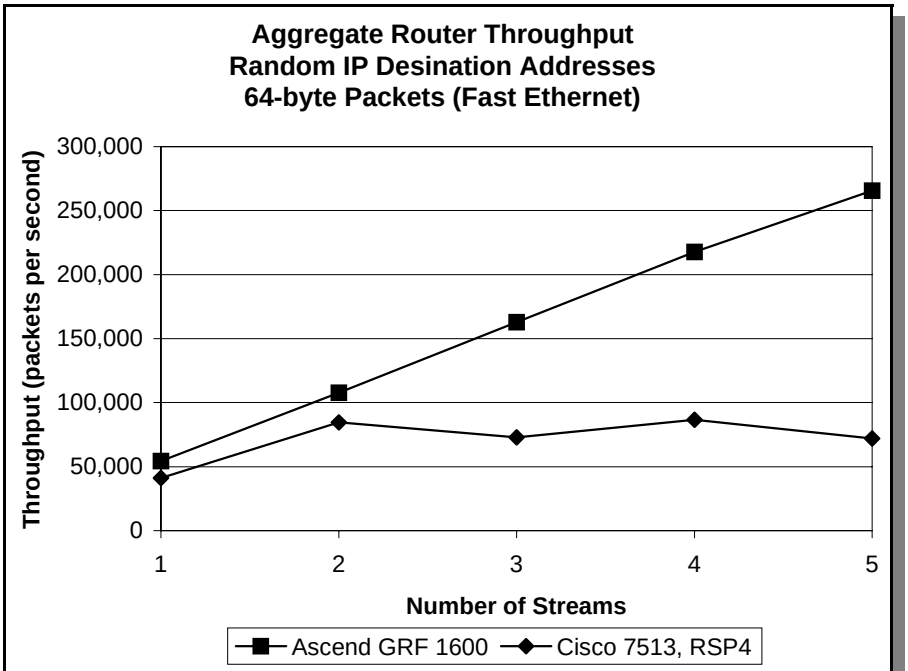
Figure 1

1,000,000 pps forwarding 16 streams of identical packets, with appropriate source and destination addresses for each stream. The Cisco 7513 RSP4 tops out at almost 400,000 forwarding 11 streams, the maximum number of streams and modules supported by the chassis.

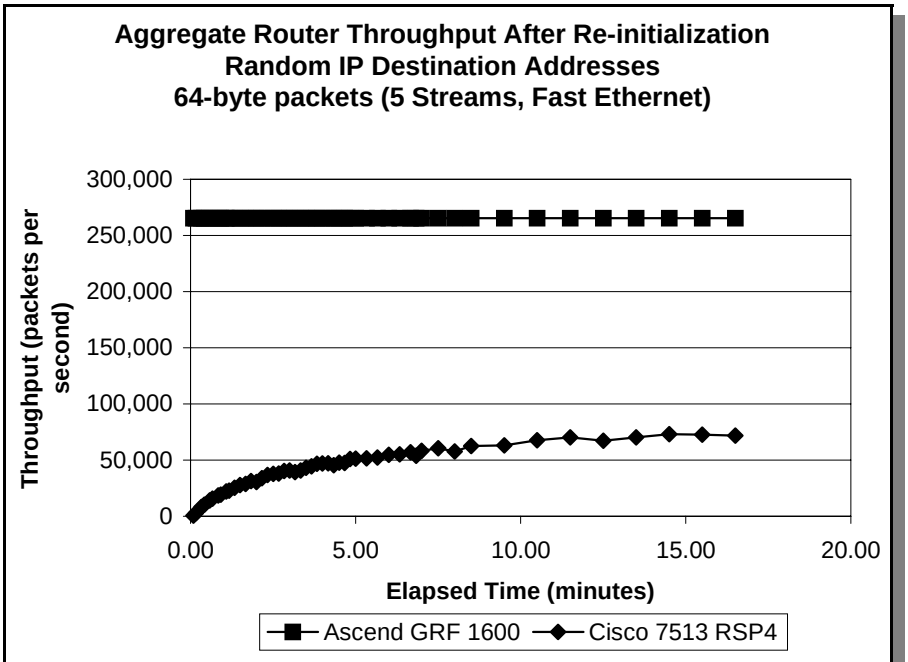
Each GRF module delivers roughly 60,338 pps per module and the system scales linearly from 60,388 pps at 1 stream, up to 965,424 pps at sixteen streams. The maximum aggregate throughput of the Cisco 7513 RSP4 is reached at only four streams. Its performance peaked at 368,515 pps with four streams, dropped to 367,390 pps with five streams, and remained under 368,000 pps with up to 11 streams (see figure 5 for throughput numbers for all data points). At all test points three streams or greater the 7513 reported CPU utilization of 100%.

The Tolly Group also tested the 7513 using the RSP2. The Route Switch Processor is the central CPU responsible for managing all routing tables, packet forwarding, dynamic routing, and system management for the 7513. Figure 1 includes throughput results for RSP2 with up to the three streams needed to illustrate the degradation of throughput. The performance of the 7513 using RSP2 peaks with two streams at 247,728 pps and 100% CPU, and drops to 240,536 pps with three streams.

In order to obtain the maximum throughput of each system, The Tolly Group first maximized the throughput for each module. Since this throughput (for both GRF and 7513) was less than line rate for Fast Ethernet, the greatest throughput of a module was attained with one stream passing through the module. Thus adding more than 16 streams to the GRF (more than 1 stream per module), would likely not have increased the aggregate throughput of the box. Each stream required 2-ports, an input port and an output port. For the GRF, two ports out of eight were used and for the 7513, two ports out of a possible two were used. All streams passed through each device's backplane.



Source: The Tolly Group, July 1997 *Figure 2*

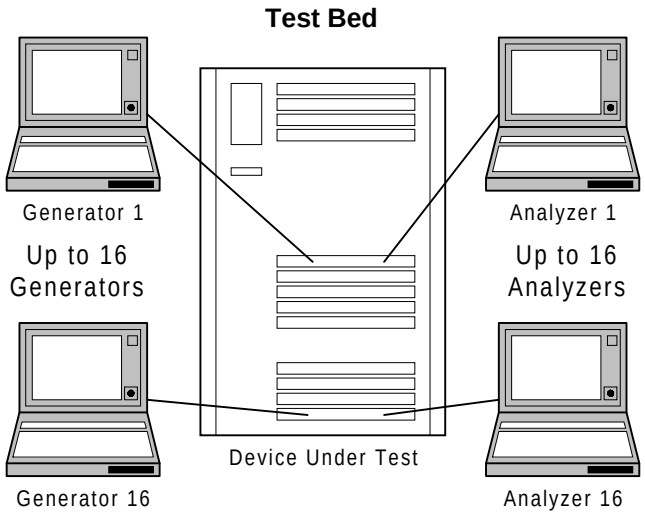


Source: The Tolly Group, July 1997 *Figure 3*

The Tolly Group also tested the GRF 400 with up to 4 modules, the maximum capacity of its chassis. Since the GRF 400 uses the same modules and CPU as the 1600, similar results are expected. Figure 5 contains numerical results for the 400, which are within 2% of the 1600 results.

Varying Destination Addresses

Since actual network environments contain traffic with packets to a variety of destinations and ever changing network configurations, The Tolly Group ran a subset of the aggregate throughput test, modifying packet content. The packets were modified to contain varying



Source: The Tolly Group, July 1997

Figure 4

Ascend Communications

GRF 1600 and GRF 400

Comparative Router Performance

THE TOLLY GROUP Up to Spec CERTIFIED

Ascend Communications
GRF 1600 and GRF 400
Product Specifications*

The GRF's architecture combines its Layer-3 switch with intelligent IP Forwarding Media cards to deliver scalable performance.

The GRF 1600 supports up to 16 media cards for up to 16 Gbit/s of bandwidth.

Available IP Forwarding Media Cards:

HSSI (2 ports per card), ATM OC-3c/STM-1 (2 ports per card), 10/100Base-T (4/8 ports per card), FDDI (4 ports per card), SONET OC-3c (PPP and Frame Relay; 1 port per card; supports an APS 1 + 1 Architecture Switching), ATM OC-12c/STM-4 (1 port per card), HIPPI (1 port per card)

Routing Protocol Support:

EGP, OSPF, BGP3/4, BGP4 extensions (Route Reflection, MEDs, Communities, DPAs, Flat Route Dampening, Weighted Route Dampening, Confederations, NextHop Self, Static Routing as an IGP), OSPF Multicast, IP Multicast, Integrated IS-IS

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**Vendor-supplied information not verified by The Tolly Group*

destination addresses more closely reflecting an actual network than packets to a single destination. Figure 2 illustrates the performance of the GRF 1600 and 7513/RSP4 under these conditions with up to five streams.

The GRF 1600 maintains aggregate throughput that scales linearly as in single-IP address tests. Throughput did not significantly degrade compared to the single-IP address tests for each number of streams tested. For one stream, throughput of the GRF was 54,454 pps, for two, 107,720 pps, and at five streams the throughput was 265,500 pps. The 7513 reaches 84,504 pps at two streams, peaks with 86,654 pps at four streams, and drops to 71,876 pps for the entire chassis at five streams, representing 19.6% of the single IP address throughput.

Furthermore, peak rates for the 7513 were realized after 15 minutes of system operation. Performance prior to the 15 minutes was significantly less than this peak rate. To quantify this performance, The Tolly Group conducted a second test with random IP destination addresses, measuring throughput from the time that each device began to forward packets after a device re-boot, until throughput reached a steady state.

Figure 3 illustrates that the GRF 1600 maintains constant throughput from the time it begins forwarding traffic throughout the almost 17 minutes of the test. Comparatively, the 7513 forwarded from 117 pps out of an offered 275,000 pps (the 7513's maximum with a single IP packet is 368,757 pps), leveling off at approximately 73,000 pps out of 275,000 pps after 15 minutes. This throughput approaches the 7513's maximum with random destination addresses of 86,654 pps. Please note that determining the profile of a typical network including traffic profiles and frequency of network re-configurations is beyond the scope of this test.

Test Methodology

The Tolly Group tested single destination IP throughput with up to sixteen streams for the GRF and up to eleven streams for the 7513. The Tolly Group repeated the throughput test up to five streams using random destination addresses. In the final test, The Tolly Group measured throughput over a 17 minute interval after a router reset.

For throughput tests, The Tolly Group first maximized the throughput for each module as mentioned above. A Netcom Smartbits analyzer was used to generate traffic. Four Wandel & Goltermann DA-30s were used to generate traffic and monitor output traffic. Throughput was determined by finding the no-loss throughput of each module: the output rate of each stream that was no more than 2% less than the input of each stream. Aggregate router throughput was calculated by adding the throughput of all streams. The packet size tested was 64-bytes.

Numerical Results for Figures 1 and 2
Aggregate Throughput (pps)

Number of modules	1	2	3	4	5	6	7	8	9	10	11	16
Cisco 7513 RSP4	122,300	244,520	366,516	368,575	367,390	367,774	367,302	367,426	366,493	366,726	366,772	Not Tested
Ascend GRF 1600	60,388	120,848	Not Tested	241,516	Not Tested	360,000	Not Tested	483,016	Not Tested	Not Tested	Not Tested	965,424
Cisco 7513 RSP2	139,332	247,728	240,536	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
Ascend GRF 400	59,731	119,348	Not Tested	236,776	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
Cisco 7513 RSP4, Random IP	41,096	84,504	72,762	86,654	71,867	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested
Ascend GRF 1600, Random IP	54,454	107,720	162,750	217,700	265,500	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested	Not Tested

Note: Only relevent data points were tested.
Source: The Tolly Group, July 1997

Figure 5

For the random destination address test, the above methodology was repeated, except that instead of single destination packets, The Tolly Group generated random Class C destination address packets within a range of 192.0.0.0 to 223.255.255.254. The input rate was held constant at roughly 55,000 pps per stream. Up to five random-address generators and five streams were used.

For the final test, The Tolly Group sent five streams from the random address generators to the router under test and measured the output from the time the router began forwarding frames until steady-state throughput was reached. Measurements were taken every 5 seconds for the first 5 minutes, every 10 seconds for the next 5 minutes, and every 30 seconds for the remaining 7 minutes.

The 7513 was tested with either RSP2 and FDDI interface processor (FIP) modules, or RSP4 and Versatile interface processor (VIP) 2-40 modules with Fast Ethernet interfaces. Both the GRF and 7513 were configured with static routes and dynamic routing protocols were disabled.

The Tolly Group gratefully acknowledges the provider of test equipment used in this project.

Vendor	Product	Web address
Wandel and Goltermann	DA-30	http://www.wg.com

About The Tolly Group

The Tolly Group provides strategic consulting, independent testing, and industry analysis. It offers a full range of services designed to furnish both vendor and end-user communities with authoritative, unbiased information. *Fortune* 1,000 companies look to The Tolly Group for vendor-independent assessments of critical corporate technologies. Leading manufacturers of computer and communications products engage The Tolly Group to test both pre-production and production equipment.

The Tolly Group is recognized worldwide for its expertise in assessing leading-edge technologies. By combining engineering-caliber test methodologies with informed interpretation, The Tolly Group consistently delivers meaningful analyses of technology solutions. The Tolly Group has published more than 100 product evaluations, network design features and columns in the industry's most prestigious publications.

Kevin Tolly is President and CEO of The Tolly Group. He is a leading industry analyst and is responsible for guiding the technology decisions of major vendor and end-user organizations. In his consulting work, Tolly has designed enterprise-wide networks for government agencies, banks, retailers, and manufacturers.

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